The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 70

February 21, 2023

by: Tessa DiTirro
Posted: Jun 7, 2018 / 07:39 PM EDT
Updated: Jun 8, 2018 / 03:44 PM EDT

A massive pipeline explosion in Marshall County shook homes and could be seen across state lines.

The TransCanada pipeline explosion Thursday morning was so powerful it shook

7News viewers' houses and could be seen for miles.

“Heard a big boom first, sky was all lit up back on here, I figured it was a gas line blow or a well went off, so I just went back to bed, listen to it roar,” said Shark Martin, Nixon Ridge resident.

Shark says he’s lived on the Ridge for 25 years.

Thursday morning’s explosion, which happened around 4:15 a.m., is one of the biggest he’s seen, but he says it still did not bother him.

“No sense getting excited about something if it’s up close to me than I take care of my own,” said Shark.

Hundreds of others in the area woke up alarmed by what they saw.

The pictures and videos from viewers spanned three states, Ohio, West Virginia and Pennsylvania. The explosion could be seen off of the interstate, from the mall, and even at the Pittsburgh Airport.

Marshall County EMA director Tom Hart said he could see the fire before he got on scene.

“From my residence, you could actually hear the roar from Cameron and you could see the glow in the sky,” said Hart.

The site of the 36-inch natural gas line rupture was under construction.

When TransCanada noticed a drop in pressure, they immediately shot off the line and started emergency procedures they had just practiced on Tuesday with first responders.

“This will be the eighth rupture that we’ve experienced in Marshall County since March of 2013,” said Hart.

West Virginia DEP examined what the explosion left behind — a crater and 10 acres of land burned and disturbed.

"I'm glad to see them in here as far as the economy, but you know I'd just like to see them have a little more respect for the locals, I mean, we have to live here," said Shark.

Hart said the residents in Marshall County are very resilient.

Local News

Morgantown mac and cheese cook-off

Morgantown mac and | Fayetteville man wins | Preston Memorial Hospital | Fir

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EXHIBIT 71

February 21, 2023

Landslide may be to blame for Beaver County explosion, pipeline owner says

Witnesses say the blast in Center Township sounded like a plane crash and caused the sky to erupt in an orange blaze.

Updated: 6:43 PM EDT Sep 11, 2018

Infinite Scroll Enabled

CENTER TOWNSHIP, Pa. — A methane gas explosion leveled one house and prompted the evacuation of about 30 other homes in Center Township, Beaver County, early Monday morning. Witnesses said the blast sent flames more than 100 feet into the air.

Dallas-based Energy Transfer, the company that owns the 24-inch pipeline, said an initial assessment of the site showed a landslide in the vicinity. An investigation was continuing Tuesday.

People living on Ivy Lane and Pine Street said they awoke to the flames and the loud explosion at 5 a.m. Monday.

"I got on the other side of my house and look out the window and the whole sky was in flames," Fortunato Luca said.

Other witnesses said the explosion sounded like a plane crash and caused the sky to erupt in an orange blaze.

"We were in bed, and it sounded like there was an 18-wheeler truck right outside our bedroom window, and the earth shook," Karen Kdula said. "Jumped out of bed, looked out and saw flames all the way into the sky, taller than the 150-foot pine trees that happened to be there in the neighborhood, and heard the hissing."

Tom Demarco saw the fire as close as someone in that area could. He lives next door and was home when the explosion that rocked his house. He captured the aftermath on camera (seen in the tweet below).

> CLOSE UP OF FIRE:
>
> Tom Demarco shared this video with @WTAE . He lives right next door to where the explosion happened. pic.twitter.com/2xxAHfI7Wj
>
> — Chris Lovingood WRAL (@LovingoodTV) September 10, 2018

"Mind-blowing," Demarco said. "Five o'clock in the morning, I heard the noise, I had the blinds drawn and all I could see were the flames."

Power lines were downed after the explosion caused a chain reaction, pulling down more towers and causing power lines above Interstate 376 to be lower than they should. About 1,500 people were left in the dark, and Bunker Hill Road was blocked.

> GAS EXPLOSION AFTERMATH: Here's video shared from the @AliquippaFFs about the gas line explosion in Center Township.
>
> We're expecting an update on when people can go back to their homes after being evacuated. A press conference is at 10 AM. pic.twitter.com/FVaTZj9viB
>
> — Chris Lovingood WRAL (@LovingoodTV) September 10, 2018

"Fortunately for all this rain that we've had, I think it helped prevent the spread of any kind of forest fire that would have burned at a much quicker rate," Center Township Police Chief Barry Kramer said.

Kramer expressed disappointment that the gas line was only in service for seven days before the explosion happened.

Center Township Fire Chief Bill Brucker said getting the evacuation underway wasn't easy.

"The heat was intense. The flames were intense," Brucker said. "Public safety is what was important, so we dealt with that, got the evacuation progressed, got people back."

Because of the downed power lines, the Central Valley School District canceled school Monday and I-376 was closed in both directions for some time.

"My house was vibrating," said Demarco. "I tried to call my neighbor, but he was already running up the driveway. I called 911 and the emergency people came and evacuated us."

Below is a statement from Energy Transfer to Pittsburgh's Action News 4:

The incident this morning was on a 24" natural gas gathering line in Beaver County, PA. There were no injuries and the area is secure. This incident, which occurred at approximately 5 am Eastern time was detected by our monitoring system, which triggered the closing of valves to isolate the line. By around 7 am, the fire on the pipeline had extinguished itself. There were evacuations from several homes in the area. Most of those evacuated have been allowed to return to their homes. All of the appropriate regulatory notifications have been made. An initial site assessment reveals evidence of a landslide in the vicinity of the pipeline. The line, which was being readied for service has been safely isolated and depressurized until a thorough investigation can be completed as our first priority continues to be on the safety of the community.

All evacuees from the explosion in Center Township were allowed to go back to their residences.

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EXHIBIT 72

February 21, 2023

The Columbus Dispatch

ENVIRONMENT

Investigation begins into Ohio pipeline explosion

GateHouse Media Ohio

Published 4:36 p.m. ET Jan. 22, 2019 | **Updated 5:07 a.m. ET Jan. 23, 2019**

SUMMERFIELD — The natural gas pipeline that exploded Monday in rural Noble County was part of the Texas Eastern Transmission system built in the early 1950s.

Enbridge Inc., the Canadian energy company that owns Texas Eastern Transmission, released a statement saying an internal inspection of the pipeline was performed in 2012 and "no remediation was needed."

The explosion and resulting fire injured one person, destroyed three homes and caused damage to three additional homes and the surrounding terrain, including Smithberger Road.

"It was a 30-inch line that has been in that location for several years," the Noble County Emergency Management Agency said in a news release. "United Ambulance treated and transported one injured resident from the scene to a local hospital where that resident received treatment for minor burns."

The Noble County Sheriff's Office responded to several reports received at approximately 10:40 a.m. Monday trying to narrow down the exact location as the Caldwell, Summerfield and Lewisville fire departments responded to the scene.

"The fire departments worked with companies in the area to identify the impacted line, and they spent several hours fighting secondary fires, including three homes," the Noble County EMA said. "They were able to clear the scene by approximately 5 p.m." No firefighters were injured.

The Noble County EMA and Office of Homeland Security contacted the families to ensure they had housing arrangements. The American Red Cross also was on standby to provide needed services for affected families.

The flames from a natural gas line explosion in Noble County Monday morning could be seen from miles away from the scene on Smithberger Road. *The Columbus Dispatch*

Investigation begins

Regulators and state-level emergency response teams will investigate the cause of the explosion, which was felt for miles around the scene.

A resident near Caldwell said pictures fell from a wall in her home.

"Our house shook so bad, things came off the walls," Trina Moore said. "It shook for about 15 seconds, but it felt like forever. All of the neighbors ran outside."

Scanner traffic from emergency responders in Noble County indicated the ground was shaking after the explosion.

Flames from the fire in the gas line were estimated to reach 80 feet high, according to a Noble County sheriff's sergeant.

Agencies expected to play roles include the Ohio Department of Natural Resources, Ohio Environmental Protection Agency, State Fire Marshal's Office and Public Utilities Commission of Ohio. PUCO acts as an agent for the federal Pipeline and Hazardous Materials Safety Administration, which has final jurisdiction over interstate pipelines.

Smithberger Road remained closed due to road damage and the need to secure the area for safety and continued assessment in the daylight. Motorists are asked to avoid the area.

Safety record

In a statement after the explosion, officials with Calgary-based Enbridge said, "Our first concern is for the safety of the community and our employees. We have activated our emergency response plan and are cooperating with authorities in our response. There was a fire, which has been contained, and residents within the proximity of the incident have been evacuated."

Texas Eastern Transmission comprises almost 9,100 miles of pipeline that connect Texas and the Gulf Coast to Ohio, the Northeast and Mid-Atlantic. Enbridge took ownership of Texas Eastern Transmission when it acquired Houston-based Spectra Energy in February 2017.

Enbridge said the pipeline section that exploded in Noble County was installed in 1952 and 1953. Other sections of the Texas Eastern Transmission system are newer.

Between 2010 and November of last year, the federal Pipeline and Hazardous Materials

Safety Administration logged 33 "significant" incidents on the Texas Eastern Transmission system. For PHMSA to classify an incident as "significant" it must have caused a death, an injury requiring hospitalization or at least $50,000 in costs, as measured in 1984 dollars.

Two incidents on the Texas Eastern Transmission system since 2010 have caused injuries requiring hospitalization.

In April 2012, a pipeline employee was injured during an incident at a compressor station in Marietta, Pa.

Four years later, a 30-inch pipeline installed in 1981 ruptured in Westmoreland County, Pa., causing an explosion and fire. One person was injured and 12 members of the general public were evacuated.

The 2016 incident cost $3.5 million, in current dollars, including property damage and the value of the released natural gas. An analysis of the steel pipeline showed corrosion, according to PHMSA.

Matt Hammond, executive vice president of the Ohio Oil and Gas Association, said in a statement, "Our thoughts and prayers are with the family during this difficult time. We are joining with industry partners to help the family and ensure their immediate needs are being met. We salute the first responders for their quick reaction and thank them for protecting human safety and the environment. The industry is waiting on the results of the pending investigation for the cause of this incident."

Industry opponents said they were concerned about pipeline safety.

"Enough is enough; it’s time that the Federal Energy Regulatory Commission and the state of Ohio put the health and safety of people before the corporate profits," said Teresa Mills of the Buckeye Environmental Network. "We also want to thank our first responders for taking on this deadly task for the second time this year."

Rick Stallion of the Daily-Jeffersonian and Shane Hoover of The Canton Repository contributed to this report.

Listen to the NewsCycle podcast:

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February 21, 2023

Kentucky Gas Pipeline Explosion ACE investigation

Maureen Orr, MS
Surveillance Team Lead, ATSDR

Outline

- **What was reported in the in the Lincoln County, Kentucky Pipeline explosion?**
- **How was ACE used to investigate and what was learned?**
- **What were the outcomes of the investigation?**

What was reported to ATSDR

- On August 1, 2019 around 1:30 AM a major natural gas pipeline in Lincoln County, Kentucky exploded and burned intensely until the gas could be shut off
- Several homes and structures were destroyed
- One woman trying to escape died and 6 people were taken to the hospital for treatment
- There were approximately 75 evacuees and 170 first responders to the incident

During the Incident

- Residents woke to a blast
- There was a loud hissing noise from the gas
- The sky was lit up like daylight
- People fled the area with their tires melting
- First responders evacuated a ½ mile radius

After the Incident

- An area of 30 acres was burned
- There was a large 30 foot crater
- Many people lost there home and belongings and were relocated to a nearby hotel

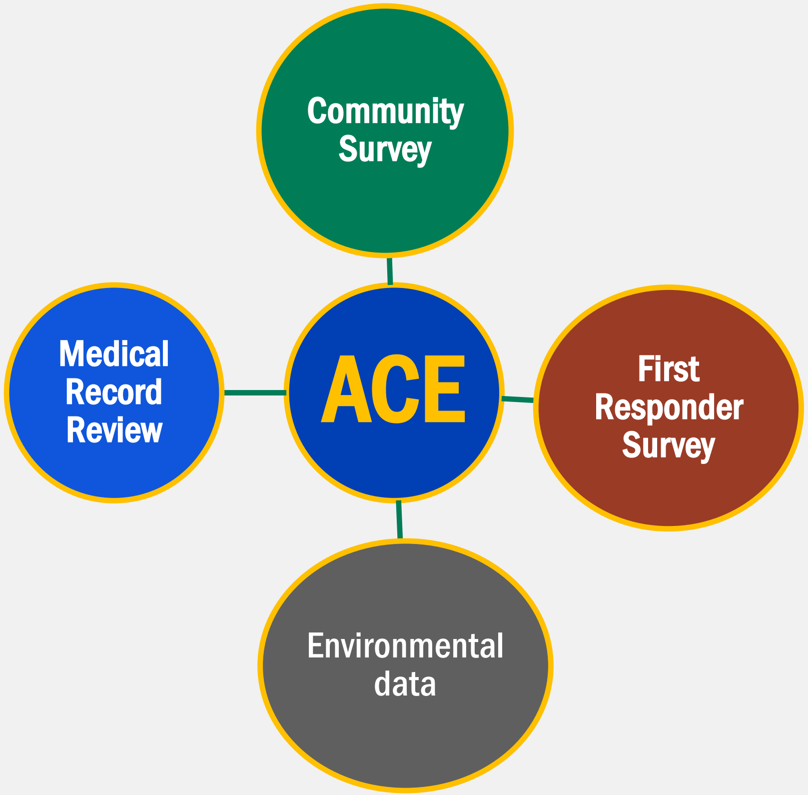
An ACE Epi Aid was requested

- **Kentucky Department of Public Health state epidemiologist requested an ACE Epi Aid September 3rd to**
  - describe the natural gas pipeline incident,
  - understand the potential health effects to the community,
  - support the local, state, and federal response,
  - and interpret the environmental data and recommend mitigation of any ongoing health exposures
- **An ACE team had a kickoff meeting with involved responding agencies to gather information and let them know our plans**

Potential Exposures the ACE Team Considered

- The heat and debris from the explosion and subsequent fires could cause injuries
- The hazardous emissions from the pipeline and fires may cause respiratory problems, skin or eye irritations, or other health complications, particularly if no personal protection
- Psychological trauma or PTSD symptoms may be common after an incident like this

ACE Toolkit Components Used



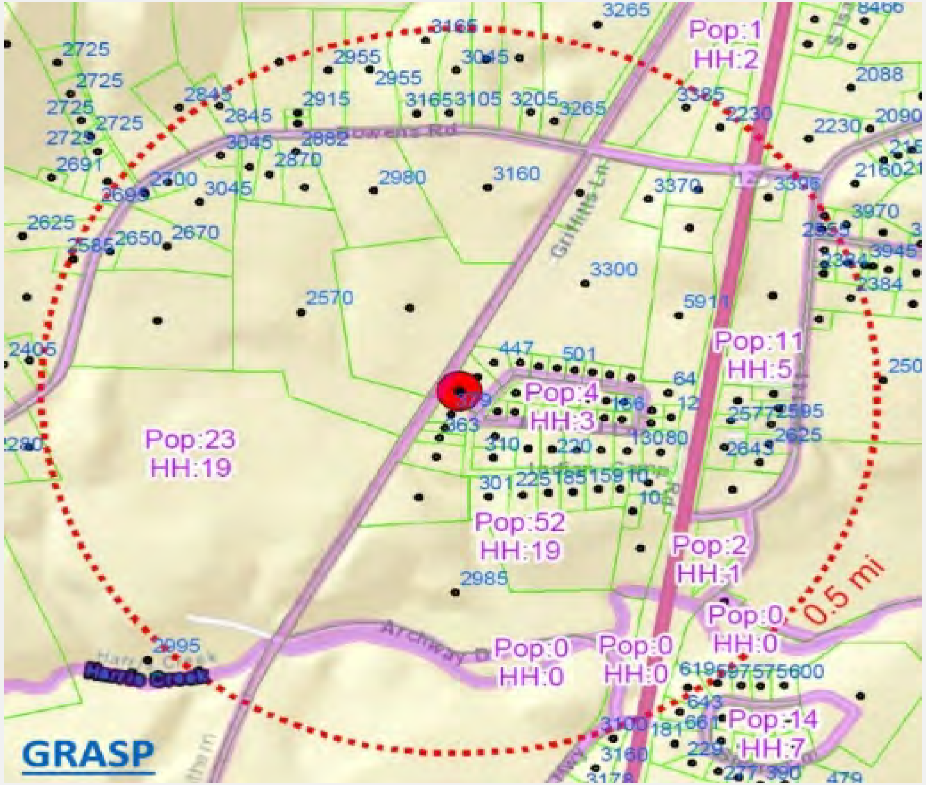
ACE Data Collection

- **Responder survey**
  - At the initial kickoff got a list of responders to the incidents and made arrangements to interview them at their stations.
  - Modified the General ACE survey to ask exposures, mental and physical health effects, personal protective equipment practices
  - Interviewed 105 of 173 responders beginning September 7
- **Environmental analysis**
  - ATSDR obtained and reviewed the soil, water and air data collected by the Pipeline's contractor looking at asbestos, particulate matter, volatiles and semi volatiles and compared it to reference values that would be most protective

ACE Data Collection

- **Community survey**
  - Sent out a news release so the community knew we were coming
  - Created a map for interviewers to locate households in a .5 mile radius
  - Modified the General ACE survey concerning exposures, mental and physical health effects, urgent needs and communication
  - Trained 23 volunteers to go door-to-door and to the hotels where people were relocated
  - Interviewed 106 adults and 14 child residents beginning September 9 for 2 weeks
- **Medical Chart Abstraction**-Obtained hospital records for the 16 people who said they were hospitalized and signed release forms-abstracted the data on the ACE medical chart form

Mapping of Households



Community Survey Results

- **Need to increase awareness about emergency procedures i.e.; sheltering in place, evacuation and communication**
- **Many people experiencing both physical (68.3%) and mental (64.2%) symptoms, but few going for care (35.8%and 13.3% respectively)**
- **Many people appreciated getting to talk to someone about the incident**

First Responder Survey Results

- **Many (43%) were not wearing personal protective equipment (PPE) despite saying they have access to it (89%)**
- **Many had physical (49.5%) or mental (26.7%) symptoms but few sought care (17.1% physical and 3.8% mental)**
- **Many of those who denied seeking healthcare for their symptoms were still experiencing symptoms (39%) at the time of interview**

Environmental Data Results

- **This was an open NTSB investigation and it was difficult for the health department to get the data**
- **The data had many limitations**
  - Collection was not begun until three days after the explosion
  - The area sampled was only the area closest to the explosion
- **ATSDR interpreted**
  - No concern for most people
  - PM in air could be a problem for people with preexisting condition
  - Consulted with ATSDR physician about potential fungal spore exposures and thought an isolated case

What were the outcomes of this investigation?

- Epi 2 report, CDC Connects, MMWR Notes from the field, first responder manuscript share lessons
- ACE formal agreement with GRASP for future incidents needing expertise in GIS
- ACE to update and expand the surveys to cover more hazards like explosions

What was the outcome of this investigation?

- **Recommended that emergency responders**
  - Examine the emergency communications plan to include community leaders, multiple jurisdictions, and agencies
  - Conduct tabletop exercises
  - Formalize mutual aid agreements to improve future responses
  - Require more training on PPE use
- **Interviewers left a variety of resources to distribute to responders and residents**
  - Mental health resources and fact sheets
  - How to address home and environmental contamination after fires

Recommendations for Similar Incidents

- **Have early contact with local community crisis response resources and the Substance Abuse and Mental Health Services Administration to provide and connect counseling services to affected persons**
- **Provide the community with healthcare and toxicology expertise and assessment resources (e.g., Pediatric Environmental Health Specialty Units)**

Thank you!

Epi Aid team Esther Kukielka (ATSDR/GRASP), Erin Blau (CSELS/KDPH), David Bui (NCEH/DEHSP), Lindsay Tompkins (NCEH/DEHSP), Maureen Orr (ATSDR/DTHHS/EHSB), Leann Bing (ATSDR/DCHI/CB), Charles Edge (ATSDR/OD), Renee Funk (ATSDR/OD), and Doug Thoroughman (CPR/DSLR).

Acknowledgments

Kater Riddle, Heather Walls, Brent Blevins, Lincoln County Department of Health, Boyle County Health Department, Kentucky Department for Public Health, and all volunteers who assisted with community interviews.

For more information, contact NCEH
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov
Follow us on Twitter @CDCEnvironment

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February 21, 2023

S&P Global
Market Intelligence

https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/enbridge-gas-pipeline-that-ruptured-in-kentucky-in-2020-had-weld-defects-68772731

Enbridge gas pipeline that ruptured in Kentucky in 2020 had weld defects

Federal safety investigators found defects in a weld connecting two sections of an Enbridge Inc. natural gas pipeline in Kentucky that ruptured in May 2020.

The fire caused by the accident on Line 10 of Enbridge's Texas Eastern Transmission LP did not cause any deaths, injuries or structural damage, but it burned part of a forest.

Enbridge estimated that the cost of the property damage and the emergency response was about $11.7 million, according to documents made public on Feb. 3 by the U.S. National Transportation Safety Board, or NTSB. The company had determined that the area was at risk because of geological conditions and had planned to remediate a portion of the pipeline system, although a site assessment team had concluded that the situation did not require urgent action.

The NTSB documents signaled that the defects at a Line 10 girth weld, which connected the sections of pipe along their circumference, could be a significant part of the ongoing investigation. The independent agency will develop a probable cause finding and issue safety recommendations to prevent or mitigate a similar accident.

Scope of review

The NTSB investigation has entailed a geohazard causation assessment and a review of Enbridge's program to manage geological hazards. The NTSB will also evaluate Enbridge's management of control and monitoring systems known as SCADA, conduct a metallurgical examination of the affected pipe and review another rupture along the line that occurred under similar circumstances.

The fire caused by the rupture on Texas Eastern Transmission LP's Line 10 did not cause any deaths or injuries but burned vegetation in a heavily forested area, the NTSB said.
Source: Kentucky Public Service Commission

The 30-inch-diameter section of Line 10 on the Texas Eastern system ruptured on the afternoon of May 4, 2020, near Hillsboro, Ky. The accident created a fire that burned vegetation over about five acres, released about 148 MMcf of natural gas and left a crater about 20 feet wide, according to the NTSB. The affected pipe was installed in 1952.

The rupture occurred at a girth weld about 100 miles from the site of an August 2019 explosion on Texas Eastern's Line 15 in Danville, Ky., that killed one person and injured five people.

Line 10 runs parallel to Line 15 on the same right of way. The NTSB has said the two incidents did not appear to be related.

Safety improvements by Enbridge

Enbridge told the NTSB it made a series of safety improvements after the Hillsboro accident and created a new framework "to implement a transformative approach to asset integrity by shifting its benchmarking away from peer companies and toward other industries with superior safety performance levels." Enbridge said it increased the number of runs with in-line inspection tools to assess pipeline integrity and revised its public awareness and emergency response programs.

The company also said it made several improvements to the way it monitors geohazards and analyzes risk.

In 2018, Enbridge had launched a geohazard management program to identify areas at risk of geological conditions such as landslides, sinkholes and earthquakes, the NTSB said. The company described the area that would become the site of the Line 10 rupture as an area of increased geohazard risk in October 2018, the NTSB previously said.

The new NTSB documents said an Enbridge contractor had reported peak movement of more than 4 feet and more than 5 feet in reports issued in July 2019 and September 2019, respectively. Enbridge planned to install strain gauges and drainage, the NTSB said. The company also planned to complete additional monitoring, mitigation and stress relief work in the summer of 2020, according to the NTSB.

The Texas Eastern system transports natural gas along 8,835 miles of pipe stretching between the U.S. Gulf Coast and the Northeast. Line 10 shuttles gas between Pennsylvania and Mississippi. It was flowing north to south at the time of the incident and operating at 657 pounds per square inch gauge, within its normal pressure range, according to the NTSB.

The NTSB has also looked at data on a rupture on Line 10 in Summerfield, Ohio, in January 2019. The U.S. Pipelines and Hazardous Materials Safety Administration traced that incident to "ground movement overstressing a girth weld to failure."

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EXHIBIT 75

February 21, 2023

PSE Bringing science to energy policy

Natural Gas Leaked from Interstate Pipelines Contains Hazardous Air Pollutants and Carcinogens

DATE
SEPTEMBER 20, 2022

AUTHOR
ADRIENNE UNDERWOOD

Natural Gas Leaked from Interstate Pipelines Contains Hazardous Air Pollutants and Carcinogens

FOR IMMEDIATE RELEASE: SEPTEMBER 20, 2022 AT 7:43 AM PT

Press Contact: Adrienne Underwood, adrienne@psehealthyenergy.org, 530-919-2164

OAKLAND, CA – Natural gas transported by interstate pipelines contains hazardous air pollutants and known human carcinogens, according to a first of its kind study published in *Environmental Research Letters* by researchers at the nonprofit research institute PSE Healthy Energy.

In the United States, interstate transmission pipelines that transport natural gas release significant quantities of unburned gas during routine operations and unintentional leaks (e.g., blowdowns and blowouts). In 2020 alone, the Environmental Protection Agency estimated that natural gas transmission infrastructure leaked over 1.4 million tons of methane—a potent greenhouse gas. Despite this, no previous analysis has evaluated whether the gas in this system contains hazardous air pollutants.

“Interstate natural gas pipelines are critical energy infrastructure that is normally off limits to researchers,” said the study’s leading author Curtis Nordgaard, an environmental health scientist at PSE Healthy Energy and a board-certified pediatrician. “This is the first study to investigate the chemicals moving through our nation’s vast natural gas transmission network. Our results indicate that there are surprising levels of harmful air pollutants and carcinogens, creating potential health risks if gas leaks into nearby communities.”

Using industry-reported data from infrastructure applications submitted to federal regulators, PSE scientists calculated the concentration of hazardous air pollutants in natural gas transmission pipelines. The researchers found BTEX (benzene, toluene, ethylbenzene, and xylenes) and hexane reported in nearly all filings that disclosed hazardous air pollutant data. Industry reports also included other health-damaging compounds, including mercury, the radioactive gas radon, and hydrogen sulfide. While concentrations of these chemicals varied, some were health-relevant. In the case of benzene, concentrations in transmission gas were reported as high as 299 parts per million, or 30,000 times the short-term exposure level considered low-risk by the California Environmental Protection Agency. Concentrations of benzene in condensate were much higher. Many of the chemicals reported in this pipeline gas are known to cause neurodevelopmental impairments, lung cancer, leukemia, and respiratory illness.

“We know that natural gas transmission infrastructure is responsible for methane emissions that damage the climate. This new study indicates that these leaks also contain chemicals that are dangerous for human health,” said PSE Healthy Energy Executive Director Seth B.C. Shonkoff. “Stopping natural gas leaks is critical for the climate and to protect the health of our communities.”

The researchers used industry-reported data from natural gas infrastructure expansion applications approved by the Federal Energy Regulatory Commission (FERC) between 2017-2020 and ongoing industry measurements reported for five interstate pipelines from December 2020 through June 2021. Because the industry is not strictly required to report the presence of hazardous air pollutants in expansion applications, over 50% of applications did not report any hazardous pollutant data. The pipelines evaluated represent 45% of all onshore natural gas transmission systems by mileage.

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About PSE Healthy Energy

PSE Healthy Energy is a nonprofit research institute dedicated to supplying evidence-based scientific and technical information on the public health, environmental, and climate dimensions of energy production and use. We are the only interdisciplinary collaboration focused specifically on health and sustainability at the intersection of energy science and policy. Visit us at psehealthyenergy.org and follow us on Twitter @PhySciEng.

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EXHIBIT 76

February 21, 2023

The Effects of Forest Management on Erosion and Soil Productivity

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Deborah Page-Dumroese — Research Soil Scientist
Peter R. Robichaud — Research Engineer
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An invited paper presented at the Symposium
on Soil Quality and Erosion Interaction
sponsored by
The Soil and Water Conservation Society of America
held at
Keystone, Colorado

July 7th, 1996

Currently under Review for inclusion in Proceedings

Introduction

For many years, research has been ongoing to relate soil erosion to productivity. Most research has focused on agricultural or rangeland conditions. Pierce (1991) presents an overview including over 60 references summarizing past research on impacts of erosion on agricultural production. He concluded that exact relationships between erosion and productivity are unclear, and considerable research is necessary over a wide range of soil and plant conditions to define any such relationship. Research on the effects of soil erosion on forest productivity is limited. This paper will provide an overview of current knowledge on the effects of forest management on soil erosion, and related onsite impacts, and the effects of those impacts on forest productivity.

Soil erosion in an undisturbed forest is extremely low, generally under 1 t ha^{-1} yr^{-1}. Disturbances, however, can dramatically increase soil erosion to levels exceeding 100 t ha^{-1} yr^{-1}. These disturbances include natural events such as wild fires and mass movements, and human-induced disturbances such as road construction and timber harvesting. Soil erosion, combined with other impacts from forest disturbance, such as soil compaction, can reduce forest sustainability and soil productivity. Research is ongoing to quantify the effects of disturbance on soil erosion and soil productivity.

Forest Practices

Soil erosion in forests generally follows a disturbance, such as road construction , logging operations, or fire. In undisturbed forests, erosion is generally due to epochal events associated with fire cycles, land slides, and geologic gully incision.

Ground cover by forest litter, duff and organic material is the most important component of the forest environment for protecting the mineral soil from erosion and provides most of the nutrients needed for sustainable forestry. Ground cover amounts can be reduced by the logging operation (harvesting and site preparation) and burning either by wildfire or prescribed fire. For example, skidder traffic on skid trails can reduce ground cover from 100 to 10-65 percent. Burning can reduce ground cover from 100 percent to 10-90 percent depending on the fire severity.

Roads

In most managed forest watersheds, most eroded sediment comes from roads. Roads have no vegetative protection, and tend to have low hydraulic conductivities leading to much greater runoff and erosion rates than in the surrounding forests (Elliot et al., 1994a). Numerous researchers, including Swift (1988) and Bilby et al. (1989), have quantified the major role of roads on sedimentation in forests. In addition to erosion, roads also reduce forest productivity by the land that they occupy. A kilometer of road in 1 km^2 of forest represents a 0.5 percent loss in area and removal from productivity. In some areas, forest roads can occupy up to 10 percent of the forest area if there is a past history of intensive logging. Roads are assumed to be unproductive in forest plans, regardless of any erosion impacts.

Currently, the USDA Forest Service has a major program to close roads. Closure methods can vary from locking a gate to completely removing the road prism in an effort to reduce sedimentation and related hydrologic problems. The productivity of closed or removed roads has not been directly measured, but frequently, additional mitigation measures such as ripping and replanting are included in any closure scenario to encourage maximum regrowth rates (Moll, 1996).

Timber Management

Traditionally, forest management practices focus on fire suppression and clear-cut logging methods. With an increased understanding of forest ecosystems, the USDA Forest Service is applying ecosystem management principles to forest management. These principles include partial cut management systems and increased use of prescribed fires. Such practices, however, require more frequent operations in the forest environment.

Harvesting Effects

Harvesting methods vary in degree of disturbance. On steeper slopes (generally > 35 percent slope) helicopter, skyline, or ground-cable logging systems are common. Trees are felled and removed with full suspension of logs via a helicopter or cable system and carried to landing sites. With a ground cable system, one end of the log is suspended and the other end is slid on the ground to a landing area. On less steep slopes (generally < 35 percent slope), wheeled or tracked forwarders or skidders remove felled trees. A forwarder loads and carries trees to a landing area in one operation, or a skidder drags the logs to the landing generally on designated skid trails. Skid trails cause the most disturbance by displacing the ground cover and compacting the mineral soil. Additional disturbance is caused by skidder tires loosening the soil, especially on slopes of 20-35 percent.

Even though timber harvest operations usually cause less erosion per unit area than roads, the area of timber harvest is usually large relative to roads so that the total erosion from timber harvest operations may approach that from roads (Megahan 1986). Tree cutting by itself does not cause significant erosion, although the resulting decrease in evapotranspiration contributes to increased subsurface flow, streamflow and channel erosion. However, soil disturbance caused by the harvesting operation results in reduced infiltration capacities and increased surface runoff which promotes surface erosion (Yoho 1980). Accelerated erosion caused by timber harvesting activity may result in deterioration of soil physical properties, nutrient loss, and degraded stream water quality from sediment, herbicides and plant nutrient inputs. (Douglas and Goodwin 1980).

Nutrient Impacts

Harvesting trees removes nutrients from a generally nutrient deficient environment (Miller et al., 1989). Table 1 shows the effect of tree harvest on nitrogen availability. Increasing harvest intensity from bole only through whole tree and complete biomass harvesting doubled nitrogen loss on the average quality site, but more than tripled loss at the poor quality site. Leaching losses are also greater on the poorer site. Researchers generally agree that harvesting the bole only will not greatly deplete nutrient reserves, but shorter rotations and whole tree harvesting removes more nutrients than can be replaced in a rotation. Harvesting crowns is undesirable because they contain a large portion of the stand nutrient content.

Fire Effects

The most common method of site preparation in the U.S. is prescribed burning. Although mechanical methods are commonly used in southern forests to physically destroy or remove unwanted vegetation from the site and to facilitate machine planting. Burning is conducted alone, and in combination with other treatments, to dispose of slash, reduce the risk of insects and fire hazards, prepare seedbeds, and suppress plant competition for natural and artificial regeneration. Current research is finding that fire helps maintain forest health. Fire has long been a natural component of forests ecosystems (Agee 1993). The use of prescribed fire will increase as ecosystem management strategies include a greater use of fire, and fewer clearcuts, and more partial cuts.

Erosion following fires can vary from extensive to minimal, depending on the fire severity and areal extent (Robichaud and Waldrop, 1994). Fire severity refers to the effect of the fire on some component of the forest ecosystem, such as nutrient loss or amount of organic material consumed (litter and duff). Erosion from high severity fires can be cover large areas.

and. fires may create hydrophobic or water repellent conditions. Erosion from low severity fires may be minimal to none (Robichaud et al. 1993b; Robichaud and Waldrop 1994).

Erosion Modeling

Since the late 1950s, soil erosion models have provided natural resource managers with tools to predict the impacts of management practices on soil erosion. Earlier models tended to focus on midwest and southeast agricultural conditions where erosion was considered to be a severe problem associated with farming practices. Models for range lands and forest lands have only recently been receiving wide-spread interest as managers have begun to focus as much on off-site sediment impacts as on onsite erosion rates.

Sediment Yield Models

Most of the early models, which culminated in the Universal Soil Loss Equation (USLE), focused on upland soil erosion rates (Wischmeier and Smith, 1978). The USLE was developed to predict soil erosion from small, relatively homogenous plots (Mutchler et al., 1994). Forest environments tend to have much greater spatial variability in vegetation and soils (Elliot et al., 1996), making the application of the USLE difficult. Dissmeyer and Foster (1985) developed a subfactor approach to predict soil erosion from forest conditions for areas where intensive operations such as tillage are carried out, and harvest areas can be considered similar to intensively managed farming systems. The erosion-productivity impact calculator (EPIC) model was developed to apply the USLE prediction technology to long-term productivity impact predictions (Williams et al., 1984). The EPIC model, however, was developed for applications to croplands only.

Forest service specialists have developed watershed models to aid in predicting the cumulative effects of road and harvest area erosion on stream sedimentation (like WATSED, Range, Air, Watershed and Ecology Staff Unit, 1991). The strength of these models is in allowing assessment of cumulative effects on stream sedimentation in a large watershed. WATSED, however, was not developed to predict site-specific effects.

More recent physically-based soil erosion models, including the Chemicals Runoff and Erosion from Agricultural Management Systems (CREAMS) model (Knisel, 1980) and the Water Erosion Prediction Project (WEPP) model (Laflen et al., 1991) have also provided estimates of sedimentation for predicting both onsite and offsite impacts. The WEPP model, in particular, has shown considerable promise as a tool to assist in predicting soil erosion and sediment yields in a forest environment (Elliot et al., 1996).

The physically-based WEPP model allows predicting upland erosion and offsite effects from erosion events influenced by management activities (Laflen et al., 1991). Erodibility values have been measured on forest roads and disturbed harvest areas, and validation activities with the WEPP model for forests have been encouraging (Elliot et al., 1994). The WEPP model not only predicts erosion, but also predicts the textural and organic composition of the eroded sediment.

Productivity Response to Management

A coordinated national research effort is being implemented on a broad spectrum of benchmark sites across the nation (Powers et al., 1990). These sites were relatively undisturbed prior to study installation. An extensive range of pre- and post-harvest measurements are being taken. This study alters site organic matter and total soil porosity over a range of intensities encompassing a range of possible management scenarios and creates a network of comparable experiments producing nil to severe soil disturbance and physiological stress in vegetation over a broad range of soils and climates. Establishing and monitoring this network directly addresses the needs of National Forest Systems, and creates a research opportunity of unusual scope and significance. Early results indicate that immediate post-harvest biomass declines are most likely caused by compaction and not organic matter removal whereas long-term productivity changes will be more dependent on organic matter losses.

Erosion Loss

The close tie between surface organic matter and forest soil productivity is clear (Jurgensen et al., 1996). As a rooting medium for higher plants, soils provide the essentials of water, structural support, nutrients, and soil biota. Mixing and/or short-distance displacement of topsoil and surface organic matter from a site can decrease productivity. Soil disturbance by logging is generally less than 30% of the total harvested area (Rice et al., 1972; Miller and Sirois 1986), but the impact can be severe. Erosion can further damage site productivity. First, erosion reduces crop productivity mainly by decreasing the soil water availability; this is a result of changing the water holding capacity and thickness of the root zone (Swanson et al. 1989). Second, erosion also removes plant available nutrients. Fertilizer applications can partly offset these losses, but they greatly increase costs and are uncommon. Third, erosion reduces productivity by degrading soil structure. Removal of the loose, organic surface materials promotes surface sealing and crusting which decreases infiltration capacity and may increase erosion (Childs et al. 1989). Fourth, erosion results in loss of important soil biota, such as mycorrhizal fungi, which facilitate nutrient uptake by plants (Amaranthus et al., 1989, 1996).

Surface erosion proceeds downward from the O horizons. Because the highest concentrations of nutrients and biota and the maximum water-holding capacity are in the uppermost soil horizons, incremental removals of soil nearer the surface are more damaging than those of subsoils. Productivity may inevitably decline on most shallow forest soils as erosion causes root-restricting layers to be nearer the surface and as organic matter is washed away. Consequently, the largest declines in productivity are most likely to occur in marginal, dry environments.

Assessing the effects of erosion on site productivity is often difficult. Erosion rates are poor indicators of loss in productivity because most soil is redistributed within a watershed and not necessarily lost to production. Soils differ in their tolerance to erosion loss. For instance, Andisols have relatively high water-holding capacity and natural fertility. Erosion may be severe on these sites, but productivity may decline little. In contrast, Spodosols frequently lose productivity because they are commonly highly leached and naturally infertile, they retain fertilizers poorly, and have low water-holding capacity.

Compaction Impacts

Field research has also found that timber harvesting systems tend to compact the soil. Compaction increases soil erosion, and adversely impacts forest productivity. Most erosion comes from skid trails on timber harvested units (Robichaud et al. 1993b). This is due to the low infiltration rates and disturbance to the organic layer.

Compaction of forest soil is a serious concern for managers because of the use of heavy equipment to harvest timber and prepare a site for planting. Usually, the more porous the soil initially, the greater the compaction depth. For example, volcanic ash soils of the western U.S. are highly productive in their undisturbed condition, but are prone to compaction because they have a low volume weight (weight-to-volume ratio) and relatively few coarse fragments (Geist and Cochran 1991). Once these sites have been disturbed through timber harvest activities and site preparation, porosity (Dickerson 1976) and hydraulic conductivity declines (Gent et al., 1984). Compaction depth can exceed 450 mm (Page-Dumroese 1996).

Compaction is a reduction in total porosity. Macro porosity is reduced while micro porosity increases as large pores are compacted into smaller ones. An increase in micro porosity can lead to greater available water-holding capacity throughout a site, but this increase is usually at the expense of aeration and drainage (Incerti et al., 1987).

There is little doubt that compaction reduces productivity (Greacen and Sands 1980; Froehlich and McNabb 1984). Reduction in root growth, height, and timber volume have been observed (Froehlich and McNabb 1984) and may be produced by a single pass of logging equipment across a site (Wronski 1984). Productivity losses have been documented for whole sites (Wert and Thomas 1981) and for individual trees (Froehlich 1979; Helms and Hipkin, 1986). Decreases in important microbial populations have been observed in compacted soils (Amaranthus et al., 1996). In general, however, the environmental degradation observed in the field result from both compaction and disturbance or removal of surface organic horizons (Childs et al., 1989).

Soil compaction may also increase surface runoff because of reduced infiltration (Greacen and Sands 1980). However, because of increased soil strength, compacted soils may have lower erodibility, and consequently suffer less erosion for the same amount of runoff (Liew 1974). A significant amount of erosion after harvest activities has been attributed to compaction, but may be attributable to both compaction and the removal of vegetative cover (Dickerson 1976).

Predicted Erosion Rates and Productivity

A series of WEPP runs were carried out on a productivity study site in central Idaho to allow comparison of a range of management effects on soil erosion. The predicted effects on erosion from wildfires were compared to prescribed fires, partial cuts, and clear cuts to better understand the interactions among natural events, human activities, soil erosion, soil productivity, and ultimately forest ecosystem sustainability.

Harvesting Impacts

For the modeling study, a slope length of 100 m, with a steepness of 61 percent was modeled, typical of the site Soil properties of the site are presented in Table 2. The WEPP management file described a forest in the first year, a disturbance in the second year, and regeneration of forest in eight subsequent years as described by Elliot et al. (1996). The biomass reduction due to harvest effects was described in the residue management and harvest index (harvest index = biomass removed/biomass present) values in the management files. The values assumed are presented in Table 3. The climate for the simulations was stochastically generated with the CLIGEN generator (Flanagan and Livingston, 1995) using the Deadwood Dam, ID climate statistics (mean annual precipitation = 830 mm).

Tables 4 and 5 present the predicted runoff and erosion rates for different treatments. Continuing field research will collect field data from the productivity treatments. The WEPP predictions are generally logical. More compaction leads to greater runoff and greater erosion. The effect of removing greater amounts of vegetation also leads to greater erosion rates. The complete removal of biomass was modeled as removing 100 percent of the surface residue, which resulted in a small increase in runoff, but a doubling of erosion rates. The role of surface residue is critical in controlling erosion in forests just as it is in agriculture.

An additional WEPP run was made with no disturbance. In this scenario, there was no runoff and no erosion. With the amount of residue cover and litter accumulation typical of forests, WEPP seldom predicts erosion. Our field observations generally confirm this, with most sediment from undisturbed watersheds coming from eroding ephemeral channels or landslides.

In order to compare the productivity impacts of soil erosion, an estimation was made of the nitrogen losses associated with the above erosion rates. It was assumed that the typical forest soil contains 4 percent organic matter, and that organic matter is 2 percent nitrogen. The resulting nitrogen losses for 8 years of predicted erosion are presented in Table 6. The values in Table 6 can be compared to Table 1 to see that nutrient losses due to erosion are significant, greater than observed leaching losses, but not as great as losses due to vegetation removal. In a generally nutrient-deficient environment, these nitrogen losses will have a significant impact on future productivity.

Natural Fire Impacts

To model a severe fire, 100 percent of the residue was burned, and half of the remaining biomass was harvested in the autumn. This is generally much more severe than observed in the field, but allows comparison of the extreme events. Generally, even "severe" fires do not remove more than 90 to 95 percent of the residue, and the remaining residue can reduce the predicted erosion rates by more than 90 percent. If the soil hydraulic conductivity remained unchanged, there was little change in either runoff or erosion from the values predicted for the severe compaction, bole removal treatment. If the hydraulic conductivity was reduced to 4 mm/hr to reflect hydrophobic soil conditions that sometimes occurs after severe fires, then the predicted runoff was doubled to 65 mm per year. The predicted erosion was 11.6 t ha^{-1}, greater than the bole and crown removal treatments, but still somewhat less than the predicted rates on sites with complete biomass removal. As the soil hydrologically recovers following a severe fire, the runoff and erosion rates would decline, a characteristic that WEPP is currently not capable of modeling continuously. Such a scenario could be developed with a series of one-year runs with a different conductivity for each year.

Summary/Conclusions

We have presented an overview of the impacts of forest management activities on soil erosion and productivity. Erosion alone is seldom the cause of greatly reduced site productivity. However, erosion in combination with other site factors, work to degrade productivity on the scale of decades and centuries. Extreme disturbances, such as wildfire or tractor logging, cause the loss of nutrients, mycorrhizae, and organic matter. These combined losses reduce long-term site productivity and may lead to sustained periods of extended erosion which could exacerbate degradation.

From a management perspective, we should be concerned with harvesting impacts, site preparation disturbances, amount of tree that is removed, and the accumulation of fuel from fire suppression. On erosion-sensitive sites, we need to carefully evaluate such management factors.

Prescribed fire is generally an excellent tool in preparing sites for regeneration, for reducing fuel loads, and for returning sites to a more natural condition. Burning conducted under correct conditions will reduce the fire hazard, make planting easier, and retain the lower duff material to protect the mineral soil and conserve nutrients to sustain forest productivity.

The WEPP model can describe various impacts due to harvesting, but further work is required to model fire effects and the subsequent temporal and spatial variation in soil hydraulic conductivity and ground cover effects. From field observations and the modeling exercise, it appears that disturbances caused by harvest activities will lead to increases in erosion and runoff rates, much greater than natural conditions, even when extreme wild fire effects are considered.

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Table 1	Comparison of height, diameter, and nitrogen pools after harvest treatments of varying intensities from two sites of differing site quality, Pack Forest, WA[1]

Harvest treatment	Height growth (m)	Diameter growth (cm)	Total N	Harvest loss	3-yr leaching loss	% loss
			- - - - - - - - - - - - kg/ha	- -- - - - - - - -		
Average site quality						
Bole only	1.7	2.9	2,935	470	4.4	16
Whole tree	1.9	3.2	2,827	678	0.5	24
Complete[2]	1.8	3.6	2,719	870	0.7	32
Poor site quality						
Bole only	1.4	2.2	984	157	2.1	16
Whole tree	1.1	1.6	903	289	4.7	32
Complete[2]	1.1	1.5	934	486	5.5	53

[1] From Miller et al. 1989.

[2]Complete removal of all above ground biomass.

Table 2.	Soil properties assumed for the WEPP model computer simulations

Soil Property	Value	Units
Sand content	40	percent
Silt content	45	percent
Clay content	15	percent
Interrill erodibility	2100	kg s m^{-4}
Rill erodibility	0.008	s m^{-1}
Critical shear	3	Pa
Saturated hydraulic conductivity		
uncompacted	20	mm hr^{-1}
moderate compaction	15	mm hr^{-1}
severe compaction	8	mm hr^{-1}

Table 3. Values describing the effects of timber harvest in the WEPP model computer simulations

Treatment	Residue Management	Harvest Index
Complete biomass removal	100 percent surface residue removed	0.9
Bole and crown removed	No surface residue removed	0.8
Bole only removed	No residue management	0.4

Table 4. Average annual runoff (mm) from rainfall from the WEPP simulations for five simulated forest conditions

	Compaction		
Treatment	None	Moderate	Severe
	-	- - - mm - - -	-
Undisturbed	0.0	--	--
Complete biomass removal	12.8	18.8	35.6
Bole & Crown removed	9.2	15.4	32.4
Bole only removed	9.1	16.1	32.7
Severe wild fire	65.0	--	--

Table 5. Average annual soil loss (t ha^{-1}) from the WEPP simulations for five simulated forest conditions

Treatment	Compaction		
	None	Moderate	Severe
	-	- - - t ha^{-1}- -	-
Undisturbed	0.0	--	--
Complete biomass removal	4.5	7.4	14.4
Bole & crown removed	2.0	3.3	7.2
Bole only removed	2.0	3.5	7.2
Severe wild fire	11.6	--	--

Table 6. Predicted nitrogen loss due to erosion in the first 8 years of regrowth following harvest

Treatment	Compaction		
	None	Moderate	Severe
		- - kg ha^{-1}- -	
Undisturbed	0.0	--	--
Complete biomass removal	28.8	47.4	92.2
Bole & crown removed	12.8	21.1	46.1
Bole only removed	12.8	22.4	46.1
Severe wild fire	74.2	--	--

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EXHIBIT 77

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ADVANCING EARTH AND SPACE SCIENCE

GeoHealth

RESEARCH ARTICLE

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Natural Gas Gathering and Transmission Pipelines and Social Vulnerability in the United States

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Key Points:

- Natural gas gathering and transmission pipelines in the US tend to be concentrated in counties with high social vulnerability
- Negative impacts associated with pipelines fall disproportionately on communities with limited capacity to deal with the impacts
- Decision-makers who plan and permit pipelines should consider whether new projects maintain the inequitable status quo

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Abstract Midstream oil and gas infrastructure comprises vast networks of gathering and transmission pipelines that connect upstream extraction to downstream consumption. In the United States (US), public policies and corporate decisions have prompted a wave of proposals for new gathering and transmission pipelines in recent years, raising the question: Who bears the burdens associated with the existing pipeline infrastructure in the US? With this in mind, we examined the density of natural gas gathering and transmission pipelines in the US, together with county-level data on social vulnerability. For the 2,261 US counties containing natural gas pipelines, we found a positive correlation between county-level pipeline density and an index of social vulnerability. In general, counties with more socially vulnerable populations have significantly higher pipeline densities than counties with less socially vulnerable populations. In particular, counties in the top quartile of social vulnerability tend to have pipeline densities that are much higher than pipeline densities for counties in the bottom quartile of social vulnerability. The difference grows larger for counties at the upper extremes of pipeline density within each group. We discuss some of the implications for the indigenous communities and others affected by recent expansions of oil and gas infrastructure. We offer recommendations aimed at improving ways in which decision-makers identify and address the societal impacts and environmental justice implications of midstream pipeline infrastructure.

Plain Language Summary Recent years have seen a wave of oil and gas development in the United States (US) and elsewhere. Research on human health and other societal impacts of oil and gas focus mainly on upstream activities, such as hydraulic fracturing, and on downstream activities, such as refining and electricity production. Gathering and transmission pipelines, which connect upstream and downstream parts of the supply chain, also have negative impacts, but receive less attention than other areas. No prior research has determined whether the negative impacts of gathering and transmission pipelines fall equitably across society. We analyzed publicly available data sets and found that the existing network of natural gas pipelines in the US is concentrated more heavily in counties where people experience high levels of social vulnerability than in counties where social vulnerability is low. These results have implications for environmental justice, which is concerned, in part, with how environmental burdens are distributed throughout the society. We highlight some of the burdens faced by indigenous peoples and others who are impacted by the ongoing pipeline development. Our work reiterates a need for researchers and decision-makers to look closely at these impacts, especially in light of environmental justice policies, to understand the broader societal costs of oil and gas infrastructure.

1. Introduction

Energy policy in the United States (US) shifted in the recent years from a focus on energy independence toward so-called energy dominance (The White House, 2019). The policy shift coincided with major investments in pipelines and other infrastructure to support the ongoing extraction and consumption of oil and gas (US Energy Information Administration, 2019a, 2019b). Even as the US policy begins to shift away from fossil fuels, analysts within the federal government project that oil and gas will continue to supply most of the energy consumed in the US for decades to come (US Energy Information Administration, 2021). The expansion of oil and gas infrastructure to support high levels of consumption will increase greenhouse gas emissions (Kalen & Hsu, 2020; Pascaris & Pearce, 2020), and climate change associated with these emissions will have long-term implications for the health of people and ecosystems worldwide (IPCC, 2018).

Besides, the indirect impacts associated with climate change and oil and gas infrastructure pose direct risks to nearby communities. At both upstream and downstream ends of the oil and gas supply chains, communities experience environmental degradation and incur a wide range of health and safety risks associated with phenomena, such as hydraulic fracturing, directional drilling, worker encampments (i.e., "man camps"), refining, electricity production, and more (Bullard, 2018; Colborn et al., 2014; Davies, 2019; Kroepsch et al., 2019; Olmstead et al., 2013; O'Rourke & Connolly, 2003; Rahm et al., 2015; Whyte, 2017).

Compared to the upstream and downstream regions of the oil and gas supply chains, the middle sections have received less attention from researchers who study the environmental and societal impacts of oil and gas. The so-called midstream infrastructure includes vast networks of gathering and transmission pipelines, pumps, compressors, and storage facilities that link production areas upstream to the downstream oil and gas processing and consumption sites. In the case of unconventional natural gas, which includes shale gas and coal bed methane, a review by Buse et al. (2019) highlights the research gap, especially as it pertains to socioeconomic and health impacts associated with midstream infrastructure. Strube et al. (2021) summarize a few of these impacts, including spills, explosions, and landslides, but the authors emphasize the difficulty in assessing risks due to confidentiality and security concerns that limit the public availability of data about pipelines.

The recent boom in unconventional oil and gas extraction from shale plays in the US (US Energy Information Administration, 2019a, 2019b; Vengosh et al., 2014) has been accompanied by a wave of proposals for major gathering and transmission pipelines to transport oil and gas to downstream consumers (Strube et al., 2021; Wang & Krupnick, 2015; Waxman et al., 2020). Some of these pipelines have already been built and put into service (e.g., Dakota Access Pipeline). Others are still in the planning or construction phases (e.g., Mountain Valley and Keystone XL Pipelines). A small number of them have been canceled altogether (e.g., Atlantic Coast and Northern Gateway Pipelines).

The pace of the US pipeline development signals an urgent need for research about health, socioeconomics, and other impacts associated with pipelines and other midstream infrastructure. In particular, there is a pressing need to understand the extent to which large-scale (e.g., regional or national) distribution of midstream pipelines may create or exacerbate societal inequities in environmental degradation, exposure to health risks, and other harms. Although individual pipeline projects can place disproportionately high and adverse burdens on racially marginalized and low-wealth communities relative to reference populations in the regions surrounding these projects (e.g., Emanuel, 2017; Emanuel & Wilkins, 2020; Whyte, 2017; Wraight et al., 2018), there is no research on social inequities associated with the geographic distribution of the networks comprising many different pipeline projects.

Inequities in the siting of harmful or polluting infrastructure spurred the modern environmental justice (EJ) movement and led to the development of EJ policies in the US. The US Environmental Protection Agency defines EJ as the fair treatment and meaningful involvement of all people in the environmental decision-making process (US Environmental Protection Agency, 2014). Environmental justice policies in the US aspire to identify disparities in the distribution of environmental burdens and amenities, to address the disparate impacts in various ways, and to remove barriers to participation in environmental decision-making by marginalized peoples (Bullard, 1993, 2018; Emanuel, 2017; Holifield et al., 2017; Johnson, 2019; Mohai et al., 2009; National Environmental Justice Advisory Council, 2000; Schlosberg & Collins, 2014; Whyte, 2011). Agencies within the US government are required by the federal executive order to evaluate potential disparities and EJ implications of their regulatory actions, including the authorization of new pipeline projects. However, there has never been an effort to examine EJ implications of the larger networks to which individual pipeline projects typically belong. The practice of evaluating EJ on a pipeline-by-pipeline basis makes it difficult to determine whether a new pipeline could exacerbate or alleviate network-wide disparities in the distribution of environmental and public health impacts. By considering the EJ implications of an entire pipeline network, decision-makers, researchers, and others can gain a fuller understanding of the societal impacts of the oil and gas flowing through the network.

To this end, we examined the US natural gas gathering and transmission pipeline network to determine whether the network, as a whole, raises system-wide concerns about EJ. Specifically, we compared the density of natural gas gathering and transmission pipelines to social vulnerability on a county-by-county basis for all the pipeline-containing counties in the US. Social vulnerability is an integrated measure of a community's capacity to prepare for, deal with, and recover from pollution, natural disasters, and other hazards (Chakraborty et al., 2020; Flanagan et al., 2018). It takes into account demographic details about a community (e.g., racial composition, age distribution) and other socioeconomic information (Flanagan et al., 2018). Thus, it is a relevant index for evaluating societal disparities in the siting of hazardous or polluting infrastructure.

Geospatial indices of social vulnerability are already used to study societal disparities related to healthcare, flood risk, and other areas (e.g., Flanagan et al., 2018; Saia et al., 2020). For EJ evaluations of pipeline networks, such indices can shed light on a community's ability to cope with the risks and threats associated with spills and leaks, explosions, structural failures, construction impacts, and other factors. Finley-Brook et al. (2018) discuss some of these factors in greater detail, but here we note that between 2001 and 2020, the federal safety regulators documented a total of 36 fatalities, 164 injuries, and approximately $2.5 billion in costs associated with industry-reported incidents from natural gas gathering and transmission pipelines in the US (US Department of Transportation, 2021). These costs include property damage as well as the value of natural gas lost to the atmosphere during these incidents. Notably, the costs do not account for the climate implications of methane emissions during incidents, which contribute disproportionately to the greenhouse gas footprint of natural gas supply chains (Brandt et al., 2014; Pandey et al., 2019). Risks of leaks and other incidents increase as these pipelines age (Alzbutas et al., 2014; Hendrick et al., 2016).

Pipelines concentrated in areas of high social vulnerability raise EJ concerns associated with the inequitable distribution of hazards resulting from energy infrastructure. Specifically, the concentration of pipelines in these areas suggests that environmental, health, and other burdens are shouldered disproportionately by communities that have an already limited capacity to carry such loads. After examining the US natural gas gathering and transmission pipeline network, we discuss the implications for the marginalized communities targeted by major pipelines in recent years. We then discuss the relevance of these findings for EJ policies and offer recommendations to scientists and decision-makers.

2. Methods

We acquired geospatial data from two different sources. First, we downloaded the social vulnerability index (SVI) for 3,142 US counties and county-level equivalents (hereafter counties) in shapefile format from the US Centers for Disease Control and Prevention (CDC) website (http://svi.cdc.gov). The CDC describes the SVI as an index to estimate the potential for external factors to impact a community's ability to deal with human suffering and financial loss. The index ranges from 0 (least vulnerable) to 1 (most vulnerable), and it has a uniform distribution among the US counties. The uniform distribution is an important property that allowed us to create similar-sized bins of the SVI at a later stage in the analysis. We used the SVI for 2018, the most recent year of data availability when we conducted the analysis.

Next, we acquired geospatial data for the US natural gas gathering and transmission pipeline network. We downloaded these data as a polyline shapefile from the US Energy Information Administration (EIA), using a version last updated in January 2020 (https://www.eia.gov/maps/layer_info-m.php). The shapefile contains information on approximately 370,000 km of interstate and intra-state pipelines, and according to the embedded metadata, is compiled from the data submitted to the federal regulators and information gleaned from industry websites and press. The US has approximately 515,000 km of natural gas gathering and transmission pipelines overall (U.S. Department of Transportation, 2020), which means that more than 25% of the network is absent from the EIA shapefile. Nevertheless, this file represents the most comprehensive US natural gas pipeline data set currently available to the public.

We processed social vulnerability and pipeline data sets using ArcGIS (Redlands, CA). First, we overlaid the pipeline shapefile on an equal-area projected map of the US counties. We then used the "Intersect" function to divide the pipeline shapefile into segments within individual counties. Next, we computed pipeline segment lengths (km) by applying the "Calculate Geometry" function to the resulting attribute table. After

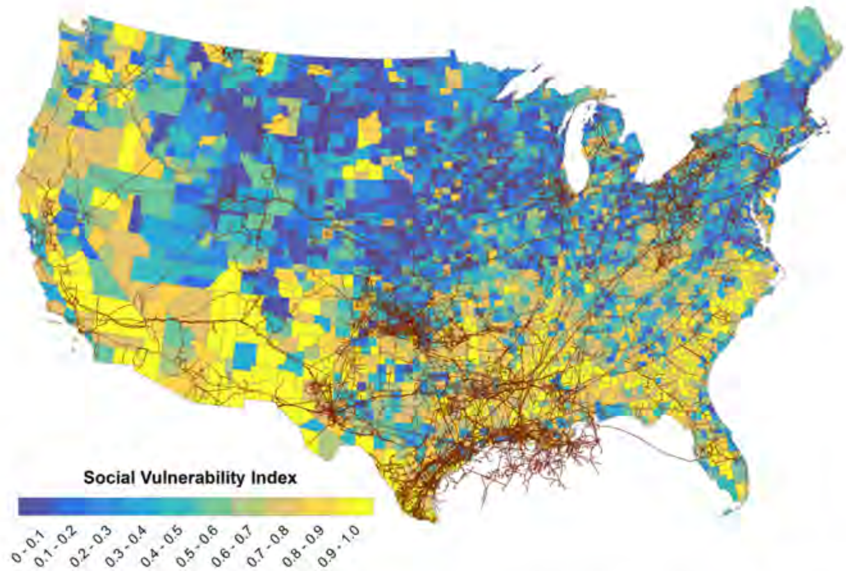

Figure 1. Natural gas gathering and transmission pipelines in the conterminous US, with social vulnerability index shown for each US county. One Alaska county is included in the statistical overview of the results but is not shown here.

computing segment lengths, we used the "Spatial Join" function to combine the pipeline and county layers into a data table, modifying the function's merge rules to compute the sum of pipeline segment lengths for each county.

Counties that contained no pipeline segments (881 of 3,142, or 28% of US counties) are visible on the map in Figure 1, but excluded from further analysis. Similarly, pipeline segments located in open water (e.g., the Gulf of Mexico) are visible in Figure 1, but excluded from further analysis. We computed the density of natural gas gathering and transmission pipelines, ρNG, as pipeline km per 100 km^2 of land area. The unit conversion places most density values in the whole number range, thus, improving readability. The conversion has no effect on statistical analyses or conclusions.

The preceding ArcGIS operations yielded an attribute table that contained the following information for each of the 2,261 US counties with natural gas pipelines: total length of pipeline segments (km), total land area (km^2), SVI, ρNG, and the Federal Information Processing Standard (FIPS) code. The FIPS code uniquely identifies each county and the state in which it is located. We exported the attribute table as a tab-delimited text file for statistical analysis using Matlab (Natick, MA).

We used Matlab's statistics toolbox to test differences in means, medians, and cumulative distributions, and we report *p*-values from the 2-sample *T*-test, Wilcoxon Rank-Sum test, and 2-sample Kolmogorov-Smirnov test, respectively. We also used the toolbox to compute Pearson's correlation coefficient and the accompanying *p*-value. Finally, we used Matlab to bin counties by the SVI decile in order to select an envelope of counties for further scrutiny if they exceed thresholds of ρNG within their respective bins. For exceedance thresholds, we used the 75th, 90th, 95th, and 97.5th percentile of counties within each SVI-decile bin. Bins were similar-sized, each containing between 200 and 245 counties, and the number of counties in each bin varied independent of the SVI values.

A few caveats apply to the data sets. No counties in Hawaii, and only one county in Alaska contained any gathering or transmission pipelines in the EIA shapefile. Thus, the results apply mainly to the 48 contiguous states. Also, the CDC did not compute the 2018 SVI for one county (Rio Arriba, NM) due to a US Census data collection error (https://www.census.gov/programs-surveys/acs/technical-documentation/errata/125.html). The county which contained 56 km of pipelines was excluded from analyses involving the SVI. Finally, we analyzed the existing natural gas pipeline network in 2020. We caution against the direct comparison of our results and conclusions with the recent work by Strube et al. (2021), which analyzes a sample of proposed new gas transmission pipelines.

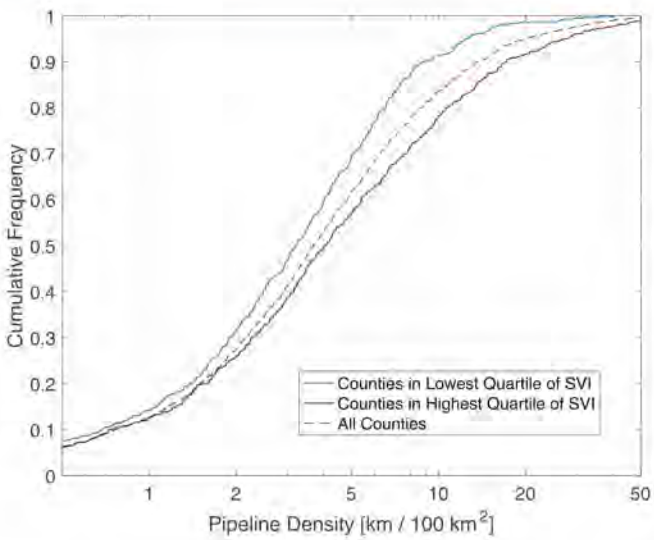

Figure 2. Cumulative frequency distributions of natural gas gathering and transmission pipeline density for counties in the lowest quartile of social vulnerability (blue), counties in the highest quartile of social vulnerability (red), and all counties (dashed). Distributions of densities for the highest and lowest quartiles differ significantly from one another (KS statistic = 0.17, $p < 0.001$).

3. Results

The US natural gas gathering and transmission network comprises approximately 515,000 km of gathering and transmission pipelines, and approximately 370,000 km of that network is shown here (Figure 1). Approximately 280,000 km of pipelines are located on land, traversing 2,261 US counties (72% of all counties). Only one county is located outside of the contiguous 48 states (Kenai Peninsula, AK). Each county contains, on average, 125 km of pipeline, and half of the counties contain at least 64 km of pipelines. Twenty-six counties have at least 1,000 km of pipelines, and 36 counties contain some amount of pipeline, but less than 1 km total. The mean density of natural gas gathering and transmission pipelines, ρNG, is 6.1 km of pipeline/100 km^2 of land area for the 2,261 counties. Half of the counties have ρNG of at least 3.7 km/100 km^2. The distribution of ρNG for all pipeline-containing counties skews positive (right).

Gathering and transmission pipelines are located in counties throughout the full range of the SVI (Figure 1). Even so, pipeline density is not distributed uniformly among the US counties with respect to the SVI. In particular, ρNG is significantly greater for counties in the highest quartile of the SVI (i.e., counties with the most vulnerable populations) than for counties in the lowest SVI quartile (i.e., counties with the least vulnerable populations). Specifically, counties in the highest quartile of social vulnerability have a mean ρNG value of 7.5 km/100 km^2, which is significantly greater than the mean ρNG value of 4.5 km/100 km^2 for counties in the lowest quartile of social vulnerability ($p < 0.001$). The median ρNG values also differs significantly between the highest and lowest quartiles of social vulnerability ($p < 0.001$). The group of 881 counties without any gathering or transmission pipelines did not differ significantly from the group of pipeline-containing counties in terms of mean ρNG, median ρNG, or the shape of the SVI cumulative distribution.

For pipeline-containing counties in the top quartile of social vulnerability, the distribution of ρNG shows a shift to the right of the ρNG distribution for counties in the bottom quartile of social vulnerability (Figure 2). Because of the positive skew in ρNG, the difference in ρNG between the two groups grows larger at higher quantiles of ρNG. For example, the difference in ρNG is less than 1 km/100 km^2 for counties that have relatively low densities of pipelines within their vulnerability quartiles, but the difference grows to more than 20 km/100 km^2 for counties that have relatively high densities of pipelines within their vulnerability quartiles. At the upper extreme, pipeline densities are greater than 50 km/100 km^2 for 1% of the counties in the top vulnerability quartile, whereas the top 1% of pipeline densities for the counties in the bottom vulnerability quartile range from approximately 27 km/100 km^2 to 40 km/100 km^2 (Figure 2). Table 1 summarizes the differences in key descriptive statistics for the two groups, and it provides upper and lower bounds for each group's 95% confidence interval. The upper bound of the confidence interval highlights the large differences in ρNG experienced by counties at the high-density end of each group's distribution.

For all pipeline-containing counties in the US, ρNG and the SVI are correlated (Pearson's $r = 0.14$, $p < 0.001$). The relationship between ρNG and the SVI is driven mainly by the counties that have relatively high ρNG for their SVI (Figure 3). For example, counties in the top 25% envelope of ρNG (defined as counties in the top 25th percentile of density for a given range of SVI) have a correlation between ρNG and the SVI that is much higher ($r = 0.33$, $p < 0.001$) than the correlation for all pipeline-containing counties ($r = 0.14$, $p < 0.001$). The correlation coefficients grow larger as the envelopes become more extreme; Table 2 summarizes the correlations for envelopes ranging from the top 25th percentile of the pipeline density to the top 97.5th percentile of pipeline density.

Table 1
Pipeline Density Characteristics of the US Counties

Category	Mean	Median	95% CI
County SVI > 0.75	7.5	4.1	0.2–38.2
County SVI < 0.25	4.5	3.2	0.2–15.4
All counties	6.1	3.7	0.2–29.4

Abbreviation: SVI, social vulnerability index.

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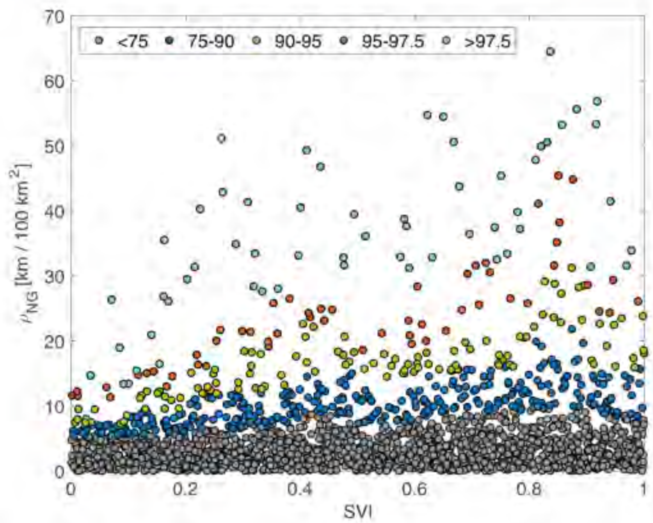

Figure 3. Pipeline density versus social vulnerability for the US counties. Colors indicate envelopes for pipeline density percentiles based on bins of social vulnerability index (SVI) (e.g., gray points indicate counties in the lower 75th percentile of density for their SVI bins, blue points indicate counties in the 75th to 90th percentile of density for their SVI bins, etc.).

4. Discussion

4.1. Significance of Findings

The correlation between pipeline density and social vulnerability is a previously undocumented characteristic of the US natural gas gathering and transmission pipeline network. Relationships between ρNG and the SVI suggest that nationally, negative impacts associated with natural gas pipelines, including air and water pollution, public health and safety concerns, and other burdens, fall disproportionately on communities with already limited capacities to deal with the challenges created by these impacts.

Relationships between pipeline density and social vulnerability neither imply that vulnerable communities were targeted by pipeline developers nor that vulnerable communities sprang up near pipelines. The relationships do, however, confirm that gathering and transmission pipeline densities are not randomly distributed with respect to county-level social vulnerability in the US. in general, counties with more socially vulnerable populations experience higher densities of gathering and transmission pipelines than counties with less socially vulnerable populations.

Since the pipeline network was constructed over the course of several decades by many different companies operating under various regulatory and policy conditions (US Energy Information Administration, 2020), one possible explanation is that the observed inequitable distribution of pipeline density is an emergent property of an inherently complex system of governance. Governance systems for energy, natural resources, and the environment exhibit structural complexity (e.g., Craig, 2012; Jacquet et al., 2018; Newig et al., 2010), and complex systems are often characterized by emergent behaviors or properties that cannot be traced to any specific system component (Manson, 2001). Perhaps the observed disparity in the distribution of gathering and transmission pipelines is an example of such emergent behavior. If so, complex systems theory may prove useful for understanding how governance systems and other structures interact to produce racial and socioeconomic disparities in the distribution of pollution and other burdens associated with fossil fuel infrastructure.

Suggesting that the association between pipeline density and social vulnerability is an emergent property of a complex system does not imply that no one bears responsibility for the inequitable distribution of environmental and public health burdens. On the contrary, multiple parties—local and state officials, federal regulators, corporations—share responsibility through decisions that often prioritize economic interests over the equitable distribution of burdens (Foreman, 2011; Steel & Whyte, 2012; Sze et al., 2009). At minimum, our results re-emphasize a major theme in EJ research: overt discrimination and malicious intent are not prerequisites for discriminatory outcomes (e.g., Bullard, 1993; Pulido, 2000; Ranganathan, 2016; Vasudevan & Smith, 2020).

Regardless of responsibility or intent, the disproportionately high density of natural gas pipelines in areas of high social vulnerability warrants further attention. Although the concentration of infrastructure in areas of high social vulnerability is consistent with patterns observed at upstream and downstream ends of the oil and gas supply chain (Colborn et al., 2014; Davies, 2019), midstream pipelines and related infrastructure have unique burdens. We discuss some of these burdens in the following section. We focus specifically on indigenous communities and others located in rural parts of the US, given that many new oil and gas pipelines are routed through the rural landscapes (Strube et al., 2021).

Table 2
Correlations Between ρNG and SVI for Groups Shown in Figure 3

Percentile group	*r*	*p*	*N*
>97.5	0.65	<0.001	58
90–95	0.59	<0.001	113
75–90	0.47	<0.001	225
<75	0.33	<0.001	562

Abbreviation: SVI, social vulnerability index.

4.2. Implications

Decision-makers responsible for permitting midstream pipelines have justified rural routes by implying that societal risk is connected to population size density, asserting, in some cases, that societal risks are greater in urban areas than to rural areas. For example, federal regulators eliminated an early route for the Dakota Access Pipeline partly because of its proximity to the city of Bismarck, ND, and its urban water supply. Regulators, instead, chose a rural route adjoining the present-day Standing Rock Sioux reservation (Whyte, 2017).

Although population density may predict the severity of certain impacts (e.g., a gas pipeline explosion may harm more people in an urban area than an equivalent explosion in a rural area), we contend that rural pipeline impacts, in general, are not simply diffuse or less intense versions of urban impacts. Instead, recent research suggests that gathering and transmission pipelines pose fundamentally distinct cultural, economic, and other challenges for rural areas (Caretta & McHenry, 2020; Donnelly, 2018; Emanuel & Wilkins, 2020; Whyte, 2017). The recent wave of oil and gas pipeline development in the US and elsewhere highlights the need for more nuanced thinking about the implications of the expanding pipeline infrastructure into rural areas. We highlight some of these below.

Several oil and gas transmission pipelines proposed or built in recent years have unique implications for the indigenous communities in rural areas due to impacts—actual and potential—on their contemporary and ancestral territories. Although indigenous peoples in the US overwhelmingly reside in urban areas (Weaver, 2012), indigenous knowledge systems, cultures, and identities are inextricably tied to certain landscapes, waterways, and other spaces that are predominantly rural in nature (e.g., Emanuel, 2019; Whyte, 2017). The Dakota Access, Keystone XL, Trans Mountain Expansion, Enbridge Line 3 pipelines, and the now-canceled Atlantic Coast and Northern Gateway Pipelines all traverse or proposed to traverse territories of indigenous peoples in the US and Canada (Emanuel, 2017; Estes, 2019; Hunsberger & Awâsis, 2019; Jonasson et al., 2019; McCreary & Milligan, 2014; Whyte, 2017). Some tribes and first nations oppose these projects not only because of concerns over pollution or risks to human health, but also because of the pipelines' potential to cause irreparable cultural harm by damaging or destroying present-day or ancestral territories with religious, historical, or cultural significance (e.g., Chen, 2020; Emanuel & Wilkins, 2020; Estes, 2019; Vypovska et al., 2018).

Despite the high stakes for indigenous peoples, few culturally oriented pipeline assessments exist. Those that do are commissioned mainly by affected tribes or first nations in response to regulatory processes that fail to address concerns they deem important (e.g., Honor the Earth, 2020; Tsleil-Waututh Nation, 2015). These assessments describe how pipeline construction and operation may disrupt, for example, the ability of indigenous peoples to maintain place-based food traditions or cultural practices. They also highlight the ways in which regulatory proceedings renew or exacerbate longstanding ethical and legal issues surrounding the participation of indigenous peoples in decision-making about their own lands and communities (Emanuel & Wilkins, 2020; Honor the Earth, 2020; Tsleil-Waututh Nation, 2015; Whyte, 2017). Occasionally, these assessments lead to agreements to provide redress for impacts to indigenous communities, or they serve to outline co-management strategies (e.g., Vypovska et al., 2018). Often, however, they serve to document various ways in which planning and permitting exclude indigenous perspectives, weaken sovereignty, or otherwise undermine indigenous self-determination (Emanuel & Wilkins, 2020; Estes, 2019; Whyte, 2017). In the US, issues raised by indigenous peoples in culturally oriented pipeline assessments and other venues are often perceived as less important than the priorities of project proponents (e.g., Brown, 2017).

Pipeline construction and operation have implications for rural landscapes more generally, including implications associated with easements on privately owned lands. Easements are property rights obtained through landowner negotiation or eminent domain, a legal process that requires landowners to relinquish certain property rights to pipeline builders and operators. The societal implications of pipeline easements, however, extend far beyond delineated and compensated boundaries. Easements for gathering and transmission pipelines place practical restrictions on adjacent land uses, affect nearby property values, and increase the risks of fire or catastrophic explosions in areas further away from easement boundaries (e.g., Caretta & McHenry, 2020; Hansen et al., 2006; Holdsworth et al., 2021). Landowners bear these risks and are still obligated to pay taxes on properties crossed by easements (Caretta & McHenry, 2020).

Rural communities often do not have the same capacity as urban areas to respond to emergencies and disasters, and are often limited in their response capabilities (Brennan & Flint, 2007; Furbee et al., 2006). These limitations extend to explosions, leaks, or other incidents related to midstream pipeline infrastructure. Some natural gas transmission pipelines proposed in the recent years exceed 1 m in diameter and have internal gas pressures approaching 1 MPa, elevating general concerns about safety and emergency response capabilities (Finley-Brook et al., 2018). Safety and other concerns about pipelines may erode the sense of belonging felt by rural residents, leading some people to move away (Caretta & McHenry, 2020). Moreover, changes associated with midstream infrastructure potentially create rifts between neighbors who disagree about the relative benefits and burdens of hosting pipelines in their communities (Caretta & McHenry, 2020). Overall, research from rural Appalachia confirms that easements, safety concerns, and other factors facilitate drastic alteration of communities, transforming rural landscapes into sprawling, industrial settings within a few years (Caretta & McHenry, 2020; Donnelly, 2018). Implications of these changes for rural public health and other societal concerns are still coming into focus, but one emerging theme is that oil and gas infrastructure often exacerbates existing social vulnerability (Blinn et al., 2020; Hemmerling et al., 2021). Together, these examples call into question the idea that midstream pipelines have negligible societal impacts in rural areas simply because populations are less dense than in urban areas.

4.3. Recommendations

In the US, federal EJ policy requires inclusion of socioeconomic analyses in pipeline regulatory reviews to help identify and address adverse environmental and other impacts that could fall disproportionately on vulnerable populations, as a result of permitted activities (e.g., Emanuel & Wilkins, 2020). For natural gas pipelines, federal regulators are also charged with determining whether projects are in the public interest (Kalen & Hsu, 2020). This work motivates us to combine these two policy priorities into a new question: Is it in the public interest to preserve or exacerbate existing patterns that disproportionately burden vulnerable populations with negative impacts from natural gas pipelines? This question guides our recommendations to decision-makers and others.

Federal policy guidance includes recommendations for conducting EJ analyses, which are sections of environmental review documents that allow regulators to identify disparities in environmental impacts by race or income status (US Council on Environmental Quality, 1997). Regulators and proponents rely on these analyses to draw conclusions and make decisions about pipelines and other infrastructure projects (Emanuel, 2017). Federal courts in the US have granted agencies wide latitude to choose or develop their own EJ analyses (Sierra Club v. Federal Energy Regulatory Commission, 2017), and although decades of research have improved the ability to identify disparities using demographic data, federal EJ analyses are frequently criticized as methodologically unsound, procedurally rote, or ineffective at preventing or minimizing negative impacts disproportionately imposed on socially vulnerable populations (e.g., Bullard, 2018; Davies, 2019; Emanuel & Wilkins, 2020). In some pipeline cases, federal EJ analyses involve only cursory demographic screenings, which can mask racial disparities or other social inequities in pipeline routing (Emanuel, 2017; Estes, 2019). Alone, such screenings are unlikely to capture the complexity of concerns about impacts and potential disparities faced by vulnerable populations, and federal policy guidance cautions against this use (e.g., US EPA, 2014). Decision-makers must re-envision the roles of demographic tools and analyses as they work toward more holistic assessments of the societal burdens of pipelines and related infrastructure. Culturally oriented assessments and community-based research have the potential to complement demographic analyses, and we reiterate many prior calls to better incorporate these types of approaches into environmental reviews (e.g., Arquette et al., 2002; Blue et al., 2020; Halseth, 2016; Stevenson, 1996; Wilson et al., 2019).

Regulators and corporations must commit to early, good-faith efforts to incorporate community perspectives into decision-making. At present, however, power asymmetries between corporations and regulators on one hand and socially vulnerable communities on the other sometimes prevent timely and meaningful efforts to incorporate these perspectives into decision-making about pipelines (e.g., Emanuel & Wilkins, 2020). Structural changes to the regulatory system may be required to overcome this particular barrier. Natural gas regulators in the US have recently signaled that they intend to review policies on identifying and addressing impacts of pipeline authorizations on low wealth and racially marginalized communities (US Federal

Energy Regulatory Commission, 2021). Periodic reviews such as this one could help regulators adopt structural changes to improve the effectiveness of their EJ policies, including accountability mechanisms to ensure that impacted communities are engaged meaningfully in environmental decision-making processes.

Scientists, for their part, can partner with communities to describe and quantify impacts related to environmental degradation, health and safety, and other issues. This work may include quantifying the value of property or assets lost through eminent domain for the construction of pipelines and related infrastructure, or identifying the extent to which midstream infrastructure increases societal tensions or desires to relocate from rural communities. Scientists also have the ability to provide technical critiques of regulatory claims about EJ and to hold regulators to rigorous standards for the design and implementation of EJ analyses. For example, regulators who draw conclusions based on demographic analyses should understand the sensitivities and limits of detection for these analyses.

Scientists and decision-makers should pay closer attention to the cumulative impacts of co-located pipelines, compressors, and other types of midstream infrastructure. Regulatory analyses focus on the implications of newly proposed infrastructure and—with few exceptions—disregard impacts associated with the gradual accumulation of infrastructure in a community. Yet people nearby do not experience newly proposed facilities in isolation; they are exposed to the cumulative effects of all nearby infrastructure on air quality, noise, explosion risks, and more. Calls to consider cumulative impacts—and to reconsider how cumulative impacts are evaluated in decision-making—are not new (Parkes et al., 2016), and thorough reviews of cumulative impacts should consider how past decisions affect conditions in the present (Halseth et al., 2016). With that in mind, it is important to remember that much oil and gas infrastructure in the US pre-dates not only EJ policies but also anti-discrimination laws, including the US Civil Rights Act. The siting of such infrastructure may reflect overt and institutionalized racism that shaped infrastructure planning and decision-making during most of US history (Bullard, 2002). It is therefore possible that existing pipeline routes may reflect historical practices that deliberately sought to concentrate polluting infrastructure in marginalized communities. With this in mind, decision-makers who review cumulative impacts of proposed pipelines should acknowledge that new infrastructure concentrated along existing easements or corridors could reinforce historic practices of oppression. The relationships between social vulnerability and pipeline density revealed in this study reiterate an urgent need for researchers and decision-makers to pay close attention to the cumulative environmental, public health, and other burdens experienced by vulnerable populations—especially as the buildout of midstream pipelines continues in the US and elsewhere.

5. Conclusions

We analyzed multiple, publicly available data sets and found that the existing network of natural gas pipelines in the US is concentrated more heavily in counties where people experience high levels of social vulnerability than in counties where social vulnerability is lower. The study, however, does more than simply document another way in which vulnerable populations are disproportionately impacted by hazardous or polluting infrastructure. It reiterates a need to identify and address disparate societal impacts of infrastructure at the level of an entire system, whether the system is part of the oil and gas supply chain or some other sector.

Assuming natural gas gathering and transmission pipelines continue to be built, decision-makers and the general public should keep in mind that the network is already distributed inequitably with respect to social vulnerability, and that future projects can either maintain the inequitable status quo or shift the distribution in ways that will potentially exacerbate or ameliorate current disparities. A more complete view of the oil and gas supply chain can inform decision-makers and the general public about the larger societal costs of US energy dominance, including the extent to which vulnerable rural communities subsidize this policy through inequitable exposure to environmental, health, and other risks.

Conflict of Interest

The authors declare no conflicts of interest relevant to this study.

Data Availability Statement

Primary data sets can be accessed using links provided in the Methods section. Derived data sets (e.g., pipeline density by county) can be accessed at https://doi.org/10.5281/zenodo.4029576.

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 78

February 21, 2023

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Michael Hatten, Chief
Regulatory Branch
Huntington District
U.S. Army Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701

Re: LRH-2015-00592-GBR, LRP-2015-798, NAO-2015-0898; Mountain Valley Pipeline, LLC; Mountain Valley Pipeline, Wetzel County, West Virginia to Pittsylvania County, Virginia

Dear Mr. Hatten:

The U.S. Environmental Protection Agency (EPA) has reviewed the public notice (PN) for the proposal by Mountain Valley Pipeline, LLC (MVP) for the discharge of dredged and/or fill material into waters of the United States associated with construction of the MVP Pipeline within the Huntington, Pittsburgh, and Norfolk Districts of the U.S. Army Corps of Engineers regulatory boundaries. The project is proposed to be approximately 304 miles long and begin at the existing Equitrans, L.P. transmission system near the Mobley processing facility in Wetzel County, West Virginia and end at the Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 Compressor Station 165 in Transco Village, Pittsylvania County, Virginia. Proposed discharges associated with the project would permanently impact 1,198 linear feet (lf) of streams and 0.5 acre (ac) of wetlands, temporarily impact 38,312 lf of streams and 13.92 ac of wetlands, and permanently convert 3.7 ac of forested and scrub-shrub wetlands to emergent wetlands. EPA's comments, provided herein, are based upon the PN and supplemental documentation, including the application, associated attachments, and maps, in addition to state databases.

EPA's review is intended to help ensure that the proposed project complies with the Clean Water Act (CWA) Section 404(b)(1) Guidelines (Guidelines) (40 C.F.R. Part 230), which provide the substantive environmental review criteria for CWA Section 404 permit applications. Based on the information available for review, EPA has identified a number of substantial concerns with the project as currently proposed, including whether all feasible avoidance and minimization measures have been undertaken, deficient characterization of the aquatic resources to be impacted, insufficient assessment of secondary and cumulative impacts and potential for significant degradation, and the proposed mitigation. More detailed concerns and comments are set forth below and in the attached enclosure.

While EPA recognizes the proposed project's purpose and need for providing transmission of natural gas, the extent of anticipated impacts, notably the large amount of temporary discharges from the proposal to the aquatic resources, warrants careful review. The project proposes impacts within streams and wetlands of the Little Muskingum – Middle Island, West Fork, Little Kanawha, Elk, Gauley, Lower New, Greenbriar, Middle New, Upper James, Upper Roanoke, and Banister watersheds in West Virginia and Virginia. The scientific literature provides strong weight of evidence that tributaries and their wetlands are vital components of the aquatic ecosystem.[1] They collectively provide habitat, water quality improvements, flood control, sediment transport, water supply, nutrient cycling, and organic matter sources, leading to maintenance of downstream aquatic communities and water quality. Even though some waterbodies may not exhibit surface flow every day of the year, they perform many of the foregoing important functions and contribute approximately 60% of the mean annual flow to all northeastern U.S. streams and rivers. Therefore, the proposed discharges to these aquatic resources have implications not only for the direct impacts, but also downstream waters.

Based on the information provided to EPA for review, more than 200 of the proposed 719 stream impacts are proposed in the Upper Roanoke watershed. This watershed includes Natural and Stockable Trout Waters, as well as habitat for Roanoke logperch (*Percina rex*), an endangered species. The Gauley and the Elk watersheds include Category B-2 Trout Waters and are proposed to have a combined total of nearly 200 stream impacts. The Middle New watershed is proposed to have nearly 100 stream impacts, one of which is a direct impact to a stream designated as critical habitat for the endangered Candy darter (*Etheostoma osburni*). Additionally, many of the waters within these watersheds already are impaired for a variety of parameters, including pH, fecal coliform, iron, other metals, and biology.

Because of the multitude of functions the existing streams and their wetlands provide and the documented water quality issues in these watersheds, every effort should be made to avoid and minimize impacts from discharges associated with this project consistent with the Guidelines. Furthermore, the direct, secondary, and cumulative impacts from the discharges associated with this project to these watersheds may result in significant degradation of the waters of the United States and reduce the ability for remaining aquatic resources to maintain hydrologic, geochemical, and biological functions. The above-mentioned qualities of these aquatic resources demonstrate the value they provide. For these reasons, EPA considers the protection of the proposed receiving waters to be important to the overall quality of the aquatic ecosystem both regionally and nationally.

In conclusion, it appears that the project, as proposed, may not comply with the Guidelines. It is not apparent that all impacts have been minimized, nor is it evident that the direct, secondary, and cumulative impacts have been thoroughly evaluated and mitigated so that the proposed project will not cause or contribute to significant degradation of the waters of the United States. EPA recommends modifications to the permit application and project be undertaken to address the detailed comments identified in the attached enclosure. EPA also requests the opportunity to meet with the Corps and others to work collaboratively to address EPA comments. At this time, EPA recommends that the permit not be issued until modifications described in the attachment, including the recommended special conditions, have been addressed and incorporated into the project.

Thank you for the opportunity to review and provide comment on the PN for the Mountain Valley Pipeline. EPA looks forward to continuing to work with the Corps and the applicant. Should you have questions, please do not hesitate to contact Christine Mazzarella, the Wetlands Branch Team Lead, at 215-814-5756 or by email at mazzarella.christine@epa.gov.

[1] Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence EPA/600/R-14/475F

Sincerely,

Jeffrey D. Lapp, Chief
Wetlands Branch

cc: Scott Hans, Chief, Regulatory Branch, Pittsburgh District, U.S. Army Corps of Engineers
Tom Walker, Chief, Regulatory Branch, Norfolk District, U.S. Army Corps of Engineers

ENCLOSURE

EPA's Technical Comments on LRH-2015-00592-GBR, LRP-2015-798, NAO-2015-0898; Mountain Valley Pipeline, Mountain Valley Pipeline, LLC, Wetzel, Harrison, Doddridge, Lewis, Braxton, Webster, Nicholas, Greenbrier, Summers, and Monroe Counties, WV and Giles, Craig, Montgomery, Roanoke, Franklin, and Pittsylvania Counties, VA

The CWA 404(b)(1) Guidelines (40 C.F.R Part 230) direct the consideration of whether the proposed fill will cause and contribute to violations of any applicable State water quality standard or to significant degradation of waters of the U.S. (230.10(b) & (c)). This includes significant adverse effects of the discharge on aquatic ecosystem diversity, productivity, and stability. EPA is concerned that the applicant has not yet demonstrated that the discharges from the project, as proposed, will not cause or contribute to water quality standards exceedances or significant degradation of receiving waters. The project proposes a substantial amount of temporary impacts in conjunction with permanent impacts. Approximately 7.25 miles of streams and 13.92 ac of wetlands are proposed to be temporarily impacted across eleven watersheds in two states. Of the 1,095 total proposed discharges of fill, 850 of them are within the Upper Roanoke, Gauley, Elk, Middle New, and Greenbrier watersheds. The streams and rivers in these watersheds have many good quality designations, such as trout waters, and provide habitat to freshwater mussels, trout, and threatened and endangered aquatic species, such as the Roanoke logperch (*Percina rex*) and Candy darter (*Etheostoma osburni*). Additionally, some of these watersheds contain streams listed as impaired for iron, other metals, biology, etc. While many of the discharges of fill associated with the proposed construction activity may be considered temporary, the impacts from those discharges may have lasting effects, particularly due to the sensitivity of the aquatic resources and the repetitive nature of impacts to some of the tributaries. The scientific literature provides strong weight of evidence that tributaries and their wetlands are vital components of the aquatic ecosystem. [2] Therefore, the impacts to these aquatic resources, including the loss of functions provided to downstream resources such as dilution, biogeochemical processes, and biodiversity, have the potential to result in significant degradation of waters of the United States and should be thoroughly assessed. To ensure that the proposed project does not result in significant degradation of waters of the United States through significant adverse effects of the discharges on aquatic ecosystems, EPA offers the following recommendations to be addressed prior to any permit decision.

Avoidance and Minimization

As directed by the Section 404(b)(1) Guidelines, the Corps' issued permit should reflect the least environmentally damaging practicable alternative (LEDPA) (230.10(a)). To identify the LEDPA, a full range of practicable alternatives, defined by the purpose and need for the project, is recommended for evaluation. Alternatives include not only geographical siting but also operational options, such as design modifications. Based on the information available for review, it is not clear that the proposed project represents the LEDPA. EPA recommends that additional examination and documentation of functional alternatives that avoid and minimize impacts be provided to ensure the proposed project is the LEDPA. Specific recommendations are provided in the following list.

1. EPA recommends updating the alternatives analysis with a narrative and table that identifies and compares the changes to the proposal since the project was authorized under the Nationwide Permit (NWP) 12. Specifically, the additional analysis should describe changes to the proposed route, modifications to stream and wetland crossing methods and subsequent changes to impacts

[2] Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence EPA/600/R-14/475F

(both permanent and temporary), and the impacts that have occurred from clearing of the right-of-way (ROW) and pipe that has already been laid.

2. EPA recognizes the efforts the applicant has made to adjust crossing methods to reduce aquatic impacts. However, EPA also recommends information be provided to explain how these methods, such as Direct Pipe and microtunneling, were selected to be used or not used throughout the project. EPA also recommends further consideration of using these methods at streams where not currently proposed, particularly streams that will be crossed multiple times, streams that are of good quality, and/or steams that may contain threatened or endangered aquatic species to better avoid or minimize impacts.
3. More than 100 of the proposed crossings will result in the intersection of multiple unique waterbodies by a single crossing. Several of these crossings are proposed to cross two to as many as ten unique waterbodies. EPA recommends the applicant examine additional avoidance opportunities for crossings that intersect multiple unique waterbodies and minimization options such as modifying crossing methods or utilizing additional effective best management practices (BMP). If these are not practicable, the rationale should be provided. Specific examples of crossings with more than four waterbodies include, but are not limited to, the following:
   - A-016, Dry-Ditch Open-Cut, 5 waterbodies crossed
   - C-032, Dry-Ditch Open-Cut, 4 waterbodies crossed
   - C-034, Dry-Ditch Open-Cut, 4 waterbodies crossed
   - C-038, Dry-Ditch Open-Cut, 10 waterbodies crossed
   - D-028, Conventional Bore, 4 waterbodies crossed
   - E-020, Dry-Ditch Open-Cut, 5 waterbodies crossed
   - E-022, Dry-Ditch Open-Cut, 4 waterbodies crossed
   - F-001, Dry-Ditch Open-Cut, 8 waterbodies crossed
   - F-029-030, Dry-Ditch Open-Cut, 4 waterbodies crossed
   - F-037, Dry-Ditch Open-Cut, 8 waterbodies crossed
   - F-045, Dry-Ditch Open-Cut, 4 waterbodies crossed
   - G-013, Guided Conventional Bore, 5 waterbodies crossed
   - H-031, Conventional Bore, 6 waterbodies crossed
   - H-036, Dry-Ditch Open-Cut, 8 waterbodies crossed
   - H-042, Conventional Bore, 4 waterbodies crossed
   - I-046, Conventional Bore, 4 waterbodies crossed
   - I-121, Conventional Bore, 5 waterbodies crossed
4. While EPA appreciates the relocation of the Blackwater River crossing to downstream of the Rocky Mount water intake, EPA also recommends that the applicant use one of the new or established trenchless methods to cross Blackwater River instead of open cut methods to further avoid or minimize impacts. If not practicable, then additional rationale for crossing the river by a trench method should be provided.
5. The application states that "incurring an unreasonable cost to avoid a short-duration temporary impact to an individual crossing is not appropriate and practicable." However, the analysis of what would be practicable for these crossings did not include the consideration of the costs associated with site restoration, monitoring and management, as well as potential additional compensatory mitigation. Additionally, the applicant considered and rejected as not practicable the use of bridges to avoid permanent impacts to streams, but it is not apparent that the relative cost of compensatory mitigation was included in that analysis. EPA recommends that the applicant provide an updated analysis incorporating these factors, and consider if there are

additional opportunities, including but not limited to bridging, using trenchless methods, etc., to avoid and or minimize aquatic resources either in crossings or in access road construction.

Aquatic Resource Characterization & Direct, Secondary and Cumulative Impacts

To fully assess the alternatives and impacts under Section 404(b)(1) Guidelines, the quality of the aquatic resources in the proposed project area must be considered. This data is needed to help inform avoidance and minimization opportunities and assess the direct, secondary, and cumulative impacts of the proposal. Furthermore, it is necessary to demonstrate the adequacy of the mitigation proposal. The data provided in the application is insufficient to determine accurate baseline conditions of the aquatic resources. Below are specific recommendations to be addressed.

1. It is unclear if a baseline assessment was completed on the quality and function of the aquatic resources proposed to be impacted either permanently or temporarily. To better evaluate the proposed project's impacts and to ensure adequate functional replacement of the aquatic resources, EPA recommends the applicant conduct a baseline assessment of the condition and functions of aquatic resources to be impacted by the proposed project, including those resources subject to temporary impacts.
    a. Specifically, EPA recommends that baseline data include biological, physical, and chemical parameters consistent with the parameters used to calculate West Virginia Stream Wetland Valuation Metric (SWVM). This data should be collected for all impacts to aquatic resources in both states.
    b. A narrative describing the methodology undertaken, photographs, measurements, and other supporting should be provided to allow the agencies to confirm the findings.
2. Substantial temporary fills are associated with this project. However, the information provided for review does not describe how long the proposed temporary fills will be in place nor how they will be removed and aquatic resources restored. Without this information, it is difficult to ascertain if the temporary fill will or will not have lasting impacts on the aquatic resources or result in secondary effects to downstream resources. **EPA recommends the permit be conditioned to require a restoration plan for temporary impacts, including post-construction monitoring and adaptive management, that has been reviewed and approved by the resource agencies.** Depending on the quality of the resource being impacted, the sensitivity of the resource, or the number of times a water is being impacted, the pre and post construction monitoring requirements could vary.
    a. At a minimum, to ensure that temporary stream and wetland impacts have no significant adverse impact to aquatic resources, the restoration plan should document baseline conditions, and elevations through georeferenced photographs and surveys, explain how all temporary fills and structures will be removed and the area restored to pre-project conditions, and require submission of post-construction georeferenced photographs and surveys to demonstrate that the impacts are in fact temporary and successfully restored.
        i. In addition, upon final stream bed restoration, the stream must have similar physical characteristics to include substrate, pattern, profile, dimension, and embeddedness of the original stream channel.
        ii. In addition, upon final wetland restoration a delineation will be conducted. At the final monitoring event a final wetland delineation will be conducted to ensure hydrology, hydric soils, and hydric vegetation communities are similar to the original wetland.
        iii. Provide a map of monitoring locations and a table illustrating this information.
        iv. Post construction monitoring for a period of three years.

    v. Should post-construction monitoring demonstrate longer term effects on the aquatic resources, EPA recommends additional corrective measures be undertaken including compensatory mitigation be provided to offset those impacts.

b. In addition to the foregoing, for the following types of receiving waters, EPA recommends the restoration plan include enhanced post-construction monitoring and an adaptive management plan to ensure that temporary impacts have no significant adverse effects. Specifically, resources that should have more extensive monitoring, include but are not limited to the following:
    i. Trout waters
    ii. Impaired waters
    iii. Waters with threatened or endangered species or that contain critical habitat including:
        1. S-S5 (Candy Darter) – proposed activity: timber mat crossing
        2. S-C21 (Roanoke Logperch) – proposed activity: timber mat crossing
        3. S-C3 (Roanoke Logperch) – proposed activity: timber mat crossing
        4. S-G36 (Roanoke Logperch) – proposed activity: temporary access road
    iv. Streams and wetlands impacted multiple times by crossings or construction activities
        1. Table 15 lists more than 15 streams and wetlands crossed multiple times by the pipeline
        2. Table 2 and 3 list single streams and wetlands that incur multiple impacts from timber mats, access roads, and ROW clearing

c. For the resources described in ‘b’, a detailed monitoring plan should be developed to measure the chemical, physical, and biological functions of the resources, along with specific success criteria, to determine successful restoration and ensure that there will be no significant adverse effects. EPA recommends that the baseline assessment of the streams and wetlands, as described above, be used to guide the development of these success criteria. In addition to the items in the above item ‘a’, specific recommendations for more detailed monitoring plan include, but are not limited to the following items:
    i. Monitoring for the parameters that are used to calculate the SWVM to assess the chemical, physical, and biological condition of the stream resources.
    ii. For stream hydrology, monitoring should be conducted to document that the flow maintains its preconstruction flow status. Wetland hydrology should be monitored to ensure that the overall seasonal hydroperiod (depth, degree, duration, and periodicity) is similar to that of the pre-construction wetland and the site is inundated or the water table is less than or equal to 12 inches below the soil surface for 14 or less consecutive days during the growing season.
    iii. To ensure wetland soils are not compacted, an example success criteria could include that the subsoil shall have a bulk density of less than 90lbs/ cubic foot for clay textures, grading less than 112 lbs/ cubic foot for sands (prior to adding organic matter or topsoil to the site). Replaced topsoil layers should also be remediated to a similar bulk density range.
    iv. To address potential sedimentation concerns, in-stream monitoring of turbidity and sedimentation should be conducted to identify any changes in sediment load. Criteria should be protective of aquatic species and water quality standards.

v. For vegetation, the application states that "in unsaturated wetlands, most vegetation will be replaced by seeding when necessary…and saturated wetlands will typically be allowed to re-vegetate naturally." However, this may allow time for invasive species that are in the seed bank to colonize the wetland. Therefore, EPA recommends planting wherever possible. Further, the application states that revegetation is considered "successful when cover of herbaceous species is at least 70 percent of the cover of the vegetation in adjacent wetland areas that were not disturbed," however this does not account for invasive species. EPA recommends a success criterion that defines no greater than 5% aerial coverage for invasive species be allowed.

vi. Post construction monitoring for a period of five years or until data from successive monitoring periods indicate site stability and success criteria have been achieved.

vii. Develop an adaptive management plan (AMP) that outlines measures to be taken if temporarily impacted areas fail to achieve success. Should corrective actions be needed, the AMP should guide decisions for implementing measures to address identified parameters. Actions should be specified for problems that may adversely affect aquatic resources, such as, but not limited to, erosion, sedimentation, and invasive species colonization. Should there be long term effects on the aquatic resources, EPA recommends additional compensatory mitigation be provided to offset those impacts should corrective measure fail or pre-construction conditions not be achieved.

viii. Review of post-construction monitoring be undertaken by an independent third party that is qualified to assess water quality, stream and wetland conditions and able to make recommendations for adaptive management measures and corrective actions; the applicant also should commit to implement such recommendations.

3. Additionally, it appears that the ROW could sever upstream reaches from downstream resources. EPA recommends analyzing the potential for effects to downstream reaches, such as, but not limited to, changes to the hydrogeomorphology and impacts of sedimentation and compaction from construction activities, to better determine if secondary impacts will occur to the remaining stream resource. Secondary effects to these downstream resources should be avoided and minimized to the maximum extent practicable. Should unavoidable secondary impacts remain, then EPA recommends additional compensatory mitigation be provided to offset those effects.
4. Although the information provided included some analysis of cumulative effects, EPA recommends a conclusive evaluation of cumulative effects at a watershed scale (i.e. HUC 12) be provided to ensure that measures are undertaken to avoid and minimize the potential of cumulative impacts.

Compensatory Mitigation

After all practicable avoidance and minimization measures have been incorporated into the proposed project, compensatory mitigation for those unavoidable impacts to waters of the US should be undertaken. Due to the significant amount of temporary impacts caused by this project and the potential for secondary and cumulative effects, it is currently unclear if the proposed mitigation will be sufficient to offset the loss of function of the impacted and downstream aquatic resources.

1. Section 332.3(b)(1) of the 2008 Mitigation Rule states that the required compensatory mitigation should be located within the same watershed as the impact site and should be located where it is

most likely to successfully replace lost functions and service. To ensure a timely and functional replacement of aquatic resources in the impacted watershed, EPA recommends using a mitigation bank whose primary service area encompasses the project locations. Additionally, basic information about the work performed at the bank, how the credits were generated (e.g. restoration, enhancement, preservation, etc.), and the credit type should be provided to ensure adequate compensation for the proposed impacts.

2. Should a bank be used whose secondary service area (SSA) includes the project, EPA recommends that the applicant provide the Corps a narrative documenting how the use of that bank is offsetting the project impacts since SSAs are geographically large and sometimes drain to different river basins.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 79

February 21, 2023

APPENDIX Q

Revised Cumulative Impact Assessment Report - Hydrology

REVISED CUMULATIVE IMPACT ASSESSMENT REPORT - HYDROLOGY

Mountain Valley Pipeline

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POTESTA

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Mountain Valley Pipeline

1.0 INTRODUCTION

Mountain Valley Pipeline, LLC (Mountain Valley) is seeking an Individual Permit (IP) for the Mountain Valley Pipeline Project (the Project) from the United States Army Corps of Engineers (USACE) Pittsburgh, Huntington, and Norfolk Districts to conduct regulated activities in navigable waters under Section 10 of the Rivers and Harbors Act of 1899 and for the discharge of dredged and fill material into "Waters of the United States" (WOTUS) under Section 404 of the Clean Water Act (CWA). In addition to the USACE IP application, Mountain Valley is seeking, and has now received, CWA Section 401 Water Quality Certification from the West Virginia Department of Environmental Protection (WVDEP) and the Virginia Department of Environmental Quality (VADEQ) for portions of the Project within their respective jurisdictions.

On August 31, 2021, Mountain Valley received a letter from the USACE Pittsburgh, Huntington, and Norfolk Districts requesting additional information (RFI) that is considered necessary by the USACE to continue its evaluation of the Project. This document addresses Item No. 4 in the August 31 RFI, an assessment of cumulative effects (40 CFR § 230.11(g)) to the aquatic environment associated with the completed and proposed discharge of dredged and/or fill material into WOTUS for each 12-digit Hydrological Unit Code (HUC). The Project impacts include those proposed as part of the Project's IP application and work that was completed under Mountain Valley's previous Nationwide Permit (NWP) 12 authorization. The Project Area in this document is defined as the limits of disturbance (LOD) along the length of the pipeline and its associated facilities (**Figures 1 and 2, Appendix A**), and both terms are used interchangeably herein.

On October 22, 2021, Mountain Valley received a second RFI from the USACE that requested the following additional information at the HUC-12 level to help assess potential cumulative impacts associated with the Project's construction:

- National Wetland Inventory (NWI) Wetlands
- Land Use/Land Cover Comparison[1]
- Hydric Soils

[1] The USACE requested a comparison of land use/land cover information from the most recent version (2019) of the U.S. Geological Survey's National Land Cover Database (NLCD) to the previous 2016 and 2011 versions in order to see the percent change overtime in the watersheds. As noted in Section 2.4 below, due to the inability to find consistent information in NLCD 2019, this report provides a comparison between NLCD 2011 and NLCD 2016 for each HUC-12 watershed.

These additional data have been incorporated into the original response to Item No. 4 in the August 31 RFI.[2]

2.0 METHODS

Each of the assessment methodologies is provided below.

2.1 Project Stream Impacts

The Project's stream impacts are generally limited in both duration and area. The primary effects associated with temporary instream work—increases in suspended particulates and turbidity levels—should dissipate within one to four days. Suspended particulate and turbidity levels in the water column attenuate not only with time but also with distance. Elevated suspended particulate and turbidity levels in the water column tend to approach background levels within a few hundred feet downstream of a crossing. Stream morphology and habitat will be restored through the measures outlined in the *Stream and Wetland Restoration, Monitoring, and Mitigation Framework* (*Mitigation Framework*). The small number of permanent stream impacts are generally associated with the installation or repair of existing culverts, which is expected to have a negligible long-term effect on streams due to appropriate countersinking and restoration measures. To cause an additive, cumulative effect with any given Project-related stream impact, other aquatic impacts would have to occur roughly contemporaneously with and in close proximity to a Project impact. Mountain Valley does not have relevant and useful information about other nearby activities, if any, that may occur during Project construction in close proximity to the Project in a manner that may result in cumulative impacts to streams. Accordingly, Mountain Valley's cumulative impacts assessment methodology for stream impacts focuses on the potential cumulative impacts of the Project.

ArcGIS Spatial Analyst was used to delineate the 12-digit HUC watersheds that are intersected by the Project area utilizing available digital elevation models (DEMs). DEMs are an array of evenly-spaced grid cells that have elevation values for each cell. ArcGIS utilizes the DEM to compute the direction of flow down a slope and in how many cells flow accumulates. Before the DEMs were delineated as watersheds, the boundaries of the focus areas were delimited. Once the study watershed areas were defined, a depressionless surface was created for each watershed utilizing the hydrologic modeling "Fill" tool. This tool fills sinks in a surface raster to remove small imperfections in the data.

To calculate a drainage network or watersheds, a grid must exist that is coded for the direction in which each cell in the surface drains. The "flow direction" hydrologic modeling tool was used to determine where a landscape drains and is necessary to determine the direction of flow for each cell in the watershed. For every cell in the surface grid, the ArcGIS grid processor finds the direction of steepest downward descent.

[2] A version of this report was provided to the USACE on October 11, 2021, in response to the first RFI. This revised report replaces the prior version.

Flow accumulation was the next step in hydrologic modeling. Watersheds are defined spatially by the geomorphological property of drainage. In order to generate a drainage network, it is necessary to determine the ultimate flow path of every cell on the landscape grid. Flow accumulation was used to generate a drainage network based on the direction of flow of each cell. By selecting cells with the greatest accumulated flow, a network of high-flow cells was generated. These high-flow cells lie on stream channels and at valley bottoms. In order to visualize the drainage network, the symbology method was changed to "classified" to utilize two classes. The threshold was then adjusted to be as consistent as possible with known delineation or verified delineation data.

The "flow length" tool was then used to show flow length to the closest downstream high-flow pathway. Using flow length with a weighted grid, a new raster was generated showing the drainage network for the appropriate threshold as determined by the known delineation data. Raster calculations made a new grid where the flow accumulation cells have a value greater than or equal to the threshold value, making those output cells null; where the flow accumulation cells are less than the threshold values, the output cells have a value of 1. The new grid was used as a weighted grid in the flow length tool. The output grid values represent the flow length distance to the closest high-flow pathway. The raster was then converted to a stream network as line shape. After the raster was converted to a polyline format, the lines were reviewed for redundancy and adjusted in the footprint of lakes and large rivers based on aerial mapping.

As noted above, this evaluation used existing delineations to determine the effectiveness of the model and its prediction of streamlines in these watersheds. While the goal is to create streamlines that overlap, the vast majority of data runs utilized in this report did not extend to the extreme headwater reaches where small ephemeral drains were identified in the Project's delineations. Achieving streamlines that extend to the extreme headwaters to what is sometimes referred to as the zero order, or the end of the linear ordinary high water mark, resulted in the model distorting and splintering streamlines in an unrealistic fashion. As a result, this modeling effort may not include the last few feet of ephemeral channels that transition into swales and no longer exhibit bed and bank at the top of ridges in the delineated watersheds. This results in fewer feet being included in the watershed estimate than likely exist in the drain, which means that the percentages associated with the impacts from the Project are conservative, i.e., a slight overestimate of cumulative impacts associated with the Project.

A summary of total stream impacts in each 12-digit HUC is also provided in this document. These impacts include those proposed as part of the Project's IP application and work that was completed under Mountain Valley's previous NWP 12 authorization. They may be found in Table 2, Table A-1, and Table B-1 in Mountain Valleys IP application submitted to the USACE on November 5 and May 14 (respectively), and from the All Streams Crossings table submitted to the USACE on November 15. Please note that proposed impacts in this document are those that are not identified as "Complete" in the All Streams Crossings table.

2.2 Project Wetland Impacts

The Project's wetland impacts are overwhelmingly temporary, and impacted sites will be restored in accordance with the *Mitigation Framework*. There will be no net loss of wetland acreage or long-term impacts to wetland functions and values. Accordingly, the potential cumulative impacts are primarily for impacts to similarly situated wetlands in the same watersheds as the Project during the period of construction and for a post-restoration period thereafter as the impacted resources return to preconstruction conditions. Similar to stream impacts, the wetland impacts most likely to fit those criteria are other impacts related to the Project. Accordingly, Mountain Valley's cumulative impacts assessment methodology for wetland impacts focuses on the potential cumulative impacts of the Project.

ArcMap was the primary tool used to generate the information necessary to evaluate wetland impacts and the presence of NWI features in each watershed. During Project development, Mountain Valley completed wetland delineations in the field in each of the HUC-12 watersheds[3]. These delineations occurred in 2015, 2016, and 2018. During these field exercises, data points were collected using GPS units to determine the bounds of wetland areas. These data were uploaded to create delineation shapefiles.

The Project's delineation shapefiles and the Project Area were imported into ArcMap. Additionally, shapefiles for West Virginia and Virginia HUC-12 watersheds were uploaded and then clipped for each of the Project's HUC-12 watershed areas. Utilizing these files, wetland features were sorted based on HUC-12 attributes and then used to calculate delineation acreage for each watershed.

Wetland impacts in this report are from the Table 3, Table A-2, and Table B-2 in Mountain Valley's IP application submitted to the USACE on March 1st and May 14th and from the All Wetlands Crossings table submitted to the USACE on November 15, 2021. Please note that proposed impacts in this document are those that are not identified as "Complete" in the All Wetland Crossings table.

- To determine the NWI types and acreage for each HUC-12 watershed, the most recent NWI datafiles were downloaded from the U.S. Fish and Wildlife Service (USFWS) on November 19, 2021[4] (updated by USFWS in May 2021). Please note that these files are now routinely updated with new information and may not reflect the same information that was previously provided for this Project.

Because these are environmental data, they are not static. Therefore, it is anticipated that the NWI shapefiles will continue to evolve over time as additional data are uploaded by the USFWS.

[3] The delineations were completed in areas being considered for access roads, pipeline ROW, laydown yards, and other Project features.

[4] https://www.fws.gov/wetlands/Data/State-Downloads.html.

Using the files downloaded from the USFWS and the HUC-12 shapefiles, ArcMap tools created an intersection shapefile of the NWI and HUC-12. Features were then dissolved to generate NWI features based on the HUC-12 attributes and NWI categories (Freshwater Emergent Wetland, Freshwater Forested/Scrub Wetland, Freshwater Pond, Lake, Riverine, and Other). Using ArcMap, the NWI acreage for each category was then generated for the HUC-12 watersheds. To determine if there were NWI features in the Project Area, the NWI file was clipped with the Project Area file.

Mapping and tables for NWI features and wetland impacts have been generated for each HUC-12. The NWI feature descriptions, including Cowardin classification, are as follows:

- Freshwater Emergent Wetland (palustrine emergent) – Herbaceous marsh, fen, swale, and wet meadow
- Freshwater Forested/Scrub Wetland (palustrine forested and/or palustrine shrub) – Forested swamp or wetland shrub bog
- Freshwater Pond (palustrine unconsolidated bottom, palustrine aquatic bed) – Pond
- Riverine (riverine wetland and deepwater) – River or stream channel
- Other – Farmed wetland, saline seep, or other miscellaneous types

As per the USFWS website, the NWI data's objective is to produce reconnaissance-level information on the location, type, and size of the mapped aquatic resources. Therefore, a margin of error is inherent in the use of the imagery, and detailed on-the-ground inspection of any particular site may result in differing information.

In this report, the NWI evaluations focus on the two described wetland types: Freshwater Emergent Wetland and Freshwater Forested/Scrub Wetland. Additional aquatic resources types are provided as they are part of the NWI resources found in the database, i.e., they are part of the USFWS inventory. The NWI files downloaded used for this Project have also greatly expanded the Riverine category compared to NWI files used earlier in the permitting process. This feature is essentially the same as the National Hydrography Dataset (NHD) streamlines, and the impacts associated with this feature are assessed with the stream impacts.

2.3 Hydric Soils

As documented in the application and *Mitigation Framework*, upland and wetland topsoils will be segregated during construction and restored to their previous conditions and contours following construction. In wetlands, the *Mitigation Framework* includes performance standards and monitoring to ensure that hydric soils are successfully restored. There is no reasonable potential for impacts to hydric soils outside of Mountain Valley's LOD. Because these impacts will be temporary and confined to the Project area, Mountain Valley's cumulative impacts assessment methodology identifies Project-related impacts to hydric soils.

- Data for the hydric soil evaluation were obtained from the U.S. Department of Agriculture (USDA), National Resource Conservation Service (NRCS) web soil survey site. Like the USFWS NWI files, the soil survey files are also updated at regular intervals. Similar to the NWI files previously-submitted information containing soil information, the current NRCS data may not be consistent with previously submitted information.

To obtain soil information, shapefiles were generated for each HUC-12. Each of these shapefiles was then uploaded to the NRCS web soil survey site. The NRCS web soil survey site then generated a soil shapefile and a soil report for each HUC-12. Mapping for each HUC-12 watershed was developed utilizing the NRCS-generated shapefiles. This process—creating a shapefile, uploading the shapefile to the NRCS soil survey site, and generating both a shapefile and a soil report—was repeated for the Project Area in each HUC-12 watershed. This resulted in having both hydric soils for the entire watershed as well has hydric soils that may occur in the Project Area. Please note that the watershed area and the Project Area acreage generated by soils mapping may vary slightly as compared to other information generated in this report due to how files are clipped and/or interpolated.

When evaluating soil data, it is important to consider where the soil is located. Soil types vary from county to county, and similar soil may be named differently. Additionally, hydric soil types are based on the county soil survey determination. Often the HUC-12 watersheds overlap several counties. Each NRCS-generated shapefile and report provides these data by county and leave it to the researcher to interpret the map symbols. For example, the map symbol CIB in the Harrison and Taylor County Soil Survey is Clarksburg silt loam, 3 to 8 percent, while in the Webster County soil survey CIB refers to Cliftop Channery silt loam, 3 to 8 percent slopes. To minimize confusion, this report provides soil tables in **Appendix B** for each HUC-12 in the Project Area as well as the entire Project Area tables summarize the relevant hydric soils information for each HUC and the Project Area that can be found in each NRCS web soil survey report including hydric ratings and hydric components.

2.4 Land Use/Land Cover (LULC)

Construction and operation of the Project will, in some locations, result in changes to the land use and cover. In agricultural use areas (e.g., pastures, cropland), meadows, and existing roadways, the preexisting LULC will be restored after construction. Within the permanent right-of-way, forested areas will be converted to meadow or scrub-shrub condition after construction. There also will be marginal increases in impervious surface associated with new access roads, mainline valve sites, and compressor stations. These long-term changes to LULC can be evaluated against other changes occurring over time in the vicinity of the Project using available LULC databases. Accordingly, Mountain Valley has summarized the cumulative impacts to LULC evaluating the Project's relative contribution to changes over time within the relevant watersheds.

The NLCD 2019 files were not utilized in the January 2022 evaluation. When this evaluation was initiated, there was difficulty in finding files that would allow for a consistent comparison from 2019 to 2016 or from 2019 to 2011 in both states. Instead, files from NLCD 2011 and 2016 were utilized to complete LULC comparisons within each HUC-12; however, even these comparisons were not perfect with difference in some of the LULC types utilized during different years and in different states. It is assumed that there would not be a substantial difference in the 2016 and 2019 files as both mining and oil and gas development slowed in both states. However, NLCD 2019 files have been utilized to provide the updated content presented herein. NLCD recategorized LULC types in 2019 and retrofitted the previous 2011 and 2016 data to account for those changes. This accounts for slight variations between what was presented in the January 2022 versus this version of the CIA.

To simplify results, some LULC categories were combined. For example, all forest types were combined under the Forest use, and all development was combined under Mixed Development (MD). In Virginia, roads and barren area were also combined under MD. The LULC files were then clipped using the previously-mentioned HUC-12 shapefiles. Once clipped, areas for each LULC were generated and available for comparison. Mapping for each watershed for the 2011, 2016 and 2019 LULC files were generated in ArcMap. As noted with the soil data, minor differences in watershed acreage may occur. These are minimal and do not affect the results found in this document.[5] A summary of LULC types is provided in **Appendix C**.

3.0 RESULTS

The Project extends 304 miles across 11 HUC-8 watersheds (**Figures 1 and 2, Appendix A**), which contain 62 HUC-12 watersheds with associated impacts to water resources. The 11 HUC-8 watersheds are listed in **Table 1**. Please note that the Upper New in West Virginia and the Middle New in Virginia are the same HUC-8 watershed. To better facilitate the discussion herein, the data are grouped by HUC-8 watershed. **Table 1** also provides the counties where each watershed is located; however, the Project Area does not fall in each of these counties. The Project Area is located in Wetzel, Harrison, Doddridge, Lewis, Braxton, Webster, Nicholas, Greenbrier, Fayette, Summers, and Monroe Counties in West Virginia and in Giles, Craig, Montgomery, Roanoke, Franklin, and Pittsylvania Counties in Virginia.

Table 1
HUC-8 Watersheds Within the Project Area

HUC-8 Watershed	Counties	State
Middle Ohio-North (05030201)	Pleasants, Tyler, Wetzel, Marion, Harrison, Lewis	West Virginia
West Fork (05020002)	Marion, Harrison, Taylor, Barbour, Wetzel, Doddridge	West Virginia
Little Kanawha (05030203)	Wood, Writ, Richie, Roan, Calhoun, Gilmer, Lewis, Braxton	West Virginia

[5] Refer to Section 4.8.1 of the Final Environmental Impact Statement for an additional analysis of the Project's cumulative impacts on land use and cover.

HUC-8 Watershed	Counties	State
Elk (05050007)	Kanawha, Roane, Clay, Braxton, Nicholas, Webster, Randolph, Pocahontas	West Virginia
Gauley (05050005)	Pocahontas, Fayette, Webster, Nicholas, Greenbrier	West Virginia
Lower New (05050004)	Fayette, Raleigh, Summers	West Virginia
Greenbrier (05050003)	Pocahontas, Greenbrier, Summers, Monroe	West Virginia
Upper/Middle New (05050002)	Mercer (WV), Summers (WV), Monroe (WV), Bland (VA), Pulaski (VA), Giles (VA), Craig (VA)	West Virginia, Virginia
Upper James (02080201)	Monroe (WV), Highland (VA), Bath (VA), Alleghany (VA), Craig (VA), Botetourt (VA), Roanoke (VA), Montgomery (VA)	West Virginia, Virginia
Upper Roanoke (03010101)	Montgomery, Roanoke, Floyd, Bedford, Botetourt, Campbell, Henry, Franklin Pittsylvania	Virginia
Banister (03010105)	Halifax, Pittsylvania	Virginia

3.1 Middle Ohio-North

The Project crosses four 12-digit HUC watersheds in the Middle Ohio-North HUC-8 watershed (**Figure 3, Appendix A**). These include North Fork Fishing Creek (050302010202), Headwaters South Fork Fishing Creek (050302010201), Buckeye Creek (050302010402), and Meathouse Fork (050302010403). The Middle Ohio-North watershed is approximately 1,813.5 square miles (mi^2). These four HUC-12 watersheds have a combined drainage area of 171.1 mi^2, which is less than 10 percent of the HUC-8 watershed.

3.1.1 North Fork Fishing Creek

Project Stream Impacts. There are 13 stream crossings in the North Fork Fishing Creek watershed. Six of the crossings are complete. Proposed crossings include one permanent access road, a temporary work area, two pipeline right-of-way (ROW) crossings, and a timber mat crossing with temporary impacts as well as two permanent crossings associated with the Mobley Interconnect. Completed crossings include five crossings associated with the Mobley Interconnect (four permanent and one temporary) and one temporary pipeline ROW crossing. Stream impacts, both temporary (419 linear feet) and permanent (518 linear feet), total 937 linear feet, which represent less than 0.0591% of the linear feet of modeled streams found in this HUC-12 watershed (**Table 2**) (**Figure 4, Appendix A**). Of these impacts, 197 linear feet of temporary impacts and 412 linear feet of permanent impacts are complete.

Project Wetland Impacts. Approximately 0.79 acre of wetland was delineated by Mountain Valley contractors in the North Fork Fishing Creek watershed (**Table 3**) (**Figure 5, Appendix A**). There are six proposed wetland crossings and one completed wetland crossing in the Project Area. Approximately 0.3045 acre of wetland will be temporarily impacted in the Project Area, with no permanent impacts. NWI data identify 225.23 acres of aquatic resources in the North Fork Fishing Creek watershed. Of this total, 0.35 acre is Freshwater Emergent Wetland with no Freshwater Forested/Scrub Wetland. None of the NWI wetlands are in the Project Area.

Soils. According to soil surveys for both Wetzel County, West Virginia and Marion and Monongalia Counties, West Virginia, there are no soils in the North Fork Fishing Creek watershed that are on West Virginia's hydric soil lists. (**Figure 6, Appendix A**).

LULC. LULC changes in the North Fork Fishing Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 4** and **Figures 7, 8 and 8a (Appendix A)**. Overall, there are approximately 27,189 acres in this watershed. The dominant LULC in this area is Forested (over 91%), followed by Stream Riparian Corridor Floodplain (approximately 2.3%). The LOD is approximately 68.6 acres, which represents less than 0.3% of the entire watershed.

3.1.2 Headwaters South Fork Fishing Creek

Project Stream Impacts. There are 24 stream crossings in the Headwaters South Fork Fishing Creek watershed. Five of these crossings, all pipeline ROW crossings, are complete. Proposed crossings include seven timber mat crossing, two pipeline ROW crossings, five temporary access roads, and five permanent access roads. Proposed stream impacts, both temporary (974 linear feet) and permanent (199 linear feet), in the Headwaters South Fork Fishing Creek watershed total 1,173 linear feet, which represent less than 0.0770% of the modeled streams found in this HUC-12 watershed (**Table 2**) (**Figure 9, Appendix A**). Of these impacts, 447 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 3.90 acres of wetland were delineated by Mountain Valley contractors in the Headwaters South Fork Fishing Creek watershed (**Table 4**) (**Figure 10, Appendix A**). There are ten wetland crossings in the Project Area that impact approximately 0.2736 acre. Two of the crossings are complete. The Project will result in 0.2127 acre of temporary impacts, 0.0547 acre of conversion impacts, and 0.0082 acre of permanent impacts in this watershed. The NWI identifies 110.06 acres of aquatic resources in the watershed. There are no Freshwater Emergent Wetlands in the inventory; however, approximately 1.61 acres of Forested/Scrub Wetland are identified. None of the NWI wetlands are in the Project Area.

Soils. Soils surveys relevant to the Headwaters South Fork Fishing Creek watershed include those for Pleasants and Tyler Counties, Wetzel County, Doddridge County, Harrison and Taylor Counties, and Marion and Monongalia Counties. Based on these soil surveys, there are no hydric soils in the Headwaters South Fork Fishing Creek watershed. (**Figure 11, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Headwaters South Fork Fishing Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 5** and **Figures 12, 13 and 13a (Appendix A)**. Overall, there are approximately 25,818 acres in this watershed. The dominant LULC in this area is Forested (over 94%), followed by Roads and Impervious Surfaces (approximately 2.5%). The LOD is approximately 236.1 acres, which represents less than 0.9% of the entire watershed.

3.1.3 Buckeye Creek Watershed

Project Stream Impacts. There are two stream crossings, both pipeline ROW, in the Buckeye Creek watershed. Stream impacts, all of which are temporary, total 130 linear feet, which represent less than 0.0081% of the modeled streams found in this HUC-12 watershed (**Table 2**) (**Figure 14, Appendix A**).

Project Wetland Impacts. Approximately 0.38 acre of wetland was delineated by Mountain Valley contractors in the Buckeye Creek watershed. The Project Area has three proposed wetland crossings that impact approximately 0.0537 acre, of which 0.0422 acre is temporary. The remaining impacts are associated with a permanent access road (0.0115 acre) and will be mitigated using mitigation banking. The NWI identifies 119.33 acres of aquatic resources in the watershed, including 2.18 acres of Freshwater Emergent Wetland and 0.14 acre of Forested/Scrub Wetland (**Table 3**) (**Figure 15, Appendix A**). None of the NWI wetlands are in the Project Area.

Soils. Based on the Harrison and Taylor Counties and the Doddridge County soil surveys, the hydric soil silt loam (Me) can be found in the Buckeye Creek watershed (15.7 acres, less than 0.1%) but not in the Project Area. (**Figure 16, Appendix A**) (**Appendix B**). According to these soil surveys, no other hydric soils or partially hydric soils are present in the watershed.

LULC. LULC changes in the Buckeye Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 4** and **Figures 17, 18 and 18a (Appendix A)**. Overall, there are approximately 25,016 acres in this watershed. The dominant LULC in this area is Forested (over 86%), followed by Stream Riparian Corridor Floodplain (approximately 4.1%). The LOD is approximately 28.9 acres, which represents less than 0.1% of the entire watershed.

3.1.4 Meathouse Fork

Project Stream Impacts. Meathouse Fork is the last HUC-12 watershed that the Project crosses in the Middle Ohio-North drain. There are 13 stream crossings in this watershed. There are four completed pipeline ROW crossing, one permanent access road that will result in permanent impacts, four timber mat crossings and four pipeline ROW crossings that will result in temporary stream impacts. Stream impacts, both temporary (713 linear feet) and permanent (25 linear feet), in the Meathouse Fork watershed total 738 linear feet, which represent less than 0.0351% of the streams found in this HUC-12 watershed (**Table 2**) (**Figure 19, Appendix A**). Of these impacts, 330 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 1.42 acres of wetland were delineated by Mountain Valley contractors in the Meathouse Fork watershed. The Project Area has three proposed wetland crossings and one completed crossing. The total wetland impacts in the watershed are approximately 0.3549 acre. Permanent Project impacts in the watershed, which total 0.0579 acre, are associated with a permanent access road and will be mitigated using mitigation banking. The NWI identifies 158.82 acres of aquatic resources in the watershed, which include 0.85 acre of Freshwater Emergent Wetland, none of which falls within the Project Area (**Table 3**) (**Figure 20, Appendix A**).

Soils. According to the Doddridge County, Lewis County, and Harrison and Taylor Counties soil surveys, the hydric soil Me will be found in the Meathouse Fork watershed (23 acres, less than 0.1%). Approximately 0.8 acre of Me soils may be found in the Project Area (**Figure 21, Appendix A**) (**Appendix B)**.

LULC. LULC changes in the Meathouse Fork watershed between 2011, 2016 and 2019 are illustrated in **Table 4** and **Figures 22, 23 and 23a (Appendix A)**. Overall, there are approximately 31,467 acres in this watershed. The dominant LULC in this area is Forested (over 88%), followed by Pasture, Hay, Agriculture (PHA) (approximately 4.5%). The LOD is approximately 64.9 acres, which represents less than 0.2% of the entire watershed.

Table 2
Cumulative Project-Related Stream Impacts in the HUC-12 Watersheds that Fall Within the Middle Ohio-North Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
North Fork Fishing Creek	13	106	222	518	419	1,586,148	937	0.0591%
Headwaters South Fork Fishing Creek	24	199	527	199	974	1,523,728	1,173	0.0770%
Buckeye Creek	2	0	130	0	130	1,609,870	130	0.0081%
Meathouse Fork	13	25	383	25	713	1,990,839	738	0.0351%

Table 3

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Middle Ohio-North Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
North Fork Fishing Creek	0.79	7	0.3045	0	0	0.3045	223.97	0.35	0.00	0.91	0.00	0.00	225.23
Headwaters South Fork Fishing Creek	3.90	10	0.2127	0.0547	0.0082	0.2756	104.69	0.00	1.61	3.76	0.00	0.00	110.06
Buckeye Creek	0.38	3	0.0422	0.0000	0.0115	0.0537	101.2	2.18	0.14	15.80	0.00	0.00	119.33
Meathouse Fork	1.42	4	0.2970	0.0000	0.0579	0.3549	143.69	0.85	0.00	14.28	0.00	0.00	158.82

[1] Acres delineated within the HUC-12 Watershed.

Table 4
LULC in the HUC-12 Watersheds that Fall Within the Middle Ohio-North Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
North Fork Fishing Creek	27,189	2011	25,502	93.8	89	0.3	506	1.9	162	0.6	6	0.0	0	0.0	0	0.0	992	3.4
	27,189	2016	25,100	92.3	207	0.8	488	1.8	450	1.7	6	0.0	0	0.0	0	0.0	937	3.4
	27,189	2019	24,917	91.6	217	0.8	489	1.8	630	2.3	6	0.0	0	0.0	2	0.0	928	3.4
Headwaters South Fork Fishing Creek	25,818	2011	24,821	96.1	103	0.4	190	0.7	38	0.1	4	0.0	0	0.0	0	0.0	661	2.6
	25,818	2016	24,540	95.1	134	0.5	187	0.7	285	1.1	5	0.0	0	0.0	0	0.0	666	2.6
	25,818	2019	24,302	94.1	148	0.6	187	0.7	522	2.0	5	0.0	0	0.0	2	0.0	652	2.5
Buckeye Creek	25,016	2011	22,527	90.0	333	1.3	985	3.9	249	1.0	5	0.0	0	0.0	0	0.0	916	3.7
	25,016	2016	21,798	87.1	544	2.2	877	3.5	821	3.3	3	0.0	0	0.0	0	0.0	973	3.9
	25,016	2019	21,573	86.2	550	2.2	877	3.5	1,036	4.1	3	0.0	0	0.0	8	0.0	968	3.9
Meathouse Fork	31,467	2011	28,310	90.0	74	0.2	1,481	4.7	361	1.1	1	0.0	0	0.0	0	0.0	1,239	3.9
	31,467	2016	27,812	88.4	173	0.5	1,442	4.6	745	2.4	1	0.0	0	0.0	0	0.0	1,293	4.1
	31,467	2019	27,710	88.1	206	0.7	1,424	4.5	828	2.6	1	0.0	0	0.0	8	0.0	1,289	4.1

3.2 West Fork

The Project crosses seven 12-digit HUC watersheds in the West Fork HUC-8 watershed (**Figure 24, Appendix A**). These include the Little Tenmile Creek (050200020503), the Outlet Tenmile Creek (050200020504), the Headwaters Tenmile Creek (050200020502, Salem Fork (050200020501), Kincheloe Creek (050200020302), Freemans Creek (050500020301), and Polk Creek-West Fork River (050200020105) (**Table 5**). The West Fork watershed is approximately 879.8 mi^2, while the seven 12-digit HUC watersheds total 210.2 mi^2.

3.2.1 Little Tenmile Creek

Project Stream Impacts. Little Tenmile Creek is the first HUC-12 watershed in the West Fork watershed with stream crossings. There are 12 stream crossings, four of which (all pipeline ROW crossings) are complete, located in this watershed. Proposed temporary impacts are associated with four timber mat crossings and two temporary access roads. Two proposed permanent stream crossings are associated with two permanent access roads. Total stream impacts, both temporary (484 linear feet) and permanent (86 linear feet), in the Little Tenmile Creek watershed total 570 linear feet, which represent less than 0.0481% of the modeled streams found in this HUC-12 watershed (**Table 5**) (**Figure 25, Appendix A**). Of these impacts, 369 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 1.00 acres of wetland were delineated by Mountain Valley contractors in the Little Tenmile Creek watershed. The Project has two proposed wetland crossings and one completed wetland crossing, which total 0.0653 acre of temporary impacts with no permanent impacts (**Table 6**). The NWI indicates that there are 123.4 acres of aquatic resources in the watershed, including 1.47 acres of Freshwater Emergent Wetland and no acres of Freshwater Forested/Scrub Wetland (**Table 6**). None of these resources are located in the Project Area (**Figure 26, Appendix A**).

Soils. The Little Tenmile Creek watershed soils data are from the Doddridge County, Harrison and Taylor Counties, and Wetzel County soil surveys. These surveys indicate that the hydric soil Atkins silt loam, 0 to 3 percent slopes, frequently flooded (At) (2.5 acres, less than 0.1% of the watershed area) and partially hydric soil Udifluvents and Fluvaquents (UF) (981.4 acres, approximately 5.4% of the watershed area) are found in the watershed (**Figure 27, Appendix A**) (**Appendix B**). Of these soils, 6.9 acres of UF soils are found in the Project Area.

LULC. LULC changes in the Little Tenmile Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 28, 29 and 29a (Appendix A)**. Overall, there are approximately 18,079 acres in this watershed. The dominant LULC in this area is Forested (over 86%), followed by PHA (approximately 6.2%). The LOD is approximately 138 acres, which represents less than 0.8% of the entire watershed.

3.2.2 Outlet Tenmile Creek

Project Stream Impacts. There are five stream crossings in the Project Area in the Outlet Tenmile Creek watershed (**Table 5**). Only one of the crossings is associated with permanent impacts, a permanent access road. The remaining stream crossings are one timber mat and three pipeline ROW crossings, one of which is complete. Total stream impacts, both temporary (347 linear feet) and permanent (29 linear feet), in the Outlet Tenmile Creek watershed total 376 linear feet, which represent less than 0.0209% of the modeled streams found in this HUC-12 watershed (**Figure 30, Appendix A**). Of these impacts, 115 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 3.29 acres of wetland were delineated by Mountain Valley contractors in the watershed. There are four proposed wetland crossings and one completed wetland crossing in the Project Area that, together, will temporarily impact 0.3939 acre of wetland. Of these impacts, 0.0276 acre of temporary impacts are complete. The NWI data indicate that there are 260.93 acres of aquatic resources, including 10.17 acres of Freshwater Emergent Wetland and 3.25 acres of Forested/Scrub Wetland in the watershed (**Table 6**). The NWI data indicate that the Project will cross approximately 0.0681 acre of Freshwater Emergent Wetland. However, this location was delineated through field surveys and, while a large wetland was identified in the vicinity, no wetlands were identified in the Project Area (**Figure 31, Appendix A**).

Soils. The Outlet Tenmile Creek watershed soils data are from the Doddridge County and Harrison and Taylor Counties soil surveys. Soils in the watershed included the hydric soil Fluvaquents, overwash (FO) (56.8 acres, approximately 0.2% of the watershed area) and partially hydric soil UF (698.6 acres, 2.7% of the watershed area) (**Figure 32, Appendix A**) (**Appendix B**). Soils in the Project Area include the partially hydric soil UF (0.4 acre).

LULC. LULC changes in the Outlet Tenmile Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 33, 34 and 34a (Appendix A)**. Overall, there are approximately 25,521 acres in this watershed. The dominant LULC in this area is Forested (over 77%), followed by PHA (approximately 11.8%). The LOD is approximately 77.6 acres, which represents less than 0.3% of the entire watershed.

3.2.3 Headwaters Tenmile Creek

Project Stream Impacts. The Headwaters Tenmile Creek watershed borders the northern and eastern edges of the Salem Fork watershed. This results in the Project crossing this watershed twice (**Figure 24, Appendix A**). There are 24 stream crossings in this watershed (**Table 5**). Six of these crossings (all pipeline ROW) are complete. Only two proposed crossings have permanent impacts (access roads). Proposed temporary stream impacts are associated with eight pipeline ROW crossings, seven are timber mat crossings, and one temporary access road. Stream impacts, both temporary (1,331 linear) and permanent (77 linear feet), in the Headwaters Tenmile Creek watershed total approximately 1,408 linear feet, which represent less than 0.0839% of the modeled streams found in this HUC-12 watershed (**Table 5**) (**Figure 35, Appendix A**). Of these impacts, 629 linear feet of temporary impacts are complete.

<u>Project Wetland Impacts</u>. Approximately 4.40 acres of wetland were delineated by Mountain Valley contractors in the Headwaters Tenmile Creek watershed. There are 18 wetland crossings, five of which are complete, in the watershed. There are 1.1541 acres of temporary impacts. Approximately 0.1444 acre of conversion impacts will occur and will be mitigated using a mitigation bank. Of these totals, approximately 0.3107 acre of temporary impacts are complete. The NWI mapping indicates that there are 177.44 acres of aquatic resources in the Headwaters Tenmile Creek. Both Freshwater Emergent Wetland (1.43 acres) and Freshwater Forested/Scrub Wetland (0.44 acre) were identified in these data (**Table 6**) (**Figure 36, Appendix A**). These features are not located in the Project Area. NWI information does indicate that a Freshwater Pond is located in the Project Area; however, the Project has avoided this waterbody.

<u>Soils</u>. The Headwaters Tenmile Creek watershed soils data are from the Doddridge County and Harrison and Taylor Counties soil surveys. Based on the information from these soil surveys, there are no hydric soils in the Headwaters Tenmile Creek. Partially hydric soil UF may be located in the watershed (1,092 acres, 4.2% of the watershed area) (**Figure 37, Appendix A**). Small amounts of UF soil (5.1 acres) may be located in the Project Area.

<u>LULC</u>. LULC changes in the Headwaters Tenmile Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 38, 39 and 39a (Appendix A)**. Overall, there are approximately 25,841 acres in this watershed. The dominant LULC in this area is Forested (over 86%), followed by PHA (approximately 6.2%). The LOD is approximately 133 acres, which represents less than 0.5% of the entire watershed.

3.2.4 Salem Fork

<u>Project Stream Impacts</u>. There is only one stream crossing, a pipeline ROW crossing, in the Salem Fork watershed. Stream impacts, all of which are temporary, are limited to 76 linear feet, which represent less than 0.0104% of the modeled streams found in this HUC-12 watershed (**Table 5**) (**Figure 40, Appendix A**).

<u>Project Wetland Impacts</u>. Approximately 1.04 acres of wetland were delineated by Mountain Valley contractors in the Salem Fork watershed. There are two proposed wetland crossings in the Project Area. The impacts associated with the crossings are temporary fill/conversion impacts, 0.0110 acre, and will be mitigated utilizing a mitigation bank. The NWI data indicate that there are 121.58 acres of aquatic resources in the Salem Fork watershed. This includes 2.5 acres of Freshwater Emergent Wetland and no Freshwater Forested/Scrub Wetland (**Table 6**) (**Figure 41, Appendix A**). None of the NWI wetlands are located in the Project Area.

<u>Soils</u>. The Salem Fork watershed soils data are from the Doddridge County and Harrison and Taylor Counties soil surveys. Soils in the watershed included the hydric soil At (11.6 acres, approximately 0.1% of the watershed) and partially hydric soil UF (311 acres, approximately 3.0% of the watershed area) (**Figure 42, Appendix A**) (**Appendix B**). Based on the soil surveys the Project Area soil may include partially hydric soil UF (0.1 acre).

<u>LULC</u>. LULC changes in the Salem Fork watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 43, 44 and 44a (Appendix A)**. Overall, there are approximately 10,515 acres in this watershed. The dominant LULC in this area is Forested (over 75%), followed by PHA (approximately 9.7%). The LOD is approximately 112 acres, which represents less than 1.06% of the entire watershed.

3.2.5 Kincheloe Creek

<u>Project Stream Impacts</u>. There are seven stream crossings in the Kincheloe Creek watershed, two of which are complete. There are four pipeline ROW crossings (two are complete), two timber mat crossings, and a temporary access road. All of these have temporary impacts, totaling approximately 701 linear feet of stream. This represents less than 0.0782% of the modeled streams mapped in this HUC-12 watershed (**Table 5**) (**Figure 45, Appendix A**). Of these impacts, 306 linear feet of temporary impacts are complete.

<u>Project Wetland Impacts</u>. Approximately 4.82 acres of wetland were delineated by Mountain Valley contractors in the Kincheloe Creek watershed. There are three proposed wetland crossings in the watershed with temporary impacts totaling 0.5264 acre. The NWI data indicate that there are 72.05 acres of aquatic resources in the Kincheloe Creek watershed. This includes 0.72 acre of Freshwater Emergent Wetland (**Table 6**) (**Figure 46, Appendix A**). None of the NWI wetlands are located in the Kincheloe Creek watershed.

<u>Soils</u>. The Kincheloe Creek watershed soils data are from the Doddridge County, Harrison and Taylor Counties, and Lewis County soil surveys. Based on data from these soil surveys, there are no hydric soils in the watershed. Two partially hydric soils, Lobdell-Holly silt loams (Lh) (108.5 acres, 0.796% of the watershed area) and UF (273.9 acres, 2.0% of the watershed), are found in the watershed and in the Project Area (0.3 acre and 0.6 acre, respectively) (**Figure 47, Appendix A**) (**Appendix B**).

<u>LULC</u>. LULC changes in the Kincheloe Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 48, 49 and 49a (Appendix A)**. Overall, there are approximately 13,629 acres in this watershed. The dominant LULC in this area is Forested (over 82%), followed by PHA (approximately 10.9%). The LOD is approximately 40.9 acres, which represents less than 0.3% of the entire watershed.

3.2.6 Freemans Creek

<u>Project Stream Impacts</u>. There are 14 stream crossings in the Freemans Creek watershed. There are eight pipeline ROW crossings (five of which are complete), five timber mat crossings, and a temporary access road. Like the Kincheloe Creek watershed, the impacts associated with these crossings are all temporary in nature (**Table 5**). Stream crossing impacts in the Freemans Creek watershed total approximately 812 linear feet of stream, which represent less than 0.0556% of the modeled streams mapped in this HUC-12 watershed (**Figure 50, Appendix A**). Of these impacts, 376 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 3.80 acres were delineated by Mountain Valley contractors in the Freemans Creek watershed. There are 15 wetland crossings in the Project Area, three of which are complete, that will result in temporary impacts to 0.6533 acre of wetland. Of these impacts, 0.1701 acre of temporary impacts are complete. The NWI data indicate that there are 127.75 acres of aquatic resources in the Freemans Creek watershed, of which 2.05 acres are Freshwater Emergent Wetland and 0.52 acre of Freshwater Forested/Scrub Wetland. These features are not located in the Project Area (**Table 6**) (**Figure 51, Appendix A**).

Soils. The Freemans Creek watershed soils data are from the Doddridge County and Lewis County soil surveys. These soil surveys indicate that there are no hydric soils in the watershed. The partially hydric soil Lh can be found in the watershed (273.8 acres, 1.4% of the watershed area). A small amount (2.9 acres) of the partially hydric Lh may be present in the Project Area (**Figure 52, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Freemans Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 53, 54 and 54a (Appendix A)**. Overall, there are approximately 19,727 acres in this watershed. The dominant LULC in this area is Forested (over 76%), followed by PHA (approximately 16%). The LOD is approximately 107 acres, which represents less than 0.4% of the entire watershed.

3.2.7 Polk Creek-West Fork River

Project Stream Impacts. The Polk Creek-West Fork River watershed is the last drain with aquatic resource crossings in the West Fork HUC-8 watershed. However, there are no impacts, temporary or permanent, to streams in the Polk Creek-West Fork River watershed (**Table 5**) (**Figure 55, Appendix A).**

Project Wetland Impacts. Approximately 0.28 acre of wetland was delineated by Mountain Valley contractors in the Polk Creek-West Fork River watershed. There is one proposed wetland crossing in the Project Area that will temporarily impact 0.0231 acre wetland. The NWI data indicate that there are 224.24 acres of aquatic resources in the Polk Creek-West Fork River watershed, of which 11.61 acres are Freshwater Emergent Wetland and 0.95 acre Freshwater Forested/Scrub Wetland (**Table 6**) (**Figure 56, Appendix A)**. None of the NWI wetlands fall in the Project Area.

Soils. The Polk Creek-West Fork River watershed soils data are from the Lewis County soil surveys. These surveys indicate that the partially hydric soil Lh is present in the watershed (87.7 acres, 0.4% of the watershed area) (**Figure 57, Appendix A) (Appendix B)**. Based on the soil survey data, there are no hydric or partially hydric soils in Project Area.

LULC. LULC changes in the Polk Creek-West Fork River watershed between 2011, 2016 and 2019 are illustrated in **Table 7** and **Figures 58, 59 and 59a (Appendix A)**. Overall, there are approximately 21,264 acres in this watershed. The dominant LULC in this area is Forested (over 75%), followed by PHA (approximately 11.4%). The LOD is approximately 16.3 acres, which represents less than 0.08% of the entire watershed.

Table 5
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the West Fork Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Little Tenmile Creek	12	86	115	86	484	1,184,108	570	0.0481%
Outlet Tenmile Creek	5	29	232	29	347	1,796,037	376	0.0209%
Headwaters Tenmile Creek	24	77	702	77	1331	1,678,285	1,408	0.0839%
Salem Fork	1	0	76	0	76	734,073	76	0.0104%
Kincheloe Creek	7	0	395	0	701	896,119	701	0.0782%
Freemans Creek	14	0	436	0	812	1,459,867	812	0.0556%
Polk Creek – West Fork River	0	0	0	0	0	1,496,397	0	0.0000%

Table 6

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the West Fork Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Little Tenmile Creek	1.00	3	0.0653	0	0	0.0653	95.32	1.47	0	26.61	0	0	123.4
Outlet Tenmile Creek	3.29	5	0.3939	0	0	0.3939	135.52	10.17	3.25	80.63	31.36	0	260.93
Headwaters Tenmile Creek	4.40	18	1.1541	0.1444	0	1.2985	129.02	1.43	0.44	18.12	28.43	0	177.44
Salem Fork	1.04	2	0	0.0110	0	0.011	54.06	2.5	0	22.94	42.08	0	121.58
Kincheloe Creek	4.82	3	0.5264	0	0	0.5264	53.13	0.72	0	18.2	0	0	72.05
Freemans Creek	3.80	15	0.6533	0	0	0.6533	90.29	2.05	0.52	34.9	0	0	127.75
Polk Creek-West Fork River	0.28	1	0.0231	0	0	0.0231	153.8	11.61	0.95	57.88	0	0	224.24

[1] Acres delineated within the HUC-12 Watershed.

Table 7
LULC in the HUC-12 Watersheds that Fall Within the West Fork Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Little Tenmile Creek	18,079	2011	15,549	86.0	189	1.0	1,144	6.3	247	1.4	1	0.0	0	0.0	5	0.0	944	5.2
	18,079	2016	15,647	86.5	195	1.1	1,115	6.2	164	0.9	1	0.0	0	0.0	5	0.0	952	5.3
	18,079	2019	15,596	86.3	201	1.1	1,115	6.2	215	1.2	1	0.0	0	0.0	5	0.0	946	5.2
Outlet Tenmile Creek	25,521	2011	19,824	77.7	452	1.8	3,085	12.1	486	1.9	82	0.3	2	0.0	93	0.4	1,497	5.9
	25,521	2016	19,756	77.4	486	1.9	3,006	11.8	560	2.2	74	0.3	2	0.0	103	0.4	1,534	6.0
	25,521	2019	19,863	77.8	493	1.9	3,000	11.8	473	1.9	86	0.3	2	0.0	77	0.3	1,527	6.0
Headwaters Tenmile Creek	25,841	2011	22,403	86.7	256	1.0	1,655	6.4	455	1.8	25	0.1	0	0.0	22	0.1	1,025	4.0
	25,841	2016	22,303	86.3	273	1.1	1,607	6.2	569	2.2	25	0.1	0	0.0	16	0.1	1,047	4.1
	25,841	2019	22,359	86.5	281	1.1	1,600	6.2	520	2.0	26	0.1	0	0.0	16	0.1	1,039	4.0
Salem Fork	10,515	2011	8,082	76.9	506	4.8	1,048	10.0	189	1.8	36	0.3	0	0.0	3	0.0	649	6.2
	10,515	2016	7,976	75.9	525	5.0	1,018	9.7	287	2.7	36	0.3	0	0.0	5	0.0	668	6.4
	10,515	2019	7,957	75.7	529	5.0	1,018	9.7	304	2.9	36	0.3	0	0.0	7	0.1	664	6.3
Kincheloe Creek	13,629	2011	11,433	83.9	32	0.2	1,494	11.0	157	1.2	1	0.0	0	0.0	7	0.1	505	3.7
	13,629	2016	11,314	83.0	40	0.3	1,486	10.9	275	2.0	1	0.0	0	0.0	7	0.1	506	3.7
	13,629	2019	11,266	82.7	44	0.3	1,486	10.9	322	2.4	1	0.0	0	0.0	8	0.1	502	3.7
Freemans Creek	19,727	2011	15,126	76.7	198	1.0	3,222	16.3	296	1.5	1	0.0	0	0.0	13	0.1	870	4.4
	19,727	2016	15,105	76.6	231	1.2	3,156	16.0	330	1.7	1	0.0	0	0.0	21	0.1	883	4.5
	19,727	2019	15,102	76.6	236	1.2	3,149	16.0	322	1.6	1	0.0	0	0.0	22	0.1	894	4.5
Polk Creek-West Fork River	21,264	2011	15,969	75.1	1,211	5.7	2,514	11.8	458	2.2	48	0.2	2	0.0	31	0.1	1,030	4.8
	21,264	2016	15,870	74.6	1,238	5.8	2,443	11.5	568	2.7	46	0.2	2	0.0	36	0.2	1,059	5.0
	21,264	2019	16,051	75.5	1,245	5.9	2,419	11.4	369	1.7	49	0.2	2	0.0	26	0.1	1,103	5.2

3.3 Little Kanawha

The Project crosses seven 12-digit HUC watersheds in the Little Kanawha HUC-8 watershed (**Figure 60, Appendix A**). These include Fink Creek (050302030201), the Headwaters Leading Creek (050302030202), the Headwaters Sand Fork (050302030101), Indian Fork (050302030102), Oil Creek (050302030306), Burnsville Lake-Little Kanawha River (050302030305), and Falls Run-Little Kanawha River (050302030303) (**Table 8**). The Little Kanawha watershed is approximately 2,307.7 mi^2. The combined drainage of the seven listed watersheds is approximately 235.1 mi^2 or less than 10% of the HUC-8 watershed.

3.3.1 Fink Creek

Project Stream Impacts: Fink Creek is the first watershed with stream crossings in the Little Kanawha watershed. Stream impacts include four temporary crossings, two of which are completed pipeline ROW crossings. The proposed impacts in the Fink Creek watershed are timber mat crossings. All impacts are temporary in nature and total 240 linear feet. This represents less than 0.0137% of the modeled streams mapped in this HUC-12 watershed (**Table 8**) (**Figure 61, Appendix A**). Of these impacts, 196 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 1.65 acres of wetland were delineated by Mountain Valley contractors in the Fink Creek watershed. Four proposed wetland crossings will temporarily impact 0.2133 acre of wetland, and one crossing will result in 0.0024 acre of wetland conversion impacts, for a total of 0.2157 acre of wetland impacts in the watershed (**Table 9**) (**Figure 62, Appendix A**). The NWI data indicate that there are 125.13 acres of aquatic resources in the watershed, of which 1.85 acres are Freshwater Emergent Wetland and 1.27 acres of Freshwater Forested/Scrub Wetland in the Fink Creek watershed. These are not located within the Project Area.

Soils. Soils data for the Fink Creek watershed were obtained from the Doddridge County, Gilmer County, and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric soils in the watershed. A small fraction (0.2%) of the watershed soils is the partially hydric soil Lh (60.6 acres) (**Figure 63, Appendix A**) (**Appendix B**). A minor amount (1.3 acre) of Lh soil may be found in the Project Area

LULC. LULC changes in the Fink Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 64, 65 and 65a (Appendix A)**. Overall, there are approximately 27,207 acres in this watershed. The dominant LULC in this area is Forested (over 90%), followed by PHA (approximately 3.9%). The LOD is approximately 42.1 acres, which represents less than 0.2% of the entire watershed.

3.3.2 Headwaters Leading Creek

Project Stream Impacts. The Headwaters Leading Creek watershed has two stream crossings: a timber mat crossing and a pipeline ROW crossing (complete). Both of these stream crossings are temporary and total approximately 89 linear feet. This represents less than 0.0064% of the modeled streams in the Headwaters Leading Creek watershed (**Table 8**) (**Figure 66, Appendix A**). Of these impacts, 67 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 1.06 acres of wetland were delineated by Mountain Valley contractors in the Headwaters Leading Creek watershed. There are four wetland crossings in the watershed, one of which is complete, which will result in 0.0180 acre of temporary impacts and 0.0086 acre of permanent impacts, for a total of 0.0266 acre of impacts (**Table 9**) (**Figure 67, Appendix A**). Permanent impacts will be mitigated using mitigation banking. Of these impacts, 0.0027 acre of permanent impacts are complete. The NWI data indicate that there are 109.17 acres of aquatic resources in the watershed, of which are 6.79 acres of Freshwater Emergent Wetland and 2.09 Freshwater Forested/Scrub Wetland. None of these are located in the proposed Project Area.

Soils. Soils data for the Headwaters Leading Creek watershed were obtained from the Gilmer County and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric soils in the watershed. A small fraction (0.5%, 98 acres) of the watershed soils is the partially hydric soil Lh (**Figure 68, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

LULC. LULC changes in the Headwaters Leading Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 69, 70 and 70a (Appendix A)**. Overall, there are approximately 19,067 acres in this watershed. The dominant LULC in this area is Forested (over 88%), followed by PHA (approximately 5.4%). The LOD is approximately 36.3 acres, which represents less than 0.2% of the entire watershed.

3.3.3 Headwaters Sand Fork

Project Stream Impacts. There are 21 stream crossings in the Headwaters Sand Fork watershed. Eight of these stream crossings, all pipeline ROW crossings, are complete. Permanent impacts are limited to two proposed permanent access road stream crossings. The remaining proposed stream impacts are eight timber mat crossing, a temporary work space, one pipeline crossing, and one temporary access road. Stream impacts, both temporary (1,003 linear feet) and permanent (53 linear feet), in the watershed total approximately 1,056 linear feet, which represent less than 0.0704% of the modeled streams found in this HUC-12 watershed (**Table 8**) (**Figure 71, Appendix A**). Approximately 721 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 1.54 acres of wetland were delineated by Mountain Valley contractors in the Headwaters Sand Fork watershed. There are 11 wetland crossings in this watershed, five of which are complete (0.1117 acre of temporary impacts). Six wetland crossings are proposed that will result in 0.2047 acre of temporary impacts (**Table 9**) (**Figure 72, Appendix A**) totaling 0.3164 acres of temporary impact. The NWI data indicate that there are 119 acres of aquatic resources in the watershed, of which 0.18 acre are Freshwater Emergent Wetland. None of these are located in the Project Area.

<u>Soils</u>. Soils data for the Headwaters Sand Fork watershed were obtained from the Gilmer County and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric soils in the watershed. A small fraction (0.09%, 21.8 acres) of the watershed soils is the partially hydric soil Lh (**Figure 73, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

<u>LULC</u>. LULC changes in the Headwaters Sand Fork watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 74, 75 and 75a (Appendix A)**. Overall, there are approximately 24,971 acres in this watershed. The dominant LULC in this area is Forested (over 92%), followed by PHA (approximately 1.7%). The LOD is approximately 128 acres, which represents less than 0.5% of the entire watershed.

3.3.4 Indian Fork

<u>Project Stream Impacts</u>. There are five stream crossings in the Indian Fork watershed (**Table 8**): three pipeline ROW crossings, one timber mat crossing, and one permanent access road. None of the associated stream impacts are permanent. Stream impacts total approximately 367 linear feet or less than 0.0407% of this HUC-12 watershed (**Figure 76, Appendix A**).

<u>Project Wetland Impacts</u>. Approximately 1.68 acres of wetland were delineated by Mountain Valley contractors in the Indian Fork watershed. There are nine wetland crossings in the Project Area that will result in 0.1176 acre of temporary wetland impacts and approximately 0.0331 acre of permanent impacts, for a total of 0.1507 acre of wetland crossing impacts (**Table 9**) (**Figure 77, Appendix A**). One crossing with temporary impacts totaling 0.0284 acre is complete. The NWI data indicate that there are 64.85 acres of aquatic resources in the Indian Fork watershed, of which 0.08 acre is Freshwater Emergent Wetland. These wetland acres are not located in the Project Area.

<u>Soils</u>. Soils data for the Indian Creek watershed were obtained from the Braxton County, Gilmer County, and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric soils or partially hydric soils present in the watershed (**Figure 78, Appendix A**) (**Appendix B)**.

<u>LULC</u>. LULC changes in the Indian Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 79, 80 and 80a (Appendix A)**. Overall, there are approximately 15,213 acres in this watershed. The dominant LULC in this area is Forested (over 92%), followed by PHA (approximately 1.5%). The LOD is approximately 76.8 acres, which represents less than 0.5% of the entire watershed.

3.3.5 Oil Creek

<u>Project Stream Impacts</u>. The Oil Creek watershed has 22 stream crossings. Two pipeline ROW crossings are complete. There are three proposed permanent access road crossings. The remaining proposed stream crossings are temporary access roads (nine), timber mats (four), and four additional pipeline ROW crossings. Stream impacts, both temporary (1,581 linear feet) and permanent (83 linear feet), total 1,664 linear feet in this watershed (**Table 8**). This is less than 0.1270% of the total modeled streams in the Oil Creek watershed (**Figure 81, Appendix A**). Approximately 248 linear feet of temporary impacts are complete.

Project Wetland Impacts. Approximately 3.06 acres of wetland were delineated by Mountain Valley contractors in the Oil Creek watershed. There are 27 wetland crossings in this watershed. Three of these wetland crossings are complete. These crossings will result in 0.5636 acre of temporary impacts and 0.1432 acre of conversion impacts, for a total of 0.7068 acre of wetland impacts (**Table 9**) (**Figure 82, Appendix A**). Conversion impacts will be mitigated using mitigation banking. Approximately 0.0185 acre of temporary impacts and 0.0146 acre of conversion impacts are complete. The NWI data indicate that there are 84.56 acres of aquatic resources in the watershed, of which 0.66 acre are Freshwater Emergent Wetland. These wetland acres do not fall within the Project Area.

Soils. Soils data for the Oil Creek watershed were obtained from the Braxton County, Gilmer County, and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric or partially hydric soils in the watershed (**Figure 83, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Oil Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 84, 85 and 85a (Appendix A)**. Overall, there are approximately 20,179 acres in this watershed. The dominant LULC in this area is Forested (over 90%), followed by Stream Riparian Corridor Floodplain (approximately 3.0%). The LOD is approximately 139 acres, which represents less than 0.7% of the entire watershed.

3.3.6 Burnsville Lake-Little Kanawha River

Project Stream Impacts. The Burnsville Lake falls in this watershed. As noted on **Figure 86** (**Appendix A**), this feature is not included in the total stream length. Without Burnsville Lake, which represents more than 10 miles of stream that have been converted to a lake, there are an estimated 1,158,723 linear feet (220 miles) of stream in Burnsville Lake-Little Kanawha River watershed. There are 12 stream crossings within this watershed in the Project Area. Two of the crossings are complete. Most of the impacts are temporary in nature (**Table 8**). The proposed permanent impacts are associated with four access roads (one temporary and three permanent). There are five pipeline ROW crossings (two of which are complete), two timber mat crossings, and a temporary access road/work space proposed in this watershed. Stream impacts, both temporary (503 linear feet) and permanent (136 linear feet), total approximately 639 linear feet. This is less than 0.0551% of the modeled streams in this HUC-12 watershed. Approximately 192 linear feet of impacts in this watershed are complete.

Project Wetlands Impacts. Approximately 0.47 acre of wetland was delineated by Mountain Valley contractors in the Burnsville Lake-Little Kanawha River watershed. These wetland areas were avoided, and there are no wetland impacts in the Burnsville Lake-Little Kanawha River watershed. NWI data indicate that there are 964.81 acres of aquatic resources in the watershed, including 27.89 acre of Freshwater Forested/Scrub Wetland (**Table 9**) (**Figure 87, Appendix A**). These wetlands fall outside of the Project Area.

Soils. Soils data for the Burnsville Lake-Little Kanawha River watershed were obtained from the Braxton County and Lewis County, West Virginia soil surveys. Based on these soil surveys, there are no hydric or partially hydric soils in the watershed (**Figure 88, Appendix A**).

LULC. LULC changes in the Burnsville Lake-Little Kanawha River watershed 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 89, 90 and 90a (Appendix A)**. Overall, there are approximately 22,753 acres in this watershed. The dominant LULC in this area is Forested (over 89%), followed by Water (approximately 3.8%). The LOD is approximately 88.9 acres, which represents less than 0.4% of the entire watershed.

3.3.7 Falls Run-Little Kanawha River

Project Stream Impacts. There are 25 stream crossings in the 21,120-acre Falls Run-Little Kanawha River watershed. This is the most southern HUC-12 watershed along the Project route in the Little Kanawha HUC-8 watershed. The impacts are associated with eight timber mat crossings, seven pipeline ROW crossings, a temporary access road, and the Harris Compressor Station. Eight of the crossings are complete – six pipeline crossings and two crossings associated with the Harris Compressor Station. The stream impacts, both temporary (1,466 linear feet) and permanent (148 linear feet), in this watershed total approximately 1,614 linear feet (**Table 8**). The percentage of modeled streams in the watershed is approximately 0.1207% (**Figure 91, Appendix A**). Approximately 539 linear feet of temporary impacts and 94 linear feet of permanent impacts are complete.

Project Wetland Impacts. Approximately 2.12 acres of wetland were delineated by Mountain Valley contractors in the Falls Run-Little Kanawha River watershed. There are four proposed wetland crossings that will result in 0.2446 acre of temporary wetland impacts. The NWI data for this watershed indicate that there are 184.25 acres of aquatic resources in the watershed, including 3.29 acres of Freshwater Emergent Wetland and 6.57 acres of Freshwater Forested/Scrub Wetland (**Table 9**) (**Figure 92, Appendix A**). These wetland acres are not located in the Project Area.

Soils. Soils data for the Falls Run-Little Kanawha River watershed were obtained from the Braxton County, Lewis County, and Webster County, West Virginia soil surveys. Based on these soil surveys, there are no hydric or partially hydric soils in the watershed (**Figure 93, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Falls Run-Little Kanawha River watershed between 2011, 2016 and 2019 are illustrated in **Table 10** and **Figures 94, 95 and 95a (Appendix A)**. Overall, there are approximately 21,098 acres in this watershed. The dominant LULC in this area is Forested (over 86%), followed by PHA (approximately 4.2%). The LOD is approximately 205 acres, which represents less than 1.0% of the entire watershed.

Table 8

Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Little Kanawha Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Fink Creek	4	0	44	0	240	1,757,227	240	0.0137%
Headwaters Leading Creek	2	0	22	0	89	1,391,441	89	0.0064%
Headwaters Sand Fork	21	53	282	53	1,003	1,500,869	1,056	0.0704%
Indian Fork	5	0	367	0	367	902,452	367	0.0407%
Oil Creek	22	83	1,333	83	1,581	1,310,301	1,664	0.1270%
Burnsville Lake – Little Kanawha River	12	136	311	136	503	1,158,723	639	0.0551%
Falls Run – Little Kanawha River	25	54	927	148	1,466	1,336,392	1,614	0.1207%

Table 9

Cumulative Project-Related Wetland Impacts and National Wetland Inventory data in the HUC-12 Watersheds that Fall Within the Little Kanawha Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Fink Creek	1.65	4	0.2133	0.0024	0	0.2157	108.82	1.85	1.27	13.2	0	0	125.13
Headwaters Leading Creek	1.06	4	0.0180	0	0.0086	0.0266	80.4	6.79	2.09	19.89	0	0	109.17
Headwaters Sand Fork	1.54	11	0.3164	0	0	0.3164	114.52	0.18	0	4.3	0	0	119
Indian Fork	1.68	9	0.1176	0	0.0331	0.1507	61.94	0.08	0	2.83	0	0	64.85
Oil Creek	3.06	27	0.5636	0.1432	0	0.7068	81.24	0.66	0	2.66	0	0	84.56
Burnsville Lake-Little Kanawha River	0.47	---	---	---	---	---	69.61	--	27.89	2.61	864.7	---	964.81
Falls Run-Little Kanawha River	2.12	4	0.2446	0	0	0.2446	102.99	3.29	6.57	6.89	64.51	0	184.25

[1] Acres delineated within the HUC-12 Watershed.

Table 10
LULC in the HUC-12 Watersheds that Fall Within the Little Kanawha Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Fink Creek	27,206	2011	24,660	90.6	37	0.1	1,071	3.9	255	0.9	2	0.0	0	0.0	1	0.0	1,180	4.3
	27,268	2016	24,660	90.4	42	0.2	1,059	3.9	316	1.2	2	0.0	0	0.0	1	0.0	1,189	4.4
	27,207	2019	24,660	90.6	46	0.2	1,053	3.9	232	0.9	2	0.0	0	0.0	2	0.0	1,213	4.5
Headwaters Leading Creek	18,914	2011	16,801	88.8	104	0.6	1,046	5.5	258	1.4	1	0.0	0	0.0	0	0.0	703	3.7
	19,191	2016	16,801	87.5	116	0.6	1,031	5.4	532	2.8	1	0.0	0	0.0	0	0.0	710	3.7
	19,067	2019	16,801	88.1	121	0.6	1,026	5.4	376	2.0	1	0.0	0	0.0	0	0.0	742	3.9
Headwaters Sand Fork	24,921	2011	23,054	92.5	61	0.2	425	1.7	375	1.5	0	0.0	0	0.0	1	0.0	1,005	4.0
	25,211	2016	23,054	91.4	74	0.3	413	1.6	659	2.6	0	0.0	0	0.0	1	0.0	1,009	4.0
	24,971	2019	23,054	92.3	79	0.3	412	1.7	400	1.6	0	0.0	0	0.0	4	0.0	1,021	4.1
Indian Fork	15,306	2011	14,129	92.3	97	0.6	240	1.6	256	1.7	0	0.0	0	0.0	0	0.0	585	3.8
	15,372	2016	14,129	91.9	103	0.7	221	1.4	323	2.1	0	0.0	0	0.0	6	0.0	592	3.8
	15,213	2019	14,129	92.9	105	0.7	221	1.5	166	1.1	0	0.0	0	0.0	3	0.0	590	3.9
Oil Creek	19,763	2011	18,193	92.1	304	1.5	379	1.9	216	1.1	0	0.0	2	0.0	10	0.0	660	3.3
	20,153	2016	18,193	90.3	310	1.5	381	1.9	590	2.9	0	0.0	2	0.0	6	0.0	671	3.3
	20,179	2019	18,193	90.2	312	1.5	377	1.9	601	3.0	0	0.0	2	0.0	6	0.0	687	3.4
Burnsville Lake-Little Kanawha River	22,445	2011	20,264	90.3	130	0.6	553	2.5	153	0.7	869	3.9	7	0.0	4	0.0	466	2.1
	22,736	2016	20,264	89.1	136	0.6	536	2.4	453	2.0	867	3.8	8	0.0	4	0.0	468	2.1
	22,753	2019	20,264	89.1	138	0.6	534	2.3	469	2.1	867	3.8	8	0.0	7	0.0	468	2.1
Falls Run-Little Kanawha River	20,522	2011	18,278	89.1	74	0.4	909	4.4	251	1.2	62	0.3	3	0.0	18	0.1	927	4.5
	20,990	2016	18,278	87.1	79	0.4	894	4.3	729	3.5	60	0.3	3	0.0	19	0.1	928	4.4
	21,098	2019	18,278	86.6	83	0.4	893	4.2	837	4.0	51	0.2	12	0.1	18	0.1	925	4.4

3.4 Elk

The Project crosses eight 12-digit HUC watersheds in the Little Kanawha HUC-8 watershed (**Figure 96, Appendix A**). These include the Outlet Holly River (050500070304), the Left Fork Holly River (050500070301), the Outlet Right Fork Holly River (050500070303), Upper Sutton Lake-Elk River (050500070602), Big Run-Elk River (050500070601), the Headwaters Laurel Creek (050500070201), Outlet Laurel Creek (050500070202), and Upper Birch River (050500070401) (**Table 11**). The Elk watershed is approximately 1,532.1 mi^2, while the eight 12-digit HUC watersheds total 268.1 mi^2.

3.4.1 Outlet Holly River

Project Stream Impacts. There are 13 stream crossings in the Outlet Holly River watershed: nine pipeline ROW crossings, three timber mat crossings, and a temporary access road. The proposed stream crossing impacts in this watershed are temporary in nature. Proposed stream impacts in the Outlet Holly River watershed total approximately 794 linear feet or less than 0.0642% of the modeled streams in this HUC-12 watershed (**Table 11**) (**Figure 97**, **Appendix A**).

Project Wetland Impacts. Approximately 1.28 acres of wetland were delineated by Mountain Valley contractors in the Outlet Holly River watershed. There are eight wetland crossings, two of which are complete, that will temporarily impact 0.1703 acre wetland in the watershed. The NWI data indicate that there are 245.14 acres of aquatic resources including 1.33 acres of Freshwater Emergent Wetland and 3.57 acres of Freshwater Forested/Scrub Wetland in the watershed (**Table 12**) (**Figure 98, Appendix A**). These NWI wetlands are not located in the Project Area.

Soils. Soils data for the Outlet Holly River watershed were obtained from the Braxton County and Webster County, West Virginia soil surveys. Based on these soil surveys, there are no hydric or partially hydric soils in the watershed (**Figure 99, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Outlet Holly River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 100, 101 and 101a (Appendix A)**. Overall, there are approximately 19,373 acres in this watershed. The dominant LULC in this area is Forested (over 92%), followed by PHA (approximately 2.0%). The LOD is approximately 83 acres, which represents less than 0.4% of the entire watershed.

3.4.2 Headwaters Holly River

Project Stream Impacts. The Headwaters Holly River watershed is sometimes referred to as the Left Fork Holly River watershed. There are approximately 634 linear feet of proposed temporary impacts associated with three pipeline ROW and one pipeline ROW crossing/temporary access road (**Table 11**). This represents less than 0.0290% of the modeled stream in this HUC-12 watershed (**Figure 102, Appendix A**).

Project Wetlands Impacts. Approximately 0.07 acre of wetland was delineated by Mountain Valley contractors in the Headwater Holly River watershed. These wetlands were avoided, and there are no wetland impacts in this watershed. The NWI data indicate that there are 244.14 acres of aquatic resources in the watershed, including 12.5 acres of Freshwater Emergent Wetland and 15.61 acres of Freshwater Forested/Scrub Wetland. These wetlands are not located in the Project Area (**Table 12**) (**Figure 103, Appendix A**).

Soils. Soils data for the Headwater Holly River watershed were obtained from the Randolph County Area, Main Part, and Webster County, West Virginia soil surveys. Based on these soil surveys, there are two hydric soils in the watershed: Atkins loam, moist, 0 to 3 percent slopes, frequently flooded (At-Webster) (5.8 acres, less than 0.02% of the watershed), and Elkins silt loam (Ek) (8.1 acres, less than 0.03% of the watershed area) (**Figure 104, Appendix A**) (**Appendix B**). These soil types are not crossed by the Project.

LULC. LULC changes in the Headwaters Holly River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 105, 106 and 106a (Appendix A)**. Overall, there are approximately 34,968 acres in this watershed. The dominant LULC in this area is Forested (over 93%), followed by Stream Riparian Corridor Floodplain (approximately 1.4%). The LOD is approximately 9.5 acres, which represents less than 0.03% of the entire watershed.

3.4.3 Outlet Right Fork Holly River

Project Stream Impacts. The Outlet Right Fork Holly River watershed has three proposed stream crossings. This includes permanent impacts (29 linear feet) associated with a permanent access road and temporary impacts (107 linear feet) from a pipeline ROW crossing and an additional temporary work space. The total stream crossing impacts are approximately 136 linear feet (**Table 11**). This equates to approximately 0.0141% of the stream length modeled in this HUC-12 watershed (**Figure 107, Appendix A**).

Project Wetlands Impacts. Approximately 0.18 acre of wetland was delineated by Mountain Valley contractors in the Outlet Right Fork Holly River watershed. These wetlands were avoided, and there are no wetland impacts in this watershed. The NWI data indicate that there are 93.35 acres of aquatic resources in this watershed, including 0.77 acre of Freshwater Emergent Wetland and 13.17 acres of Freshwater Forested/Scrub Wetland (**Table 12**) (**Figure 108, Appendix A**). These wetlands are not in the Project Area.

Soils. Soils data for the Outlet Right Fork Holly River watershed were obtained from the Braxton County and Webster County, West Virginia soil surveys. Based on these soil surveys, the hydric soil At-Webster (20.3 acre and less than 0.15% of the watershed area) is found in the watershed (**Figure 109, Appendix A**) (Appendix B). This soil type is not crossed by the Project.

LULC. LULC changes in the Outlet Right Holly River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 110, 111 and 111a (Appendix A)**. Overall, there are approximately 13,679 acres in this watershed. The dominant LULC in this area is Forested (over 93%), followed by PHA (approximately 2.1%). The LOD is approximately 71.4 acres, which represents less than 0.5% of the entire watershed.

3.4.4 Upper Sutton Lake-Elk River

Project Stream Impacts. The Upper Sutton Lake-Elk River watershed contains the tailwaters of Sutton Lake. For the reasons explained in Section 2.0 above, and as noted in **Figure 112** (**Appendix A**), this aquatic resource is excluded from the stream model. There are six proposed stream crossings in this watershed, which total 208 linear feet of temporary impacts (**Table 11**). This includes four timber mat crossings and two pipeline ROW crossings. The total impacts equate to approximately 0.0305% of the stream length modeled in this HUC-12 watershed.

Project Wetlands Impacts. Approximately 0.50 acre of wetlands was delineated by Mountain Valley contractors in the Upper Sutton Lake-Elk River watershed. The Project includes four proposed wetland crossings. The Project will temporarily impact approximately 0.0662 acre of wetland. The NWI data indicate that there are 365.44 acres of aquatic resources in this watershed, including 2.3 acres of Freshwater Emergent Wetland and 1.85 acres of Freshwater Forested/Scrub Wetland. None of these wetlands are located in the Project Area (**Table 12**) (**Figure 113, Appendix A**).

Soils. Soils data for the Upper Sutton Lake-Elk River watershed were obtained from the Braxton County and Webster County, West Virginia soil surveys. Based on these soil surveys, there are no hydric or partially hydric soils in the watershed (**Figure 114, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Upper Sutton Lake-Elk River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 115, 116 and 116a (Appendix A)**. Overall, there are approximately 12,053 acres in this watershed. The dominant LULC in this area is Forested (over 92%), followed by Stream Riparian Corridor Floodplain (approximately 2.6%). The LOD is approximately 100.3 acres, which represents less than 0.8% of the entire watershed.

3.4.5 Big Run-Elk River

Project Stream Impacts. There are four proposed stream crossings in the Big Run-Elk River watershed: three pipeline ROW crossings and one timber mat crossings. These impacts are temporary and total approximately 114 linear feet of stream (**Table 11**). This represents less than 0.0102% of the stream length modeled in this HUC-12 watershed (**Figure 117, Appendix A**).

Project Wetlands Impacts. Approximately 0.13 acre of wetland was delineated by Mountain Valley contractors in the Big Run-Elk River watershed. There are seven wetland crossings, three of which are complete, in the watershed. The Project will result in a total of 0.1013 acre of temporary wetland impacts. The three completed crossings resulted in 0.0463 acre of temporary impacts. The NWI data indicate that there are 333.77 acres of aquatic resources in the watershed, including 0.75 acre of Freshwater Emergent Wetland and 5.01 acres of Freshwater Forested/Scrub Wetland. None of these wetlands are in the Project Area (**Table 12**) (**Figure 118, Appendix A**).

Soils. Soils data for the Big Run-Elk River watershed were obtained from the Webster County, West Virginia soil surveys. Based on this soil survey, the hydric soil At-Webster (3.8 acres, 0.02%

of the watershed area) occurs in the watershed (**Figure 119, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

LULC. LULC changes in the Big Run-Elk River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 120, 121 and 121a (Appendix A)**. Overall, there are approximately 17,907 acres in this watershed. The dominant LULC in this area is Forested (over 93%), followed by Stream Riparian Corridor Floodplain (approximately 2.0%). The LOD is approximately 26.8 acres, which represents less than 0.15% of the entire watershed.

3.4.6 Outlet Laurel Creek

Project Stream Impacts. There are 12 proposed stream crossings in the Outlet Laurel Creek watershed. The only permanent stream crossing impacts are associated with a permanent access road. Other proposed stream crossings include 10 pipeline ROW crossings and one temporary access road. Stream impacts, both permanent (30 linear feet) and temporary (773 linear feet), total approximately 803 linear feet or less than 0.0549% of the modeled stream in this HUC-12 watershed (**Table 11**) (**Figure 122, Appendix A**).

Project Wetland Impacts. Approximately 3.15 acres of wetland were delineated by Mountain Valley contractors in the Outlet Laurel Creek watershed. The Project has 22 wetland crossings, of which two are complete. The Project will temporarily impact approximately 0.4076 acre of wetland, will result in 0.4849 acre of wetland conversion impacts, and will permanently impact 0.0907 acres of wetland, for a total of 0.9832 acre of wetland impacts in the Project Area. The completed impacts include 0.0725 acre of wetland conversion impacts and 0.0117 acre of temporary impacts. Conversion and permanent wetland impacts will be mitigated using mitigation banking. The NWI data indicate that there are 129.49 acres of aquatic resources in the watershed, including 3.26 acres of Freshwater Emergent Wetland and 1.87 acres of Freshwater Forested/Scrub Wetland (**Table 12**) (**Figure 123, Appendix A**). These wetlands are not located in the Project Area.

Soils. Soils data for the Outlet Laurel Creek watershed were obtained from the Braxton County and Webster County, West Virginia soil surveys. Based on these soil surveys, the hydric soil At-Webster (4.6 acres, less than 0.02% of the watershed area) is found in the watershed (**Figure 124, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

LULC. LULC changes in the Outlet Laurel Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 125, 126 and 126a (Appendix A)**. Overall, there are approximately 23,571 acres in this watershed. The dominant LULC in this area is Forested (over 88%), followed by Stream Riparian Corridor Floodplain (approximately 7.5%). The LOD is approximately 118 acres, which represents less than 0.6% of the entire watershed.

3.4.7 Headwaters Laurel Creek

Project Stream Impacts. The Headwaters Laurel Creek watershed has 19 stream crossings, three of which are complete. The completed stream crossings include two pipeline ROW crossings and an area that includes pipeline ROW and temporary access road. Eleven of the proposed stream crossings are pipeline ROW crossings. The remaining are three timber mat crossings and two temporary access roads. The stream impacts in this watershed are temporary in nature (**Table 11**). Combined, the 1,498 linear feet of stream impacts represent less than 0.1179% of the modeled streams in this HUC-12 watershed (**Figure 127**, **Appendix A**). Approximately 301 linear feet of temporary impacts are complete.

Project Wetlands Impacts. Approximately 2.96 acres of wetland were delineated by Mountain Valley contractors in the Headwaters of Laurel Creek watershed. There are five proposed wetland crossings in the Project Area. The crossings will result in 0.2553 acre of temporary impacts, 0.0108 acre of wetland conversion impacts, and 0.0400 acre of permanent wetland impacts. Conversion and permanent wetland impacts will be mitigated using mitigation banking. The NWI data indicate that there are 109.8 acres of aquatic resources in the watershed, including 1.01 acre of Freshwater Emergent Wetland and 1.57 Freshwater Forested/Scrub Wetland (**Table 12**) (**Figure 128, Appendix A**). These wetlands are not located in the Project Area.

Soils. Soils data for the Headwater Laurel Creek watershed were obtained from the Webster County, West Virginia soil surveys. Based on this soil survey, the hydric soils At-Webster (52.4 acres, less than 0.3% of the watershed area) and Ek (60.6 acres, approximately 0.3% of the watershed area) are mapped in the watershed. Approximately 0.9 acre of the hydric soil At-Webster may be present in the Project Area (**Figure 129, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Headwaters Laurel Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 130, 131 and 131a (Appendix A)**. Overall, there are approximately 19,065 acres in this watershed. The dominant LULC in this area is Forested (over 87%), followed by Stream Riparian Corridor Floodplain (approximately 5.0%). The LOD is approximately 126.5 acres, confirm which represents less than 0.7% of the entire watershed.

3.4.8 Upper Birch River

Project Stream Impacts. The Upper Birch River watershed is the southernmost 12-digit HUC crossed by the Project in the Elk HUC-8 watershed. The 21 stream crossings include five complete pipeline ROW crossings. The remaining proposed stream crossings are two pipeline ROW crossings, seven timber mat crossings, and seven temporary access roads (**Table 11**). The total stream crossing impacts are approximately 700 linear feet. These impacts are all temporary in nature and amount to less than 0.0319% of the streams mapped in the Upper Birch River watershed (**Figure 132**, **Appendix A**). Approximately 228 linear feet of the temporary impacts are complete.

Project Wetlands Impacts. Approximately 2.96 acres of wetland were delineated by Mountain Valley contractors in the Upper Birch River watershed. There are ten wetland crossings, three of which are complete, in the Project Area. The Project will temporarily impact 0.1746 acre of wetland and result in 0.0188 acre of wetland conversion impacts. Wetland conversion impacts will be mitigated using mitigation banking. The three completed crossings temporarily impacted 0.0136 acre of wetland. The NWI data indicate that there are 140.94 acres of aquatic resources in the watershed, including 3.27 acres of Freshwater Emergent Wetland and 0.81 acre of Freshwater Forested/Scrub Wetland (**Table 12**) (**Figure 133, Appendix A**). These wetlands are not located in the Project Area.

Soils. Soils data for the Upper Birch River watershed were obtained from the Braxton County, Nicholas County, and Webster County, West Virginia soil surveys. Based on these soil surveys, the hydric soil At-Webster (56.4 acre, less than 0.2% of the watershed area) may be found in the watershed. Approximately 1.7 acre At-Webster may be crossed by the Project (**Figure 134, Appendix A**) (**Appendix B**).

LULC. LULC changes in the Upper Birch River watershed between 2011, 2016 and 2019 are illustrated in **Table 13** and **Figures 135, 136 and 136a (Appendix A)**. Overall, there are approximately 31,002 acres in this watershed. The dominant LULC in this area is Forested (over 87%), followed by Stream Riparian Corridor Floodplain (approximately 6.1%). The LOD is approximately 85.9 acres, which represents less than 0.3% of the entire watershed.

Table 11
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Elk Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Outlet Holly River	13	0	743	0	794	1,236,071	794	0.0642%
Headwaters Holly River	4	0	634	0	634	2,183,798	634	0.0290%
Outlet Right Fork Holly River	3	29	107	29	107	964,639	136	0.0141%
Upper Sutton Lake – Elk River	6	0	208	0	208	681,017	208	0.0305%
Big Run – Elk River	4	0	114	0	114	1,122,166	114	0.0102%
Outlet Laurel Creek	12	30	773	30	773	1,463,657	803	0.0549%
Headwaters Laurel Creek	19	0	1,197	0	1,498	1,270,457	1,498	0.1179%
Upper Birch River	21	0	472	0	700	2,191,918	700	0.0319%

Table 12

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Elk Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Outlet Holly River	1.28	8	0.1703	0.000	0.000	0.1703	80.55	0	1.33	3.57	159.7	0	245.14
Headwaters Holly River	0.07	0	---	---	---	---	202.31	12.5	15.61	13.98	0	0	244.14
Outlet Right Fork Holly River	0.18	0	---	---	---	---	73.48	0.77	13.17	5.93	0	0	93.35
Upper Sutton Lake – Elk River	0.50	4	0.0662	0.000	0.000	0.0662	91.19	2.3	1.85	2.26	267.84	0	365.44
Big Run Elk River	0.13	7	0.1013	0.000	0.000	0.1013	320.07	0.75	5.01	7.94	0	0	333.77
Outlet Laurel Creek	3.15	22	0.4076	0.4849	0.0907	0.9832	116.85	3.26	1.87	7.51	0	0	129.49
Headwaters Laurel Creek	2.96	5	0.2553	0.0108	0.0400	0.3061	86.41	1.01	1.57	20.81	0	0	109.8
Upper Birch River	2.96	10	0.1746	0.0188	0.000	0.1934	129.4	3.27	0.81	7.46	0	0	140.94

[1] Acres delineated within the HUC-12 Watershed.

Table 13

LULC in the HUC-12 Watersheds that Fall Within the Elk Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Outlet Holly River	19373.9	2011	18035.1	93.1	22.9	0.1	392.5	2.0	143.4	0.7	139.7	0.7	0.0	0.0	5.3	0.0	634.9	3.3
	19373.9	2016	17861.0	92.2	25.8	0.1	387.0	2.0	323.8	1.7	139.9	0.7	0.0	0.0	3.6	0.0	632.9	3.3
	19373.9	2019	17823.2	92.0	27.6	0.1	387.0	2.0	373.6	1.9	127.9	0.7	0.0	0.0	3.6	0.0	631.2	3.3
Headwaters Holly River	34968.5	2011	32950.5	94.2	44.5	0.1	436.3	1.2	257.1	0.7	5.1	0.0	12.7	0.0	21.6	0.1	1240.7	3.5
	34968.5	2016	32593.7	93.2	46.9	0.1	435.0	1.2	612.0	1.8	5.8	0.0	12.7	0.0	21.6	0.1	1240.7	3.5
	34968.5	2019	32711.6	93.5	48.5	0.1	432.1	1.2	503.9	1.4	5.8	0.0	12.7	0.0	14.7	0.0	1239.2	3.5
Outlet Right Fork Holly River	13679.3	2011	12849.3	93.9	39.8	0.3	295.3	2.2	111.2	0.8	1.8	0.0	3.8	0.0	1.1	0.0	377.0	2.8
	13679.3	2016	12793.9	93.5	41.8	0.3	295.1	2.2	166.6	1.2	1.8	0.0	3.8	0.0	1.1	0.0	375.2	2.7
	13679.3	2019	12724.3	93.0	42.7	0.3	293.8	2.1	236.2	1.7	1.8	0.0	3.8	0.0	2.4	0.0	374.3	2.7
Upper Sutton Lake – Elk River	12053.8	2011	11067.7	91.8	13.6	0.1	69.4	0.6	385.2	3.2	307.1	2.5	0.9	0.0	1.1	0.0	208.8	1.7
	12053.8	2016	11152.7	92.5	14.5	0.1	64.3	0.5	303.8	2.5	305.6	2.5	0.9	0.0	2.0	0.0	210.2	1.7
	12053.8	2019	11147.5	92.5	14.9	0.1	64.3	0.5	314.7	2.6	299.8	2.5	0.9	0.0	2.0	0.0	209.7	1.7
Big Run Elk River	17907.9	2011	16518.4	92.2	53.4	0.3	141.2	0.8	463.5	2.6	205.9	1.1	2.7	0.0	112.8	0.6	410.1	2.3
	17907.9	2016	16494.4	92.1	59.6	0.3	139.9	0.8	564.2	3.2	201.3	1.1	1.3	0.0	42.3	0.2	405.0	2.3
	17907.9	2019	16721.0	93.4	62.3	0.3	139.9	0.8	365.4	2.0	201.3	1.1	1.3	0.0	14.5	0.1	402.3	2.2
Outlet Laurel Creek	23571.6	2011	21572.5	91.5	93.9	0.4	162.3	0.7	935.6	4.0	4.2	0.0	0.7	0.0	299.1	1.3	503.3	2.1
	23571.6	2016	20757.2	88.1	111.0	0.5	160.6	0.7	1816.7	7.7	2.0	0.0	0.7	0.0	215.5	0.9	507.9	2.2
	23571.6	2019	20763.7	88.1	113.4	0.5	159.7	0.7	1757.6	7.5	1.6	0.0	0.7	0.0	269.5	1.1	505.5	2.1
Headwaters Laurel Creek	19065.9	2011	16723.0	87.7	141.2	0.7	611.8	3.2	367.6	1.9	3.3	0.0	17.6	0.1	644.5	3.4	556.9	2.9
	19065.9	2016	16757.9	87.9	143.2	0.8	610.7	3.2	637.2	3.3	3.3	0.0	16.5	0.1	339.2	1.8	558.0	2.9
	19065.9	2019	16612.7	87.1	146.6	0.8	612.3	3.2	954.5	5.0	4.2	0.0	16.5	0.1	164.6	0.9	554.7	2.9
Upper Birch River	31002.5	2011	26958.0	87.0	87.8	0.3	649.6	2.1	1700.7	5.5	7.8	0.0	2.9	0.0	801.5	2.6	794.2	2.6
	31002.5	2016	27239.4	87.9	91.2	0.3	644.1	2.1	1583.0	5.1	8.9	0.0	2.7	0.0	634.0	2.0	799.3	2.6
	31002.5	2019	27147.1	87.6	95.0	0.3	642.9	2.1	1875.9	6.1	6.4	0.0	2.7	0.0	437.0	1.4	795.5	2.6

3.5 Gauley

The Project crosses ten 12-digit HUC watersheds in the Gauley HUC-8 watershed (**Figure 137, Appendix A**) near the center of the watershed. These include Big Laurel Creek-Gauley River (050500050303), Big Beaver Creek (050500050801), Panther Creek-Gauley River (050500050804), the Outlet Hominy Creek (050500050502), the Headwaters Hominy Creek (050500050501), Anglins Creek (050500050607), Meadow Creek-Meadow River (050500050606), Mill Creek-Meadow River (050500050605), Sewell Creek (050500050604), and Otter Creek-Meadow River (050500050602) (**Table 14**). The Gauley watershed is approximately 1,419.7 mi^2. The combined drainage of the ten listed watersheds is approximately 465.8 mi^2.

3.5.1 Big Laurel Creek-Gauley River

Project Stream Impacts. Big Laurel Creek-Gauley River is the first watershed 12-digit HUC in the Gauley watershed with stream crossings in the Project area. There are 18 stream crossings in this watershed. Two of these crossings are complete (pipeline ROW crossings). It is one of the largest 12-digit HUCs that the Project passes through in West Virginia. Seven of the proposed stream crossings are pipeline ROW crossings, while seven are timber mat crossings and two are temporary access roads. The impacts in this watershed are all temporary in nature. The total stream impacts, an estimated 851 linear feet of stream, represent approximately 0.0388% of the modeled streams in the Big Laurel Creek-Gauley River watershed (**Table 14**) (**Figure 138, Appendix A**). Approximately 96 linear feet of temporary impacts are complete.

Project Wetlands Impacts. Approximately 15.49 acres of wetland were delineated by Mountain Valley contractors in the Big Laurel Creek-Gauley River watershed. The Project includes 21 wetland crossings -three are complete. Wetland impacts include 0.6279 acres of temporary impacts and 0.1085 acre of wetland conversion impacts totaling 0.7364 acre of wetland impacts. The wetland conversion impacts will be mitigated using mitigation banking. The completed wetland crossings include 0.0224 acre of temporary impacts and 0.0107 acre of wetland conversion impacts. The NWI data indicate that there are 625.08 acres of aquatic resources in the watershed, including 18.96 acres of Freshwater Emergent Wetland and 45.25 acre of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 139, Appendix A**). These wetlands are not located in the Project Area.

Soils. Soils data for the Big Laurel Creek-Gauley River watershed were obtained from the Nicholas County and Webster County, West Virginia soil surveys. Based on these soil surveys, the hydric soils At-Webster (57.1 acres, less than 0.2% of the watershed area), Ek (229.2 acres and less than 0.7% of the watershed area), Elkins silt loam, drained (Ed) (346.2 acres, less than 1.0% of the watershed area), and Purdy silt loam, 0 to 5 percent slopes (62.6 acres, less than 0.2% of the watershed area) may be found in the watershed (**Figure 140, Appendix A**) (Appendix B). Approximately 4.7 acres of the hydric soil Ed may also be found in the Project Area.

LULC. LULC changes in the Big Laurel Creek-Gauley River watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 141, 142 and 142a (Appendix A)**. Overall, there are approximately 36,237 acres in this watershed. The dominant LULC in this area is Forested (over

82%), followed by PHA (approximately 6.5%). The LOD is approximately 110.7 acres, which represents less than 0.3% of the entire watershed.

3.5.2 Big Beaver Creek

Project Stream Impacts. The Big Beaver Creek watershed has 21 proposed stream crossings. Ten of these are pipeline ROW crossings, while nine stream crossings are associated with timber mat crossings and two are associated with temporary road crossings. These are all temporary in nature. The total stream impacts, approximately 1,216 linear feet of stream, represent approximately 0.0589% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 143, Appendix A**).

Project Wetlands Impacts. Approximately 2.93 acres of wetlands were delineated by Mountain Valley contractors in the Big Beaver Creek watershed. There are 14 wetland crossings, including three completed crossings, in this watershed. Impacts include 0.2264 acre of temporary impacts and 0.1598 acre of wetland conversion impacts, for a total of 0.3862 acre of wetland impacts. The wetland conversion impacts will be mitigated using mitigation banking. The three completed crossings resulted in 0.0165 acre of temporary impacts. The NWI data indicate that there are 809.50 acre of aquatic resources in the watershed, including 102.39 acres of Freshwater Emergent Wetland and 569.46 Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 144, Appendix A**). These wetlands are not located in the Project Area.

Soils. Soils data for the Big Beaver Creek watershed were obtained from the Nicholas County and Webster County, West Virginia soil surveys. Based on these soil surveys, the hydric soils Ed (750.5 acres, less than 3.5% of the watershed area), Ek (175.7 acres, less than 1.0% of the watershed area), Elkins silt loam, ponded (Ep) (645.5 acres, less than 2.7% of the watershed), and Pu (224.1 acres, less than 1.0% of the watershed area) may be found in the watershed. (**Figure 145, Appendix A**) (**Appendix B**). Approximately 0.5 acre of the hydric soil Pu may also be present in the Project Area.

LULC. LULC changes in the Big Beaver Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 146, 147 and 147a (Appendix A)**. Overall, there are approximately 24,725 acres in this watershed. The dominant LULC in this area is Forested (over 61%), followed by Stream Riparian Corridor Floodplain (approximately 14.6%). The LOD is approximately 92.6 acres, which represents less than 0.4% of the entire watershed.

3.5.3 Panther Creek-Gauley River

Project Stream Impacts. There are eight proposed stream crossings in the Panther Creek-Gauley River watershed. There are seven pipeline ROW crossings and one timber mat crossing. The proposed stream impacts, which total approximately 604 linear feet, are temporary. The impact total represents approximately 0.0343% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 148, Appendix A**).

Project Wetlands Impacts. Approximately 2.04 acres of wetlands were delineated by Mountain Valley contractors in the Panther Creek-Gauley River watershed. Six wetland crossings are proposed in the Project Area. Impacts include 0.0974 acre of temporary impacts and 0.1226 acre of wetland conversion impacts, for a total of 0.220 acre of wetland impacts. The NWI data indicate that there are 688.30 acres of aquatic resources in the watershed, including 3.85 acres of Freshwater Emergent Wetland and 6.18 acres of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 149, Appendix A**). These wetlands do not fall in the Project Area.

Soils: Soils for the Panther Creek-Gauley River watershed were obtained from the Nicholas County, West Virginia soil survey. These data indicate that the hydric soils Ed (19.9 acres, less than 0.07% of the watershed area), Elkins silt loam, ponded (Ep) (10.5 acres, less than 0.04% of the watershed area), and Pu (7.9 acres, less than 0.03% of the watershed area) may be found in the watershed (**Figure 150, Appendix A**) (**Appendix B**). These soil types are not crossed by the Project.

LULC. LULC changes in Panther Creek-Gauley River watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 151, 152 and 152a (Appendix A)**. Overall, there are approximately 30,376 acres in this watershed. The dominant LULC in this area is Forested (over 74%), followed by Stream Riparian Corridor Floodplain (approximately 13.2%). The LOD is approximately 139.5 acres, which represents less than 0.5% of the entire watershed.

3.5.4 Outlet Hominy Creek

Project Stream Impacts. The Outlet Hominy Creek watershed is another large drain, approximately 32,064 acres, in the Gauley watershed. There are 11 proposed stream crossings in the Outlet Hominy Creek watershed, all temporary in nature. Nine of the proposed stream crossings are pipeline ROW crossings. The remaining two stream crossings are one timber mat crossing and one temporary access road. The total stream impacts, an estimated 782 linear feet of stream, represent approximately 0.0344% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 153, Appendix A**).

Project Wetland Impacts. Approximately 0.52 acre of wetland was delineated by Mountain Valley contractors in the Outlet Hominy Creek watershed. There are four wetland crossings, one completed, in the Project Area that will temporarily impact of 0.0197 acre of wetland. The completed crossing temporarily impacted 0.0029 acre of wetland. The NWI data indicate that there are 391.75 acres of aquatic resources in the watershed, including 28.08 acres of Freshwater Emergent Wetland and 33.48 acre of Freshwater Forested/Scrub Wetland. These wetlands fall outside of the Project Area. The NWI data also indicate that the Project will impact a Freshwater Pond found in the database. However, the NWI data do not accurately reflect the location of the pond, which is approximately 130 feet from an access road and avoided by the Project (**Table 15**) (**Figure 154, Appendix A**).

Soils: The soils data for the Outlet Hominy Creek watershed were obtained from the Nicholas County, West Virginia soil survey. These data indicate that the hydric soils Ed (51.6 acres), Ep (61.9 acres), and Pu (56.5 acres) may be located in the watershed (**Table 20**) (**Figure 155,**

Appendix A) (**Appendix B**). Each of these hydric soils represent less than 0.2% of the watershed area. These soil types are not crossed by the Project.

LULC. LULC changes in Outlet Hominy Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 156, 157 and 157a (Appendix A)**. Overall, there are approximately 32,031 acres in this watershed. The dominant LULC in this area is Forested (over 78%), followed by PHA (approximately 8.9%). The LOD is approximately 86.1 acres, which represents less than 0.3% of the entire watershed.

3.5.5 Headwaters Hominy Creek

Project Stream Impacts. There are 17 stream crossings in the Headwaters Hominy Creek watershed. Two of these crossings are complete (pipeline ROW crossings). Twelve of the proposed crossings are pipeline ROW crossings, and three are timber mat crossings. The stream impacts are all temporary in nature. These total approximately 1,261 linear feet of stream, which represent less than 0.0516% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 158, Appendix A**). Approximately 266 linear feet of the temporary impacts are complete.

Project Wetland Impacts. Approximately 2.07 acres of wetland were delineated by Mountain Valley contractors in the Headwaters Hominy Creek watershed. There are 13 wetland crossings, three of which are complete, in this watershed. Wetland crossings will temporarily impact 0.3511 acre of wetland and will result in 0.0177 acre of permanent impacts, for a total of 0.3688 acre of wetland impacts. Permanent impacts will be mitigated using mitigation banking. The completed crossings temporarily impacted 0.0728 acre of wetland. The NWI data indicate that there are 247.06 acres of aquatic resources in the watershed, including 25.69 acre of Freshwater Emergent Wetland and 49.12 acre of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 159, Appendix A**). These wetlands fall outside of the Project Area.

Soils: Soil data for the Headwaters Hominy Creek watershed were obtained from the Greenbrier County, and Nicholas County, West Virginia soil survey. The soil survey data indicate that three hydric soils—Holly silt loam (Ho) (17.1 acres, less than 0.05% of the watershed area), Ed soil (117.5, less than 0.4% of the watershed area), and Ep soil (36 acres, less than 0.2% of the watershed area)—may be present in the watershed (**Figure 160, Appendix A**) (**Appendix B**). Approximately 9.8 acres of Ed soil may be present in the Project area.

LULC. LULC changes in Headwaters Hominy Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 161, 162 and 162a (Appendix A)**. Overall, there are approximately 34,057 acres in this watershed. The dominant LULC in this area is Forested (over 77%), followed by Stream Riparian Corridor Floodplain (approximately 15%). The LOD is approximately 228.3 acres, which represents less than 0.7% of the entire watershed.

3.5.6 Anglins Creek

<u>Project Stream Impacts</u>. The Project area also crosses the Anglins Creek watershed. However, there are no stream crossings in this watershed (**Figure 163**, **Appendix A**).

<u>Project Wetland Impacts</u>. Approximately 0.48 acre of wetlands was delineated by Mountain Valley contractors in the Anglin Creek watershed. Four wetland crossings will result in a temporary impact to 0.1011 acre of wetlands and conversion of 0.0039 acre of wetland, for a total of 0.1050 acre of wetland impacts in this watershed. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 172.70 acres of aquatic resources in the watershed, including 13.53 acre of Freshwater Emergent Wetland and 38.95 acre of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 164, Appendix A**). These fall outside of the Project Area.

<u>Soils</u>. Soil data for the Anglins Creek watershed were obtained from the Fayette and Raleigh, Counties, Greenbrier County, and Nicholas County, West Virginia soil survey. The soil survey data indicate that there are no hydric soils and no partially hydric soils in the watershed (**Figure 165, Appendix A**) (**Appendix B**).

<u>LULC</u>. LULC changes in Anglins Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 166, 167 and 167a (Appendix A)**. Overall, there are approximately 21,111 acres in this watershed. The dominant LULC in this area is Forested (over 85%), followed by Stream Riparian Corridor Floodplain (approximately 8.7%). The LOD is approximately 41.5 acres, which represents less than 0.2% of the entire watershed.

3.5.7 Meadow Creek-Meadow River

<u>Project Stream Impacts</u>. There are six crossings in the Meadow Creek-Meadow River watershed, three timber mat crossings and three pipeline ROW crossings. One of the pipeline ROW crossings is complete. The stream impacts in this watershed, approximately 315 linear feet, represent approximately 0.0127% of the modeled streams in this HUC-12 watershed and are temporary in nature (**Table 14**) (**Figure 168, Appendix A**). Approximately 96 linear feet of the temporary impacts are complete.

<u>Project Wetland Impacts</u>. Approximately 6.69 acres of wetland were delineated by Mountain Valley contractors in the Meadow Creek-Meadow River watershed. Seven wetland crossings are proposed in this watershed. These crossings will result in 0.0951 acre of temporary impacts and 0.0744 acre of wetland conversion impacts for a total of 0.1695 acre of wetland impacts. The wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 605.37 acres of aquatic resources in the watershed, including 49.84 acres of Freshwater Emergent Wetland, 116.48 acres of Freshwater Forested/Scrub Wetland and 92.37 acres of Freshwater Pond (**Table 15**) (**Figure 169, Appendix A**). All of the potential impacts that were generated when evaluating the NWI data are associated with access roads. There are several areas where a NWI wetland falls adjacent to and sometimes overlaps access roads. In these instances, the roads are pre-existing, and there are no wetland impacts. In three of these locations, there are Project wetland impacts associated with access road crossings; however, these impacts are upgradient, outside of the NWI. The Freshwater Pond impacts were avoided. Based on these observations, none of the NWI wetlands, as well as other aquatic resources identified in the NWI data, actually fall within the Project Area.

Soils. Soil data for the Meadow Creek-Meadow River watershed were obtained from the Fayette and Raleigh, Counties, Greenbrier County, and Nicholas County, West Virginia soil survey. The soil survey data indicate that there are no hydric soils present in the watershed; however, the data indicate the partially hydric soil Atkins-Philo-Potomac complex (An) (45.4 acres, less than 0.2% of the watershed area may be located in the watershed. Approximately 2.9 acres of the partially hydric soil An may be present in the Project Area (**Figure 170, Appendix A**) (**Appendix B**).

LULC. LULC changes in Meadow Creek-Meadow River watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 171, 172 and 172a (Appendix A)**. Overall, there are approximately 32,563 acres in this watershed. The dominant LULC in this area is Forested (over 83%), followed by Stream Riparian Corridor Floodplain (approximately 12.4%). The LOD is approximately 139 acres, which represents less than 0.4% of the entire watershed.

3.5.8 Mill Creek-Meadow River

Project Stream Impacts. The Mill Creek-Meadow River watershed may also be referred to as the Big Clear Creek-Meadow River watershed. There are three stream pipeline ROW crossings in this watershed, each with temporary impacts only. Two of the stream pipeline ROW crossings are complete. The total stream impacts, an estimated 496 linear feet of stream, represent approximately 0.0230% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 173, Appendix A**). The completed crossings total approximately 330 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 2.09 acres of wetland were delineated by Mountain Valley contractors in the Mill Creek-Meadow River watershed. Five wetland crossings are proposed in this watershed, which will temporarily impact 0.3104 acre of wetland and permanently impact 0.0370 acre of wetlands. Permanent impacts will be mitigated using mitigation banking. The NWI data indicate that there are 979.05 acres of aquatic resources in the watershed, including 91.83 acres of Freshwater Emergent Wetland and 662.42 acre of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 174, Appendix A**). None of these wetlands fall within the Project Area.

Soils. Soil data for the Mill Creek-Meadow River watershed were obtained from the Greenbrier County, West Virginia soil survey. The data indicate that the hydric soil Purdy silt loam, 0 to 3 percent slopes (PuA) (24.2 acres, less than 0.1% of the watershed area) as well as the partially hydric soils An (181.5 acres, less than 0.8% of the watershed area) and Melvin-Lindside complex (MI) (1,160.5 acres, approximately 4.8% of the watershed area) are present in the watershed. These soils are not crossed by the Project (**Figure 175, Appendix A**) (**Appendix B**).

LULC. LULC changes in Mill Creek-Meadow River watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 176, 177 and 177a (Appendix A)**. Overall, there are approximately 25,404 acres in this watershed. The dominant LULC in this area is Forested (over 78%), followed by Stream Riparian Corridor Floodplain (approximately 11.9%). The LOD is approximately 58.4 acres, which represents less than 0.2% of the entire watershed.

3.5.9 Sewell Creek

Project Stream Impacts. There are 17 stream crossings in the Sewell Creek watershed. This includes three proposed permanent access roads, three proposed timber mat crossings, and eight proposed pipeline ROW crossings. There are an additional three pipeline ROW crossings that are complete. The total temporary (890 linear feet) and permanent (84 linear feet) stream impacts, an estimated 974 linear feet of stream, represent approximately 0.0458% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 178, Appendix A**). The completed crossings total approximately 187 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 12.04 acres of wetland were delineated by Mountain Valley contractors in the Sewell Creek watershed. Eight wetland crossings are proposed that will temporarily impact 0.2442 acre and permanently impact 0.0633 acre of wetlands for a total of 0.3075 acre of wetlands impacts. The permanent wetland impacts will be mitigated using mitigation banking. The NWI data indicate that there are 449.62 acres of aquatic resources in the watershed, including 53.38 acre of Freshwater Emergent Wetland and 222.56 acre of Freshwater Forested/Scrub Wetland (**Table 15**) (**Figure 179, Appendix A**). The NWI data indicate that the Project will impact NWI Freshwater Emergent Wetland (0.0523 acre) and Freshwater Forested/Scrub Wetland (0.0846 acre). The Freshwater Forested/Scrub Wetland impacts are associated with an access road. The wetland lies adjacent to the road and was avoided by the Project. The Freshwater Emergent Wetland impacts are also associated with an access road. The area was delineated, and the Project will permanently impact 0.0633 acre of Freshwater Emergent Wetland at this location (W-IJ47-PEM).

Soils. Soil data for the Sewell Creek watershed were obtained from the Fayette and Raleigh, Counties, Greenbrier County, and Mercer and Summers Counties, West Virginia. The soil survey data indicate that there are two hydric soils, Atkins loam, warm 0 to 3 percent slopes, frequently flooded (AtA) (36.4 acres, less than 0.2% of the watershed area) and Knowlton silt loam, 0 to 3 percent slopes, rarely flooded (KwA) (27.1 acres, less than 0.1% of the watershed area) are present in the Sewell Creek watershed. The partially hydric soil An (358.7 acres, less than 1.4% of the watershed area) may also be present in the watershed. These soils are not crossed by the Project (**Figure 180, Appendix A**) (**Appendix B**).

LULC. LULC changes in Sewell Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 181, 182 and 182a (Appendix A)**. Overall, there are approximately 25,910 acres in this watershed. The dominant LULC in this area is Forested (over 76%), followed by Stream Riparian Corridor Floodplain (approximately 10.5%). The LOD is approximately 145 acres, which represents less than 0.6% of the entire watershed.

3.5.10 Otter Creek-Meadow River

Project Stream Impacts. The Otter Creek-Meadow River watershed is the last drain with stream crossings in the Gauley River watershed. There are 19 stream crossings in this watershed. The permanent stream impacts in this watershed are associated with two Stallworth Compressor Station impacts and two permanent access roads. Temporary stream impacts are associated with ten pipeline ROW crossings, one access road, two temporary work spaces, and two Stallworth Compressor Station crossings. The impacts associated with the Stallworth Compressor Station are complete. The total temporary (1,161 linear feet) and permanent (421 linear feet) stream impacts, an estimated 1,582 linear feet of stream, represent approximately 0.0533% of the modeled streams in this HUC-12 watershed (**Table 14**) (**Figure 183, Appendix A**). The completed crossings total approximately 169 linear feet of temporary stream impacts and 362 linear feet of permanent stream impacts.

Project Wetlands Impacts. Approximately 59.97 acres of wetlands were delineated by Mountain Valley contractors in the Otter Creek-Meadow River watershed. There are 14 wetland crossings, including two completed crossings, located in this watershed. The wetland crossings will result in 1.3753 acres of temporary wetland impacts, 0.0885 acre of conversion wetland impacts, and 0.0621 acre of permanent impacts for a total of 1.529 acres of wetland impacts. The conversion and permanent wetland impacts will be mitigated using mitigation banking. The two completed wetland crossings resulted in 0.0071 acre of permanent impacts. The NWI data indicate that there are 5,615.68 acres of aquatic resources in the watershed, including 1,536.22 acres of Freshwater Emergent Wetland and 2,956.02 acres of Freshwater Forested/Scrub Wetland, and 74.59 acres of Freshwater Pond. The NWI data also indicate that the Project will impact 0.7999 acre of Freshwater Emergent Wetland, 0.3983 acre of Freshwater Forested/Scrub Wetland, and 0.2949 acre of other aquatic resources. One of the Freshwater Forested/Scrub wetlands is located in the Project Area's LOD in a pasture. This area was delineated by Mountain Valley's contractor, and it was determined not to be a forested or scrub-shrub wetland or other wetland type. The other NWI wetland areas were also part of the Project's delineation efforts. Only one area identified as wetland in the NWI data was field identified as wetland. The associated wetland crossing is W-K9-PEM-1, which temporarily impacts 0.0354 acre of emergent wetland (**Table 15**) (**Figure 184, Appendix A**).

Soils. Soils data for the Otter Creek-Meadow River watershed were obtained from the Fayette and Raleigh Counties, Greenbrier County, and Mercer and Summers Counties, West Virginia. The soil data indicate that the hydric soils At (16.5 acres, less than 0.04% of the watershed area) and PuA (4.3 acres, less than 0.01% of the watershed area), as well as the partially hydric soils Melvin-Lindside complex (Md) (17.7 acre, less than 0.06% of the watershed area), MI (653.6 acres, less than 1.8% of the watershed area), and Melvin-Lindside complex, 0 to 3 percent slopes, frequently flooded (MIA) (36.1 acres, less than 0.2% of the watershed area) are located in the watershed (**Figure 185, Appendix A**) (**Appendix B**). Approximately 10.8 acres of the partially hydric soil MI and approximately 8.6 acres of the partially hydric soil MIA may be present in the Project Area.

LULC. LULC changes in Otter Creek-Meadow River watershed between 2011, 2016 and 2019 are illustrated in **Table 16** and **Figures 186, 187 and 187a (Appendix A)**. Overall, there are approximately 35,682 acres in this watershed. The dominant LULC in this area is Forested (over 55%), followed by PHA (approximately 20.4%). The LOD is approximately 149 acres, which represents less than 0.4% of the entire watershed.

Table 14
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Gauley Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Big Laurel Creek – Gauley River	18	0	755	0	851	2,550,891	851	0.0338%
Big Beaver Creek	21	0	1,216	0	1,216	2,064,382	1,216	0.0589%
Panther Creek – Gauley River	8	0	604	0	604	1,758,427	604	0.0343%
Outlet Hominy Creek	11	0	782	0	782	2,272,489	782	0.0344%
Headwaters Hominy Creek	17	0	995	0	1261	2,445,086	1,261	0.0516%
Anglins Creek	0	0	0	0	0	1,365,792	0	0.0000%
Meadow Creek – Meadow River	6	0	219	0	315	2,483,496	315	0.0127%
Mill Creek – Meadow River	3	0	166	0	496	2,160,428	496	0.0230%
Sewell Creek	17	84	703	84	890	2,127,081	974	0.0458%
Otter Creek – Meadow River	19	59	992	421	1,161	2,968,000	1,582	0.0533%

Table 15

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Gauley Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub	Freshwater Pond	Lake	Other	Total
Big Laurel Creek-Gauley River	15.49	21	0.6279	0.1085	0	0.7364	461.84	18.96	45.25	33.19	65.84	0	625.08
Big Beaver Creek	2.93	14	0.2264	0.1598	0	0.3862	65.1	102.39	569.46	72.55	0	0	809.50
Panther Creek-Gauley River	2.04	6	0.0974	0.1226	0	0.220	545.54	3.85	6.18	33.81	98.92	0	688.30
Outlet Hominy Creek	0.52	4	0.0197	0	0	0.0197	206.32	28.08	33.48	48.33	75.37	0	391.57
Headwaters Hominy Creek	2.07	13	0.3511	0	0.0177	0.3688	126.36	25.69	49.12	45.89	0	0	247.06
Anglins Creek	0.48	4	0.1011	0.0039	0	0.1050	101.42	13.53	38.95	18.8	0	0	172.70
Meadow Creek-Meadow River	6.69	7	0.0951	0.0744	0	0.1695	345.93	49.84	116.48	92.37	0	0.75	605.37
Mill Creek-Meadow River	2.09	5	0.3104	0	0.0370	0.3474	162.28	91.83	662.42	62.51	0	0	979.05
Sewell Creek	12.04	8	0.2442	0	0.0633	0.3075	115.47	53.38	222.56	56.05	0	2.17	449.62
Otter Creek-Meadow River	59.97	14	1.3753	0.0885	0.0621	1.5259	223.52	1536.22	2956.02	74.59	28.79	796.55	5615.68

[1] Acres delineated within the HUC-12 Watershed.

Table 16

LULC in the HUC-12 Watersheds that Fall Within the Gauley Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Big Laurel Creek-Gauley River	36237.7	2011	30582.6	84.4	621.1	1.7	2386.5	6.6	360.3	1.0	356.3	1.0	74.9	0.2	186.1	0.5	1669.7	4.6
	36237.7	2016	30003.3	82.8	643.4	1.8	2356.9	6.5	935.4	2.6	362.5	1.0	78.1	0.2	125.2	0.3	1732.9	4.8
	36237.7	2019	29985.1	82.7	654.3	1.8	2370.3	6.5	968.3	2.7	360.9	1.0	78.1	0.2	98.7	0.3	1722.0	4.8
Big Beaver Creek	24725.0	2011	14844.4	60.0	344.9	1.4	3088.0	12.5	2474.4	10.0	30.5	0.1	740.6	3.0	2132.8	8.6	1069.5	4.3
	24725.0	2016	15254.7	61.7	361.2	1.5	3071.3	12.4	2335.6	9.4	31.1	0.1	759.3	3.1	1802.1	7.3	1109.8	4.5
	24725.0	2019	15153.1	61.3	371.6	1.5	3076.4	12.4	3611.9	14.6	9.6	0.0	751.7	3.0	651.4	2.6	1099.3	4.4
Panther Creek-Gauley River	30376.5	2011	23234.3	76.5	230.8	0.8	1677.3	5.5	3315.7	10.9	463.7	1.5	13.6	0.0	290.9	1.0	1150.2	3.8
	30376.5	2016	21139.5	69.6	240.6	0.8	1677.3	5.5	5423.8	17.9	460.6	1.5	12.2	0.0	245.3	0.8	1177.1	3.9
	30376.5	2019	22714.3	74.8	245.7	0.8	1681.1	5.5	4010.4	13.2	472.6	1.6	13.6	0.0	66.7	0.2	1172.0	3.9
Outlet Hominy Creek	32031.5	2011	25070.6	78.3	349.6	1.1	2877.3	9.0	1941.5	6.1	63.8	0.2	88.7	0.3	294.9	0.9	1345.0	4.2
	32031.5	2016	24683.4	77.1	366.7	1.1	2846.9	8.9	2269.5	7.1	74.3	0.2	84.3	0.3	292.4	0.9	1414.0	4.4
	32031.5	2019	25268.1	78.9	376.5	1.2	2846.0	8.9	1928.8	6.0	74.3	0.2	72.9	0.2	60.7	0.2	1404.2	4.4
Headwaters Hominy Creek	34057.3	2011	26875.1	78.9	318.5	0.9	1092.8	3.2	4563.8	13.4	7.6	0.0	87.2	0.3	192.4	0.6	920.0	2.7
	34057.3	2016	24448.5	71.8	330.5	1.0	1083.7	3.2	6988.5	20.5	3.8	0.0	79.8	0.2	179.9	0.5	942.5	2.8
	34057.3	2019	26407.2	77.5	338.7	1.0	1080.8	3.2	5112.0	15.0	3.8	0.0	79.8	0.2	100.7	0.3	934.3	2.7
Anglins Creek	21111.9	2011	17776.2	84.2	176.4	0.8	601.4	2.8	1821.4	8.6	0.7	0.0	41.8	0.2	220.8	1.0	473.3	2.2
	21111.9	2016	17278.3	81.8	179.7	0.9	602.5	2.9	2288.4	10.8	0.2	0.0	40.3	0.2	233.3	1.1	489.3	2.3
	21111.9	2019	17941.7	85.0	181.9	0.9	600.0	2.8	1831.6	8.7	0.2	0.0	38.3	0.2	31.1	0.1	487.0	2.3
Meadow Creek-Meadow River	32563.5	2011	27124.6	83.3	355.2	1.1	131.0	0.4	3608.6	11.1	147.0	0.5	129.7	0.4	481.7	1.5	585.8	1.8
	32563.5	2016	26350.7	80.9	358.5	1.1	123.2	0.4	4404.5	13.5	147.4	0.5	96.3	0.3	486.6	1.5	596.2	1.8
	32563.5	2019	27091.7	83.2	361.4	1.1	123.0	0.4	4044.9	12.4	147.4	0.5	91.0	0.3	110.8	0.3	593.3	1.8

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Mill Creek-Meadow River	25404.8	2011	20222.1	79.6	708.3	2.8	363.8	1.4	2511.9	9.9	28.0	0.1	592.0	2.3	366.1	1.4	612.5	2.4
	25404.8	2016	19217.8	75.6	710.1	2.8	357.6	1.4	3494.0	13.8	29.4	0.1	600.5	2.4	332.9	1.3	662.5	2.6
	25404.8	2019	19903.4	78.3	723.9	2.8	353.4	1.4	3029.7	11.9	29.4	0.1	594.9	2.3	114.5	0.5	655.6	2.6
Sewell Creek	25910.1	2011	21044.8	81.2	845.5	3.3	1066.8	4.1	1262.5	4.9	2.4	0.0	368.7	1.4	382.1	1.5	937.2	3.6
	25910.1	2016	19855.6	76.6	850.0	3.3	1061.0	4.1	2462.4	9.5	2.9	0.0	352.9	1.4	385.6	1.5	939.6	3.6
	25910.1	2019	19862.3	76.7	854.0	3.3	1061.3	4.1	2716.3	10.5	2.9	0.0	352.9	1.4	124.8	0.5	935.6	3.6
Otter Creek-Meadow River	35682.8	2011	20606.0	57.7	1083.3	3.0	7278.3	20.4	465.9	1.3	19.8	0.1	4859.5	13.6	178.4	0.5	1191.6	3.3
	35682.8	2016	20024.7	56.1	1099.7	3.1	7243.4	20.3	1047.9	2.9	32.5	0.1	4828.6	13.5	193.5	0.5	1212.5	3.4
	35682.8	2019	19823.2	55.6	1142.0	3.2	7269.4	20.4	1254.1	3.5	32.5	0.1	4815.3	13.5	138.3	0.4	1208.0	3.4

3.6 Lower New

The Project crosses one 12-digit HUC watershed in the Lower New HUC-8 watershed (**Figure 188, Appendix A**), Lick Creek (050500040203) (**Table 17**). The Lower New watershed is approximately 690.9 mi^2. The drainage of the Lick Creek watershed is approximately 39.2 mi^2 or less than 10% of the HUC-8 watershed.

3.6.1 Lick Creek

Project Stream Impacts. The Lick Creek watershed is located on the eastern edge of the Lower New watershed. The Project Area includes 18 stream crossings in the watershed. Five of these crossings, pipeline ROW crossings, are complete. The proposed permanent stream impacts include two permanent access roads. Proposed temporary stream impacts are associated with five pipeline ROW crossings, five timber mat crossings, and one temporary access road. The total temporary (1,084 linear feet) and permanent (64 linear feet) impacts, an estimated 1,148 linear feet of stream, represent approximately 0.0540% of the modeled streams in this HUC-12 watershed (**Table 17**) (**Figure 189, Appendix A**). The completed crossings total approximately 433 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 1.02 acres of wetland were delineated by Mountain Valley contractors in the Lick Creek watershed. The Project has two proposed wetland crossings in this watershed that will temporarily impact 0.1517 acre of wetland. The NWI data indicate that there are 90.53 acres of aquatic resources in the watershed, including 4.82 acres of Freshwater Emergent Wetland, 1.18 acre of Freshwater Forested/Scrub Wetland, and 10.46 acres of Freshwater Pond. These wetlands fall outside of the Project Area (**Table 18**) (**Figure 190, Appendix A**).

Soils. Soils data for Meadow Creek watershed are from the Greenbrier County, Mercer and Summers Counties, and New River Gorge National River, West Virginia soil surveys. The soil surveys indicate that there are no hydric or partially hydric soils in the watershed (**Figure 191, Appendix A**) (**Appendix B**).

LULC. LULC changes in Lick Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 19** and **Figures 192, 193 and 193a (Appendix A)**. Overall, there are approximately 25,087 acres in this watershed. The dominant LULC in this area is Forested (over 87%), followed by PHA (approximately 4.2%). The LOD is approximately 114.2 acres, which represents less than 0.5% of the entire watershed.

Table 17

Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Lower New Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Lick Creek	18	64	651	64	1,084	2,125,309	1,148	0.0540%

Table 18

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Lower New Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub	Freshwater Pond	Lake	Other	Total
Lick Creek	1.02	2	0.1517	0	0	0.1517	74.08	4.82	1.18	10.46	0	0	90.53

[1] Acres delineated within the HUC-12 Watershed.

Table 19
LULC in the HUC-12 Watersheds that Fall Within the Lower New Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Lick Creek	25087.0	2011	22127.6	88.2	659.2	2.6	1067.1	4.3	407.9	1.6	0.7	0.0	11.8	0.0	144.6	0.6	668.3	2.7
	25087.0	2016	21870.3	87.2	662.3	2.6	1057.3	4.2	671.4	2.7	0.9	0.0	9.1	0.0	145.9	0.6	669.9	2.7
	25087.0	2019	21856.1	87.1	664.5	2.6	1056.6	4.2	791.1	3.2	0.7	0.0	9.1	0.0	41.4	0.2	667.6	2.7

3.7 Greenbrier

The Project crosses two 12-digit HUC watersheds in the Greenbrier HUC-8 watershed (**Figure 194, Appendix A**), Hungard Creek-Greenbrier River (050500030906) and Stony Creek-Greenbrier River (050500030907) (**Table 20**). The Greenbrier watershed is approximately 1,678.5 mi^2. The combined drainage of the two listed watersheds is approximately 51.2 mi^2 or less than 10% of the HUC-8 watershed.

3.7.1 Hungard Creek-Greenbrier River

Project Stream Impacts. The Project Area includes 28 stream crossings in the Hungard Creek-Greenbrier River watershed. This includes four completed pipeline ROW crossings. This watershed includes two proposed access roads that have permanent impacts. The remaining proposed stream crossing impacts—nine pipeline ROW crossings, 10 timber mat crossings, and three temporary access roads—are temporary in nature. The total temporary (1,435 linear feet) and permanent (53 linear feet) impacts, an estimated 1,488 linear feet of stream, represent approximately 0.0853% of the modeled streams in this HUC-12 watershed (**Table 20**) (**Figure 195, Appendix A**). The completed crossings total approximately 387 linear feet of temporary stream impacts.

Project Wetlands Impacts. Approximately 11.53 acres of wetland were delineated by Mountain Valley contractors in the Hungard Creek-Greenbrier River watershed. There are six wetland crossings, including one completed crossing, in the watershed. The Project will temporarily impact 0.1376 acre of wetland and will result in 0.299 acre of wetland conversion impacts, for a total of 0.4366 acre of impacts. The wetland conversion impacts will be mitigated using mitigation banking. The completed crossing temporarily impacted 0.0191 acre of wetland. The NWI data indicate that there are 344.48 acres of aquatic resources in the watershed, including 33.9 acres of Freshwater Emergent Wetland and 25.83 acres of Freshwater Forested/Scrub Wetland (**Table 21**) (**Figure 196, Appendix A**). The NWI data also indicate that the Project will impact 2.1683 acre of Freshwater Forested/Scrub Wetland and 0.0007 acre of Freshwater Pond. The Freshwater Forested/Scrub Wetland is located adjacent to the Greenbrier River. Impacts associated with this location were part of the Project's delineation efforts. A large wetland was identified and avoided to the extent practicable but will result in conversion impacts. The associated wetland crossing is identified as W-MM20-PFO, which will result in conversion impacts to 0.2990 acre of forested wetland. These impacts will be mitigated using mitigation banking. The Freshwater Pond was also included in the Project's delineation and was avoided.

Soils. The soil data from the Hungard Creek-Greenbrier River watershed are from the Mercer and Summers Counties, and Monroe County, West Virginia. The hydric soils At (10.9 acres, less than 0.05% of the watershed area) and Me (90.5 acres, less than 0.5% of the watershed) and the partially hydric soil Udifluvents-Fluvaquents complex (Uf) (95.5 acres, less than 0.5% of the watershed) may be present in the watershed (**Figure 197, Appendix A**) (**Appendix B)**. These soil types are not crossed by the Project.

<u>LULC</u>. LULC changes in Hungard Creek-Greenbrier watershed between 2011, 2016 and 2019 are illustrated in **Table 22** and **Figures 198, 199 and 199a (Appendix A)**. Overall, there are approximately 22,038 acres in this watershed. The dominant LULC in this area is Forested (over 75%), followed by PHA (approximately 15.1%). The LOD is approximately 248 acres, which represents less than 1.1% of the entire watershed.

3.7.2 Stony Creek-Greenbrier River

<u>Project Stream Impacts</u>. There are five stream crossings in the Stony Creek-Greenbrier River watershed: two timber mat crossings and three pipeline ROW crossings. One of the pipeline ROW crossings is complete. These impacts are all temporary in nature. The total impacts, an estimated 274 linear feet of stream, represent approximately 0.0349% of the modeled streams in this HUC-12 watershed (**Table 20**) (**Figure 200, Appendix A**). The completed crossing totals approximately 76 linear feet of temporary stream impacts.

<u>Project Wetland Impacts</u>. Approximately 3.96 acres of wetland were delineated by Mountain Valley contractors in the Stony Creek-Greenbrier River watershed. There is one proposed wetland crossing in this watershed that will temporarily impact 0.1359 acre of wetland. The NWI data indicate that there are 261.4 acre of aquatic resources in the watershed, including 22.89 acres of Freshwater Emergent Wetland and 8.79 acres of Freshwater Forested/Scrub Wetland (**Table 21**) (**Figure 201, Appendix A**). None of these wetlands fall within the Project Area.

<u>Soils</u>. The soil data from the Stony Creek-Greenbrier River watershed are from the Mercer and Summers Counties, and Monroe County, West Virginia. The hydric soil At (3.0 acres, less than 0.03% of the watershed area), Atkins silt loam, warm, 0 to 3 percent slopes, frequently flooded (At-Monroe) (72.5 acres, less than 0.7% of the watershed area), and the partially hydric soil Uf (167.1 acres, less than 1.6% of the watershed area) may be present in the watershed. Approximately 1.0 acres of the hydric soil At and approximately 0.3 acre of the hydric soil Uf will be crossed by the Project (**Figure 202, Appendix A**) (**Appendix B).**

<u>LULC</u>. LULC changes in Stony Creek-Greenbrier watershed between 2011, 2016 and 2019 are illustrated in **Table 22** and **Figures 203, 203a and 203b (Appendix A)**. Overall, there are approximately 10,775 acres in this watershed. The dominant LULC in this area is Forested (over 60%), followed by PHA (approximately 26.2%). The LOD is approximately 75.9 acres, which represents less than 0.7% of the entire watershed.

Table 20
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Greenbrier Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Hungard Creek – Greenbrier River	28	53	1,048	53	1,435	1,744,033	1,488	0.0853%
Stony Creek – Greenbrier River	5	0	198	0	274	786,091	274	0.0349%

Table 21

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Greenbrier Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Hungard Creek-Greenbrier River	11.53	6	0.1376	0.299	0	0.4366	261.75	33.9	25.83	23	0	0	344.48
Stony Creek-Greenbrier River	3.96	1	0.1359	0	0	0.1359	208.58	22.89	8.79	21.14	0	0	261.4

[1] Acres delineated within the HUC-12 Watershed.

Table 22
LULC in the HUC-12 Watersheds that Fall Within the Greenbrier Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Hungard Creek-Greenbrier River	22,038	2011	16,661	75.6	415	1.9	3,340	15.2	524	2.4	184	0.8	29	0.1	58	0.3	827	3.8
	22,038	2016	16,529	75.0	422	1.9	3,329	15.1	653	3.0	184	0.8	22	0.1	62	0.3	837	3.8
	22,038	2019	16,562	75.2	429	1.9	3,337	15.1	635	2.9	184	0.8	22	0.1	39	0.2	830	3.8
Stony Creek WV – Greenbrier River	10,775	2011	6,558	60.9	299	2.8	2,822	26.2	383	3.5	189	1.8	11	0.1	2	0.0	513	4.8
	10,775	2016	6,524	60.5	305	2.8	2,802	26.0	433	4.0	191	1.8	10	0.1	2	0.0	509	4.7
	10,775	2019	6,484	60.2	307	2.8	2,819	26.2	451	4.2	191	1.8	10	0.1	7	0.1	506	4.7

3.8 Upper/Middle New

The Project crosses six 12-digit HUC watersheds in the Upper/Middle New HUC-8 watershed (**Figure 204, Appendix A**). These include Middle Indian Creek (050500020704), Rich Creek (050500020601), Stony Creek (050500020305), Little Stony Creek-New River (050500020304), Lower Sinking Creek (050500020303), and Upper Sinking Creek (050500020302) (**Table 24**). The Middle/Upper New watershed is approximately 1,687.8 mi^2. The combined drainage of the six listed watersheds is approximately 282.2 mi^2.

3.8.1 Middle Indian Creek

<u>Project Stream Impacts</u>. There are 28 stream crossings in the Middle Indian Creek watershed. Two of these crossings, pipeline ROW crossings, are complete. The proposed stream crossings include four permanent access roads with permanent impacts and temporary impacts associated with 16 pipeline ROW crossings, four timber mat crossings and two temporary access road crossings. The total stream impacts, temporary (1,346 linear feet) and permanent (109 linear feet) impacts, total an estimated 1,455 linear feet of stream, represent less than 0.0529% of the modeled streams in this HUC 12 watershed (**Table 23**) (**Figure 205, Appendix A**). The completed crossing totals approximately 152 linear feet of temporary stream impacts.

<u>Project Wetlands Impacts</u>. Approximately 14.64 acres of wetland were delineated by Mountain Valley contractors in the Middle Indian Creek watershed. Eleven wetland crossings are proposed that will result in 0.5132 acre of temporary wetland impacts, 0.2020 acre of wetland conversion impacts, and 0.0288 acres of permanent wetland impacts for a total of 0.7380 acre of wetland impacts. The NWI data indicate that there are 547.83 acres of aquatic resources in the watershed, including 37.38 acres of Freshwater Emergent Wetland and 25.35 acres of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.1201 acre of Freshwater Emergent Wetland and 0.0525 acre of Freshwater Pond. Mountain Valley has completed wetland delineations in this area and no wetlands were identified in the areas where the NWI wetlands are located within the Project Area. The Freshwater Pond is no longer present and would have been avoided (**Table 24**) (**Figure 206, Appendix A**).

<u>Soils</u>. The soil data for the Middle Indian Creek watershed are from the Jefferson National Forest, Virginia and the Monroe County, West Virginia soil surveys. The hydric soils At-Monroe) (468.3 acres, less than 1.4% of the watershed area), Dunning silty clay loam, karst (Dz) (25.8 acres, less than 0.08% of the watershed area), Mauretown silt loam, 0 to 3 percent slopes (MaA) (61.4 acres, less than 0.2% of the watershed area), and Me (959.3 acres, less than 3.0% of the watershed area) and the partially hydric soils Uf (364.2 acres, less than 1.1% of the watershed area) may be located in the watershed. Approximately 6.7 acres of the hydric soil Me and approximately 5.6 acres of the hydric soil Uf may be present in the Project Area (**Figure 207, Appendix A**) (**Appendix B)**.

<u>LULC</u>. LULC changes in Middle Indian Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 25** and **Figures 208, 209 and 209a (Appendix A)**. Overall, there are approximately 34,866 acres in this watershed. The dominant LULC in this area is Forested (over

67%), followed by PHA (approximately 24.6%). The LOD is approximately 184 acres, which represents less than 0.5% of the entire watershed.

3.8.2 Rich Creek

Project Stream Impacts. There are nine stream crossings in the Rich Creek watershed. These proposed impacts are limited to seven pipeline ROW crossings and two temporary access road crossings. The stream impacts are temporary in nature. The total stream impacts, an estimated 766 linear feet of stream, represent approximately 0.0308% of the modeled streams in this HUC-12 watershed (**Table 23**) (**Figure 210, Appendix A**).

Project Wetlands Impacts. Approximately 2.04 acres of wetland were identified by Mountain Valley contractors in the Rich Creek watershed. Four wetland crossings are proposed that will temporarily impact 0.2632 acre of wetland. The NWI data indicate that there are 428.33 acres of aquatic resources in the watershed, including 2.01 acre of Freshwater Emergent Wetland and 1.31 acre of Freshwater Forested/Scrub Wetland. None of these wetlands fall within the Project Area (**Table 24**) (**Figure 211, Appendix A**).

Soils. The soil data for the Rich Creek watershed are from the Jefferson National Forest, Virginia and the Monroe County, West Virginia soil surveys. The soil surveys indicate that the hydric soils At-Monroe (1507.5 acres, less than 5.0% of the watershed area), MaA (61.4 acres, less than 0.2% of the watershed area), and Me (412.4 acres, less than 1.4% of the watershed area) and the partially hydric soil, Uf (329.5 acres, less than 1.1% of the watershed area) may be located in the watershed. Approximately 7.4 acres of the hydric soil Me, and 5.5 acres of the hydric soil MaA as well as approximately 1.0 acres the partially hydric soil, Uf may be located in the Project Area (**Figure 212, Appendix A**) (**Appendix B**).

LULC. LULC changes in Rich Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 25** and **Figures 213, 214 and 214a (Appendix A)**. Overall, there are approximately 34,114 acres in this watershed. The dominant LULC in this area is Forested (over 53%), followed by PHA (approximately 34.4%). The LOD is approximately 113.7 acres, which represents less than 0.4% of the entire watershed.

3.8.3 Stony Creek

Project Stream Impacts. There are six stream crossings in the southern portion of the Stony Creek watershed. These proposed stream impacts are limited to three timber mat crossings and three pipeline ROW crossings and are temporary in nature. The total impacts, an estimated 344 linear feet of stream, represent approximately 0.0240% of the modeled streams in this HUC-12 watershed (**Table 23**) (**Figure 215, Appendix A**).

Project Wetland Impacts. Approximately 1.33 acres of wetland were identified by Mountain Valley contractors in the Stony Creek watershed. There are no wetland impacts in this watershed. The NWI data indicate that there are 344.30 acres of aquatic resources in the watershed, including

54.46 acres of Freshwater Forested/Scrub Wetland. None of these wetlands fall in the Project Area (**Table 24**) (**Figure 216, Appendix A**).

<u>Soils</u>. The soil data for the Stony Creek watershed are from the Giles County, and Jefferson National Forest, Virginia and the Monroe County, West Virginia soil surveys. The hydric soils Fluvaquents, nearly level (Soil 12) (207.5 acres, less than 1.0% of the watershed area), Atkins loam, 0 to 3 percent slopes, frequently flooded (Soil 1) (15.1 acres, less than 0.05% of the watershed area), and Haplosaprists, high elevation bog, 0 to 3 percent slopes (Soil 110) (44.7 acres, less than 0.2% of the watershed area) may be present in the watershed (**Figure 217, Appendix A**) (**Appendix B**). These soil types are not crossed by the Project.

<u>LULC</u>. LULC changes in Stony Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 25** and **Figures 218, 219 and 219a (Appendix A)**. Overall, there are approximately 31,289 acres in this watershed. The dominant LULC in this area is Forested (over 94%), followed by Stream Riparian Corridor Floodplain (approximately 1.6%). The LOD is approximately 119 acres, which represents less than 0.4% of the entire watershed.

3.8.4 Little Stony Creek-New River

<u>Project Stream Impacts</u>. There are 21 stream crossings in the Little Stony Creek-New River watershed. These proposed stream impacts are limited to 13 timber mat crossings, seven pipeline ROW crossings, and a temporary access road, all temporary in nature. The total stream impacts, an estimated 981 linear feet of stream, represent approximately 0.0795% of the modeled streams in this HUC-12 watershed (**Table 23**) (**Figure 220, Appendix A**).

<u>Project Wetlands Impacts</u>. Approximately 0.09 acre of wetlands was delineated by Mountain Valley contractors in the Little Stony Creek-New River watershed. There are two proposed crossings in this watershed. Impacts are limited to 0.0262 acre of temporary wetland impacts and 0.0136 acre of wetland conversion impacts for a total of 0.0398 acre of wetland impacts. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 787.88 acres of aquatic resources in the watershed, including 7.32 acres of Freshwater Emergent Wetland and 9.96 acres of Freshwater Forested/Scrub Wetland (**Table 24**) (**Figure 221, Appendix A**). None of these wetlands fall within the Project Area.

<u>Soils</u>. Soil data for Little Stony Creek-New River watershed are from Giles County and Jefferson National Forest, Virginia. The soil surveys indicate that Soil 1 (an Atkins loam soil type) (4.1 acres, less than 0.02% of the watershed area), Philo fine sandy loam, 0 to 3 percent slopes, occasionally flooded (Soil 2) (31.8 acres, less than 0.2% of the watershed area), and Soil 110 (a Haplosaprist soil type) (75.8 acres, less than 0.3% of the watershed area) soil types are present in the watershed (**Figure 222, Appendix A**) (**Appendix B**). These soil types are not crossed by the Project.

<u>LULC</u>. LULC changes in Little Stony Creek-New River watershed between 2011, 2016 and 2019 are illustrated in **Table 25** and **Figures 223, 224 and 224a (Appendix A)**. Overall, there are approximately 29,250 acres in this watershed. The dominant LULC in this area is Forested (over

78%), followed by PHA (approximately 9.2%). The LOD is approximately 110.5 acres, which represents less than 0.4% of the entire watershed.

3.8.5 Lower Sinking Creek

Project Stream Impacts. There are 20 proposed stream crossings in the Lower Sinking Creek watershed. This includes temporary impacts for eight temporary access roads, one permanent access road, seven pipeline ROW crossings, and three timber mat crossings. Permanent stream impacts are limited to one permanent access road crossing. The total temporary (870 linear feet) and permanent (31 linear feet) impacts, an estimated 901 linear feet of stream, represent approximately 0.1048% of the modeled streams in this HUC-12 watershed (**Table 23**) (**Figure 225, Appendix A**).

Project Wetland Impacts. Approximately 0.53 acre of wetlands was delineated by Mountain Valley contractors in the Lower Sinking Creek watershed. These areas were avoided, resulting in no wetland impacts in the watershed. The NWI data indicate that there are 160.15 acres of aquatic resources in the watershed, including 1.6 acres of Freshwater Emergent Wetland. None of these wetlands fall in the Project Area (**Table 24**) (**Figure 226, Appendix A**).

Soils. The soil data from the Lower Sinking Creek watershed are from Craig County, Giles County, and Jefferson National Forest, Virginia soil surveys. The hydric soil, Soil 12 (Fluvaquents) (6.1 acres, less than 0.04% of the watershed area) may be found in the watershed (**Figure 227, Appendix A**) (**Appendix B)**. These soil types are not crossed by the Project.

LULC. LULC changes in Lower Sinking Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 25** and **Figures 228, 229 and 229a (Appendix A)**. Overall, there are approximately 18,795 acres in this watershed. The dominant LULC in this area is Forested (over 62%), followed by PHA (approximately 27.6%). The LOD is approximately 111 acres, which represents less than 0.6% of the entire watershed.

3.8.6 Upper Sinking Creek

Project Stream Impacts. There are 13 proposed stream crossings in the Upper Sinking Creek watershed. Ten of these proposed crossings are pipeline ROW crossings, while two are temporary access roads, and one is a timber mat crossing. Impacts associated with these stream crossings are temporary in nature. The total impacts, an estimated 884 linear feet of stream, represent approximately 0.0585% of the modeled streams in this HUC-12 watershed (**Table 23**) (**Figure 230, Appendix A**).

Project Wetlands Impacts. Approximately 0.36 acre of wetlands was delineated by Mountain Valley contractors in the Upper Sinking Creek watershed. Three wetland crossings are proposed that will result in 0.0518 acre of temporary impacts. The NWI data indicate that there are 374.44 acres of aquatic resources in the watershed, including 35.13 acres of Freshwater Emergent Wetland and 14.2 acres of Freshwater Forested/Scrub Wetland (**Table 24**) (**Figure 231, Appendix A**). These wetlands fall outside of the Project Area.

Soils. The soil data from the Upper Sinking Creek watershed are from the Craig County, Giles County, Jefferson National Forest, and Montgomery County, Virginia soil surveys. The soil surveys indicate that hydric soils Atkins fine sandy loam, 0 to 3 percent slopes, frequently flooded (Soil 3A) (338.9 acres, less than 1.1% of the watershed area) and Mauretown silt loam, 0 to 3 percent slopes, rarely flooded (Soil 24A) (74.2 acres, less than 0.3% of the watershed area) may be located in the watershed (**Figure 232, Appendix A**) (**Appendix B**). These soil types are not crossed by the Project.

LULC. LULC changes in Upper Sinking Creek watershed between 2011 and 2016 are illustrated in **Table 25** and **Figures 233, 234 and 234a (Appendix A)**. Overall, there are approximately 33,803 acres in this watershed. The dominant LULC in this area is Forested (over 62%), followed by PHA (approximately 31.4%). The LOD is approximately 108.4 acres, which represents less than 0.3% of the entire watershed.

Table 23
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Upper/Middle New Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Middle Indian Creek	28	109	1,194	109	1,346	2,777,615	1,455	0.0524%
Rich Creek	9	0	766	0	766	2,487,504	766	0.0308%
Stony Creek	6	0	344	0	344	1,392,380	344	0.0240%
Little Stony Creek – New River	21	0	981	0	981	1,243,725	981	0.0795%
Lower Sinking Creek	20	31	870	31	870	860,082	901	0.1048%
Upper Sinking Creek	13	0	884	0	884	1,509,862	884	0.0585%

Table 24

Cumulative Project-Related Wetland Impacts and National Wetland Inventory data in the HUC-12 Watersheds that Fall Within the Upper/Middle New Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Middle Indian Creek	14.64	11	0.5132	0.2020	0.0288	0.7380	422.1	37.38	25.35	63	0	0	547.83
Rich Creek	2.04	4	0.2632	0	0	0.2632	374.12	2.01	1.31	50.88	0	0	428.33
Stony Creek	1.33	0	0	0	0	0	282.11	0	54.46	7.73	0	0	344.3
Little Stony Creek-New River	0.09	2	0.0262	0.0136	0	0.0398	711.2	7.32	9.96	11.77	47.63	0	787.88
Lower Sinking Creek	0.53	0	0	0	0	0	151.25	1.6	0	7.31	0	0	160.15
Upper Sinking Creek	0.36	3	0.0518	0	0	0.0518	303.1	35.13	14.2	22.01	0	0	374.44

[1] Acres delineated within the HUC-12 Watershed.

Table 25
LULC in the HUC-12 Watersheds that Fall Within the Upper/Middle New Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Middle Indian Creek	34,866	2011	23,550	67.5	621	1.8	8,588	24.6	675	1.9	18	0.1	134	0.4	7	0.0	1,273	3.7
	34,866	2016	23,774	68.2	632	1.8	8,572	24.6	489	1.4	18	0.1	103	0.3	8	0.0	1,270	3.6
	34,866	2019	23,674	67.9	634	1.8	8,578	24.6	580	1.7	18	0.1	100	0.3	12	0.0	1,267	3.6
Rich Creek	34,114	2011	18,421	54.0	1,714	5.0	11,733	34.4	490	1.4	10	0.0	83	0.2	39	0.1	1,625	4.8
	34,114	2016	18,339	53.8	1,748	5.1	11,710	34.3	626	1.8	8	0.0	37	0.1	39	0.1	1,607	4.7
	34,114	2019	18,241	53.5	1,764	5.2	11,725	34.4	697	2.0	8	0.0	37	0.1	51	0.2	1,590	4.7
Stony Creek (VA)	31,289	2011	28,202	90.1	165	0.5	441	1.4	1,763	5.6	4	0.0	72	0.2	80	0.3	562	1.8
	31,289	2016	28,567	91.3	167	0.5	416	1.3	1,435	4.6	4	0.0	64	0.2	76	0.2	561	1.8
	31,289	2019	29,468	94.2	168	0.5	415	1.3	514	1.6	4	0.0	64	0.2	58	0.2	597	1.9
Little Stony Creek-New River	29,250	2011	22,614	77.3	870	3.0	2,734	9.3	1,053	3.6	524	1.8	39	0.1	38	0.1	1,376	4.7
	29,250	2016	22,739	77.7	885	3.0	2,708	9.3	926	3.2	528	1.8	32	0.1	42	0.1	1,389	4.7
	29,250	2019	23,067	78.9	913	3.1	2,694	9.2	592	2.0	527	1.8	38	0.1	26	0.1	1,391	4.8
Lower Sinking Creek	18,795	2011	11,870	63.2	505	2.7	5,216	27.7	285	1.5	2	0.0	0	0.0	2	0.0	917	4.9
	18,795	2016	11,847	63.0	516	2.7	5,180	27.6	328	1.7	2	0.0	0	0.0	2	0.0	921	4.9
	18,795	2019	11,735	62.4	522	2.8	5,186	27.6	433	2.3	2	0.0	0	0.0	3	0.0	916	4.9
Upper Sinking Creek	33,803	2011	20,830	61.6	333	1.0	10,675	31.6	727	2.2	0	0.0	23	0.1	4	0.0	1,211	3.6
	33,803	2016	21,076	62.3	342	1.0	10,623	31.4	522	1.5	0	0.0	21	0.1	4	0.0	1,215	3.6
	33,803	2019	21,066	62.3	348	1.0	10,621	31.4	534	1.6	0	0.0	21	0.1	4	0.0	1,208	3.6

3.9 Upper James

The Project crosses one 12-digit HUC watersheds in the Upper James HUC-8 watershed (**Figure 235, Appendix A**), Trout Creek-Craig Creek (020802011001) (**Table 26**). The Upper James watershed is approximately 2,210.7 mi^2. The drainage of the Trout Creek-Craig Creek watershed is approximately 51.9 mi^2 or less than 3% of the HUC-8 watershed.

3.9.1 Trout Creek-Craig Creek

Project Stream Impacts. There are seven proposed stream crossings in the Trout Creek-Craig Creek watershed: six timber mat crossings and one temporary access road. These are the only stream crossings in the Upper James HUC-8 watershed. The stream impacts are all temporary in nature and total approximately 200 linear feet. This represents approximately 0.0121% of the modeled streams in this HUC-12 watershed (**Table 26**) (**Figure 236, Appendix A**).

Project Wetland Impacts. Approximately 0.04 acre of wetlands was delineated by Mountain Valley contractors in the Trout Creek-Craig Creek watershed. These wetlands were avoided, and there are no wetland impacts in the watershed. The NWI data indicate that there are 478.39 acres of aquatic resources in the watershed, including 0.2 acre of Freshwater Emergent Wetland and 2.02 acres of Freshwater Forested/Scrub Wetland. None of these wetlands fall in the Project Area (**Table 27**) (**Figure 237, Appendix A**).

Soils. The Trout Creek-Craig Creek watershed soil data are from the Craig County, Jefferson National Forest, Montgomery County, and Roanoke County and the Cities of Roanoke and Salem, Virginia. The data indicate that there are no hydric soils in the watershed. The data also indicate that the partially hydric soil McGary and Purdy soils (Soil 25) (7.5 acres, less than 0.03% of the watershed area) may be located in the watershed (**Figure 238, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

LULC. LULC changes in Trout Creek-Craig Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 28** and **Figures 239, 240 and 240a (Appendix A)**. Overall, there are approximately 33,194 acres in this watershed. The dominant LULC in this area is Forested (over 91%), followed by PHA (approximately 4.1%). The LOD is approximately 34.9 acres, which represents less than 0.1% of the entire watershed.

Table 26
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Upper James Watershed

HUC-12 Watershed	Total Number of Proposed Stream	Proposed Impacts in Application (feet)		Total Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Trout Creek – Craig Creek	7	0	200	0	200	1,655,432	200	0.0121%

Table 27
Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Upper James Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Proposed Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub	Freshwater Pond	Lake	Other	Total
Trout Creek-Craig Creek	0.04	0	0	0	0	0	471.66	0.2	2.02	4.51	0	0	478.39

[1] Acres delineated within the HUC-12 Watershed.

Table 28
LULC in the HUC-12 Watersheds that Fall Within the Upper James Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Trout Creek-Craig Creek	33,194	2011	30,265	91.2	185	0.6	1,388	4.2	798	2.4	0	0.0	0	0.0	14	0.0	544	1.6
	33,194	2016	30,257	91.2	189	0.6	1,376	4.1	815	2.5	0	0.0	0	0.0	14	0.0	543	1.6
	33,194	2019	30,411	91.6	196	0.6	1,377	4.1	593	1.8	0	0.0	0	0.0	2	0.0	614	1.8

3.10 Upper Roanoke

The Project crosses thirteen 12-digit HUC watersheds in the Upper Roanoke HUC-8 watershed (**Figure 241, Appendix A**). These include Dry Run-North Fork Roanoke River (030101010201), Wilson Creek-North Fork Roanoke River (030101010202), Bradshaw Creek-North Fork Roanoke River (030101010203), Brake Branch-South Fork Roanoke River (030101010105), Sawmill Hollow-Roanoke River (030101010301), Bottom Creek (030101010102), South Fork Blackwater River (030101010502), North Fork Blackwater River (030101010501), Madcap Creek-Blackwater River (030101010503), Maggodee Creek (030101010504), Standiford Creek-Smith Mountain Lake (030101010601), Owens Creek-Pigg River (030101010804), and Tomahawk Creek-Pigg River (030101011001) (**Table 29**). The Upper Roanoke watershed is approximately 2,189.9 mi^2. The combined drainage of the thirteen listed watersheds is approximately 529.6 mi^2.

3.10.1 Dry Run-North Fork Roanoke River

Project Stream Impacts. There are 14 stream crossings in the Dry Run-North Fork Roanoke River watershed. Four of these crossings are complete. The proposed crossings include six pipeline ROW crossings, three timber mat crossings, and one temporary access road. These stream impacts are all temporary in nature. The total stream impacts, an estimated 1,041 linear feet of stream, represent approximately 0.0771% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 242, Appendix A**). The completed crossings total approximately 385 linear feet of temporary stream impacts.

Project Wetlands Impacts. Approximately 4.48 acres of wetland were delineated by Mountain Valley contractors in the Dry Run-North Fork Roanoke River watershed. There are four wetland crossings, one complete, in this watershed. The Project with temporarily impact a total of 0.0529 acre of wetland in the watershed. The completed crossing temporarily impacted 0.0083 acre of wetland. The NWI data indicate that there are 362.09 acres of aquatic resources in the watershed, including 2.85 acres of Freshwater Emergent Wetland (**Table 30**) (**Figure 243, Appendix A**). The NWI data also indicate that the Project will impact 0.0963 acre of Freshwater Emergent Wetland. One area identified as wetland by NWI was identified as wetland during the Project's delineation efforts. The associated wetland crossing is identified as W-NN6, which temporarily impacts 0.0083 acre of emergent wetland. The delineations at the other areas did not confirm the presence of a wetland.

Soils. The soil data from the Dry Run-North Fork Roanoke River are from the Jefferson National Forest, Montgomery County, and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. The data indicate that the hydric soil Clubcaf silt loam, 0 to 2 percent slopes, occasionally flooded (Soil 7A) (17 acres, less than 0.06% of the watershed area) and partially hydric soil, Soil 25 (a McGary and Prudy soil) (265.2 acres, less than 0.9% of the watershed area) may be present in the watershed. Approximately 2.4 acres of the partially hydric soil, Soil 25 may be present in the Project Area (**Figure 244, Appendix A**) (**Appendix B**).

LULC. LULC changes in Dry Run-North Fork Roanoke River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 245, 246 and 246a (Appendix A)**. Overall, there are approximately 32,811 acres in this watershed. The dominant LULC in this area is Forested (over 68%), followed by PHA (approximately 22.8%). The LOD is approximately 129.5 acres, which represents less than 0.4% of the entire watershed.

3.10.2 Wilson Creek-North Fork Roanoke River

Project Stream Impacts. There are 10 proposed stream crossings in the Wilson Creek-North Fork Roanoke River watershed. Nine of the proposed stream crossings are pipeline ROW crossings, while the remaining crossing is a timber mat crossing. These stream impacts are all temporary in nature. The total impacts, an estimated 760 linear feet of stream, represent approximately 0.0751% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 247, Appendix A**).

Project Wetland Impacts. Approximately 0.161 acre of wetlands was delineated by Mountain Valley contractors in the Wilson Creek-North Fork Roanoke River watershed. Five wetland crossings are proposed in the watershed. These crossings will temporarily impact 0.2205 acre of wetland and result in conversion impacts to 0.1153 acre of wetland for a total of 0.3358 acre of wetland impacts. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 289.28 acres of aquatic resources in the watershed, including 4.61 acre of Freshwater Emergent Wetland and 0.98 acre of Freshwater Forested/Scrub Wetland (**Table 30**) (**Figure 248, Appendix A**). These wetlands fall outside of the Project Area.

Soils. The soil data from the Wilson Creek-North Fork Roanoke River watershed are from the Montgomery County, Virginia soil survey. The data indicate that the partially hydric soil, Soil 25 (185.8 acres, less than 0.8% of the watershed area) may be present in the watershed. Approximately 0.5 acre of the watershed area of the partially hydric soil, Soil 25 may be located in the Project Area (**Figure 249, Appendix A**) (**Appendix B**).

LULC. LULC changes in Wilson Creek-North Fork Roanoke River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 250, 251 and 251a (Appendix A)**. Overall, there are approximately 25,895 acres in this watershed. The dominant LULC in this area is Forested (over 69%), followed by Mixed Development (approximately 11.9%). The LOD is approximately 33.3 acres, which represents less than 0.1% of the entire watershed.

3.10.3 Bradshaw Creek-North Fork Roanoke River

Project Stream Impacts. There are three proposed stream crossings in the Bradshaw Creek-North Fork Roanoke River watershed. Two of the proposed stream crossings are pipeline ROW crossings, while the remaining crossing is a timber mat crossing. These impacts are all temporary in nature. The total impacts, an estimated 248 linear feet of stream, represent approximately 0.0345% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 252, Appendix A**).

Project Wetland Impacts. Approximately 0.26 acre of wetlands was delineated by Mountain Valley contractors in the Bradshaw Creek-North Fork Roanoke River watershed. There is one proposed wetland crossing in the watershed that will temporarily impact 0.0454 acre of wetland. The NWI data indicate that there are 233.62 acres of aquatic resources in the watershed, including 2.13 acres of Freshwater Emergent Wetland and 1.61 acre of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.2377 acre of Freshwater Pond. The Freshwater Pond has been avoided and is outside of the Project Area (**Table 30**) (**Figure 253, Appendix A**).

Soils. The soils data in the Bradshaw Creek-North Fork Roanoke River watershed are from the Montgomery County and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. The data indicate that there are no hydric soils in the watershed, but the partially hydric soil, Soil 25 (a McGary and Prudy soil) (85.5 acres, less than 0.6% of the watershed area) may be present in the watershed. The soil surveys also indicates that the partially hydric soil, Soil 25 (10.2 acres would be crossed by the Project (**Figure 254, Appendix A**) (**Appendix B**). This represents less than 12% of the Soil 25 in the watershed.

LULC. LULC changes in Bradshaw Creek-North Fork Roanoke River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 255, 256 and 256a (Appendix A)**. Overall, there are approximately 15,320 acres in this watershed. The dominant LULC in this area is Forested (over 83%), followed by PHA (approximately 7.3%). The LOD is approximately 101.2 acres, which represents less than 0.7% of the entire watershed.

3.10.4 Brake Branch-South Fork Roanoke River

Project Stream Impacts. There is only one proposed stream crossing in the Brake Branch-South Fork Roanoke River watershed. The pipeline ROW crossing is temporary in nature. The total impacts, an estimated 79 linear feet of stream, represent approximately 0.0102% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 257, Appendix A**).

Project Wetland Impacts. Approximately 0.20 acre of wetlands was delineated by Mountain Valley contractors in the Brake Branch-South Fork Roanoke River watershed. There is one proposed wetland crossing in this watershed that will permanently impact 0.0392 acre of wetland. These impacts will be mitigated using mitigation banking. The NWI data indicate that there are 253.17 acres of aquatic resources in the watershed, including 4.42 acre of Freshwater Emergent Wetland and 1.96 acre of Freshwater Forested/Scrub Wetland. None of these wetlands are located in the Project Area (**Table 30**) (**Figure 258, Appendix A**).

Soils. The soils data in the Brake Branch-South Fork Roanoke River watershed are from the Montgomery County and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. The data indicate that there are no hydric soils in the watershed, but the partially hydric soil, Soil 25 (226.4 acres, less than 1.1% of the watershed area) may be present in the watershed. The soil surveys also indicate that the partially hydric soil, Soil 25 (0.9 acre) may be present in the Project Area (**Figure 259, Appendix A**) (**Appendix B**).

LULC. LULC changes in Brake Creek-North Fork Roanoke River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 260, 261 and 261a (Appendix A)**. Overall, there are approximately 21,870 acres in this watershed. The dominant LULC in this area is Forested (over 78%), followed by PHA (approximately 9.4%). The LOD is approximately 22.6 acres, which represents less than 0.1% of the entire watershed.

3.10.5 Sawmill Hollow-Roanoke River

Project Stream Impacts. There are seven proposed stream crossings in the Sawmill Hollow-Roanoke River watershed. These stream impacts are all temporary in nature and include four pipeline ROW crossings and three timber mat crossings. The total stream impacts, an estimated 468 linear feet of stream, represent approximately 0.0284% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 262, Appendix A**).

Project Wetland Impacts. Approximately 1.97 acres of wetlands were delineated by Mountain Valley contractors in the Sawmill Hollow-Roanoke River watershed. The Project includes two proposed wetland crossings that will result in 0.0040 acres of temporary impacts and 0.0852 acre of wetland conversion impacts for a total of 0.0892 acre of wetland impacts in this watershed. The conversion impacts will be mitigated using banking. The NWI data indicate that there are 646.93 acres of aquatic resources in the watershed, including 1.18 acre of Freshwater Emergent Wetland and 3.47 acre of Freshwater Forested/Scrub Wetland (**Table 30**) (**Figure 263, Appendix A**). None of these wetlands fall in the Project Area.

Soils. The soil data for the Sawmill Hollow-Roanoke River watershed are from the Montgomery County and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. The data indicate that the hydric soils Soil 7A (4.9 acres, less than 0.02% of the watershed area) and Purdy silt loam, 0 to 4 percent slopes (Soil 36A) (68.8 acres, less than 0.2% of the watershed area) as well as the partially hydric soil, Soil 25 (16.8 acres, less than 0.05% of the watershed area) may be present in the watershed. The soil survey data indicate that the partially hydric soil, Soil 25 (2.0 acres) may be present in the Project Area (**Figure 264, Appendix A**) (**Appendix B**).

LULC. LULC changes in Sawmill Hollow-Roanoke River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 265, 266 and 266a (Appendix A)**. Overall, there are approximately 40,523 acres in this watershed. The dominant LULC in this area is Forested (over 66%), followed by MD (approximately 20.2%). The LOD is approximately 147.3 acres, which represents less than 0.4% of the entire watershed.

3.10.6 Bottom Creek

Project Stream Impacts. There are 25 stream crossings in the Bottom Creek watershed. Sixteen of the proposed crossings are associated with timber mat crossings, and seven are pipeline ROW crossings. The remaining two are temporary access roads. These stream impacts are all temporary in nature. The total impacts, an estimated 1,225 linear feet of stream, represent approximately 0.1871% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 267, Appendix A**).

Project Wetland Impacts. Approximately 28.38 acres of wetlands were delineated by Mountain Valley contractors in the Project Area. There are 40 wetland crossings proposed in the Project Area. These proposed crossings will result in 1.3295 acres of temporary impacts and 0.7001 acre of wetland conversion impacts, for a total of 2.0296 acres of wetland impacts. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 315.66 acres of aquatic resources in the watershed, including 45.12 acre of Freshwater Emergent Wetland and 60.81 acre of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.0038 acre of Freshwater Emergent Wetland, 0.3114 acre of Freshwater Forested/Scrub Wetland, and 0.0375 acre of Freshwater Pond in the watershed (**Table 30**) (**Figure 268, Appendix A**). The Freshwater Pond has been avoided and is outside of the Project Area. Freshwater Emergent Wetland impacts are included in W-AB6-PEM-2, which has 0.3271 acre of temporary impacts. Freshwater Forested/Scrub Wetland impacts occur at W-EF46, which has 0.0682 acre of scrub-shrub wetland, and W-IJ36, which has 0.1237 acre of scrub-shrub wetland. These impacts will be mitigated using mitigation banking.

Soils. Soil data for the Bottom Creek watershed are from the Floyd County, Franklin County, Montgomery County and Roanoke County and Cities of Roanoke and Salem, Virginia soil surveys. The data indicate that the hydric soils Alderflats silt loam, 0 to 4 percent slopes (Soil 1A) (465.2 acres, less than 2.6% of the watershed area) and Soil 7A (42 acres, less than 0.3% of the watershed area) may be present in the watershed. The survey data also indicate that hydric soil, Soil 1A (5.9 acres) may be present in the Project Area (**Figure 269, Appendix A**) (**Appendix B**).

LULC. LULC changes in Bottom Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 270, 271 and 271a (Appendix A)**. Overall, there are approximately 18,129 acres in this watershed. The dominant LULC in this area is Forested (over 80%), followed by PHA (approximately 11.3%). The LOD is approximately 117 acres, which represents less than 0.7% of the entire watershed.

3.10.7 South Fork Blackwater River

Project Stream Impacts. There are nine stream crossings in the South Fork Blackwater River watershed. Three of these crossings are completed pipeline ROW crossings. Two of the proposed crossings are pipeline ROW crossings, three are timber mat crossings, and one is a permanent access road. These stream impacts are all temporary in nature. The total impacts, an estimated 421 linear feet of stream, represent approximately 0.0606% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 272, Appendix A**). The completed crossings total approximately 236 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 3.53 acres of wetlands were delineated by Mountain Valley contractors in the South Fork Blackwater River watershed. There are five proposed wetland crossings that will result in 0.1871 acre of temporary wetland impacts in this watershed. The NWI data indicate that there are 222.00 acres of aquatic resources in the watershed, including 9.66 acres of Freshwater Emergent Wetland and 13.65 Freshwater Forested/Scrub Wetland (**Table 30**) (**Figure 273, Appendix A).** None of these wetlands fall in the Project Area.

Soils. The soil data for the South Fork Blackwater River watershed are from the Floyd County, Franklin County, and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. The soil data indicate that there are no hydric soils in the watershed, but the partially hydric soil Delanco-Kinkora complex, 0 to 8 percent slopes, rarely flooded (15B) (0.4 acre, less than 0.003% of the watershed area) may be present in the watershed (**Figure 274, Appendix A**) (**Appendix B**). This soil type is not crossed by the Project.

LULC. LULC changes in South Fork Blackwater River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 275, 276 and 276a (Appendix A)**. Overall, there are approximately 18,019 acres in this watershed. The dominant LULC in this area is Forested (over 71%), followed by PHA (approximately 20.3%). The LOD is approximately 30.8 acres, which represents less than 0.2% of the entire watershed.

3.10.8 North Fork Blackwater River

Project Stream Impacts. There are 22 stream crossings in the North Fork Blackwater River watershed. Four of these crossings, pipeline ROW crossings, are complete. The proposed stream impacts are all temporary in nature and include 12 pipeline ROW crossings and six timber mat crossings. The total impacts, an estimated 1,588 linear feet of stream, represent approximately 0.1866% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 277, Appendix A**). The completed crossings total approximately 377 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 2.23 acres of wetlands were delineated by Mountain Valley contractors in the North Fork Blackwater River. There are three proposed wetland crossings and one completed wetland crossing in the watershed. The Project will result in 0.0779 acre of temporary impacts. The NWI data indicate that there are 268.88 acres of aquatic resources including 0.89 acre of Freshwater Emergent Wetland and 4.36 acre of Freshwater Forested/Scrub Wetland in the watershed. The NWI data also indicate that the Project will impact 0.3939 acre of Freshwater Forested/Scrub Wetland in the watershed (**Table 30**) (**Figure 278, Appendix A**). This area is maintained pasture, and no wetlands during Project delineation were identified in the NWI wetland footprint.

Soils. The soil data for the North Fork Blackwater River watershed are from the Franklin County, and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. Based on these data, there are no hydric soils or partially hydric soils present in the watershed or Project Area (**Figure 279, Appendix A**).

LULC. LULC changes in North Fork Blackwater River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 280, 281 and 281a (Appendix A)**. Overall, there are approximately 20,475 acres in this watershed. The dominant LULC in this area is Forested (over 70%), followed by PHA (approximately 20.3%). The LOD is approximately 111 acres, which represents less than 0.5% of the entire watershed.

3.10.9 Madcap Creek-Blackwater River

Project Stream Impacts. There are 55 stream crossings in the Madcap Creek-Blackwater River watershed. Twelve of these crossings are complete, all of which are pipeline ROW crossings. The proposed crossings include 24 pipeline ROW crossings, 18 timber mat crossings, and one temporary work area. These stream impacts are all temporary in nature. The total stream crossing impacts in this watershed are approximately 3,373 linear feet. While this represents the largest total amount of impacts in any of the 12-digit HUCs in the Virginia portion of the Project area, the percentage of modeled streams in the watershed is approximately 0.2301% (**Table 29**) (**Figure 282, Appendix A**). The completed crossings total approximately 994 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 8.29 acres of wetlands were delineated by Mountain Valley contractors in the Madcap Creek-Blackwater River watershed. The Project has ten proposed wetland crossings that will result in 0.4095 acre of temporary impacts and 0.2372 acre of wetland conversion impacts, for a total of 0.6467 acre of wetland impacts in the watershed. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 704.00 acres of aquatic resources in the watershed, including 47.4 acres of Freshwater Emergent Wetland and 103.79 acres of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.2544 acre of Freshwater Emergent Wetland and 0.9832 acre of Freshwater Forested/Scrub Wetland in the watershed (**Table 30**) (**Figure 283, Appendix A**). These areas were delineated, and any wetland identified has been avoided.

Soils. The soil data for the Madcap Creek-Blackwater River watershed are from the Franklin County, Virginia soil survey. Based on these data, there are no hydric soils or partially hydric soils present in the watershed or Project Area (**Figure 284, Appendix A**) (**Appendix B**).

LULC. LULC changes in Madcap Creek-Blackwater River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 285, 286 and 286a (Appendix A)**. Overall, there are approximately 37,059 acres in this watershed. The dominant LULC in this area is Forested (over 52%), followed by PHA (approximately 34.9%). The LOD is approximately 245 acres, which represents less than 0.7% of the entire watershed.

3.10.10 Maggodee Creek

Project Stream Impacts. There are seven proposed stream crossings in the Maggodee Creek watershed: five pipeline ROW crossings, one temporary access road, and one timber mat crossing. These stream impacts are all temporary in nature. The total impacts, an estimated 497 linear feet of stream, represent approximately 0.0420% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 287, Appendix A**).

Project Wetland Impacts. Approximately 0.20 acre of wetlands was delineated by Mountain Valley contractors in the Maggodee Creek watershed. There is one proposed wetland crossing that will result in 0.0004 acre of temporary impacts in the watershed. The NWI data indicate that there are 460.4 acres of aquatic resources in the watershed, including 36.09 acres of Freshwater

Emergent Wetland and 11.58 acres of Freshwater Forested/Scrub Wetland (**Table 30**) (**Figure 288, Appendix A).** None of these wetlands are in the Project Area.

Soils. The soil data for the Maggodee Creek watershed are from the Franklin County, and Roanoke County and the Cities of Roanoke and Salem, Virginia soil surveys. Based on these data, there are no hydric soils or partially hydric soils present in the watershed or Project Area (**Figure 289, Appendix A**).

LULC. LULC changes in Maggodee Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 290, 291 and 291a (Appendix A)**. Overall, there are approximately 29,144 acres in this watershed. The dominant LULC in this area is Forested (over 63%), followed by PHA (approximately 25.2%). The LOD is approximately 26.1 acres, which represents less than 0.1% of the entire watershed.

3.10.11 Standiford Creek-Smith Mountain Lake

Project Stream Impacts. There are 28 stream crossings in the Standiford Creek-Smith Mountain Lake watershed. One of these crossing, a pipeline ROW crossing, is complete. As noted in other drains, lakes are not included in stream miles in the model that was used to estimate stream lengths. Proposed stream impacts include 15 pipeline ROW crossings, 10 timber mat crossings, and two temporary access roads, all of which are temporary in nature. The total impacts, an estimated 1,577 linear feet of stream, represent approximately 0.1725% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 292, Appendix A**). The completed crossing total approximately 78 linear feet of temporary stream impacts.

Project Wetland Impacts. Approximately 5.66 acres of wetlands were delineated by Mountain Valley contractors in the Standiford Creek-Smith Mountain Lake watershed. There are four wetland crossings proposed in the watershed that will result in 0.1464 acre of temporary impacts and 0.0697 acre of wetland conversion impacts totaling 0.2161 acre of wetland impacts. The wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 2,483.43 acres of aquatic resources in the watershed, including 28.02 acre of Freshwater Emergent Wetland and 69.01 acre of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.1073 acre of Freshwater Emergent Wetland in the watershed (**Table 30**) (**Figure 293, Appendix A**). These areas were delineated, and Freshwater Emergent Wetland impacts present are included in W-A12-PEM, which has 0.0651 acre of temporary impacts.

Soils. The soil data for the Standiford Creek-Smith Mountain Lake watershed are from the Franklin County, Virginia soil surveys. Based on these data, there are no hydric soils or partially hydric soils present in the watershed or Project Area (**Figure 294, Appendix A**) (**Appendix B**).

LULC. LULC changes in Standiford Creek-Smith Mountain Lake watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 295, 296 and 296a (Appendix A)**. Overall, there are approximately 29,829 acres in this watershed. The dominant LULC in this area is Forested (over 44%), followed by PHA (approximately 31%). The LOD is approximately 142.4 acres, which represents less than 0.5% of the entire watershed.

3.10.12 Owens Creek-Pigg River

Project Stream Impacts. There are 31 proposed stream crossings in the Owens Creek-Pigg River watershed. Stream impacts in this watershed are temporary in nature and are associated with 18 timber mat and 13 pipeline ROW crossings. The total impacts, an estimated 1,330 linear feet of stream, represent approximately 0.1511% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 297, Appendix A**).

Project Wetland Impacts. Approximately 2.31 acres of wetlands were delineated by Mountain Valley contractors in the Owens Creek-Pigg River watershed. There are eight wetland crossings proposed in the watershed that will result in 0.1057 acre of temporary impacts and 0.0440 acre of wetland conversion impacts for a total of 0.1497 acre of wetland impacts. The conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 448.12 acre of aquatic resources in the watershed, including 36.87 acre of Freshwater Emergent Wetland and 48.91 acre of Freshwater Forested/Scrub Wetland (**Table 30**) (**Figure 298, Appendix A**). These wetlands are not located in the Project Area.

Soils. The soils data for the Owens Creek-Pigg River watershed are from the Franklin County, and Pittsylvania County and the City of Danville, Virginia soil surveys. These soil data indicate that there are no other hydric soils or partially hydric soils present in the watershed or Project Area (**Figures 299, Appendix A**) (**Appendix B**).

LULC. LULC changes in Owens Creek-Pigg River watershed between 2011, 2016 and 2019 are illustrated in **Table 31** and **Figures 300, 301 and 301a (Appendix A)**. Overall, there are approximately 23,204 acres in this watershed. The dominant LULC in this area is Forested (over 60%), followed by PHA (approximately 22.5%). The LOD is approximately 117 acres, which represents less than 0.5% of the entire watershed.

3.10.13 Tomahawk Creek–Pigg River

Project Stream Impacts. There are 22 proposed stream crossings in the Tomahawk Creek-Pigg River watershed. Proposed stream impacts in this watershed are temporary in nature and are associated with 10 timber mat crossings and 12 pipeline ROW crossings. The total impacts, an estimated 1,191 linear feet of stream, represent approximately 0.1194% of the modeled streams in this HUC-12 watershed (**Table 29**) (**Figure 302, Appendix A**).

Project Wetland Impacts. Approximately 3.93 acre of wetlands were delineated by Mountain Valley contractors in the Tomahawk Creek-Pigg River watershed. Seven wetland crossings are proposed in this watershed. The crossings will result in 0.2378 acre of temporary impacts and 0.0332 acre of wetland conversion impacts that total 0.2710 acre of wetland impacts. Wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 777.91 acre of aquatic resources in the watershed, including 54.22 acres of Freshwater

Emergent Wetland and 194.52 acres of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.8589 acre of Freshwater Forested/Scrub Wetland in the Project Area (**Table 30**) (**Figure 303, Appendix A**). This area was delineated, and no wetlands were identified.

Soils. The soils data for the Tomahawk Creek-Pigg River watershed are from the Franklin County, and Pittsylvania County and the City of Danville, Virginia soil surveys. These data indicate that there are no hydric or partially hydric soils present in the watershed or Project Area (**Figure 304, Appendix A**) (**Appendix B**).

LULC. LULC changes in Tomahawk Creek-Pigg River watershed between 2011 and 2016 are illustrated in **Table 31** and **Figures 306, 307 and 307a (Appendix A)**. Overall, there are approximately 26,599 acres in this watershed. The dominant LULC in this area is Forested (over 48%), followed by PHA (approximately 31.9%). The LOD is approximately 188.4 acres, which represents less than 0.7% of the entire watershed.

Table 29
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Upper Roanoke (03010101) Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Dry Run – North Fork Roanoke River	14	0	656	0	1,041	1,350,145	1,041	0.0771%
Wilson Creek – North Fork Roanoke River	10	0	760	0	760	1,012,489	760	0.0751%
Bradshaw Creek – North Fork Roanoke River	3	0	248	0	248	719,801	248	0.0345%
Brake Branch – South Fork Roanoke River	1	0	79	0	79	777,601	79	0.0102%
Sawmill Hollow – Roanoke River	7	0	468	0	468	1,648,284	468	0.0284%
Bottom Creek	25	0	1,225	0	1,225	654,699	1,225	0.1871%
South Fork Blackwater River	9	0	185	0	421	695,228	421	0.0606%
North Fork Blackwater River	22	0	1,211	0	1,588	851,091	1,588	0.1866%
Madcap Creek – Blackwater River	55	0	2,379	0	3,373	1,466,132	3,373	0.2301%
Maggodee Creek	7	0	497	0	497	1,184,040	497	0.0420%
Standiford Creek – Smith Mountain Lake	28	0	1,499	0	1,577	914,176	1,577	0.1725%
Owens Creek – Pigg River	31	0	1,330	0	1,330	880,190	1,330	0.1511%
Tomahawk Creek – Pigg River	22	0	1,191	0	1,191	997,467	1,191	0.1194%

Table 30
Cumulative Project-Related Wetland Impacts and National Wetland Inventory data in the HUC-12 Watersheds that Fall Within the Upper Roanoke Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Dry Run-North Fork Roanoke River	4.48	4	0.0529	0	0	0.0529	342.9	2.85	0	16.34	0	0	362.09
Wilson Creek-North Fork Roanoke River	1.61	5	0.2205	0.1153	0	0.3358	264.03	4.61	0.98	19.66	0	0	289.28
Bradshaw Creek-North Fork Roanoke River	0.26	1	0.0454	0	0	0.0454	225.01	2.13	1.61	4.88	0	0	233.62
Brake Branch-South Fork Roanoke River	0.20	1	0	0	0.0392	0.0392	240.71	4.42	1.96	6.07	0	0	253.17
Sawmill Hollow-Roanoke River	1.97	2	0.0040	0.0852	0	0.0892	610.28	1.18	3.47	32	0	0	646.93
Bottom Creek	28.38	40	1.3295	0.7001	0	2.0296	183.79	45.12	60.81	25.95	0	0	315.66
South Fork Blackwater River	3.53	5	0.1871	0	0	0.1871	187.46	9.66	13.65	11.24	0	0	222.00
North Fork Blackwater River	2.23	4	0.0779	0	0	0.0779	224.23	0.89	4.36	39.39	0	0	268.88
Madcap Creek-Blackwater River	8.29	10	0.4095	0.2372	0	0.6467	479.48	47.4	103.79	73.33	0	0	704.00
Maggodee Creek	0.20	1	0.0004	0	0	0.0004	357	36.09	11.58	55.73	0	0	460.4
Standiford Creek-Smith Mountain Lake	5.66	4	0.1464	0.0697	0	0.2161	258.86	28.02	69.01	69.15	2058.39	0	2483.43

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Owens Creek-Pigg River	2.31	8	0.1057	0.0440	0	0.1497	289.21	36.87	48.91	73.14	0	0	448.12
Tomahawk Creek–Pigg River	3.93	7	0.2378	0.0332	0	0.2710	353.98	54.22	194.52	113.14	62.05	0	777.91

[1] Acres delineated within the HUC-12 Watershed.

Table 31
LULC in the HUC-12 Watersheds that Fall Within the Upper Roanoke Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Dry Run-North Fork Roanoke River	32,811	2011	22,094	67.3	1,174	3.6	7,519	22.9	693	2.1	4	0.0	0	0.0	3	0.0	1324.1	4.0
	32,811	2016	22,080	67.3	1,192	3.6	7,479	22.8	732	2.2	5	0.0	0	0.0	2	0.0	1319.7	4.0
	32,811	2019	22,305	68.0	1,219	3.7	7,473	22.8	502	1.5	5	0.0	0	0.0	4	0.0	1303.2	4.0
Wilson Creek-North Fork Roanoke River	25,895	2011	18,324	70.8	2,972	11.5	2,690	10.4	568	2.2	8	0.0	0	0.0	102	0.4	1231.6	4.8
	25,895	2016	17,918	69.2	3,015	11.6	2,666	10.3	961	3.7	7	0.0	0	0.0	102	0.4	1226.5	4.7
	25,895	2019	17,951	69.3	3,090	11.9	2,632	10.2	865	3.3	7	0.0	0	0.0	136	0.5	1214.3	4.7
Bradshaw Creek-North Fork Roanoke River	15,320	2011	12,865	84.0	605	3.9	1,142	7.5	279	1.8	1	0.0	0	0.0	83	0.5	346.0	2.3
	15,320	2016	12,888	84.1	609	4.0	1,132	7.4	259	1.7	1	0.0	0	0.0	84	0.5	346.9	2.3
	15,320	2019	12,789	83.5	634	4.1	1,112	7.3	332	2.2	1	0.0	0	0.0	107	0.7	345.6	2.3
Brake Branch-South Fork Roanoke River	21,870	2011	17,286	79.0	1,375	6.3	2,073	9.5	280	1.3	0	0.0	1	0.0	85	0.4	769.0	3.5
	21,870	2016	17,115	78.3	1,397	6.4	2,054	9.4	456	2.1	0	0.0	1	0.0	84	0.4	762.1	3.5
	21,870	2019	17,112	78.2	1,407	6.4	2,051	9.4	457	2.1	0	0.0	1	0.0	81	0.4	760.1	3.5
Sawmill Hollow-Roanoke River	40,523	2011	27,224	67.2	8,044	19.8	1,849	4.6	733	1.8	141	0.3	0	0.0	19	0.0	2514.0	6.2
	40,523	2016	26,833	66.2	8,121	20.0	1,805	4.5	1,052	2.6	142	0.3	0	0.0	20	0.0	2551.1	6.3
	40,523	2019	26,858	66.3	8,196	20.2	1,788	4.4	990	2.4	142	0.3	0	0.0	50	0.1	2499.7	6.2
Bottom Creek	18,129	2011	14,180	78.2	337	1.9	2,046	11.3	810	4.5	8	0.0	164	0.9	5	0.0	580.5	3.2
	18,129	2016	14,237	78.5	343	1.9	2,040	11.3	759	4.2	7	0.0	155	0.9	5	0.0	581.8	3.2
	18,129	2019	14,593	80.5	348	1.9	2,045	11.3	398	2.2	7	0.0	155	0.9	5	0.0	577.1	3.2
	18,019	2011	12,989	72.1	227	1.3	3,650	20.3	521	2.9	3	0.0	4	0.0	3	0.0	622.0	3.5

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
South Fork Blackwater River	18,019	2016	12,747	70.7	234	1.3	3,641	20.2	764	4.2	3	0.0	4	0.0	3	0.0	624.3	3.5
	18,019	2019	12,811	71.1	239	1.3	3,658	20.3	682	3.8	3	0.0	4	0.0	3	0.0	619.1	3.4
North Fork Blackwater River	20,475	2011	14,652	71.6	303	1.5	4,153	20.3	570	2.8	21	0.1	2	0.0	2	0.0	772.4	3.8
	20,475	2016	14,522	70.9	310	1.5	4,155	20.3	688	3.4	21	0.1	2	0.0	1	0.0	776.8	3.8
	20,475	2019	14,423	70.4	314	1.5	4,160	20.3	779	3.8	21	0.1	2	0.0	4	0.0	772.8	3.8
Madcap Creek-Blackwater River	37,059	2011	19,653	53.0	1,395	3.8	13,003	35.1	1,023	2.8	28	0.1	32	0.1	5	0.0	1919.3	5.2
	37,059	2016	19,457	52.5	1,465	4.0	12,903	34.8	1,272	3.4	31	0.1	30	0.1	5	0.0	1896.4	5.1
	37,059	2019	19,271	52.0	1,485	4.0	12,919	34.9	1,432	3.9	31	0.1	30	0.1	8	0.0	1882.3	5.1
Maggodee Creek	29,144	2011	18,524	63.6	995	3.4	7,375	25.3	769	2.6	27	0.1	8	0.0	2	0.0	1445.8	5.0
	29,144	2016	18,371	63.0	1,060	3.6	7,313	25.1	966	3.3	26	0.1	8	0.0	2	0.0	1398.2	4.8
	29,144	2019	18,383	63.1	1,069	3.7	7,331	25.2	935	3.2	26	0.1	8	0.0	3	0.0	1389.1	4.8
Standiford Creek-Smith Mountain Lake	29,829	2011	13,493	45.2	959	3.2	9,345	31.3	2,232	7.5	1,897	6.4	30	0.1	21	0.1	1851.7	6.2
	29,829	2016	13,527	45.3	995	3.3	9,196	30.8	2,322	7.8	1,892	6.3	31	0.1	22	0.1	1843.7	6.2
	29,829	2019	13,364	44.8	1,003	3.4	9,256	31.0	2,425	8.1	1,891	6.3	34	0.1	21	0.1	1835.4	6.2
Owens Creek-Pigg River	23,204	2011	14,532	62.6	290	1.3	5,237	22.6	2,370	10.2	26	0.1	28	0.1	7	0.0	714.1	3.1
	23,204	2016	14,046	60.5	306	1.3	5,196	22.4	2,887	12.4	26	0.1	26	0.1	7	0.0	710.3	3.1
	23,204	2019	13,998	60.3	310	1.3	5,214	22.5	2,918	12.6	26	0.1	26	0.1	7	0.0	706.3	3.0
Tomahawk Creek-Pigg River	26,599	2011	13,117	49.3	418	1.6	8,382	31.5	3,446	13.0	132	0.5	60	0.2	0	0.0	1043.0	3.9
	26,599	2016	12,203	45.9	427	1.6	8,391	31.5	4,342	16.3	137	0.5	58	0.2	1	0.0	1039.9	3.9
	26,599	2019	12,831	48.2	435	1.6	8,489	31.9	3,615	13.6	137	0.5	58	0.2	1	0.0	1031.9	3.9

3.11 Banister

The Project crosses three 12-digit HUC watersheds in the Banister HUC-8 watershed (**Figure 72, Appendix A**). These include Cherrystone Creek (030101050104), Mill Creek-Whitehorn Creek (030101050201), and Shockoe Creek-Banister River (030101050203) (**Table 42**). The Banister watershed is approximately 596.7 mi^2, the smallest in the Project area. The combined drainage of the three listed watersheds is approximately 116.6 mi^2. This includes the Shockoe Creek-Banister River watershed that has no stream impacts.

3.11.1 Cherrystone Creek

Project Stream Impacts. There are 34 proposed stream crossings in the Cherrystone Creek watershed. There is one proposed permanent access road with permanent impacts. The 33 remaining proposed stream crossings are associated with 18 timber mat crossings and 15 pipeline ROW crossings. These impacts are temporary in nature. The total impacts, temporary (1,646 linear feet) and permanent (32 linear feet), an estimated 1,646 linear feet of stream, represent approximately 0.1519% of the modeled streams in this HUC-12 watershed (**Table 42**) (**Figure 308, Appendix A**).

Project Wetland Impacts. Approximately 27.35 acres of wetland were delineated by Mountain Valley contractors in the Cherrystone Creek watershed. There are 14 proposed wetland crossings that will result in 1.0421 acres of temporary impacts and 0.5706 acre of wetland conversion impacts totaling 1.6127 acres of wetland impacts. The wetland conversion impacts will be mitigated using mitigation banking. The NWI data indicate that there are 816.46 acres of aquatic resources in the watershed, including 57.23 acres of Freshwater Emergent Wetland and 170.75 acres of Freshwater Forested/Scrub Wetland. The NWI data also indicate that the Project will impact 0.0701 acre of Freshwater Emergent Wetland and 0.7166 acre of Freshwater Forested/Scrub Wetland located in two separate parcels in the Project Area. These areas were included in the Project's delineation. A portion of the Freshwater Forested/Scrub Wetland impacts are included in W-MM9, which has 0.0108 acre of temporary impacts (**Table 43**) (**Figure 309, Appendix A**). The other Freshwater Forested/Scrub Wetland area were investigated, and no wetlands were identified. The Freshwater Emergent Wetland area was also delineated, and a wetland was not present.

Soils. The soils data for the Cherrystone Creek watershed are from the Pittsylvania County and City of Danville, Virginia soil survey. The data indicate that one hydric soil Hatboro silt loam, 0 to 2 percent slopes, frequently flooded (Soil 41A) (150.3 acres, less than 0.6% of the watershed area) may be present in the watershed. The soil survey data also indicate that the hydric soil, Soil 41A (1.1 acres) may be present in the Project Area **(Figure 310, Appendix A**) (**Appendix B**).

LULC. LULC changes in Cherrystone Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 44** and **Figures 311, 312 and 312a (Appendix A)**. Overall, there are approximately 29,138 acres in this watershed. The dominant LULC in this area is Forested (over 41%), followed by PHA (approximately 36.2%). The LOD is approximately 175 acres, which represents less than 0.6% of the entire watershed.

3.11.2 Mill Creek-Whitehorn Creek

Project Stream Impacts. There are four proposed pipeline ROW stream crossings in the Mill Creek-Whitehorn Creek watershed. These impacts are temporary in nature. The total impacts, an estimated 390 linear feet of stream, represent approximately 0.0394% of the modeled streams in this HUC-12 watershed (**Table 42**) (**Figure 313, Appendix A**).

Project Wetland Impacts. Approximately 0.69 acre of wetland was delineated by Mountain Valley contractors in the Mill Creek-Whitehorn Creek watershed. These impacts have been avoided, and there are no wetland impacts in the watershed. The NWI data indicate that there are 670.10 acres of aquatic resources in the watershed, including 72.67 acres of Freshwater Emergent Wetland and 191.44 acres of Freshwater Forested/Scrub Wetland (**Table 43**) (**Figure 314, Appendix A**). None of these wetlands fall in the Project Area.

Soils. The soils data for the Mill Creek-Whitehorn Creek watershed are from the Pittsylvania County and City of Danville, Virginia soil survey. The soil data indicate that the hydric soils, Soil 41A (18 acres, less than 0.07% of the watershed area), and Leaksville silt loam, 0 to 4 percent slopes (Soil 20B-Pittsylvania) (11.1 acres, less than 0.05% of the watershed) may be present in the watershed; however, these soil types are not crossed by the Project (**Figure 315, Appendix A**) (**Appendix B**).

LULC. LULC changes in Mill Creek-Whitehorn Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 44** and **Figures 316, 317 and 317a (Appendix A)**. Overall, there are approximately 26,718 acres in this watershed. The dominant LULC in this area is Forested (over 43%), followed by PHA (approximately 36.9%). The LOD is approximately 33.5 acres, which represents less than 0.1% of the entire watershed.

3.11.3 Shockoe Creek-Banister River

Project Stream Impacts. The Project area includes the Shockoe Creek-Banister River watershed. However, there are no stream crossings in this watershed (**Table 42**) (**Figure 318**, **Appendix A**).

Project Wetland Impacts. Approximately 0.67 acre of wetlands was delineated by Mountain Valley contractors in the Shockoe Creek-Banister River watershed. There are two proposed wetland crossings that will result in 0.0773 acre of wetland conversion impacts in the watershed. These impacts will be mitigated using mitigation banking. The NWI data indicate that there are 564.95 acres of aquatic resources in the watershed, including 31.31 acres of Freshwater Emergent Wetland and 236.77 acres of Freshwater Forested/Scrub Wetland (**Table 43)** (**Figure 319, Appendix A**). These wetlands are not located in the Project Area.

Soils. The soils data for the Shockoe Creek-Banister River watershed are from the Pittsylvania County and City of Danville, Virginia soil survey. The soil data indicate that the hydric soil, Soil 41A (161.7 acres, less than 0.9% of the watershed area) and Soil 20B-Pittsylvania (437.9 acres, less than 2.4% of the watershed area) may be present in the watershed; however, these data indicate that there are no hydric soils or partially hydric soils in the Project Area (**Figure 320, Appendix A**) (**Appendix B**).

<u>LULC</u>. LULC changes in Mill Creek-Whitehorn Creek watershed between 2011, 2016 and 2019 are illustrated in **Table 44** and **Figures 321, 322 and 322a (Appendix A)**. Overall, there are approximately 18,816 acres in this watershed. The dominant LULC in this area is Forested (over 58%), followed by PHA (approximately 21.9%). The LOD is approximately 11.9 acres, which represents less than 0.1% of the entire watershed.

Table 42
Cumulative Project Stream Impacts in the HUC-12 Watersheds that Fall Within the Banister (03010105) Watershed

HUC-12 Watershed	Total Number of Stream Crossings	Proposed Impacts in Application (feet)		Total Project-Related Impacts (feet)		Estimated Linear Feet of Streams in Watershed	Project-Related Cumulative Impacts (feet)	Percentage of Impacted Linear Stream Feet Estimated in the Watershed
		Perm	Temp	Perm	Temp			
Cherrystone Creek	34	32	1,646	32	1,646	1,083,738	1,646	0.1519%
Mill Creek – Whitehorn Creek	4	0	390	0	390	989,566	390	0.0394%
Shockoe Creek – Banister River	0	0	0	0	0	703,910	0	0%

Table 43

Cumulative Project-Related Wetland Impacts and National Wetland Inventory Data in the HUC-12 Watersheds that Fall Within the Banister Watershed

HUC-12 Watershed	Delineated Acres[1]	Total Number of Wetland Crossings	Temporary Impacts (acres)	Permanent Conversion Impacts (Acres)	Permanent Fill Impacts (acres)	Total Wetland Impacts	National Wetland Inventory Data (acres)						
							Riverine	Freshwater Emergent Wetland	Freshwater Forested/Scrub Wetland	Freshwater Pond	Lake	Other	Total
Cherrystone Creek	27.35	14	1.0421	0.5706	0	1.6127	273.4	57.23	170.75	185.8	129.28	0	816.46
Mill Creek-Whitehorn Creek	0.69	---	---	---	---	---	274.9	72.67	191.44	131	0	0	670.10
Shockoe Creek-Banister River	0.67	2	0	0.0773	0	0.0773	207.78	31.31	236.77	89.09	0	0	564.95

[1] Acres delineated within the HUC-12 Watershed.

Table 44
LULC in the HUC-12 Watersheds that Fall Within the Banister Watershed

HUC-12 Watershed	Total HUC-12 Watershed Size (Acres)	Year	Forest		Mixed Development		Pasture, Hay, Agriculture		Streams Riparian Corridor, Floodplain		Water		Wetlands		Barren Including Mine, Oil and Gas		Roads, Impervious Surface	
			Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12	Acres	% of Total HUC-12
Cherrystone Creek	29,138	2011	11,996	41.2	1,136	3.9	10,662	36.6	3,637	12.5	220	0.8	133	0.5	15	0.1	1,340	4.6
	29,138	2016	11,201	38.4	1,200	4.1	10,481	36.0	4,511	15.5	215	0.7	133	0.5	14	0.0	1,382	4.7
	29,138	2019	12,193	41.8	1,222	4.2	10,560	36.2	3,431	11.8	216	0.7	133	0.5	12	0.0	1,371	4.7
Mill Creek-Whitehorn Creek	26,718	2011	11,473	42.9	825	3.1	9,970	37.3	3,222	12.1	69	0.3	75	0.3	3	0.0	1,083	4.1
	26,718	2016	10,839	40.6	850	3.2	9,729	36.4	4,048	15.1	67	0.2	76	0.3	4	0.0	1,106	4.1
	26,718	2019	11,706	43.8	857	3.2	9,866	36.9	3,034	11.4	67	0.2	76	0.3	12	0.0	1,099	4.1
Shockoe Creek-Banister River	18,816	2011	10,443	55.5	243	1.3	4,157	22.1	3,084	16.4	52	0.3	278	1.5	0	0.0	559	3.0
	18,816	2016	10,353	55.0	247	1.3	4,070	21.6	3,248	17.3	49	0.3	290	1.5	0	0.0	558	3.0
	18,816	2019	11,087	58.9	255	1.4	4,117	21.9	2,463	13.1	50	0.3	290	1.5	0	0.0	553	2.9

4.0 CONCLUSIONS

Stream Impacts. This report estimates the total number of linear feet of streams in each 12-digit HUC watershed, identifies the number of linear feet of streams that will be affected by the Project in that watershed, and provides the percentage of the total HUC-12 stream feet that those Project impacts represent. This process included the modeling of stream flow paths to establish the total linear feet of stream in each watershed. Using the model for this type of evaluation provides a more accurate estimate than using NHD streamlines. The NHD values typically are limited to blue-line or hatched blue-line streams and, in most instances, do not count high-gradient intermittent and ephemeral streams that fall within the USACE's jurisdiction.

Based on the information generated for this analysis, the Project will have negligible impacts to streams in each 12-digit watershed. Permanent stream impacts are limited and are primarily the result of installing, repairing, or replacing culverts under access roads.[6] Temporary impacts are primarily associated with timber mat crossings or the pipeline ROW. Timber mats are placed within the ordinary high water mark and thus are included in the impacts; however, they do not sit in the streambed and do not significantly alter substrate. These structures also have little to no potential to affect water quality or aquatic habitat. Temporary pipeline ROW crossings are very short term, with construction crews completing these types of crossings within a few hours to few days, when practicable. Further, crossings in many of the intermittent and ephemeral streams will be completed during low-flow or no-flow conditions, minimizing the potential for downstream water-quality impacts.

In addition, Mountain Valley has developed a proposed *Stream and Wetland Restoration, Monitoring, and Mitigation Framework*. The *Mitigation Framework* presents a comprehensive approach to mitigating unavoidable impacts that exceeds the regulatory requirements in the USACE and Environmental Protection Agency compensatory mitigation rule (40 C.F.R. § 230.93). The *Mitigation Framework* provides compensatory mitigation for both permanent and temporal losses, including temporal losses associated with the period of post-construction recovery of temporarily impacted streams and wetlands. Because it is proposing to provide compensatory mitigation in advance of temporary impacts, Mountain Valley is confident this approach will result in no net impacts to aquatic functions and values—if not produce a net lift—at any time during or after construction. In the *Mitigation Framework*, Mountain Valley has proposed to conduct post-construction monitoring in accordance with defined performance standards. If the success criteria are not attained, corrective action plans measures will be developed in accordance with adaptive management principles. The results of the post-construction monitoring and, where necessary, corrective action plans will be reported to the USACE, WVDEP, and VADEQ annually. These measures will ensure that the relevant resource agencies can verify that restoration has been successfully completed. All of these factors play a role in minimizing the potential effects both individually and cumulatively.

[6] Many of the existing culverts included in the application are inadequately sized, poorly constructed, and/or damaged in a manner that adversely affects stream flow and aquatic habitat. Repairing or replacing improper culverts in those situations with properly sized and countersunk culverts will have a beneficial long-term effect on streams, which is relevant to the consideration of the net cumulative impacts of these "permanent" stream impacts.

All permanent and conversion impacts have been mitigated for using banks or in-lieu-fee programs. Temporary impacts will be restored post construction. The result is an extremely small fraction of permanent impacts, and in some cases no permanent impacts, in each 12-digit HUC watershed.

Wetland Impacts. The combined impacts on wetlands within each 12-digit HUC watershed are similarly insignificant. Eight of the HUC-12 watersheds have no wetland impacts. The watershed with the largest combined wetland impact is Bottom Creek, with 2.03 acres of impact in a large watershed with a total drainage area exceeding 18,000 acres. However, two-thirds of the temporary impacts in this watershed (1.33 acres) are palustrine emergent wetlands that will be restored to preconstruction conditions. The Project will not cause the "loss" of any wetland acreage in this watershed; the 0.70 acres of "permanent" impacts are all conversions that will be restored to palustrine emergent wetlands. The watershed with the greatest area of combined permanent wetland fill is Outlet Laurel Creek, which has six small areas of fill associated with access road construction that sum to less than 0.10 acre (before accounting for compensatory mitigation). In short, the total Project-related wetland impacts are minimal in each 12-digit HUC watershed.

Approximately 2,578 acres of NWI emergent wetland and 6,043 acres of NWI forested/scrub wetland were identified in the Project Area. Of this total, ArcGIS NWI data suggested that the Project would have impacts to 7.6599 acres of wetland in 13 of the HUC-12 watersheds. However, results of the Project-specific wetland delineation demonstrated that the Project would have fewer impacts than suggested by the NWI data. Nine wetland crossings were identified in NWI wetlands; the other locations identified as NWI wetland were not, in fact, delineated as wetlands. The total impact associated with the nine crossings in NWI wetlands is approximately 1.0009 acres; however, this is an overestimate as not all of the impact area at some of these locations were identified as an NWI wetland, i.e., only a portion of the wetland is found in the NWI boundary. This 1.0009 acres represent approximately 0.01% of the NWI wetlands identified in the Project's HUC-12 watersheds. The NWI data also indicated impacts to seven Freshwater Ponds. However, there are no impacts to Freshwater Ponds. Some of the ponds were no longer present, and all of the locations were avoided.

NWI data are generally used as a screening tool during project development. The NWI data are created from remote-sensing techniques and are typically not field-verified resources. To accurately identify wetlands within a project area, field surveys are required and were completed for the Mountain Valley Pipeline Project. The total amount of wetland acreage that was delineated in the Project's watersheds, 281.53 acres, is a more accurate reflection of the Project's wetland impacts than USFWS's NWI mapping and Mountain Valley's efforts to avoid wetlands.

Hydric Soils. Because much of the Project is located along ridgetops, a large amount of hydric soil was not expected to be found in the Project Area. The NRCS soil surveys confirmed that this expectation was accurate. There are no hydric soils in the Project Area in the HUC-12 watersheds in the Middle Ohio North, West Fork, Little Kanawha, Lower New, and Upper James watersheds. There are 2.6 acres of Atkins loam, moist, 0 to 3 percent slopes, frequently flooded (At) present in the Elk Run watershed. The Gauley watershed has two hydric soils in the Project Area: Elkins silt loam, drained (Ed) (14.5 acres) and Purdy silt loam, 0 to 5 percent slopes (Pu) (0.5 acre). The Greenbrier watershed has 1.0 acres of Atkins silt loam, warm, 0 to 3 percent slopes, frequently flooded. The Upper New watershed has two hydric soils present in the Project Area: Melvin silt loam (Me-Monroe) and Mauretown silt loam, 0 to 3 percent slopes (MaA) (14.1 acres and 5.5 acres, respectively). There are 5.9 acres of hydric soil (Alderflats silt loam, 0 to 4 percent slopes – 1A) in the Upper Roanoke watershed and 1.1 acres of hydric soil (Hatboro silt loam, 0 to 2 percent slopes, frequently flooded – 41A) in the Banister watershed. In total, based on the various soil surveys, there are 45.2 acres of hydric soils in the 6,403 acres of Project Area. It should be noted that the presence of hydric soils does not mean that these soils will be disturbed or that a wetland is present.

LULC. With a few exceptions, the majority of the HUC-12 watersheds are primarily Forested, 44 of which have forested areas that exceed 70%. In most HUC-12 watersheds (60 out of 62), the Project Area represents less than 1.0% of the watershed area.

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HOW MISAPPLICATION OF THE HYDROLOGIC UNIT FRAMEWORK DIMINISHES THE MEANING OF WATERSHEDS

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Abstract

Hydrologic units provide a convenient but problematic nationwide set of geographic polygons based on subjectively determined subdivisions of land surface areas at several hierarchical levels. The problem is that it is impossible to map watersheds, basins, or catchments of relatively equal size and cover the whole country. The hydrologic unit framework is in fact composed mostly of watersheds and pieces of watersheds. The pieces include units that drain to segments of streams, remnant areas, noncontributing areas, and coastal or frontal units that can include multiple watersheds draining to an ocean or large lake. Hence, half or more of the hydrologic units are not watersheds as the name of the framework “Watershed Boundary Dataset” (WBD) implies. Nonetheless, hydrologic units and watersheds are commonly treated as synonymous, and this misapplication and misunderstanding can have some serious scientific and management consequences. We discuss some of the strengths and limitations of watersheds and hydrologic units as spatial frameworks. Using examples from the Northwest and Southeast United States, we explain how the misapplication of the hydrologic unit framework has altered the meaning of watersheds and can impair understanding associations between spatial geographic characteristics and surface water conditions.

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Keywords

watersheds; hydrologic units; rivers/streams; aquatic ecology; watershed management

The Hydrologic Unit Code (HUC) dataset provides a convenient nationwide set of geographic polygons based on drainage subdivisions of land surface areas at several hierarchical levels (USGS and USDA-NRCS 2013). However, many people, perhaps unknowingly, treat HUCs and watersheds as synonymous (e.g., Jones et al. 1997; Ruhl 1999; Alexander et al. 2000; Graf 2001; Wardrop et al. 2005; Mylavarapu et al. 2012; Foran et al. 2015; USEPA 2016; Eagles-Smith 2016). For example, Entrekin et al. (2015) used 12-digit HUCs interchangeably with catchments throughout their paper on watershed sensitivity to natural and anthropogenic disturbances. Al-Chokhachy et al. (2010) stated that they used "…sixth field HUC watersheds (hereafter referred to simply as watersheds)". Lanigan et al. (2013, 2014) claimed to be evaluating watershed condition by sampling sites located within HUCs and extrapolating results to those HUC polygons. Hudy et al. (2008) used "fifth-level watersheds" (10-digit HUCs) in New York State to assess brook trout distributions. Nonetheless, roughly half the HUCs are not true topographic watersheds (Omernik and Griffith 1991; Omernik and Bailey 1997; Griffith et al. 1999). Omernik (2003) demonstrated how HUCs are less relevant than watersheds in explaining patterns in water quality and quantity in Texas waters. Van Sickle and Hughes (2000) reported that an ecoregion or a simple geographic distance measure had greater classification strengths than HUCs for western Oregon aquatic vertebrate assemblages. Daniel et al. (2014) found that entire watersheds better estimated mining effects on fish assemblages than did stream reaches between confluences (similar to what a 12-digit HUC might delineate). Therefore, our objectives in this paper are threefold: 1) we address the nature of HUCs and watersheds (catchments, drainage basins) and explain how misapplication of the HUC framework has altered the meaning of watersheds and can impair understanding associations between spatial geographic phenomena and water body conditions; 2) using 8-digit HUCs, we go beyond Omernik (2003) to demonstrate that the issue of misuse is more problematic in the Columbia Basin than in Texas; and 3) to dispel arguments that the problem does not pertain to more detailed 12-digit HUCs, we present a water quality dataset from South Carolina comparing data from HUCs that are watersheds to HUCs that drain areas comprising multiple HUCs.

Definitions, strengths, and limitations of watersheds

Watersheds (also called catchments and drainage basins) are topographic areas within which surface and shallow groundwaters drain to a specific point (Omernik and Bailey 1997; Griffith et al. 1999). Webster's Dictionary (Merriam-Webster 1986) defined a watershed as "a region or area bounded peripherally by water parting and draining ultimately to a particular watercourse or body of water." Flotemersch et al. (2015) stated that, "A watershed is a landscape that contributes surface water to a single location, such as a point on a stream or river, or a single wetland, lake or other water body." These definitions are essentially the same and unambiguous. However, watershed has two meanings for some people. For example, Houghton-Mifflin (1982) defined a watershed as: 1) "a ridge of high land dividing two areas that are drained by different river systems, and 2) the region draining into a river, river system or body of water”. The first defines a linear characteristic whereas the second, which is the focus of this paper, defines a spatial or areal characteristic. Watersheds defined based on spatial or areal characteristics have been useful for water resource managers and scientists in associating natural and anthropogenic characteristics with water quality, discharge, fish distributions, and other aquatic-related phenomena (Vannote et al. 1980; Swank et al. 2001; Saly et al. 2011; Marzin et al. 2012; Likens 2013; Macedo et al. 2014). Hence, where watersheds can be defined, any point on a stream reflects the aggregate of the characteristics upgradient from that point.

Nonetheless, watersheds can only be approximated in many regions including those with karst topography, continental glaciation, extremely flat plains, deep sand, xeric climates, or where water is diverted from one drainage basin to another (Hughes and Omernik 1981; Omernik and Bailey 1997; Currens and Ray 2001). In those regions watersheds do not encompass the same integrating processes as in mesic and hydric areas where topographic watersheds are well defined (Strahler 1975; Omernik and Bailey 1997).

There also is a common misconception that watersheds are ideal for evaluating environmental condition and ecosystem services (Kolok et al. 2009; Jordan and Benson 2015). However, it is important to recognize that watersheds seldom circumscribe regions of similarity in multiple factors that influence water quality. Soil, physiographic, vegetative, and ecological regions do define such areas. Watersheds tend to cross those regions, but watersheds that are completely within a particular ecological region will tend to be similar to each other and dissimilar to watersheds entirely in other ecological regions (Dodds and Whiles 2004; Stoddard 2004; Zuellig and Schmidt 2012; Griffith 2014).

Definitions, strengths, and limitations of HUCs

Hydrologic units have evolved from the U.S. Geological Survey (USGS) framework of hydrologic unit maps described by Seaber et al. (1987). They have been modified in conjunction with the development of geographic information systems, digital orthophotoquads, and improved hydrography datasets (Horn et al. 1994; Simley and Carswell 2009; McKay et al. 2012). The hydrologic unit framework is hierarchical and shows “drainage hydrography, culture, and political and hydrologic unit codes (HUCs)” (Seaber et al. 1987). This system, now labeled the Watershed Boundary Dataset (WBD), defines HUCs at six hierarchical levels (USGS and USDA-NRCS 2013). The 1st level divides the United States into 21 units and the 6th level comprises over 86,000 units within the conterminous U.S. The levels are also identified by code length and level names, e.g., 2-digit (regions), 4-digit (subregions), 6-digit (basins), 8-digit (subbasins), 10-digit (watersheds), and 12-digit (subwatersheds) (USGS 2013). Some of these level names and the WBD title are a major source of users’ misconception that all HUCs are watersheds.

The 21 HUC regions (2-digit or 1st level) of the U.S. contain the drainage area of a major river in only four cases (Missouri, Upper Colorado, Rio Grande, and Tennessee Rivers). The remaining 17 2-digit HUCs comprise combined drainage areas of a series of rivers and adjacent interstices or are based on political units (Alaska, Hawaii, and Puerto Rico). Each subregion (2nd level or 4-digit HUC) "…includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area" (Seaber et al. 1987). Likewise, at lower hierarchical levels, each nested subdivision is an area representing part or all of a drainage basin, a combination of drainage basins, or a distinct hydrologic feature (Seaber et al. 1987). Clearly, these definitions indicate that many HUCs at all levels are not truly watersheds, catchments, or basins.

The WBD establishes a framework that accounts for all land surface areas, and the codes can provide a general location for water resources (Laitta et al. 2004). The boundary delineations are rarely affected by political units or agency missions, and the multiagency coordination resulted in a relatively consistent and nationally accepted set of drainage delineations. The HUC framework provides a national set of terrestrial polygons at roughly comparable size at each hierarchical level, and the standardized attribute structure of the hydrologic units aids aggregation of drainage information at different geographic scales. In some cases, the polygons can be used to delineate watersheds by joining, merging, modifying, or adding additional boundaries from any particular point on a stream. For example, HUCs are commonly used in ecohydrological modeling. Daggupati et al. (2016) used "head watersheds" and regions to calibrate 12-digit HUCs in the Missouri River Basin, and by doing so were able to simulate crop and water yields and distinguish topographic watersheds with strong groundwater inputs. In other modeling examples, (e.g., Affuso and Duzy (2013), Ghimire and Johnson (2013)_S1_Reference17, Gurung et al. (2013), and Pai et al. (2011)) watersheds and HUCs appear confounded. If that is the case, their models could be improved by using just watersheds or by linking upstream watersheds and downstream HUCs that are pieces of watersheds into watersheds, thereby modeling the entire areas that drain to their sites rather than fractions of those areas or portions of neighboring but hydrologically disconnected areas.

Hydrologic units are sometimes seen as useful spatial polygons for subjects not specifically hydrologic (e.g., Zank et al. 2016) due to the perception of relative size uniformity. Nonetheless, hydrologic unit sizes do vary at any particular level within broad physiographic areas. At the 1st level (2-digit), the variation in size can be as much as 10x, and at lower levels, a particular HUC can be two to five times larger than that of another. The typical sizes of 5th level (10-digit) HUCs are 16,200 to 101,200 ha, although the total range is much larger; and, in some places HUC boundaries can only be approximated owing to the lack of hydrologic features or insufficient topographic relief (USGS and USDA-NRCS 2013). As with watersheds, the process of identifying HUCs is complicated by the variable representation of permanent and temporary streams on maps, even of the same scale, as well as by areas where watersheds are difficult to define.

The underlying problem regarding the misapplication and misunderstanding of the HUC framework lies in its intent to define relatively equal size watersheds relative to points on streams at several hierarchical levels and cover the entire country with those areas. However, this is impossible because streams are linear characteristics and there are literally an infinite number of points on streams. Regardless of the hierarchical level of watersheds (e.g., roughly 100 km^2, 1000 km^2, 10,000 km^2, etc.) only about half the United States will be covered. The remaining area will be composed of downstream segments of watersheds or adjacent interstices. Hence, the areas defined by HUCs are watersheds *and parts* of watersheds. The HUC framework would be less susceptible to misapplication if a clear distinction were made at each level between HUCs that are watersheds and those that are not. Although the HUC framework provides a set of polygons for locating sampling sites, alternative geographic polygons representing areas that are unambiguous include equal-sized hexagons (Rathert et al. 1999; Herlihy et al. 2000; Hughes et al. 2000), squares (Hocutt and Wiley 1986), or political units (Hughes et al. 2015).

The HUC framework is also problematic for those that use it as a convenient way of referring to the size of a watershed. First, as we noted previously, the size of HUCs at any level can vary greatly by as much as 10x. Second, roughly half of the HUCs at any level are not in fact watersheds. Finally, the number of HUCs that are watersheds represent a minute fraction of topographic watersheds upgradient from the infinite number of points on streams or water bodies. Although somewhat tangential to the usefulness of HUCs, stream size is often described by stream order. However, as an approximation of stream or watershed size, the use of stream order by itself is problematic (Hughes and Omernik 1981; 1983; Hughes et al. 2011). The reasons for this are associated with methods for determining when a stream becomes a stream, which include natural variation in the watershed area required to generate a channel and intermittent or perennial stream, imprecise and subjective field annotation of streams on maps, and inconsistent mapping between humid and xeric regions (Morisawa 1957; Hughes and Omernik 1981, 1983; Oberdorff et al. 1995).

Another limitation of HUCs lies in their intended use, which according to Seaber et al. (1987) is to provide “a standard geographic and hydrologic framework for water-resource and related land-resource planning.” This purpose is questionable because large HUCs, basins, and watersheds tend to overlap dissimilar geographical regions (Omernik and Griffith 1991; Omernik and Bailey 1997; Griffith et al. 1999; Omernik 2003; Brenden et al. 2006; Hollenhorst et al. 2007). The U.S. Environmental Protection Agency adopted the HUC framework for its watershed approach for environmental management (USEPA 1995, 1996). However, analysis of its HUCs for the State of Washington, USA (Figure 1), revealed that only two of the 23 (Upper Yakima and Crab Creek hydrologic units) are in fact watersheds. Many of the HUCs contain vastly different ecological regions (Omernik and Griffith 2014). For example, the northwestern part of the Upper Yakima HUC is in the forested, mountainous Cascade Range, which receives >2541 mm of mean annual precipitation, whereas the lower part of the HUC is in the Columbia Plateau, which is sagebrush steppe and grassland where mean annual precipitation is <254 mm (Figure 2) (PRISM Climate Group 2016). Therefore, the Upper Yakima is *not* a homogeneous area for environmental management; the part of the HUC in the Cascades ecoregion is markedly different ecologically from the part in the Columbia Plateau. Similarly, Nadeau and Rains (2007) included figures intended to illustrate patterns of combined intermittent and ephemeral stream length as a proportion of total stream length within “…each 8 digit HUC watershed”. In one of their figures, they extrapolate this stream characteristic to HUCs in Washington State (adapted in Figure 2), where hydrologic units span mountainous areas with heavy precipitation and relatively flat plateaus with xeric conditions. Those two regions have very different percentages and lengths of perennial and intermittent streams. Neither watersheds nor HUCs, unlike ecoregions, capture a logical stratification in landscape characteristics that are consistent with regional expectations for developing resource management strategies and interpreting environmental research and assessment results (Bryce et al. 1999; Glover et al. 2010).

The major misapplication of the HUC framework stems from the common misconception that all HUCs at all hierarchical levels are watersheds. The second sentence in USGS (2015) reads: "The Watershed Boundary Dataset (WBD) defines the areal extent of surface water drainage to a point, accounting for all land and surface areas." That sentence and the title of the framework both imply that HUCs and watersheds are synonymous. Moreover, there is no mention in any of the published explanations of the HUC/WBD frameworks that half or more of all HUCs at all levels are not watersheds and that many HUCs are only downstream segments of watersheds draining areas that are in many instances orders of magnitude greater in size than the defined HUC area. Even some developers of the 12-digit (6^{th} level) HUCs, who recognized the inaccurate perception and relationship that is permeated by labeling HUCs as watersheds (e.g., Berelson et al. 2004), have not attempted to rectify the problem by appropriate labeling, thereby furthering the inaccurate perception. Maps of HUCs at any hierarchical level contain only 40 to 60% watersheds, and only about 20% in the case of 2-digit (1^{st} level) HUCs (Omernik 2003). Therefore, many HUCs do not serve the critical purpose of watersheds.

Prompted by a peer reviewer's comment on Omernik (2003) that the limitation of the HUC framework may occur in Texas but not in the Pacific Northwest, we examined the 8-digit (4^{th} level) HUCs in the Columbia River Basin of the U.S. Only 53% (86 of 163) of the 8-digit HUCs in this large river basin are watersheds (Figure 3). If all HUCs were watersheds, one might expect that water quality, flow regime, or biotic condition at downstream points of HUCs within the same ecoregion would be generally similar in comparison to HUCs within adjacent ecoregions where conditions are distinctly different. For example, consider four 8-digit HUCs that lie completely or nearly completely within the Columbia Plateau ecoregion (Figure 4). Only two of the four 8-digit HUCs (B and C) are watersheds (Figure 5). HUC A is a downstream segment of the Columbia River, which drains large parts of northeastern Washington, northern Idaho, northwestern Montana, and southeastern British Columbia. HUC D is a downstream segment of the Snake River, which drains eastern Oregon, most of Idaho, and parts of Nevada and western Wyoming. The biota at the downstream points of HUCs A and D differ from those of HUCs B and C (Lomnicky et al. 2007; Paulsen et al. 2008; Stoddard et al. 2008; Pont et al. 2009).

To rectify misconceptions that the limitations of HUCs at the 8-digit (4^{th} level) (Omernik 2003) do not exist at the more detailed 12-digit (6^{th} level), we examined a water quality dataset from South Carolina. Of the 986 12-digit HUCs completely or partially in South Carolina, only 47% are watersheds (Figure 6). We selected six different 12-digit HUCs that lie completely within the Southeastern Plains ecoregion for analysis (Figure 7a). This region is characterized by a mosaic of cropland, pasture, woodland, and forest, and the irregular plains are lower in elevation and have less relief than the Piedmont ecoregion to the northwest. Three of those HUCs (D, E, and F) are watersheds whereas three (A, B, and C) are downstream segments of the Pee Dee/Yadkin River watershed, covering a large part of the Piedmont ecoregion and a small portion of the Blue Ridge ecoregion (Figure 7b). Patterns in water quality characteristics measured at or near the downstream points of HUCs A, B, and C are relatively similar to one another and dissimilar to those of HUCs D, E, and F as illustrated by the three parameters shown in Figure 8 and Table 1.

The watershed for the downstream point of HUC C near the sampling site is more than 22,950 km^2, which is over 150 times greater than the 150-km^2 HUC itself (Figures 7a and 7b). The differences in water quality between the sites with much of their watersheds in the Piedmont and the smaller ones that are completely within the Southeastern Plains are associated with more fertilized pasture lands, greater relief, erodible soils, and urban and exurban land cover in the Piedmont versus more woody wetlands and low gradient streams in the Southeastern Plains (Glover et al. 2010).

Summary and conclusions

For many years, watersheds served as a fundamental geographic unit to study the effects of natural and anthropogenic characteristics on the quality and quantity of water. Examples include classic watershed studies (Likens 2013; Swank et al. 2001), paired watershed studies (e.g. Bisson et al. 2008; King et al. 2008), river basin commissions and river basin studies (White 1969; Mulvey et al. 2009), disturbance partitioning studies (e.g., Saly et al. 2011; Marzin et al. 2012; Macedo et al. 2014), and studies on basic aquatic ecology principles (Hynes 1975; Vannote et al. 1980; Fausch et al. 2002). Indeed, until about 30 years ago most scientists and resource managers were in agreement on the spatial meaning of the term watershed. The HUC framework has changed this understanding, with many persons treating all HUCs as watersheds—despite the fact that only about half are truly watersheds.

Revising the guidance and documentation for the HUC/WBD framework at all hierarchical levels by using more precise language to more clearly identify what units are and are not watersheds would reduce the misunderstanding and misapplication of HUCs. Renaming the Watershed Boundary Dataset as the Hydrologic Unit Dataset, identifying the various HUC levels by their level number or code digit length only, and clearly identifying the HUCs that are and are not watersheds at each hierarchical level would further reduce the misunderstanding of HUCs. These steps would facilitate a better understanding of the strengths and limitations of this type of spatial framework for the research, monitoring, assessment, and management of aquatic and terrestrial resources.

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Fig. 1.
Hydrologic units called "water quality management areas" for Washington, USA, from the cover page of USEPA (1995). Note that only 2 of the 23 units, Upper Yakima and Crab Creek, are watersheds

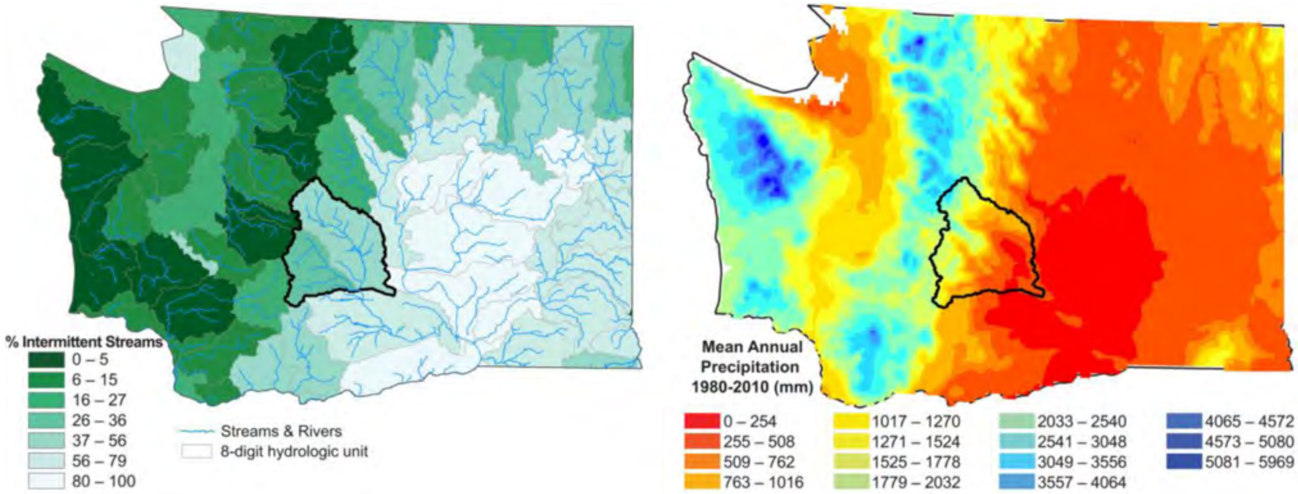

Fig. 2.

Combined intermittent and ephemeral stream lengths as a proportion of total stream lengths for 8-digit (4th level) HUCs in Washington (left) (adapted from Nadeau and Raines, 2007), and mean annual precipitation (1980–2010) in Washington (right) (PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu). Note the dramatic contrast in precipitation amounts between the northwestern (>2541 mm) and southeastern parts (<254 mm) of the Upper Yakima watershed (highlighted)

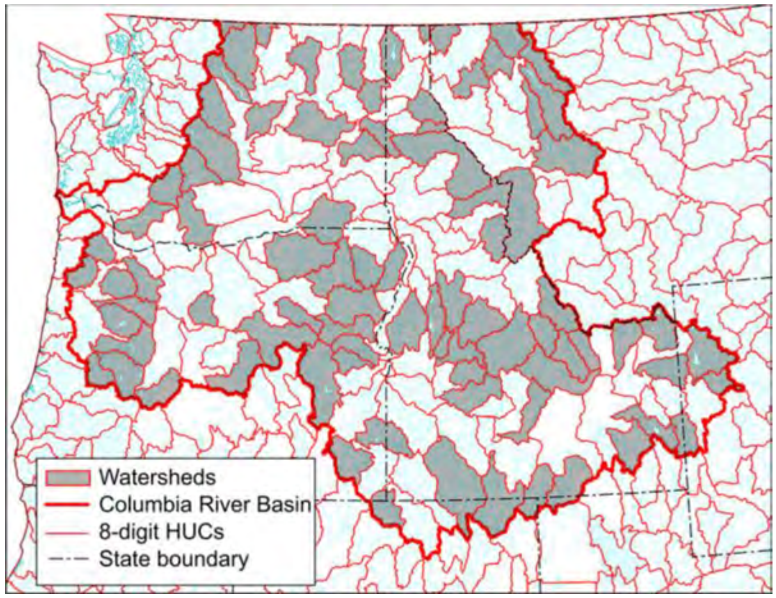

Fig. 3.

Eight-digit (4th level) HUCs that are watersheds (shaded dark gray) within the Columbia River Basin. Note that only 53% of the HUCs (86 of 163) within the basin are watersheds

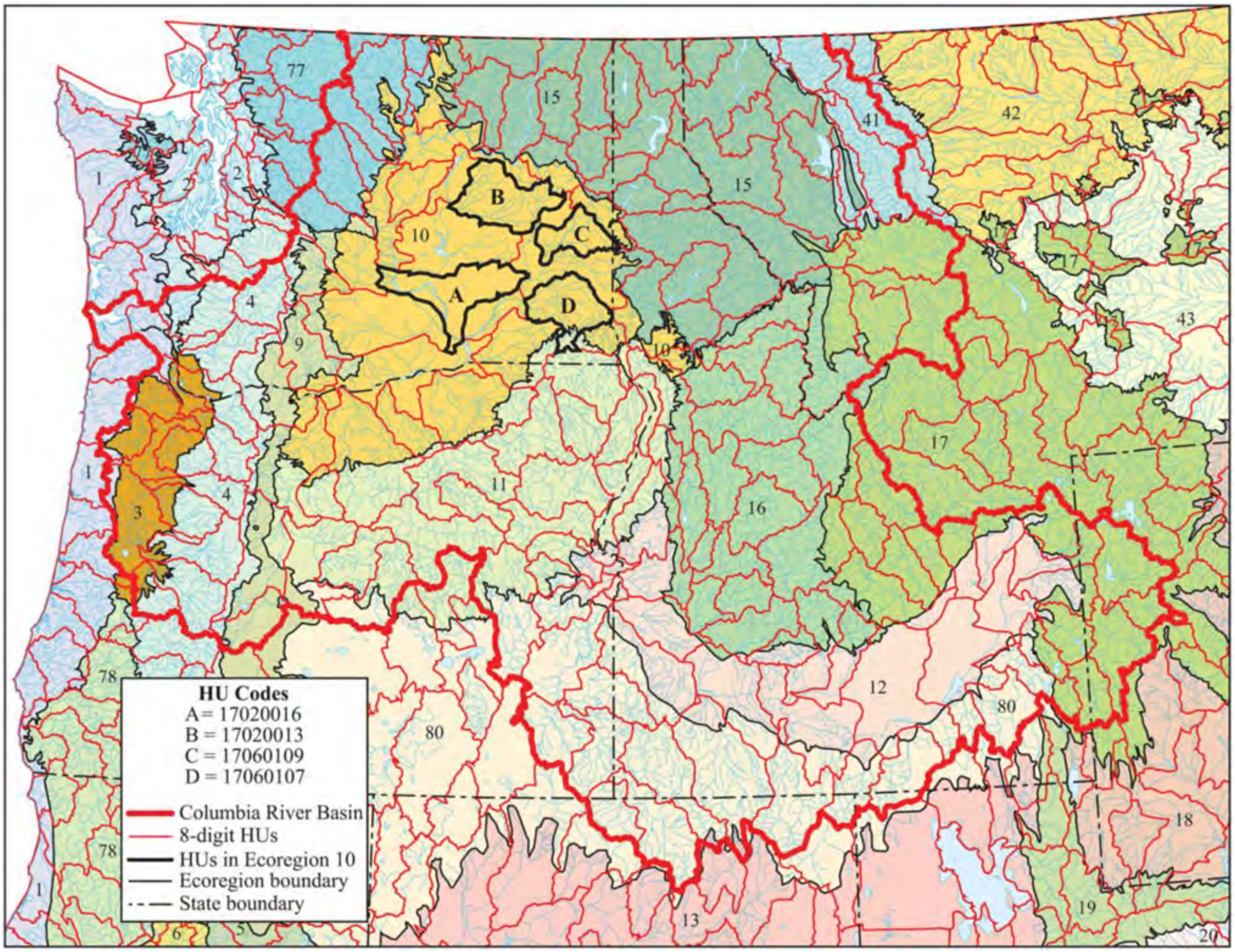

Fig. 4.

Four 8-digit (4th level) HUCs (A, B, C, and D) in the Columbia Plateau (10) Level III ecoregion

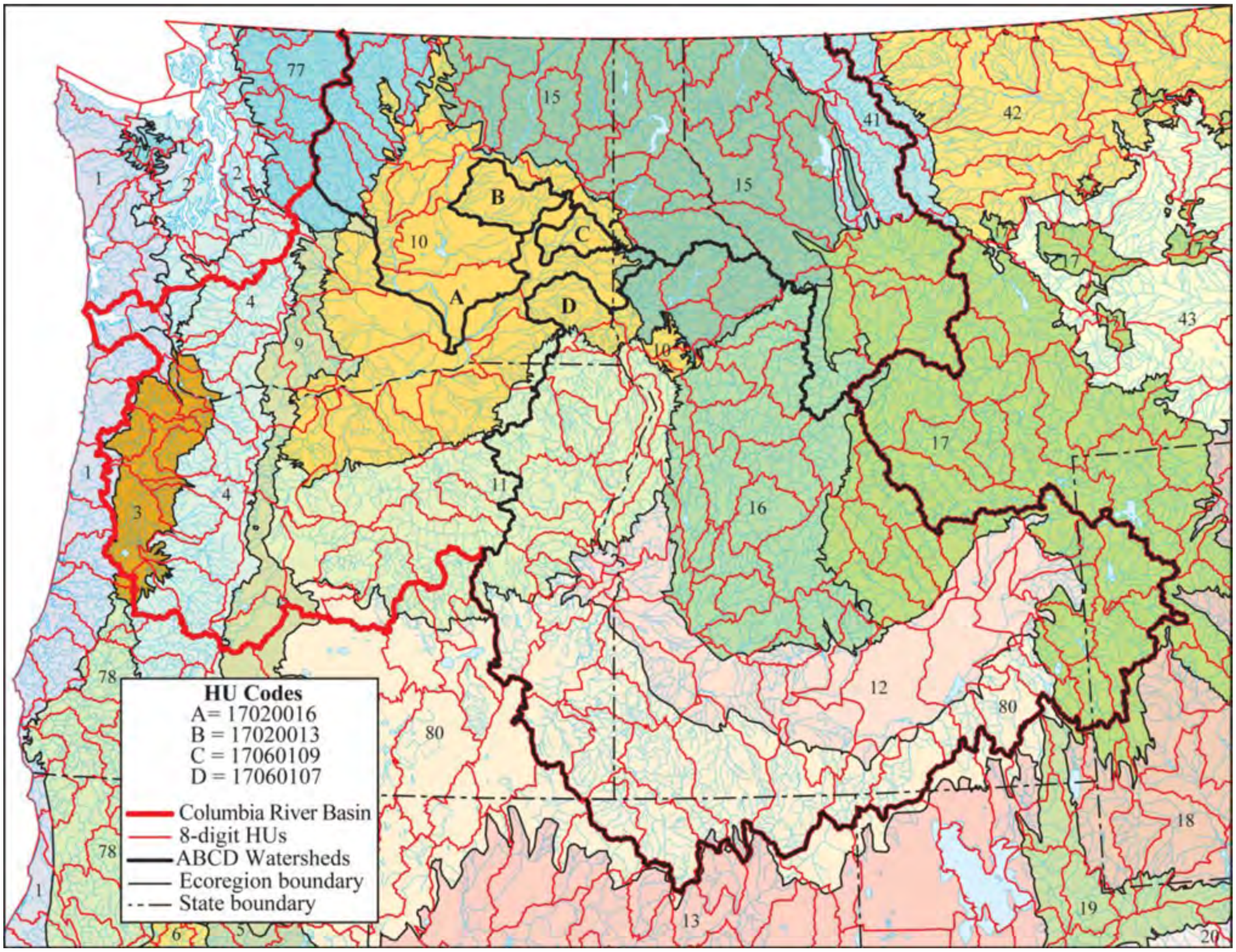

Fig. 5.
Watersheds (bold black outlines) associated with downstream points in HUCs A, B, C, and D. Note that B and C are watersheds whereas HUCs A and D (shown in Fig 4) are merely downstream segments of vast watersheds, respectively, of the Columbia (which drains a similar area in Canada) and Snake Rivers

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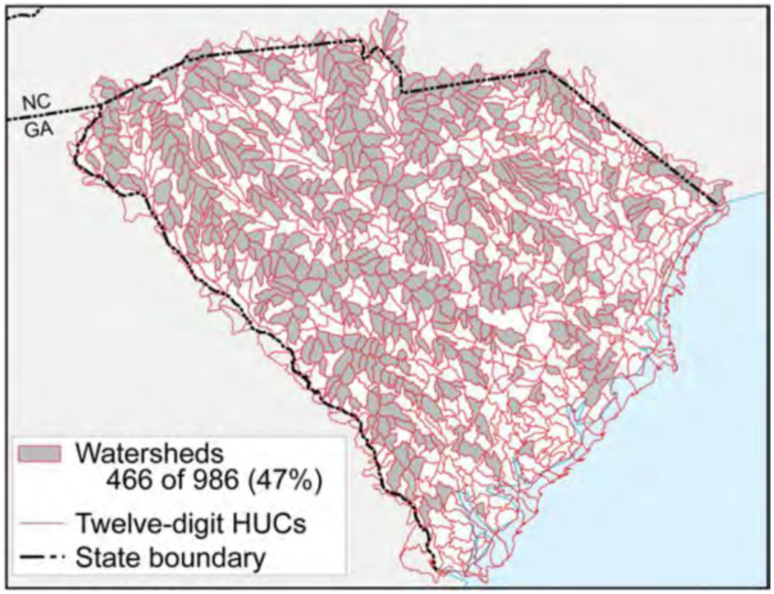

Fig. 6.
Twelve-digit (6th level) HUCs in South Carolina that are watersheds (shaded dark gray). Only 47% of the HUCs (466 of 986) are watersheds

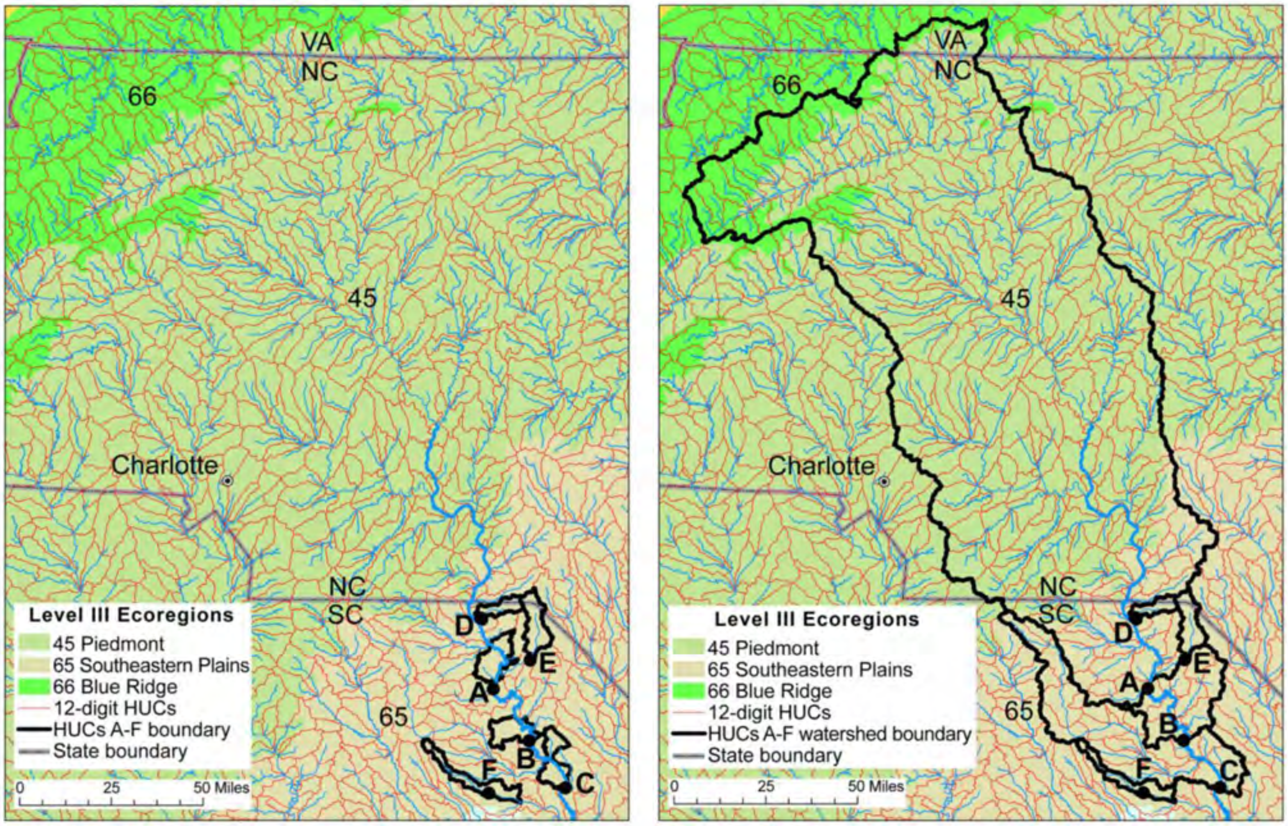

Fig. 7.

a (left). Stream sampling sites at or near downstream locations of six 12-digit (6th level) HUCs (A, B, C, D, E, and F) in the Southeastern Plains Level III ecoregion of South Carolina

Fig. 7b (right). Watersheds (bold black outlines) associated with downstream points in HUCs A, B, C, D, E, and F. Note that only HUCs D, E, and F are watersheds within the Southeastern Plains ecoregion whereas HUCs A, B, and C are downstream segments of larger watersheds comprising multiple HUCs that drain different ecoregions in parts of North Carolina and Virginia

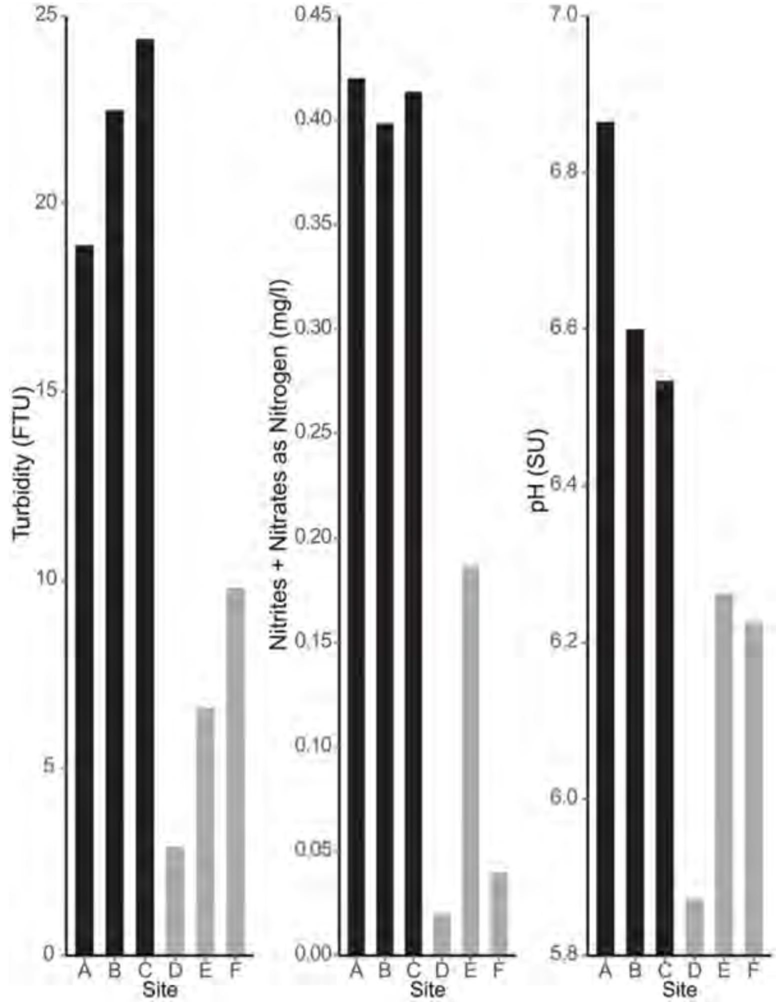

Fig. 8.

Water quality mean values for sampling sites at or near the downstream points of HUCs A, B, C, D, E, and F in South Carolina. HUCs D, E, and F are watersheds; HUCs A, B, C are downstream segments of larger watersheds. Turbidity in Formazin Turbidity Units (FTU), nitrites plus nitrates as nitrogen in milligrams per liter (mg/l), and pH in standard units (SU) (Data from Bureau of Water, South Carolina Department of Health and Environmental Control; see Table 1)

Table 1.

Surface water quality parameters collected by South Carolina Department of Environmental Control (SCDHEC) water quality monitoring program. Stations located on the Great Pee Dee River and select tributaries within the Southeastern Plains ecoregion of South Carolina.

Parameter	**STORET Station # Figure 8 Site Code**	**PD-015 A**	**PD-028 B**	**PD-337 C**	**PD-191 D**	**PD-107 E**	**PD-256 F**
Turbidity (FTU) (STORET Parameter Code 00076 Method APHA 2120 (B))	Count Mean Variance	29 18.9 79.6	17 22.5 155.3	30 24.4 175.2	11 2.9 1.2	18 6.6 75.0	17 9.8 229.7
Nitrites+Nitrates as Nitrogen (mg/l) (STORET Parameter Code 0630 Method EPA 353.2; APHA 4500)	Count Mean Variance	29 0.42 0.03	17 0.40 0.02	27 0.41 0.04	12 0.02 0.00	17 0.19 0.01	17 0.04 0.00
pH (standard units) (STORET Parameter Code 00400 Method APHA 4500 OG)	Count Mean Variance	29 6.87 0.17	17 6.62 0.10	30 6.53 0.17	11 5.87 1.05	18 6.26 0.20	17 6.23 0.12

Water quality parameters collected as part of the SCDHEC water quality monitoring program and available through the EPA STORET database at www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange#warehouse.

Data for the years 1994-1998 and months May-October.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 81

February 21, 2023

VIRGINIA:

IN THE CIRCUIT COURT OF HENRICO COUNTY

DAVID K. PAYLOR, Director of the
Department of Environmental Quality,

and

STATE WATER CONTROL BOARD,

Plaintiffs,

v. Case No.:

MOUNTAIN VALLEY PIPELINE, LLC,

Serve: CT CORPORATION SYSTEM
4701 Cox Road, Suite 285
Glen Allen, VA 23060

Defendant.

COMPLAINT

The Plaintiffs David K. Paylor, Director of the Department of Environmental Quality (the "Department" or "DEQ"), and the State Water Control Board (the "Board") (collectively the "Plaintiffs") bring this action against the Defendant Mountain Valley Pipeline, LLC ("MVP" or "Defendant") for its violations of the Commonwealth's environmental laws and regulations at sites in Craig, Franklin, Giles, Montgomery, and Roanoke Counties. Plaintiffs state the following in support of their Complaint:

INTRODUCTION

1. This is a civil action seeking injunctive relief and civil penalties brought pursuant to Va. Code §§ 62.1-44.15:42, 62.1-44.15:48, 62.1-44.15:63, 62.1-44.23, and 62.1-44.32 for violations of the State Water Control Law, Va. Code §§ 62.1-44.2, *et seq.*, the Virginia Stormwater Management Act, Va. Code §§ 62.1-44.15:24, *et seq.*, the Virginia Erosion and

Sediment Control Law, Va. Code §§ 62.1-44.15:51, *et seq.*, the Virginia Stormwater Management Program (VSMP) Regulation, 9 VAC 25-890, *et seq.*, the Erosion and Sediment Control Regulations, 9 VAC 25-840, *et seq.*, the Virginia Water Resources and Wetlands Protection Program, Va. Code § 62.1-44.15:20, *et seq.*, the Virginia Water Protection Program Permit Regulation, 9 VAC 25-210, *et seq.*, and the Clean Water Act § 401 Water Quality Certification No. 17-001 issued to MVP on December 8, 2017.

PARTIES

2. The State Water Control Board (the "Board") is an agency of the Commonwealth of Virginia. The Board has the duty and authority to issue, revoke or amend certificates – i.e., permits, under prescribed conditions for the discharge of sewage, industrial wastes and other wastes into or adjacent to state waters and also to initiate administrative and civil enforcement actions to prevent pollution.

3. David K. Paylor is the Director of the Department of Environmental Quality and the Executive Director of the Board. It is the duty of the Executive Director of the Board to exercise general supervision and control over the quality and management of all state waters and to administer and enforce the State Water Control Law, and all certificates, standards, policies, rules, regulations, rulings and special orders promulgated by the Board.

4. MVP is a foreign limited liability company registered to do business in the Commonwealth.

VENUE

5. The Circuit Court of Henrico County is the proper forum pursuant to Va. Code § 8.01-262(2).

STATUTORY AND REGULATORY AUTHORITY

6. The purposes of the State Water Control Law are to (1) protect existing high quality state waters and restore all other state waters to such condition of quality that any such waters will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them; (2) safeguard the clean waters of the Commonwealth from pollution; (3) prevent any increase in pollution; and (4) reduce existing pollution. *See* Va. Code § 62.1-44.2.

7. To accomplish these purposes, the State Water Control Law prohibits certain activities without a certificate or a permit issued by the Board.

8. Specifically, the State Water Control Law provides that except in compliance with a certificate or permit issued by the Board or other entity authorized by the Board to issue a certificate or permit pursuant to the State Water Control Law, it shall be unlawful for any person to, among other things, discharge stormwater into state waters from land disturbing activities or otherwise alter the physical, chemical or biological properties of state waters and make them detrimental to the public health, or to animal or aquatic life, or to uses of such waters for domestic or industrial consumption, recreation, or for other uses. *See* Va. Code §§ 62.1-44.5(A)(3) and (5)

9. In addition, the Virginia Water Resources and Wetlands Protection Program and Virginia Water Protection Permit Program Regulations prohibit the dredging, filling, or discharging of any pollutant into, or adjacent to wetlands or other surface waters without a Virginia Water Protection Permit issued by the Board. *See* Va. Code § 62.1-44.15:20 and 9 VAC 25-210-50.

10. "Land disturbance" or "land-disturbing activity" means a man-made change to the land surface that potentially changes its runoff characteristics including clearing, grading, or excavation. *See* Va. Code § 62.1-44.15:24.

11. "State waters" means all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction, including wetlands. *See* Va. Code § 62.1-44.3.

12. The Commonwealth has developed a regulatory framework designed to minimize the environmental impact associated with land disturbing activities that imposes strict requirements on entities in advance of engaging in any such activity and continuing until land disturbing activity is complete and permanent stabilization is achieved.

13. Accordingly, "Interstate and intrastate natural gas pipeline companies...shall...annually submit a single set of standards and specifications for Department approval that describes how land-disturbing activities shall be conducted. Such standards and specifications shall be consistent with the requirements of [the Stormwater Management Act] and associated regulations, including the regulations governing the General Virginia Stormwater Management Program (VSMP) Permit for Discharges of Stormwater from Construction Activities and the Erosion and Sediment Control Law (§ 62.1-44.15:51 *et seq.*) and associated regulations." Va. Code § 62.1-44.15:31(A); *see also* Va. Code § 62.1-44.15:55(D).

14. The standards and specifications shall include:

a. Technical criteria to meet the requirements of [the Stormwater Management Act] and regulations developed under [the Stormwater Management Act];

b. Provisions for the long-term responsibility and maintenance of stormwater management control devices and other techniques specified to manage the quantity and quality of runoff;

c. Provisions for erosion and sediment control and stormwater management program administration, plan design, review and approval, and construction inspection and enforcement;

d. Provisions for ensuring that responsible personnel and contractors obtain certifications or qualifications for erosion and sediment control and stormwater management comparable to those required for local government;

e. Implementation of a project tracking and notification system to the Department of all land-disturbing activities covered under [the Stormwater Management Act]; and

f. Requirements for documenting onsite changes as they occur to ensure compliance with the requirements of the [Stormwater Management Act].

Id.

15. In addition to Annual Standards and Specifications, the Department may require site specific erosion and sediment control and stormwater management plans for linear projects. *See* 9 VAC 25-840-30(B) and 9 VAC 25-870-76.

16. Both Annual Standards and Specifications and any site specific plan must meet the minimum standards and technical criteria laid out in the Board's regulations at 9 VAC 25-840-40. *See* 9 VAC 25-840-30(A).

17. "Any person violating or failing, neglecting, or refusing to obey any rule, regulation, ordinance, approved standard and specification, order, or permit condition issued by the Board, Department, or [Virginia Stormwater Management Program] authority as authorized to do such, or any provisions of this article, may be compelled in a proceeding instituted in any appropriate court by the Board, Department, or [Virginia Stormwater Management Program] authority where authorized to enforce this article to obey same and to comply therewith by injunction, mandamus, or other appropriate remedy." Va. Code § 62.1-44.15:42(A).

18. "Any person who violates any provision of [the Virginia Stormwater Management Act] or of any regulation, ordinance, or standard and specification adopted or approved

hereunder, including those adopted pursuant to the conditions of an MS4 permit, or who fails, neglects, or refuses to comply with any order of a VSMP authority authorized to enforce this article, the Department, the Board, or a court, issued as herein provided, shall be subject to a civil penalty not to exceed $32,500 for each violation within the discretion of the court. Each day of violation of each requirement shall constitute a separate offense." Va. Code § 62.1-44.15:48(A).

19. "Any person violating or failing, neglecting or refusing to obey any rule, regulation, order, water quality standard, pretreatment standard, or requirement of or any provision of any certificate issued by the Board, or by the owner of a publicly owned treatment works issued to an industrial user, or any provisions of [the State Water Control Law], except as provided by a separate article, may be compelled in a proceeding instituted in any appropriate court by the Board to obey same and to comply therewith by injunction, mandamus or other appropriate remedy." Va. Code § 62.1-44.23.

20. "Except as otherwise provided in [the State Water Control Law], any person who violates any provision of [the State Water Control Law], or who fails, neglects, or refuses to comply with any order of the Board, or order of a court, issued as herein provided, shall be subject to a civil penalty not to exceed $32,500 for each violation within the discretion of the court. Each day of violation of each requirement shall constitute a separate offense." Va. Code § 62.1-44.32.

GENERAL ALLEGATIONS

21. MVP proposes to construct and operate a 303.5-mile long, 42-inch-diameter natural gas pipeline from Wetzel County, West Virginia to Pittsylvania County, Virginia.

22. Approximately 106 miles of pipeline will be located in Virginia and traverse portions of Giles County, Craig County, Montgomery County, Roanoke County, Franklin County, and Pittsylvania County.

23. The proposed project is regulated by the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act, 15 U.S.C. § 717f(c), which provides that "[n]o natural-gas company or person which will be a natural-gas company upon completion of any proposed construction or extension of shall...undertake the construction or extension of any facilities therefor...unless there is in force with respect to such natural-gas company a certificate of public convenience and necessity issued by the Commission authorizing such acts or operations."

24. FERC issued a Certificate of Public Convenience and Necessity to MVP on October 13, 2017 ("FERC Certificate").

25. The FERC Certificate imposed 40 separate environmental conditions upon MVP.

26. Paragraph 187 of the FERC Certificate provides that in addition to the conditions required therein, the U.S. Army Corps of Engineers and the respective states in which the proposed project may be constructed may impose additional conditions to protect water quality pursuant to Sections 401 and 404 of the Clean Water Act; that MVP must obtain all necessary federal and state permits and authorizations, including water quality certifications, prior to receiving FERC authorization to commence construction; and that FERC expects strict compliance with any federal and state mandated conditions.

27. Section 401(a) of the Clean Water Act, 33 U.S.C. § 1341(a), provides that "[a]ny applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge to navigable waters,

shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate…that any such discharge will comply with the applicable provisions of [the Clean Water Act]."

28. "Any certification provided under [Section 401 of the Clean Water Act] shall set forth any effluent limitations and other limitations, and monitoring requirements necessary to ensure that any applicant for a Federal license or permit will comply with any applicable [provisions of the Clean Water Act], and with any other appropriate requirements of State law set forth in such certification, and shall become a condition on any Federal license or permit subject to the provisions of [Section 401 of the Clean Water Act]." 33 U.S.C. § 1341(d).

29. The State Water Control Board issued a Section 401 Water Quality Certification to MVP on December 8, 2017.

30. Condition 13 of the Section 401 Water Quality Certification requires that MVP comply with the requirements of the Virginia Stormwater Management Act, Va. Code § 62.1-44.15:24, *et seq.*, the Erosion and Sediment Control Law, Va. Code § 62.1-44.15:51, *et seq.*, and the Virginia Water Protection Permit Program Regulations, 9 VAC 25-210-10, *et seq.*

31. In accordance with the Virginia Stormwater Management Act, MVP sought approval of its Annual Standards and Specifications.

32. The Department approved MVP's Annual Standards and Specifications related to erosion and sediment control and stormwater management on June 20, 2017.

33. The Annual Standards and Specifications required MVP to submit site specific Erosion and Sediment Control and Stormwater Management Plans to the Department for review and approval and that any erosion and sediment control program adopted by MVP be consistent

with minimum standards outlined in the Virginia Erosion and Sediment Control Regulations at 9 VAC 25-840-40.

34. MVP's approved Annual Standards and Specifications state that it is MVP's responsibility to ensure "the repair of all ineffective temporary [erosion and sediment control] measures within 24 hours of identification, or as soon as conditions allow if compliance with this time frame would result in greater environmental impacts."

35. In addition, the Annual Standards and Specifications provide that the Department will perform pre-scheduled as well as random site inspections for the project to ensure compliance with the Stormwater Management Act, the Erosion and Sediment Control Law, and regulations adopted thereunder and that the Department may take enforcement action if areas of non-compliance are identified during a routine inspection or in response to a complaint report.

36. The Department approved MVP's site specific Erosion and Sediment Control and Stormwater Management Plans ("Site Specific ESC and SWM Plans") on March 26, 2018.

37. MVP has since commenced land disturbing activities along the pipeline route.

38. Since commencement of land disturbing activities, the Department has inspected specific locations along the pipeline route in response to complaints received by the Department and in accordance with its inspection authority under the Annual Standards and Specifications.

39. In addition, the Department has engaged a third-party contractor, McDonough Bolyard Peck, Inc. ("MBP"), to evaluate compliance with MVP's Annual Standards and Specifications as well as MVP's Site Specific ESC and SWM Plans. Each of MBP's compliance monitor inspectors holds the requisite Erosion and Sediment Control and Stormwater Management inspector certification.

Department Inspections

40. On May 21, 2018, the Department conducted a complaint investigation of a site in the vicinity of Cahas Mountain Road in Franklin County and observed denuded areas, including stockpiles and earthen structures, which lacked temporary or permanent stabilization as required by MVP's Annual Standards and Specifications as well as MVP's Site Specific ESC and SWM Plans . The Department documented that erosion and sediment controls were overwhelmed resulting in sediment going onto Cahas Mountain Road which caused the road to be closed.

41. On May 23, 2018, the Department revisited the site in the vicinity of Cahas Mountain Road in Franklin County and observed: (i) that the temporary or permanent stabilization had not been applied; (ii) that MVP's self-inspection reports failed to identify all erosion and sediment controls requiring maintenance; and (iii) that erosion and sediment controls near station markers 13476+16 and 13489+10 were in need of repair, which resulted in a release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth.

42. On May 24, 2018, the Department conducted a complaint investigation of a site in the vicinity of Catawba Road in Montgomery County and observed: (i) that erosion and sediment controls including a silt fence and J hooks were in need of repair; (ii) that MVP's self-inspection reports contained inadequate information regarding the specific location of all erosion and sediment controls requiring maintenance; and (iii) that controls identified as in need of repair had not been repaired within 24 hours as required by the approved Annual Standards and Specifications.

43. On May 30, 2018, the Department conducted a complaint investigation of a site in the vicinity of Grassy Hill Road in Franklin County and observed that clean water diversion

structures were not installed in accordance with MVP's approved Site Specific Erosion and Sediment Control Plan.

44. On May 31, 2018, the Department revisited the site in the vicinity of Cahas Mountain Road in Franklin County and observed sedimentation within two separate unnamed stream channels on property adjacent to the MVP right of way. In the first stream, located approximately 260 feet south of the right of way, the Department observed approximately 1,110 linear feet of stream channel containing sediment ranging from 1 to 11 inches in depth. In the second stream, located approximately 420 feet north of the right of way, the Department observed approximately 1,110 linear feet of stream channel containing sediment ranging from 1 to 10 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

45. On June 6, 2018, the Department conducted an inspection of a site in the vicinity of Mount Tabor Road in Montgomery County and observed clean water diversion structures were not installed in accordance with MVP's approved Site Specific Erosion and Sediment Control Plan and that MVP's self-inspection reports contained inadequate information to verify whether repair of deficient erosion and sediment controls was accomplished within 24 hours.

46. On June 13, 2018, the Department conducted field monitoring of various sites within Spreads H and I in Franklin County and observed (i) denuded areas, including stockpiles and earthen structures which lacked temporary or permanent stabilization; (ii) that water bars were not installed in accordance with the MVP's approved Annual Standards and Specifications and MVP's approved Site Specific ESC and SWM Plans; and (iii) end treatment conveyances down slope were not adequate or installed in accordance with the approved Site Specific ESC and SWM Plans.

47. On June 26, 2018 the Department conducted field monitoring of various sites within Spread H in Montgomery County and observed that erosion and sediment controls, including water bars above stream crossing 39 and stream crossing 40 were not maintained or repaired to ensure functionality and that as a result sediment-laden stormwater left the right of way causing sediment to be deposited within the stream channel. In the vicinity of stream crossing 39 and stream crossing 40, the Department observed approximately 2,200 linear feet of stream channel containing sediment ranging from 1 to 5 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

48. On June 27, 2018 the Department conducted field monitoring of various sites within Spread H in Montgomery County and observed that wetlands crossings WC5, WC6, WC11, and WC12 were not properly installed prior to use and that access roads 270 and 272 required repair and sump maintenance. In addition, the Department observed sediment to be deposited within the stream channel of streams identified as SMM-15 and MN-513. With respect to SMM-15, the Department observed approximately 3,600 linear feet of stream channel containing sediment ranging from 1 to 7 inches in depth, and with respect to MN-13, the Department observed approximately 209 linear feet of stream channel containing sediment ranging from <0.5 to 3 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

49. The Department's observations on May 21, May 23, May 24, May 31, June 6, June 13, June 26, and June 27 constitute violations of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Erosion and Sediment Control Law, the Virginia Stormwater Management Program Regulation, the Erosions and Sediment Control Regulations,

the Virginia Water Protection Permit Program Regulations, and Section 401 Water Quality Certification 17-001 issued to MVP.

50. On July 9, 2018, the Department issued a Notice of Violation ("NOV") to MVP citing the alleged violations identified during the May and June complaint investigations and inspections.

51. On August 29, 2018 the Department conducted field monitoring of various sites within Spread G in Giles County in the vicinity of stream crossing NN-12 and observed that erosion and sediment controls in the vicinity of stream crossing NN-12 had been repaired but that sediment-laden stormwater had left the right of way causing sediment to be deposited within the stream channel. The Department observed approximately 600 linear feet of stream channel containing sediment ranging from <.5 to 3 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

52. On September 5, 2018 the Department conducted field monitoring of various sites within Spread G in Giles County in the vicinity of stream crossing Q-14 and observed that erosion and sediment controls in the vicinity of stream crossing Q-14 were in the process of being repaired but that sediment-laden stormwater had left the right of way causing sediment to be deposited within the stream channel. The Department observed approximately 630 linear feet of stream channel containing sediment ranging from <.5 to 9 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

53. On September 19, 2018, the Department conducted a comprehensive inspection of Spread G in Craig, Giles, and Montgomery Counties and observed that ineffective temporary ESC measures were not repaired within 24 hours of identification.

54. On September 20, 2018 the Department conducted field monitoring of various sites within Spread H in Roanoke County in the vicinity of wetland crossing IJ-10 and observed that erosion and sediment controls in the vicinity of wetland crossing IJ-10 had been repaired but that sediment-laden stormwater had left the right of way causing sediment to be deposited within a wetland. The Department observed approximately 350 square feet of wetland containing sediment ranging from <.5 to 6 inches in depth. MVP did not possess a permit to discharge the fill into surface waters.

55. On September 25, 2018, the Department conducted a field inspection within Spread H in Montgomery County in the vicinity of MP 227.9 and observed that the dewatering structure was inadequately stabilized and that the pump around energy dissipator was inadequate resulting in sediment deposition in a stream.

56. On October 3, 2018, the Department conducted a comprehensive inspection of Spread G in Craig and Giles Counties and observed that ineffective temporary ESC measures were not repaired within 24 hours of identification.

57. On October 16, 2018, the Department conducted a field inspection within Spread I in Franklin County in the vicinity of MP 262-266 and observed inadequate stabilization, that sediment and debris had been deposited off of the construction right of way, and that ineffective temporary ESC measures were not repaired within 24 hours of identification..

58. On October 16, 2018 the Department conducted field monitoring of various sites within Spread I in Franklin County in the vicinity of stream crossing E-48 and observed that erosion and sediment controls in the vicinity of stream crossing E-48 were in the process of being repaired but that sediment-laden stormwater had left the right of way causing sediment to be deposited within the stream channel. The Department observed stream channel containing

sediment ranging from <.5 to 2 inches in depth. Linear footage of stream channel impacts could not be assessed because assess to downstream property was denied. MVP did not possess a permit to discharge the fill into surface waters.

59. On October 17, 2018, the Department conducted a comprehensive inspection of Spread G in Giles and Montgomery Counties and observed inadequate stabilization and that ineffective temporary ESC measures were not repaired within 24 hours of identification.

60. The Department's observations on August 29, September 5, September 19, September 20, September 25, October 3, October 16, and October 17 constitute violations of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Erosion and Sediment Control Law, the Virginia Stormwater Management Program Regulation, the Erosion and Sediment Control Regulations, the Virginia Water Protection Permit Program Regulations, and Section 401 Water Quality Certification 17-001 issued to MVP.

MBP Inspections

61. In addition to the Department's observations, from the beginning of June through November 15, 2018, MBP documented an additional 180 instances where MVP failed to repair ineffective erosion and sediment control measures within 24 hours of identification. The individual delays range from 1 to 48 days past due.

62. From the beginning of June through November 15, 2018, MBP identified 42 instances where sediment was deposited off of the construction right of way as a result of erosion and sediment control measures being improperly installed or maintained. In 16 such instances, sediment was observed in an adjacent stream.

63. From the beginning of June through November 15, 2018, MBP observed 58 instances of inadequate stabilization in violation of Minimum Standard 1, which provides that "Permanent or temporary stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days." 9 VAC 25-840-40(1).

64. From the beginning of June through November 15, 2018, MBO observed 65 instances of inadequate stabilization in violation of Minimum Standard 2, which provides that "During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles as well as borrow areas and soil intentionally transported from the project site." 9 VAC 25-840-40(2).

65. MBP's observations from the beginning of June through November 15, 2018, constitute violations of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Erosion and Sediment Control Law, the Virginia Stormwater Management Program Regulation, the Erosion and Sediment Control Regulations, and Section 401 Water Quality Certification 17-001 issued to MVP.

COUNT I
Unpermitted Discharge

66. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

67. As noted on May 23, 2018, the Department observed that the release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth had occurred near stations markers 13476+16 and

13489+10.

68. As noted on May 31, 2018, the Department observed sedimentation within two separate unnamed stream channels on property adjacent to the MVP right of way in the vicinity of Cahas Mountain Road in Franklin County.

69. As noted on June 26, 2018, the Department observed that the release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth had occurred near stream 39.

70. As noted on June 26, 2018, the Department observed that the release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth had occurred near stream 40.

71. As noted on June 27, 2018, the Department observed that the release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth had occurred near stream SMM15.

72. As noted on June 27, 2018, the Department observed that the release of sediment and sediment laden stormwater off of the right of way onto adjacent private property and into surface waters of the Commonwealth had occurred near stream MN-513.

73. From the beginning of June through November 15, 2018, MBP observed 16 additional instances where sediment was deposited off of the construction right of way into an adjacent stream as a result of erosion and sediment control measures being improperly installed or maintained.

74. The activities described herein are in violation of the State Water Control Law, the Virginia Water Resources and Wetlands Protection Program, and the Virginia Water Protection Permit Program Regulations.

75. Pursuant to Va. Code § 62.1-44.23 and Va. Code § 62.1-44.32, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT II
Failure to Maintain and Repair Erosion and Sediment Control Structures

76. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

77. The Erosion and Sediment Control Regulations state that "All erosion and sediment control structures and systems shall be maintained, inspected, and repaired as needed to insure continued performance of their intended function." 9 VAC 25-840-60(A).

78. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

79. As noted on May 23, 2018, the Department detected erosion and sediment controls near station markers 13476+16 and 13489+10 in need of repair.

80. As noted on May 24, 2018, the Department detected erosion and sediment controls near station markers 11971+00 and 11972 in need of repair.

81. As noted on June 26, 2018, the Department detected water bars above stream crossing 39 and stream crossing 40 were not maintained or repaired to ensure functionality and sediment was observed off of the construction site at station point 12071+50.

82. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

83. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-

44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT III
Failure to Repair Erosion and Sediment Controls within Required Timeframe

84. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

85. The Erosion and Sediment Control Regulations state that "All erosion and sediment control structures and systems shall be maintained, inspected, and repaired as needed to insure continued performance of their intended function." 9 VAC 25-840-60(A).

86. MVP's approved Annual Standards and Specifications require MVP to ensure the "repair of all ineffective temporary ESC measures within 24 hours of identification, or as soon as conditions allow if compliance with this time frame would result in greater environmental impacts."

87. As noted on May 23 and 24, 2018, the Department observed that areas had not been stabilized and that repairs to controls had not been performed in accordance with the time frame specified in MVP's approved Annual Standards and Specifications or as directed by the Department during the May 21, 2018 inspection.

88. From the beginning of June through November 15, 2018, MBP documented an additional 180 instances where MVP failed to repair ineffective erosion and sediment control measures within 24 hours of identification. The individual delays range from 1 to 48 days past due.

89. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

90. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT IV
Failure to Apply Temporary or Permanent Stabilization

91. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

92. The Erosion and Sediment Control Regulations state that "Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 14 days. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year." 9 VAC 25-840-40(1).

93. "During construction of the project, soil stock piles and borrow areas shall be stabilized or protected with sediment trapping measures. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site." 9 VAC 25-840-40(2).

94. "Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation." 9 VAC 25-840-40(5).

95. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

96. As noted on May 21, May 23, and June 13, 2018, the Department observed denuded areas, including stockpiles and earthen structures, which were not stabilized.

97. From the beginning of June through November 15, 2018, MBP observed 58 instances of inadequate stabilization in violation of 9 VAC 25-840-40(1) ("Minimum Standard 1").

98. From the beginning of June through November 15, 2018, MBP observed 65 instances of inadequate stabilization in violation of 9 VAC 25-840-40(2) ("Minimum Standard 2").

99. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

100. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT V
<u>Sediment off of Right of Way</u>

101. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

102. The Erosion and Sediment Control Regulations state that "Properties and waterways downstream from development sites shall be protected from sediment deposition…." 9 VAC 25-840-40(19).

103. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

104. From the beginning of June through November 15, 2018, MBP identified at least 26 instances where, as a result of erosion and sediment control measures being improperly installed or maintained, sediment was deposited off of the construction right of way but where stream impacts were not observed.

105. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

106. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT VI
Failure to Install Clean Water Diversions

107. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

108. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

109. MVP's approved Annual Standards and Specifications state that "MVP and its construction contractors will implement these Standards and Specifications for all regulated land disturbances associated with the Project in the Commonwealth."

110. As noted on May 30 and June 6, 2018, MVP failed to ensure that clean water diversions shown on MVP's approved Site Specific ESC Plan were constructed and made functional before upslope land disturbance took place.

111. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

112. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT VII
Failure to Keep a Daily Log of Activity Documenting Project Activities Related to Environmental Permit Compliance and Corrective Measures Implemented

113. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

114. MVP's approved Annual Standards and Specifications state that "The Lead Environmental Inspector will also keep a daily log of activity documenting Project activities related to environmental permit compliance and corrective measures implemented, site visitors (i.e. non-project staff), waterbody and wetland crossing log and ESC installation and maintenance activities."

115. As noted on May 23, May 24, and June 6, 2018, the Department's review of records on site revealed that self-inspection reports failed to identify erosion and sediment controls requiring maintenance and failed to document that corrective action was performed within the requisite timeframe.

116. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

117. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT VIII
Failure to Install Adequate Channel, Flume, or Slope Drain Structure

118. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

119. The Erosion and Sediment Control Regulations state that "Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure." 9 VAC 25-840-40(8).

120. "Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel." 9 VAC 25-840-40(11).

121. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

122. As noted on June 13, 2018 the Department observed that water bars were not installed in accordance with the MVP's approved Annual Standards and Specifications and MVP's approved Site Specific ESC and SWM Plans and that end treatment conveyances down slope were not adequate or installed in accordance with the approved Site Specific ESC and SWM Plans.

123. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the

Board's regulations.

124. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT IX
Failure to Construct Vehicular Stream Crossing

125. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

126. The Erosion and Sediment Control Regulations state that "When a live watercourse must be crossed by construction vehicles more than twice in any six-month period, a temporary vehicular stream crossing constructed of nonerodible material shall be provided." 9 VAC 25-840-40(13).

127. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

128. As noted on June 27, 2018 the Department observed that wetlands crossings WC5, WC6, WC11, and WC12 were not properly installed prior to use.

129. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

130. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

COUNT X
Failure to Maintain Access Roads

131. Plaintiffs reallege and incorporate by reference Paragraphs 1-65.

132. The Erosion and Sediment Control Regulations state that "Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner. This provision shall apply to individual development lots as well as to larger land-disturbing activities." 9 VAC 25-840-40(17).

133. The Stormwater Management Program Regulation states that "An erosion and sediment control plan consistent with the requirements of Virginia Erosion and Sediment Control Law and regulations must be designed and implemented during construction activities." 9 VAC 25-870-54(B).

134. As noted on June 26, the Department detected that access roads 270 and 272 required repair and sump maintenance.

135. The activities described herein are in violation of MVP's Annual Standards and Specifications, MVP's Site Specific ESC and SWM Plans, the State Water Control Law, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, and the Board's regulations.

136. Pursuant to Va. Code § 62.1-44.23, Va. Code § 62.1-44.32, Va. Code § 62.1-44.15:42, and Va. Code § 62.1-44.15:48, the Defendant is liable for injunctive relief and civil penalties up to $32,500 per day for each violation.

PRAYER FOR RELIEF

WHEREFORE, David K. Paylor, Director of the Department of Environmental Quality, and the State Water Control Board respectfully request that this Court:

A. Order the Defendant to immediately come into compliance with the State Water Control, the Virginia Stormwater Management Act, the Virginia Erosion and Sediment Control Law, the Board's regulations;

B. Assess a civil penalty against the Defendant to the maximum allowed by law;

C. Award the Plaintiffs their costs and reasonable attorneys' fees; and

D. Grant any and all further relief that this Court deems just and proper.

Respectfully submitted,

David K. Paylor, Director of the Department of Environmental Quality, and the State Water Control Board

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Attorney General of Virginia

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 82

February 21, 2023

NATIONAL ASSOCIATION OF STATE FORESTERS
444 North Capitol Street NW | Suite 387 | Washington, DC 20001 | www.stateforesters.org

Public Comments Processing
Attn: FWS-HQ-ES-2020-0102
U.S. Fish and Wildlife Service, MS:JAO/3W
5275 Leesburg Pike
Falls Church, VA 22041-3803

Dockett: FWS-HQ-ES-2020-0102; 50 CFR 402; Endangered and Threatened Wildlife and Plants; Regulations for Interagency Cooperation

RIN: 1018–BF17; 0648–BJ77

Dear Sir or Madam:

The National Association of State Foresters (NASF) is pleased to provide comments in response to the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) proposed revisions to consultation regulations under the Endangered Species Act (ESA) of 1973, as amended pertaining to the U.S. Forest Service and Bureau of Land Management. The proposed rule addresses the precedent set by *Cottonwood Environmental Law Center v. U.S. Forest Service*, 789 F.3d 1075 (9th Cir. 2015) (*"Cottonwood")*, cert. denied, 137 S. Ct. 293 (2016), a ruling which presents significant challenges for managing National Forest System lands.

NASF is composed of the directors of forestry agencies in all 50 states, eight U.S. territories, and the District of Columbia. Our members manage and protect state and private forests, which encompass nearly two-thirds of the nation's forests, and partner with federal agencies through authorities like Good Neighbor Authority in managing and protecting national forests, and support the goal of protecting threatened and endangered species. In many cases, the ecosystems involved in implementing ESA are forested landscapes. As such, ESA implementation plays a substantial role in how many forests are protected and managed in the U.S. Therefore, NASF has a substantial interest in the law's provisions and how they are implemented.

The *Cottonwood* decision set a harmful and disruptive precedent requiring the Forest Service to reinitiate ESA consultation on completed National Forest plans when a new species is listed, when critical habitat is designated, and when "new information" is brought forward. The fundamental issue in the *Cottonwood* decision is whether a finalized (or approved) forest plan – that has already undergone consultation under the ESA – is a completed agency action or whether "discretionary Federal involvement or control over the action has been retained or is authorized by law." It was the Obama administration's position[1] that a finalized forest plan is *not* an ongoing action and *does not* allow for discretionary involvement. In practice, this means that

[1] This position was argued by the Department of Justice during the Obama Administration's 2016 Petition for Certiorari to the Supreme Court appealing the *Cottonwood* decision. On October 11, 2016, the Supreme Court denied the Petition.

the Forest Service should *not* be required to reinitiate ESA consultation on completed plans when a new species is listed, critical habitat is designated, or new information becomes available.

The *Cottonwood* decision has created a new set of administrative and legal hurdles that have made it more difficult for the Forest Service to manage forests and reduce the threat of wildfire on federal lands. This issue affects program delivery and consumes valuable agency resources that could be used for active forest management and protecting communities from wildfire. The decision has no direct conservation benefit for threatened and endangered species. The Forest Service already consults on listed species and designated critical habitat when it approves, amends, and revises forest plans and when it carries out individual projects.

The Tenth Circuit Court of Appeals in *Forest Guardians v. Forsgren*, 478 F.3d 1149 (2007) has expressly rejected the premise that reinitiation of consultation is required for forest plans. The substantial burden associated with consulting on a forest plan after it has been finalized is duplicative and wasteful work that has no conservation benefits.

Congress recognized the implications of *Cottonwood* and worked in a bipartisan manner to provide a partial legislative fix to the problem in the Consolidated Appropriations Act of 2018 (Public Law 115-141, March 23, 2018). The "*Cottonwood* fix" exempts the Forest Service from having to reinitiate consultation on completed forest plans when a species is listed or critical habitat is designated, but does not provide an exemption from reinitiation of consultation when new information about a species is brought forward.

We strongly support this proposed rule to further amend the Code of Federal Regulations § 402.16 (b) and clarify the duty of federal agencies to reinitiate section 7 consultation under ESA. We agree that reinitation of consultation is not necessary on approved land management plans prepared pursuant to the Federal Land Policy and Management Act (FLPMA) or the National Forest Management Act (NFMA) in instances when new information is identified.

The proposed rule reinforces bipartisan efforts to rectify the negative implications of the *Cottonwood* decision by providing much needed administrative relief. It also aligns the intent of Congress (as laid out in the Consolidated Appropriations Act of 2018) and ensures that the needs of listed species are addressed at the appropriate stage of the forest planning process and through project-level coordination and consultation.

More than 60 listed species reside in two or more Forest Service regions, including the lynx, grizzly bear, bull trout, and spotted owl. A single lawsuit challenging the agency's decision to reinitiate plan-level consultation could involve significant acreage and delay important restoration, vegetation management, or fuels reduction projects over broad geographies. Significant agency resources are required to reinitiate consultation on finalized forest plans; and new species may be listed, new critical habitat designated, and new information may be brought forward at any time. The *Cottonwood* decision does not limit when or how often the agency is required to reinitiate consultation on completed forest plans. If the requirements imposed by the

Cottonwood decision are not changed, the Forest Service anticipates increasing legal actions seeking plan-level reinitiation of consultation that could have severe consequences on the landscape, long into the future.

We urge the FWS and NMFS to finalize the proposed rule, as it largely mirrors the legal opinions expressed by the Obama administration's Justice Department. With the ever-growing threat of wildfire and over 80 million acres of National Forest System land at risk of insect and disease infestation, we need to increase the pace and scale of active forest management. Both economic recovery and forest health will be enhanced by correcting *Cottonwood*.

Sincerely,

Joe Fox
NASF President
Arkansas State Forester

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 83

February 21, 2023

Indiana Bat

Image Details (/media/157423)

Overview

The Indiana bat is a small, insectivorous, migratory bat that hibernates colonially in caves and mines in the winter. The species was originally listed as in danger of extinction under the Endangered Species Preservation Act of 1966 and is currently listed as endangered under the Endangered Species Act of 1973, as amended. The scientific name of the Indiana bat is Myotis sodalis. Myotis means “mouse ear” and refers to the relatively small, mouse-like ears of the bats in this genus. Sodalis is the Latin word for “companion” and is a reference to the very social nature of the species. Indiana bats are colonial both in summer and in winter. During hibernation, clusters of up to 500 bats per square foot form in the hibernacula. The species is called the Indiana bat because the first specimen described to science in 1928 was based on a specimen found in southern Indiana’s Wyandotte Cave.

Indiana bats require forests for foraging and roosting and are found in forested areas in the eastern half of the United States. In winter, Indiana bats hibernate in caves and mines. They are highly concentrated during hibernation, with 72% of the population hibernating in just four sites in Missouri, Indiana and Illinois. Other states within the range include Alabama, Arkansas, Connecticut, Georgia, Iowa, Kentucky, Maryland, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia and West Virginia, according to the U.S. Fish and Wildlife Service, 2007. In spring, reproductive females migrate from hibernacula and form maternity colonies in wooded areas where each female bears a single pup that is raised within the colony. Females return to the same colony every summer. Maternity habitat ranges from areas that are completely forested to highly fragmented forest. Maternity colonies are not uniformly distributed across Indiana bat range; the highest density of maternity colonies occurs in the midwest. Males and nonreproductive females often do not roost in colonies and may stay close to their hibernaculum or migrate shorter distances to summer habitat. Summer roosts are typically behind exfoliating bark of large, often dead, trees. Both males and females return to hibernacula in late summer or early fall to mate and enter hibernation.

The 2019 winter census estimate of the population was 537,297 bats occurring within 223 hibernacula in 16 states. The current population has declined by half compared to when the species was listed as endangered.

Threats to the species include human disturbance of hibernating bats, commercialization of caves where the bats hibernate, loss of summer habitat, pesticides and other contaminants, and most recently, the disease white-nose syndrome. The range-wide population has declined by 19% since 2007, when white-nose syndrome first arrived in North America.

Scientific Name

Myotis sodalis

Common Name

Indiana Myotis, Indiana bat, Cluster Bat, Social Bat

FWS Category

Mammals

Kingdom

Animalia (/species/animals-animalia)

Location in Taxonomic Tree ❓ ()

Subgenus
↳ *Myotis (Pizonyx) (/taxonomic-tree/262797)*

Species
↳ *Myotis sodalis (/taxonomic-tree/31648)*

Identification Numbers

TSN: ()

180001 (https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=180001)

Characteristics

LIFE CYCLE

HABITAT

PHYSICAL CHARACTERISTICS

FOOD

SIMILAR SPECIES

Geography

Range

As of November 2006, the Service had records of extant winter populations - positive winter occurrence since 1995 - of the Indiana bat at approximately 281 different hibernacula located in 19 states: Alabama, Arkansas, Connecticut, Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia and West Virginia. However, most bats hibernate in just a few sites; in 2019 72% of the population hibernated in just four sites in three states.

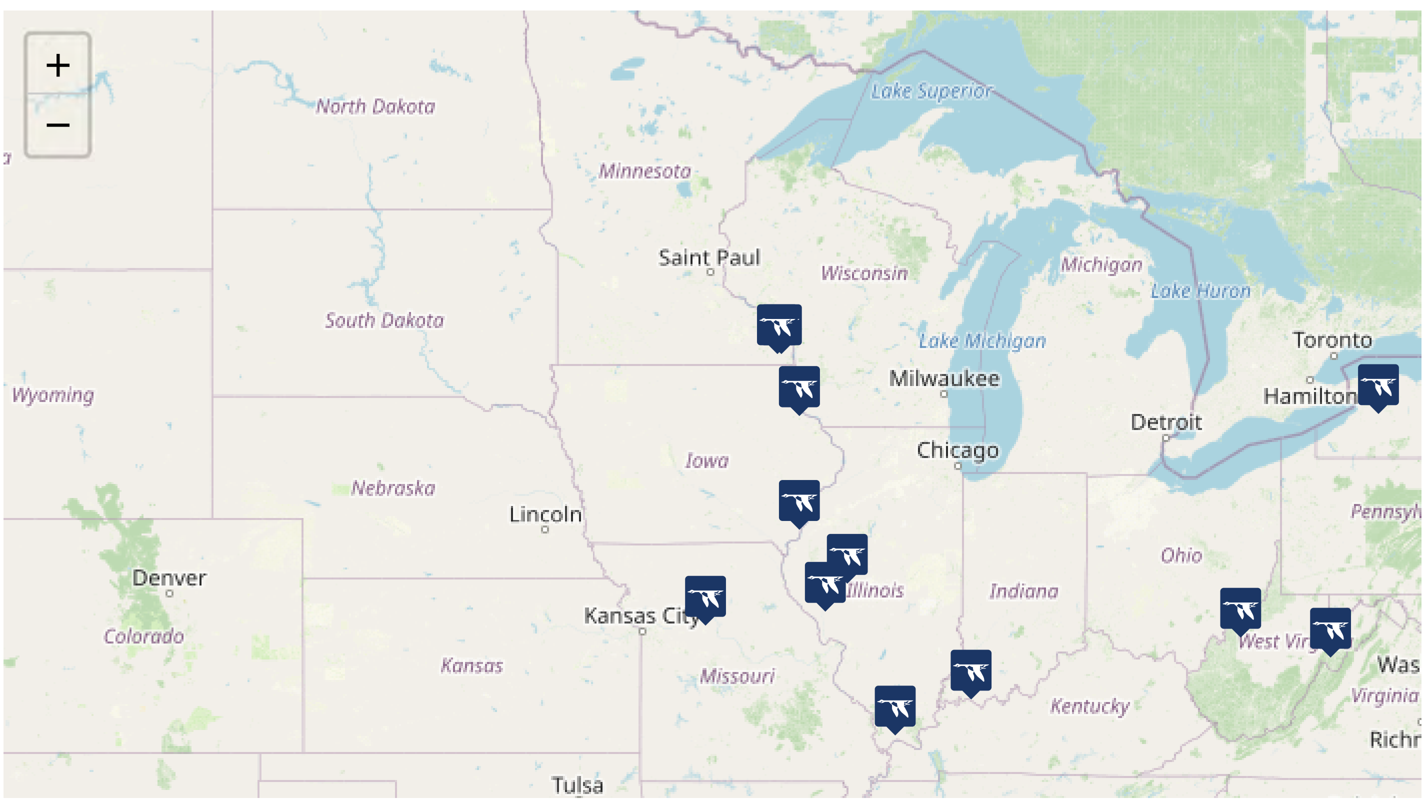
The overall geographic range and distribution of winter habitat/hibernacula has changed relatively little since the Indiana bat was first listed with “extant” winter populations, meaning one or more positive records over past 10 years since 2009, presently occurring in 18 states. However, over the past 10 years, as significant population declines related to white-nose syndrome have occurred, there have also been considerable shifts in the spatial distribution and abundance of occupied hibernacula.

In summer, Indiana bats are largely found in the same states where they winter. In 2007, extant maternity colonies were thought to exist in 17 states. See appendix 2 in USFWS 2007. Historic summer distribution and range for this species is poorly documented, but is assumed to be similar to current summer distribution.

Import/Export

Collection of Indiana bats from hibernacula for sale to biological supply houses was cited by Myers in 1964 as a threat to the species prior to listing as an endangered species. There is no known current import/export of this species.

LAUNCH INTERACTIVE MAP **(/SPECIES/INDIANA-BAT-MYOTIS-SODALIS/MAP)**



The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 84

February 21, 2023

assumed occupied features (69) was then multiplied by the proportion of caves with known Ibat occurrences (0.15) to estimate the number of assumed occupied Ibat caves within the action area (10.35 caves was rounded down to the nearest whole cave = 10 caves).

Approximately 42.3 miles of construction ROW and 32.2 miles of ARs, a total of 828.65 acres[6] (524.62 acres in VA and 304.03 acres in WV), occurs within unknown use spring staging/fall swarming habitat, 827.03 acres of which has already been cleared (Table 21). As most of the acreage has already been cleared, it is not possible to verify what percentage, if any, was in fact utilized by Ibats for spring staging/fall swarming prior to clearing.

Table 21. Ibat forested habitat removal categories in VA and WV (M. Hoover, Mountain Valley, email to T. Lennon, Service, June 30, 2020).

Habitat Category[a]	Acres of Tree Removal						
	VA	WV	Future Slips	Variance Requests (all VA)	Existing Slip Remediation (all WV)	Downed Trees Due to Slips (all WV)	Total
Known use spring staging/fall swarming habitat	131.43	176.76	0	0.78	0	0	308.97
Unknown use spring staging/fall swarming habitat	523.12	303.91	0	1.50	0.12	0	828.65

[a]Habitat categories are based on the 2.0-mile terrestrial action area.

Determining the Number of Ibats Hibernating within the Action Area – The Service (2019a) estimates the 2019 hibernating Ibat population is 648 in VA and 620 in WV; these numbers indicate a 30.9% increase in VA and a 42.4% decline in WV since the 2017 census. WNS was first detected in VA and WV during the 2008/2009 winter hibernacula surveys (Stihler 2012, Powers et al. 2015). VA and WV hibernacula surveys indicate Ibat populations have decreased at least 95% since the discovery of WNS (https://www.fws.gov/midwest/endangered/mammals/inba/pdf/2019_IBat_Pop_Estimate_6_27_2019a.pdf).

To determine the current status of the species within the action area, the Service used the best scientific data available to estimate the number of hibernating Ibats that may be present within all assumed occupied hibernacula[7] (10) and known hibernacula (2) (Table 22). The Service used

[6] Because the majority of the suitable features (69) within the action area overlap, the Service applied the estimated acreages provided within the SBA (Mountain Valley 2020) for all of these features to the 10 assumed occupied hibernacula.

[7] The Service assumes that all hibernating bats will utilize the habitat surrounding the 10 assumed occupied hibernacula during the spring staging/fall swarming periods. This habitat is considered to be unknown use spring staging/fall swarming habitat.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 85

February 21, 2023

U.S. Fish and Wildlife Service

Indiana Bat

(*Myotis sodalis*)

5-Year Review: Summary and Evaluation

Photo credit: USFWS/R. Andrew King

U.S. Fish and Wildlife Service
Interior Region 3 – Great Lakes

Indiana Ecological Services Field Office
Bloomington, Indiana

September 2019

Table of Contents

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology used to complete the review:

This 5-year review (review) was prepared by R. Andrew King, Endangered Species Biologist, U.S. Fish and Wildlife Service (Service), Indiana Ecological Services Field Office (INFO), in consultation with Service biologists from throughout the species' range.

To prepare this status review, the Service solicited pertinent information from the public through Federal Register notices in 2011 (76 FR 44564; July 26, 2011) and 2014 (79 FR 38560; July 8, 2014) and also reviewed past and recent scientific reports, published and unpublished records and a wealth of new literature that has become available since publication of the *Indiana Bat Draft Recovery Plan: First Revision* (2007 Plan) (USFWS 2007) and subsequent to the September 2009 5-year Review (USFWS 2009). We reviewed these documents for new information, but generally focused on new information received since the 2009 review that presented how the species' status and threats have changed since that time.

The Service reviewed comments received from the general public following the 26 July 2011 and 8 July 2014 Federal Register notices announcing initiation of this review. However, no new information that had a substantive bearing on the species' classification was received from the general public. Since publication of the 2009 review, we coordinated with state and federal natural resource agencies in 18 states and they provided us with substantive new population data conducted as part of the biennial Indiana bat winter population surveys (discussed below in 2.3.1.2) and current protection status of hibernacula in their respective jurisdictions. We used the most recent (2019) population and threats data (see 2.3.2.3) from across the species' range to assess whether the recovery criteria included within the 2007 Plan had been achieved (see Appendix A for detailed analyses). Ultimately, our recommendation of maintaining the Indiana bat in its current 'endangered' status has remained the same since the 2009 review.

1.3 Background

1.3.1 FR Notice Citations announcing initiation of this review:

76 FR 44564 (July 26, 2011) Endangered and Threatened Wildlife and Plants; 5-Year Status Reviews of Seven Listed Species.

79 FR 38560 (July 8, 2014) Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of Nine Listed Animal and Two Listed Plant Species.

1.3.2 Listing History

Original Listing
FR notice: 32(48) FR 4001
Date Listed: March 11, 1967
Entity Listed: Indiana Bat – *Myotis sodalis* (the species)
Classification: endangered

1.3.3 Associated rulemakings

Critical Habitat Designated
FR notice: 41(187) FR 41914
Date Listed: September 24, 1976
Entity Listed: 13 hibernacula (winter habitat) including 11 caves and two mines in six states were listed as Critical Habitat:
Illinois - Blackball Mine (LaSalle Co.); Indiana - Big Wyandotte Cave (Crawford Co.), Ray's Cave (Greene Co.); Kentucky - Bat Cave (Carter Co.), Coach Cave (Edmonson Co.); Missouri - Cave 021 (Crawford Co.), Caves 009 and 017 (Franklin Co.), Pilot Knob Mine (Iron Co.), Bat Cave (Shannon Co.), Cave 029 (Washington Co.); Tennessee - White Oak Blowhole Cave (Blount Co.); and West Virginia - Hellhole Cave (Pendleton Co.).

1.3.4 Review History

The Indiana bat was included in four previous 5-year reviews: (1) for wildlife classified as endangered or threatened prior to 1975 (44 FR 29566); (2) for species listed before 1976 and in 1979 and 1980 (50 FR 29901); (3) of all species listed before January 1, 1991 (56 FR 56882); and (4) the first species-specific review in 2009 (71 FR 55212; USFWS 2009). These 5-year reviews resulted in no change to the listing classification of 'endangered.'

1.3.5 Species' Recovery Priority Number at start of 5-year review: 5
A Recovery Priority Number (RPN) of "5" means that a species has a high degree of threat and a low recovery potential.

1.3.6 Recovery Plan or Outline

Name of Plan: Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision
Date Issued: 13 April 2007
Date of Original Recovery Plan: 1976

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy:

2.1.1 Is the species under review a vertebrate? *Yes.*

2.1.2 Is the species under review listed as a DPS? *No.*

2.1.3 Was the DPS listed prior to 1996? *Not Applicable*.

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy? *No*. Band returns and some early population genetics research using mitochondrial DNA suggested Indiana bat populations had some discrete genetic structuring (USFWS 2007). However, more recent analyses using nuclear microsatellite markers showed an absence of differentiation among hibernacula across the species' range, suggesting the occurrence of extensive gene flow through wide-spread dispersal and mating (i.e., essentially a panmictic population; Vonhof et al. 2016). In addition, no other lines of evidence suggest that any population segments are markedly different or separated from other populations of the species as a consequence of physical, physiological, ecological, or behavioral factors. Therefore, based on the genetic and other biological evidence and the fact that the Indiana bats' range lies wholly within the United States, the discreteness standard within the Service's 1996 DPS policy has not been met and thus, no DPSs are recognized for this species.

2.2 Recovery Criteria:

2.2.1 Does the species have an approved recovery plan containing objective, measurable criteria? *No.* Although, the 2007 Plan was issued as a "draft" and was not finalized or formally "approved" by the Service, it does contain objective and measurable recovery criteria. We respond to the remaining questions regarding recovery criteria with respect to the 2007 Plan.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? *Yes.*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? *No*. There are no explicit threat-based criteria. Protection of hibernacula can help address some of the threats. However, protection is not fully defined. In addition, threats during migration, spring, fall, and summer are not addressed. Finally, white-nose syndrome (WNS) is not addressed.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met; citing information.

Appendix A contains a list of all the recovery criteria and a detailed assessment of their present status and Table 1 (below) contains a summary of current recovery criteria achievements.

2.3 Updated/New Information and Current Species Status

Since the last review was completed in 2009, a very large previously unknown Indiana bat hibernaculum was discovered near Hannibal, Missouri. This "new" Priority 1 site (an extensive abandoned limestone mine is now protected within Sodalis Nature Preserve) contained a minimum of 123,000 bats when partially surveyed in January 2013 and had over 197,000 when completely surveyed for the first time in January 2017. Based upon first-hand accounts of many very large clusters (a key trait of Indiana bats) of unidentified hibernating bats being present and observed by locals at this site for several decades prior to its discovery by bat biologists (Kirsten Alvey-Mudd, Missouri Bat Census, 2017, pers. comm.), the Service decided to add the same number of Indiana bats as was found in 2017 to each previous biennium for this site back through 1981. Incorporating the newly discovered bat numbers in this manner, improved the accuracy of the Missouri, Ozark-Central Recovery Unit (RU) and range-wide population estimates over those reported in previous years and also avoided what otherwise would have been artificial spikes in population trends in 2013, 2015 and 2017.

The 2019 (most current) range-wide Indiana bat population estimate was approximately 537,297 bats with 71% of these bats hibernating in sites located in Missouri and Indiana (36.3% and 34.4%, respectively). The 2019 range-wide population declined an additional 4% from the 2017 estimate and represented a 19% decline since the arrival of WNS in New York in 2007. A detailed summary of the 2019 and previous state-by-state, regional, recovery unit and range-wide population estimates and trends is available on the Service's Indiana bat webpage and is hereby incorporated by reference (see USFWS 2019b).

TABLE 1. Summary of progress towards achieving recovery criteria.

Criterion	Relevant Measure	Current Status	Conclusion
Reclassification Criterion 1	Permanent protection of 80% of all Priority 1 hibernacula in each Recovery Unit.	Ozark-Central (n=9): 67% Midwest (n=13): 69% Appalachia (n=2): 50% Northeast (n=3): 67%	Not Achieved
Reclassification Criterion 2	A minimum overall population estimate equal to the (previously assumed) 2005 population estimate of 457,000 bats.	The 2019 overall population estimate is 537,297 bats, which exceeds the 457,000 minimum.	Achieved
Reclassification Criterion 3	Predicted continued positive population growth rate at each of the most populous hibernacula in each RU (using a linear regression with 90% confidence interval through 5 most recent population estimates as a means of predicting trend over the next 10-year period).	Noted below are the numbers of hibernacula that currently "pass" this criterion. Ozark-Central: 1 of 2 Midwest: 0 of 3 Appalachia: 0 of 4 Northeast: 0 of 2	Not Achieved
NOTE: The reclassification criteria (above) currently have not been met. Nonetheless, to see how much progress has been made to-date towards full recovery of the species, we also assessed the delisting criteria (below) using currently available data.			
Delisting Criterion 1	Protection of a minimum of 50% of Priority 2 hibernacula in each Recovery Unit.	Ozark-Central (n=23): 35% Midwest (n=26): 46% Appalachia (n=6): 33% Northeast (n=3): 0%	Not Achieved
Delisting Criterion 2	A minimum overall population estimate equal to the (previously assumed) 2005 population estimate of 457,000 bats.	The 2019 overall population estimate is 537,297 bats, which exceeds the 457,000 minimum.	Achieved
Delisting Criterion 3	Positive population growth rates at a minimum of 80% of all Priority 1A hibernacula/ complexes as evidenced by a positive slope of a linear regression through the 5 most recent population estimates post-reclassification.	40% (4 out of 10) of P1A hibernacula currently pass. Magazine Mine, IL: Pass Sodalis Nat. Pres., MO: Fail Wyandotte/Jughole, IN: Pass Ray's, IN: Fail Carter Caves, KY: Pass Coon & Grotto,IN: Fail White Oak Blowhole, TN: Fail Hellhole, WV: Fail Barton Hill Mine, NY: Pass Williams Mines, NY: Fail	Not Achieved

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology, life history, threats and conservation:

Three primary sources of information on the Indiana bat's biology and life history are 1) a proceedings edited by Kurta and Kennedy (2002) from a

2001 symposium entitled *The Indiana Bat: Biology and Management of an Endangered Species,* 2) the 2007 Draft Recovery Plan (USFWS 2007), and 3) the 2009 5-year review, which are hereby incorporated by reference. The 2007 Plan is available at http://www.fws.gov/midwest/Endangered/mammals/inba/index.html and the 2009 5-year review is available at http://ecos.fws.gov/docs/five_year_review/doc2627.pdf.

As one of the most researched bat species in North America (perhaps the world), keeping abreast of old and new literature pertaining to the Indiana bat is challenging. Therefore, since the last review, the Service's Indiana Field Office (INFO) launched an online bat literature database as a tool for improving management and accessibility of the rapidly growing number of scientific publications and other reference materials pertaining to Indiana bats and other bat species in eastern North America. The database currently contains over 2,700 references with over 700 items added over the past year. Approximately 700 publications specifically refer to various aspects of the Indiana bat's life history, ecology, habitat, population status and conservation. Other relevant bat-related topics in the database include WNS, bat and wind energy issues and other federally listed bat species. A publicly available version of the Service's bat literature reference database is available at http://www.refworks.com/refworks2/?site=040621159761600000%2fRWWEB103971662%2fUSFWS+Bat+Lit.+Database+-+Public+Version

Since the last review, over 200 new scientific papers, theses and dissertations have been published that directly or indirectly relate to the Indiana bat and its conservation. The following is a topical listing of some of the most relevant of these publications:

Artificial Roosts/Bat Boxes (Adams et al. 2015, Benedict et al. 2017, Bergeson et al. 2019, Hoeh et al. 2018, Mangan and Mangan 2016, Mering and Chambers 2014, and Rueegger 2016)

Bridges and Roadways (Bennett and Zurcher 2013, Bennett et al. 2013, Cervone et al. 2016, Fensome and Matthews 2016, Zurcher et al. 2010)

Climate Change (Adams 2010, Bergeson et al. 2013, Brandt et al. 2014, Burles et al. 2009, Dukes et al. 2009, Foden et al. 2019, Frick et al. 2010a, Jones and Rebelo 2013, Jones et al. 2009, Loeb and Winters 2012, Lundy et al. 2010, Matthews et al. 2011, O'Shea et al. 2016, Perry 2013, Prasad et al. 2007, Rebelo et al. 2010, Sherwin et al. 2013, Stepanian and Wainwright 2018, USGCRP 2018)

Contaminants (Bayat et al. 2014, Eidels et al. 2016, Mineau and Callaghan 2018, Secord et al. 2015, Stahlschmidt and Bruhl 2012, Yates et al. 2014)

Conservation (Dixon et al. 2013, Furey and Racey 2015, Hammerson et al. 2017, Loeb et al. 2009, Mering and Chambers 2014, Pfeiffer 2019, Pruitt 2013, Sparks et al. 2009, Voight and Kingston 2016)

Economic Importance (Boyles et al. 2011a, Boyles et al 2011b, Fisher and Naidoo 2011, Maine and Boyles 2015)

Forestry and Prescribed Fire (Austin et al. 2018, Bergeson et al. 2015, Brose et al. 2014, Caldwell et al. 2019, Cox et al. 2016, D'Acunto and Zollner 2019, Dickinson et al. 2009, Dickinson et al. 2010, Duchamp et al. 2010, Jachowski et al. 2016, Johnson et al. 2010, Johnson and King 2018, Loeb and O'Keefe 2011, Loeb and O'Keefe 2014, Luna et al. 2014, Nowacki and Abrams 2008, O'Keefe et al. 2013, O'Keefe and Loeb 2017, Pauli et al. 2015, Perry 2012, Schroeder et al 2017, Sheets et al. 2013a, Sheets et al. 2013b, Silvis et al. 2016a, Silvis et al. 2016b, Titchenell et al. 2011)

Genetics (Amelon et al. 2011, Oyler-McCance & Fike 2011, Oyler-McCance et al. 2018, Tujillo and Amelon 2009, Vonhof et al. 2016)

Habitat Modeling (De La Cruz and Ward 2016, Hammond et al. 2016, Pauli et al. 2015, Weber and Sparks 2013)

Hibernacula Management (Abigail and Chambers 2017, Boyles and Willis 2010, Crimmins et al. 2014, Muthersbaugh et al. 2019)

Hibernation Ecology (Boyles 2016, Boyles et al. 2008, Boyles and McKechnie 2010, Boyles and Brack 2013, Boyles et al. 2017, Britzke et al. 2012, Day and Tomasi 2014, Haase et al. 2019, Hayman et al. 2017, Langwig et al. 2012, Perry 2013, Thogmartin et al. 2014)

Invasive Species (Brack et al. 2013, Welch and Leppanen 2017)

Migration (Gumbert et al. 2011, Hicks et al. 2012, Judy et al. 2010, Pettit and O'Keefe 2017b, Roby et al. 2019, Rockey et al. 2013)

Paleontology (Colburn et al. 2015)

Population Ecology (Erickson et al. 2014a, Erickson et al. 2014b, Ingersoll et al. 2013, Powers et al. 2015, Thogmartin et al. 2012a, Thogmartin et al. 2012b, Thogmartin et al. 2013)

Range and Life History (Adams et al. 2015, Arndt et al. 2018, Bergeson et al. 2013, Brandebura et al. 2011, Caylor and Sheets 2014, Divoll and O'Keefe 2018, Gumbert and Roby 2011, Jachowski et al. 2014, Jachowski et al. 2016, Kniowski and Gehrt 2014, Lacki et al. 2009, Lacki et al. 2015, Mangan and Mangan 2016, Muthersbaugh et al. 2019, O'Keefe and Loeb 2017, Perry et al. 2016, Rockey et al. 2013, Silvis et al. 2014, Silvis et al. 2016c, Sparks and Brack 2010, St. Germain et al. 2017, Timpone et al. 2010, White et al. 2012, Womack et al. 2013a, Womack et al. 2013b)

Survey and Surveillance Techniques (Britzke et al. 2011, Britzke et al. 2014, Clement et al. 2014, Clement et al. 2015, Cliff et al. 2018, Coleman et al. 2014, Ford 2019, Francl et al. 2011, Hamilton et al.

2009, Hayman et al. 2017, Kaiser & O'Keefe 2015, Loeb et al. 2015, Meretsky et al. 2010, O'Keefe et al. 2014, Oyler-McCance et al. 2018, Robbins and Carter 2009, Romeling et al. 2012, Russo and Voight 2016, Samoray et al. 2019, Tonos et al. 2014, Turner et al. 2014, Whitby et al. 2014)

Theses (various topics) [Austin 2017, Bergeson 2012, Bergeson 2017, Bishop-Boros 2014, Boyles 2009, Byrne 2015, Cable 2019, Caylor 2011, Coleman 2013, Corcoran 2009, D'Acunto 2012, D'Acunto 2018, Damm 2011, Dey 2009, Fishman 2017, Flory 2010, Gikas 2011, Hale 2012, Hammond 2013, Hohoff 2016, Just 2011, Kniowski 2011, Langwig 2015, Lemen (J.L.) 2015, Lemen, (J.R.) 2015, Lemzouji 2010, Nocera 2018, Oehler 2011, Pauli 2014, Pennington 2014, Petitt 2015, Roby 2019, Romeling 2012, Schroder 2012, Sheets 2010, Sichmeller 2010, Titus 2018, Torrey 2018, Whitby 2012, Womack 2011, Womack 2017].

White-Nose Syndrome (not an exhaustive list) (Amelon et al. 2011, Blehert et al. 2009, Blehert 2012, Cheng et al. 2019, Cryan et al. 2010, Cryan et al. 2013, Drees et al. 2017, Erickson et al. 2016, Ford et al. 2011, Francl et al. 2012, Frick et al. 2010, Frick et al. 2015, Gargas et al. 2009, Grieneisen et al. 2015, Hayman et al. 2016, Hoyt et al. 2018, Hoyt et al. 2019, Ingersoll et al. 2013, Jachowski et al. 2014b, Janicki et al. 2015, Langwig et al. 2012, Langwig et al. 2015, Langwig et al. 2016, Lilley et al. 2016, Lorch et al. 2011, Lorch et al. 2013, Lorch et al. 2016, Maslo et al. 2017, Mayberry et al. 2018, Meierhofer et al. 2018, Meteyer et al. 2011, Nocera et al. 2019, O'Keefe et al. 2019, O'Shea et al 2016, Pettit and O'Keefe 2017a, Reichard et al. 2014, Reeder et al. 2012, Rocke et al. 2019, Russel et al. 2015, Swezey and Garrity 2011, Thogmartin et al. 2012a, Thogmartin et al. 2012b, Thogmartin et al. 2013, Turner et al. 2011, Turner et al. 2015, USFWS 2018, Verant et al. 2012, Verant et al. 2014, Verant et al. 2018, Warnecke et al. 2012, Warnecke et al. 2013, and Willis 2011), and

Wind Energy (Arnett et al. 2009, Arnett et al. 2011, Arnett and Baerwald 2013, Arnett et al. 2013, BWEC 2018, Cryan et al. 2014, Ellison 2012, Erickson et al. 2016, Frick et al. 2017, Hayes 2013, Khalil 2019, O'Shea et al. 2016, Pruitt and Reed 2018, Schirmacher et al. 2018).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Indiana bat winter population surveys are conducted every other winter (biennially) at most hibernacula across the species' range. In 2005, the INFO developed an Indiana bat hibernacula and winter population database. Every known Indiana bat hibernaculum (n=549) and its associated bat population data from 1930 through the present have been entered into this database. The INFO uses this database to generate the range-wide Indiana bat population estimate every other year. Likewise, the database is used to track population trends, identified threats, and conservation measures implemented at hibernacula.

As discussed in the last review, since the Indiana bat's original listing and since standardized winter surveys began in the early 1980's, the Indiana bat's overall population decreased precipitously until an increasing population trend began in 2003 and continued through 2007 (Figure 1). From the time of listing in 1967 through 2001, most of the overall population declines were attributed to declines at high-priority hibernacula in Kentucky and Missouri and to a lesser extent, Indiana. In contrast, a distinct population increase occurred from 2001 to 2007 due to population growth at hibernacula in Illinois, Indiana, Kentucky, New York, and West Virginia (USFWS, unpublished data, 2019), which presumably stemmed from conservation efforts at hibernacula and summer habitat areas. We presume the downward range-wide trend from 2009 to present was caused by significant WNS-associated declines in the Northeast, Appalachia and Midwest. Detailed state-by-state, recovery unit and range-wide population estimates for 2019 are available on the Service's Indiana bat website. (http://www.fws.gov/midwest/Endangered/mammals/inba/index.html).

Since publication of the last review, the Service received new population data from the 2011, 2013, 2015, 2017, and 2019 biennial winter surveys conducted throughout the species' range. The 2019 estimates were used in calculations to assess achievement of recovery criteria for this 5-Year review (see Appendix A).

Since the last review, WNS and the fungus that causes it, *Pseudogymnoascus destructans* (Pd), has spread across the entire range of the Indiana bat and caused mortality of tens of thousands of Indiana bats and affected eleven other bat species (WNS 2019). Thus, WNS has led to regional and range-wide declines in Indiana bat abundance and triggered a decreasing population trend at most, but not all, affected hibernacula (Thogmartin et al. 2012a, Thogmartin 2012b, Thogmartin et al. 2013). Essentially, all Indiana bat hibernacula across the range were considered to be WNS-affected by 2017 (USFWS, unpublished data, 2019). While Indiana bat numbers have fared better than some of its congeners (i.e., *M. lucifugus* and *M. septentrionalis*) (Turner et al. 2011), researchers remain concerned that its apparent tolerance of Pd may not be indicative of reduced long-term extinction risk (Maslo et al. 2017, Thogmartin et al. 2013).

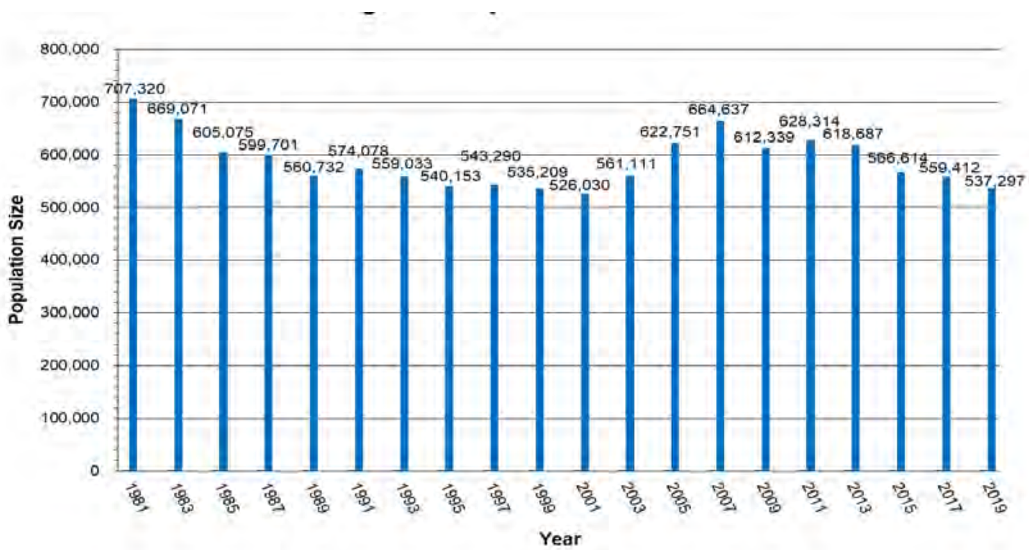

FIGURE 1. Range-wide Indiana bat population estimates from 1981 – 2019 (estimates derived from winter surveys at all known hibernacula) (USFWS 2019b).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Pre-WNS population structure of the Indiana bat has been investigated using mitochondrial DNA from wing tissue of Indiana bats sampled at 13 hibernacula with the discovery of four separate population groups: Midwest, Appalachia, Northeast 1, and Northeast 2 (USFWS 2007). However, more recent analyses using nuclear microsatellite markers showed an absence of differentiation and widespread gene flow among hibernacula spread across the species' range, suggesting the occurrence of extensive gene flow through male dispersal and mating (i.e., essentially a panmictic population) (Vonhof et al. 2016). Whether WNS-associated population declines and potentially severe bottlenecks will adversely affect genetic diversity remains to be seen. It is also not known whether there are genetic differences between Indiana bats surviving WNS vs. those that are dying.

2.3.1.4 Taxonomic classification or changes in nomenclature:
No change.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The overall geographic range and distribution of winter habitat/hibernacula has changed relatively little since the Indiana bat was first listed with "extant" winter populations (i.e., one or more positive records over past 10 years/since 2009) presently occurring in 18 states (USFWS 2019a, USFWS 2019b). However, over the past ten years, as significant WNS-related population declines have occurred, there have also been considerable shifts in the spatial distribution and abundance of occupied hibernacula (Table 2). After the arrival of WNS, all four recovery units (RU) experienced declines in the number of their occupied hibernacula across almost all size classes. The most dramatic declines in the number of occupied hibernacula have occurred in the Northeast and Appalachia RUs. Remaining Indiana bats have also become significantly more concentrated in some areas. For example, Barton Hill Mine in New York now contains 93% of the Northeast RU's remaining Indiana bat population (Table 2).

In at least three known cases, the species has expanded its current winter range beyond its historical winter limits as a result of occupying man-made hibernacula (e.g., mines, tunnels, and a dam) in relatively recent times. Some occupied man-made structures are relatively far removed from natural cave areas (e.g., Black Ball Mine in northern Illinois, Lewisburg Limestone Mine in west central Ohio, Tippy Dam near the eastern border of Lake Michigan in Michigan). Of the 29 mines with extant winter populations, some have served as hibernacula for Indiana bats for nearly a century or more (e.g., Pilot Knob Mine in Missouri; Clawson 2002). Others, where mining activities have been abandoned more recently, have only supported significant winter populations within the past couple decades, such as the Magazine Mine in southern Illinois (Kath 2002). In 2012, biologists discovered the largest known winter population of Indiana bats within a large abandoned limestone mine in Hannibal, Missouri (i.e., Sodalis Nature Preserve; SNP). The discovery of this huge previously unknown population may help to explain why some other sites in Missouri had experienced otherwise puzzling declines (i.e., SNP may have drawn bats away from other sites over time).

TABLE 2. Pre- and post-WNS abundance and aggregation of Indiana bats at hibernacula by Recovery Unit.

Recovery Unit (pre-WNS year)	**# of Sites ≥100 bats**		**# of Sites ≥1,000 bats**		**# of Sites ≥10,000 bats**		**% of RU Population within Largest Hibernaculum in each RU**	
	Pre-WNS	**2019**	**Pre-WNS**	**2019**	**Pre-WNS**	**2019**	**Pre-WNS** (site/pop. size)	**2019** (site/pop. size)
Northeast (2007)	11	4	6	1	2	1	45% Williams Hotel Mine, NY; 24,317	93% Barton Hill, NY 12,570
Appalachia (2009)	13	3	3	0	1	0	51% Hellhole, WV 15,708	37% White Oak Blowhole, TN; 736
Midwest (2011)	46	38	18	14	8	6	21% Wyandotte, IN 64,372	32% Jug Hole, IN 79,358
Ozark-Central (2013)	28	22	11	9	2	2	70% Sodalis Nat. Pres., MO; 197,419	65% Sodalis Nat. Pres., MO; 180,801
Totals	98	67	38	24	13	9	USFWS, unpublished data, 2019	

These findings suggest that Indiana bats are capable of adapting to man-made sites and expanding their winter distribution by colonizing suitable hibernacula as they become available within and for some distance beyond their traditional winter range. In 2019, approximately 49.8% (267,286 bats) of the range-wide population of Indiana bats hibernated in man-made hibernacula (267,260 bats in 19 mines, 20 bats in 1 dam, and 6 bats in 1 tunnel) and 50.2% (269,991 bats) hibernated in natural caves (n=202; USFWS, unpublished data, 2019). In addition, it appears in some instances that Indiana bats may redistribute themselves over relatively short periods of time (e.g., several years) as evidenced by swift population declines in some hibernacula that coincided with rapid population increases at others nearby (e.g., Twin Domes and Wyandotte caves in Indiana, which are approx. 2.7 miles apart; USFWS, unpublished data, 2019). Such rapid increases cannot be attributed to reproduction alone, and are due at least in part to immigration.

Because maternity colonies are widely dispersed during the summer and difficult to locate, all the combined summer survey efforts have found only a fraction of the colonies presumed to exist (based on range-wide population estimates derived from winter hibernacula surveys). For example, based on the 2019 range-wide population estimate of 537,000 bats, and assuming a 50:50 sex ratio and an average maternity colony size of 50 to 80 adult females (Whitaker and Brack 2002), the 269 or so known maternity colonies may only represent 5 to 8% of the 3,356 to 5,370 maternity colonies that we assume exist (e.g., 537,000 total bats ÷ 2 = 268,500 females, ÷ 50 females/colony = 5,370 colonies). Regardless of reasonable disagreements regarding the average colony size, the geographic locations of the vast majority of Indiana bat maternity colonies remain unknown in much of the range.

Since the last review, the Service updated its range-wide presence/probable absence survey guidance for the Indiana bat to incorporate and standardize additional methods (Niver et al. 2014)[1]. The Service has also implemented standardized reporting of occurrence data which will serve to improve our ability to assess spatial and population trends over time and can be used for future reviews.

Additional summer survey efforts and spring/fall radio-tracking studies are needed to locate remaining maternity colonies in areas along the periphery of the range and interior areas heavily impacted by WNS (see Roby et al. 2019). Because of ongoing WNS-related declines, field surveys aimed at locating "new" maternity colonies and monitoring the status of known maternity colonies and hibernacula will remain vital to the species' long-term conservation and recovery. Likewise, a comprehensive analysis of existing positive and negative summer survey data is warranted.

[1] https://www.fws.gov/midwest/Endangered/mammals/inba/inbasummersurveyguidance.html

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Additional literature pertaining to the Indiana bat's habitat needs has been published since the last review (see "habitat modeling" references in section 2.3.1.1). However, our general understanding has not significantly changed.

2.3.1.7 Other: *None.*

2.3.2 Five-Factor Analysis

Pursuant to the ESA and our implementing regulations, we must determine whether species are threatened or endangered based on any one or a combination of the following five section 4(a)(1) factors (i.e., the "five-factor analysis"): 1) the present or threatened destruction, modification, or curtailment of habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) inadequacy of existing regulatory mechanisms; and 5) any other natural or manmade factors affecting the species' existence (16 U.S.C. 1533(a)(1), 50 CFR 424.11(c)). Below, we present our evaluation of the information regarding each of the ESA section 4(a)(1) factors and their impact on the extinction risk of the Indiana bat and whether any one or a combination of these factors are causing declines in the species or likely to substantially negatively affect it within the foreseeable future to such a point that it is at risk of extinction now or likely to become so in the foreseeable future. Please refer to the 2007 Plan (USFWS 2007, pp. 71-101) for an in-depth 5-factor threats analysis and a discussion of the species' status including biology and habitat, threats, and management efforts, as well as the last review.

The 1967 federal document that listed the Indiana bat as "threatened with extinction" (32 FR 4001, March 11, 1967) did not address the five factor threats analysis later required by section 4 of the 1973 ESA. The original recovery plan (USFWS 1983) identified threats or "causes of decline" as:

- natural hazards (i.e., flooding, freezing, mine ceiling collapse),
- human disturbance and vandalism at hibernacula (identified as "the most serious cause of Indiana bat decline"),
- deforestation and stream channelization,
- pesticide poisoning,
- indiscriminate scientific collecting,
- handling and banding of hibernating bats by biologists,
- commercialization of hibernacula,
- exclusion of bats from caves by poorly designed gates,
- man-made changes in hibernacula microclimate (blocking or adding entrances and/or by poorly designed gates), and
- flooding of caves by dams/reservoir developments.

Several of the original threats listed above have largely been addressed and are no longer adversely affecting the species to the degree or extent that they once had (e.g., human disturbance at hibernacula, indiscriminate scientific collecting, banding of hibernating bats, commercialization of hibernacula, and poorly designed cave gates). The 1999 agency draft recovery plan (USFWS 1999) identified all of the causes of decline listed above, but also pointed out that "although several human-related factors have caused declines in the past, they do not appear to account for the declines we are now witnessing."

The 2007 Plan (USFWS 2007) identified and expounded upon additional threats including:

- quarrying and mining operations (impacting summer and winter habitat),
- loss/degradation of summer/migration/swarming habitat,
- loss of forest habitat connectivity,
- some silvicultural practices and indiscriminate firewood collection,
- disease and parasites,
- predation,
- competition with other bat species,
- environmental contaminants (not just "pesticides"),
- climate change, and
- collisions with man-made objects (e.g., wind turbines, communication towers, airstrikes with airplanes, and roadkill).

With few exceptions, all of the previously identified threats are still affecting the species to varying degrees in 2019. The most significant range-wide threats to the Indiana bat have traditionally been habitat loss/degradation, forest fragmentation, winter disturbance, and environmental contaminants, but now WNS, non-native invasive species, climate change, and wind turbines have emerged as significant new threats to the recovery of the Indiana bat (see Frick et al. 2019).

While progress to alleviate some long-standing threats has been made over the years, we find that information presented in this review, together with other information available within our files, regarding WNS is substantial enough to make a determination that a reasonable person would conclude that the Indiana bat continues to warrant listing as endangered based on this factor alone. As such, we focus much of our discussion below on WNS and other threats that have emerged and have been better researched since the last review.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Destruction and degradation of the bat's winter hibernacula (i.e., caves and mines) and summer/fall/spring habitat (i.e., forests) has been identified as a long-standing and ongoing threat to the species. Many of the species' most important hibernacula have been protected via acquisition or conservation easements, but several key sites have not and remain vulnerable to vandalism, modifications of entrances/microclimate changes, and incompatible surrounding land use. At present, 59% of Priority 1 hibernacula (n = 27) are considered protected and 38% of Priority 2 sites (n = 58) (see Appendix A, Tables 1 and 5, respectively).

Among the currently protected high-priority hibernacula, there remains some degree of threat from potentially harmful developments and activities. For example, an underground pumped-water storage system designed to produce 240 mega-watts of electricity has recently been proposed in a decommissioned subterranean mine complex located near the Barton Hill Mine (BHM) in Essex County, New York. The BHM is the largest remaining Indiana bat hibernaculum in the Northeast (contained 93% of the Northeast RU's Indiana bats in 2019). It is not presently known if a hydrological connection exists between BHM and the proposed project's mine complex, but if there is, the hibernaculum could be altered (flooding and draining repeatedly) or its microclimate could be adversely affected.

In addition to urbanization and development, one of the greatest emerging causes of conversion of forest/habitat loss within the range of the Indiana bat is energy production and transmission (e.g., oil, gas, coal, wind) (Oswalt et al. 2019, USFWS 2007). A distinction should be drawn between forest habitat conversion for agriculture and conversion for development. Agricultural conversion has historically been responsible for high rates of forest conversion within the range of the Indiana bat; however, some marginal farmlands have been abandoned and allowed to revert back to forest. Since the time of listing as endangered, there has been a net increase in forestland within the range of the Indiana bat, particularly in the Northeast, but the overall amount of forestland has stagnated over the past decade (Oswalt et al. 2019). A recent analysis of U.S. forestlands also indicates an increase in forest fragmentation and a decrease in the amount of core forests in portions of the bat's range (Oswalt et al. 2019).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Human disturbance of hibernating bats was originally identified as one of the primary threats to the species and remains a threat at several important hibernacula in the bat's range (USFWS 2007). The primary forms of human disturbance to hibernating bats result from recreational caving, cave commercialization (i.e., cave tours and other commercial uses of caves), vandalism, and research-related activities. Disturbance of hibernating Indiana bats seldom results in immediate mortality of bats within the hibernacula, except in cases of vandalism when bats are purposely killed. Impacts of recreational caving on hibernating bats are more difficult to assess and to control compared with commercial uses because commercial caves are generally gated, or have some effective means of controlling access. Many noncommercial Indiana bat hibernacula also have controlled access, but others do not and may be used for recreational caving during the hibernation season. Disturbance of hibernating bats by cavers remains a threat in many hibernacula.

Steady progress has been made in reducing the number of caves and mines in which disturbance threatens hibernating Indiana bats, but the threat has not been eliminated. When biologists throughout the range of the Indiana bat were asked to identify the primary threat at specific hibernacula, “human disturbance” ranked the highest at 38% of Priority 1, 2 and 3 hibernacula combined (USFWS 2007, p. 82) (note that this ranking was prior to the wide-spread effects of WNS). Additional high-priority hibernacula have been protected via fee-simple acquisition and conservation easements and/or gated since the last review, but others remain vulnerable to unauthorized entry and vandalism (see App. A, Tables 1 and 5).

2.3.2.3 Disease or predation: *See the 2007 Plan for additional discussion of diseases and predation (USFWS 2007, page 87).*

White-Nose Syndrome

WNS is considered one of worst wildlife diseases in modern times (WNS 2019). Prior to the ongoing WNS epizootic, there had been little research into the occurrence and effects of diseases in bats in the United States, with the exception of rabies (Weller et al. 2009). Since the last review, WNS has spread across the entire range of the Indiana bat (Figure 2). Since the winter of 2007-2008, millions of bats have died from this devastating disease (USFWS 2012, WNS 2019). If current trends of mortality at affected sites and spread to additional sites continue, WNS threatens to drastically reduce the abundance of many species of hibernating bats in North America in a remarkably short period of time.

As of summer 2019, the causative fungal pathogen, *Pseudogymnoascus destructans* (Pd), has spread to 33 states and 7 Canadian provinces, and the syndrome currently affects 12 species of bat (WNS 2019, Figure 2). WNS infection leads to mortality by resulting in a massive homeostatic imbalance caused by the destruction of wing tissue (Cryan et al. 2010, Cryan et al. 2013), varying degrees of diminished and elevated immunological responses to the infection (Meteyer et al. 2012), and a loss of stored fat needed for overwinter survival (Blehert et al. 2009, Blehert 2012, Gargas et al. 2009). WNS has caused an overall estimated 90% decline in hibernating bat populations within the WNS-affected area and threatens regional or range-wide extinction in multiple species including the Indiana bat (Frick et al. 2010b, Thogmartin et al. 2013, Turner et al. 2011). However, some North American bat species are showing some resistance to WNS and some individuals of highly susceptible species (e.g., little brown bats, *Myotis lucifugus*) are persisting (Cheng et al. 2019, Dobony and Johnson 2018). Cheng et al. (2019) found that little brown bats in persisting populations had increased fat reserves in the autumn (i.e., they tended to be fatter than they had been in pre-WNS years), which may allow them to physically tolerate the high energetic costs of the disease. Low reproductive rates and long lifespan of bats will make any

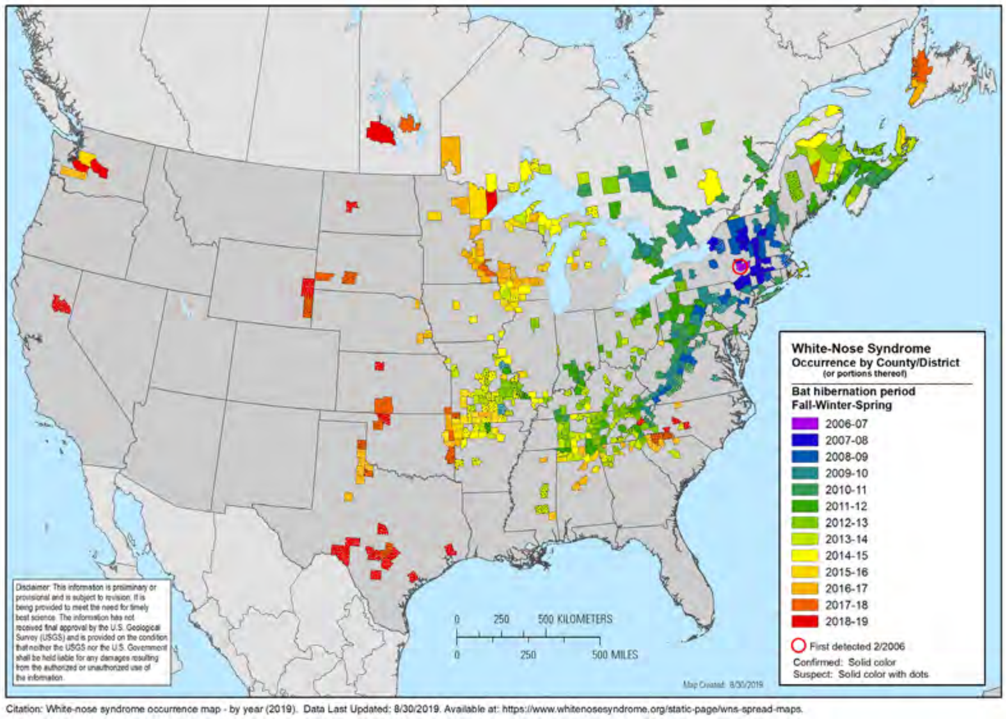

FIGURE 2. WNS occurrence by county/district and year from 2006 to present.
(updated 8/30/2019) (visit https://www.whitenosesyndrome.org/for current map)

possible recovery of Indiana bats and other impacted species extremely slow. In the interim, low bat abundance may have adverse affects on natural ecosystems (O'Keefe et al. 2019) and agriculture (Boyles et al. 2011a).

Management of WNS in bats is a complex challenge similar to other diseases in free-ranging wildlife populations. There is no effective method available to treat bats in the wild or to fully control the spread and persistence of the pathogen in the environment, but many efforts to develop treatments and controls are being researched. Members of local, state, federal, tribal, and nonprofit agencies, as well as an international group of researchers from academic and other institutions, are committed to understanding and managing this epizootic (WNS 2019). To date, management actions for reducing impacts of WNS on bat populations have primarily focused on reducing disturbance of bats through protection of hibernacula, and minimizing risks of human-assisted spread of Pd through managing access to caves, education and development of decontamination protocols.

Some WNS research has been focused on the Indiana bat, but an equal or greater focus has been on other WNS-affected species such as the little brown bat (*M. lucifugus*). While the little brown bat may serve as a surrogate subject for many of the patterns being investigated to understand WNS, some differences between it and the Indiana bat are known and have been taken into consideration.

Applicable WNS research was reviewed and the following list highlights some of the established facts and newly emerging information surrounding WNS, its impacts and potential treatments.

- WNS is caused by Pd, which invades and infects skin of the muzzle, ears, and wings of hibernating bats (Gargas et al. 2009). Growth of Pd is restricted to cold temperatures (0°C–19°C), with maximal growth rates at 13°C–15°C, which is within the range of temperatures typically selected by Indiana bats for hibernation (3°C–8°C). The strain of Pd in North America matches a strain commonly found in western Europe (Wibbelt et al. 2010).

- Field signs of WNS can include excessive or unexplained mortality at a hibernaculum; visible white fungal growth on the muzzle or wings of live or freshly dead bats; abnormal daytime flying during winter months or selecting roost sites closer to hibernacula openings/colder areas than normal; and severe wing damage in bats that have recently emerged from hibernation. Infected bats experience a cascade of physiologic changes that result in weight loss, dehydration, electrolyte imbalances, and death. Occasionally, carcasses of little brown bats by the hundreds to thousands have been found outside affected hibernacula with more found inside, but many affected bats appear to exit hibernacula and die elsewhere on the landscape.

- In New York, WNS initially killed up to 95% or more of bats in affected hibernacula (Turner et al. 2011), but more recently some evidence of WNS resiliency or resistance among little brown bats has been observed (e.g., Dobony and Johnson 2018).

- WNS is a multi-host pathogen that has infected 12 bat species including the Indiana bat, northern long-eared bat (*M. septentrionalis*; federally listed as “threatened” in 2015 predominately due to WNS impacts), little brown bat (under consideration for ESA listing due to WNS impacts), gray bat (*M. grisescens*) small-footed bat (*M. leibii*), southeastern bat (*M. austroriparius*), cave bat (*M. velifer*), long-legged bat (*M. volans*), western long-eared bat (*M. evotis*), Yuma bat (*M. yumanensis*), tri-colored bat (*Perimyotis subflavus*) (formerly known as the eastern pipistrelle; under consideration for ESA listing due to WNS impacts), and big brown bat (*Eptesicus fuscus*) and Pd has been detected on 8 additional bat species.

- Hibernating bats with WNS arouse much more frequently (torpor bouts of only 1-3 days) than normal (Reeder et al. 2012). Frequent arousal of bats leads to depletion of stored fat reserves before the end of winter. Therefore, starvation prior to the spring emergence of insects may be the ultimate cause of death of WNS-affected bats. This pattern is especially apparent during the first several years of a colony being infected with Pd, but after peak impact of the disease in a colony, surviving bats may exhibit arousal frequencies more typical of healthy bats before WNS had arrived (Lilley et al. 2016).

- Transmission of WNS is primarily bat-to-bat, but human-assisted transmission from WNS-affected hibernacula to unaffected hibernacula remains a possibility. Thus, in March 2009, the Service issued a cave advisory recommending that people refrain from entering caves and mines in WNS-affected and adjacent states. The National WNS Response Team revised this advisory to create "Recommendations for Managing Access to Subterranean Bat Roosts" in 2016. The purpose for this guidance is to reduce the potential for people to disturb hibernating bats or inadvertently transport Pd to uncontaminated habitats. (https://www.whitenosesyndrome.org/press-release/updated-cave-advisory-recommendations-for-managing-access-to-subterranean-bat-roosts-to-reduce-the-impacts-of-white-nose-syndrome-in-bats)

- Pd is now present in Washington State (since at least 2016) and WNS has since been confirmed there. While the exact means by which Pd reached the west coast is not known, the long distance to the nearest known occurrence of the fungus at the time and other genetic information suggests that natural movements of bats alone are unlikely to have transmitted it. Now that Pd is in the West, it appears to be expanding its range through more common bat-to-bat transmission. In July 2019, news that Pd may have reached northern California was announced (https://www.wildlife.ca.gov/Conservation/Laboratories/Wildlife-Investigations/Monitoring/WNS).

- If WNS-affected bats survive the potentially fatal wing damage and inflammation that may occur post-emergence, they typically can recover during the summer months (Fuller et al. 2011, Lorch et al. 2013). However, WNS-affected females that survive may have lower reproductive success (e.g., loss of fetus/pup or delayed parturition) (Francl et al. 2012). Bats in WNS endemic areas are generally re-infected with Pd each fall as they enter hibernation, but band recoveries have shown interannual survival of little brown bats for up to 6 years in spite of WNS (Reichard et al. 2014).

- Pd can persist in the soil of caves and mines for long periods of time, potentially causing bats to become repeatedly exposed each year (Lorch et al. 2013, Hoyt et al. 2014, Langwig et al. 2015).

- Langwig et al. (2012) found bats roosting at more humid and warmer temperatures manifested higher fungal loads and greater impacts of WNS and evidence of threshold fungal loads, above which the probability of mortality increased sharply. The local microclimate within hibernacula appeared to be a key determinant in forcing disease. In addition, they found that differences in bat sociality during hibernation can influence the impacts of WNS on their populations. The fraction of little brown bats roosting individually increased (i.e., they became less social) after populations had declined; having fewer neighbors during hibernation reduced their pathogen exposure. Apparently, the total number of individuals within a hibernaculum did not determine transmission intensity (i.e., no evidence of density-dependent transmission), interactions among species appeared to play a relatively minor role in transmission, and clustering behavior facilitated high transmission regardless of colony size. [Langwig et al. are currently leading an effort to better characterize microclimates at Indiana bat hibernacula with remaining populations in hopes of improving our understanding of Pd growth and WNS impacts, which could lead to new or improved treatments and/or management options]

- Current WNS treatment/control efforts are focused on integrated approaches that combat Pd directly or reduce infection and mortality in bats, as well as promoting overall health of bat populations to support resistance to and recovery from WNS. Disease management options that are currently being researched include vaccination to strengthen immune responses to infection, ultraviolet (UV) light to kill Pd, anti-fungal biological agents (e.g., probiotics, chitosan, and bacterially produced volatile compounds), anti-fungal chemical agents (e.g., Chlorine dioxide, decanal, B23 and Polyethylene glycol 8000), and gene manipulation/RNA silencing of Pd (via a partitivirus) (WNS 2019). Some of these treatments have demonstrated effectiveness against Pd in the laboratory; however, field trials to assess applicability, safety, and efficacy in wild bats, as well as potential ecologic side effects, are ongoing and are in various stages of development. The potential for causing adverse effects by introducing various natural and/or synthetic microbicidal agents into natural cave ecosystems remains a significant concern in need of further investigation as does the overall challenge of implementing widespread and/or targeted applications at meaningful scales. Physical manipulation of hibernacula is also being explored as a means to make the environment less conducive to Pd growth (e.g., making them colder) (Zalik et al. 2016). Some have recently suggested that management efforts that increase bats' ability to increase fat stores in autumn (e.g., improving foraging habitat quality and quantity near hibernacula) may help facilitate population persistence (Cheng et al. 2019). In contrast to these approaches, some have suggested that WNS treatments and interventions may be unnecessary, have unintended consequences, or may even exacerbate population declines (Dobony and Johnson 2018, Tuttle 2019).

- Because WNS is not the only cause of bat mortality and population decline, conservation of bat populations will require a holistic approach. In recent years, the Conservation and Recovery Working Group (organized under the National WNS Plan; USFWS 2011a) has sought to minimize potential non-WNS-related stressors to bats by developing and promoting the use of guidelines containing bat-friendly management practices on a variety of topics. For example, beneficial forest management guidelines for WNS-affected bats in the eastern U.S. were recently published (Johnson and King 2018).

- The Service and other state and federal managers/biologists and other researchers and conservation partners have taken many additional actions in response to WNS. A summary of these actions is available at https://www.whitenosesyndrome.org/ under the "What are We Doing?" heading.

Current and Projected WNS Impacts on Indiana Bats

- By 2015, 99% of the range-wide Indiana bat population was hibernating in WNS-affected sites (USFWS 2019a). At present, all known Indiana bat hibernacula fall within the "endemic area" or zone of WNS in North America and are assumed to be WNS-affected.

- The percent change in the range-wide Indiana bat population from 2007 (i.e., since arrival of WNS in NY) to 2019 = -19.2% (see USFWS 2019b).

- States with largest net loss of Indiana bats since 2007 (% decline since 2007): Indiana = -53,220 (-22%), New York = -39,367 (-75%), Missouri = -18,157 (-9%), Kentucky = -15,220 (-21%), West Virginia = -14,125 (-96%), Tennessee =-6,509 (-73%), Ohio = -4,739 (-62%), and Pennsylvania = -1,027 (-99%).

- Thogmartin et al. (2012) developed a stochastic, stage-based population model to forecast the population dynamics of the Indiana bat subject to two different WNS scenarios: "acquired immunity" (AI) and "persistent mortality" (PM). The AI model predicted that by 2022, only 12 of the initial 52 wintering populations would possess wintering populations of >250 females and 3.7% of wintering populations would be above 250 females after 50 years (year 2057) after a 69% decline in abundance to around 64,768 bats. Under the PM scenario, Indiana bats continued to decline after 2022 and reached their nadir by 2035, resulting in a remaining population of 43,000 bats; after that point in time, the underlying positive population dynamic in 3 of the 4 Recovery Units pre-WNS led to a 4% increase over the year 2035 population size. The PM scenario led to 297,000 fewer bats at the end of the projection interval compared to the AI scenario (10,000 fewer bats in the Ozark-Central, 203,000 fewer in the Midwest, 21,000 fewer in the Appalachians, and 63,000 fewer in the Northeast). At the nadir of projections, they predicted regional quasi-extirpation of wintering populations in 2 of 4 Recovery Units while in a third region, where the species is currently most abundant, >95% of the wintering populations were predicted to be below 250 females. Their modeling suggested WNS is capable of bringing about severe numerical reduction in population size and local and regional extirpation of the Indiana bat.

Note: This paper was published just before the discovery of the new P1 hibernaculum in Hannibal, Missouri, Sodalis Nature Preserve, and therefore, it was not included in this modeling.

- Maslo et al. (2017) found that a relatively high annual survival in infected Indiana bats may veil a persistent extinction risk from disease. They conducted a mark–recapture study of Indiana bats at a WNS-positive mine in New Jersey during 2011–2016, and observed a decrease in annual survival of both females and males. They modeled two explanatory mechanisms potentially driving the observed patterns: (1) phased exposure to disease through the spatial spread of the pathogen within the hibernaculum; and (2) cumulative mortality risk from iterative yearly WNS infection. Their results suggest that Indiana bats tolerate a pathogen load prior to onset of infection, leading to a less pronounced population decline than for other susceptible species. However, the cumulative long-term risk of WNS to Indiana bats may be more severe than current population trends suggest. Despite their relatively high survival rates, however, they found strong evidence for a declining trend in this vital rate over time since disease emergence, and both population models stabilized at negative growth. Therefore, the apparent tolerance of Pd by Indiana bats (compared to species such as little brown bats that show precipitous declines in early years of infection) may not be indicative of reduced long-term extinction risk. Subtle cumulative costs, aggregating over time, may insidiously compromise population persistence in ways that take a decade or more to reach their full impact (due to baseline host life expectancy). The selective forces acting on Indiana bats appear to be considerably weaker than those on little brown bats, as evidenced by their more gradual population decline and lower mortality levels in most sites. Therefore, evolutionary processes are unlikely to rescue populations from extirpation even if resistant genotypes are present. However, less pronounced population-level impacts likely render proposed conservation actions more feasible for Indiana bats. These researchers' vital rate sensitivity analysis suggested that modest increases in survival (4–5%) through targeted intervention may return declining populations to stability (k = 1.0).

- Unlike the social changes observed in hibernating little brown bats, Langwig et al. (2012) stated that "the smaller changes in sociality observed in Indiana myotis apparently were not large enough to reduce transmission and disease impact to allow for populations to stabilize, and this puts this species at a high risk of extinction."

- Because of WNS, Indiana bats also have additional energetic demands.
  - Because WNS causes rapid fat depletion, affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Meteyer et al. 2009; Reichard and Kunz 2009) that makes flight (migration and foraging) more challenging.
  - Females that migrate successfully to their summer habitat must partition energy resources between foraging, keeping warm, reproducing, and recovering from the disease.
  - Bats may use torpor to conserve energy during cold, wet weather when insect activity is reduced and increased energy is needed to thermoregulate. However, use of torpor reduces healing opportunities, as immune responses are suppressed (Field et al. 2018).
  - Dobony et al. (2011) and Frick et al. (2010) found evidence of lower reproductive rates in little brown bat maternity colonies in the years immediately after onset of WNS.
  - Francl et al. (2012) observed a reduction in juveniles captured pre- and post-WNS in West Virginia, suggesting similarly reduced reproductive rates.
  - Meierhofer et al. (2018) found higher resting metabolic rates in the spring in WNS-infected (vs. uninfected) little brown bats suggesting additional energy costs during spring in WNS survivors.
- A full bibliography of WNS-related research is available at https://www.whitenosesyndrome.org/static-page/publishing-science

In short, WNS has significantly and rapidly raised the degree of threat against the Indiana bat by causing reductions in its fitness, reproductive success and survival, which has lowered the species' overall recovery potential (see discussion at 3.2).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

No updates since the last review except for the following. Ownership of Indiana bat habitat is probably the primary factor that limits effectiveness of existing regulatory mechanisms. Of the 85 Priority 1 and 2 hibernacula, 16 (19%) are federally owned, 22 (26%) are state-owned, 45 (53%) are privately owned, 1 (1%) is city owned and 1 (1%) has an unknown ownership (USFWS 2019a). ESA protection extends to hibernacula that are privately owned, but recovery options are often limited on private lands. However, it should be noted that most private hibernacula owners are cooperative in efforts to protect Indiana bats.

2.3.2.5 Other natural or man-made factors affecting its continued existence:

Several natural factors are a threat to local bat populations, including flooding and freezing events at winter hibernacula (USFWS 2007). These natural events typically are not widespread, but rather associated with specific flood/freeze-prone sites.

Anthropogenic factors that may affect the continued existence of Indiana bats include numerous environmental contaminants (e.g., organophosphate and carbamate insecticides, oil spills, and PCBs), collisions with man-made objects (e.g., poorly constructed cave gates, vehicles, and wind turbines), non-native invasive species (NNIS), and climate change. For this review, we have focused on four emerging man-made threats: wind energy/turbines, climate change, NNIS, and light pollution.

Wind Energy/Turbines

With growing concerns about climate change, wind energy has become one of the fastest growing sources of renewable energy in the United States (AWEA 2019). The current juxtaposition of wind energy facilities within the range of the Indiana bat may lead to a meaningful impact on the population dynamics of the species, depending upon the magnitude of risk from collision faced by migrating and summer resident bats. Large-scale fatalities of bats (mostly other species) have occurred at multiple wind energy facilities across the range of the Indiana bat and beyond. While much of the emphasis of early wind energy-wildlife research was on bird impacts, more recent studies have found that far more bats than birds are typically killed in the Midwest and Eastern United States (Arnett and Baerwald 2013, O'Shea et al. 2016). Increasingly, monitoring efforts have focused on bat fatalities, and research to understand bat interactions with turbines is providing new insights into this problem. Studies of bat fatalities have shown that turbines have been consistently associated with fatalities of some species of bats particularly, migratory tree-roosting bats including hoary bats (*Lasiurus cinereus*), eastern red bats (*L. borealis*), and silver-haired bats (*Lasionycteris noctivagans*), which make up a large proportion of the bats killed (Arnett et al. 2009, Arnett et al. 2011, Arnett and Baerwald 2013, Arnett et al. 2013, BWEC 2018, Cryan et al. 2014, Ellison 2012, Erickson et al. 2016, Frick et al. 2017, O'Shea et al. 2016, Pruitt and Reed 2018, Schirmacher et al. 2018).

The only well-documented method to reduce fatalities at wind turbines is limiting operation during high-risk periods, such as nocturnal periods of low wind speeds during fall migration (Arnett et al. 2011, Baerwald et al. 2009). Such operational curtailment can reduce bat fatalities by 44–93% (Arnett et al. 2011). The American Wind Energy Association (AWEA) has adopted policies to limit blade movement in low-wind speeds as a voluntary operating protocol that could reduce fatalities up to 30% (AWEA 2017). Studies are underway regarding new methods for possible reductions in fatalities (e.g. acoustic deterrents and smart curtailment).

A total of 13 Indiana bat fatalities has been documented at wind energy facilities in six states (Illinois, Indiana, Iowa, Ohio, Pennsylvania, and West Virginia) since 2009 (Pruitt and Reed 2018). To put this number of fatalities in context, it is important to understand that monitoring of bat fatalities at wind facilities is expensive and difficult. Not all facilities conduct fatality monitoring, and even when monitoring is conducted only a small proportion of dead bats are found during ground searches. We assume that additional Indiana bat mortality has occurred at these facilities and at other wind facilities throughout the range of the species. Additional Indiana bat fatality information and Service guidance is available online (see Pruitt and Reed 2018, USFWS 2011b).

Erickson et al. (2016) used a spatially explicit full-annual-cycle model to investigate how wind turbine mortality and WNS may singly and then together affect population dynamics of Indiana bats. In their simulation, wind turbine mortality impacted the metapopulation dynamics of the species by causing extirpation of some of the smaller winter colonies. In general, effects of wind turbines were localized and focused on specific spatial subpopulations. Conversely, WNS had a depressive range-wide effect. Wind turbine mortality interacted with WNS and together these stressors had a larger impact than would be expected from either alone, principally because these stressors together act to reduce species abundance across the spectrum of population sizes. Their findings illustrated the importance of not only prioritizing the protection of large winter colonies as is currently done, but also of protecting metapopulation dynamics and migratory connectivity. Multiple wind companies are working with the Service to operate their facilities in ways to avoid impacts to Indiana bats. Others have developed habitat conservation plans (HCPs) and received incidental take permits to address unavoidable impacts.

Climate Change

Climate change has already had observable impacts on biodiversity, ecosystems, and the benefits they provide to society. These impacts include the migration of native species to new areas and the spread of invasive species. Such changes are projected to continue, and without substantial and sustained reductions in global greenhouse gas emissions, extinctions and transformative impacts on some ecosystems cannot be avoided in the long term. More frequent and intense extreme weather and climate-related events, as well as changes in average climate conditions, are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities (USGCRP 2018).

Mounting data on the impact of climate change, including extreme events such as drought and flooding, on bats are a cause for concern as recent increases in global temperature represent one fifth, or less, of those expected over the next century (Frick et al. 2019, O'Shea et al. 2016, Rebelo et al. 2010, Sherwin et al. 2013, USGCRP 2018). In combination with WNS, habitat destruction, and other sources of environmental degradation, climate change poses a serious and increasing threat to Indiana bats. During the last 30 years of the 20th century, evidence accumulated suggests that the phenology of organisms, species biogeography and the composition and dynamics of communities are changing in response to a changing climate (Walther et al. 2002).

Climate influences food availability, timing of hibernation, frequency and duration of torpor, rate of energy expenditure, reproduction and development rates of juveniles (Sherwin et al. 2013). Warmer climates may benefit females by causing earlier parturition and weaning of young, allowing more time to mate and store fat reserves in preparation for hibernation. Similarly, earlier gestation and parturition may benefit juveniles by providing a longer growth period prior to the breeding season (Burles et al. 2009). Frick et al. (2010a) supported this finding by showing that little brown bat pups born early in the summer have higher survival and first-year breeding probabilities than those born later in the summer. In contrast, disruption of hibernation, extreme weather events, reduced water availability in arid environments, and the spread of disease may also cause significant mortalities (Adams and Hayes 2008, Adams 2010, Hayes and Adams 2017).

Among the most likely future impacts are changes in the range of migratory species, which recently has been reported in two European bat species (Lundy et al. 2010, Ancillotto et al. 2016) and the Mexican free-tailed bat (*Tadarida brasiliensis*) in the southeastern U.S. (McCracken et al. 2018). Similarly, the common vampire bat (*Desmodus rotundus*) is expected to expand its range northward from Mexico to the southern tip and coastal areas of Texas and potentially eastward to Florida where fossil evidence suggests it previously occurred during the Pleistocene (Gut 1959, Mistry and Moreno-Valdez 2008). Dixon (2011) provided genetic evidence that one lineage of little brown bats (*M. l. lucifugus*) expanded their range northwards after taking refuge in the southeastern U.S. during the last glacial maximum during the Pleistocene. Climate change is also likely to affect the timing of migration. Stepanian and Wainwright (2018) found that Mexican free-tailed bats are migrating to Bracken Cave in Texas roughly two weeks earlier than they were just two decades ago. They now arrive, on average, in mid-March rather than late March, likely in response to insect prey becoming available earlier in the year.

It is not clear how Indiana bat maternity colonies will respond behaviorally to the anticipated changes to their climatically suitable summer habitats. Females show high multi-annual fidelity to roost areas and may migrate up to 673 km (418 miles) (Butchkoski and Bearer 2016), often from different hibernacula, to reach these colonies (Kurta et al. 2002, Winhold and Kurta 2006). Thus, Loeb and Winters (2012) suggested initial shifts may occur at the microhabitat scale with females selecting roosts in more shaded areas than currently observed in many areas and that larger scale range shifts may take more time and locating more climatically suitable areas may result in the temporary or long-term disruption of the colony structure. Loeb and Winters (2012) modeled the current summer maternity distribution of Indiana bats and then modeled future distributions based on four different climate change scenarios. They found that due to projected changes in temperature, the most suitable summer range for Indiana bats would decline and become concentrated in the northeastern U.S. and Appalachian Mountains (Figure 3). The western part of the range (Missouri, Iowa, Illinois, Kentucky, Indiana, and Ohio)– currently considered the heart of Indiana bat maternity range – would become unsuitable under most climates that were modeled. Their model suggested that once average summer (May through August) maximum temperatures reach 27.4°C (81.3°F), the climatic suitability of the area for Indiana bat maternity colonies would decline. Once these temperatures reach 29.9°C (85.8°F), the area is forecast to become completely unsuitable. Interestingly, models by Thogmartin et al. (2012a) also predicted Indiana bats should fair relatively well in the Northeast RU due to increased precipitation coupled with warming winter conditions that may allow for higher reproduction and winter survival there. These studies may have implications for managers in the Northeast and the Appalachian RUs as these areas may serve as climatic refugia for Indiana bats when other parts of the range become too warm.

Changes in temperature may also affect hibernation periods and the availability of suitable hibernacula in the future (e.g., some currently occupied sites may become too warm). Increased variation in climatic extremes raises the possibility of bats emerging from hibernation early or at a greater frequency. That would not only put hibernating bats at risk from depleted energy stores, but could also affect the birth and survival of pups. Resources, especially insect prey, may be limited or variable during

FIGURE 3. Forecasted climatically suitable areas for Indiana bat maternity colonies under four climate scenario/global circulation model scenarios and three time periods. (from Loeb and Winters 2012)

periods of early arousal from hibernation. Thus, climate change will likely also affect the future distribution of suitable hibernacula (Humphries et al. 2002). Therefore, finding suitable maternity sites may be a function of finding new hibernacula, and summer and winter range shifts may occur concurrently. Furthermore, it remains uncertain as to how climate change may influence and interact with future WNS infection rates of Indiana bats (e.g., some "cold" sites may become more suitable to Pd growth if hibernacula microclimates warm).

At least some of the world's forested ecosystems already may be responding to climate change and raise concern that forests may become increasingly vulnerable to higher background tree mortality rates and die-off in response to future warming and drought, even in environments that are not normally considered water-limited (Allen et al. 2010, Zhang et al. 2010). Climate change could have large impacts on tree species in the eastern United States that are commonly used by Indiana bats as roost trees. For example, of the 134 eastern U.S. tree species modeled by Iverson et al. (2008), approximately 66 species would gain habitat and 54 species would lose at least 10% of their suitable habitat by year 2100 from climate change. They predicted that most of the tree species' suitable habitat in the eastern U.S. is expected to generally move northeast, up to 800 km (assuming the hottest climate scenario and the highest emissions trajectory) and that the spruce-fir zone would retreat up the Appalachian mountain chain while southern oaks and pines advance northward. Somewhat surprisingly, in an abundance study of 86 eastern U.S. tree species over time, Fei et al. (2017) found that more tree species had experienced a westward shift (73%) than a poleward shift (62%), which they attributed to changes in moisture availability.

The composition of tree species in eastern hardwood forests are expected to change due to longer growing seasons, shorter/warmer winters, increased extreme precipitation events, changes in soil moisture and drought, enhanced fire risk, and intensified biological stressors. Model results project that species currently near their northern range limits in the region may become more abundant and more widespread under a range of climate futures. At the same time, observed trends have suggested that forest species may be more prone to range contraction at southern limits and less able to expand ranges northward to track climate change (Brandt et al. 2015).

Questions about the degree to which negative effects of climate change will be offset by positive effects on other life history features, whether population losses in one part of the species' range will be offset by gains in other regions, and the degree to which bats can adapt by adjusting their behavioral, ecological, and phenological characteristics remain largely unanswered. Further monitoring and research is needed to better understand the impacts of climate change on Indiana bats and their habitat.

Non-Native and Invasive Species

Biological invasions by non-native invasive species (NNIS) are one of the most significant environmental threats to the maintenance of natural forest ecosystems in North America and elsewhere (Liebhold et al. 1995). Invasive forest insect pests (and fungal diseases) have the ability to cause massive mortality events across vast areas. Apart from the staggering economic losses attributed to exotic insect pests such as the gypsy moth (*Lymantria dispar L*), emerald ash borer (EAB; *Agrilus planipennis*) and Asian long-horned beetle (*Anoplophora glabripennis*)(Wallner 1997, Aukema et al. 2011), these pests can have devastating adverse impacts on the health, productivity, species richness and overall biodiversity of eastern U.S. forests and the bat communities dependent on them. The impacts of NNIS to Indiana bats specifically are not well documented, but are presumed to be significant in some portions of the species' range.

The EAB is a non-native, invasive, phloem-feeding beetle that was inadvertently introduced into Michigan in the late 20th century and has since spread and killed hundreds of millions of native ash (*Fraxinus*) trees and cost municipalities, property owners, nursery operators and the forest products industry hundreds of millions of dollars (EABIN 2019). Canopy gaps and accumulation of coarse woody debris caused by dying ash trees have cascading impacts on forest communities, and have caused shifts in understory vegetation that enhance growth of NNIS, increase successional rate to shade-tolerant species (i.e., mesophication), alter soil chemistry and soil-dwelling and herbivorous arthropod communities, and alter bird foraging behavior, abundance, and community composition. (Dolan and Kilgore 2018, Klooster et al. 2018).

Impacts of EAB-induced ash mortality on Indiana bats have not yet been quantified. Dying ash trees along the EAB invasion front may temporarily benefit some Indiana bat colonies by providing an abundance of available roosting habitat. However, the long-term loss of ash species is more likely to be detrimental by eliminating the future availability of ash species as suitable roost trees and causing a decline in insect diversity and abundance. While Indiana bats can roost in many different tree species (USFWS 2007), they have exhibited a preference for some tree species (Kurta et al 2002). For example, Kurta et al. (1996), demonstrated a preference by Indiana bats for green ash (*F. pennsylvanica*) over silver maple (*Acer saccharinum*) in Michigan, and Carter (2003) showed that these bats chose green ash and pin oak (*Quercus palustris*) more often than expected based on availability in Illinois. Therefore, adverse impacts are likely to be greatest in portions of the Indiana bat range where ashes were/are a primary source of roost trees (e.g., southern Michigan). A significant loss of roost trees may fragment a maternity colony and reduce reproductive success (Kurta et al. 2002). Effects of EAB may be similar to those caused by chestnut blight and Dutch-elm disease.

Other NNIS that negatively impact the quality of Indiana bat habitat include plants such as Asian bush honeysuckles (*Lonicera* spp.), Japanese honeysuckle (*Lonicera japonica*), Russian olive (*Elaeagnus angustifolia*), Oriental bittersweet (*Celastrus orbiculatus*), and Kudzu (*Pueraria montana* var. *lobata*), which can outcompete and choke out native trees and thereby alter the long-term succession of the forest. Non-native plants may also reduce the amount of insect biomass available to bats and other insectivores and disrupt terrestrial and aquatic food webs (Tallamy 2004, Tallamy et al. 2010, McNeish et al. 2017). Numerous other NNIS ranging from fungi to exotic earthworms impact forest dynamics within the Indiana bat range, but few are well studied or easily controlled at present (Brack et al. 2013, Welch and Leppanen 2017). Further research and strategic eradication and control efforts of NNIS are encouraged as they indirectly support the maintenance of quality habitat for Indiana bats.

Artificial Lighting/Light Pollution

The rapid global spread of artificial light at night is causing unprecedented disruption to ecosystems, but its biological impacts have only recently been recognized (Rowse et al. 2016). Artificial lighting attracts and repels animals in taxon-specific ways and may affect their physiological processes. Being nocturnal, bats are among the taxa most likely to be affected by light pollution. Bats may react to artificial lighting in a number of ways, including deserting roosts which are lit, delaying roost emergence thus shortening time available for foraging, and avoiding drinking, foraging or commuting in lit areas (Haddock et al. 2019, Russo et al. 2017, Stone et al. 2009, Stone et al. 2015). Artificial lighting, therefore, has potentially serious conservation consequences. It has been associated with lower colony size in some species suggesting continued use of artificial lighting could negatively impact local populations (Kurvers and Hölker. 2015, Stone et al. 2015).

At present, very little information is available as to what impacts light pollution may be having on Indiana bat populations or to what degree. However, we can gain some insight from surrogate species of insectivorous bats and from anecdotal accounts of Indiana bat behavior. For example, from his study of radio-tagged Indiana bats near the Indianapolis Airport, Sparks (2003) concluded that the most heavily used foraging areas were in the middle of the darkest regions of his study area and that the effects of artificial light were in need of additional study. Others have noted that bat responses to lighting are species-specific and reflect differences in flight morphology and performance. For example, fast-flying aerial hawking species frequently feed around street lights, and relatively slow-flying bats (like the Indiana bat), that forage in more confined spaces tend to be more light-averse (Rydell and Baagøe 1996, Rowse et al 2016). Additional research on the potential impacts of artificial lighting on Indiana bats is needed particularly as lighting technologies are rapidly changing, with the increased use of light-emitting diode (LED) street lamps (Stone et al. 2012).

2.4 Synthesis

Since the last review, WNS has caused severe declines in many Indiana bat populations and has rapidly erased decades worth of population gains. At present, very few healthy populations remain in the Northeast and Appalachia RUs. WNS impacts are expected to continue across the range for years to come as are other ongoing threats (e.g., climate change, NNIS, and wind turbines) to the bats and their habitats. Given the species' limited reproductive potential, populations are not likely to rebound in the near term. In short, over the past decade, WNS has increased the Indiana bat's risk of extinction as the resiliency, redundancy, and representation of its remaining populations have declined (see Smith et al. 2018).

The majority of the Indiana bats' population-based, and protection-based recovery criteria have not yet been achieved. At this time, only one of the three reclassification criteria, Criterion 2, has been met (Table 1, see Appendix A for details). Reclassification Criteria 1 and 3 have not been met. Therefore, identified threats have not yet been sufficiently reduced and stable population growth at the most important hibernacula has not been sustained for long enough for the species to be reclassified (i.e., downlisted) as "threatened."

Although Delisting Criterion 2 is being numerically met, Delisting Criteria 1 and 3 have not been met. Therefore, additional recovery efforts, such as protection of additional Priority 2 hibernacula are needed (i.e., Delisting Criterion 1), and positive population trends at more P1A sites (i.e., Delisting Criterion 3) are needed (Table 1, see Appendix A for details).

Based on the Service's review, the Indiana bat should remain listed as 'endangered' because the species status has not improved since listing and new and old threats have not been sufficiently ameliorated. We reached this conclusion by using the most current population data from 2019 (USFWS 2019a, USFWS 2019b) (in conjunction with the recovery criteria set forth in the 2007 Plan (USFWS 2007, see Appendix A)) and a review of new information on threats.

3.0 RESULTS

3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X_ **No change is needed**

3.2 New Recovery Priority Number: 5

The Recovery Priority Number (RPN) remains at "5" following the guidelines in Federal Register notice 48(184) FR 43098-43105 (September 21, 1983). An RPN of "5" means that a species has a high degree of threat and a low recovery potential.

Brief Rationale: In the previous review, the RPN was changed from "8" to "5" due to factors associated with WNS. The ongoing WNS epizootic persists and thus the "degree of threat" to the Indiana bat remains "high." The high category means "extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction" whereas the moderate category means "the species will not face extinction if recovery is temporarily held off although there is continual population decline or threat to its habitat." Prior to emergence of the WNS threat, the Service considered the Indiana bat to have a "high" recovery potential (i.e., biological/ecological limiting factors and threats were well understood and intensive management was not needed and/or recovery techniques had a high probability of success). The Service now considers the Indiana bat to have a "low" recovery potential, because we currently have very limited ability to alleviate the threat posed by WNS. Preliminary/experimental management techniques/efforts will likely be intensive with an uncertain probability of success. At this time, the Service is not aware of any significant "conflict" that would warrant adding a “c” designation to the Indiana bat’s RPN. Therefore, according to Table 3 in 48(184) FR 43098-43105 (above), a species having a “high” degree of threat, a “low” recovery potential and no conflict should be assigned a recovery priority number of “5.” The RPN can be changed at any time and changes will be considered as our understanding of WNS and its management improves.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Future revisions to the Indiana Bat Recovery Plan should addresses WNS and other longstanding and emerging threats. Although WNS was not identified/addressed as a threat in the 2007 Plan, the population-based recovery criteria in the 2007 Plan are likely to remain as one of the most effective means of assessing the WNS-related mortality and potential recovery from WNS in the future.

The Service has a long and successful record of collaborating with many state and federal partners to survey and monitor Indiana bat populations at their hibernacula and these should continue.

Additional efforts to monitor known maternity colonies and to discover additional ones on the summer landscape is needed particularly in regions hardest-hit by WNS. In some areas, aerial tracking of radio-tagged females during the spring migration is likely to be the most efficient means of locating and subsequently conserving new maternity colonies (see Roby et al. 2019).

We also recommend that the Service and our partners support and take actions to implement the North American Bat Monitoring Program (NABat; https://www.nabatmonitoring.org/).

Additional research to better understand the impacts of WNS on the species and the larger bat community is warranted as well as research, funding and strategic implementation of practicable management actions should they prove successful at improving Indiana bat survival and reproduction. In the interim, we should continue to pursue tried and true management approaches of fostering high reproductive success and survival, such as providing for the continual recruitment of large-diameter snags in landscapes with a variety of well-connected forested habitat types and protecting hibernating bats from indiscriminate alterations to hibernacula, unauthorized human disturbance, and excessive research-related activities (see Boyles 2017).

We concur with Ingersoll et al. (2016) who stated… “Although research on bat responses to WNS must proceed apace in hopes of mitigating the most severe effects of this disease, renewed management attention to other threats may hold more immediate promise for reducing further declines. Reducing such threats could alleviate synergistic or interacting effects that may be compounding threats to bats, ameliorate other stressors to make bats more resilient to WNS, and enable immediate intervention on threats more amenable to management than WNS." In other words, effective Indiana bat conservation will require further research to mitigate impacts of WNS, and renewed attention to other threats to the species.

To be most effective at alleviating threats, we will also need to continue public education/outreach efforts about WNS, wind turbine conflicts, climate change, NNIS, light pollution and other threats to bats and pursue opportunities to share how others can help bats (e.g., Johnson and King 2018).

The Service also needs to make a more concerted effort to reach out to public and private stakeholders to improve understanding of our legal responsibilities (e.g., ESA) and mutual natural resource goals (see D'Acunto and Zollner 2019).

It is also apparent from this review that additional attention should be placed on securing permanent/long-term protection of additional Priority 1 and Priority 2 hibernacula. Several Priority 1 hibernacula would satisfy Reclassification Criterion 1 if their cave/mine entrances were gated or if appropriate buffer zones were delineated and protected.

We also recommend that the Service continue to pursue some of the highest priority recovery actions identified within the 2007 Plan that have yet to be completed in an effort to improve or refine our current understanding of the Indiana bat's population status and progress towards recovery (e.g., develop site-specific hibernacula management plans at high priority hibernacula, develop standardized methods for characterizing and monitoring hibernacula microclimates, and determine beneficial land management practices for maternity colonies).

In order to successfully implement the recovery actions outlined in the 2007 Plan across the species' range, the Service will need to continue to improve and maintain a significant, ongoing level of coordination with state, federal and private agencies, bat surveyors, the caving and academic communities, and other conservation and research partners to further develop and maintain the Service's existing hibernacula and maternity colony databases.

Finally, to ensure we are obtaining reliable information about Indiana bat summer occurrences, the Service will need to continue to 1) update and improve our range-wide presence/probable absence survey protocols, 2) work with others to test and approve the accuracy of new automated acoustic ID software versions and 3) provide training on proper survey techniques and interpretation and reporting of survey results.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the INDIANA BAT (*Myotis sodalis*)

Current Classification: **Endangered**

Recommendation resulting from the 5-Year Review:

___ Downlist to Threatened
___ Uplist to Endangered
___ Delist
_X_ No change is needed

Appropriate Recovery Priority Number: __5___

Review Conducted By: R. Andrew King, Indiana ES Field Office, Bloomington, IN

FIELD OFFICE APPROVAL:
Lead Field Supervisor, Fish and Wildlife Service

Approve Scott E. Pruitt Date 9/30/19

Scott E. Pruitt,
Indiana ES Field Office,
Bloomington, IN

APPENDIX A:

Status of Recovery Criteria from the Indiana Bat Draft Recovery Plan: First Revision (USFWS 2007)

(as of September 2019)

The recovery criteria are presented in quotations (and blue text) and their supporting text from the Plan (USFWS 2007) is shown in italics. Current status of each criterion is summarized within yellow text boxes with supporting tables and figures.

Reclassification Criteria (RC):

"Reclassification Criterion 1: Permanent protection at 80 percent of all Priority 1 hibernacula in each Recovery Unit, with a minimum of one Priority 1 hibernaculum protected in each unit." (In the Appalachia and Northeast Recovery Units, 80-percent protection would translate to 100-percent protection because these units have two and three Priority 1 hibernacula, respectively.)

Greater than 80 percent of the Indiana bat population hibernates in the Priority 1 hibernacula. Thus, by achieving this criterion, a significant proportion (but not necessarily 80%) of the Indiana bat range-wide population will be protected from disturbance in its winter habitat and from anthropogenic changes to the thermal regime of the hibernacula. Protection of hibernacula includes conserving a buffer zone around each hibernaculum and restoration of hibernacula if necessary.

Protection of hibernacula was and remains a primary focus of the recovery plan for this species (U.S. Fish and Wildlife Service 1983). To be considered protected, the hibernacula can be publicly or privately owned, but there must be a long-term voluntary landowner agreement, such as a stewardship plan, conservation easement, habitat management plan, or memorandum of agreement that protects the hibernacula in perpetuity. Protection of hibernacula includes assuring minimal disturbance to the bats during the season of hibernation (e.g., only authorized surveys or other conservation-related activities). While it is advisable to avoid disturbance between mid-August and mid-May, entry to hibernacula should be prohibited between September 1 to April 30 in most of the species' range, and September 1 to May 31 in the northern portion of the range (Connecticut, Massachusetts, Michigan, New York, and Vermont).

The protection of hibernacula also involves conserving a buffer zone around each hibernaculum to prevent adverse impacts to the physical structure or microclimate. In general, conservation of buffer zones ensures the elimination of the negative effects of disturbances such as land clearing or development. Specific management plans for each P1 hibernaculum will be developed (see Recovery Action 1.1.1.2.2 and 1.1.1.2.3) that include recommendations on size and management actions for a buffer zone.

Status of Reclassification Criterion 1 (as of Aug. 2019)**: NOT ACHIEVED.**
Currently, none of the four Recovery Units has successfully achieved adequate protection of 80% or more of their respective Priority 1 hibernacula (see Table 1). This criterion directly addresses threats at the most important hibernacula and ensures that they be addressed throughout the range by the per Recovery Unit requirement (i.e., redundancy).

[Previous Status: In 2009, none of the four RUs had achieved this criterion.]

TABLE 1. Status of Priority 1 hibernacula in regards to Reclassification Criterion 1. Responses highlighted in bright green represent positive changes/increased protection since the last 5-year review in 2009.

Recovery Unit & Priority 1 Hibernacula Names	Priority 1 Subcategory	Ownership	Has Long-term/ Permanent Protection Been Secured?	Is Wintertime Human Disturbance Physically Controlled?	Is Human Disturbance of Hibernating Bats still a Threat in this Hibernaculum?	Are Surface Buffer Zones Being Conserved/ Protected?	Pass/Fail (80% of hibernacula must pass for an RU to "pass")
Ozark-Central (n= 9)							FAIL **(67% pass)**
Magazine Mine, IL	A	Private	Yes	Yes (gate)	No	Yes	Pass
Bat, MO	B	State	Yes	Yes (gate)	No	Yes	Pass
Brooks, MO	B	Federal	Yes	No	Yes	No	Fail
Copper Hollow Sink, MO	B	State	Yes	No	Yes	No	Fail
Great Scott, MO	B	State	Yes	Yes (gate)	No	Yes	Pass
Onyx, MO	B	State	Yes	Yes (gate)	No	Yes	Pass
Pilot Knob Mine, MO	B	Federal	Yes	No	Yes	Yes	Fail
Ryden, MO	B	State	Yes	Yes (gate)	No	Yes	Pass
Sodalis Nature Preserve, MO	A	City	Yes	Yes (gates)	No	Yes	Pass
Midwest (n=13)			\				FAIL **(69% pass)**
Batwing, IN	B	State	Yes	Yes (gate)	No	Yes	Pass
Coon, IN	A	Private	Yes	No	Yes	Yes	Fail
Grotto, IN	A	Private	Yes	Yes (fence)	No	Yes	Pass
Jug Hole, IN	A	Private	Yes	No	Yes	Yes	Fail
Ray's, IN	A	Private	No	No	Yes	No	Fail
Twin Domes, IN	A	State	Yes	Yes (fence)	No	Yes	Pass
Wyandotte, IN	A	State	Yes	Yes (new gate)	No	Yes	Pass
Bat, KY	A	State	Yes	No	Yes	Yes	Fail
Coach, KY	B	Private	Yes	Yes (gates)	No	Yes	Pass
Dixon, KY	B	Federal	Yes	Yes	No	Yes	Pass
Line Fork, KY	B	State	Yes	Yes	No	Yes	Pass
Long, KY	B	Federal	Yes	Yes (gate)	No	Yes	Pass
Saltpeter, KY	A	State	Yes	Yes (gates)	No	Yes	Pass
Appalachia (n=2)							FAIL **(50% pass)**
White Oak Blowhole, TN	A	Federal	Yes	Yes (gate)	No	Yes	Pass
Hellhole, WV	A	Private	No	Yes (fence)	Yes	No	Fail
Northeast (n=3)							FAIL **(67% pass)**
Barton Hill, NY (see sec. 2.3.2.1)	A	Private	Yes	Yes	Yes	Yes	Fail
Williams Hotel Mine, NY	B	Private	Yes	Yes	No	Yes	Pass
Walter Wms. Pres. Mine, NY	A	State	Yes	Yes	No	Yes	Pass

"Reclassification Criterion 2: A minimum overall population estimate equal to the 2005 population estimate of 457,000."

Because of lack of information on the species' demographic parameters, it is not possible to calculate a minimum viable population number for this species or to justify biologically an overall numerical population goal. Furthermore, a low population number was not one of the reasons that the bat was originally listed as endangered; the species was listed because of vulnerability to human and environmental disturbance and subsequent large-scale declines (Barbour and Davis 1969; Mohr 1972; Greenhall 1973; L. Pruitt, pers. comm., 2006). Species experts consider the 2005 population estimate of 457,000 to be an adequate number for recovery as long as the threats to the species have been alleviated (e.g., RC 1), the population growth rate has been positive (e.g., RC 3), and there is a range-wide distribution that incorporates the need for redundancy, resiliency, and representation (i.e., achieved via recovery unit-based criteria).

At the present time, hibernaculum counts comprise the only data that can be used as a basis for reclassification and delisting of the Indiana bat. Given the progress that has been made to date in securing hibernacula and in analyzing information needs for the species, and given the recent apparent upward trends in species numbers, reclassification on the basis of hibernaculum data represents an acknowledgement of progress made towards recovery.

NOTE: As mentioned above, at the time RC2 was written in 2007, the Service and species experts believed the 2005 population estimate of 457,000 to be an adequate number for recovery as long as the threats to the species have been alleviated (e.g., RC1), the population growth rate has been positive (e.g., RC3), and there is a range-wide distribution that incorporates the need for redundancy, resiliency, and representation (i.e., achieved via recovery unit-based criteria). Since then, we have had to recalculate our previous range-wide population estimates to account for additional bats discovered at previously unknown hibernacula (e.g., added 197,000 bats to previous survey periods following discovery of bats at Lime Kiln Mine/Sodalis Nature Preserve in MO) and to add/subtract bats at sites where more accurate estimates became available (e.g., Pilot Knob Mine in MO). At present, the overall population estimate for 2005 stands at approximately 623,000 bats (not 457,000) and the 2019 estimate is 537,000 bats. So, while the current population stands at approximately 80,000 bats above the previously set 457,000 benchmark, it also represents an 18% decline from where the population actually stood in 2005.

Status of Reclassification Criterion 2 (as of of Aug. 2019)**: ACHIEVED.**
In January and February 2019, significant new Indiana bat population data was obtained during biennial winter surveys of hibernacula across the species' range. The Service's Indiana Field Office coordinated with all bat surveyors, collated the new data, and calculated a 2019 population estimate (Tables 2 and 3; USFWS 2019b). The 2019 population estimate is approximately 537,000 Indiana bats. Because the 2019 estimate is > 457,000 bats, the numerical requirement of Reclassification Criterion 2 has been achieved.

RC2 sets a min. population estimate that must be met before we would consider the species eligible to reclassify to "threatened" status. The range-wide population estimate for the Indiana bat is generated every 2 years, and represents the Service's single most important and straightforward means of indirectly assessing how well all threats to the species are being reduced or mitigated on an overall basis.

[Previous Status: In 2009, the range-wide population was approx. 612,000 bats; the criterion was met.]

TABLE 2. 2019 range-wide population estimate for the Indiana bat by USFWS Region (USFWS 2019b).

USFWS Region	State	2011	2013	2015	2017	2019	% Change from 2017	% of 2019 Total
Region 2	**Oklahoma**	**13**	**5**	**5**	**8**	**8**	**0.0%**	**0.0%**
Region 3	Missouri	212,942	214,453	216,289	217,884	195,157	-10.4%	36.3%
	Indiana	225,477	226,572	185,720	180,611	184,848	2.3%	34.4%
	Illinois	57,212	66,817	69,924	81,143	78,403	-3.4%	14.6%
	Ohio	9,870	9,259	4,809	2,890	2,890	0.0%	0.5%
	Michigan	20	20	20	20	20	0.0%	0.0%
	Total	**505,521**	**517,121**	**476,762**	**482,548**	**461,318**	**-4.4%**	**85.9%**
Region 4	Kentucky	70,626	62,018	64,599	58,057	55,946	-3.6%	10.4%
	Tennessee	12,887	15,569	4,952	2,567	2,397	-6.6%	0.4%
	Arkansas	1,206	856	1,398	1,722	2,749	59.6%	0.5%
	Alabama	261	247	90	85	90	5.9%	0.0%
	North Carolina	1	1	0	0	0	0.0%	0.0%
	Georgia	0	0	0	1	0	-	-
	Total	**84,981**	**78,691**	**71,039**	**62,432**	**61,182**	**-2.0%**	**11.4%**
Region 5	New York	15,654	17,772	15,564	12,693	13,412	5.7%	2.5%
	West Virginia	20,296	3,845	2,373	1,076	620	-42.4%	0.1%
	Virginia	863	632	601	495	648	30.9%	0.1%
	New Jersey	409	448	193	118	79	-33.1%	0.0%
	Pennsylvania	516	120	24	23	11	-52.2%	0.0%
	Vermont	61	53	53	19	19	0.0%	0.0%
	Total	**37,799**	**22,870**	**18,808**	**14,424**	**14,789**	**2.5%**	**2.8%**
Range-wide Total:		**628,314**	**618,687**	**566,614**	**559,412**	**537,297**	**-4.0%**	**100.0%**
	2-yr. Net Change:		**-9,627**	**-52,073**	**-7,202**	**-22,115**		
	2-yr. % Change:		-1.5%	-8.4%	-1.3%	-4.0%		

TABLE 3. 2019 range-wide population estimate for the Indiana bat by Recovery Unit (USFWS 2019b).

IBat Recovery Unit	State	2011	2013	2015	2017	2019	% Change from 2017	% of 2019 Total
Ozark-Central	Missouri	212,942	214,453	216,289	217,884	195,157	-10.4%	36.3%
	Illinois	57,212	66,817	69,924	81,143	78,403	-3.4%	14.6%
	Arkansas	1,206	856	1,398	1,722	2,749	59.6%	0.5%
	Oklahoma	13	5	5	8	8	0.0%	0.0%
	Total	**271,373**	**282,131**	**287,616**	**300,757**	**276,317**	**-8.1%**	**51.4%**
Midwest	Indiana	225,477	226,572	185,720	180,611	184,848	2.3%	34.4%
	Kentucky	70,626	62,018	64,599	58,057	55,946	-3.6%	10.4%
	Ohio	9,870	9,259	4,809	2,890	2,890	0.0%	0.5%
	Tennessee	1,791	2,369	2,401	1,587	1,561	-1.6%	0.3%
	Alabama	261	247	90	85	90	5.9%	0.0%
	SW Virginia	307	214	137	70	119	70.0%	0.0%
	Michigan	20	20	20	20	20	0.0%	0.0%
	Georgia	0	0	0	1	0	-	-
	Total	**308,352**	**300,699**	**257,776**	**243,321**	**245,474**	**0.9%**	**45.7%**
Appalachia	West Virginia	20,296	3,845	2,373	1,076	620	-42.4%	0.1%
	E. Tennessee	11,096	13,200	2,551	980	836	-14.7%	0.2%
	Pennsylvania	516	120	24	23	11	-52.2%	0.0%
	Virginia	556	418	464	425	529	24.5%	0.1%
	North Carolina	1	1	0	0	0	-	-
	Total	**32,465**	**17,584**	**5,412**	**2,504**	**1,996**	**-20.3%**	**0.4%**
Northeast	New York	15,654	17,772	15,564	12,693	13,412	5.7%	2.5%
	New Jersey	409	448	193	118	79	-33.1%	0.0%
	Vermont	61	53	53	19	19	0.0%	0.0%
	Total	**16,124**	**18,273**	**15,810**	**12,830**	**13,510**	**5.3%**	**2.5%**
Range-wide Total:		**628,314**	**618,687**	**566,614**	**559,412**	**537,297**	**-4.0%**	**100.0%**
	2-yr. Net Change:		**-9,627**	**-52,073**	**-7,202**	**-22,115**		
	2-yr. % Change:		-1.5%	-8.4%	-1.3%	-4.0%		

"Reclassification Criterion 3: Documentation using statistically reliable information that indicates important hibernacula within each Recovery Unit, on average, have positive annual population growth rates and minimal risk of population declines over the next 10-year period. Using population estimates from the most recent 10 years (i.e., five sequential biennial surveys), linear regression lines will be calculated for each of the most populous hibernacula and/or hibernaculum complexes (P1s and largest P2s) that collectively account for 80% or more of their respective Recovery Units' estimated total number of bats. Each hibernaculum's regression line and 90% confidence interval will be projected through the most recent five data points and extended into the next 10-year period as a means of estimating future potential population levels. For reclassification, the slope of each hibernaculum's regression line must be positive or neutral and the lower bound of the 90% confidence interval must not fall below the minimum threshold set at 90% of the hibernaculum's 2005 population estimate by the end of the predicted 10-year period (see Figure 15)."

In other words, a 90% confidence interval for the regression extended forward 10 years will need to sit above 90% of a given hibernaculum's 2005 population estimate.

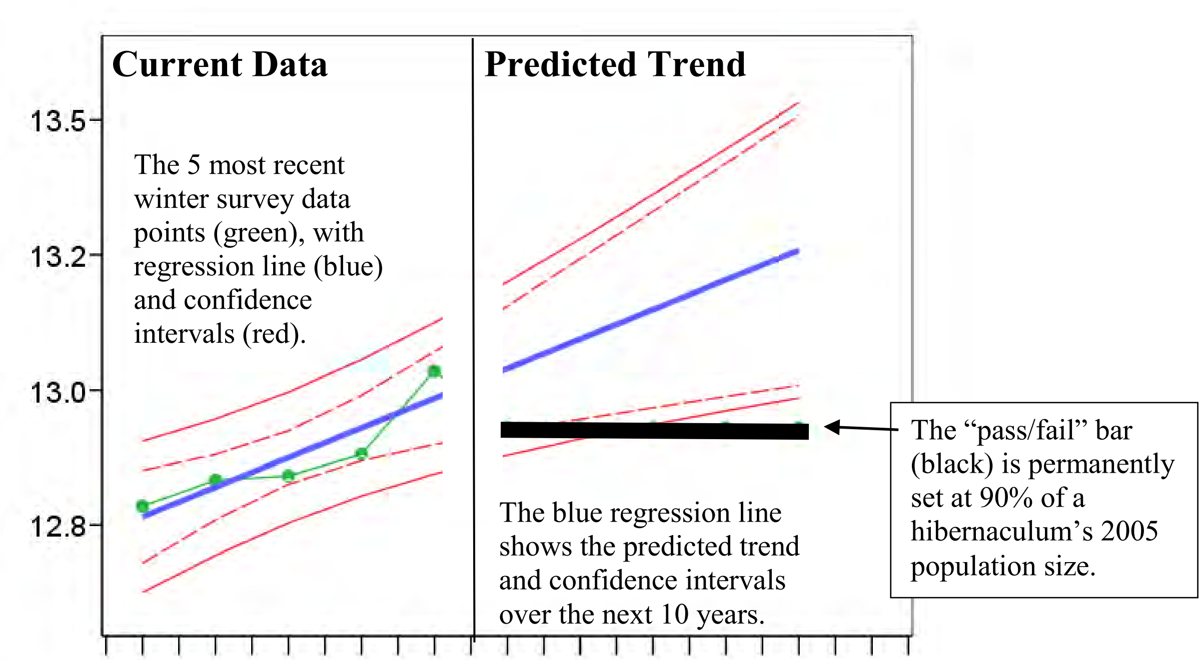


Figure 15. *Example regression (blue line) and confidence intervals (red; 90% - broken lines, 95% solid lines) using a 10-year data set that would "pass" Reclassification Criterion 3. Note: The Y axis is population size in natural logarithms so that constant growth becomes a straight line, instead of an exponential curve. The X axis is the year. The left side shows the 10-year data set that generates the regression line and confidence intervals. The right side is the continuation of the regression line and confidence intervals 10 years into the future, and compares the predicted trend (blue line) to the "pass/fail" bar, which is permanently set at 90% of a hibernaculum's 2005 population size.*

The data in Figure 15 would pass Reclassification Criterion 3 because the 90% confidence interval around the projected regression line rises above the bar by the end of the 10-year period. Therefore, we have a relatively high level of confidence that this example hibernaculum would continue to maintain a positive population growth rate and would not drop below the pass/fail bar over the next 10 years.

Meeting Reclassification Criterion 3 requires a positive population growth rate within each RU and allows only a small statistical possibility of a future population decline to a size that is at or below the 2005 population level. Criterion 3 complements Criterion 2, which requires the population to be larger (i.e., to be estimated to be larger) than the 2005 population estimate. Criterion 3 is a conservative extension of this requirement because it also requires that each hibernaculum's predicted estimate of population size 10 years after downlisting be so far above its 2005 population estimate that a 90% confidence limit on the predicted estimate must also be greater than 90% of each hibernaculum's 2005 population estimate.

The 80% requirement within Reclassification Criterion 3 allows some P1 hibernacula or hibernaculum complexes in the Midwest RU to have less strong trends. In the Northeast and Appalachian Mountain RUs, which have few P1 hibernacula, the 80% requirement will require that all of their Priority 1 hibernacula meet the trend requirement, because even one hibernaculum with a lower trend will drop the proportion in the region below the 80% mark. For the Ozark-Central RU to meet this criterion with a reasonable confidence level, the estimated number of bats hibernating in Pilot Knob Mine will need to be confirmed as previously discussed. Because Pilot Knob Mine is assumed to account for the majority of hibernating bats in the Ozark-Central RU, an inability to accurately estimate numbers there could be an obstacle to future downlisting. Again, we propose that Pilot Knob Mine's estimated population remain in future regional and range-wide population estimates and count towards meeting the recovery criteria unless improved survey techniques and/or field tests for improved accuracy indicate otherwise. [**UPDATE**: An internal survey for bats was conducted in Pilot Knob Mine in 2008 and population estimates where adjusted accordingly (downward)]

In 2005, approximately 80% of each RUs bats overwintered in a combined total of 12 hibernacula and hibernaculum complexes that would each need to pass Reclassification Criterion 3. The current list of hibernacula needing to pass this criterion includes:

- *Ozark-Central RU – Pilot Knob Mine (MO), Magazine Mine (IL), and Great Scott Cave (MO)*
- *Midwest – Wyandotte Complex (IN; includes Bat Wing, Jug Hole, Twin Domes, and Wyandotte caves), Ray's Cave (IN), Coon-Grotto Complex (IN) and Bat Cave (Carter Co., KY)*
- *Appalachian Mountain – Hellhole Cave (WV) and White Oak Blowhole Cave (TN)*
- *Northeast – Ulster County Complex (NY; includes Walter Williams Preserve Mine and Williams Hotel Mine), Barton Hill Mine (NY), and Jamesville Quarry Cave (NY).* [NOTE: this list of hibernacula will be updated in the final recovery plan].

Based on the five most recent winter survey data points (1997, 1999, 2001, 2003, and 2005), five out of these 12 hibernacula/complexes currently would pass this criterion and several others are likely to pass it over the next one or two survey periods, provided that their population numbers continue to increase.

As mentioned above, Reclassification Criterion 3 allows a small possibility of modest population decline over the predicted 10-year period. As Schwartz et al. (2006) point out in their discussion of grizzly bear recovery, once populations reach carrying capacity they are relatively stable (i.e., slope of regression lines ≈ 0), and out of necessity have confidence intervals about their trend lines that are fully 50% in negative numbers. The only way for a population to continue to fulfill Criterion 3 is either for it to continue to grow indefinitely, or for confidence intervals around its trend line to be quite small. It is possible or likely that neither of these requirements will be achievable continuously for all necessary hibernacula. Therefore, if range-wide recovery of the bat is prolonged and some hibernacula had fully met Criterion 3 at some point during their "recovery phase" and then subsequently stabilized near their 2005 population level, then the Service may still consider those populations as having passed this criterion.

Status of Reclassification Criterion 3 (as of Aug. 2019)**:** **NOT ACHIEVED.**
In January and February 2019, new Indiana bat population data was obtained during the biennial winter surveys of hibernacula across the species' range. The Service's Indiana Field Office used this new population data to determine whether Reclassification Criterion 3 had been achieved. We statistically analyzed population data and trends from 2011-2019 (i.e., the 5 most recent population estimates) from the most populous hibernacula/hibernacula complexes within each of the four Recovery Units (USFWS 2019a: Table 4, Figs. 1-11). Based on the resulting linear regressions and 90% confidence intervals, one (Magazine Mine in S. Illinois) out of 11 (9%) "passed" Reclassification Criterion 3 while high variability and/or overall negative population trends (presumably due to WNS-associated mortality) at the ten other important hibernacula/complexes caused them to "fail" (Table 4, Figs. 1-11).

[Previous Status: In 2009, RC3 was not achieved as 71% or 10 out of 14 P1A hibernacula passed.]

TABLE 4. The five most recent Indiana bat population estimates for the most populous hibernacula within each Recovery Unit that were used to assess whether Reclassification Criterion 3 had been met. To pass this criterion the projected Y-intercept of the lower bound of the 90% confidence interval surrounding the linear regression line must be greater than the "pass-fail" bar.

Recovery Unit*	State	Most Populous Hibernacula in Each RU in 2019	2011	2013	2015	2017	2019	2019 Total Pop. Est. for Each RU	% of the 2019 RU Total Pop. that the Most Populous Hib. Represent	The "Pass/ Fail Bar" (90% of 2005 pop. est.)	Projected Y-Intercept of Lower bound of 90% CI** (year 2029)	Pass or Fail?
1	MO	Sodalis Nature Preserve	197,419	197,419	197,419	197,419	180,801			177,677	105,427	FAIL
	IL	Magazine Mine	45,159	53,136	61,113	69,090	69,090	276,317	90%	40,122	72,794	PASS
2	IN	Jug Hole/Wyandotte Complex	123,937	130,151	120,435	120,261	134,730			116,010	96,777	FAIL
	KY	Carter Caves Complex	45,849	36,528	41,446	40,191	38,043			32,029	18,505	FAIL
	IN	Ray's	48,403	49,617	30,518	31,503	25,693	245,474	81%	48,893	-66,243	FAIL
3	TN	White Oak Blowhole Complex	11,063	13,042	2,551	975	835			7,876	-34,646	FAIL
	WV	Hellhole	18,557	2,540	1,875	794	372			10,701	-5,175	FAIL
	VA	Rocky Hollow	266	192	240	205	327			140	85	FAIL
	VA	Arbogast/Cave Hollow	320	334	125	79	83	1,996	81%	211	-665	FAIL
4	NY	Barton Hill Mine	7,398	13,553	14,023	11,083	12,570			24,149	2757	FAIL
	NY	Ulster Co. Complex	6,511	3,374	1,109	1,240	579	13,510	97%	6,136	-13,709	FAIL

* Recovery Units: 1 = Ozark-Central, 2 = Midwest, 3 = Appalachia, and 4 = Northeast.

** linear regressions and confidence intervals were calculated using the Real Statistics add-in for Microsoft Excel (http://www.real-statistics.com).

FIGURES 1 – 11. Linear regressions used to assess pass/fail status for Reclassification Criterion 3.

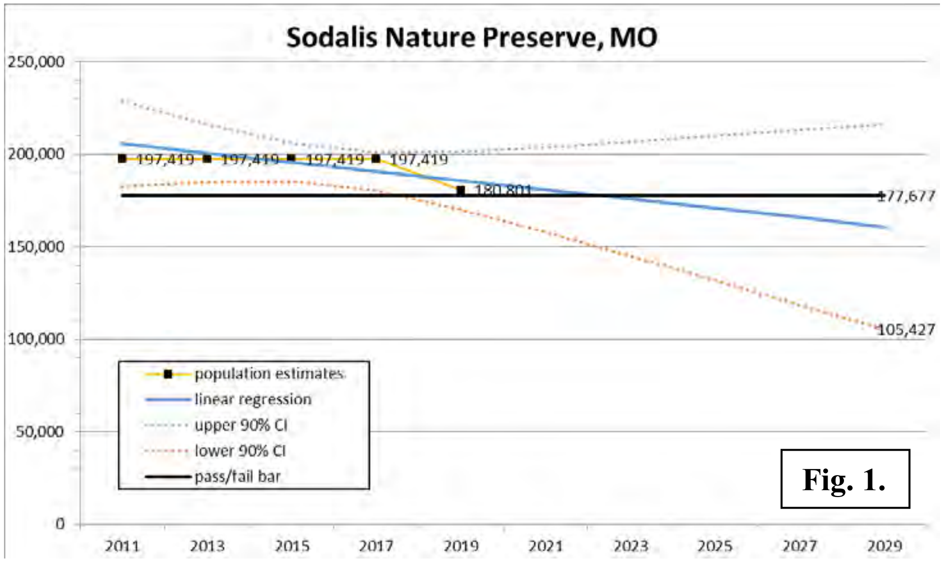


Fig. 1.

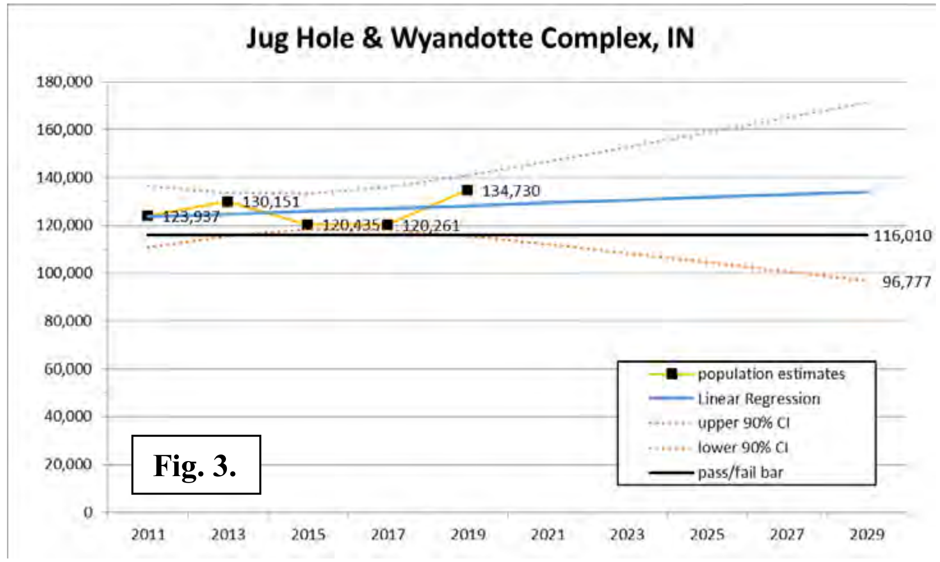


Fig. 3.

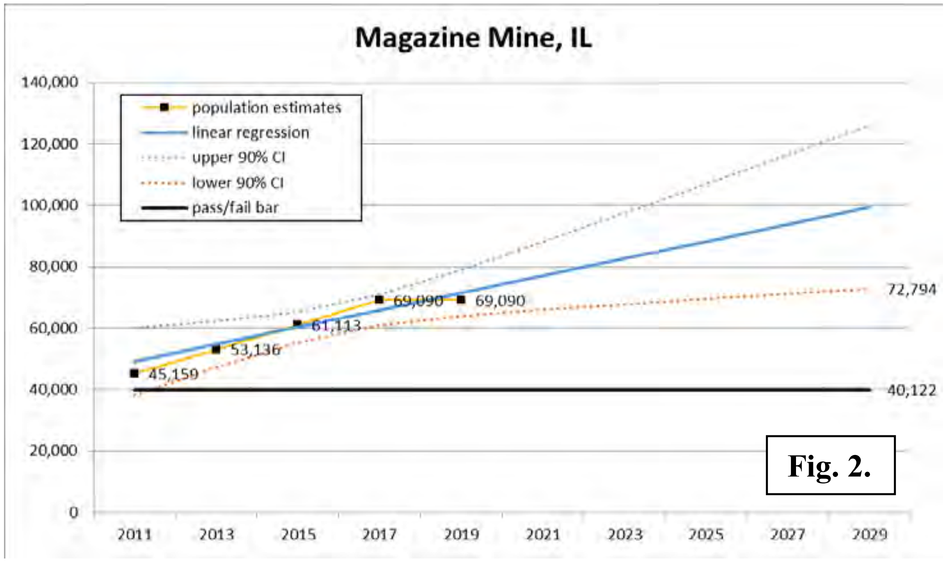


Fig. 2.

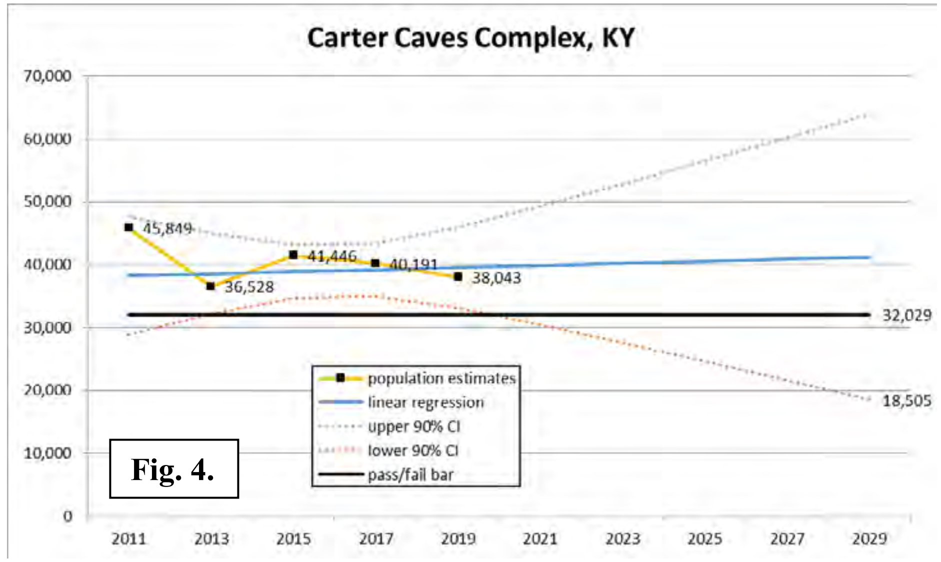
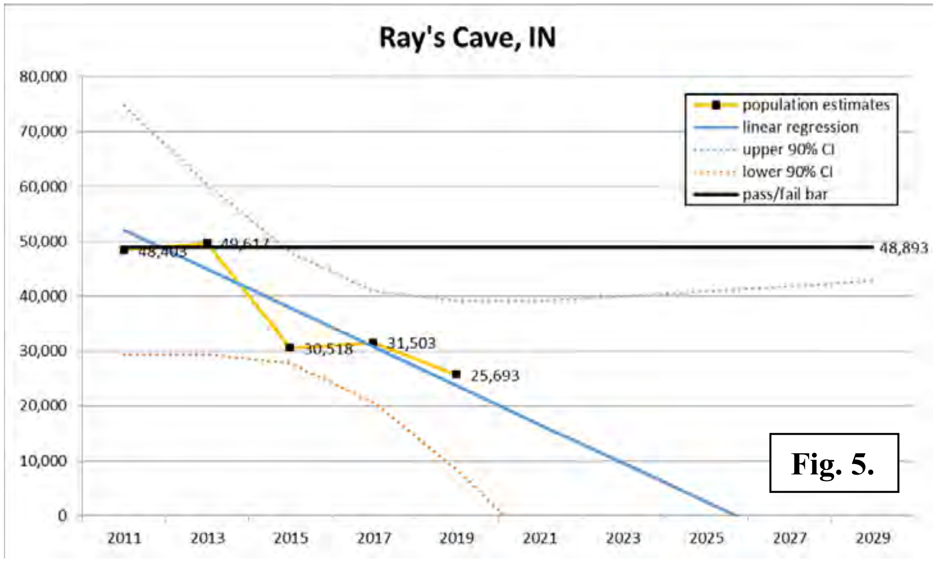
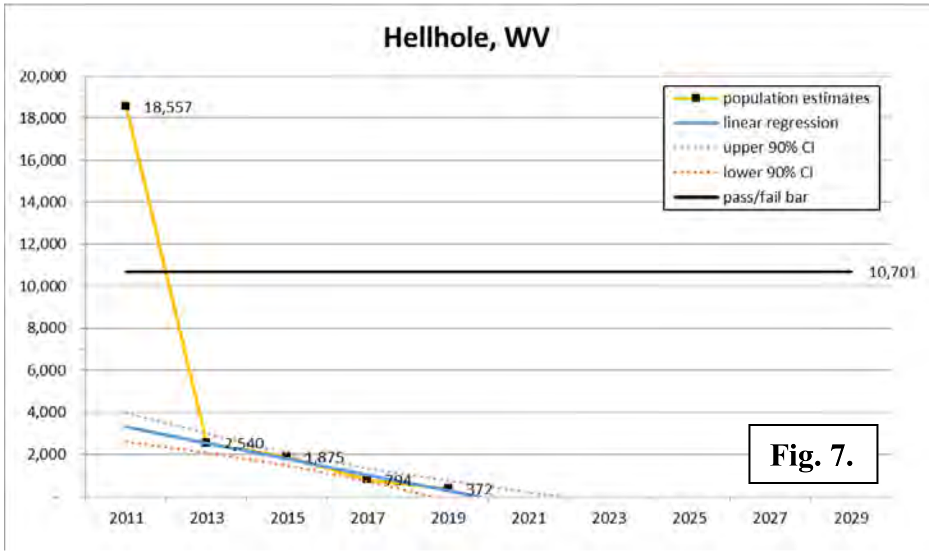
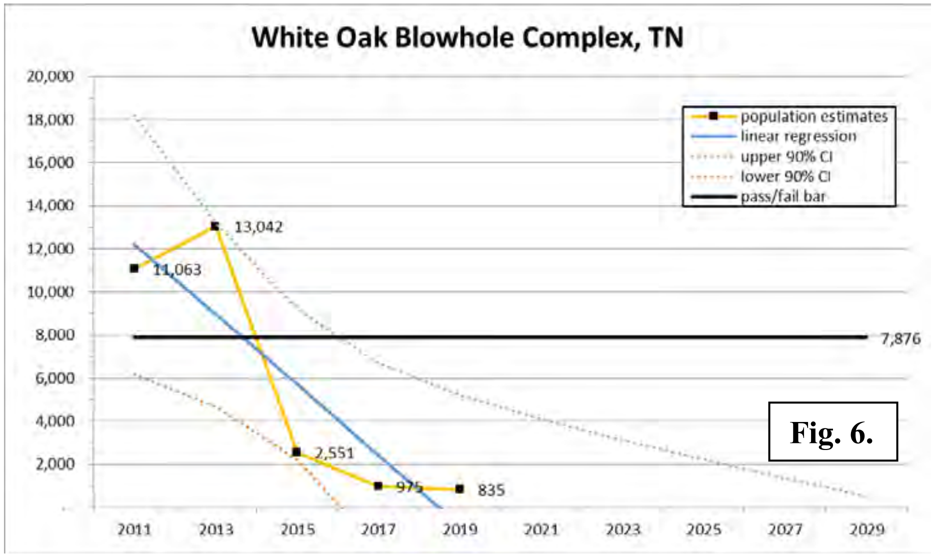
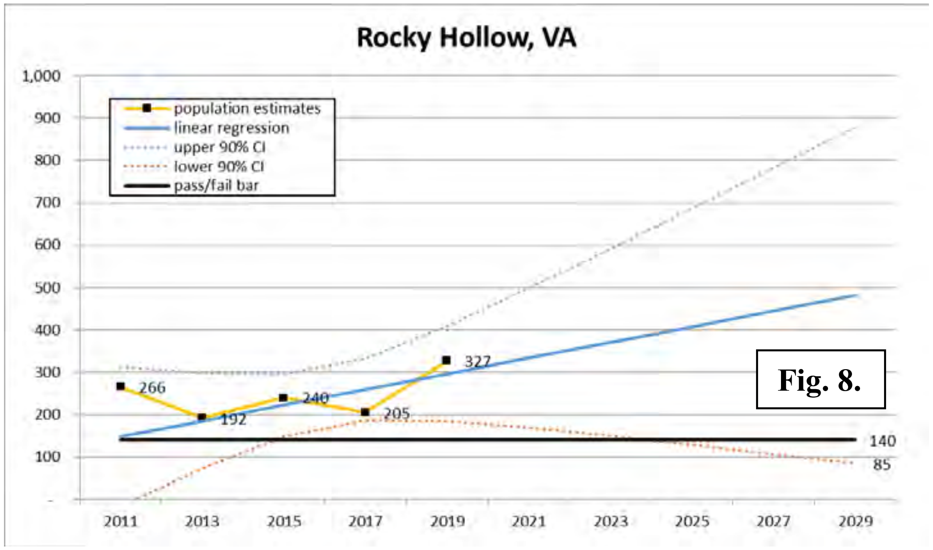


Fig. 4.


Ray's Cave, IN
population estimates
linear regression
upper 90% CI
lower 90% CI
pass/fail bar
48,403
49,617
48,893
30,518
31,503
25,693
Fig. 5.


Hellhole, WV
population estimates
linear regression
upper 90% CI
lower 90% CI
pass/fail bar
18,557
10,701
2,540
1,875
794
372
Fig. 7.


White Oak Blowhole Complex, TN
population estimates
linear regression
upper 90% CI
lower 90% CI
pass/fail bar
13,042
11,063
7,876
2,551
975
835
Fig. 6.


Rocky Hollow, VA
population estimates
linear regression
upper 90% CI
lower 90% CI
pass/fail bar
266
192
240
205
327
140
85
Fig. 8.

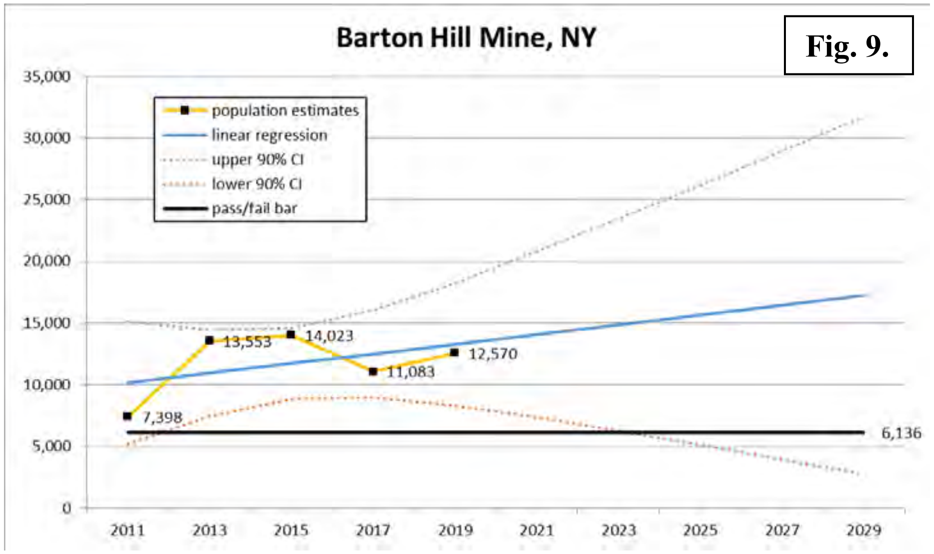


Fig. 9.

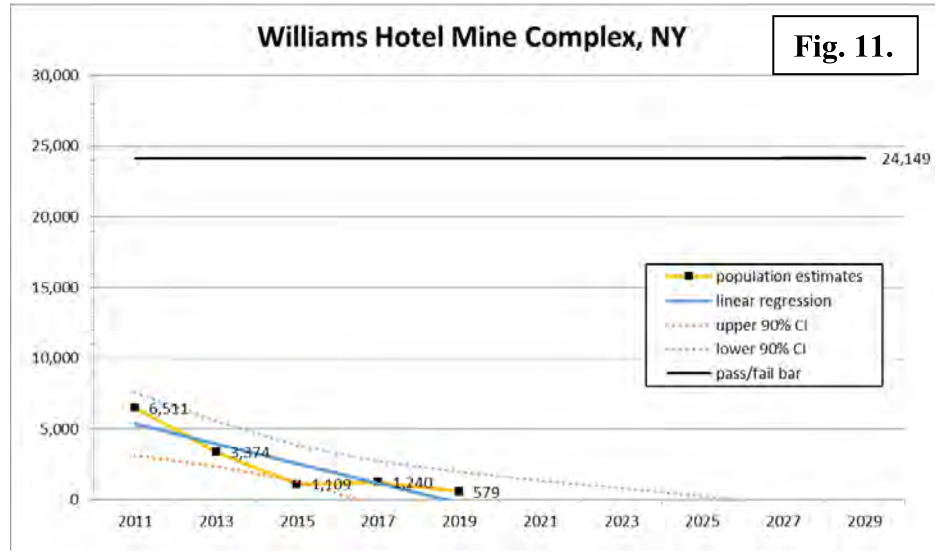


Fig. 11.

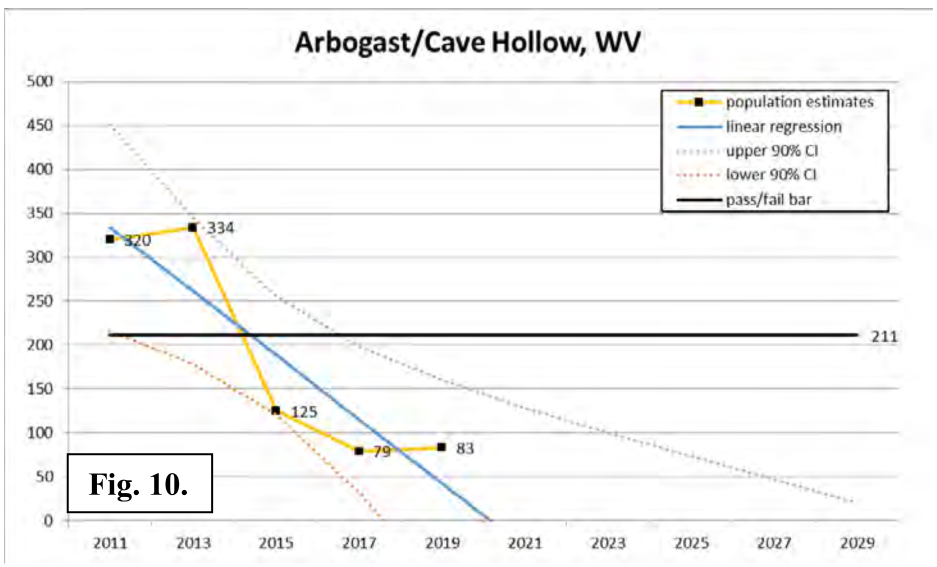


Fig. 10.

NOTE: The reclassification criteria (above) currently have not been met. Nonetheless, to see how much progress has been made to-date towards full recovery of the species, we also assessed the delisting criteria (below) using currently available data.

Delisting Criteria

We do not currently know what "normal" fluctuations in population size might be for the various RUs, and such fluctuations may well vary among RUs. Thus, writing strict requirements for delisting is inappropriate at this time. In addition, as discussed earlier, delisting requirements based exclusively on hibernaculum survey data are also inappropriate. Given that trend information, even high-quality trend information, becomes less, rather than more positive as a species reaches carrying capacity, multiple lines of evidence are the best insurance against overly optimistic delisting decisions. We provide here an initial delisting requirement, and add adaptive requirements for continuously improving the delisting requirement as data become available.

The Indiana bat will be considered for delisting when the Reclassification Criteria have been met, and the following additional criteria have been achieved.

"Delisting Criterion 1: Protection of a minimum of 50 percent of Priority 2 hibernacula in each Recovery Unit."

Greater than 14 percent of the Indiana bat population hibernates in the Priority 2 hibernacula. By achieving this criterion, a significant proportion (but not necessarily 14%) of Indiana bats range-wide will be protected from disturbance in winter habitat and from anthropogenic changes to the thermal regime of hibernacula. Protection of hibernacula includes conserving a buffer zone around each hibernacula and restoration of hibernacula if necessary.

See Reclassification Criterion 1 for further detail and justification.

Status of Delisting Criterion 1 (as of Aug. 2019): **NOT ACHIEVED.**
Currently, adequate protection of 50% or more of Priority 2 (P2) hibernacula in each of the four Recovery Units (RU) has not been achieved (see Table 5). Protection has been secured at 30% (7 of 23) of P2 hibernacula in the Ozark Central RU, 46% RU (12 of 26) in the Midwest, 33% (2 of 6) in the Appalachia RU, and 0% (0 of 3) in the Northeast RU.

[Previous Status: In 2009, DC1 was not met as protection was secured at 25% of P2 hibernacula in the Ozark Central, 42% in the Midwest, 25% in the Appalachia, and 0% in the Northeast RUs.]

TABLE 5. Current status of Priority 2 hibernacula regarding Delisting Criterion 1.

RU / State	County	Hibernaculum Name	P2 Subcategory	Current Ownership	Has Long-term /Permanent Protection Been Secured?	Is Wintertime Human Disturbance Physically Controlled?	Is Human Disturbance of Hibernating Bats still a Threat in this Hibernaculum?	Are Surface Buffer Zones Being Conserved/ Protected?	Pass/Fail
Ozark-Central (n=23): 35% currently "pass"									
AR	Madison	Horsethief	B	Private Individual(s)	Unknown	No	Yes	No	FAIL
AR	Newton	Cave Mountain	A	Federally owned	Yes	No	Yes	Unknown	FAIL
AR	Newton	Edgeman	A	Private Individual(s)	Yes	Yes (gate)	No	Yes	PASS
AR	Newton	Horseshoe	B	Federally owned	Yes	No	Yes	Unknown	FAIL
IL	Alexander	Mine 30	A	Private Organization	Yes	Yes (gate)	No	Yes	PASS
IL	Hardin	Griffith	A	Federally owned	Yes	Yes (gate)	No	Unknown	FAIL
IL	Hardin	Gutherie	B	Private Individual(s)	No	No	Yes	Unknown	FAIL
IL	Jackson	Toothless	B	State-owned	Yes	Yes (gate)	No	Yes	Uncertain
IL	Jersey	Brainerd	A	State-owned	Yes	Yes (gate)	No	Yes	PASS
IL	LaSalle	Blackball/Zimmerman Mine	A	State-owned	Yes	No	Yes	Unknown	FAIL
IL	Pope	Ellis	A	Federally owned	Yes	Yes	No	Yes	PASS
MO	Barry	Chimney Rock	B	Federally owned	Yes	No	Yes	No	FAIL
MO	Franklin	Bear	B	State-owned	Yes	Yes (gate)	No	No	FAIL
MO	Pulaski	Great Spirit	B	State-owned	Yes	Yes (gate)	No	Yes	PASS
MO	Pulaski	Tunnel	B	Private Individual(s)	Unknown	No	Yes	No	FAIL
MO	Shannon	Big Bear	A	Private Organization	Yes	Unknown	Unknown	Unknown	Uncertain
MO	Shannon	Cookstove	A	Private Organization	Yes	Yes (gate)	No	No	FAIL
MO	Shannon	Martin # 1	A	Private Individual(s)	Unknown	Yes (gate)	No	No	FAIL
MO	Shannon	Mose Prater	A	Federally owned	Yes	Yes (gate)	No	Yes	PASS
MO	Shannon	Powder Mill Creek	A	State-owned	Yes	Yes (gate)	No	Yes	PASS
MO	Ste. Genevieve	Coldwater Spring	A	Private Individual(s)	Unknown	Yes	Unknown	Unknown	Uncertain
MO	Washington	Hamilton	A	State-owned	Yes	Yes (gate)	No	No	FAIL
MO	Washington	Scotia Hollow	B	Private Organization	Unknown	Yes (gate)	No	Yes	PASS

TABLE 5. Continued.

RU / State	County	Hibernaculum Name	P2 Subcategory	Current Ownership	Has Long-term /Permanent Protection Been Secured?	Is Wintertime Human Disturbance Physically Controlled?	Is Human Disturbance of Hibernating Bats still a Threat in this Hibernaculum?	Are Surface Buffer Zones Being Conserved/ Protected?	Pass/Fail
Midwest (n=26): 46% currently "pass"									
IN	Greene	Clyfty	A	Private Individual(s)	Yes	No	Yes	Unknown	FAIL
IN	Harrison	Parker's Pit	A	Private Individual(s)	No	No	Yes	No	FAIL
IN	Harrison	Wallier	A	Private Organization	Yes	No	Yes	Yes	FAIL
IN	Washington	Endless	A	State-owned	Yes	Yes	No	Yes	PASS
KY	Breckinridge	B&O	A	Private Individual(s)	No	Yes	No	No	FAIL
KY	Breckinridge	Norton Valley	B	Private Individual(s)	No	No	No	No	FAIL
KY	Breckinridge	Thornhill	B	Private Individual(s)	No	Yes (gate)	No	No	FAIL
KY	Carter	Laurel	A	State-owned	Yes	No	Yes	Yes	FAIL
KY	Edmonson	Colossal	A	Federally owned	Yes	Yes (gate)	No	Yes	PASS
KY	Edmonson	Jesse James	B	Private Individual(s)	Yes	Yes (gates)	No	Yes	PASS
KY	Estill	Morton	A	Private Individual(s)	No	No	No	No	FAIL
KY	Jackson	Wind	A	Private Individual(s)	No	No	Yes	No	FAIL
KY	Lee	Cave Hollow	A	Federally owned	Yes	Yes (gate)	No	Yes	PASS
KY	Lee	Stillhouse	B	Federally owned	Yes	Yes (gate)	No	Yes	PASS
KY	Letcher	Green	A	Private Individual(s)	No	No	No	Yes	FAIL
KY	Menifee	Little Amos	B	Federally owned	Yes	Yes	No	Yes	PASS
KY	Rockcastle	Smokehole	A	Private Individual(s)	No	No	Yes	No	FAIL
KY	Rockcastle	Waterfall	A	Federally owned	Yes	Yes (gate)	No	Yes	PASS
KY	Wayne	Wind	A	Private Individual(s)	No	No	Yes	No	FAIL
OH	Preble	Lewisburg Limestone Mine	A	Private Individual(s)	No	Yes	Yes	No	FAIL

TABLE 5. Continued.

RU / State	County	Hibernaculum Name	P2 Subcategory	Current Ownership	Has Long-term /Permanent Protection Been Secured?	Is Wintertime Human Disturbance Physically Controlled?	Is Human Disturbance of Hibernating Bats still a Threat in this Hibernaculum?	Are Surface Buffer Zones Being Conserved/ Protected?	Pass/Fail
TN	Campbell	New Mammoth	B	Private Individual(s)	No	No	Yes	Yes	FAIL
TN	Fentress	Wolf River	A	Private Organization	Yes	Yes (gate)	No	Yes	PASS
TN	Marion	Nickajack	B	Federally owned	Yes	Yes (gate)	No	Yes	PASS
TN	Montgomery	Bellamy	B	State-owned	Yes	Yes	No	Yes	PASS
TN	Warren	Hubbards	B	Private Organization	Yes	Yes (gates)	No	Yes	PASS
VA	Lee	Cumberland Gap Saltpeter	B	Federally owned	Yes	Yes (gates)	No	Yes	PASS
Appalachia (n=6): 33% currently "pass"									
PA	Blair	Hartman Mine	B	State-owned	Yes	Yes (gates)	No	Yes	PASS
TN	Blount	Bull	A	Federally owned	Yes	Unknown	Unknown	Yes	Uncertain
TN	Blount	Kelley Ridge	A	Private Individual(s)	Unknown	Unknown	Unknown	Unknown	Uncertain
TN	Hawkins	Pearson	B	State-owned	Yes	Yes (gate)	No	Yes	PASS
VA	Wise	Rocky Hollow	B	Unknown	Unknown	Yes (gate)	No	Yes	Uncertain
WV	Pendleton	Trout	B	Private Organization	No	Yes	Yes	No	FAIL
Northeast (n=3): 0% currently "pass"									
NY	Jefferson	Glen Park	A	Private Organization	No	No	Yes	No	FAIL
NY	Onondaga	Jamesville Quarry Cave	B	Private Individual(s)	No	Yes	No	No	FAIL
NY	Ulster	Williams Lake Mine	B	Private Individual(s)	Yes	Yes	Yes	Yes	FAIL

"Delisting Criterion 2: A minimum overall population estimate equal to the 2005 population estimate of 457,000."

See Reclassification Criterion 2 for justification.

Status of Delisting Criterion 2 (as of Aug. 2019): **Provisionally ACHIEVED.**
In January and February 2019, new Indiana bat population data was obtained during biennial winter surveys of hibernacula across the species' range. The Service's Indiana Field Office used these data to calculate the 2019 overall population estimate (USFWS 2019b) (Tables 2 and 3). The current range-wide population estimate is approximately 537,000 Indiana bats, which is approximately 80,000 bats above the 457,000 benchmark and thus Delisting Criterion 2 is currently being met.

[Previous Status: In 2009, the range-wide pop. stood at approximately 612,000 bats and thus achieved this criterion.]

NOTE: For Reclassification Criterion 3 (RC3) and Delisting Criterion 3 (DC3) to be successfully met, the overall population minimum established in RC2 and DC2 will have to, by default, increase or stabilize well above 457,000 bats. In the future, the Service plans to modify this criterion to require that the overall population estimate must be equal to or greater than the population estimate at the time of reclassification, which will be by statistical necessity much greater than 457,000 bats.

"Delisting Criterion 3: Documentation using statistically reliable information that shows a positive population growth rate over an additional five sequential survey periods (i.e., 10 years). The protocol will attempt to include methods for estimating variances in counts, ideally allowing partitioning of variance into components based on population growth processes and on sampling variance. Each Priority 1A hibernaculum will be analyzed independently for trends in growth, with the exception of hibernacula that act as a composite unit (e.g., Wyandotte, Twin Domes, Batwing) or "complex", in which case all hibernacula within the composite unit will be analyzed collectively. Documented increases at 80% of P1A hibernacula are needed for reclassification. An increase will be measured using linear regression through the data points; a slope greater than 0 will be considered an increase.

If improvement in the precision of hibernacula sampling techniques falls short of that desired, we will attempt to determine the population growth rate based on concordance of estimates from two data sets developed independently. The second data set, proposed to be developed from implementation of the recovery actions related to population demographic research, will result in a demographically based life-history model for population growth rate. The model will be derived from reproduction data and survival rate estimates based on individual animal capture-recapture histories in the field."

See Reclassification Criterion 3 for further detail and justification.

Status of Delisting Criterion 3 (as of Aug. 2019): **NOT ACHIEVED.**
We analyzed population data from 2011-2019 (i.e., the 5 most recent population estimates) for each of the Priority 1A hibernacula and P1A hibernacula complexes (n=10) (USFWS 2019a) (Table 6). Based on the resulting linear regressions, four out of the ten hibernacula or 40% have positive slopes/pass this criterion. Therefore, the requirement for Delisting Criterion 3 has not been met.

[Previous Status: In 2009, 80% or 8 out of 10 P1A hibernacula had positive slopes to their regression lines and thus DC3 had been achieved.]

Winter bat populations within 60% of P1A hibernacula have suffered declines and currently have a negative trend/linear regression line over the past ten-year period. The declining P1A hibernacula include Sodalis Nature Preserve (Lime Kiln Mine), Ray's Cave, Coon & Grotto Complex, White Oak Blowhole Complex, Hellhole Complex, and the Williams Hotel Mine Complex. Furthermore, we have yet to consistently achieve the desired level of accuracy in our hibernacula sampling techniques that would allow us to reliably estimate confidence intervals around each of our population data points. Likewise, the Service has not yet developed a second, independent data set that could be used with a demographically based life-history model for population growth rate as stated in the original criterion. However, significant progress in developing a demographic model for the Indiana bat has been made (Thogmartin et al. 2013), which was identified as a recovery action within the recovery plan.

TABLE 6. Indiana bat population estimates for Priority 1A hibernacula/complexes (n=10) that were used to assess whether or not Delisting Criterion 3 had been met. For this criterion to be achieved, 80% of the linear regressions through each P1A hibernaculum's data must have a positive slope (i.e., slope > 0).

Recovery Unit*	State	County	Hibernaculum Name	2011	2013	2015	2017	2019	Is Slope >0?	Pass or Fail?
1	IL	Alexander	Magazine Mine	45,159	53,136	61,113	69,090	69,090	YES	PASS
	MO	Marion	Sodalis Nature Preserve	197,419	197,419	197,419	197,419	180,801	NO	FAIL
2	IN	Harrison	Wyandotte/Jughole Complex	123,937	130,151	120,435	120,261	134,730	YES	PASS
	IN	Greene	Ray's	48,403	49,617	30,518	31,503	25,693	NO	FAIL
	KY	Carter	Carter Caves Complex	45,849	36,528	41,446	40,191	38,043	YES	PASS
	IN	Monroe	Coon and Grotto Complex	47,185	38,345	24,381	19,124	14,757	NO	FAIL
3	TN	Blount	White Oak Blowhole Complex	11,063	13,042	2,551	975	835	NO	FAIL
	WV	Pendleton	Hellhole	18,557	2,540	1,875	794	372	NO	FAIL
4	NY	Essex	Barton Hill Mine	7,398	13,553	14,023	11,083	12,570	YES	PASS
	NY	Ulster	Williams Hotel Mine Complex	6511	3374	1109	1240	579	NO	FAIL

* Recovery Units: 1 = Ozark-Central, 2 = Midwest, 3 = Appalachia, and 4 = Northeast.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 86

February 21, 2023

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
6669 Short Lane
Gloucester, Virginia 23061

January 13, 2004

Mr. Robert T. Jacobs
Regional Forester
U.S. Forest Service
1720 Peachtree Road NW
Atlanta, Georgia 30309

Re: 2003 Revised Jefferson National Forest Land and Resource Management Plan, Virginia, West Virginia, Kentucky

Dear Mr. Jacobs:

This document transmits the U.S. Fish and Wildlife Service's (FWS) biological opinion based on our review of the 2003 Revised Jefferson National Forest Land and Resource Management Plan (JLRMP) and its effects on federally endangered and threatened species and their critical habitats. The planning area covers approximately 723,300 acres and is located in 19 Virginia counties (Bedford, Bland, Botetourt, Carroll, Craig, Dickenson, Giles, Grayson, Lee, Montgomery, Pulaski, Roanoke, Rockbridge, Scott, Smyth, Tazewell, Washington, Wise, and Wythe); Monroe County, West Virginia; and Letcher and Pike Counties, Kentucky. This biological opinion is submitted in accordance with Section 7 of the Endangered Species Act (ESA) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). The U.S. Forest Service's (FS) August 18, 2003 request for formal consultation was received on August 19, 2003.

This biological opinion is based on information provided in the FS's August 2003 programmatic biological assessment, the February 2003 JLRMP and Environmental Impact Statement, telephone conversations with FS biologists, joint FWS-FS meetings and field investigations, and other sources of information. A complete administrative record of this consultation is on file in the Southwestern Virginia Field Office, 330 Cummings Street, Abingdon, VA 24210; telephone (276) 623-1233.

The FWS concurs with your Biological Assessment (BA) that the Revised JLRMP provides broad goals, objectives, standards and guidelines with respect to meeting the needs of the federally listed species and critical habitat evaluated in your BA. The FWS concurs with your findings that activities described in the JLRMP will have no effect on the gray bat (*Myotis grisescens*), bald eagle (*Haliaeetus leucocephalus*), Virginia round-leaf birch (*Betula uber*), and

Peter's Mountain-mallow (*Iliamna corei*). The FWS believes that the proposed actions under the JLRMP are not likely to adversely affect the following species and their critical habitats due to the Forest Service's proposed management actions to protect these species, and the fact that any specific actions that may affect these species will undergo separate consultation between the FS and the FWS.

Mammals and Birds: Virginia big-eared bat (*Corynorhinus townsendii virginica*), Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*).

Fishes: Spotfin chub (*Cyprinella monacha*), slender chub (*Erimystax cahni*), duskytail darter (*Etheostoma percnurum*), yellowfin madtom (*Noturus flavipinnis*), Roanoke logperch (*Percina rex*), blackside dace (*Phoxinus cumberlandensis*).

Mollusks: Fanshell (*Cyprogenia stegaria*), dromedary pearlymussel (*Dromus dromas*), Cumberland combshell (*Epioblasma brevidens*), oyster mussel (*Epioblasma capsaeformis*), tan riffleshell (*Epioblasma florentina walkeri*), green-blossom pearlymussel (*Epioblasma torulosa gubernaculums*), shiny pigtoe (*Fusconaia cor*), fine-rayed pigtoe (*Fusconaia cuneolus*), cracking pearlymussel (*Hemistena lata*), pink mucket pearlymussel (*Lampsilis abrupta*), birdwing pearlymussel (*Lemiox rimosus*), little-winged pearlymussel (*Pegias fibula*), James spinymussel (*Pleurobema collina*), rough pigtoe (*Pleurobema plenum*), rough rabbitsfoot (*Quadrula cylindrica strigillata*), Cumberland monkeyface (*Quadrula intermedia*), Appalachian monkeyface (*Quadrula sparsa*), purple bean (*Villosa perpurpurea*), Cumberland bean (*Villosa trabilis*).

Plants: Small whorled pogonia (*Isotria medeoloides*), northeastern bulrush (*Scirpus ancistrochaetus*), Virginia spiraea (*Spiraea virginiana*).

The FWS believes the Revised JLRMP's riparian standards are a significant improvement from previous JLRMP standards and are sufficient in maintaining riparian function for the protection of federally listed aquatic species. The FWS recognizes the importance of riparian areas associated with intermittent and ephemeral streams as well as perennial streams in protecting and maintaining riparian habitats and water quality. We applaud the FS's adoption of protective standards that extend beyond perennial streams to include intermittent and ephemeral streams. However, we consider the core buffer widths outlined in the Revised JLRMP riparian standards to be the minimum widths necessary to protect the aforementioned federally listed aquatic species. Consequently, standards may need to be adjusted at the project level to ensure additional protection. The forest-wide riparian standards outlined in the Revised JLRMP require a 100 foot (ft.) and 50 ft. riparian core protection area on each side of perennial and intermittent streams, respectively. While the revised riparian standards offer considerable habitat benefits to many species, protecting diverse terrestrial riparian wildlife communities generally requires stream-side buffers of 300 ft. or greater (Wenger 1999). Given that more detailed planning will be required at the project level, the FWS stresses the need for our continued involvement as part of an interdisciplinary team that will ensure adequate protective measures for aquatic listed species and critical habitat.

The remainder of this biological opinion applies to the FS's determination that the revised JLRMP is likely to adversely affect the Indiana bat (*Myotis sodalis*). Much of the information used in this biological opinion has been taken from the FS's 2003 Biological Assessment.

Consultation History

Significant events related to this consultation, including actions taken prior to formal consultation, are listed chronologically in Appendix A.

The FS completed a previous Biological Assessment in April 1997 to analyze effects to the Indiana bat resulting from continued implementation of the George Washington and Jefferson National Forest Plans. The FS requested formal consultation with the U.S. Fish and Wildlife Service on May 12, 1997. The FWS issued a Biological Opinion on September 16, 1997, which included incidental take provisions along with Terms and Conditions and Conservation Recommendations. The 1985 Jefferson Forest Plan (along with the 1993 George Washington Forest Plan) was amended to include provisions resulting from that formal consultation. Information presented in the 1997 Biological Assessment and Biological Opinion is still pertinent to the 2003 Revised JLRMP, Final Environmental Impact Statement for the JLRMP (2003), and the 2003 Biological Assessment and is therefore incorporated by reference. The 2003 Biological Assessment includes new information resulting from observations and studies since 1997.

BIOLOGICAL OPINION

I. DESCRIPTION OF PROPOSED ACTION

As defined in 50 CFR 402.02, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. The "action area" is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. The direct and indirect effects of the actions and activities from the Federal action must be considered in conjunction with the effects of other past and present Federal, state, or private activities, as well as cumulative effects of reasonably certain future state or private activities within the action area.

The FWS has determined the action area for this project includes the entire Jefferson National Forest (JNF) since the FS will conduct activities throughout the JNF. The JNF consists of approximately 723,300 acres, of which 716,400 acres are forested and 6,900 are non-forested including water bodies. The JNF is located in 19 Virginia counties (703,300 acres), one West Virginia county (19,000 acres), and two Kentucky counties (1,000 acres). The JNF is subdivided into the Mount Rogers National Recreation Area and four Ranger Districts: Clinch, Glenwood, New Castle, and New River Valley.

Proposed Actions

This biological opinion addresses a variety of land management directions and associated activities that are planned, funded, executed, or permitted by the JNF. The original JLRMP was issued October 1985. The 2003 Revised JLRMP is a general programmatic planning document that provides management goals, objectives, and standards under which project level activities (e.g., timber sales, wildlife habitat management, road construction, special uses, etc.) may be planned and implemented to carry out management direction of the JNF. Land use allocations are made and outputs projected based upon direction established in the Revised JLRMP. All project level activities undergo National Environmental Policy Act (NEPA) review by appropriate Forest Service personnel when proposed, as well as assessment of project effects to federally listed species in compliance with Section 7 of the ESA. The Revised JLRMP establishes multiple use management area prescriptions (including associated standards and guidelines) for future decision making, which are adjustable (via monitoring and evaluation) through amendment and/or revision.

Specific proposed activities include regeneration timber sales, salvage and firewood sales, routine creation/maintenance of small clearings, road construction/reconstruction, utility corridor construction, and herbicide applications. Other activities include, but are not limited to, the felling of occasional trees for fish structures, removal of hazard trees in developed recreational areas (campgrounds and picnic sites) and along roads, special use applications that require the clearing of small acreages, fireline construction for prescribed burns plus implementation of those burns, and creation of brush piles for small game species.

Timber sales, which include both regeneration cuts and salvage and firewood sales, are one of the primary management activities that alter and/or disturb the greatest acreage of forested habitat on the JNF. Currently, the predominant regeneration method is modified shelterwood, which typically results in a residual basal area of 20-50 square feet/acre remaining in the harvest unit. Approximately 75% of the stand is harvested, thereby leaving a partial canopy to soften the visual appearance and provide for wildlife habitat while allowing enough sunlight to provide for the growth of a new forest. The total projected annual regeneration harvests include modified shelterwood (1300 acres or 71% of total acres harvested), thinning (40 acres or 2.1% of total), group selection (40 acres or 2.1% of total), and clearcutting (450 acres or 2.4% of total). Timber sales are offered through a competitive bid process to achieve various objectives, which include stand regeneration for wildlife habitat improvement and commodity production in support of local economies. The projected annual regeneration harvests (by forest community type) are as follows: oak-hickory (1,131 acres, 72% of total), mixed pine-hardwood (165 acres, 11%), cove hardwoods (176 acres, 11%), white pine-hemlock (93 acres, 6%), and southern yellow pine (1 acre, <1%). The total average annual harvest of potentially suitable habitat for the Indiana bat (hardwood and hardwood-pine types) is projected to be 1,472 acres, which makes up approximately 94% of the total annual harvest. This acreage constitutes 0.2 % of the Forest's total land base. Over the past three years, the average annual timber harvest of hardwood and mixed hardwood-pine stands on the JNF has been 451 acres/year, with an average harvest unit size of 15-20 acres. The trend of harvested acres per year over the past three years has been one of decline from 1,115 acres in 2000 to 226 acres in 2003. Over the next ten years, the projected timber harvest trend (excluding salvage and personal use firewood) on the JNF is expected to be approximately 1,830 acres per year containing a mix of all diameter hardwood trees.

Projected personal use firewood and salvage sales (approximately 7% of total timber harvests) have two primary objectives. The first objective is to make dead trees along Forest Service roads available for personal firewood uses. Occasionally, some local operators purchase this wood for commercial use. These sales take place in designated areas on each Ranger District's closed timber sale units, and along Forest Developed Roads (FDRs). Firewood sales occur throughout the year, but occur primarily in the fall and winter. Approximately 466 fuelwood permits were sold on the JNF in fiscal year 2002 (Federal fiscal year is October 1 – September 30). Firewood cutting is done on an individual tree basis and thus it is impossible to assign an "acres treated per year" figure to this activity. Each permit allows the individual purchaser to cut 3 cords of wood (a cord = 128 cubic feet of wood).

The second objective is to salvage trees for use as wood products following natural disasters such as wind storms, tornados, heavy snow/ice, and floods or insect outbreaks (e.g. gypsy moth, southern pine beetle). Although salvage sales are similar to other timber sales, they differ by being implemented quickly to recover dead or damaged trees for forest products (before they decay or become unsuitable for such commercial use). Between 1998 and 2003, 190 acres were cut as salvage on the JNF, which equates to approximately 38 acres/year.

It is impossible to accurately project future amounts of salvage. Potential salvage depends on the amount and severity of future tree mortality and damage resulting from events such as insect outbreaks, ice storms, and windstorms. Between 1988 and 2003, 2,672 acres were salvaged with annual amounts ranging from 0 to 766 acres per year and an average annual amount of 178 acres. Between 1998 and 2003, 245 acres were salvaged with an average of 49 acres each year. Therefore, the future projected amounts of salvage may range from 0-500 acres per year. Approximately 80% of these acres will be in hardwood (oak) forest types with the remaining 20% in pine types.

In general, road management for the JNF entails the maintenance or improvement of existing corridors (reconstruction) rather than establishing new roadways (construction). Under the Revised JLRMP, an estimated 0.5 miles/year (40 ft. wide) of new system roads are projected to be constructed. The total estimated loss of hardwood and hardwood/pine communities as a result of new system roads is approximately 2.4 acres/year. However, an estimated 1.5 to 2 miles of road are projected to be decommissioned annually as a result of the roadless area initiative. Currently, the JNF manages 1,198 miles of National Forest System Roads.

The JNF utilizes herbicides to accomplish several objectives including timber stand improvement, wildlife stand improvement, exotic plant control, endangered, threatened and rare species recovery, rare community restoration, and control of roadside vegetation. Treatment application methods include streamline bark treatment (basal stem), individual stem injection using the hack and squirt method (cut method), and chainsaw slash-down and stump spray (cut surface) using appropriate mitigation measures. The herbicides used, namely imazapyr (Arsenal, Chopper), glyphosate (Rodeo, Accord, Roundup), triclopyr amine (Garlon 3A and Garlon 4), have been evaluated and approved in the FS's Region 8 Final EIS, Vegetation Management in the Appalachian Mountains (1989).

Pest insect management (e.g., gypsy moth, southern pine beetle) was not considered as a proposed action in this opinion. If the JNF deems it necessary to initiate gypsy moth or other pest insect control in the future, a separate consultation with FWS will be necessary.

Additional acreages of trees cleared annually on the JNF potentially affecting Indiana bat summer habitat occur during routine maintenance or creation of small openings (approximately 2% of the total timber harvest). The objectives include maintaining and maximizing the benefits of linear openings to game wildlife species, maintaining safe public access within the Forest, minimizing damage to power transmission and other utility lines, and allowing reasonable use and access to private lands within the Forest's proclamation boundary. Proposed actions include cutting of encroaching woody vegetation to provide openings for cool or warm season grasses for wildlife; removing hazard trees for road right-of-way and powerline/utility corridor right-of-way maintenance; removing hazard trees and expanding existing recreational areas (such as horse staging areas) and trail construction for recreation/trail maintenance; permitting clearing of proposed utility and communication line easements for private inholdings; and permitting the clearing of proposed private road/driveway easements, which allows the reasonable use of private lands within the Forest's proclamation boundary. Approximately 12 right-of-way/easement clearings are permitted Forest-wide per year. Because total acreages are highly variable, the best available estimate is a total of 12 projects per year at approximately 2 acres/project (24 acres/year). Recreational area expansion and trail construction is estimated at 18 acres/year.

Between 1998 and 2003, the JNF burned approximately 2,500 acres per year under prescribed conditions, primarily during the winter and spring months, for ecosystem restoration, wildlife and rare species management, site preparation, and oak/pine regeneration. An increase in the prescribed burn program is planned and is estimated to increase to 11,500 to 15,000 acres per year. The majority of these burns will occur during the spring and early summer. Additional late winter or early fall burns may also occur. Control lines will generally consist of existing roads, trails, and streams wherever possible. In areas where control lines need to be constructed, methods will include use of hand tools and/or bulldozer. Lines will consist of 2-5 foot wide strips dug to mineral soil and may amount to 9.5 to 10 acres/year over the next 10 years. Some smaller trees (9" diameter at breast height [dbh] or less) will be felled during construction, but larger trees will usually be avoided with the line going around and between them. Snags (standing dead trees) near the line will be felled which pose a hazard to personnel or may burn and fall thus spreading fire across the line into areas not scheduled for burning.

Existing Forest Service Standards and Guidelines that Provide Protection of the Indiana Bat

Standards and guidelines within the 1985 JLRMP, as amended in 1997, provided a significant level of protection for Indiana bat hibernacula (caves in which the bats spend the winter) and habitat. These standards and guidelines provide for a significant number of secure summer and fall foraging areas, and a steady supply of potential roost trees across the JNF. In addition, protection is afforded to known Indiana bat hibernacula through cave protection standards. These standards and guidelines were developed with the best information available at the time the JLRMP was amended in 1997 and remain appropriate for the management for the Indiana bat on the JNF.

For example, the potential for Indiana bats to be disturbed during hibernation on the JNF has been greatly reduced or entirely eliminated with cave gating projects now completed for both known hibernacula (Kelly Cave, Wise County, Clinch Ranger District and Shires Cave, Craig County, New Castle Ranger District), occurring on the JNF. These two caves were prioritized for gating based on the degree of human disturbance and recent Indiana bat usage. Biologists also conduct surveys of these hibernating populations every two years to determine if the populations are stable, increasing, or declining. If additional hibernacula are found, the JNF will gate those caves, if necessary, to protect Indiana bats during the critical hibernation period.

The standards and guidelines in the 1997 amendment to the JLRMP also provided direction for maintaining snags and potential "den" or "wildlife" trees in areas that are influenced by timber regeneration cuts. Standards developed to provide hard mast will also result in maintenance of the oak and hickory tree species typically utilized as roosts by Indiana bats. Riparian area standards for streams, lakes, and ponds protect potential drinking water sources for the Indiana bat while maintaining some overstory cover for protection from avian predators while foraging.

Conservation Measures Provided in the 2003 Revised JLRMP

At the time the 1985 JLRMP was written, land management directions were based upon the most up to date information available (UWFWS 1983) for the management of the Indiana bat and its habitat on the JNF. Both the JNF and George Washington National Forest (GWNF) were then known to harbor several small Indiana bat hibernacula, and the Forest Plans emphasized the protection of these cave sites. Measures specifically designed to protect, maintain, or enhance summer habitat or prevent impacts to Indiana bats roosting in trees were not identified in either of the two former LRMPs because there were no documented summer occurrence records at the time of the LRMPs' implementation. Since then, summer occurrences of this species have been documented. Five adult males and one immature male were captured in western Virginia during the summer of 1992 (Hobson 1993). A single male Indiana bat was observed (via radio telemetry) utilizing a mature live shagbark hickory for roosting in April-May of 1993 within the GWNF (Warm Springs Ranger District, Bath County) (Hobson and Holland 1995). Consequently, GWJNF biologists (in coordination with the Virginia Department of Game and Inland Fisheries (VDGIF), Ferrum College and the FWS), developed an Indiana Bat Recovery Strategy (IBRS) for the two National Forests (USFS 1997), which was intended to manage for Indiana bats on the National Forests in a manner that would help reverse the population decline that has occurred, and reestablish a healthy population that would help contribute to the down-listing (changing the status from endangered to threatened) and eventual delisting (removal of the Indiana bat from the endangered species list).

Management direction and activities outlined in the 2003 Revised JLRMP are based on the guidelines of the 1997 IBRS and are designed to: 1) protect hibernacula; 2) maintain and enhance upland and riparian swarming and foraging areas; and 3) identify and protect summer roosting and maternity site habitat. Like the IBRS, conservation measures identified in the Revised JLRMP to protect and promote Indiana bats and their habitat are applied at three scales:

1) A **primary cave protection area** consisting of a radius of no less than one half mile around each hibernacula, defined by National Forest surface ownership and topography. This area is intended to protect the integrity of the cave and the immediate surrounding uplands where bats may swarm and forage in the fall.

2) A **secondary cave protection area** consisting of a radius of approximately 1½ miles around each primary cave protection area, defined by easily recognizable features on the ground. This area is managed to further maintain and enhance swarming, foraging, and roosting habitat.

3) Because Indiana bats are known to travel over 200 miles between winter and summer habitats, standards are also applied to the Jefferson National Forest as a whole since the entire Forest is potential habitat for the species. These standards

are designed to protect foraging areas, non-cave associated roosts, and maternity sites, if any are discovered on the Forest.

Further explanation of how these distances were developed is found in the Forest Service's 2003 Biological Assessment and the 1997 IBRS. The 0.5-mile primary area and 1.5-mile secondary area around a hibernaculum is delineated on the ground by using National Forest/private land ownership boundaries and noticeable man-made and landform features (i.e. roads, trails, streams, ridgetops, etc.). In most cases the actual boundary when drawn is greater than 0.5 or 2.0 miles from the cave due to the nature of ownerships and man-made features and landforms. The lines were drawn by placing 0.5-mile and 2.0-mile circles on a map around each hibernaculum. Then the actual boundary was drawn using the noticeable land features. When a decision was necessary +/- from the circle, the line was always drawn greater than the circle indicated. This is discussed in standards of the Revised Jefferson NF Plan under prescription 8.E.4 – Indiana Bat Hibernacula Protection Areas and illustrated on maps showing prescription allocations.

The 2003 Revised JLRMP identifies that of the total 723,300 acres on the JNF, approximately 464,000 acres (64% of the JNF land base) are unsuitable for timber harvest due to low productivity, steepness of slope, visual concerns, wilderness designation, and other resource management priorities. These lands will provide a continuous supply of roost trees and foraging areas for Indiana bats. These are well distributed across the JNF and occur intermixed with those stands in the land base suitable for timber harvest. The management actions that are the subject of this consultation will occur primarily on the remaining 259,300 acres of the JNF. Appendix B provides the specific standards and conservation measures for the Indiana bat proposed in the Revised JLRMP, and is pertinent to the evaluation of the effects of the JLRMP on the Indiana bat.

II. RANGEWIDE STATUS OF THE SPECIES

Species Description

The Indiana bat is a monotypic species (there are no subspecies) of the genus *Myotis* that is known to occur in much of the eastern half of the United States. These bats are medium-sized with head and body length of individuals range from 41 to 49 millimeters (mm) (1 5/8 - 1 7/8"), and forearm length of 35-41 mm (1 3/8 - 1 5/8") (USFWS 1983). This species is similar in appearance to both the little brown bat (*M. lucifugus*) and the northern long-eared bat (*M. septentrionalis*). The Indiana bat often has a distinctly keeled calcar (cartilage that extends from the ankle to support the tail membrane). The hind feet tend to be small and delicate with fewer, shorter hairs (i.e., do not extend beyond the toenails) than its congeners. The fur lacks luster (Barbour and Davis 1969; Hall 1981). The ears and wing membranes have a dull appearance and flat coloration that do not contrast with the fur. The fur of the chest and belly is lighter than the flat (not glossy), pinkish-brown fur on the back, but does not contrast as strongly as does that of the little brown or northern long-eared bat (Clawson, pers. observ. as cited in USFWS 1996). The skull has a small sagittal crest, and the braincase tends to be smaller, lower, and narrower than that of the little brown bat (Barbour and Davis 1969; Hall 1981).

The species was listed as endangered by the FWS pursuant to the Endangered Species Preservation Act (ESPA) on March 11, 1967. Species listed under ESPA carried over and became listed by the Endangered Species Act when it became law in 1973. A recovery plan for the species was completed on October 14, 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision is still in preparation. Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and 2 abandoned mines. The following sites have been designated as critical habitat for the Indiana bat: Bat Cave in Carter County, Kentucky; Coach Cave in Edmonson County, Kentucky; White Oak Blowhole Cave in Blount County, Tennessee; the Blackball Mine in LaSalle County, Illinois; Big Wyandotte Cave, Crawford County, Indiana; Ray's Cave, Greene County, Indiana; Cave 021, Crawford County, Missouri; Cave 009, Franklin County, Missouri; Cave 017, Franklin County, Missouri; Pilot Knob Mine, Iron County, Missouri; Bat Cave, Shannon County, Missouri; Cave 029, Washington County, Missouri; and Hellhole Cave, Pendleton County, West Virginia. No critical habitat has been designated in Virginia or near the Jefferson National Forest.

Life History

Indiana bats hibernate in caves and mines that provide specific climatic conditions, preferring hibernacula with stable winter temperatures below 10 degrees Celsius and relative humidity above 74% (USFWS 1999). Recent examination of long-term data suggests optimal temperatures range from is 3-7 degrees Celsius (Richter et al. 1993, Tuttle and Kennedy 2002). Stable low temperatures allow the bats to maintain a low rate of metabolism and conserve fat reserves through the winter until spring (Humphrey 1978; Richter et al. 1993). Because few caves or mine shafts provide these exacting conditions, approximately 52% of the species' total population hibernates in only seven caves and one abandoned mine shaft (Clawson 2002).

Indiana bats undergo swarming prior to hibernation, an activity that entails bats congregating around the hibernacula, flying into and out of the cave, and roosting in trees outside (Kiser et al. 1996). Swarming continues for several weeks, during which time the bats mate and replenish fat reserves prior to hibernation (USFWS 1983). Figure 1 provides a depiction of the Indiana bat's annual life cycle. During the swarming season, both males and female bats roost under sloughing bark and in cracks of dead, partially dead and live trees in close proximity to cave entrances prior to hibernation (MacGregor et al. 1999). Depending on local weather conditions, swarming may continue through October or November. Males generally remain active longer than the females during this pre-hibernation period, but all Indiana bats are usually hibernating by late November (USFWS 1983). Indiana bats typically hibernate in dense clusters, with bat densities ranging in size from 300 to approximately 500 individuals per square foot (Clawson et al. 1980). Indiana bats select roosts within hibernacula that best meet their needs for cool temperatures; in many hibernacula, these roosting sites are near an entrance, but may be deeper in the cave or mine if that is where the cold air flows and is trapped (Tuttle and Stevenson 1978). Females emerge from hibernation first (generally in late March or early April). Although most hibernating colonies leave the hibernacula by late April, some males may spend the summer in the vicinity of the hibernaculum. Those leaving the hibernaculum migrate varying distances to their summer habitats.

Figure 1. Indiana Bat Annual Chronology (USFWS 1999).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Both sexes:			Hibernation								Hibernation	
Females:				Emerge	Pregnant			Swarming				
"						Lactating						
Young:						Born	Flying					
Males:				Emerge				Swarming				
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

During the summer months, male and female Indiana bats typically roost during the day beneath loose or exfoliating bark in snags (dead standing trees) or living trees. To a limited extent, tree cavities or hollow portions of tree boles and limbs also provide suitable roost sites (Gardner et al. 1991a, Kurta et al. 1993b). Reproductive females form maternity colonies that may be hundreds of miles from the hibernacula, and females in a maternity colony may come from more than one hibernaculum. In contrast, males often use wooded areas near the hibernaculum, occasionally visiting the hibernaculum throughout the summer. Although less migratory than females, males sometime migrate long distances to summer habitat. During this time, males often roost individually, and likely use trees similar in character to those used near hibernacula in autumn and spring.

Females store sperm through the winter and become pregnant via delayed fertilization soon after emergence from the hibernacula. In the Spring, adult females roost in maternity colonies that may include more than 100 bats (Callahan et al., 1997) under loose bark or in cavities of snags or mature live trees in riparian or upland forests. Adults forage on winged insects usually within three miles of the occupied maternity roost (Gardner et al. 1991a). Each female gives birth to a single young in late June or early July and the young can fly in approximately one month. By late August, the maternity colonies begin to disperse. Reproductive females often roost in forested habitat and may require multiple alternate roost trees to fulfill summer habitat needs. Indiana bat maternity sites generally consist of one to several primary maternity roost trees (i.e., trees used repeatedly by relatively high numbers of bats in the maternity colony during the maternity season) and varying numbers of alternate roost trees (i.e., those trees used by smaller numbers of bats throughout the course of the maternity season). Primary roost trees that have been studied to date have ranged in size from 12.2 to 29.9" dbh (Romme et al. 1995). Studies have shown that adults in maternity colonies may use as few as two, to as many as 33 alternate roost trees (Humphrey et al. 1977; Gardner et al. 1991a; Garner and Gardner 1992; Callahan 1993; Kurta et al. 1993a; Romme et al. 1995; Kurta et al. 1996). Alternate roost trees also tend to be large, mature trees, but the range in size is somewhat wider than that of primary roosts (7.1 to 32.7 inches dbh) (Romme et al. 1995). In Missouri, maximum distances between roost trees used by bats from the same maternity colony have ranged from 1.0 to 1.9 miles (Callahan 1993). Snags exposed to direct solar radiation were found to be used most frequently by Indiana bats as summer roosts, followed by snags not fully exposed to solar radiation and live trees not fully exposed (Callahan 1993).

Until recently, most documented Indiana bat maternity colonies were located in riparian or floodplain forests (Humphrey et al. 1977). However, recent studies and survey results indicate that upland forests provide important maternity habitat for Indiana bats (Gardner et al. 1990; Romme et al. 1995). In addition, females are known to exhibit relatively strong loyalty to summer roosting and foraging habitat (Bowles 1981; Gardner et al. 1991a, 1991b).

Indiana bats are known to occupy distinct home ranges during the summer (Gardner et al. 1990). Average home range sizes vary from approximately 70 acres (juvenile males) to over 525 acres (post-lactating adult females). Roosts occupied by individuals ranged from 0.33 miles to over 1.6 miles from preferred foraging habitat, but are generally within 1.2 miles of water (e.g., stream, lake, pond, natural or manmade water-filled depression). A more detailed description of the life history of the Indiana bat is provided in the Indiana Bat Recovery Plan (USFWS 1983) and the Revised Technical Draft Indiana Bat Recovery Plan (1996).

A habitat suitability index model was developed for the Indiana bat (Romme et al. 1995), which identifies nine variables that comprise the components of summer habitat for the species. The model was developed for use in southern Indiana, a core area of the Indiana bat population. Therefore, caution must be applied to peripheral areas within the species' range, such as Virginia and the JNF. Five variables considered important for roosting habitat within analysis areas included: amount of overstory canopy, diameter of overstory trees, density of potential live roost trees, density of snags, and the amount of understory cover. Variables considered to be important foraging habitat components in southern Illinois included the amount of overstory canopy and the percentage of trees in the 2 to 2.7 inch dbh class. Distance to water, and percentage of the analysis area with forest cover were also considered to be important habitat variables: habitat with distance to water of 0 to 1.5 km (0-1 mile) and percent of forested land greater than 30% received high use.

The habitat model classified species of trees that may provide roosts for Indiana bats. Class I trees, identified as those most frequently used as roosts, include: silver maple, shagbark hickory, shellbark hickory, butternut hickory, green ash, white ash, eastern cottonwood, red oak, post oak, white oak, slippery elm, American elm. Shagbark and butternut hickory, red and white oak, and white ash are tree species typical of southern Appalachian mixed hardwood forests and are commonly found on JNF.

Class I trees are likely to develop the loose, exfoliating bark as they age and die that is preferred by Indiana bats for roosting sites. However, several of these species are typical of bottomland hardwood forests in areas where much of Romme's research was done, and they do not occur in significant numbers on the JNF. Romme also identified Class II trees, which include sugar maple, shingle oak, and sassafras as tree species believed to be of somewhat lesser value for roosting Indiana bats. Class III trees are all other species not included in the other two classes. In addition, Class II and III trees are species that are less likely to provide optimal roosting habitat, but may develop suitable cracks, crevices, or loose bark after death.

Preferred roost sites are in trees that are 9 inches (22 cm) or larger in dbh and are located in forested habitat where the degree of overstory canopy cover ranges from 60-80%. In general, the largest available trees with suitable bark characteristics and at least some daily exposure to sunlight are the most likely to be used by Indiana bats as maternity roosts. The suitability of a given area as roosting habitat declines slightly as canopy closure increases from 80-100%, and also declines as canopy closure falls below 60% (Romme et al. 1995).

Indiana bats prefer to forage within the upper canopy layers of forests where the degree of overstory canopy cover ranges from 50-70%. The suitability of a given area as foraging habitat declines slightly as canopy closure increases from 70-100%, and also declines as canopy closure decreases below 50% (Romme et al. 1995). Foraging also takes place over clearings with early successional vegetation, along the forested borders of agricultural land, and along strips of trees extending into more open habitats.

Drinking water is essential when bats actively forage. Throughout most of the summer range, Indiana bats frequently forage along riparian corridors and obtain water from streams. However, studies in the Cumberland Plateau and Cumberland Mountains of eastern Kentucky (MacGregor et al. 1996) indicated that riparian habitats there received very little use, and natural and man-made ponds and water-filled road ruts in the forest uplands were very important water sources for Indiana bats in those regions.

Status and Distribution

The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Bats are often readily found and easily counted at this time. Census of hibernating Indiana bats is the most reliable method of tracking population trends range-wide. As such, winter distribution of the Indiana bat is well documented. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range.

According to the known and suspected range of the Indiana bat presented in the species' recovery plan (USFWS 1983, 1999), the Indiana bat is a migratory species that ranges over an area of approximately 580,550 square miles in the eastern half of the United States. Over 52% of the known range-wide population of Indiana bats occupy eight "Priority One" hibernacula (hibernation sites with a recorded population >30,000 bats since 1960), three each in Indiana and Missouri and two sites in Kentucky (Clawson 2002). Smaller populations of hibernating Indiana bats are known from Alabama, Arkansas, Connecticut, Florida, Georgia, Illinois, Iowa, Maryland, Massachusetts, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin. Although the winter range is large, the known population of the species has been found in only 336 hibernacula in an area with tens of thousands of caves and mines.

"Priority Two" hibernacula (recorded population >500 but <30,000 bats since 1960) are known to occur in Indiana, Kentucky, and Missouri as well as Arkansas, Illinois, New York, Ohio, Tennessee, Pennsylvania, Virginia, and West Virginia. Priority Three hibernacula (recorded populations of <500 bats or single hibernating individuals) have been reported in the all the states with known Indiana bat hibernacula.

Many hibernacula populations have been decreasing in numbers since monitoring efforts were initiated. The most serious declines have occurred in two of the three historically highest populated states for Indiana bats, Kentucky and Missouri. Kentucky numbers declined by an estimated 200,000 bats between 1960-2001 (Clawson 2002). Losses were attributed to exclusion and changes in the microclimate of two of the three most important hibernation sites in the state. More specifically, poorly designed cave gates (Humphrey 1978) and construction of buildings over the upper entrance to one of the hibernacula (J. MacGregor, Daniel Boone National Forest, pers. observ. cited in USFWS 1996) appeared to have caused great declines. Many of the most important remaining hibernating populations (west-central, northeastern, and extreme southeastern Kentucky) have continued to decline steadily in the last 20 years. The colonies of Indiana bats in all of the 16 known Priority One and Two hibernacula in Missouri have declined since 1980. Despite efforts such as cave gating, the overall Missouri population has steadily and drastically declined by 269,000 bats between 1980 and 2001 (Clawson 2002). These losses represent more than 80% of the population (USFWS 1996). Likewise, Clawson (2002) reported an 80% decrease over the last 40 years over the southern portion of the Indiana bat's range (Alabama, Arkansas, Kentucky, Missouri, Tennessee, and Virginia).

Although overall known Indiana bat numbers have declined since 1960, populations in the northern Midwest and Northeast including populations in New York, Pennsylvania, West Virginia, Ohio, Illinois, and Indiana appear to have increased by 30% (Clawson 2002).

Based on censuses taken at hibernacula in 1999, the total known Indiana bat population was estimated to be approximately 350,000 bats (FWS 1999). The current estimated range-wide population of Indiana bats is 382,350 individuals, which hibernate in 336 hibernacula (Clawson 2002). The eight largest "Priority One" hibernacula contained 198,000 Indiana bats, or 52% of the total known population. The 69 hibernacula classified as "Priority Two" contained 171,000 Indiana bats, or 45% of the total known population (Rocky Hollow Cave is in this category). The remaining 259 caves known to have been occupied by Indiana bats contained only 14,000 bats, less than 4% of the total population (three other hibernacula on or near the Jefferson National Forest – Kelly, Newberry-Bane, and Shires Cave – are in this category).

Much less is known about the location of maternity colonies or the migration patterns of the Indiana bat. Although the majority of known maternity colonies occur in Midwestern states such as Ohio and Indiana, there have been documented maternity colonies in Kentucky and North Carolina, and some limited evidence to suggest the presence of maternity colonies in Virginia and West Virginia. A juvenile male was discovered in West Virginia on August 5, 1999 (Kiser et al. 1999). It is not known whether the juvenile bat had immigrated from a distant or resident maternity colony. Similarly, a juvenile male was captured on July 28, 1992 in Cumberland Gap National Historic Park, Lee County, Virginia (Hobson 1993). Despite these findings, no lactating females or actual maternity colonies have been reported in Virginia or West Virginia to date.

<u>Status in Virginia</u>

In Virginia, 11 hibernacula are currently known from 7 counties (Bath, Bland, Craig, Highland, Lee, Tazewell, and Wise) and continue to support varying numbers of Indiana bats. The Virginia Fish and Wildlife Information Service has additional historic records of Indiana bats wintering in Dickenson, Giles, Montgomery, and Shenandoah Counties (Virginia Department of Game and Inland Fisheries). Critical habitat for the Indiana bat has not been designated in Virginia.

The Indiana bat has been documented in southwestern Virginia since the mid-1960s. In the early 1960s, the state's Indiana bat population was estimated at over 5,000. In 1997 the state's population was estimated to be 1,840 bats. The Recovery Team (USFWS 1999) considered the data from Virginia too sketchy for trend analysis. The 2000-2001 survey for hibernating Indiana bats in Virginia totaled 833 individuals, but the hibernaculum in Tazewell County was not surveyed that season. The entrance to this cave is dangerously unstable. The last survey in that cave was on January 21, 1999, and yielded 136 Indiana bats. Results of the 2002-2003 survey show an estimated number of hibernating Indiana bats in Virginia at 1081 (10 of the 11 known hibernacula were surveyed; hibernaculum in Tazewell County was inaccessible), less than 0.3% of the total population (Rick Reynolds, VDGIF, pers. comm. 2003). This represents an approximate 57% decline in the population since Dalton (1987) found 2,500 Indiana bats hibernating in eight caves during a 10-year survey of 170 caves in 22 Virginia counties.

Humphrey (1978) acknowledged the increasing importance of these small populations of Indiana bats in management of the species if the larger populations continue to decline. In addition, genetic composition of populations at the edge of a species' range may differ considerably from that at the center of the species' range (Mayr 1954, 1963, 1982).

In 1977, the VDGIF began distribution surveys for cave-dwelling bats in Virginia. A total of 170 caves in 22 counties were surveyed (Dalton 1987). Indiana bats were located in 8 caves in 5 counties. Indiana bats were not found in four historic sites, but five new sites were located. Additional surveys have since located three new caves that house small populations of Indiana bats (R. Reynolds, VDGIF, pers. comm. as cited in the 1997 Biological Opinion). The continued decline of *M. sodalis* numbers in Virginia through the 1980s prompted gating efforts in the 1990s. Of the 11 known hibernacula in Virginia, eight have been gated to reduce or eliminate human disturbance, two are under negotiation, two are believed to be protected due to land ownership, and two will not be gated due to landowner concerns (R. Reynolds, VDGIF, pers. comm. 2003). Surveys of the caves containing threatened or endangered species, including Indiana bats, are ongoing.

Hobson (1993) surveyed the areas associated with known *M. sodalis* hibernacula in western Virginia (Lee, Tazewell, Wise, Scott, Bland, Bath, and Highland Counties) in 1992 during 50 "net nights" at 40 sites. The primary objective of the study was to determine various aspects of summer ecology, distribution, and abundance of bats, with emphasis on the Indiana bat. All 40 net sites were located along riparian corridors and other natural or man-made corridors in upland and lowland areas. No female Indiana bats were captured. However, one juvenile male was captured on July 28, 1992, along Station Creek in Cumberland Gap National Historic Park (CGNHP). Five male Indiana bats were captured in CGNHP along Station Creek, and Lewis Hollow Branch, within 3 miles of Cumberland Gap Saltpeter Cave, which harbors the largest known hibernating colony of Indiana bats in Virginia. A single male was captured along the Cowpasture River in Highland County, within 2 miles of Hupman's Saltpeter Cave, which harbors an estimated 225 Indiana bats during the winter. The five Indiana bats found in CGNHP were using small permanent or intermittent streams in heavily wooded areas as flyways. The single male captured in Highland County was using a disturbed portion of the Cowpasture River, approximately 50 ft. wide, which contained no water on the date of capture. This study documented that at least male individuals of Indiana bats use habitat in the vicinity of known hibernaculum in Virginia during the summer. In addition, the capture of a single juvenile male suggests that at least one nursing female may be using habitat in the Cumberland Gap area (which could include Virginia and/or Kentucky and/or Tennessee).

Rocky Hollow Cave, which occurs adjacent to the Clinch Ranger District of the JNF, supported one of the largest Indiana bat populations in Virginia. In the 1960s, Dr. Tuttle (Bat Conservation International, pers. comm. as cited in the 1993 GWJNF's biological assessment) visited this site and observed approximately 1,200 Indiana bats. The 2003 survey results show as few as 325 Indiana bats at this site. The Nature Conservancy, in cooperation with the FWS and VDGIF, has recently gated Rocky Hollow Cave.

Hellhole Cave, a site designated as critical habitat for the Indiana bat, occurs in Pendleton County, West Virginia, and contains approximately 8,566 Indiana bats (last surveyed Winter 2001) (Graig Stihler, West Virginia Department of Natural Resources, pers. comm. 2003). The cave is approximately 90 air miles north northeast of the JNF.

Threats to the Species

A number of identified factors have likely contributed to the decline of the Indiana bat throughout its range, with the most significant being human disturbance of hibernating bats and vandalism. Human entry into a hibernaculum during the winter causes the bats to awaken. Each time a bat awakens, it utilizes some of the fat reserves it has accumulated for the winter. Frequent disturbance may cause the bats to use up all of their stored fat reserves, forcing them to leave the cave too early in the year to search for food, likely resulting in starvation. Vandalism is also a serious problem that has resulted in deliberate destruction of many bat colonies simply because these animals are often viewed by the public as nuisances or threats to human health.

Other possible causes of decline of Indiana bat populations include natural disasters, alteration of habitat (summer maternity and winter hibernacula), and chemical poisoning. Caves occupied by Indiana bats (and other bat species) occasionally flood or collapse, killing a few, to thousands of bats. Timber harvest, water quality degradation, stream channelization, and other actions can, in some cases, result in destruction or alteration of actual or potential roosting and/or foraging habitat. However, it should be noted that the location of suitable Indiana bat roost trees across the landscape changes over time as various trees develop or lose bark, or as the trees die and fall. In addition, Indiana bats frequently change roost trees as particular trees become unsuitable and other become suitable as roosts. It is not currently known how long or how far female Indiana bats will search to find new roosting habitat if traditional habitats have been destroyed or rendered unsuitable. If they are required to search for prolonged periods of time after emerging from hibernation in the spring, this effort may place additional stress on the females at a time when they are already expending significant amounts of energy.

The impacts of herbicide use on Indiana bats have not been studied, but insecticides are thought to have contributed to the decline of other insectivorous species of bats (Clark 1981). Insecticides, particularly those used for forest pests, could have both direct (potential of a bat eating a contaminated insect) or indirect effects (loss of the species forage base since most insecticides are not very specific). It is possible that herbicide use (e.g., aerial application) could have indirect impacts on the Indiana bat by potentially reducing vegetation, and consequently the insect population numbers or diversity, in the treatment area. This potential indirect effect, however, would not be anticipated to be significant with the typical irregular use of herbicides.

In addition, the exposure of bats to open oil pits in some states has resulted in direct mortality of individuals (many unable to be identified by species).

Historic collecting, handling, and banding by biologists are also thought to have contributed to declines in Indiana bat population numbers. During the winter, these activities cause hibernating bats to awaken and utilize stored fat reserves; during the summer they may disturb sensitive maternity colonies. Winter counts are now conducted on a biennial basis. Banding of bats collected by mistnetting during the maternity season, however, is thought to have negligible effects on bats.

Poorly designed and installed cave gates restrict bat movement and alter air flow into caves. Air flow alterations may change the climatic conditions and render the cave unsuitable for hibernation. Commercialization of caves results in disturbance to summer or hibernating bat colonies, and impoundment of streams result in permanent or seasonal flooding of caves (USFWS 1983).

Recovery Goals and Accomplishments

Recovery for the Indiana bat depends to a large extent on maintaining the ecological integrity of essential hibernacula and protecting these areas from human disturbance (USFWS 1983). In addition, foraging habitat (including riparian forest vegetation, dead trees) must be maintained, protected, and restored. Lastly, in order to evaluate the success of protection efforts, a monitoring program is needed to document changes in Indiana bat populations.

Delisting will be considered when: (a) criteria listed above are fulfilled; and (b) protection and documentation of increasing or stable populations occurs for three consecutive census periods at 50% of the Priority Two caves in each state (USFWS 1983).

More specifically, the recovery outline entails the following:

1. Prevent disturbance to important hibernacula by: (a) preventing entry; (b) preventing adverse modifications to winter and fall roost sites; (c) protecting winter and fall roost sites.
2. Maintain, protect, and restore foraging and nursery roosts by preventing adverse modification to foraging area and nursery roost habitat.
3. Monitor population trends.
4. Public education.
5. Research needs.

Thirteen mines or caves have been designated as critical habitat for the Indiana bat (found within Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia). In general, priority levels for protection of hibernacula have been based on recorded populations of the Indiana bat within each hibernacula. Since the priority designation for hibernacula was developed in 1983, an active set of programs at the state and Federal levels have led to the acquisition and protection of a number of Indiana bat hibernation caves. Of 127 caves/mines with populations >100 bats, 54 (43%) are in public ownership or control. In addition, approximately 46 (36%) hibernacula (most on public land) were gated or fenced as of 1996 (USFWS 1996).

Additional recovery criteria are currently being considered and a revised Indiāna Bat Recovery Plan is currently under review (USFWS 1996).

III. ENVIRONMENTAL BASELINE IN THE ACTION AREA

The JNF extend along Virginia's western boundary east of West Virginia from Lexington, Virginia south to Kentucky. Of the approximate 723,300 acres that comprises the JNF, 716,400 acres are forested and 6,900 are non-forested including water bodies. The Forest lies in the Ridge and Valley physiographic province, the Blue Ridge physiographic province, and the Appalachian Plateau physiographic province. These publicly owned lands are located in 19 Virginia counties (703,300 acres), one West Virginia county (19,000 acres), and two Kentucky counties (1,000 acres). Elevations on the JNF reach their highest elevation of 5,729 feet on Mount Rogers (the highest point in Virginia) in Grayson County, Virginia. Topography is generally characterized by long linear parallel mountains with steep side-slopes, narrow ridge tops, and narrow stream valleys in a trellis drainage pattern. Lands under Forest Service management are distributed primarily on the sides and tops of mountains along with associated spur-ridges. Most adjacent privately-owned lands are located in intervening valleys and in scattered small acreage inholdings on the mountains.

The limited karst formations (closed depressions, sinkholes, underground caverns, solution channels) of the JNF are found in scattered valley settings within the Ridge and Valley and Appalachian Plateau where carbonate bedrock (limestone and dolomite) are near the surface or in windows exposing Ordovician age Knox group strata and Cambrian age Shady dolomites beneath thrust sheets of clastics along the western edge of the Blue Ridge Mountains (Holsinger 1975). In Virginia, there are approximately 4,100 caves scattered along the western edge of the state (Wil Orndorff, Virginia Department of Conservation and Recreation, Division of Natural Heritage, pers. comm. 2003). To date, 39 caves have been recorded as occurring on lands managed by the JNF.

In 1997, a Biological Opinion (BO) was issued by the FWS to the FS regarding activities outlined in the Land and Resource Management Plans for both the GWNF and JNF, and their effects on the Indiana bat. The incidental take statement in the 1997 BO anticipated annual removal or disturbance to no more than 4,500 acres of potential Indiana bat habitat and that no more than ten Indiana bats would be incidentally taken within the GWJNF annually. To date, no dead Indiana bats have been found on either of the National Forests, although the chance of finding a dead individual of this species is small. Table 1 shows the combined acreage of habitat disturbance from activities other than prescribed burning for the combined GWJNF. An average of 808 acres per year of forested habitat has been disturbed on the Jefferson National Forest since 1997, based on the information provided by the Forest Service. When combined with the average annual prescribed burning of 2500 acres on the JNF, the total average Indiana bat habitat that has been disturbed on the JNF is approximately 3300 acres per year.

Table 1. Trend in removal of or disturbance to potential Indiana bat habitat on the GWNF and JNF (unit of measure = acres).

Year (fiscal)	Timber GWNF	Timber JNF	*Total Timber Harvested	*Road Const.	*Rx Burn Line Const.	*Recreation Develop.	*Wildlife Opening Develop.	*Special Use Develop.	*Grand Totals
1998	1,449	1,293	2,742	3.15	15.8	40	7.5	5.8	2,814.25
1999	1,284	942	2,226	3.2	10.2	23	9.0	15.5	2,286.9
2000	1,254	1,115	2,369	0.1	12.7	11	14.4	12.3	2,419.5
2001	1,162	795	1,957	2.8	13.8	15	12.5	7.1	2,008.2
2002	881	332	1,213	0.3	15.1	10.5	8.0	4.2	1,251.1
2003	789	226	1,015	0.2	12.3	6.2	10.1	8.3	1,052.1

= acres for both GW & JNF

Under the 2003 Revised LRMP, the JNF manages a total of approximately 723,300 acres with 258,900 forested acres (36%) (based on Continuous Inventory of Stand Conditions (CISC) acreage) considered suitable for timber production. The remaining 464,000 acres (64%) are deemed unsuitable for timber production due to low productivity, steepness of slope, visual concerns, wilderness designation, and other resource management priorities. Over 74% of the forest on the JNF is currently greater than 70 years old (approximately 521,182 acres). Over the next 30 years, an expected 77,473 acres will move into the over 70 year old age class, increasing the mature forest condition acreage to 598,655 or 85% of the total forested acres.

Hardwood and hardwood-pine forest types have the highest likelihood of providing suitable summer roosting sites for the Indiana bat. The current CISC data indicates that approximately 21% of the JNF land base (146,700 acres) is typed as Dry and Dry Mesic Oak-pine with most trees currently in the 9" dbh or larger size class (age class 41-80 years). Approximately 67% of the JNF land base (473,400 acres) is typed as Mixed Mesophytic (12%), Dry Mesic Oak (38%), and Dry and Xeric Oak (17%) with most trees currently in a size class greater than 16" dbh (>80 years old). Therefore, a minimum of 88% of the forested land base (620,100 acres) is likely to provide the species and size classes of trees suitable for potential roost sites for Indiana bats. The remaining acres of the JNF are in vegetation types such as yellow pine, montane spruce-fir, northern hardwoods, white pine/hemlock, or grasslands, which are not considered suitable vegetation for summer roost sites. In addition, the Revised JLRMP recognizes approximately 51,500 acres as "old growth" forest (generally greater than 130 years). Of those 51,500 acres, 33,400 (65%) will not have timber harvest activities. Harvest determinations on the remaining 18,100 acres of dry-mesic oak dominated forests will be determined on a case-by-case basis.

Approximately 73,600 acres of riparian buffers (10% of the JNF land base) are located adjacent to approximately 1,053 miles of perennial stream and 1,970 miles of intermittent streams within the JNF. The JNF contains 15 impoundments greater than 1 acre in size for flood control and drinking water, as well as smaller impoundments built for recreational use. In addition, at least 335 small ponds less than 0.25 acres in size are located across the Forest that support various forms of wildlife. In total, approximately 348 acres of lakes, ponds, and reservoirs greater than acre in size occur within the JNF.

Status of the Species in the Action Area

Populations of the Indiana bat hibernating in the JNF typify a peripheral population in that they occur on the eastern edge of their range and represent roughly 0.14% of the current total estimated population. Five caves that support hibernating Indiana bats occur on or near the Jefferson National Forest, four of which are gated to control human access (Table 2). Newberry-Bane Cave is not gated but access is strictly controlled by the private landowners. Two (Shires Cave and Kelly Cave) of the eleven known hibernacula in Virginia occur on the JNF providing for a portion of the estimated 1,081 individuals statewide (approximately 2.5% of the known Virginia population).

Table 2. Indiana bat populations within hibernacula on or near the JNF since 1970. Adapted and modified from the 2003 Biological Assessment for the JLRMP.

	Number of Bats Counted				
Winter Survey Year	Shires Cave, VA**	Newberry-Bane Cave, VA	Kelly Cave, VA**	Rocky Hollow Cave, VA	Patton Cave, WV
1970				1,200	
1978				750	
1981					3
1984				647	
1985				270	
1986		90	1		
1988	13				0
1989	13				
1990	3	120			
1991				202	
1992		100			
1993	20	107	18	241	
1994					
1995		110			
1996	27				
1997			10*		
1998					17
1999	23	120	10		
2000		235			8
2001	36		3	166	
2002					10
2003	19	189	9	325	

Blank cells = no survey done that winter or data not available
*Incomplete survey of Kelly Cave was done in 1997
**Cave located on Forest Service land

Steps have been taken by the Jefferson National Forest to protect these caves for the Indiana bat. In 1995, bat gates were installed in the entrance of Shires Cave on the New Castle Ranger

District and Kelly Cave on the Clinch Ranger District. Kelly Cave has historically received heavy recreational visitation. Prior to gating, some cave rescues occurred in the winter months confirming recreational use of the site during the hibernation period. The most recent (2003) survey indicated the presence of nine hibernating Indiana bats (R. Reynolds, VDGIF, pers. comm. 2003). Shires Cave historically appeared to have less human use prior to gating, but vandalism of cave closure signs indicated visitation at this site. In 2003, nineteen Indiana bats were observed during the winter count (R. Reynolds, VDGIF, pers. comm. 2003), a decrease in number from the 2001 count of 36. Rocky Hollow Cave, Newberry-Bane Cave, and Patton Cave are on private land, but are located 0.32, 0.25, and 1.08 miles from JNF land, respectively. Therefore, portions of the primary and/or secondary cave protection areas extend onto the Forest. Cave Springs Cave (Clinch Ranger District) has been gated but is not currently known to be a hibernaculum for any rare bat species (however, it has the potential to serve as a hibernaculum) and is known to contain a variety of rare troglobitic amphipods and isopods.

In an attempt to learn more about summer foraging, roosting and potential use of the GWJNF by Indiana bats, Hobson and Holland (1995) initiated a study in the spring of 1993. The purpose of the study was to determine if male Indiana bats wintering in a Virginia cave remained in the vicinity of the hibernaculum during spring and summer months, and to characterize foraging and roosting habitats of male Indiana bats. The study took place within the George Washington NF in proximity to Starr Chapel Cave, Bath County, in the Warm Springs Ranger District. On April 28, 1993, two male Indiana bats were captured at the cave and fitted with radio transmitters. They were observed (radio telemetry located) for two weeks (until transmitter battery failure) and subsequently followed with night vision goggles and ultrasonic detectors. One of the male bats was never located from the ground after release, but its signal was detected by an aircraft in the cave area May 8 and 10, 1993. The other male bat foraged in the GWNF until May 20, 1993 when the transmitter battery failed. For 19 days, the bat roosted in a mature (98 feet tall, dbh of 24") live shagbark hickory above Back Creek near the Blowing Springs Campground (approximately 10 air miles southwest of Starr Chapel Cave hibernacula). The roost tree was located on a steep, north-facing slope at an elevation between 667 to 758 meters (2,187 to 2,486 feet). The surrounding forest consisted of mature shagbark hickory, pignut hickory, American basswood, red maple, red oak, and tulip poplar. The male bat foraged over mature forest and riparian areas near the roost tree, encompassing approximately 625 ha (1,540 acres). In addition, ten other bats were observed roosting in the same tree. While netting efforts did not capture these bats, discussions with other Indiana bat researchers led the FS to believe that these were also Indiana bats (R. Reynolds, VDGIF, pers. comm. as cited in the 1997 Biological Opinion). This was the first evidence that Indiana bats roosted and foraged on the GWNF during summer months.

It is difficult to quantify summer roosting habitat for the Indiana bat at a range-wide, regional, or local level due to the variability of known roost sites and lack of knowledge about landscape scale habitat characteristics. According to recent telemetry studies, Indiana bats appear to be very adaptable, living in highly altered landscapes and are somewhat dependent on ephemeral resource (dead or dying trees). Two recent telemetry studies in Virginia documented use of a variety of habitats within 2 miles of two caves on the JNF (Nutt 2001, Brack and Brown 2002). In late September 1999, four Indiana bats (3 males, 1 female) were trapped and fitted with radio transmitters at the entrance of Rocky Hollow Cave in Wise County, Virginia (Nutt 2001). From September 23rd to October 13th (21 days) three roost trees were located (all on private land) that were used by two of the bats (one male and one female). The female used two different trees in open woodlands approximately 1.5 miles southwest of the cave near the Lonesome Pine Country Club. One was a shagbark hickory 19" dbh and the other was a yellow poplar with peeling bark that had been damaged during a logging operation located next to a skid-road. The tree occupied by the male bat was used as a roost on multiple days and was a pignut hickory 28" dbh located 0.15 miles north of the cave. Other observations made during the course of the study included extensive foraging activity over hayfields and along edges of forests and fields.

During September and October of 2000, an extensive survey was made of fall swarming activity near Newberry-Bane Cave in Bland County, Virginia as part of the proposed American Electric Power (AEP) 765kv Wyoming (WV) to Jacksons Ferry (VA) powerline project (Brack and Brown 2002). Of 27 Indiana bats captured (24 males and 3 females) at the mouth of Newberry-Bane Cave, 17 (14 males and 3 females) were fitted with transmitters. Radio-tagged bats were monitored between September 9 and October 21 within 2-miles of the cave entrance.

Information gathered by Brack and Brown (2002) on foraging ecology found that Indiana bats most frequently used agricultural land (44.7%), intermediate deciduous forests (22.6%), and open deciduous forests (19.0%), comprising 86.3% of all habitat types used for foraging during the survey. The bats' activity areas included proportionally more agricultural lands and open forests than were available in the study area. Closed canopy woodlands were not used by foraging bats to the extent they were available. The study concluded that Indiana bats more frequently used rights-of-way, pasture edges, savannah-like woods, and other openings rather than large, continuous tracts of closed canopy forests. These findings are consistent with the interpretation of telemetry data in similar studies (Brack 1983, Callahan 1993, Gumbert et al. 2002).

During Brack and Brown's (2002) survey, a total of 26 roost trees were identified for 8 of 17 bats fitted with transmitters. Of the 26 roost trees, 39% were shagbark hickories (*Carya ovata*) and 12 % northern red oak (*Quercus rubra*). Other tree species used as roosts included white oak (*Quercus alba*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), American basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*). Five (19%) of the roost trees were dead snags. All roost trees were located in close proximity to the cave entrance ranging from 0.16 to 0.86 miles, with an average distance of 3,280 feet (0.6 miles). All roost trees were located near forest canopy openings such as open woodlands or pastures, scattered trees of recently logged areas, old logging roads, utility line corridors, and natural drainages. Five of the eight bats used the same roost tree for two to three consecutive days. Roosts were located in all types of deciduous forests, but exhibited a disproportional small use of mixed evergreen and deciduous forests. Roosts trees were very exposed with little or no canopy. It is likely that the bats were taking advantage of exposure to solar radiation in order to better regulate body temperature. Many open-canopy areas existed due to recent logging activity that left scattered trees within the harvested areas. Roosts in closed canopy deciduous forests were often in small openings near open corridor flyways.

While much of the activity observed by Brack and Brown (2002) was close to the cave (within approximately 0.6 mile), bats also left the 2-mile study area all together. Males more so than females tended to range further from the cave. Perhaps they would leave to forage where there was less competition for prey (the caves in the area serve as hibernacula for over 8,000 individual bats of at least five different species) and return to the cave area periodically to mate. It is likely that roosting and foraging activity also occurred outside this 2-mile area, however, monitoring was not conducted beyond the two mile radius.

It is not known whether there are any maternity colonies of the Indiana bat on the JNF or elsewhere in Virginia. Limited evidence suggests the presence of maternity colonies in Virginia and West Virginia. A juvenile male was discovered in West Virginia on August 5, 1999 (Kiser et al. 1999). It is not known whether the juvenile bat had immigrated from a distant or resident maternity colony. Similarly, a juvenile male was captured on July 28, 1992 in Cumberland Gap National Historic Park, Lee County, Virginia (Hobson 1993). Based on this limited information, it is reasonable to assume that there may be some maternity roosts in Virginia, but that if present, the maternity colonies are likely to be small and widely dispersed since Virginia is on the periphery of the species range. It is more likely that the majority of this species' habitat in Virginia is occupied by males. Wooded lands closer to hibernacula are more likely to support males in summer than areas farther away, but essentially all of the Jefferson National Forest may provide suitable migratory and summer habitat for both males and females of the species.

It is impossible to quantify the actual number of Indiana bats that forage and roost throughout the summer on the JNF. However, it is reasonable to assume that the percentage of the Indiana bats that forage and roost on the JNF is relatively proportional to the number of Indiana bats known from hibernacula located on or in near proximity to the JNF. Based on the last ten years of survey data collected from the five hibernacula on or near the JNF (Table 2), an average of 443 Indiana bats may forage and roost on the JNF each summer. This is probably an over-estimation of the number of Indiana bats that roost and forage on the JNF since the lands available to these bats include other areas that are predominantly under private ownership. To provide an analysis of the approximate number of Indiana bats that may use the JNF for summer roosting and foraging, the FWS made the following assumptions:

1. Assuming Indiana bat immigration equals emigration in this area, the 10-year average number of Indiana bats (443 from surveys of the five hibernacula on or near the JNF) represents the population that may use the JNF and other nearby lands for summer roosting and foraging. This assumes some of the bats that winter in the hibernacula leave the area altogether, but other bats immigrate into the area from farther away.
2. Indiana bats from these five hibernacula primarily utilize the Appalachian range and that this area can be defined by the following 4th level watersheds: The Middle and Upper New River, North Fork Holston River, Powell River, Upper Clinch River, Upper Cumberland River, Upper James River, and Upper Levisa River. Three watersheds of the JNF (Middle James-Buffalo, Upper Roanoke, and South Fork Holston) are in the Piedmont and Blue Ridge physiographic regions, where it is less likely that Indiana bats may occur.

Based on these assumptions, the estimated 443 Indiana bats that may summer in this area have approximately 6,186,241 acres of land available to them for roosting and foraging. Of this acreage, 611,643 acres (~10%) are owned by the JNF. Assuming Indiana bats were distributed evenly over the land-area defined by the combined 4th level watersheds, an estimated 44 Indiana bats (10% of the Indiana bats that hibernate on or near the JNF) may forage and roost on the

JNF. It is not likely, though, that the bats would be evenly distributed. It is more likely that male bats may be found closer to the hibernacula during all seasons, and that any pregnant females would be found in larger groups in any maternity colonies, which could occur anywhere with suitable habitat on the JNF.

IV. EFFECTS OF THE ACTION

Direct Effects

Direct impacts to the Indiana bat could occur as the JNF continues to implement its forest-wide management activities. Occupied and potential roost trees could be directly affected by vegetation management, (timber sales, prescribed burns, herbicide treatments) firewood and salvage sales, routine maintenance/permitting of small clearings including easements, rights-of-way and reasonable access to privately-owned lands, and road construction. Plan implementation will result in vegetation disturbance and possible impact to occupied (but unknown) maternity and roost trees. Direct impacts to the Indiana bat may result in direct mortality or injury to undetected individuals or small groups of roosting bats during timber harvest, site preparation, or other activities that result in the removal of trees. The likelihood of cutting a tree containing a maternity colony or individual roosting Indiana bat is anticipated to be low, but not discountable, because of the large number of suitable roost trees present on the JNF, the rarity of the species, and the wide dispersal of Indiana bats and maternity colonies throughout the species' range.

Timber Cutting

Direct effects to Indiana bats could result from the harvesting of hardwood and hardwood/pine habitat or other types of tree removal, forcing the bats in a roosting or maternity colony to abandon a traditionally used site. Additional stress would be placed on pregnant females that are already expending energy. Lower reproductive success or lower survival of young could also result with forced abandonment of lactating females. The FS anticipates that annual regeneration harvests will affect approximately 1,830 acres of potential Indiana bat habitat on the JNF. Salvage operations have averaged about 178 acres a year, but not all salvage occurs in habitats suitable for the Indiana bat. Road construction and maintenance is estimated at about 2.4 acres a year. Tree removal from minor special use permits is estimated at 2 acres a year, and for recreational facilities at 18 acres a year.

Personal Firewood Use

The National Forest fuelwood program allows the public to purchase and collect downed or standing/leaning dead trees for personal firewood use. The program is regulated by issuance of an area-specific permit, and collection occurs primarily along roadsides and other specified sites with easy access. Vehicles must remain on open roads and are not allowed to travel through the forest in order to find, cut, and load firewood. This therefore restricts the distance at which most people are willing to cut and haul firewood and results in most firewood being cut within 150 feet of an open road, and limited almost exclusively to level terrain or the uphill side. During 2001 and 2002, the JNF issued 510 and 466 firewood permits, respectively, for an average of 488 permits over the two-year period. Each permit allowed for the collection of 2 cubic feet (CCF) of firewood (2 CCF roughly equals 1.5 cords of firewood). Therefore, 488 permits equal approximately 732 cords of firewood. Based on yield tables from Firewood Volume Tables

(Mize & Prestemon, 1998), a red oak 16" dbh and 60 ft. tall contains approximately 0.50 cords of firewood, while a white oak the same diameter and height contains approximately 0.54 cords. Therefore, the 732 cords of firewood collected as an average during 2001 and 2002 equals approximately 1,464 dead trees (in this case red oak 16" dbh, 60 ft. tall).

The approximate number of standing dead trees on the JNF can be calculated based on the data collected during the 1991 Forest Inventory and Analysis conducted by the Southern Forest Research Station, Asheville, NC. (More recent data have been collected, but 1991 is the last year Forestwide data are available for analysis.) The number of dead standing trees in 1991 was 15.4 per acre with an average dbh of 9.0". Given that the JNF is approximately 723,000 acres, this equates to at least 11,134,200 snags. The northern portions of the JNF (Glenwood and New Castle Ranger Districts) have been infested with gypsy moths, and pine bark beetle infestations are now Forestwide. Oak and pine tree mortality in the overstory is extensive as a result of these insect infestations. Based on 1991 Forestwide data, personal firewood collection represents approximately 0.0135% of the total available snags. Since most snags are not close to roads or are in Management Prescriptions where firewood cutting is not allowed, the possibility of harming an Indiana bat is remote. In addition to snags, roosting Indiana bats also use live trees. Brack and Brown (2002) reported 81% of roost sites used by radio tagged Indiana bats were live trees. Assuming this trend represented Indiana bat roost selection throughout the JNF, personal firewood collection could affect 0.0027% of the potential Indiana bat roost sites. Although risk of "take" resulting from firewood cutting cannot be completely eliminated, the risk of direct effects to roosts in the vicinity of hibernacula is further minimized since the collection of firewood in primary and secondary cave protection areas is not allowed by prescription standard.

Impacts to Hibernacula

Direct effects to the Indiana bat could also result from human activity (disturbance and vandalism) during the winter in caves containing hibernating Indiana bats. Bat disturbance may cause a bat's fat reserves to become exhausted prior to spring, increasing the potential for mortality. In addition, direct mortality, due to humans killing Indiana bats in caves, has been documented (Mohr 1972). However, the potential of Indiana bats to be disturbed during hibernation on JNF has been greatly reduced or entirely eliminated with the construction of gates at both known hibernacula on the JNF, and the limitation of any human recreational use to the period of June 1 to September 1, which is controlled by the Forest Service.

Prescribed Burning

Over the past several years, the JNF has steadily increased its prescribed burn program. The JNF currently burns approximately 2,500 acres per year under prescribed conditions. The FS anticipates this to increase to as much as 11,000 to 15,000 acres of prescribed burning per year on the JNF. Most of these burns will occur during the spring and early summer with some during the late winter and early fall. Due to this increase in prescribed burning, incidental take of the Indiana bat could increase. Prescribed burning during the summer season could result in direct mortality or injury to the Indiana bat caused by burning or smoke inhalation, especially death to young bats that are not able to fly. Prescribed burns could consume standing snags, thus removing potential roost trees. Living trees suitable as roosts could potentially be killed from the heat/flames from prescribed fire. While this may remove potential live roost trees, it is also likely that the fire will increase the availability of snags. Snags could be created either directly by fire mortality or indirectly by making them more susceptible to insect attacks or pathogens (Bull *et al.* 1997). Depending on the tree species, live trees subsequently killed by fire activity would remain as suitable potential roost trees until such a time that peeling/lost bark renders them unsuitable as summer roost sites.

Summary of Direct Effects

The FS anticipates that up to 16,800 acres (2.4% of the total forested JNF) of Indiana bat habitat may be disturbed annually on the JNF as a result of timber sales, road construction, prescribed burning, control line construction, development and maintenance of recreational areas, special uses, etc. Implementation of the Revised JLRMP conservation measures (Appendix B) will minimize direct adverse effects to the Indiana bat by maintaining suitable Indiana bat roosting and foraging habitat and protecting Indiana bats from the potential effects of timber harvest and other activities. Because Indiana bats gather near hibernacula in late summer and autumn to swarm and forage, and because these bats require trees suitable for roosting during the daylight hours near each site, the JNF prohibits any logging or road construction within an approximate ½ mile radius of any hibernacula. With the additional 1.5 mile secondary buffer, the total protective buffer around the hibernacula is approximately 2.0 miles. These protective areas are based on the average foraging area seen by Kiser et al. (1996), who found Indiana bats in Kentucky foraging between 1.5 and 2.5 miles from the hibernaculum during the fall. Recent work in Missouri (Romme et. al. 2002) and Kentucky (Kiser and Elliott 1996, Gumbert 1996) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods. However, these studies were conducted in areas of rolling lower elevation topography, areas that are quite different than the ridge and valley topography of western Virginia (mountainous with vertical relief 1,300 to 2,500 feet). It is likely that Indiana bat swarming activity in the JNF is confined to the valley in which the hibernacula occurs and may extend into adjacent valleys via gaps in the surrounding ridges or mountains. Telemetry data from Virginia reported by Brack et al. (2002) suggests that the great majority of Indiana bat swarming activity occurs within 2 miles of the hibernaculum in the ridge and valley type topography. Consequently, the 2 mile protective radius around hibernacula on and near the JNF is sufficient to maintain the structural integrity of the cave system, adjoining landscapes, and provide protection for the fall swarming and foraging area, and corridors to both upland forest and riparian areas.

If maternity and roost sites are identified (to date, no maternity sites have been identified in Virginia or the JNF), a radius of approximately 2 miles and ¼ mile, respectively, around each site will be protected. The selection of 2 miles was based on the work of Gardner et al. (1991b) and Garner and Gardner (1992) who found that pregnant, lactating or post-lactating females will travel up to 1.9 miles from their roost trees to forage. In addition, LaVal et al. (1977) and LaVal and LaVal (1980) found that females traveled up to 1.5 miles from their roosts to reach foraging areas nearer to perennial streams. As roost trees are identified, a ¼ mile buffer around the roost tree will result in no logging, road construction, or pesticide use. Therefore, implementation of the above JNF conservation measures will minimize disturbances that could result in the potential taking of Indiana bats within these buffers.

Quantifying incidental take to the Indiana bat from activities on the JNF that result from harassment, injury or death is difficult. As discussed in the *Status of the Species in the Action*

Area, the FWS estimates that 10% or approximately 44 of the Indiana bats that use the five hibernacula on or within proximity to the JNF may occur on the National Forest at any one time. This estimate is based on the proportion of land owned by the JNF (10%) within the watersheds surrounding these hibernacula. However, with such limited information on the actual distribution and total numbers of Indiana bats that summer in Virginia and the surrounding areas of West Virginia and Kentucky, deriving such a number is based on best professional judgment.

Assuming that the Indiana bats that forage and roost on the JNF during the summer are evenly distributed and the number is proportional to the number of Indiana bats in hibernacula near or on the JNF, each bat would occupy 1,590 acres of JNF. If this were the scenario, 10 Indiana bats would be affected annually by the disturbance of 16,800 acres of JNF. However, the distribution of Indiana bats is not likely to be evenly distributed over the landscape. Males may sometimes be found proportionally closer to hibernacula during the summer. Indiana bats, especially pregnant females, tend to roost in colonies. Hobson and Holland (1995) observed up to 10 Indiana bats occupying a shagbark hickory tree on the Warm Spring Ranger District of the George Washington National Forest in Bath County, Virginia. Since the FS has implemented measures to protect foraging and roosting habitat within 2 miles of the known hibernacula, it is less likely that Indiana bats will be injured or killed within that zone. No maternity colonies or individual roost trees have been located on the JNF but likely occur at some low incidence over the 723,300 acres. A worse case scenario would be that one tree annually containing Indiana bats may be cut, burned, or disturbed to the point of harassing, injuring or killing the bats. Using Hobson and Holland's (1995) study as a basis for deriving a number, up to 10 Indiana bats may be impacted annually by FS activities on the JNF.

Although some direct mortality or injury to Indiana bats is anticipated as a result of tree cutting or prescribed burning, many bats are likely to survive such disturbance since the adults may be able to fly away. Belwood (2002) reported a maternity colony in Warren County, Ohio, where 6 dead bats (1 adult and 5 juveniles) were found out of 38 observed Indiana bats (5 adults and 33 juveniles) as a result of the felling of a maternity tree. After fleeing the tree, mother bats apparently returned to the site to retrieve their young. The survival and exact number of bats affected by this incident are not known; however, the finding suggests that Indiana bats have some degree of resilience to direct impacts. If it is assumed that this maternity colony included at least one mother for each juvenile (mothers only produce one juvenile per year), then at least 66 bats occupied the colony. Assuming observed mortality accurately represented actual mortality, then approximately 9% of the bats at the maternity colony were killed. However, it is reasonable to assume unobserved mortality occurred in this incident, especially to the juveniles that may have been abandoned and not observed or that died later as a result of exposure, injury, and/or starvation. Given the limited data on direct effects to Indiana bats, it is our professional judgment that less than 100 % of Indiana bats subject to disturbance will be injured or killed, but we cannot quantify that percentage with present information. Without a basis to predict an exact number, the FWS will use its best professional judgment to assume that up to 10 Indiana bats may be incidentally taken annually from activities on the JNF.

<u>Indirect Effects</u>

Indirect effects are defined as those that are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 CFR 402.02). Removal of living trees or snags that have the potential to serve as roosts for maternity colonies or individual bats, or reduction of density of mature trees and overstory canopy could result in the loss or alteration of the summer (roosting and foraging) and pre-hibernation (fall foraging) habitat. In addition, timber harvest could alter insect species composition and may reduce the availability of insects on which bats feed, thereby causing the bats to search for alternate foraging habitat.

Indirect effects to the Indiana bat due to herbicides are considered minimal since herbicides are infrequently used and integrated pest management (which targets the specific pest organisms) is the course of action typically followed. Direct application of herbicides to individual stumps, basal stem treatment, hack and squirt, and cut surface treatments are the usual methods of application. Because these methods target individual stems (versus general broadcast spraying), direct application of these chemicals to bats is not likely. Situations where broadcast application of herbicides are used include conversion of cool season grass fields to warm season grasses and roadside vegetation control. In these situations, although considered temporary, herbicide treatment may cause a short term indirect effect to the Indiana bat by reducing the amount of vegetation, and perhaps a reduction of insect populations, after treatment of an area.

Implementation of the Revised JLRMP conservation standards (Appendix B) will minimize indirect effects on the Indiana bat, Some activities that have associated negative impacts may also have commensurate beneficial effects. Potential habitat (mature forests with trees having exfoliating bark) exists across the entire JNF and contains tree species of the size and type known to be used by the Indiana bat. The retention of snags, trees with exfoliated bark, and hollow trees (as available) will allow for potential Indiana bat roost sites. Management practices that create small forest openings may foster the development of suitable roosting and foraging habitat (Krusic and Neefus 1996). Activities that involve tree removal, which could adversely affect roosting habitat, may at the same time improve foraging and/or roosting habitat conditions by opening the canopy and exposing potential roost trees to a greater amount of sunlight. Romme et al. (1995) reported that stands with closed canopy conditions (>80% canopy closure) provide less than optimal roosting habitat conditions. Selective timber harvesting that reduces canopy closure levels to <80% may enhance Indiana bat roosting habitat. Callahan (1993) stated that manmade disturbances unintentionally made nine trees suitable for Indiana bat maternity roosts. These were in areas that had been heavily logged within the past 20 years and had been used as a hog lot in recent years. Callahan also stated "those activities probably benefited Indiana bats by removing most of the canopy cover and leaving behind many standing dead trees." Gardner et al. (1991b) found that the selective harvesting of living trees did not directly alter summer roosting habitat. The development of infrequently used or closed logging roads and small wildlife openings may improve foraging habitat conditions by providing narrow foraging corridors within a larger network of mature closed canopy forest.

Most types of timber harvest activities (salvage, even-aged, uneven-aged, etc.) would require minimum snag and potential roost tree retention plus specific retention of leave trees such as shagbark hickories, as indicated in Appendix B. In stand regeneration treatments greater than ten acres in size, a minimum average basal area of 15 square feet per acre of live trees is retained throughout the rotation, and priority is given to retaining the largest available trees that exhibit characteristics favored by roosting Indiana bats (sloughing bark, cracks and crevices).

The JNF conservation measures for forest-wide conditions require that timber activities within hardwood dominated forests will leave all shagbark hickory trees (6" dbh) and a minimum number of snags or cavity trees (9" dbh) as potential roost sites except where they pose a safety hazard. The retention of these hickory trees and snags or cavity trees in relatively open habitat provide Indiana bats with good numbers of roost sites that resemble those studied by Callahan (1993) in Missouri and Kurta et al. (1993b) in Michigan. Literature summarized by Romme et al. (1995) shows the smallest roost trees where female Indiana bats have been found were in the range of 9" dhb.

In order to ensure a continuous supply of adequate roost trees, the conservation measures also require the following: a minimum of 60% of the acreage of all CISC Forest Types be maintained at 70 years of age or older; and a minimum of 40% of the acreage of CISC Forest Types 53 (white oak, northern red oak, hickory) and 56 (yellow poplar, white oak, northern red oak) on the JNF be maintained at an age greater than 80 years old. The protection for the two CISC Forest Types 53/56 was based on several components. First, these two Forest Types include shagbark hickory, white oak, and red oak as species components, each being Class I trees, which commonly occur across the JNF. In addition, the majority of known roost sites (shagbark hickory) identified in Virginia (Hobson and Holland 1995, Brack and Brown 2002) have been within an 80+ year old white-oak-red oak-hickory stand. The bat's selection of this forest type and age class prompted the FS to promote and manage these forest types in a mature condition. This age class has a high probability of containing large snags and cavity trees for roosting. Of the total JNF forested acreage (approximately 704,300 acres out of 723,300 acres total for the JNF), approximately 49% (346,500 acres) are in the 53/56 forest types. Of the total acreage of the 53/56 forest types, approximately 50% (172,700 acres) is currently >80 years old.

Acknowledging that stand age and dbh are two features that influence habitat structure, and that these parameters are easily measured at sites proposed for management, secondary cave protection areas are maintained using either of two following criteria:

> A minimum of 60% of the acreage of all Forest Types are maintained over 70 years of age; and a minimum of 40% acreage of CISC Forest Types 53 (white oak, red oak, hickory) and 56 (yellow poplar, white oak, red oak) are maintained at an age greater than 80 years old;
>
> OR
>
> When the above age criteria cannot be met, forest stands receiving even-aged regeneration harvesting are maintained with a minimum of 20 trees per acre in the 10-16 inch dbh class and 15 trees per acre in the greater than 16 inch dbh class, of which two trees per acre must be 20 inches dbh or greater.

The protection and promotion of mature upland forests was based on findings of conducted research (LaVal et al. 1977; LaVal and LaVal 1980; Garner and Gardner 1992; Hobson 1993, Romme et al. 1995). The foraging area selected by individual bats in studies conducted in Virginia (Hobson and Holland 1995, Brack and Brown 2002) have been comprised of mature forest of 70+ years with a closed canopy. Of the total forested acreage unsuitable for timber harvest (436,300 acres), approximately 74% (322,900 acres) are greater than 70 years old.

Approximately 65% (174,200 acres) of the harvestable timber is considered greater than 70 years old. For all forest types on the Forest, 78% (552,608 acres) are greater than 70 years old.

The retention of a minimum of 35 trees per acre, each of which is 10" dbh or greater is based on the knowledge that preferred roost sites are in trees that are 9" dbh or larger. Since most maternity trees that have been discovered to date have been 16" dbh or larger (Gardner et al. 1991, Callahan 1993, Hobson and Holland 1995, Romme et al. 1995, Kurta et al. 1996), the JNF determined that it would be preferable if some of the residual trees per acre be comprised of this size.

Based upon the evidence of overlapping foraging areas (Garner and Gardner 1992), and the occurrence of over 322,900 acres of forest >70 years old, the FWS believes that implementation of the JLRMP conservation measures will provide adequate foraging and roosting habitat for the maintenance and promotion of Indiana bats. Studies in other states have identified Indiana bats utilizing a variety of habitat types from open fields to mature forests. This trend is further supported by the findings of Brack and Brown (2002) during a telemetry study conducted in Bland County, Virginia. According to the 2002-2003 winter survey, Indiana bat numbers are increasing slightly over the past 15 years in hibernacula on and near the JNF (R. Reynolds, VDGIF, pers. comm. 2003). This may be an indication of adequate foraging, roosting, and possibly maternity sites in the area with the increase due to lessened human disturbance in hibernacula.

The use of early successional habitat for foraging has been documented by several authors (LaVal et al. 1977; Gardner et al. 1991b; Garner and Gardner 1992) and is considered a legitimate habitat need. Romme et al. (1995) identified essential summer habitat as including 30%+ forested cover on a landscape scale. The Revised JLRMP conservation measures provide for more than twice the forested area (at least 60% of the JNF be maintained in a mature forest condition) recommended by Romme et al. (1995). Data from a study of habitat usage by bats in Virginia showed more summer foraging activity in regeneration areas than in pole timber, small saw timber, or large saw timber forest stands (Nutt 2001).

Prescribed fire may also improve Indiana bat foraging and roosting habitat by creating a mosaic of early to late successional forest stages. Prescribed burning most often results in some degree of midstory mortality to small-diameter trees and shrubs, producing more open understory conditions. Opening of the midstory may improve foraging and roosting habitat conditions. Individual mortality to trees would increase the number of snags and create scattered canopy gaps, which would improve roosting. Increased insect populations produced in burned areas for foraging is also likely to occur in successional years.

Proposed riparian prescriptions in the Revised JLRMP will further protect riparian areas, an important drinking water source and foraging area for Indiana bats. There are approximately 73,600 acres (10% of the JNF land base) of riparian areas associated with 1,053 miles of perennial streams and 1,970 miles of intermittent streams located throughout the JNF. There are also approximately 348 acres of lakes, ponds, and reservoirs and at least 335 small ponds scattered across the JNF. The FWS believes these provide adequate Indiana bat drinking water sources throughout the Forest.

V. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of ESA.

American Electric Power (AEP) has proposed a 90-mile long, 765 kV electric transmission line on a 200-foot wide right of way, connecting AEP's Wyoming station, located in Wyoming County, West Virginia, with its Jackson Ferry station, located in Wythe County, Virginia. The Forest Service served as the lead Federal action agency for the various Federal permits associated with this transmission line, and issued an environmental impact statement on the project in 2002. The FS issued a special use permit for this project on November 9, 2003. The proposed transmission line would cross 11.3 miles of the Jefferson National Forest, within the action area of this current consultation. The Indiana bat is known to occupy Bane Cave in the Skydusky Hollow Cave system, approximately 1.25 miles from the proposed AEP transmission line right of way in Bland County, Virginia. Direct effects to the Indiana bat from the AEP project have been avoided by precluding any clearing within 0.5 mile of the hibernaculum and by time of year restrictions that preclude clearing and blasting from 0.5 to five miles of the hibernaculum during the period of April 1 through November 15. Activities farther than five miles from the hibernaculum would be precluded during April 15 through September 15, or would only be conducted after mist netting indicated that the Indiana bat was unlikely to be present in the right of way area. Indirect effects to the Indiana bat from the AEP project include the clearing of approximately 1,614 acres of potential habitat within the right of way and for access roads. (Of the 1,614 acres, 271 acres have been permitted for clearing within the Jefferson National Forest.) The 1,614 acres represents 1.1 percent of the 140,898 acres of potential Indiana bat habitat within two miles of the AEP right of way. In its letter of December 18, 2002 to the Forest Service, the FWS concurred that the AEP project was not likely to adversely affect the Indiana bat, given the large amount of habitat in the project area that would remain after project construction, the avoidance of clearing within 0.5 miles of the hibernaculum, and the time of year restrictions on habitat clearing and blasting.

Activities on private land adjacent to and inholdings within the Jefferson NF are expected to continue at rates as they have in the recent past. Small easements are granted for inholdings through special use permits by the FS. Ten to fifteen projects per year are anticipated to occur on the JNF affecting no more than 30 acres of JNF land. This amount of annual disturbance has been factored into the analysis of take.

This biological opinion addresses activities authorized, funded, or carried out on the Jefferson National Forest, which are under the jurisdiction of the U.S. Forest Service. Any future Federal, State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion will either be carried out by, or will require a permit from, the Forest Service and will require compliance with Section 7 of the ESA. Therefore, cumulative effects, as defined by the ESA, will be analyzed under future consultations between the Forest Service and the Fish and Wildlife Service for any activities within the Jefferson National Forest.

VI. CONCLUSION

Regulations implementing Section 7(a)(2) of the ESA (50 CFR 402) require the FWS to formulate its biological opinion as to whether a Federal action that is the subject of consultation, taken together with cumulative effects, is likely to jeopardize the continued existence of listed species or the adverse modification of critical habitat. "Jeopardize the continued existence of" is defined by this regulation as, "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." "Destruction or adverse modification" of critical habitat is defined as, "a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical."

In reaching a decision of whether the continued implementation of activities outlined in the JLRMP is or is not likely to jeopardize the continued existence of the Indiana bat, the FWS must factor into its analysis previous biological opinions and any incidental take permits issued to private individuals pursuant to Section 10 of the ESA involving the species. Although a few previously issued biological opinions involve the loss of riparian corridors or foraging and roosting habitat for the Indiana bat, most involve large scale activities implemented under Land Resource Management Plans on National Forests in the Eastern United States. Such opinions involve the potential impact to the largest acreage of Indiana bat roosting and foraging habitat. All previously issued Service biological opinions involving the Indiana bat have been nonjeopardy. The opinions with the largest amount of incidental take were to the U.S. Forest Service for the Cherokee, Daniel Boone, Ozark and St. Francis, Nantahala and Pisgah, Mark Twain, Alleghany, Ouachita, and George Washington and Jefferson National Forests, as shown in Table 3. There has been one Section 10 incidental take permit issued to date, for the Six Points Road Interchange and Associated Development Project, in which the FWS anticipated the incidental take of 344 acres of Indiana bat habitat, which would be a one time permanent impact.

Table 3. Annual Anticipated Incidental Take as Identified in Biological Opinions Previously Issued by the FWS Involving National Forests in the Eastern United States.

Forest	Annual Anticipated Incidental Take (Acres)	Estimated Number of Indiana Bats Potentially Affected
Alleghany	13,984[1]	~400
Cherokee	1,300	~200[2]
Daniel Boone	4,500	~1,600[2]
Mark Twain	38,375	~500
Ozark and St. Francis	19,000[3]	~1,000
Ouachita	43,000	~9
Nantahala and Pisgah	10,772	~25
George Washington & Jefferson	4500	~10
Totals	135,434	~3,744

[1] Five-year average.
[2] MacGregor, personal communication, 1999 as cited in USFWS 2000.
[3] Includes hardwoods, pines, and pine/hardwoods, all of which provide suitable roosting habitat for the Indiana bat.

The cumulative impacts of an annual anticipated incidental take of 135,434 acres on these eight National Forests and the one time loss of 344 acres from the Section 10 permit, and the potential impact to the Indiana bat were evaluated within the context of: (1) the large amount of remaining surrounding landscape that provides suitable foraging and roosting habitat for the species, (2) the conservation measures incorporated into a particular management plan to minimize the impact of tree and habitat removal, (3) the terms and conditions associated with the reasonable and prudent measures provided by the FWS in its nonjeopardy biological opinions for each National Forest that minimize the impact of incidental take, and (4) the percentage of the rangewide population that is predicted to be impacted by the proposed actions. While it is doubtful that the level of incidental take of individual Indiana bats has reached the anticipated number of 3,744 per year, if such a level was reached, it would constitute about 1 percent of the known population of the species. The FWS believes that this amount of incidental take does not rise to the level of effect that would significantly reduce the reproduction, overall population, or distribution of the Indiana bat.

After reviewing the current rangewide status of the Indiana bat, the environmental baseline for the action area, the effects of forest management and other activities on the JNF as described in the 2003 Revised Land and Resource Management Plan, and the cumulative effects, it is the FWS's biological opinion that implementation of forest management and other activities as specified in the Jefferson Land and Resource Management Plan are not likely to jeopardize the continued existence of the Indiana bat. Critical habitat for this species has been designated in Kentucky, Tennessee, Illinois, Indiana, Missouri, and West Virginia. However, this action does not affect those areas and no destruction or adverse modification of that critical habitat will occur as a result of JNF management activities.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the ESA, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the U.S. Forest Service (FS) and become binding conditions of any permit, contract, or grant issued by the FS in order for the exemption of Section 7(o)(2) to apply. The Forest Service has a continuing duty to regulate the activity covered by this incidental take statement. The protective coverage of Section 7(o)(2) may lapse if the Forest Service (1) fails to assume and implement the terms and conditions of the incidental take statement, and/or (2) fails to require any permittee, contractor, or grantee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, permit or grant document. In order to monitor the impact of incidental take, the Forest Service must report the progress of the action and its impact to the FWS as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

AMOUNT OR EXTENT OF INCIDENTAL TAKE ANTICIPATED

This incidental take statement anticipates the taking of Indiana bats from habitat manipulation activities (e.g., timber sales, road construction, prescribed burning, control line construction, development and maintenance of recreational areas, special uses, etc.) on up to 16,800 acres per year on the JNF. The incidental take of individual Indiana bats as a result of forest management activities or other actions implemented on the JNF will be difficult to quantify and detect due to: 1) the bat's small body size, 2) formation of small (i.e., 25 or fewer to 100 individuals), widely dispersed colonies under loose bark or in cavities of trees, and 3) unknown aerial extent and density of the species summer roosting populations range within JNF.

Incidental take of Indiana bats is expected to be in the form of killing, harming, or harassing. Cutting trees during the non-hibernation season for harvest or other activities may result in injury or mortality to females and young, or to individually roosting male Indiana bats, if a particular tree that is cut contains a maternity colony or roosting bats. If the bats are not killed, the colony or roosting individuals will be forced to find an alternate roost or may be forced to abandon a roost in the area, possibly leading to lower reproduction or survival. Clearing an area may also result in alteration of feeding activities by the bats (i.e., the bats may have to fly farther to forage, or they may be forced to abandon the area altogether). Prescribed burns may result in burning of occupied roost trees, and the smoke and fire generated during prescribed burns could cause roosting bats injury or death. Burning may cause a maternity colony or individual roosting bat to abandon a traditionally used roost site.

Determining the amount of take of individual bats within an expansive area of forested habitat such as the 723,300 Jefferson National Forest is a complex and difficult task. Unless every individual tree that exhibits characteristics for suitable roosting habitat is inspected by a knowledgeable biologist before habitat disturbance begins, it is impossible to know if a maternity colony or roosting Indiana bat(s) is present in an area. It is also impossible to evaluate the amount of incidental take of Indiana bats unless a post-disturbance inspection is immediately made of every tree that has been cut or disturbed. Inspecting individual trees is not considered by the FWS to be a reasonable monitoring method and is not recommended as a means to determine incidental take. The FWS believes if a maternity colony or roosting individuals are present in an area proposed for timber harvest or other disturbance, loss of such suitable habitat could result in incidental take of Indiana bats. Therefore, the level of take of this species can be indirectly anticipated by the areal extent of potential roosting and foraging habitat affected.

Disturbance of Indiana bat habitat on the JNF, excluding prescribed burning, is anticipated to impact approximately 1,800 acres per year. Prescribed fire is estimated to affect up to 15,000 acres of potential Indiana bat habitat per year. The combined activities are expected to result in an annual removal of or disturbance to up to 16,800 acres of potential Indiana bat habitat (2.4% of the total forested JNF land base). However, the consequent taking of Indiana bats is significantly reduced through implementation of the protective standards found in Appendix B of this Biological Opinion. We also recognize that prescribed burning may improve habitat for the Indiana bat on the JNF by creating additional roost trees and open understory. While the FWS believes that the JNF has taken a significant number of measures to greatly reduce impacts to the Indiana bat, we cannot rule out injury or mortality to the species completely. Based on our analysis of the effects of the action in Section IV of this Biological Opinion, the FWS believes that it is reasonable to estimate that there may be up to 10 Indiana bats on the JNF incidentally taken on an annual basis through actions that kill, harm, or harass.

EFFECT OF THE TAKE

In the accompanying biological opinion, the FWS determined that this level of anticipated take is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of critical habitat. Implementation of the Indiana bat recovery strategies described in the JNF's standards and guidelines of the 2003 Revised JLRMP, and the reasonable and prudent measures (with implementing terms and conditions) presented below should minimize the potential for incidental take of Indiana bats.

REASONABLE AND PRUDENT MEASURES

The U.S. Fish and Wildlife Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of the Indiana bat:

1. Proposed land management activities will be planned, evaluated and implemented consistent with measures developed to protect the Indiana bat and maintain, improve, or enhance its habitat. These measures include, but are not limited to, the standards and guidelines developed in the Revised JLRMP, the GWJNF Indiana Bat Recovery Strategy, and terms and conditions outlined in this biological opinion.

2. The JNF will monitor timber sales and other activities to determine if these measures are being implemented and to document the extent of incidental take.

3. The JNF will continue its efforts to determine use of the JNF by Indiana bats during the hibernation, summer roosting, maternity, and pre-hibernation seasons.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of Section 9 of the ESA, the U.S. Forest Service (FS) must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline the required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. In order to minimize possible adverse impacts to Indiana bats and promote recovery of this species within the Jefferson National Forest (JNF), the FS will implement the prescriptions and forest-wide standards outlined in Appendix B of this Biological Opinion.

2. The FS will consult with the Fish and Wildlife Service (FWS) on a case by case basis to determine direct, indirect, and cumulative effects on Indiana bats for the following activities:

(a) Large-scale projects and management activities not covered under the JNF Land and Resource Management Plan, including but not limited to utility corridors (such as transmission lines, oil and gas pipelines); transportation projects; mineral, oil and gas exploration and extraction; wind energy projects; water development projects; and pesticide programs (with the exception of non-aerial herbicide programs).

(b) All activities that may affect Indiana bats or their habitat within 2 miles of Indiana bat hibernacula and/or maternity colonies, and within ¼ mile of known individual roost trees, unless covered by the JNF Land and Resource Management Plan standards as defined in Appendix B.

3. The amount of incidental take as measured indirectly by acreage (both total and categorical levels) must be monitored on an annual basis. The FS will report the number of acres disturbed on a fiscal year basis, to include regeneration harvest, salvage, road construction and maintenance, prescribed burns, and other actions such as special use permits and recreational uses, and will report the estimated number of trees removed for personal firewood. This information is to be provided to the FWS no later than March 1 following the end of the previous fiscal year's activities. Monitoring of timber sales, prescribed burning, and the above activities will be implemented as follows:

(a) Project administrators or biologists will conduct and report normal inspections of projects as identified in Table 1 of the Biological Opinion, prescribed burns, and personal firewood programs to ensure that measures defined in these Terms and Conditions have been implemented. Timber sale administrators will conduct normal inspections of all timber sales to administer provisions for protecting residual trees (residual trees are those trees not designated for cutting under provisions of the timber sale contract). Unnecessary damage to residual trees will be documented in sale inspection reports and proper contractual or legal remedies will be taken. The JNF will include this information in their annual monitoring reports to the FWS.

(b) Consultation between the FWS and the FS will occur as needed in order to review and determine any need to modify provisions of the biological opinion, and other issues regarding the Indiana bat.

4. The FS will continue its efforts to determine use of the JNF by Indiana bats during the hibernation, summer roosting/maternity, and pre-hibernation seasons by implementing the following monitoring. Selection of sites for monitoring and research will be left to the discretion of the JNF biologists in consultation with the FWS and/or Virginia Department of Game and Inland Fisheries. The FWS believes that implementation of this term and condition is necessary to evaluate the underlying assumptions made on Indiana bat presence and characterized use on the JNF. Implementation of this term and condition will, in turn, provide a more site-specific measure of the protective adequacy of the conservation measures for the Indiana bat on the JNF.

a. Continue JLRMP monitoring by working with the FWS, universities, the Virginia Department of Game and Inland Fisheries, the Virginia Department of Conservation and Recreation, and local experts to locate and survey caves and mines that may contain Indiana bats. Surveys of all known Indiana bat hibernacula shall continue every two years following the protocol of the Indiana Bat Recovery Team. After any new gating of a hibernaculum, yearly surveys shall be conducted to determine the effects of the gates on all bat species. This effort will be conducted for the first three years after gating and then continue with biennial monitoring according to the Indiana bat Recovery Team protocol.

b. Continue monitoring efforts to refine the distribution and abundance of the Indiana bat on the JNF. Survey efforts shall be focused on those areas which, based on habitat characteristics (e.g., percent canopy closure, presence of suitable roost trees, proximity to water, etc.) and/or previous survey results, appear to be conducive to maternity colonies. These surveys shall be designed to determine the distribution of the species on the JNF and its habitat use and movements during the spring through fall periods. If any Indiana bats are captured during mist net surveys, the FWS and the Virginia Department of Game and Inland Fisheries must be notified within 24 hours. The habitat at identified maternity sites will be characterized and quantified, and these habitat data will then be used to assist in identifying additional sites. Information gained during these studies can be used to refine FS strategies for the protection and management of the species.

c. Habitat at all sites where Indiana bats are documented on the JNF shall be characterized and quantified at both local and landscape levels.

d. The FS shall provide the results of these surveys to the FWS within 6 months of completion.

5. Care must be taken in handling dead specimens of listed species that are found in the project area to preserve biological material in the best possible state. In conjunction with the preservation of any dead specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the FWS to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective. Upon locating a dead, injured, or sick specimen of an endangered or threatened species, initial notification must be made to the U.S. Fish and Wildlife Service at the telephone number and address provided below.

6. The Forest Service shall provide all required monitoring reports and any other additional information to the FWS at the following addresses:

Southwestern Virginia Field Office
U.S. Fish and Wildlife Service
330 Cummings Street
Abingdon, Virginia 24210
Phone: (276) 623-1233
Fax: (276) 623-1185

Virginia Field Office
U.S. Fish and Wildlife Service
6669 Short Lane

Gloucester, Virginia 23061
Phone: (804) 693-6694
Fax: (804) 693-9032

The FWS believes that no more than 16,800 acres (15,000 acres prescribed burning and 1,800 all other disturbances) annually of potential Indiana bat habitat will be disturbed as a result of the proposed action, and that no more than 10 Indiana bats may be incidentally taken on an annual basis on the Jefferson National Forest. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize incidental take that might otherwise result from the proposed actions. If, during the course of the action, this level of incidental take is exceeded, as measured by the total amount of habitat disturbance or the location of injured or dead Indiana bats, such incidental take represents new information requiring review of the reasonable and prudent measures. The U.S. Forest Service must immediately provide an explanation of the causes of the take, and review with the FWS the need for possible modification of the reasonable and prudent measures and the terms and conditions.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The FWS believes this provision of the ESA places an obligation on all Federal agencies to implement positive programs to benefit listed species, and a number of recent court cases appear to support that belief. Agencies have some discretion in choosing conservation activities, but Section 7(a)(1) places a mandate on agencies to implement some type of conservation program.

The FWS recommends that the FS implement the following conservation actions for the benefit of the Indiana bat:

1 The protection of Rocky Hollow Cave through conservation easement or acquisition is recommended and should be given a high priority. This is one of the largest known historic hibernacula in Virginia and is located adjacent to JNF lands.

2 It is recommended that the FS give high priority to the protection of inholdings and lands near primary cave protection areas through conservation easements or acquisition.

3. It is recommended the FS pursue the purchase of mineral rights to the area surrounding Kelly Cave.

4 Comparative evaluations of the effectiveness of mist-netting surveys and Anabat detectors are strongly encouraged. We recommend tracking studies using radio-telemetry to identify and characterize roost trees and foraging habitat.

5. Where appropriate, FS biologists should conduct training for employees regarding bats in the National Forests. Training should include sections on bat identification, biology, habitat requirements, and sampling techniques.

6. Approximately 20 million people visit the JNF annually. Therefore, informational/ educational displays regarding all bats occurring on the JNF are strongly encouraged. The FWS believes that such information is important in informing the public about the value of this misunderstood group of mammals.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on land and resource management and other actions conducted on the Jefferson National Forest. This biological opinion will remain in effect for the duration of the current JLRMP and will constitute compliance with the ESA's section 7 consultation requirements for future actions covered by the JLRMP, provided that those actions are carried out in compliance with all of the requirements contained in this biological opinion, or until one or more of the following conditions arise. As provided in 50 CFR Sec. 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

The FWS appreciates this opportunity to work with the U.S. Forest Service in fulfilling our mutual responsibilities under the ESA. Please contact Shane Hanlon of the Southwestern Virginia Field office at (276) 623-1233, extension 25 if you have any questions or require additional information.

Sincerely,

Karen L. Mayne

Karen L. Mayne
Supervisor
Virginia Field Office

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Appendix A – Consultation History

06/1993	The George Washington and Jefferson National Forest (GWJNF) began working with the U.S. Fish and Wildlife Service (FWS), Virginia Department of Game and Inland Fisheries (VDGIF), and Ferrum College to develop a comprehensive Indiana Bat conservation plan.
1996 - 1997	Discussions were reinitiated between the FWS and GWJNF regarding a programmatic consultation of the GWJNF forest management activities and other actions that alter forest habitats. In addition, the GWJNF was concurrently revising the draft 1993 Indiana Bat Conservation Plan and developing a comprehensive Indiana Bat Recovery Strategy (IBRS).
04/1997	A Biological Assessment was finalized by the Forest Service (FS) on the effects of implementing GWJNF management plans on the Indiana bat.
05/13/1997	A request by the FS for initiation of formal consultation was received by FWS regarding the 1985 Jefferson National Forest Land and Resource Management Plan (JLRMP) and the 1993 George Washington Land and Resource Management Plan (GWLRMP).
9/16/1997	FWS non-jeopardy Biological Opinion on the Indiana bat was sent to FS.
02/11/1999	Letter from the FWS to the FS regarding a typographical error correction to the 9/16/1997 Biological Opinion related to prescribed burning.
10/01/2001	Letter from the FWS to the FS designating the Virginia Field Office and Southwestern Virginia Field Office with lead responsibility for Ecological Services programs in Virginia. This includes ESA section 7 consultation. Prior to this, the Chesapeake Bay Field Office in Annapolis, Maryland had this responsibility.
01/15/2002	The FWS met with the FS in Roanoke, VA to discuss roles and responsibilities for Section 7 consultation.
03/07/2002	Region 8 of the FS in coordination with Region 4 of the FWS established ESA consultation working group leaders and teams.
03/26/2002	Conference call between the FWS and the FS to finalize botany ESA consultation working group sub-team.
03/27/2002	Meeting in Knoxville, TN between the FWS and the FS to clarify ESA consultation working group team objectives and standardize language.
04/03/2002	FWS and FS sign *a Memorandum of Agreement entitled Consultation Agreement, USDA Forest Service, Region 8 and USDI Fish and Wildlife Service, Region 4 and 5 for Southern Appalachian Forest Plan Revisions.*

04/09/2002	FWS and FS conference call regarding aquatic species ESA consultation working group assignments.
04/22/2002	FWS and FS conference call regarding aquatic species ESA consultation working group recommendations to FWS.
12/12/2002	FWS and FS meeting in Roanoke, VA to review the JLRMP consultation process.
01/13/2003	Service received letter from the FS requesting review of a list of 35 species to be included in the LRMP Revision.
01/17/2003	FWS sent letter to the FS responding to the FS species list. The FWS deemed appropriate the list of 35 species and recommended analysis of 2 candidate species and designated critical habitats.
02/10/2003	FWS made a field visit with FS to the Cinch Ranger District (RD) to discuss recent timber harvest practices on JNF lands.
02/11/2003	The FWS hosted a meeting with the FS in Abingdon, VA to review the FS/FWS consultation agreement, the FS's Aquatic Conservation Plan, and a comparison of the Jefferson Land and Resource Management Plan (JLRMP) and existing Conservation Plan.
03/05/2003	The FWS met with FS in Wytheville to continue discussion of the Jefferson NF proposed LRMP, specifically issues regarding personal-use firewood cutting and cable corridor standards.
03/11/2003	FWS participated in a field visit with FS to the Glenwood RD to look at cable logging practices and their impact on channeled intermittent and ephemeral streams to evaluate standards of the JLRMP.
04/23/2003	FWS participated in a field visit with FS to the Clinch RD to look at recent cable logging projects and their impact on perennial streams to evaluate standards of the Jefferson NF proposed LRMP.
04/24/2003	The FWS hosted a meeting with the FS in Abingdon, VA to continue discussion of the Jefferson NF proposed LRMP.
04/28/2003	The FWS participated in a field visit with FS to the New Castle RD to discuss riparian buffer width for channeled intermittent and ephemeral streams and other riparian standards related to the Jefferson NF proposed LRMP.
05/29/2003	The FWS hosted a meeting with the FS in Abingdon, VA to discuss riparian corridor and conservation plan standards related to the Jefferson NF proposed LRMP.

06/17/2003	The FWS hosted a meeting with the FS in Abingdon, VA to continue discussion of the Jefferson NF proposed LRMP.
08/19/2003	The FWS received a letter from the FS requesting formal section 7 consultation and met with the FS in Abingdon, VA to receive and discuss the Biological Assessment for the Jefferson NF LRMP.
09/11/2003	The FWS sent a letter to the FS acknowledging that the FWS had received the FS request for formal section 7 consultation and that the package was complete.
09/2003 - 01/2004	Through telephone, fax, and electronic mail correspondences, FWS obtained additional information and analysis from the FS on the present and projected condition of the JNF and effects of the JLRMP on Indiana bats.

Appendix B – Standards and Conservation Measures Outlined in the 2003 Revised Jefferson Land and Resource Management Plan for the Indiana Bat

Forest-wide Indiana Bat Management

Each Indiana bat hibernaculum has a primary and secondary cave protection area managed according to management prescription 8E4. If additional hibernacula are found, the desired condition and standards of management prescription 8E4 apply until an environmental analysis to consider amendment to the Forest Plan is completed.

- In order to promote potential summer roost trees and maternity sites for the Indiana bat throughout the Forest, planned silvicultural practices in hardwood-dominated forest types will leave all shagbark hickory trees greater than 6 inches d.b.h. and larger, except when they pose a safety hazard. In addition:

    Clearcut openings 10 to 25 acres in size will also retain a minimum average of 6 snags or cavity trees per acre, 9 inches d.b.h. or larger, scattered or clumped.

    Group selection openings and clearcuts less than 10 acres in size have no provision for retention of a minimum number of snags, cavity trees, or residual basal area due the small opening size and safety concerns.

    All other harvesting methods (and clearcut openings 26-40 acres in size) will retain a minimum residual 15 square feet of basal area per acre (including 6 snags or cavity trees) scattered or clumped. Residual trees are greater than 6 inches d.b.h. with priority given to the largest available trees, which exhibit characteristics favored as roost trees by Indiana bats.

  To insure a continuous supply of roost trees and foraging habitat, the following forest-wide conditions must be maintained:

    Minimum of 60% of the combined acreage of all CISC Forest Types on the Forest will be maintained over 70 years of age; AND

    Minimum of 40% of the combined acreage of all CISC Forest Types 53 (white oak, red oak, hickory) and 56 (yellow poplar, white oak, red oak) will be maintained at an age greater than 80 years old.

- When active roost trees are identified on the Forest, they will be protected with a ¼ mile buffer surrounding them. This protective buffer remains until such time the trees and associated area no longer serve as a roost (e.g., loss of exfoliating bark or cavities, blown down, or decay).

- No disturbance that will result in the potential taking of an Indiana bat will occur within this active roost tree buffer.

    Commercial timber harvesting, road construction, and use of the insecticide diflubenzuron are prohibited.

Prescribed burning, timber cutting, road maintenance, and integrated pest management using biological or species-specific controls during non-roosting season are allowed, following project level analysis to determine the direct, indirect, and cumulative effects on Indiana bats and the hibernacula.

Other activities within this buffer are allowed following determination that they will not result in a potential taking of an Indiana bat.

- Removal of known Indiana bat active roost trees will be avoided, except as specified in the next 2 standards.

  If during project implementation, active roost trees are identified, all project activity will cease within a ¼ mile buffer around the roost tree until consultation with U.S. Fish and Wildlife Service is completed to determine whether project activities can resume.

- In the event that it becomes absolutely necessary to remove a known Indiana bat active roost tree, such a removal will be conducted during the time period when the bats are likely to be in hibernation (November 15 through March 31), through informal consultation with the U.S. Fish and Wildlife Service. Trees identified as immediate threats to public safety may be removed when bats are not hibernating; however, informal consultation with U.S. Fish and Wildlife Service is still required. Examples of immediate threats to public safety include trees leaning over a trail, public road or powerline that could fall at any time due to decay or damage.

- Prescribed burning is allowed to maintain flight and foraging corridors in upland and riparian areas potentially used by bats in the summer. To avoid injury to non-flying young Indiana bats, prescribed burning of active maternity roosting sites between June 1 and August 1 is prohibited.

- Opportunities should be sought to include creation of drinking water sources for bats in project plans, where appropriate, in areas where no reliable sources of drinking water are available. Opportunities will be considered when the creation is not detrimental to other wetland-dependent species (I.e., damage to natural springs and seeps).

- If active maternity roost sites are identified on the Forest, they will be protected with a 2-mile buffer defined by the maternity roost, alternate roost sites, and adjacent foraging areas.

- No disturbance that will result in the potential taking of an Indiana bat will occur within this active maternity roost site buffer. Commercial timber harvesting, road construction, and use of all pesticides is prohibited. All other activities within this buffer will be evaluated during project level analysis to determine the direct, indirect, and cumulative effects on Indiana bats, through informal consultation with the U.S. Fish and Wildlife Service.

- If during project implementation, active maternity roost sites are identified, all project activity will cease within a 2-mile buffer around the maternity roost until consultation with U.S. Fish and Wildlife Service is completed to determine whether project activities can resume.

Monitoring of timber sales and other activities will be implemented as follows:

Timber sale administrators or biologists will conduct and report normal inspections of all timber sales to ensure that measures to protect the Indiana bat have been implemented. Timber sale administrators will conduct normal inspections of all timber sales to administer provisions for protecting residual trees not designated for cutting under provisions of the timber sale contract. Unnecessary damage to residual trees will be documented in sale inspection reports and proper contractual or legal remedies will be taken. The Forest will include this information in their annual monitoring reports and made available to the U.S. Fish and Wildlife Service, if requested.

Informal consultations among the U.S. Fish and Wildlife Service and the Forest will occur as needed in order to review and determine any need to modify provisions of the biological opinion, and other issues regarding the Indiana bat.

- Where appropriate, training should be conducted for employees regarding bats in the National Forests. Training should include sections on bat identification, biology, habitat requirements, and sampling techniques.

  Develop informational and educational displays about bats to inform the public about this misunderstood group of mammals.

When not specifically stated otherwise, the following standards refer to both the primary (8E4a) and secondary (8E4b) cave protection areas.

Primary Cave Protection Area

8E4-001 Each Indiana bat hibernaculum will have a primary buffer consisting of a radius of no less than one half mile around each hibernaculum, defined by national forest surface ownership and topography.

8E4-002 No disturbance that will result in the potential taking of an Indiana bat will occur within this buffer.

Commercial timber harvesting, road construction, use of the insecticide diflubenzuron, creation of early successional habitat, expansion or creation of permanent wildlife openings, and mineral exploration and development are prohibited.
Prescribed burning, tree cutting, road maintenance, and integrated pest management using biological or species-specific controls are evaluated during project level analysis to determine the direct, indirect, and cumulative effects on Indiana bats and the hibernacula.

8E4-003 All currently known hibernacula are gated. If additional hibernacula are found, the caves are gated, if necessary, to protect Indiana bats during the critical hibernation period.

8E4-004 All caves may be opened for public use during the summer months for recreational use from June 1 to September 1.

Secondary Cave Protection Area

8E4-005 A secondary buffer consisting of a radius of approximately 1½ miles around each primary cave protection area, defined by easily recognizable features on the ground, will have limited disturbance.

8E4-006 Within the secondary cave protection area, the following management activities can occur following evaluation to determine the direct, indirect, and cumulative effects on Indiana bats and the hibernacula:

- Regeneration timber sales;
  Thinning;
  Road construction or reconstruction;
  Prescribed burning;
- Trail construction or reconstruction;
- Special uses; and
- Biological or species-specific pesticide use.

<u>Active Maternity Site Protection</u>

8E4-007 If active maternity roost sites are identified on the Forest, they are protected with a 2-mile buffer defined by the maternity roost, alternate roost sites, and adjacent foraging areas. See Forestwide standards.

<u>Active Roost Tree Protection</u>

8E4-008 As active roost trees are identified on the Forest, they are protected with a ¼ mile buffer surrounding them. This protective buffer remains until such time they no longer serve as a roost (e.g., loss of exfoliating bark or cavities, blown down, or decay). See Forestwide standards.

<u>Terrestrial and Aquatic Species</u>

8E4-009 Management for other plant and animal species within the primary cave protection areas is evaluated during project level analysis to determine the direct, indirect, and cumulative effects on Indiana bats and the hibernacula.

8E4-010 Opportunities should be sought to include creation of drinking water sources for bats in project plans, where appropriate, in areas where no reliable sources of drinking water are available. Opportunities are considered when the creation is not detrimental to other wetland-dependent species (i.e., damage to natural springs and seeps).

8E4-01 Limit creation of early successional habitat to 10 percent of forested acres in the secondary cave protection area. Creation of early successional habitat in the primary cave protection area is prohibited.

8E4-012 Existing old fields, wildlife openings, and other habitat improvements for fish and wildlife may be present and maintained within both the primary and secondary cave protection areas, but no expansion of openings or creation of new permanent openings of this type occurs within the primary cave protection area. Native species are emphasized when establishing food plants for wildlife. Some openings provide permanent shrub/sapling habitat as a result of longer maintenance cycles.

8E4-013 Structural habitat improvements for fish and other aquatic species are allowed.

Threatened, Endangered and Sensitive Species

8E4-014 Management for other known populations of threatened, endangered, sensitive, and locally rare species within the primary cave protection areas are evaluated during project level analysis to determine the direct, indirect, and cumulative effects on Indiana bats and the hibernacula.

Rare Communities and Old Growth

8E4-015 Maintain rare communities in both the primary and secondary cave protection areas.

8E4-016 Old growth patches of all sizes and community types are maintained and restored.

Vegetation and Forest Health

8E4-017 Allow vegetation management activities within primary cave protection areas to:

- Promote trees that retain slabs of exfoliating bark;
  Promote large diameter roost trees with some daily exposure to sunlight;
  Thin dense midstories that restrict bat movement;
- Improve other threatened, endangered, sensitive, and locally rare species habitat;
- Maintain rare communities and species dependent on disturbance;
  Reduce fuel buildups;
- Restore historic fire regimes, particularly in pine and pine-oak woodlands;
- Reduce insect and disease hazard to oak-hickory forest communities;
- Control non-native invasive vegetation.

8E4-018 Allow vegetation management activities within secondary cave protection areas to:

- Maintain oak-hickory forest communities; and restore pine and pine-oak woodlands;
- Promote trees that retain slabs of exfoliating bark;
- Promote large diameter roost trees with some daily exposure to sunlight;
  Thin dense midstories that restrict bat movement;
  Improve other threatened, endangered, sensitive, and locally rare species habitat;
- Maintain rare communities and species dependent on disturbance;

- Reduce fuel buildups;
- Restore, enhance, or mimic historic fire regimes;
- Reduce insect and disease hazard;
- Control non-native invasive vegetation;
- Salvage dead and dying trees as a result of insects, diseases, or other natural disturbance events;
- Provide up to 10% early successional habitat conditions.

8E4-019 Strive for optimum roosting habitat of 16 or more Class 1 and/or Class 2 trees greater than 9 inches d.b.h. per acre, as averaged across the prescription area associated with each hibernaculum. Class 1 trees are those species which are most likely to have exfoliating bark either in life or after death, and which are most likely to retain it for several years after they die. Class 2 trees characteristically have exfoliating bark as well, but are considered to be of slightly lower quality than Class 1 trees. See Table 3-2.

Table 3-2. Class 1 and 2 Trees

Class 1 Trees	Class 2 Trees
Carya cordiformis (bitternut hickory)	*Acer rubrum* (red maple)
Carya laciniosa (shellbark hickory)	*Acer saccharum* (sugar maple)
Carya ovata (shagbark hickory)	*Aesculus octandra* (yellow buckeye)
Fraxinus Americana (white ash)	*Betula lenta* (sweet birch)
Fraxinus pennsylvanica (green ash)	*Carya glabra* (pignut hickory)
Quercus alba (white oak)	*Carya spp.* (other hickories)
Quercus prinus (chestnut oak)	*Fagus grandifolia* (American beech)
Quercus rubra (red oak)	*Liriodendron tulipifera* (tulip poplar)
Quercus stellata (post oak)	*Nyssa sylvatica* (black gum)
Ulmus rubra (slippery elm)	*Platanus occidentalis* (sycamore)
	Robinia pseudoacacia (black locust)
	Quercus coccinea (scarlet oak)
	Quercus velutina (black oak)
	Sassafras albidum (sassafras)
	Pinus echinata (shortleaf pine)
	Pinus virginiana (Virginia pine)
	Pinus rigida (pitch pine)
	Pinus pungens (table mountain pine)

<u>Timber Management</u>

8E4-020 Primary cave protection areas are unsuitable for timber production. Commercial timber harvest is not allowed.

8E4-021 Secondary cave protection areas are suitable for timber production. The remainder of the standards under this Timber Management section refer only to the secondary cave protection area:

8E4-022 Clearcutting is prohibited.

8E4-023 In order to promote fall foraging and swarming areas, timber activities will leave all shagbark hickory trees and retain a minimum average of 6 snags or cavity trees (greater than or equal to 9 inches d.b.h.) per acre as potential roost sites (except where they pose a safety hazard). For group selection harvest method, all shagbark hickories are maintained (except where they pose a safety hazard) with no provision for minimum number of snags or cavity trees due to the small opening size.

8E4-024 Forested communities are maintained using either of two following criteria:

A minimum of 60% of the acreage of all Forest Types are maintained over 70 years of age; and a minimum of 40% acreage of CISC Forest Types 53 (white oak, red oak, hickory) and 56 (yellow poplar, white oak, red oak) are maintained at an age greater than 80 years old;

OR

When the above age criteria cannot be met, forest stands receiving even-aged regeneration harvesting are maintained with a minimum of 20 trees per acre in the 10-16 inch d.b.h. class and 15 trees per acre in the greater than 16 inch d.b.h. class, of which two trees per acre must be 20 inches d.b.h. or greater.

8E4-025 The 0 - 10 age class will not exceed 10% at any time (regardless which of the criteria above are used).

8E4-026 Timber marking and harvesting crews will receive training in the identification of potentially valuable roost trees.

8E4-027 Timber harvesting operations will be suspended from September 15 until November 15.

Non-timber Forest Products

8E4-029 Do not issue authorizations for the commercial or personal use of any forest products, including firewood.

Prescribed Fire and Wildland Fire Use

8E4-030 Prescribed burning and wildland fire use is allowed to manage vegetation to maintain flight and foraging corridors in upland and riparian areas potentially used by bats in the summer.

Recreation

8E4-031 Maintain trails to the minimum standard necessary for protection of the soil, water, vegetation, visual quality, user safety, and long-term maintenance.

8E4-032 New trail construction is allowed only within the secondary cave protection area.

8E4-033 Licensed OHV use is permitted in this prescription area only on existing open roads.

Scenery

8E4-034 Management activities are designed to meet or exceed the following Scenic Integrity Objectives, which may vary by inventoried Scenic Class:

Inventoried Scenic Class	1	2	3	4	5	6	7
Scenic Integrity Objectives	H	M	M	M	M	M	M

8E4-035 Management activities are designed to meet or exceed a high Scenic Integrity Objective in semi-primitive non-motorized areas within this prescription area.

Range

8E4-036 In order to maintain open woodland and grassland conditions suitable for fall swarming and roosting, livestock grazing is permitted to continue where it currently exists.

Minerals

8E4-037 The primary cave protection areas are administratively unavailable for oil and gas and other Federal leasable minerals. Existing leases are not renewed upon expiration. These areas are not available for mineral materials for commercial, personal, or free use purposes. Administrative use of mineral materials is allowed when: a) the materials are used within the primary cave protection area itself; and b) use is necessary to protect Indiana bat habitat.

8E4-038 Within the secondary cave protection areas, oil and gas are allowed with a timing stipulation to protect Indiana bat habitat from September 15 to November 15. Other Federal minerals are allowed on a case-by-case basis after full consideration of effects on Indiana bat habitat. Permit mineral materials for commercial, personal, free, and administrative use purposes with conditions to protect Indiana bat habitat.

8E4-039 The Kelly Cave area is underlain by private mineral rights. Requests for access to a non-Federal interest in lands pursuant to a reserved or outstanding right are recognized, and reasonable access is granted. Encourage such interests to minimize disturbance to Indiana bat habitat when possible.

Roads

8E4-040 Within the primary cave protection area, do not permit road construction, subject to valid existing rights or leases. Road reconstruction and minor relocation are permitted to benefit the Indiana bat and its habitat.

8E4-041 New construction and reconstruction are allowed in the secondary cave protection area.

8E4-042 Decommission roads when adversely affecting caves, their hydrology, or Indiana bat habitat security.

Lands and Special Uses

8E4-043 The Rocky Hollow Cave (Clinch Ranger District) is given a high priority for acquisition (on a willing seller basis) since it is one of the largest known historic hibernacula in Virginia and is situated adjacent to national forest lands.

8E4-044 Primary cave protection areas are unsuitable for new special uses, except for research and outfitter-guide operations. Phase out existing non-conforming uses.

8E4-045 Allow commercial use by outfitters and guides if compatible with preservation of the primary cave protection areas. Do not allow contest events such as foot races or horseback endurance events. Require outfitters and guides to use leave-no-trace techniques. Do not allow permanent camps.

8E4-046 Within secondary cave protection areas, new special use proposals are analyzed on a case-by-case basis to determine the potential effects on the Indiana bat.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 87

February 21, 2023

Virginia Big-Eared Bat
(Corynorhinus townsendii virginianus)
5-Year Review:
Summary and Evaluation

Photo by: C. Stihler

U.S. Fish and Wildlife Service
West Virginia Field Office
Elkins, West Virginia

February 2019

5-YEAR REVIEW
Virginia big-eared bat
(Corynorhinus townsendii virginianus)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office:
Anne Hecht, Region 5, Hadley MA, (413) 575-4031

Lead Field Office:
Barbara Douglas, West Virginia Field Office (304) 636-6586

Cooperating Field Office/Biologist(s):
Sumalee Hoskin, Virginia Field Office (804) 824-2414
Sue Cameron, Ashville North Carolina Field Office (828) 258-3939
Mike Armstrong, Kentucky Field Office (502) 695-0468

Cooperating Regional Office(s):
Region 4, Kelly Bibb, (404) 679-7132

1.2 Methodology used to complete the review:

The Virginia big-eared bat (VBEB) 5-year review was compiled primarily by the lead recovery biologist for this species. U.S. Fish and Wildlife Service (Service) field office and state natural resource agency personnel responsible for the recovery of this species were contacted for current information on occurrences, threats, and recovery activities in West Virginia, Virginia, North Carolina, Tennessee, and Kentucky. The Service appreciates the efforts of numerous biologists and volunteers who have assisted in gathering data and conducting surveys that were used in this review. We also appreciate the efforts of the following Federal and state agency biologists who provided detailed information that assisted this review:

- Craig Stihler, West Virginia Division of Natural Resources (WVDNR)
- Paul Lenza, New River Gorge National River (NRGNR)
- Traci Hemberger, Sunni Carr, and Zach Couch, Kentucky Department of Fish and Wildlife Resources (KYDFWR)
- Rick Reynolds, Virginia Department of Game and Inland Fisheries (VDGIF)
- Katherine Caldwell and Joey Weber, North Carolina Wildlife Resources Commission (NCWRC)

1.3 Background:

1.3.1 Federal Register (FR) notice announcing initiation of this review:

83 FR 39113-39115; August 8, 2018

Two public comments were received in response to this notice. One commenter provided non-substantive comments. The other provided comments on the distribution and threats to the VBEB in Virginia, and recommended that the species status should not be downgraded. This information has been evaluated and incorporated as appropriate in this review.

1.3.2 Listing history

Original Listing

FR notice: 44 FR 69206-69208
Date listed: November 30, 1979
Entity listed: This was a joint listing and critical habitat designation for the Ozark big-eared bat (OBEB)(*Plecotus townsendii ingens*) and the VBEB.
Classification: Endangered

1.3.3 Associated rulemakings:

A proposed listing and critical habitat designation was published on December 2, 1977 (42 FR 61290-61292). However because amendments were made to the Endangered Species Act (ESA) before a final action could be taken, the FR notice was revised on August 30, 1979 to address the new requirements for proposing critical habitat (44 FR 51144 51145). There have been no further rulemakings since that time.

1.3.4 Review History

The Virginia big-eared bat was included in cursory 5-year reviews for listed species, as follows: July 22, 1985 (50 FR 29901); July 7, 1987 (52 FR 25523); and November 6, 1991 (56 FR 56882). A detailed formal status review was completed on August 20, 2008. That review determined that the species should remain listed as endangered. The 2008 review also recommended that the Recovery Plan for the species should be updated to address current species information, including genetics, distribution, and threats. An important component of this was recognizing importance of and differences between the four geographic regions within the range of the species. This 2019 review summarizes new information that has become available since the 2008 review was completed.

1.3.5 Species' Recovery Priority Number at start of 5-year review: The VBEB currently has a recovery priority number of 9c, indicating a moderate degree of threat, high recovery potential, and conflict with economic development for this subspecies.

1.3.6 Recovery Plan or Outline
Name of plan or outline: Ozark & Virginia Big-Eared Bat Recovery Plan
Date issued: May 8, 1984
Dates of previous revisions, if applicable: On March 28, 1995, a Recovery Plan specifically for the OBEB was finalized. Therefore, the 1984 plan no longer applies to that sub-species. No revisions specific to the VBEB have been finalized. Recovery plan amendments are currently being planned.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

__X_ **Yes**
_____**No**

2.1.2 Is the species under review listed as a DPS?

____ **Yes**
_X_ **No**

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

____ **Yes**
__X_ **No**

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

_X_ **Yes, but only for reclassification.**
____ **No**

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

____ **Yes**
_X_ **No**

The recovery criteria do not reflect the most current information in regard to genetics and population structure of the species (See section 2.3.1.3).

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

____ **Yes**
_X_ **No**

The recovery criteria for downlisting do not directly address the need for adequate regulatory mechanisms to reduce threats from wind power, road construction, development, and quarry/mining activities in the absence of the ESA. Although the recovery criteria requiring "documented stable or increasing populations" may be an indirect measure of this, the criteria do not directly address threats as a result of modification or destruction of habitat, or "other factors" such as disturbance and vandalism.

In addition, no recovery criteria are provided for delisting the species.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The Recovery Plan lists four criteria for downlisting the VBEB to threatened status:

1. Documentation of long-term protection of 95 percent of all known active colony sites.

2. Documentation of stable or increasing populations at 95 percent of the known active maternity sites and hibernacula for a period of 5 years.

3. Foraging habitat for both subspecies must be identified, and restored as much as possible. However, a given amount of foraging habitat cannot be required in the objective at this time due to lack of information on colony needs.

4. Finally, a periodic monitoring program must be established to ensure a continued awareness of the status of these animals.

The Recovery Plan also concluded that "It seems unlikely that the Virginia big-eared bat will recover to a point where it can be removed from the threatened list. However, this matter should be reconsidered at the time its status is reduced from endangered to threatened."

Recovery Criterion 1: Documentation of long-term protection of 95 percent of all known active colony sites

This is a difficult criterion to measure, particularly for hibernacula, since there are a number of sites that are used by low numbers (e.g., less than 20) of VBEBs each year.

However, we can evaluate the status of the sites that house the majority of the current population, as shown in the table below. The 2008 status review considered a site to have documented long-term protection if it was: 1) signed as closed with no history of access violations and/or gated, fenced AND 2) was in private ownership with a signed conservation agreement that will transfer to new owners or is owned by Federal or state conservation agencies. This definition was used by previous recovery leads for the species (Service, unpublished data, 1996). The protection status of the major VBEB hibernacula and maternity sites as well as the number of VBEBs present at each site is shown in table 1. Major sites were previously defined in the 2008 status review as sites that have currently or in the past supported more than 200 VBEBs.

Table 1: Numbers and Protection Status of Major VBEB Hibernacula and Maternity Sites

Hibernacula							
# of VBEBs last status review (2007/2008)	**# of VBEBs prev. 5 years (2012/2013)**	**# of VBEBs most recent count (2017/2018)**	**Name**	**State**	**Gated**	**Ownership**	**Long-term protection?**
5,006	7,640	13,493	Hellhole	WV	Fenced	Private	No
3,121	4,668	3,609	Stillhouse	KY	Yes	USFS	Yes
1,285	885	660	Schoolhouse	WV	Yes	State	Yes
543	591	487	Cave Hollow/Arbogast	WV	Yes	USFS	Yes
1,160[1]	433	301	Higgenbotham	VA	Yes	State	Yes
87	146	258	Cliff	WV	No	Private	No
203	136	237	Minor Rexrode	WV	Yes	State	Yes
76	264	204	Sinnett/Thorne	WV	Yes	Private	No
376	316	179	Blackrock Cliff	NC	Yes	TNC	Yes
35	98	146	Johnson	KY	No	Private	No
11,892	**15,177**	**19,574**	**Total**				
Maternity							
910	1,165	1,517	Cliff	WV	No	Private	No
1,175	1,195	1,456	Hoffman School	WV	Yes	State	Yes
979	1,246	1,240	Peacock	WV	No	USFS	Yes
698	933	1,200	Cave Hollow/Arbogast	WV	Yes	USFS	Yes
361	841	1,050	Sinnitt/Thorn Mountain	WV	Yes	Private	No
630	905	912	Schoolhouse	WV	Yes	State	Yes
576	537	797	Mystic	WV	No	Private	No
NA	NA	760	Johnson	KY	No	Private	No
131	297	522	Mill Run	WV	No	Private	No
350	NA	474[1]	Arbegast	VA	Yes	Private	No
564	368	469	Cave Mountain	WV	Yes	USFS	Yes
450	791[2]	450[1]	MBC	VA	Yes	Private	Yes
NA	**NA**	301	Gale Warner	WV	No	Private	No
NA	NA	295	Mama's Cave	NC	No	State	No[3]
288	447	235	Lambert	WV	Yes	Private	No
57	270	111	Cave Hollow Pit	KY	No	USFS	Yes
299	203	22	Plecotus Pit	KY	No	USFS	Yes
350	12	8	Higgenbotham	VA	Yes	State	Yes
7,818	**9,210**	**11,819**	**Total**				

1: No surveys for the target window are available. These counts are for the closest survey period to the time period given.
2: This count likely includes volant young.
3. This site is owned by the State, however it is not signed so it does not meet the full definition of protected.

A total population of 19,574 VBEBs has been documented within the 10 major hibernacula. Six of these caves (60 percent) have documented long-term protection. These sites are owned by State resource agencies, the U. S. Forest Service (USFS) and The Nature Conservancy (TNC). However, the previously-used definition of long-term protection does not explicitly address the fact that access violations can occur even if a site is gated. Three of the six "protected" caves have been subject to vandalism of the cave gates, or had illegal entries in the last 5 years; therefore even these protected caves are still subject to continued threats from disturbance. In addition, 14,101 of the hibernating VBEBs (72 percent) use unprotected caves, therefore only 28 percent of the population is currently hibernating in caves that meet the previously-used definition of protected. Approximately 69 percent of the total range wide population hibernates in a single cave, Hellhole, which does not have long-term protection. Therefore, this criterion has not been met for VBEB hibernation sites.

Since the time of the 2008 status review, three hibernacula that had less than 100 bats have increased to over 200 bats (Johnson Cave, Cliff, and Sinnitt/Thorne). Two additional sites were also purchased by their respective states, Schoolhouse and Higgenbotham. At the time of the last status review, 57 percent of the major hibernacula were protected and these caves supported 37 percent of the population. As of 2018, a greater percentage of the hibernacula are protected caves, but these protected caves support a lesser percentage of the overall population.

There are 18 major VBEB maternity colony sites that support a total of 11,819 VBEBs. Nine of these caves (50 percent) are protected. These protected caves support 5,868 (49 percent) of the maternity population. Therefore, this criterion has not been met for maternity sites.

Since the 2008 status review, two new major maternity sites have been discovered (Mama's Cave and Johnson Cave) and one historical site has been restored and become occupied (Gale Warner). Numbers at two sites that previously supported more than 200 bats have dropped to less than 25 VBEBs (Plecotus Pit and Higgenbotham). In addition, Black Rock Cliff Cave in North Carolina, a known hibernacula, was documented to also support a maternity colony of 125 VBEB (including some young).

Recovery Criterion 2: Documentation of stable or increasing populations at 95 percent of the known active maternity sites and hibernacula for a period of 5 years.

The most recent monitoring data show a significant overall population increase since the time of the last status review and for the last 5 years as shown in table 1. Total population numbers have increased 30 percent and 28 percent over the past 5 years for hibernating and maternity sites, respectively. However, numbers within a single cave, Hellhole, are driving this overall increase. Over the past 5 years, numbers of VBEBs hibernating within Hellhole have increased by 5,853 bats, while the overall population has increased by only 4,397 bats. Outside of Hellhole, there has been some variation between regions and within specific caves. Six of the 10 major hibernacula have had numbers decline in the past 5 years, as have 5 of the 18 major maternity sites (60 percent and 28 percent of hibernating and maternity caves declining). Some of these declines may be due to bats switching between roosts, but in some cases and regions, increases in some caves do not compensate for losses in others. For example, although the number of bats hibernating in Johnson Cave in Kentucky has increased by 48 bats, populations in Stillhouse Cave, the other major hibernacula in the state, have decreased by 1,059 bats. Additional information on cave and region-specific trends can be found in the Regional Summaries in Appendix A.

While overall population numbers appear to be steadily increasing, these increases are not consistent across sites and recent declines have been seen at a number of the major VBEB sites. Therefore, this recovery criterion has been partially met.

Recovery Criterion 3: Foraging habitat must be identified, and restored as much as possible.

When the Recovery Plan was written, very little information was known about VBEB foraging needs. However, the Recovery Plan acknowledged the importance of identifying and protecting this habitat through the establishment of this criteria. Since that time, substantial new information has been developed about this recovery need. The 2008 status review summarized new information on foraging habitats for the VBEB that had become available since the time of listing. That information is still valid except as supplemented or modified by new information below. Since the 2008 status review, new information is available on foraging strategies and prey selection, habitats used for foraging and roosting, and movement patterns between these areas.

Lacki and Dodd (2011) summarized foraging strategies and prey selection for *Corynorhinus* species including VBEB. These species are foraging specialists with lepidopterans (moths) comprising greater than 80 percent of the prey (Lacki and Dodd 2011). The bats use both aerial hawking and gleaning foraging strategies (meaning they capture prey in air or from the surface of objects) (Lacki and Dodd 2011). This genus of bats has a number of morphological features making them well-adapted to gleaning, which in turn can provide ecological advantages because gleaning bats are not dependent on having insects actively flying during foraging efforts (Lacki and Dodd 2011). They can therefore feed later at night, at cooler temperatures, and for a longer season, than bats that rely solely on aerial hawking (Lacki and Dodd 2011). Foraging tends to occur near forest/edge interfaces and along forested and riparian corridors in areas that have abrupt changes in vertical structure as well as both vertical and horizontal surface area for gleaning (Lacki and Dodd 2011). Lacki and Dodd (2011) also note that the majority of moth species that make up the primary prey base for *Corynorhinus* bats are dependent on woody plant hosts for larval development. They therefore recommend managing for landscapes with "sufficient acreage in forest while providing for corridors and other forest/edge interfaces;" although what constitutes "sufficient" has not yet be defined. These bats appear resilient to moderate levels of timber harvest, but do require a diversity and abundance of local plant species, which suggests that managing for woody plant diversity is required to provide an adequate prey base (Lacki and Dodd 2011). Summerville and Crist (2002) found that moth species richness was significantly lower in clear-cut stands, but did not differ between selectively logged and unlogged stands. This is consistent with Stihler (1994) who found VBEBs did not use clearcuts during foraging. Thus, selective logging appears to be a better strategy for timber harvests to maintain Lepidoptera species richness.

Telemetry studies have been conducted on VBEBs in North Carolina, Kentucky, and West Virginia since the time of the last status review. These studies have provided additional information on VBEB foraging and movement.

The North Carolina study (Weber et al. 2016) tracked 10 bats captured at their hibernacula in early spring (mid-March through end of April). After the bats left the hibernacula, they appeared to stage at higher elevations (over 4,600 feet above mean sea level (MSL)) on nearby mountains for 1-9 days before moving towards a new maternity site that was located during this study. The maternity site is approximately 8.7 miles from the hibernacula. Bats moved up to 9.4 miles in a night and up to 15 miles between the hibernacula and spring roost sites. Foraging distance from daytime roosts ranged from 1.1 to 5 miles, with a mean of 1.7 miles. The bats moved across smaller roads while commuting to the primary maternity roost, but generally did not cross major roads during nighttime foraging bouts. Home range polygons were delineated for all the bats tracked. Mean home ranges were 1,169 acres (kernel density estimation) and 818 acres (minimum convex polygon). Land-use within the foraging areas consisted of forest and rock vegetation (mean probability of use was 76 percent), riparian vegetation/water (7 percent), developed (9 percent), and agriculture (9 percent). Bats used the different habitat types in close proportion to their availability on the landscape indicating that the bats did not specialize on any of the habitat types. The bats were also tracked to day roosts throughout their home ranges, which included natural rock shelters and overhangs; caves; and man-made structures such as barns, porch decks, and uninhabited houses.

Telemetry studies in Kentucky (Copperhead 2014, Copperhead 2012) included early spring tracking (mid-late March) of 3 female bats over 9 nights, and then 15 females over a 15-day period in May. These studies confirmed that a previously known VBEB cave is being used as a maternity site, and also documented the first known case of a summer colony using a rock shelter. The mean distance between roosts and foraging areas was 3.5 miles (range was 1.8 to 7 miles) and the mean foraging area size was 289 acres. The tracked bats had separate foraging areas. Foraging areas consisted of cliff line habitat, and upper reaches of forested valleys and ridges. Day roosts included small caves, rock shelters, and cliff lines within their foraging areas.

The West Virginia telemetry study (WVDOH 2017) included 1 female and 4 male VBEBs that were tracked after emerging from abandoned mine portals in the fall. This study was done to assess the effects of potential highway construction nearby; therefore, tracking was limited to the action area of the highway project. Mean delineated home range was 3,009 acres (95 percent kernel) and mean core-use area (50 percent kernel) was 501 acres. Most locations were within 1.9 miles of the portals and the furthest location was 3.9 miles away (although bats were not tracked outside the study area so greater distances are possible). The males often seemed to follow the female, which would be consistent with breeding activity. Habitat composition of delineated home ranges was 77 percent forested, 22 percent open, >1 percent water/impervious surface. The area is characterized by native and restored upland prairie, wetlands, forest, and rocky outcrops. A number of perennial streams, ponds, and wetland-like areas are present. Day roosts included rock crevices and fissures as well as man-made structures such as porches, outbuildings, and barns.

These studies provide substantial information for identifying and managing VBEB foraging areas. These studies indicate that VBEB foraging areas are generally located within a few miles (less than 7 miles) of cave/mine roost sites and consist of a mix of primarily forested habitats interspersed with open fields/hay fields, cliff lines, rock shelters or outcrops, riparian areas, and water sources such as streams, ponds, and wetlands. Foraging areas should have a diversity of native woody plant species suitable to produce an ample amount of moths and other prey, and should be connected to the cave/mine site with suitable travel corridors. Foraging areas may include small-scale/limited residential or rural development, and VBEBs may use man-made structures for short-term day or night roosts. There are substantial differences between foraging area and home range sizes that were delineated between sites. This could indicate that there are differences between sites, as well as between areas used during maternity versus fall periods. Care must also be taken when comparing the size of delineated area, as different criteria and methods may have be used to between studies (e.g., home range versus foraging area).

Despite the progress made in identifying foraging habitat requirements for the VBEB in accordance with this criterion, to date, no coordinated efforts have been made to delineate the availability and quantity of these habitats within the vicinity of major VBEB caves, and there have been few efforts to pro-actively protect, manage, restore, improve, or maintain suitable VBEB foraging areas. Some lands around VBEB sites are publicly owned by the USFS, the National Park Service, or State land management agencies. Management plans for these areas generally include some measures to protect or manage for habitats that provide VBEB foraging, as described in the 2008 status review. The Service and the Monongahela National Forest have discussed developing a habitat management plan for areas around Cave Hollow/Arbogast in West Virginia, but this has not been completed. Therefore, while substantial progress has been made toward meeting this recovery criterion, it has not been fully met because we still have considerable work left to do in restoring, protecting, and managing foraging habitat.

Recovery Criterion 4: A periodic monitoring program must be established to ensure a continued awareness of the status of these animals.

Protocols for monitoring both maternity and hibernacula sites have been published. In 1985, Bagley and Jacobs published the summer monitoring protocol, which has remained in-place with the exception of the use of new technology as described in Stihler (2011). Hibernacula monitoring is conducted consistent with the Indiana Bat Hibernacula Survey Guidelines (Service 2007). Under these protocols, all maternity colonies should be monitored annually, and hibernacula should be monitored bi-annually.

Although some sites have not been surveyed due to safety or landowner access concerns, and in some cases, maternity surveys have been conducted later in the season than recommended, all States within the range of the species had generally been using these protocols until recently. Virginia recently switched methods for monitoring maternity caves from using emergence counts to using a bat call data recorder to document acoustic passage rates. Although these recorders will provide useful information, they are not able to determine number of bats present. Additional work is planned to video-record exit counts and then determine if there is an association with the passage rates detected on the acoustic recorders. However, until that is completed and a method of correlating results is established, results from the acoustic recorders cannot be compared with previous monitoring data, and population trends cannot be established.

Periodic monitoring has been conducted during the fall at abandoned mine portals in southern West Virginia that have been documented to have VBEBs. At this time, no protocols have been established to correlate fall trapping results with actual numbers of hibernating VBEBs.

Therefore, although a periodic monitoring program has been established, and this criterion has been substantially met, additional work may be needed to ensure that consistent, comparable results are obtained. These data are needed to determine whether Recovery Criteria 1 and 2 are met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:
See section 2.2.3, Recovery Criteria 3 regarding new information on VBEB foraging life history, and on newly documented cases of VBEB maternity use in rock crevices. In addition, new information on seasonal activities has been gathered from data loggers placed at the entrances to VBEB caves. New information on seasonal activities at bachelor colonies and the use of these sites as breeding sites in the fall has also been gathered.

<u>Data loggers</u>
Acoustic and temperature loggers placed at Schoolhouse Cave in West Virginia, have provided additional data on VBEB seasonal activities. This cave serves as both a maternity and a hibernacula site. These loggers detected some VBEB activity throughout the year including in January and February when maximum daily temperatures were below 50ºF and minimum nightly temperatures were below 20ºF. Activity was lowest between November and March. Activity substantially increased in late April and activity was highest in August.

Acoustic loggers at Blackrock Cliffs Cave, a hibernaculum in North Carolina, also documented that VBEBs were active during the winter (Weber et al. 2016).

Activity was highest on nights when temperatures were above 23°F, but activity was also documented on particularly cold nights when temperatures were 5°F. In 2013, activity was documented from late November through early January, but in 2014, activity was documented throughout the winter, even though the winter of 2014 had more days when temperatures were under 32°F.

Acoustic loggers placed at Arbegast Cave, a maternity site in Virginia, provide a detailed look at summer activity patterns (emergence and return rates, emergence in relation to climatic conditions, behavioral activity that may indicate birth times, date of first occupation, date of last occupation, etc.). An increase in the number of passes during emergence (1800-2200 hrs.), nightly (2201-0330 hrs.), and return (0331-0800 hrs.) periods in July suggest that young become volant at this time. By late August these numbers declined significantly suggesting the colony is dispersing at this time. Additional analysis of these data is ongoing.

<u>Bachelor Colonies</u>
In 2014 and 2015, fall and spring surveys were conducted in Trout Cave, a bachelor colony in West Virginia, to determine if there was a period during the year when access would minimize impacts to listed bats. Surveys were conducted 4 times between September 23 and October 23, 2014. VBEB numbers in the cave declined steadily over this period, from 86 to 11 (the numbers of Indiana bats present steadily increased over this time period from 0 to 69). This site is used as a hibernaculum by Indiana bats, but only occasionally used by VBEBs during the winter. Surveys on April 14, 2015 documented that 217 VBEBs had already moved into the cave from their winter roosts (WVDNR 2015).

Activities at Elkhorn Cave, a bachelor colony in Grant County, West Virginia were monitored from April through October (Stihler et al. 1997). A few VBEBs (3) were present the first week of April, and then numbers increased to 92 in mid-June. Mist-netting in early July captured 27 males and 2 non-reproductive males, confirming that this site was a bachelor colony. Numbers increased unexpectedly in late August when 159 VBEBs were observed. Mist-netting in mid-September captured 21 males and 17 females. When released, the males did not leave the capture site, but rather landed on the cages holding the females. Most bats had left the area by mid-October and the site is not used as a VBEB hibernaculum. The timing of VBEB use at Elkhorn Cave is consistent with that observed at Trout Cave, as described above.

These studies of Trout and Elkhorn Cave suggest that female VBEBs travel to bachelor sites to breed in the fall, and that bachelor sites are important to the breeding behavior of this species (Stihler et al. 1997). In addition, these studies further document that male bats may form colonies during the summer, whereas it was previously thought that males were solitary during summer (Service 1984).

2.3.1.2 Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate), or demographic trends:
See information provided in the Regional Summaries (Appendix A).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding):

Genetic information gathered since the time of listing has documented that the VBEB has low overall genetic diversity and that the species' overall population is segregated into four distinct regions. Each region supports an important share of the remaining genetic and adaptive diversity of the species. Therefore, these studies concluded that all four areas should be protected and managed as discrete units (Piaggio et al. 2009, Piaggio 2013).

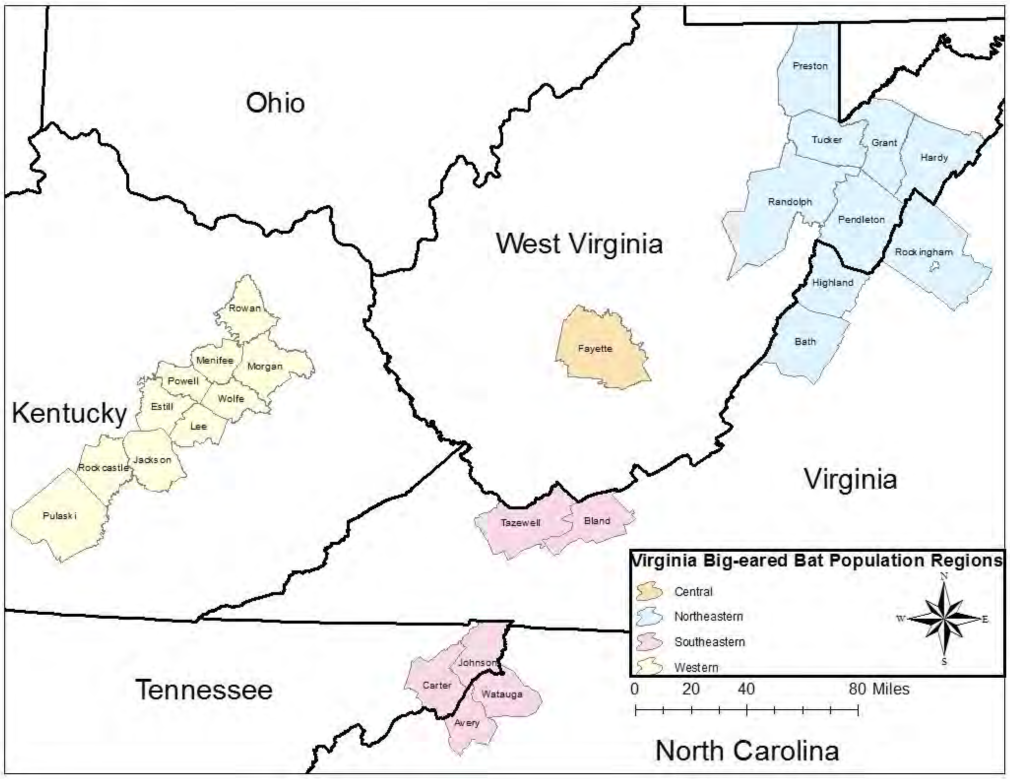
Piaggio (et al. 2009) evaluated mtDNA and autosomal microsatellites from VBEBs at sites in Pendleton, Grant, and Fayette counties, West Virginia; Tazewell County, Virginia; and Lee, Estill and Jackson counties, Kentucky. Following that effort, additional samples were gathered from Pendleton, Tucker and Fayette counties, West Virginia; and Avery County, North Carolina. These areas or sites were previously not sampled or were previously represented by a limited number of samples (Piaggio 2013). Genetic samples used in Piaggio et al. 2009 and Piaggio 2013 have been archived at the National Wildlife Research Center in Fort Collins, Colorado.

Combined results of both efforts indicate that VBEB populations are clustered into four genetically distinct regions roughly located in northern West Virginia/Virginia (Northeastern Region), southern West Virginia (Central Region), Kentucky (Western Region), and North Carolina/southern Virginia (Southeastern Region), as shown in figure 1. Both class of markers indicated almost complete loss of connectivity between these regional populations. Each region harbors unique genetic diversity (private alleles that were not present in other regions) and supports a portion of the remaining genetic diversity of the VBEB (Piaggio et al. 2009, Piaggio 2013).

Genetic diversity was greatest in the Northeastern Region. This region also includes haplotypes that were likely the source for genetic diversity in other regional populations and thus may have been a glacial refugium for the species (Piaggio 2013). The population within the Southeastern Region had the lowest overall diversity with haplotypes approaching fixation. The species' overall reduced genetic diversity means that genetic drift may be driving diversity within these populations and that the biodiversity and evolutionary potential of the VBEB has been diminished. The 2009 study estimated that the effective population size for the Northeastern Region was 936, while estimates for the remaining three regions ranged between 323 and 361.

The loss of genetic diversity, the degree of genetic separation, and low effective population sizes suggest that each of these four regions should be managed as separate units. The fact that these four areas are geographically distinct and are outside of the known dispersal distances of these bats, further supports the lack of connectivity and the need to manage these areas as discrete units. The study concluded that each of the four regions required protection because they represent the remaining evolutionary potential of the bats (Piaggio et al. 2009).

Figure 1: VBEB Regional Populations Based on Genetics and Geography



The results of the mtDNA analysis suggested that males and females are indeed philopatric to summer and winter roosts and that gene flow may occur by intermixing of males and females at transient fall roosts or by females moving over to bachelor colony sites in late summer/early fall, as has been indicated by monitoring data at these sites (Piaggio et al. 2009). These genetic results provide further support that protecting transient fall roosts and bachelor colony sites is important to the conservation of the species, as has also been suggested by surveys conducted at bachelor colonies as described in Section 2.3.1.1.

2.3.1.4 Taxonomic classification or changes in nomenclature:

No new information has become available since the 2008 status evaluation. The genus was previously changed from *Plecotus* to *Corynorhinus* (Bogdanowicz et al. 1998).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):

The range of the VBEB is shown in figure 1. Since the 2008 status review, there are new county records for:

- Watauga, North Carolina where a new maternity cave has been documented (Weber et al. 2016);
- Carter and Johnson Counties, Tennessee where VBEBs were tracked to day roost sites from known caves in adjacent counties (Weber et al. 2016);
- Bath County, Virginia where 4 VBEBs were found hibernating in 2 caves (VDGIF 2017 data); and
- Pulaski County, Kentucky where one male VBEB was found hibernating. This site is located 32.8 miles from the closest known VBEB site (Kiser 2016).

As described in the Regional Summaries, many of the counties within the range of the VBEB only support a small number of bats found in a few caves, similar to the records for Bath and Pulaski Counties. Hardy and Preston Counties, West Virginia and Rowan County, Kentucky have historical records for VBEBs, but are not currently occupied by the species.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):
See Section 2.2.3, Recovery Criteria 3, for new information on suitable foraging habitat conditions.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The threats as described in the 2008 status review are all ongoing, with the exception of new information indicating that the threat from disease has been reduced, as described below. Additional information on ongoing or increasing threats is provided below.

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

<u>Quarries</u>
Limestone and rock quarries are a continuing threat, particularly near Hellhole and Schoolhouse Cave, as there is an active and expanding limestone quarry in that area. In addition, the entrance to Hellhole is currently privately owned and controlled by the quarry operator. As a result of negotiations between the quarry owner, the West Virginia Department of Environmental Protection (WVDEP), WVDNR, and the Service, the quarry is currently conducting activities in a

manner that is not adversely affecting these caves. However, modifications to project operations or further expansions could adversely affect these caves and the foraging habitat around them.

Oil and Gas Development

Oil and gas development and associated pipeline construction is an emerging threat. The Marcellus and Utica Shale formations underlie the range of the VBEB in West Virginia. Recent increasing development of these formations could threaten VBEB sites and foraging habitats. Improvements to drilling techniques (fracking) have allowed for the development of gas deposits in additional areas that underlay the range of the VBEB. These advanced drilling techniques can go horizontally, as well as deeper than previous techniques, which could affect the geological or hydrological integrity of caves and mines that support the VBEB. There is also an increase in pipeline construction associated with this gas development. Blasting and construction could affect caves and mines used by the species. Slips (the sliding of a mass of land down a slope or cliff) from construction on steep slopes could block or alter entrances and affect rock faces, forests, streams, and wetlands used by the species. Construction of gas wells, pipelines, and other associated facilities could degrade or destroy foraging habitat.

Coal Mining

Coal mining, particularly in the southern West Virginia Region may remove or degrade foraging and drinking habitat, and also destroy abandoned mine portals and passages used as roosting, hibernation, breeding, and maternity sites. Current mining and reclamation techniques are not likely to result in the creation and abandonment of mine portals that might be used by VBEBs in the future.

Roads

Major new roads have been proposed in the range of the species in West Virginia and North Carolina. These roads could remove or alter caves and mines used by the species, cause direct mortality through road kills, fragment VBEB habitats, and affect known roosting and foraging areas. As noted in the last status review, VBEB mortalities have been documented along smaller roads that are already present near VBEB sites. If mortality from collisions or reduced reproductive success occurs from increased road development, the VBEB may be slow to recover from population losses because of their life history strategy. Like most bats, this species is long-lived, has low reproductive rates, and requires larger than expected home range areas for its body size (Weber et al. 2016). Roads constructed between roosting and foraging sites, or between roost sites could also reduce foraging success, fragment habitats, and present a barrier to VBEB movement between key areas needed to support various life stages of the species. One design alternative for a proposed new four-lane road in West Virginia would directly affect and destroy an abandoned mine complex that is used by the VBEBs. It would also remove known foraging areas. A road-widening project in North Carolina is proposed in an area between known VBEB hibernacula and maternity sites. Telemetry data from North Carolina suggest that VBEBs may move across smaller roads but generally did not cross major roads during nighttime foraging bouts (Weber et al. 2016). Studies from Europe suggest that roads can be a barrier to bat movement, but that effects may vary depending on species, landscape context, nearby tree cover, and level of traffic (Kerth and Melber 2009, Abbott et al. 2012). Therefore, additional site-specific work would be needed to properly design and site roads so that potential effects to VBEBs are avoided and minimized.

Development

As described in Section 2.2.3, many of the largest VBEB sites are located on private lands and are not protected. In addition, foraging habitat around both protected and unprotected sites is often on private lands. Development could impact foraging habitat, travel corridors, and roosting locations. This is an increasing threat especially in the vicinity of hibernaculum and maternity sites in North Carolina. Development and land-use changes may also result in old buildings that are used as day or night roosts being torn down. It can also result in increased predation from cats and other species adapted to human presence.

Other

As noted in the 2008 review, rock and tree falls, and invasive vegetation can block cave entrances and reduce numbers in caves. Abandoned mine entrances may also become unstable and collapse. These types of changes should be monitored and action taken to control vegetation or stabilize entrances and slopes where feasible. In addition, caves may be actively changing in ways that could alter habitat suitability or increase threats. Sinkholes may form creating new entrances, or interior breakdown may occur by changing interior microclimate or airflow. The extent of some caves and mine sites are not well-documented or not well known. Therefore, the ability to assess effects from projects or identify areas for protection is limited. The development of accurate baseline speleographic maps and the regular monitoring of caves would assist in addressing these threats (see Section 4.0).

There are likely additional sites that are used by VBEBs that have not yet been identified, particularly in the Western, Southeastern, and Central Regions. Surveys for additional sites are needed. No protocols have been established to survey caves or mine portals for potential summer VBEB use; therefore, their presence may not be detected during project reviews and assessments (e.g., quarries, oil and gas, coal mining, roads, and other developments).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

There is no evidence that VBEBs are being adversely affected by commercial or educational uses. Scientific uses are regulated through state and Federal collecting permits. It does not appear that these activities are having an adverse effect on VBEBs. Sites occupied by VBEB can be used by recreational cavers;

these threats are discussed in Section 2.3.2.5.

2.3.2.3 Disease or predation:

Disease

In the 2008 status review, White-nose Syndrome (WNS) was listed as an emerging threat to the VBEB. However, information developed since that time suggests that the species is not susceptible to the disease (Coleman 2014, Reeder and Moore 2013).

WNS is an infectious disease that is a serious threat to many cave-dependent bat species throughout the country. This disease is caused by the fungus *Pseudogymnoascus destructans (Pd)*, and affects hibernating bats. It first emerged in the winter of 2006-2007 in New York and by 2014, was estimated to have killed more than 5.5 million bats (Coleman 2014). By 2018, WNS had spread to 33 States and 8 Canadian Provinces and is present throughout the entire range of the VBEB (whitenosesyndrome.org 2018). Both the fungus and the resulting disease have been found in hibernacula used by VBEBs, and the fungus has been detected on VBEBs during hibernation. However, no VBEBs have been documented with WNS infection, and it appears that the species is not susceptible to the disease (Coleman 2014, Reeder and Moore 2013).

The reasons for the VBEB's lack of susceptibility to WNS are not understood, and research on this topic is ongoing. One theory is that as a larger-bodied bat species, VBEBs can store and carry more fat. The species also hibernates for shorter periods than affected species, and has lower surface area-to-volume ratios, which can slow heat loss. VBEBs also select colder roost sites within the hibernacula. These characteristics taken together could confer an advantage against *Pd* (Reeder and Moore 2013). It is also hypothesized that VBEBs may have some innate chemical resistance to the fungus, potentially associated with a yellow-oily substance they secrete from their parahinal glands, however this has not yet been confirmed (Danford et al. 2018).

Predation

VBEB continue to be vulnerable to predation. VBEBs are particularly vulnerable to predation because they must emerge from the cave entrance each night during the summer and the passages and openings that they must travel through are often confined spaces that make it conducive for predators to routinely catch emerging VBEBs. In addition, during the winter, VBEBs often roost in large clusters that may be on low ceilings within the cave that can be easily reached by predators. Therefore, one predator could have a significant impact on a colony. Predation is a potential problem at all VBEB caves. Incidences of predation by owls, raccoons, and cats have been noted at VBEB caves within the last 5 years. For example, in North Carolina raccoons were documented entering both hibernacula and maternity caves, and trail cameras documented coyotes attempting to prey on emerging bats. Predators may include raccoons, bobcats, house cats, skunks, coyotes, owls, and snakes. Increased development around VBEB caves, particularly residential development, may increase predation associated with domestic cats.

Heavy infestations of parasitic strebilid flies have been noted at some caves recently. It is not clear whether they are affecting the health of the VBEB.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Existing regulatory mechanisms are inadequate to protect the VBEB in the absence of the ESA.

West Virginia has no state threatened and endangered species legislation. Kentucky also does not have a State endangered species list; however, they do have a regulation that prohibits the importation, transportation or possession of an endangered species or any part thereof without a permit (KRS 150.183). The Kentucky Department of Fish and Wildlife Resources may issue permits "for zoological, educational, or scientific purposes, and for the propagation of such wildlife in captivity for preservation purposes except as otherwise prohibited by law."

In Virginia, the VBEB is protected under State law (4 VAC 15-20-130). It is unlawful to "take, transport, process, sell, or offer for sell within the Commonwealth any threatened or endangered species of fish or wildlife except as authorized by law."

VBEBs are protected and listed as endangered by North Carolina. G.S. 113-337 states "It is unlawful to take, possess, transport, sell, barter, trade, exchange, or export, or give away for any purpose including advertising or other promotional purpose any animal on a protected wild animal list, except as authorized according to the regulations of the Commission, including those promulgated pursuant to G.S. 113-133(1).

While these laws do provide protection against collection, possession, or trade of the VBEB, these are not primary threats facing the species. In addition, although they provide some protection against direct take, these laws do not provide protection for habitats needed to support or recover the species.

Currently, there is no Federal oversight of wind power production, and State permitting and siting regulations are inconsistent. Therefore, there is a lack of formal means for the state and Federal resource agencies to participate in wind development planning. In addition, there is a lack of information regarding the effectiveness of mitigation measures for wind farms, particularly in regard to non-migratory species such as the VBEB.

In summary, in the absence of the ESA, protections for the VBEB are limited and current regulatory mechanisms are not adequate to protect VBEB populations from their primary threats.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Disturbance and Vandalism

Disturbance and vandalism at cave and roost sites is one of the primary threats facing this species. As described in Section 2.2.3, many of the largest VBEB sites are located on private lands and are not protected. These sites are threatened with continued human access that can make these caves less suitable or unsuitable to support the species. Even when caves are protected, significant threats to these caves remain. Vandalism of cave gates and illegal entry into caves on protected lands owned by State and Federal agencies has occurred at multiple sites within the last 5 years, as described in the Regional Summaries. As a result, disturbance and vandalism is an increasing and significant threat to the species. Disturbance within caves can result in direct mortality of bats, reduce survival of young, reduce survival of adult hibernating bats, and cause bats to abandon sites, all of which can result in long-term adverse effects to populations.

Rock climbers and other recreational users have been noted as a potential threat in Kentucky, West Virginia, and North Carolina. These users could disturb bats roosting on cliff faces, rock shelters and crevices. VBEB maternity activity has recently been documented in this habitat type in Kentucky, and rock climbing is very popular in the NRGNR in West Virginia. Repeated disturbance from recreational users could result in mortality to young or abandonment of sites.

Wind

The development of wind turbines near VBEB sites is a current and increasing threat. Although there are no documented occurrences of VBEBs being taken by wind turbines to-date, there are currently very few wind facilities within the range of the species, and the sites closest to VBEB sites are not actively monitoring for bat mortalities. High mortality of other bat species has been documented at wind turbine sites when monitoring has been conducted. For example, studies at the Mountaineer, West Virginia and Meyersdale, Pennsylvania sites documented between 30 and 38 bats killed per turbine during one 6-week period (Service 2006). It is estimated that the total number of bats killed annually at the Mountaineer site could approach 4,000 (Tuttle 2004). These sites are not located in the immediate proximity of any known VBEB sites. However, projects have been proposed in Pendleton County, West Virginia, and Highland County, Virginia. These proposed sites are located in close proximity to a number of major VBEB maternity and hibernacula caves and have an increased probability of impacts to this species (Service 2006). Foraging VBEBs or bats moving to and from maternity and hibernacula caves would be vulnerable to mortality at wind turbines.

Beech Ridge Wind Farm, located in Greenbrier County, WV completed a Habitat Conservation Plan (HCP) in 2013 that included take coverage for the VBEB (Beech Ridge Energy LLC 2013). This site is outside the known range of the species and there are no known VBEB sites within this county. However, adjacent counties contain VBEBs, and the sites is in between the Northeastern and Central Regions; therefore, the species could potentially occur there over the life of the project. Other projects near the edge of the range of the species are also considering HCPs that may include the VBEB.

Although there have been advances in measures used to reduce bat mortality from wind facilities, there are significant differences in behavior, migration and foraging patterns, distribution, and detection probabilities between other bat species that have been the focus of these conservation measures (e.g., Myotis species) and the VBEB. These differences must be considered when evaluating the applicability of existing wind related bat mortality and activity data, and the effectiveness of potential avoidance and minimization measures for the VBEB. For example, much of the data used to establish wind turbine curtailment below 6.9 m/s as an effective avoidance measure for Indiana bats were developed using acoustic monitoring to assess when the majority of bat activity occurs, or by looking at bat mortality data from existing wind facilities. Data assessing bat activity patterns using acoustical studies are not likely to capture most *Corynorhinus* activities because they produce low intensity calls that are difficult to detect (Piaggio and Sherman 2005, Britzke 2003, O'Farrell and Gannon1999). One study found that *C. townsendii* calls could only be detected when the bats were less than 5 meters from the detectors (O'Farrell and Gannon 1999), such as when the detectors are placed within restricted spaces like cave entrances. Even when *Corynorhinus* are detected, they may only make up a small proportion of total calls. For example, when acoustic detectors were used near OBEB caves, their calls never made up more than 0.4 percent of the total calls recorded at any site (Korman 2013). Therefore, additional assessments are needed to determine the extent to which existing acoustical and mortality data from wind projects can be used to develop effective avoidance measures for the VBEB (see Section 4.0).

In addition, VBEBs have different migration patterns and are active on the landscape longer than other hibernating bat species. Because *Corynorhinus* species mate from September through February, movements between hibernacula may occur during this late fall and winter time period (Barbour and Davis 1969). Data from closely-related OBEB and Rafinesque big-eared bats (RBEB)(*C. rafinesquii*) document that during the winter these bats moved between caves and/or other roosts located over 3.7 miles apart and that the number of bats present in individual hibernacula varied markedly from November, December, and February. These data indicate that relatively large numbers of bats were moving between caves during these time periods (Clark *et al*. 1997, Johnson *et al*. 2012). VBEBs also leave roosts during the winter to forage and drink. VBEBs arouse more frequently in the winter than some *Myotis* species (D. Reeder, personal communication) and evidence of winter foraging activity such as fresh feces and moth wings, have been seen during VBEB winter hibernacula surveys (C. Stihler, personal communication). OBEBs and RBEBs have also been found to be active on the landscape during winter nights, including on nights that temperatures were near or below freezing (Clark *et al*. 2002, Johnson *et al*. 2012). This is consistent with the recent results from monitoring conducted at VBEB hibernacula discussed in Section 2.3.1.1. Big-eared bats may also begin moving from winter hibernacula into summer/maternity roosts earlier than the Indiana bat and the timing of colony formation in spring varies by year (Clark *et al*. 2002). WVDNR survey records from four caves show that by the beginning of April, hundreds of VBEBs had already migrated from winter to summer roosts (WVDNR unpublished data). Telemetry studies in North Carolina document that VBEBs leave hibernacula and arrive at springtime roosts by late March or early April (Weber et al. 2016). As a result, curtailment strategies limited to the "active season" for Myotis bats (April 1 to November 15) will not be sufficient to avoid periods when VBEBs are present on the landscape.

Other Sources of Direct Mortality
Direct mortality and injury from oil and brine separation pits, and other holding ponds are a continuing threat to the VBEB. These threats are described in the 2008 status review. The recent increase in gas development in West Virginia could increase the extent of this threat in that region.

Population Size and Genetic Health
The small size of colonies is the Southeastern and Central Regions is a concern. Numbers of bats within the Virginia caves is decreasing, and it is unclear why. The total number of bats within the Central Region is very low. Populations in these two regions may have restricted resiliency. Low genetic diversity may limit the VBEB's adaptive capacity. Minimum viable population size is not known. Additional research to evaluate the significance of these threats is needed.

2.4 Synthesis

The overall range-wide population of the VBEB within both hibernacula and maternity colonies has increased between 30 percent and 28 percent respectively since the time of the last status review. The current total population of the species is approximately 19,574 bats in hibernacula and 11,778 within the known maternity sites (Recovery Criterion 2). Within this overall population increase, there have been population declines within certain regions, and within some major sites. Research has established that there are four distinct population areas within the range of the species that are geographically and genetically differentiated, and that these regions should be managed as separate units. The Northeastern Region supports the largest population and encompasses all of the currently designated critical habitat. Overall numbers within this region have been on a consistently upward trend over the past 10 years, and are at their historical maximum although declines at some caves have been seen due to suspected roost switching, and human disturbance. Increases in the number of VBEB within a single cave in this region, Hellhole, are responsible for the overall population increase seen for the species range wide. The Western Region supports the next largest population. Overall numbers in this region have declined since the late 1990s and early 2000s. Numbers have been trending back upward in the past few years, although there have been large fluctuations in both individual caves and overall numbers since 2008. Population fluctuations and declines have also been seen in many caves in the Southeastern Region. Although a new maternity cave has been discovered in this region, declines have occurred in the major hibernacula and other maternity sites, and some sites may have been abandoned. The reasons for these fluctuations/declines in these two regions including potential threats or potential unidentified roosts should be investigated. A total of 67 VBEBs have been found over 15 years of surveys in the Central Region. All these bats were found in abandoned mine portals. Additional work is needed to understand the abundance and distribution of VBEBs in this region, and to identify additional sites in this area.

Progress has been made in identifying and/or protecting additional VBEB caves since the 2008 status review, including the discovery or colonization of major new caves in Kentucky, North Carolina, and West Virginia, and the protection of additional caves in North Carolina, Virginia, and West Virginia. However, VBEB populations continue to be concentrated in a small number of caves, making them extremely vulnerable to disturbance and large-scale population losses from single catastrophic events. Throughout the four state range of the species, there are only 10 major hibernacula and 18 major maternity sites. Many of these sites are not protected. Only 28 percent of the overall hibernating population and 49 percent of the overall maternity population uses protected sites. Many "protected" sites are still subject to threats from human disturbance through vandalism and illegal access into gated sites. Significantly, approximately 69 percent of the total range wide population hibernates in a single cave, Hellhole, which is not considered protected and is threatened by limestone quarry development. The concentration of VBEBs into a small number of caves, and the lack of effective protection of these sites, makes this species particularly vulnerable to the continued threats of disturbance and loss of habitat that were the primary reasons for listing the species (Recovery Criterion 1).

Recent progress has been made in identifying foraging habitat requirements for the VBEB. However, to date, no coordinated efforts have been made to delineate the availability and quantity of these habitats within the vicinity of major VBEB sites, and there have been few efforts to pro-actively manage, restore, improve, or maintain suitable VBEB foraging areas (Recovery Criterion 3). Therefore, key foraging areas around VBEB sites are not protected, and the species continues to be threatened by loss and degradation of this habitat type which is required to support the species.

In addition to human disturbance and vandalism, and lack of effective long-term protection for foraging areas, threats to the species include loss of habitat from quarries, oil and gas development, coal mining, roads, and development; and mortalities from predation, roads, wind farms, and oil and brine pits. Small population size and reduced genetic variability may be a threat to populations in Southeastern and Central Regions. Existing regulatory mechanisms are not adequate to manage these threats in the absence of the ESA. There is no evidence that VBEBs are threatened by overutilization. Recent evidence suggests that VBEBs are no longer threatened by disease from WNS. Protocols for monitoring maternity and hibernation sites have been established and are generally being implemented (Recovery Criterion 4). These protocols allow for population trends to be effectively monitored.

Based on this analysis, Recovery Criteria 1 and 3 have not been met. Recovery Criterion 2 has been partially met, and Criterion 4 has been substantially met. The species does not meet the current criteria for downlisting. In addition, although overall population numbers have been increasing, significant threats to the species remain, and the species continues to be highly concentrated in a small number of caves, which makes it highly vulnerable to stochastic events and human disturbance. The species should continue to remain listed as endangered.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number: No change needed.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

This status review identified the highest priority threats to the VBEB as well as additional conservation planning, management/threat reduction measures, and survey and monitoring needs for the species. In some cases, additional research is needed to help identify appropriate management actions that would reduce these threats. The following is a list of priority future actions based on the results of this review.

Conservation Planning
The Recovery Plan and associated recovery criteria for the species needs to be updated to address current species information, including genetics, population structure, and threats. The four regional populations should be recognized as discrete units. New recovery criteria should be developed that provide VBEB resiliency, redundancy, and representation and address the five-factors and provide for adequate means to gauge and ensure long-term recovery. The recovery actions could also be updated to delete actions that have been completed since listing, and to add new actions or reprioritize existing actions to reflect current information on threats and recovery opportunities.

Management Actions/Threat Reduction
Long-term protection measures should be implemented at major VBEB sites. Permanent management agreements or purchase should be sought for major maternity, bachelor, and hibernacula sites. These agreements should seek to protect both surface and subsurface habitats that are required to support the species. Sites with smaller numbers of VBEBs may also warrant protection if data indicate they previously have supported, or could support increased numbers of VBEBs, or if they are important to maintaining the reproduction or distribution of the species.

Sites that are subject to uncontrolled human access should be gated or fenced using designs similar to those used on other VBEB sites that have been demonstrated to be effective.

Gates, fences, signs and closure dates should be routinely monitored and maintained to ensure that protection measures remain effective. If evidence of vandalism or inappropriate entry into sites is documented, remedial actions should be immediately taken, and law enforcement measures should be employed.

Habitats within commuting distances around VBEB caves/mines should be mapped to assess availability and distribution of suitable foraging areas. Land-use type and ownership should be assessed. Management plans should be developed that include measures to create, maintain, enhance, and protect VBEB foraging and commuting habitat. Permanent protection should be sought for areas that serve as important VBEB foraging habitat. Additional telemetry studies could be used to further identify VBEB foraging areas.

Numbers of VBEBs have been declining at some sites or regions as described above. The causes of these declines are not currently known. The causes of declines at established VBEB sites should be investigated, and mitigation measures for any causes should be implemented.

Efforts to reduce threats from habitat loss and degradation, and other natural and manmade factors should continue through the use of cooperative partnerships and regulatory means. Threats identified in this status review should be prioritized for action.

Research needs to be conducted to determine what types of siting and/or operational methods will eliminate or reduce bat mortality at wind farm projects that may be proposed in the vicinity of VBEB sites. The development of consistent guidelines and permitting requirements at either the state or Federal level would also assist in avoiding potential impacts from future project proposals. Project planning for any wind farms roads proposed near VBEB sites should include avoiding locations that are within foraging and migration areas for the VBEB as well as measures to avoid and minimize VBEB mortality.

The effects of roads and other barriers to movement should be investigated to determine what features or factors can reduce adverse effects, and research should be conducted to test the effectiveness of any measures that are developed. Project planning for any roads proposed near VBEB should include measures to avoid and minimize VBEB habitat fragmentation as well as the potential for direct mortality of bats through vehicle strikes.

<u>Surveys and Monitoring</u>

Data suggests there may be additional, as yet unidentified, sites that are serving as maternity, hibernacula, or bachelor colonies. Biologists should search for additional caves or roosts of importance to VBEBs particularly in the Central, Southeastern, and Western Regions. This should include additional telemetry work and searching for sites within rock outcrops or crevices.

Established summer maternity and winter hibernacula survey protocols should be continued to be used throughout all states in the range, with maternity sites surveyed annually and hibernacula surveyed biannually. Efforts to correlate results from new technologies (like acoustic loggers) with existing protocols should be undertaken.

Transient fall roosts and bachelor colony sites may be important to the conservation of the species. These sites may be primary locations for breeding and genetic interchange. Currently, most bachelor sites are not routinely monitored, and many are not protected. These sites should be included in monitoring efforts, perhaps at a less frequent interval than for maternity sites. These caves should also be protected and gated using the long-term protection measures described above.

The effectiveness of Indiana bat mist net survey protocols for detecting VBEB presence during the summer should be assessed. The timing of VBEB entrance to and emergence from hibernacula differs from the Indiana bat, so VBEB specific spring/fall emergence protocols to confirm winter use of portals should be developed. Standardized protocols for conducting summer surveys to determine maternity or bachelor site usage particularly at abandoned mine portals should be developed.

Population viability assessments or other similar measures should be conducted to help understand and manage for long-term sustainable population numbers. This is particularly important for regions where populations are small or not-well understood, such as the Southeastern and Central Regions.

Mapping of important caves or mines should be completed. Baseline maps of these subsurface habitats may help to assess natural changes over time or evaluate future threats from development such as mining or other construction.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF THE VIRGINIA BIG-EARED BAT

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Barbara Douglas, West Virginia Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve ________________________________ Date 8/7/19

COOPERATING REGIONS

Actg **Region 4, Assistant Regional Director, Ecological Services, Fish and Wildlife Service**

__✓__ Concur _____ Do Not Concur

Signature ________________________________ Date 2/12/19

5 YEAR REVIEW ***for the***

VIRGINIA BIG-EARED BAT (Corynorhinus townsendii virginianus)

December 2018

Surname: ______________________ Date: 2/5/2019

ARD-ES, Region 5, U.S. Fish and Wildlife Service

Appendix A
Regional Summaries

- **Northeastern Region**
- **Central Region**
- **Southeastern Region**
- **Western Region**

Northeastern Region

The Northeastern Region includes caves or roosts within Grant, Hardy, Pendleton, Preston, Randolph, and Tucker counties, West Virginia; and Bath, Highland, and Rockingham counties, Virginia. All currently designated critical habitat for the VBEB occurs in this region. This region also supports the largest population of VBEB, has more VBEB caves/roosts than any other region. A list of major VBEB sites is shown in table 2.

There are 23 caves in this region that have been used by VBEBs during the winter in the past 10 years. However, only six of these have had more than 100 hibernating VBEBs: Cliff, Minor Rexrode, Schoolhouse, Hellhole, Sinnett/Thorne, and Cave Hollow/Arbogast. The last three are designated critical habitat. Cliff is not gated and is on private land, and is not considered protected. Hellhole is fenced and considered closed to access but it is on private lands and the entrance and surrounding area are controlled by a limestone quarry company. It is therefore, not protected. Sinnitt/Thorne is gated and on private land. Although there is no permanent conservation agreement, at this time it is actively managed for both recreation and conservation purposes. The other three caves are gated and located on public lands, and are considered protected. This information is summarized in table 2.

The total hibernating population of VBEB in this region has been steadily increasing and has more than doubled over the past 10 years from 7,311 at the time of the last status review in 2007 to 15,467 in 2018. This increase has primarily been driven from increases seen in a single cave: Hellhole. During that time the total population increased by 8,064 bats, while the numbers in Hellhole increased by 8,487. Therefore, decreases at other sites have been occurring despite increases at Hellhole. Currently, 13,493 VBEBs (87 percent of the regional population) hibernate in Hellhole and 15,339 (99 percent) occur in the six caves mentioned above. Therefore, hibernating VBEBs in this region are highly concentrated in a small number of caves, and the largest number of bats occurs in a single cave that does not have long-term protection, but is currently only afforded protections through the ESA.

There are 12 caves used as maternity sites in this region that support a total of 10,173 VBEBs. Four of these maternity caves are designated as critical habitat. Six of these caves (including three that are designated as critical habitat) are considered protected. These protected caves support approximately 52 percent of the maternity population. The total maternity population of VBEBs has been steadily increasing over the past 10 years from 6,614 at the time of the last status review in 2008 to 9,699 in 2018, a 42 percent increase. This is the highest total population recorded to date for this region.

While there have been some fluctuations in individual cave counts during this time period, overall most caves are steadily increasing with the exception of Cave Mountain and Lambert Caves. The declines seen in Lambert Cave may be related to the restoration and reoccupation of a historical maternity cave, Gale Warner, which is located only 0.2 miles away (WVDNR 2017). Although historical numbers are not available for Gale Warner Cave, records indicate that this cave supported a maternity colony during the late 1950s (WVDNR 2014). However, a previous owner blocked the entrance with debris. In 1999, the current cave owner and a local caving group removed the debris and restored the entrance. Then, in 2014, a cluster of 80 VBEBs was documented in the cave, and subsequent surveys in 2015 confirmed that a maternity colony was present. There were 301 VBEBs in 2018. The re-establishment of this colony coincides with the decline seen in Lambert Cave. Numbers in Lambert Cave had been steadily increasing to a maximum of 517 in 2014 but then began to annually decrease to 137 in 2017. The combined number of bats from both caves was 597 in 2014 and 536 in 2018. Both Lambert and Gale Warner are privately owned, and only Lambert is gated. It is not clear why the VBEBs may be leaving Lambert for Gale Warner, or other sites.

The other maternity cave with notable declines, Cave Mountain, is designated as critical habitat and historically supported over 1,000 VBEBs in the summer. However, numbers in this cave have declined and it is now one of the smaller maternity sites in the region with 469 VBEBs (only Lambert and Gale Warner have fewer VBEBs). Although Cave Mountain is on public lands and is gated, it has been subject to significant vandalism over the years. Most recently, vandalism to the cave gate was discovered in June 2017 whereas this gate had previously been checked and was secure in February 2017. The June 2017 summer count showed a 16.6 percent decline from the previous year (from 483 to 403 bats)(WVDNR 2017).

Although Mystic Cave has seen an overall increase in the last 5 years, recent events indicate increasing threats to this cave. Mystic Cave is a privately owned cave that is currently not gated and is not considered protected. The previous owner of Mystic Cave lived close to the entrance and closed the cave to public access during the summer maternity season. She recently passed away and although the new owner is conservation-minded and does not allow public access to the cave, he does not live nearby. Monitoring of the entrance over the past year has documented a number of groups entering the cave including during times of year when the bats are present. The number of VBEBs in this cave declined from 845 VBEBs in 2017 to 797 in 2018.

This region also has at least four caves that support documented bachelor colonies of at least 100 bats: Elkhorn in Grant County; and Hellhole, Minor Rexrode, and Trout in Pendleton County. These caves are not monitored on a regular basis; therefore, information on current status and trends is not available. Elkhorn and Hellhole are not protected. Trout Cave is a new bachelor colony that has become established since the time of the last status review. Trout Cave was historically known to support up to 2,000 hibernating Indiana bats and was occasionally used by VBEBs in the winter and fall. There were no historical records of VBEBs using the cave in the summer (WVDNR 2014). Trout Cave is located in close proximity to a number of other caves known to be used by VBEBs during the summer and the winter. The cave is owned by the National Speleological Society and was heavily used for year-round recreation. In fall 2008, the cave was gated and closed to access in the winter to protect the hibernating Indiana bats. However, in January 2009, signs of WNS were detected in the cave. This was the first documented occurrence of WNS in WV (WVDNR 2011). As a result, the cave was closed to recreational access year-round. In June 2010, the cave manager noticed a “sizeable number” of VBEBs using the cave and a subsequent emergence count documented 159 VBEBs exiting the cave. In August, harp trapping at the entrance captured 15 VBEBs consisting of 14 males and one juvenile female, indicating that the cave was being used as a bachelor colony (WVDNR 2010). Another emergence count was conducted in July 2014, which documented 407 VBEBs exiting the cave (WVDNR 2014). The results of these surveys indicate that male VBEBs will readily move into nearby caves with suitable habitat after disturbance is reduced, particularly when the cave was previously used by the species in even low numbers. It is not known which cave or caves these bachelor bats moved from.

Table 2: Major VBEB Maternity or Hibernacula Sites in the Northeastern Region

State	County	Cave Name	Protected	Most Recent Mat #	Most Recent Hib #
VA	Highland	Arbegast	Yes	474	7
WV	Grant	Peacock	Yes	1,240	38
WV	**Pendleton**	**Cave Mountain***	**Yes**	**469**	3
WV	Pendleton	Cliff	No	1,517	258
WV	Pendleton	Gale Warner	No	301	NA
WV	**Pendleton**	**Hoffman School***	**Yes**	**1,456**	**2**
WV	Pendleton	Lambert	No	235	NA
WV	Pendleton	Mill Run	No	522	NA
WV	Pendleton	Mystic	No	797	4
WV	Pendleton	Schoolhouse	Yes	912	660
WV	**Pendleton**	**Sinnitt/Thorn***	**No**	**1,050**	**204**
WV	**Pendleton**	**Hellhole**	**No**	**NA**[1]	**13,493**
WV	Pendleton	Minor Rexrode	Yes	NA	237
WV	**Tucker**	**Cave Hollow/Arbogast***	**Yes**	**1,200**	**487**
VA/WV	Various	Other Caves	NA	NA	74
		Total		**10,173**	**15,467**

***Designated critical habitat.**

Since the time of the last review, two historical sites Gale Warner (discussed above) and Smokehole, have been reoccupied, and one new portal complex has been discovered. None of these sites are considered protected. Smokehole in Pendelton County was historically occupied but had only been occasionally used by VBEBs in recent years. This cave is privately owned. In late June 2017, a bat biologist visiting the cave noted a cluster of VBEBs approximately 8-10" wide. Harp trapping conducted in late August 2017 captured 11 VBEBs including a post-lactating female, 5 juveniles, and 5 males. Because these surveys were conducted during the time of year that VBEBs may be moving between sites, it is not clear whether this cave is being used as a maternity colony site, or if it is a bachelor colony/fall swarming and breeding site. Additional surveys are needed to confirm the type and extent of VBEB use at this cave.

In 2014, VBEBs were documented using an abandoned mine complex in this region during the fall swarm. A total of 23 VBEBs were found using these sites over 3 years of surveys. Both males and females in approximately equal numbers were captured. Follow-up surveys did not document use during the summer or emergence during the spring, so this site may be used as a breeding and swarming area. This is the first documented use of abandoned mines by VBEBs in this region. These portals and the surrounding foraging areas are threatened by major highway development that could directly affect the mine passages and foraging areas.

[1] NA indicates that this site is not used for this purpose.

Threats to VBEB in the region and associated conservation needs include:

- Some significant sites within this region are currently not protected including major caves, and the foraging areas surrounding them. Measures to permanently protect and preserve these areas are needed. Even when caves are protected, significant threats to these caves remain. Vandalism of cave gates and illegal entry into caves is increasing and widespread threat within this region. The gates and/or fences of at least seven major VBEB caves have been vandalized in the last 6 years, including Hellhole, Cave Mountain, Cave Hollow/Arbogast, Mystic, Sinnitt/Thorne, Trout, and Hoffman School. Vandalism has included excavating under gates or fences, cutting gate bars or locks, and entry during closed periods. Law enforcement officers were able to successfully identify and close a case against perpetrators attempting to enter one of the caves. Additional investigations are ongoing. In some instances, it does not appear that attempts to enter the cave illegally were successful, although in other cases they were. In at least two caves (as described above), declines in VBEBs coincide with periods of illegal entry.

- The number of wind facilities in this region is increasing. There are a number of wind facilities located on the edge of the range of the species in this area and at least one major wind facility proposed in Pendleton County near where many of the major VBEB caves are located.

- There is at least one new major road proposed in close proximity to VBEB sites in this region. Roads constructed in between roosting and foraging sites, or between roost sites can cause direct mortality and could also reduce foraging success, fragment habitats, and present a barrier to VBEB movement between key areas needed to support various life stages of the species.

- Limestone and rock quarries are a continuing threat including near Hellhole and Schoolhouse Cave, as there is an active and expanding limestone quarry in that area. As a result of negotiations between the quarry owner, the WVDEP, WVDNR, and the Service, the quarry is currently conducting activities in a manner that is not adversely affecting the cave. However, if modifications to project operations or further expansions are planned, or if additional information on cave passages is developed, then this determination may be revised.

- Oil and gas development and associated pipeline construction is an emerging threat in this region. Recent improvements to drilling techniques (fracking) have allowed for the development of gas deposits in previously inaccessible areas that underlay the range of the VBEB. These advanced drilling techniques can go deeper as well as horizontally, which could affect the geological or hydrological integrity of caves and mines that support the VBEB. There is also an increase in pipeline construction associated with this gas development. Pipelines could affect roosting and foraging habitat for the VBEB, and blasting and construction could affect caves and mines used by the species. Slips from construction on steep slopes could block or alter entrances and affect rock faces, forests, streams, and wetlands used by the species.

- The extent of some caves and mine sites are not well-documented or not well known. Therefore the ability to assess effects from projects or identify areas for protection is limited. The Cave Research Foundation is currently working to map the Cave Hollow/Arbogast system. Additional mapping projects on key caves may be warranted.

- No protocols have been established to survey caves or mine portals for potential summer VBEB use, therefore these types of sites may not be detected during project reviews and assessments.

Central Region

Very little is known about the population of VBEBs within the Central Region. Surveys conducted between 2002 and 2017 have captured a total of 67 VBEBs at 20 abandoned mine portal entrances in Fayette County within the New River Gorge National River (NRGNR) (Lenza 2018, Johnson et al. 2003). Twelve of these portals have been gated and all are located on public lands. The majority of VBEB captures (64) occurred in the fall by trapping at portal entrances. The fall captures consisted of both males and females. The maximum number of VBEBs captured in one year was in 2002 when 26 were captured at 13 out of 36 sites surveyed. The maximum captured at any one site was eight at the Nuttallburg B portal in 2002. That year also had both the largest level of effort and largest number of sites sampled. The number of VBEBs detected each year has declined since then, with 16 detected in 2005, two detected each year between 2013 and 2015, and none detected in 2016 or 2017. However, the number of sites and locations surveyed has varied between years, making an assessment of overall trends difficult. It should also be noted that the level of effort associated with entrance trapping is not designed to capture or quantify the total number of bats using the site during the winter. Therefore, the total number of bats captured likely does not equal the total number of bats present within the area.

Ideally, internal surveys during the winter would be conducted to confirm use as hibernacula and allow for a more complete count of bats present. However, conducting fall entrance trapping is the best available method for determining whether an abandoned mine site may be used as a hibernaculum because it is not safe to enter mines due to site instability (Johnson et al. 2003). Therefore, it is assumed that sites with fall detections have been or are being used for both fall swarming and hibernation (Johnson et al. 2005). This is consistent with other studies that have shown that fall captures at caves indicates behavior typically associated with mating and hibernacula selection (Davis and Hitchcock 1965, and Fenton 1969 in Johnson et al. 2005). Although recent surveys at abandoned mine sites in the Northeastern Region indicate that some sites where VBEBs are present in the fall may not be used as hibernacula (WVDOH 2017). In that case, other known hibernacula are present nearby.

The number of female captures in the fall at NRGNR portals also indicates that a maternity colony may occur in the area (Johnson et al. 2005). However, to date, no maternity sites have been discovered within this region. Summer surveys targeting VBEBs have been limited. Summer trapping at portal entrances was conducted in 2002. Out of 36 sites surveyed, a total of three male VBEBs were captured at 2 sites. In addition, no VBEBs were captured during mist netting conducted in 2003 and 2004 at 41 sites within the Gauley, Bluestone and NRGNRs (Castleberry et al. 2005).

This area is geographically separated from other known VBEB sites by distances greater that the dispersal patterns these bats (Johnson et al. 2005) and genetic information indicates that this area is isolated from other surrounding populations (Piaggio 2013, Piaggio et al. 2009). These factors suggest that this area may support a separate and distinct VBEB population. Notwithstanding the small numbers of bats that have been found in this RU, there is strong genetic evidence that this population is not of recent origin (Piaggio et al 2009, Piaggio 2013, Piaggio, personal communication). This population also contains unique genetic legacies not found elsewhere within the range, and the VBEB are using alternative habitat features (abandoned mines) that may provide additional adaptive capacity for the species. In addition, the estimated effective population is for this region (361) is similar to those estimated for the Western and Southeastern Regions (323 and 326, respectively) (Piaggio et al. 2009). All these factors suggest that there are more VBEB present in this region than are currently known.

It is likely that there are additional currently unknown sites used by the VBEBs in this region. Abandoned mine portals are common throughout the area in and around the NRGNR including in many surrounding counties (Johnson et al. 2005). VBEBs are known to use rock shelters and cliff faces as both roosting and maternity sites in other portions of the range, and this type of habitat is also abundant in the area (Johnson et al. 2005). In addition, the NRGNR provides large tracts of intact mature forest in close proximity to reliable water sources which provide foraging and drinking habitat for the VBEB (Johnson et al. 2003, Castleberry et al. 2005). Therefore, additional surveys both within and outside the NRGNR are warranted. Genetic samples should be gathered from any additional VBEBs that are captured in this area to help further evaluate the relationship between this and other regions.

Threats to VBEBs within the region include:

- Vandalism of cave gates and disturbance to ungated mine sites, rock shelters, or cliff faces used for roosting, hibernation or maternity sites.

- Many abandoned mines are inherently unstable and are degrading over time, therefore sites used by VBEBs may be subject to collapse potentially trapping or killing VBEBs inside and/or making the mines unsuitable for future use.

- Active coal mining in areas outside of the NRGNR may damage or destroy existing abandoned mine portals and passages used as roosting, hibernation, breeding, and maternity sites, and may remove or degrade foraging and drinking habitat. No protocols have been established to survey mine portals for potential summer VBEB use, therefore these types of sites may not be detected.

- Recreational rock-climbers and other users may inadvertently disturb VBEBs roosting on cliff faces, rock shelters, and crevices.

The primary conservation needs of this region are to continue to monitor sites that have documented VBEB use, periodically check and maintain existing openings and bat gates, further understand the relationship of this region to other regions through additional genetic testing or potential telemetry work, and to search for additional VBEB sites. Searches should include adjacent counties within the known dispersal distance of the bats.

Southeastern Region

The Southeastern Region includes caves or roosts within Avery and Watauga Counties, North Carolina; Carter and Johnson Counties, Tennessee; and Bland and Tazewell Counties, Virginia.

There are two major hibernacula within this population; Black Rock Cliffs Cave in Avery County, North Carolina, and Higgenbotham in Tazewell County, Virginia. Black Rock Cliffs Cave is owned by TNC, and Higgenbotham is owned by VDGIF. Both are gated and considered protected. There are eight other minor hibernacula. The total number of hibernating VBEBs in this population based on the last 2 years of data is 526. Numbers in both main hibernacula have fluctuated over time, and some confounding factors at each site make a determination of trends difficult.

Estimates from Higgenbotham in the 1980s indicated the colony was as large as 2,000 VBEBs. However, these counts were made from estimates of the cluster size (x' by x') multiplied by an average number per square foot. In the 1990s, greater effort was made to count individual bats, but the numbers fluctuated widely (from lows of 400-500 to a high of 1,600). Surveys were stopped in the late 1990s due to safety concerns about an unstable rock ledge near the entrance. After these concerns were addressed, surveys began again in 2011 using photography, which documented 892 VBEBs. The most recent survey conducted in 2017 documented 301 VBEBs. This survey was conducted during a very warm week and the bats were noted to be active with one cluster located closer to the entrance than previously noted. However, because of the lower counts during the past two surveys there are concerns about population declines.

The number of VBEBs at the main known hibernaculum in North Carolina, Black Rock Cliffs Cave, has fluctuated since discovery of the cave in 1981 when 34 bats were found within the cave. Subsequent surveys indicated an initial trend of increasing numbers in the first decade, but since the mid-1990s there have been some dramatic drops on several occasions (as low as 31 and 55 bats). At the time of the previous status review (2007), there were 376 VBEBs documented in this cave, which was the highest number recorded. The most recent survey conducted in 2018 documented 179 VBEBs. One other minor hibernaculum, Black Rock Mystery Hole, has seen similar fluctuations of between 70 and 4 bats over a 10-year period, with the most recent count in 2018 documenting 42 VBEBs. These fluctuations may be due to factors negatively affecting the species, or due to the complexity of the habitat. It is suspected that there are other areas where the bats overwinter as the surrounding mountain landscape is very rocky, with a multitude of crevices and openings yet unexplored or inaccessible to humans. Thus, it is difficult to determine the status of hibernating VBEBs in North Carolina.

No significant bachelor caves have been identified in this region. There are, or were, three major maternity sites in this population area: MBC (Cassel Farm #2) and Higgenbotham in Tazewell County, Virginia; and Mama's Cave in Watauga County, North Carolina. Black Rock Cliff Cave in Avery County, North Carolina is also a maternity cave as well as a hibernaculum. MBC is privately owned, while Higgenbotham and Mama's Cave are owned by State Agencies. Although Mama's Cave is not gated, the location is not widely known, which may reduce chances of visitation. VBEB use of Mama's Cave was first discovered in 2013 and it is now considered the primary maternity cave in North Carolina. This cave has been monitored annually since it was discovered, and numbers have ranged from 292 in 2014 to 422 in 2017. The most recent count conducted in 2018 documented 295 VBEBs. Maternity activity at Black Rock Cliff Cave was first documented in 2013 when 30 VBEBs including young-of-year were seen. Numbers increased to 125 VBEBs and young in 2014.

Maternity counts were conducted at MBC in 2013 and 2016 with 346 and 450 VBEBs documented respectively. Higgenbotham was last monitored during the maternity season in 2013 when 8 VBEBs were seen. Prior to that, numbers were approximately 300, suggesting that this cave has been abandoned. Numbers at both Virginia maternity sites are down from maximums in the late 1990s when 656 were counted at MBC and 621 were counted at Higgenbotham.

In 2018, Virginia switched methods for monitoring maternity caves from using emergence counts to using a bat call data recorder to document acoustic passage rates. These recorders are not capable species identification, but do document emergence over time. These units may provide information on summer activity patterns (emergence in relation to climatic conditions, behavioral activity that may indicate birth times, date of first occupation, date of last occupation, etc.). However, they are not able to determine number of bats present, so results cannot be correlated with previous monitoring data. Additional work to video record exit counts to determine if there is an association with passage rates detected on the acoustic recorders is planned.

In summary, overall population trends for this region are unclear due to the history of fluctuations at primary sites; however, the status may be declining since numbers at both of the two major hibernacula have recently decreased, and as have numbers at two of the three maternity sites. All but one of these sites are publically owned and considered protected.

Threats and conservation needs within this region include:

- Although the primary maternity colony in North Carolina is considered protected, the areas where many of the secondary roosts and foraging areas are concentrated are popular for second home development and are being rapidly developed. This development and associated projects (e.g., road creation/widening) could impact foraging habitat, travel corridors, and roosting locations. It could also result in increased predation from cats and other species adapted to human presence. Protection and management of foraging and roosting habitat around primary roost sites is needed. The Service and other partners have already initiated outreach to local landowners regarding conservation needs of the VBEB, and continued work in this regard is needed.

- The small size of colonies is this region is also a concern. Genetic isolation may be an issue. It is also unclear why these colonies are not growing, given the protection of the main cave sites. Additional research to determine limiting factors is needed.

- Surveys for additional maternity/hibernacula roosts are needed. The last year that all three maternity sites were surveyed during the same season was in 2015 when a total of 934 VBEBs were documented. During that following winter, a total of 258 VBEBs were counted in all the hibernacula, giving strong indication that additional undocumented hibernacula exist.

Western Region

The Western Region includes caves or roosts within Estill, Jackson, Lee, Menifee, Morgan, Powell, Rockcastle, Rowan, Wolfe, and Pulaski counties, Kentucky. However, many of these counties only have records of a few VBEBs. The major sites in Kentucky are in Jackson and Lee Counties.

Since the time of the last status review, one major new site, Johnson Cave, has been located in Jackson County, Kentucky. Use of this site by big-eared bats was first documented in June 1964, but at that time it could not be determined whether these bats were RBEBs or VBEBs. Intermittent winter surveys between 1969 and 1995 documented only occasional use by VBEBs with no more than eight present per year, as well as no more than 47 RBEBs. However, surveys since 2008 have documented a generally increasing trend in the number of VBEBs hibernating in the cave with 35 in 2008, 29 in 2010, 10 in 2011, 98 in 2012, 161 in 2014, 216 in 2016, and 146 in 2018. Large amounts of guano were first noticed during the 2011 survey, indicating that the cave was also being used by big-eared bats in the summer. Entrance surveys in May 2013 and May 2015 documented the presence of both RBEBs and VBEBs. Entrance, emergence, and harp trap surveys were conducted in June 2016. These surveys confirmed that both RBEBs and VBEBs are using this cave for maternity habitat. A total of 679 BEBs were counted emerging from the cave and of the 180 bats captured during the harp trap effort, 92.8 percent were VBEBs including 115 (68.9 percent) reproductive females, 6 (3.3 percent) non-reproductive females, and 46 (25.6 percent) males. These results confirm that the site is being used as both a winter hibernaculum and a summer maternity/bachelor site. Johnson Cave is privately owned and is not gated and therefore, is not considered protected.

There are six known active maternity sites in Kentucky. Three of these are or were major sites: Johnson, Cave Hollow Pit, and Plecotus Pit. While numbers have generally been increasing at Johnson Cave, numbers have generally been decreasing at Cave Hollow Pit and Plecotus Pit. This may be a result of bats switching from these roost sites over to Johnson Cave. Johnson Cave now supports approximately 75 percent of Kentucky's maternity population. Both Cave Hollow Pit and Plecotus Pit are located on national forest lands and are posted with signs as closed but are not gated. These sites are located in remote areas of the forest and are difficult to access. Total numbers in maternity caves were 985 in 2018. This is a decline from the 1,116 documented in 2017 but still an overall increase in the last 5 years from 523 in 2013. These numbers are up from the 409 counted during the 2008 status review, primarily as a result of the discovery of a new maternity site. During this time, numbers declined at Stillhouse Cave, the major bachelor site from 422 in 2007 to 141 in 2018. This is a significant decline from the maximum number (1,153) of bats found in Stillhouse Cave in 1990.

Winter hibernacula are surveyed every other year, therefore a complete count of caves includes results over a two-year period. The total population of hibernating VBEBs has declined 16 percent over the last two complete survey periods, from 4,839 in 2015-2016 to 4,054 in 2017-2018. However, this is still a 22 percent increase from the time of the last status review, which documented a total of 3,166 VBEB in 2006-2007. Although there a total of 55 sites that have been documented to contain hibernating VBEBs, most VBEBs hibernate in two caves: Stillhouse and Johnson. Stillhouse Cave, Kentucky's largest VBEB hibernacula, supports approximately 90 percent of Kentucky's hibernating population. This cave is on national forest lands, is gated and closed year-round, and has no recent history of vandalism, is therefore considered protected. The other caves supported a total of 299 bats in the last survey period (only 33 of the other caves were surveyed within the most recent two year period). The total number of bats at all monitored hibernation sites in 2017-2018 is less than the maximum number (6,335) of bats found hibernating in Stillhouse Cave in 2001.

In summary, the VBEB population in the Western Region has been on a generally increasing trend over the last 10 years, however there have been significant fluctuations within that time period. The discovery of new caves and bats switching between caves makes it difficult to determine clear trends. Overall numbers are down from the 1990s and early 2000s, even when incorporating data from new caves.

Threats to VBEBs in the region and associated conservation needs include:

- Variation in population trends indicates that there may be additional undiscovered caves in the region and/or that there are ongoing unidentified threats. Surveys should be conducted in other suitable habitats throughout the area, and existing known-use areas should be monitored for disturbances and other threats. Additional telemetry efforts may be useful in finding additional sites or understanding habitat usage in the area.

- Over half of the known roosting caves, sandstone rock shelters, and arches known to be used by VBEBs in Kentucky are located on national forest lands. Only 8 of those are currently gated from human access. Many of the ungated ones are in areas that are difficult to access. Existing forest management plans provide protections for VBEB habitat (e.g., rock shelters and caves). However, disturbance in caves on the national forest continues to be a threat. For example, horseback riders located one cave in 2016 and began riding their horses into the entrance. Efforts to reduce this situation are ongoing. Rock climbers may also disturb VBEBs roosting in rock shelters or on cliff faces. Of the 22 privately owned caves, rock shelters, and arches known to have been used by VBEBs, only one is currently gated. These areas could be targeted for protection measures such as gating, fencing, conservation easements, and/or purchase.

- There may be continued threats from oil and gas drilling as described in the 2008 status review.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 88

February 21, 2023

Virginia Spiraea
(*Spiraea virginiana* Britton)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Virginia Field Office
Gloucester, Virginia

October 2021

5-YEAR REVIEW
Virginia spiraea (*Spiraea virginiana*)

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5-YEAR REVIEW
Virginia spiraea *(Spiraea virginiana)*

1.0 GENERAL INFORMATION

1.1 Reviewers

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Technical Reviewers/Experts:
See Appendix A (Coordination List of Partners and Experts) for list of technical reviewers and experts.

1.2 Methodology Used to Complete This Review:

This 5-year review, conducted primarily by the lead recovery biologist for Virginia spiraea, summarizes and evaluates new information relevant to the listing status of the species. New data and information regarding the species' population status and habitat used in this report were based on: peer reviewed literature; information and occurrence data from state natural resource agencies, federal agencies (National Park Service, U.S. Forest Service [USFS]), and researchers; and information provided in the biological status review conducted by Ogle (2008). In 2007, the U.S. Fish and Wildlife Service (Service) funded a scientific assessment (Ogle 2008) to comprehensively review research regarding the ecology, conservation, and status of this species and to provide the most up-to-date information on Virginia spiraea. Ogle (2008) requested information about Virginia spiraea from various management agencies and/or species experts in states of known or potential occurrences. The Ogle (2008) report was the basis for the Service's 2008 draft 5-year review, which was not finalized. In 2019, Service Field Offices, state natural resource agencies, federal agencies, and researchers were contacted for up-to-date information on species' occurrences, threats, and recovery activities (see Appendix A for list of partners and experts contacted). Since the 2008 5-year review was not finalized, this review provides the first comprehensive status review of the species since the 1992 recovery plan was written (Service 1992). All pertinent literature and documents on file at the Virginia Field Office were used for this review.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: 84 FR 46562-46563 (September 4, 2019)

1.3.2 Listing history:

FR notice: 55 FR 24241-24247
Date listed: June 15, 1990
Entity listed: species
Classification: threatened

1.3.3 Associated rulemakings: None

1.3.4 Review history:

Previous 5-Year Review
Initiated: 73 FR 3991-3993
Date Finalized: review drafted but not finalized and signed
Results: not applicable

1.3.5 Species' Recovery Priority Number at start of review: 8. This designation corresponds to a species experiencing a moderate degree of threat and a high recovery potential.

1.3.6. Recovery Plan:

Name of plan: Virginia Spiraea (*Spiraea virginiana* Britton) Recovery Plan
Date issued: November 13, 1992

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? No. Because Virginia spiraea is a plant, the 1996 DPS policy does not apply.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes, the species has an approved plan containing objective, measurable criteria; however, two criteria merit clarification to support consistent, objective evaluation.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No, recovery criteria 1 and 2 do not reflect current information because state natural resource agencies do not track populations in the same manner as in the recovery criteria (e.g., waterbody and clones) and the definition for drainage system was not clearly defined.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The criteria for delisting are:

1. <u>Any existing or, if possible, a minimum of three stable populations are permanently protected in each drainage system where populations are currently known.</u>
   It is difficult to determine abundance and population trends for Virginia spiraea due to different monitoring approaches for abundance (e.g., stem counts, areal coverage, clumps) and definitions for populations (clones, population, element occurrence [EO], and sub-EOs) over time and among the states in Virginia spiraea's current range. See Section 2.3.1.2 for additional information. In addition, drainage system was not sufficiently defined in this criterion. Recognizing the ambiguity in this criterion, we made an assessment based on assumptions that an EO is a population, stable populations are those with an A or B rank, and drainage system is a minor drainage basin based on hydrologic unit code (HUC) 4 basins. Based on these assumptions, the criterion has not been met because only 4 of the 9 minor drainage basins with known populations (i.e., based on 1992 recovery plan) have 3 or more A- or B-ranked EOs on public or permanently managed/protected lands. For the 5

minor drainage basins that do not meet the criterion, 4 have no A- or B-ranked EOs on public or permanently managed/protected lands and 1 has 1 A- or B-ranked EO on public or permanently managed/protected lands. Section 2.3.1.5 provides additional details on the distribution of EOs throughout the current range, based on various geographic scales of drainage systems.

2. A minimum of three stable populations are established or found in drainages where documented vouchers have been collected, and that the species is not currently known. These populations must also be permanently protected.
   This criterion is ambiguous for the same reasons discussed above for the first criterion. If we make the same assumptions as for criterion 1, there is only 1 minor drainage basin where documented vouchers have been collected and the species was not known at the time of the 1992 recovery plan, which is the Middle-Tennessee-Elk. This basin contained a historical occurrence in Cypress Creek, AL. This criterion has not been met because no Virginia spiraea occurrences have been documented in this basin since the 1890s. Section 2.3.1.5 provides information about this occurrence.

3. Potential habitat in all states with present or past collections has been searched for other populations.
   This criterion has not been met as stated. Ogle (2008) estimated that approximately 60% of potential habitat in states with present or past collections, specifically in the Blue Ridge and Appalachian Plateau physiographic provinces, had been surveyed for additional populations by 2007. Since then, additional surveys in known drainages (as defined by state natural resource agencies) have found 12 new EOs across the range in North Carolina, Ohio, Tennessee, and West Virginia, as well as rediscovered an EO in the Buckhannon River, WV, in 2019, which was thought to be extirpated in 2007. It would be difficult to provide an updated percent of potential habitat surveyed in states with any collections, but it is expected to be more than 60% but less than 100%. State natural resource agencies expect to find new EOs/sub-EOs with additional comprehensive surveys of potential habitat in known drainages. Also, there is the possibility of additional areas of suitable habitat based on a species distribution model. See Sections 2.3.1.5 and 2.3.1.6 for additional information.

4. Representative genotypes are cultivated in permanent collections with adequate locality information.
   This criterion has not been met. Collections of living Virginia spiraea plants from 26 of 72 extant EOs (36.1%) and 2 of 7 historical/extirpated EOs (28.6%) across the range are maintained at multiple gardens. Efforts to conduct genetic analyses to determine genotypes across the range and within the collections are needed to determine which localities should be added to cultivated collections to provide genetic representation. Genetic analyses are ongoing. See Sections 2.3.1.2 and 2.3.1.3 for additional information.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Since 1992, research has been conducted on multiple topics associated with Virginia spiraea's biology and life history. See Section 2.3.1.3 for research related to character variation between populations, genetic structure, and reproduction (e.g., seed viability, pollinators, self-incompatibility) and Section 2.3.1.6 for research about habitat characterization and management of populations. Below is new research on biology of the species related to identification.

The survey season in West Virginia is June 1 to September 30, during peak flowering when it is easiest to identify Virginia spiraea. The West Virginia Division of Natural Resources (WVDNR) studied the feasibility of conducting winter surveys to detect Virginia spiraea and distinguish it from other *Spiraea* species (e.g., shinyleaf meadowsweet [*Spiraea betulifolia* var. *corymbosa]*) (K. O'Malley and P.J. Harmon, WVDNR, letter to J. Stanhope, Service, January 23, 2020). Virginia spiraea can be identified if vestigial inflorescences are still on the plants, but WVDNR biologists observed that stems and inflorescences regularly fell off because they were fragile and very brittle during the winter. Therefore, Virginia spiraea were more difficult to identify. If inflorescences were present and plants were 1-2 meters tall with multiple stems, researchers could identify Virginia spiraea. In addition, researchers were not able to find young Virginia spiraea, in particular small plants with single stems (about 0.3-0.5 meters tall) that had not flowered, when they visited a site on the Bluestone River with previously documented plants. Based on these results, WVDNR determined that winter surveys are not recommended.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

Abundance and populations

It is challenging to assess abundance and determine population trends for Virginia spiraea due to different approaches for monitoring abundance (e.g., stem counts, areal coverage, clumps) and defining populations. Abundance has been estimated in several different ways and most methods have generally been a source of confusion and inconsistency for field workers and researchers (Ogle 2008). Generally, for smaller populations, upright stem counts or "clumps" counts are used. For larger populations, "clumps" counts or area/percent cover estimates are used. In some cases, all methods are used at a site. Methods have also changed over time at the same population, making it difficult to assess trends. There have been several attempts to use other methods, including line intercept and segmental "pie" sectioning procedures to estimate number of clones in a 360-degree matrix (Ogle 2008). Without exception, these have proven difficult to apply for several reasons. The number of upright stems can vary drastically within a season and over time at one location due to hydrologic variation. There are currently no standardized methods to estimate abundance that will accurately reflect numbers or relative abundance (in terms of spatial extent or percent cover) of individuals in the field. Because the plant is clonal, most abundance estimates are likely an estimate of plant size rather than actual abundance or population size. Determination of "N" (the number of genetically different plants) versus "n" (the number of genetically identical nodules or clones that are part of a single plant) would address this problem. The actual number of genetically different plants in the wild is not known but is currently being assessed (see Section 2.3.1.3).

Regarding definitions of populations, terms such as clone, population, EO, and sub-EO are used to refer to an occurrence of one or more Virginia spiraea stems found in a given location. Clone was used in the recovery plan (Service 1992) and not specifically defined, but appeared to be used interchangeably with population. An EO is the spatial representation of a species or ecological community at a specific location. The EO concept originated within the state Natural Heritage Programs (NHP) and was not in general use in 1992 when the species' recovery plan was completed. EO and/or sub-EO was used in Ogle (2008), but was not reported consistently. For this 2021 assessment, states reported data by EO, but they utilized different definitions. As defined by NatureServe (2002, 2020a), the recommended default EO minimum separation distance for plants (i.e., considered to be part of a different EO or population) is 0.62 mile (1 kilometer [km]). States may use this standard, but may also use other separation distances (i.e., less than 0.62 miles) or further refine this separation distance based on NatureServe's (2020a) guidance, which considers if there is continuous suitable habitat, such as flowing water (as described below). There is no standard conversion factor between population/clone counts and EO counts and no consistent EO definition across the range, and as a result, there is a lack of clarity about the relative abundance and population trends of this species.

Table 1 provides a summary of the numbers of extant clones reported in 1992 (Service 1992) and extant EOs/sub-EOs in 2007 (Ogle 2008). To attempt to compare and assess abundance/population trends, occurrence data provided by state natural resource agencies are summarized by EO (Table 2), based on their own EO definition. We did not change their EO definition to be consistent across states because we are relying on the state natural resource agencies' expertise and experience with the species. Also, it will allow comparison of data in the future, if they maintain their EO definitions. We also summarized the number of sub-EOs (or sub-populations) by state. It appears that the following states applied the default 0.62-mile separation distance or less for defining EOs: Georgia, Kentucky, Ohio, and Tennessee. Virginia, West Virginia, and North Carolina used greater separation distances based on continuous suitable habitat; therefore, they have lower number of EOs and greater number of sub-EOs than other states. Most states did not specifically define sub-EO (except North Carolina), and we based the number of sub-EOs on various sources of information, including: EO description indicating sub-populations, number of source features in the GIS shapefile, and state agency expert opinion. North Carolina NHP (NCNHP) provided their occurrence data as parent EOs and EOs. For this assessment, we considered EOs nested within parent EOs as sub-EOs because NCNHP defined EO to be within the same parent EO when it "is less than 10 km from the next nearest conspecific EO, shares linear water-current flow in the same riparian system, and is not separated by an area of persistently unsuitable habitat greater than 3km long (NatureServe 2020a)." We therefore considered parent EOs as EOs in North Carolina.

Tables 1 and 2 illustrate the difficulty in trying to analyze trends in populations when using information from different sources. Differences in the number of populations across years, as reported in clones, EOs, and sub-EOs, should not be assumed to be a direct increase or decrease in abundance or populations but may be an artifact of different monitoring methods and population definitions. In addition, due to the predominantly clonal nature of reproduction (i.e., asexual), the actual number of genetically distinct populations in the wild is not known and currently being assessed.

To evaluate the current status of the EOs, Tables 2 and 3 also provide a summary of EO by rank in 2019. As defined by NatureServe (2002), "EO ranks provide a succinct assessment of ESTIMATED VIABILITY, or PROBABILITY OF PERSISTENCE (based on condition, size, and landscape context) of occurrences of a given Element [i.e., species or taxon]. In other words, EO ranks provide an assessment of the likelihood that if current conditions prevail an occurrence will persist for a defined period of time, typically 20-100 years." State natural resource agencies assign ranks to their EOs. Based on the definitions, EOs with A or B ranks have excellent or good viability, respectively, and are very likely or likely to persist for the foreseeable future (i.e., at least 20-30 years), respectively, if current conditions prevail (NatureServe 2020b, see Appendix B). EOs with C rank have fair viability; the definition for this rank includes EOs that have uncertain persistence under current conditions, may persist with appropriate protection or management, or are likely to persist but may decrease in size or condition. For the purposes of this review, we assumed that EOs with ranks of F (failed to find), H (historical), and X (extirpated) are not currently extant. NatureServe provides additional specifications for the EO ranks for Virginia spiraea that take into account areal coverage, occurrence at multiple locations within a river, and/or habitat conditions, as defined by D. White on January 25, 2005 (see Appendix B). Virginia Department of Conservation and Recreation – Division of Natural Heritage (VDCR-DNH) and Tennessee Department of Environment and Conservation, Division of Natural Areas (TDEC-DNA) indicated that their EO ranks are based on the January 25, 2005 specifications and the Office of Kentucky of Nature Preserves (OKNP) applied these specifications to some of their EOs; the other states did not indicate the exact specifications or criteria used for assessing EO ranks. It should also be noted that some extant EOs have not been observed or surveyed for more than 15 years, providing some uncertainty about the current status and ranks of these extant EOs (Table 2). In most cases for extant EOs, year last observed is the same as year last surveyed (e.g., monitored for abundance, such as stem counts, areal coverage, clumps; assessed habitat); however, for a small number of EOs (e.g., all EOs in Virginia, 1 EO in Ohio), the presence of the plant was noted, but information to support assessment of viability was not collected.

As of 2019, of 89 total EOs across the range, 72 are extant (80.9%), 32 have an A or B rank (36.0% of historically known EOs) and 23 have a C rank (25.8% of historically known EOs) (Tables 2 and 3). Fifteen EOs (16.9% of historically known EOs) have a D rank (poor condition) and NatureServe (2020b) indicates that "if current conditions prevail, occurrence has a high risk of extirpation." For the 17 EOs that are not extant, 11 EOs became presumed extirpated (F or X rank) since 1992, when the species' recovery plan was completed. Of the extant EOs, 36 (40.4% of historically known EOs) are located on public or permanently managed/protected property, and of those, 20 have an A or B rank (22.5% of historically known EOs). A greater proportion of the A or B ranked EOs are located on public or permanently managed/protected property (20 EOs) versus not (12 EOs) (62.5% vs. 37.5%), suggesting a potential conservation benefit from being located on such lands. When considering C ranked EOs, a lower proportion are located on public or permanently managed/protected property (9 EOs) vs. not (14 EOs) (39.1% vs. 60.9%). However, it should be noted that 6 of the 11 EOs that became presumed extirpated since 1992 were located on public or permanently managed/protected property.

To further help evaluate the status of the EOs, state natural resource agencies were asked for their assessment of population stability in their state in 2007 (Ogle 2008) and 2019. In 2007, populations were assessed as: stable in Georgia, North Carolina, West Virginia, and Ohio; increasing in Tennessee; decreasing to stable in Virginia; and decreasing in Kentucky (Ogle 2008) (Table 1). At that time, most experts cautioned that assessments were based on anecdotal or casual observation and little, if any quantitative data were available for those determinations. Kentucky State Nature Preserves Commission (now OKNP) was considering raising their state listing status from threatened to endangered, and Tennessee officials were considering lowering their state status from endangered to threatened (Ogle 2008). In 2019, some state natural resource agencies and federal agencies indicated that they conduct periodic monitoring of their EOs (Ohio Department of Natural Resources, Division of Natural Areas and Preserves [ODNR-DNAP]; TDEC-DNA; WVDNR; National Park Service [NPS] at Big South Fork National River and Recreation Area/Obed Wild and Scenic River [BSFNRRA/OWSR]) or have conducted status surveys of their EOs recently (e.g., OKNP in 2018, NPS at Great Smoky Mountains National Park [GSMNP] in 2020). Populations are currently assessed as stable in Georgia, Kentucky, North Carolina, Ohio, Tennessee, and Virginia and stable to decreasing in West Virginia (Table 2). State listing status has not changed (see Section 2.3.2.4).

Table 1. Number of extant clones reported in 1992 (Service 1992). Number of element occurrences (EOs) and sub-EOs reported in 2007 and related information (Ogle 2008). N/A = not applicable.

State	Number of extant clones in 1992	Number of extant EOs in 2007	Number of extant sub-EOs in 2007	Were EOs located on public property as of 2007?	Population stability as assessed by survey respondents in 2007
Alabama	0 (historical record prior to 1992)	0	N/A	N/A	N/A
Georgia	7	3	8	Partial	Stable
Kentucky	20	17	not reported	Yes (7), No (10)	Decreasing
Louisiana	misidentification	N/A	N/A	N/A	N/A
North Carolina	12	not reported	36	Partial	Stable
Ohio	3	not reported	5	Partial	Stable
Pennsylvania	0 (historical record prior to 1992)	0	N/A	N/A	N/A
Tennessee	20	32+	not reported	Partial	Increasing
Virginia	18	not reported	24[1]	Partial (at least 3 clones)	Decreasing to Stable
West Virginia	27	not reported	109[2]	Partial but primarily on private lands	Stable
All States	107	52+	182	Partial	

[1] Four sub-EOs with propagated/outplanted stems not included because these sites are not tracked in VDCR-DNH database.
[2] Reported as 109 EOs and sub-EOs in Ogle (2008). Placed in sub-EO column due to unknown number of EOs vs. sub-EOs.

Table 2. Number of element occurrences (EOs) and sub-EOs in 2019, and number of extant EOs located in managed/protected land and their EO rank (i.e., estimated viability by state natural resource agency). Extant EOs are those with A, B, C, D, or E rank (see Table 3). N/A = not applicable.

State	Number of extant EOs in 2019	Number of extant sub-EOs in 2019 (of total sub-EOs)	Total Number of EOs (all ranks)	Number of extant EOs located on public or permanently managed/ protected land			Range of years for when extant EOs last observed	Population stability as assessed by survey respondents in 2019/2020
				A or B rank[1]	C rank[1]	Total extant (all ranks)		
Alabama	0	N/A	1	N/A	N/A	N/A	N/A	N/A
Georgia	3	6+ (of 8+) [2]	3	3	0	3	2010-2015	Stable
Kentucky	13	15+ (of 37) [3]	16	1	3	7	2018, except 1 in 1996 and 1 in 2013	Stable
North Carolina	14 [4]	46 (of 55)[5]	16	2	0	3	2011-2019	Stable
Ohio	6	9 (of 9) [2, 6, 7]	6	0	1	1	2015-2018	Stable
Pennsylvania	0	N/A	1	N/A	N/A	N/A	N/A	N/A
Tennessee	22 [8]	57 (of 67) [3, 6]	28	9	5	16 (3 partial)	2007-2019, except 2 in 1995	Stable
Virginia	4 [9]	24 (of 25) [3, 10]	5	2	0	3	2017 [11]	Stable
West Virginia	10 [12]	126 (of 136) [6]	13	3	0	3	2015-2020 [12], except 1 in 2002	Stable to Decreasing
All States	**72**	**283+ (of 337+)**	**89**	**20**	**9**	**36**		

[1] A or B rank (excellent or good viability) includes B?, BC-ranked occurrences, though there is uncertainty regarding the rank. C rank (fair viability) includes BCD and CD-ranked occurrences (D indicates poor viability). See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology and Appendix B for ranking definitions.
[2] Number of sub-EOs based on EO description.
[3] Number of sub-EOs based on number of source features.
[4] Number of EOs based on number of parent EOs and standalone EOs (e.g., EOs that are not nested within a parent EO)
[5] Number of sub-EOs based on number of EOs nested within a parent EO (i.e., each sub-EO had a separate record) and standalone EOs.
[6] Number of sub-EOs based on state agency expert opinion or provided in occurrence table.
[7] Historical number of sub-EOs not provided and assumed to be the same as current.
[8] Two EO rankings updated to failed to find based on EO descriptions of not finding plants when last surveyed (C. Elam, TDEC, email to J. Stanhope, Service, March 11, 2021).
[9] One EO on the North Fork Pound River is assumed to be failed to find because it was last observed in 2002 and not found during 3 searches in recent years (J. Rhode Ward, University of North Carolina at Asheville [UNCA], email to J. Stanhope, Service, January 24, 2020). Ogle (2008) also suggested that an EO on the North Fork Pound River was based on a misidentified specimen and should be deleted from the database. It is not clear if this is the same EO.
[10] Three sub-EOs with propagated/outplanted stems not included because they are not tracked in VDCR-DNH database and status is unknown. They were last observed to be extant 10 years ago (D. Ogle, formerly Virginia Highlands Community College, email to J. Stanhope, Service, March 4, 2021).
[11] Although the 4 extant EOs were last observed by Appalachian State University researchers in 2017, they were last surveyed in 1992, 1993, 2007, and 2014 and their EO ranks may not be current.
[12] Includes new EO found in 2020.

Table 3. Number of element occurrences (EOs) by rank (i.e., estimated viability by state natural resource agency) in 2019. N/A = not applicable.

State	Number of EOs by ranks[1]						
	Excellent or Good (A or B rank)	**Fair (C rank)**	**Poor (D rank)**	**Verified Extant (E rank)**	**Failed to Find (F rank)**	**Historical/ Extirpated (H or X rank)**	**Total (all ranks)**
Alabama	0	0	0	0	0	1	1
Georgia	3	0	0	0	0	0	3
Kentucky	3	4	6	0	3	0	16
North Carolina	8	3	3	0	1	1	16
Ohio	0	5	0	1	0	0	6
Pennsylvania	0	0	0	0	0	1	1
Tennessee	10	9	3	0	5 [2]	1	28
Virginia	2	0	2	0	1 [3]	0	5
West Virginia	6	2	1	1	0	3	13
All States	**32**	**23**	**15**	**2**	**10**	**7**	**89**

[1] A or B rank includes B? and BC-ranked occurrences, though there is uncertainty regarding the rank. C rank includes CD and BCD-ranked occurrences. E rank are EOs that have been recently verified as extant, but insufficient information to estimate viability. See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology and Appendix B for ranking definitions.
[2] Two EO rankings updated to failed to find based on EO descriptions of not finding plants when last surveyed (C. Elam, TN Department of Environment and Conservation, email to J. Stanhope, Service, March 11, 2021).
[3] One EO on the North Fork Pound River (VA EO#7) is assumed to be failed to find because it was last observed in 2002 and not found during 3 searches in recent years (J. Rhode Ward, University of North Carolina at Asheville [UNCA], email to J. Stanhope, Service, January 24, 2020). Ogle (2008) also suggested that an EO on the North Fork Pound River was based on a misidentified specimen and should be deleted from the database. It is not clear if this is the same EO.

Propagation for reintroduction and rescue efforts

There have been multiple efforts to propagate Virginia spiraea, either to reintroduce the species to new areas within its range or to rescue/safeguard them from anthropogenic threats. Plants were propagated from a sub-EO of VA EO#3 in the Pound River, VA, downstream of John Flannagan Reservoir (Ogle 2003). The reintroduction effort originally established 4 sub-populations on the Pound and Cranesnest rivers, VA, by 2007 (Ogle 2008). Three of the outplanted sub-populations were extant about 10 years ago but have not been visited since then (D. Ogle, formerly Virginia Highlands Community College [VHCC], email to J. Stanhope, Service, March 4, 2021). These sub-populations were not included in VDCR-DNH's database.

In North Carolina, whole plants were removed in Lakey Creek (NC EO#61), in advance of bridge construction by the North Carolina Department of Transportation (NCDOT). Whole plant stems and cuttings were held or propagated, respectively, in pots and reintroduced to near original plant locations in March and November 2015 within a NCDOT permanent right-of-way (NCDOT 2016). Transplants were reported as surviving as of February 2018 (NCNHP 2020). In the Cheoah River in the Nantahala National Forest (NC EO#25, sub-EO of parent NC EO#57), 100-150 cuttings were collected, in case herbicide application to remove invasive species (kudzu [*Pueraria montana*]) harmed the plants, and grown in 10- to 20-gallon nursery pots at the Service's Asheville Field Office (NC Department of Agriculture and Consumer Services [NCDACS] 2015; J. Mizzi, Service, letter to A. Punsalan, Nantahala National Forest, March 25, 2015). Some of the cuttings did not take root and grow. Thirty-three pots of propagated plants were outplanted to 4 sites within 3 sub-EOs (NC EO#25, 27, and 53 within parent NC EO#57) along the Cheoah River in March

2018 and of those, only 9 plants (i.e., pots) have survived (NCDACS 2018; G. Kauffman, USFS, Service, emails to J. Stanhope, Service, August 8, 2021 and August 16, 2021). Re-establishment of most of the plants was limited primarily by heavy competition from non-native, invasive plants, primarily kudzu, but also from native, invasive plants at 1 site. The surviving 9 plants are also threatened by the invasive plants and being managed to reduce this threat.

In Georgia, stems were collected from 2 EOs in Rock Creek (GA EO#1, 3) and grown and currently maintained at the Atlanta Botanical Gardens (ABG) (Georgia Plant Conservation Alliance 2019). In 2009 as part of a restoration project, 64 of these propagated plants were outplanted to the edge of a limestone spring in Crockford-Pigeon Wildlife Management Area, which is a protected area but appears to be outside of the Tennessee River basin and Virginia spiraea's historical and occupied range (ABG 2012). Beaver activities impacted the plants by both inundation and use of the planted material to make their dams. As of 2011, approximately 17% of the plants had survived (Georgia Plant Conservation Alliance 2019).

Abundance in living collections

There are collections of living plants of this species in multiple gardens. The Arnold Arboretum of Harvard University's collection includes 39 plants from 24 EOs in 20 counties in Georgia, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia (https://arboretum.harvard.edu/explorer/; accessed December 7, 2020). Most of the plants were grown from cuttings, divisions, or a plant, except for 3 grown from seed (K. Richardson, Arnold Arboretum, email to J. Stanhope, Service, January 21, 2021). Several of the plants originated from EOs that are now thought to be extirpated including Hominy Creek, Buncombe County, NC, and Little River, Blount County, TN. The plants are located in 3 main areas of the Arboretum, but are kept as individual plants (i.e., not planted close together), labeled accurately, and not allowed to grow together. Each plant is monitored and maintained by each horticulturist managing the zone in which each individual plant resides. However, specific precautions are not taken on a routine basis to prevent cross pollination (K. Richardson, Arnold Arboretum, email to J. Stanhope, Service, August 16, 2021).

In addition to the stems propagated and grown from 2 EOs in Georgia (described above), ABG collected 6 stem cuttings from a single clump with a single branched stem in 2020 from White Oak Creek in Nantahala National Forest, NC, for vegetative propagation and are growing them in their greenhouse (Duke Energy Carolinas, LLC et al. 2015, ABG 2020). Cuttings taken to ABG had a 69.8% success rate in rooting. Propagated plants may be reintroduced into the source location pending permits.

At Appalachian State University (ASU) and University of North Carolina at Asheville (UNCA), plants from stem cuttings are being grown in protected gardens and in greenhouses/growth chambers. The cuttings were collected from 4

EOs, consisting of at least 7 sub-EOs, in the Lower and Upper South Fork New Rivers, Little Tennessee River, and Cheoah River (J. Rhode Ward, UNCA, email to J. Stanhope, Service, January 24, 2020; M. Estep, ASU, email to J. Stanhope, Service, January 5, 2021). They recently acquired a cutting of the extirpated Hominy Creek EO from Harvard University's Arnold Arboretum and the plant is being maintained at UNCA. Cuttings were also collected from 4 EOs in Virginia, however, they were not successful in rooting.

There are less than 6 plants (clumps) of Virginia spiraea at VHCC in Abingdon, VA, grown from 1 cutting collected from an undocumented location in 2016 (B.L. Casteel, VHCC, emails to J. Stanhope, Service, December 7 and 8, 2020). There were previously multiple plants from various locations throughout the species range grown at VHCC, but the caretaker of the collection retired and the plants were mistakenly mowed by grounds workers.

The Holden Arboretum in Kirtland, OH, has 1 Virginia spiraea plant from Scioto Brush Creek, Scioto County, OH (E. Johnson, Holden Arboretum, email to J. Stanhope, Service, February 22, 2021).

Efforts are currently proposed or planned to collect stems from additional EOs for cultivation and propagation in gardens and to augment/reintroduce Virginia spiraea in several states. In West Virginia, the NPS is planning to collect stems for propagation and safeguarding at Mt. Cuba Center, DE, from EOs in the Gauley and Meadow Rivers in the Gauley River National Recreation Area (GRNRA) and Bluestone River within WVDNR-managed lands (D. Manning, NPS, email to J. Stanhope and J. Norris, June 11, 2021). They are proposing to utilize the propagated plants to augment declining sub-populations. In Tennessee, the NPS is proposing to augment the EO in Abrams Creek within the GSMNP with propagated stems, potentially from Cheoah River, NC, being grown at ASU and UNCA gardens (Estep and Rhode Ward 2021). In June 2021, the Georgia Department of Natural Resources received funding from the Service's Recovery Challenge Grant for a 5-year project to implement safeguarding actions for 14 federally listed plant species. Specifically for Virginia spiraea in Georgia, they propose to: "secure the one occurrence that is not in living collection; seed bank both natural occurrences; [and] introduce and monitor 2 in-situ safeguarded populations in suitable habitat on protected land" (J. Moffett, Service, email to J. Stanhope, M. Elmore, and A. Protus, Service, July 1, 2021).

Seed collections

The North Carolina Botanical Garden collected wild-produced seeds from plants in Bluestone River and Gauley River, WV, and Abrams Creek in GSMNP, TN, in 2006 to 2007 and the seeds are being stored at their facility or at the National Laboratory for Genetic Resource Preservation (NLGRP) in Fort Collins, CO (M. Kunz, North Carolina Botanical Garden, email to J. Stanhope, Service, December 8, 2020). The Missouri Botanical Garden collected wild-produced seeds from the Obed River and Big South Fork Cumberland River, TN, in 2005 and these are stored at NLGRP (https://www.livingcollections.org/mobot/Home.aspx, accessed December 8, 2020).

Summary of abundance, population trends, demographic features, or demographic trend

Data gathered since the listing and recovery plan provide additional information on the abundance and number of populations of Virginia spiraea throughout its range, but it is difficult to assess population trends due to different monitoring approaches for abundance and definitions for populations over time and among the states. Although population trends and accurate counts of populations cannot be determined, the current data suggest that at least 72 of the 89 historically known EOs (80.9%) are extant, and 32 EOs (36.0% of historically known EOs) are considered to have excellent or good viability (A or B rank) and are very likely or likely to persist, respectively, if current conditions prevail. However, 23 EOs (25.8% of historically known EOs) have an uncertain probability of persisting (fair viability; C rank) and 15 EOs (16.9% of historically known EOs) have a poor probability of persisting (D rank) and a high risk of extirpation, if current conditions prevail. For the 17 EOs that are not extant, 11 EOs became presumed extirpated (F or X rank) since 1992 when the species' recovery plan was completed. Of the extant EOs, 36 (40.4% of historically known EOs) are located on public or permanently managed/protected lands, and 20 of these 36 EOs (22.5% of historically known EOs) are considered to have excellent or good viability. Populations are currently estimated by the state natural resources agencies as stable (Georgia, Kentucky, North Carolina, Ohio, Tennessee, and Virginia) or stable to decreasing (West Virginia). Propagation efforts have been successful in reintroducing Virginia spiraea to new or known rivers and rescuing them from construction and herbicide application; new propagation efforts are proposed or recently funded in Georgia, West Virginia, and Tennessee. Collections of living Virginia spiraea are maintained at multiple gardens, including plants from 26 of 72 extant EOs (36.1%) and 2 of 7 historical/extirpated EOs (28.6%), across the species range. Seeds collected from 5 EOs in the wild are stored at NLGRP.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

Anders and Murrell (2001) examined leaf morphological differences within sub-drainage basins and across the range; their analyses indicated no clear differences of leaf shape and size among sub-drainage basins, but some general patterns emerged in 3 of the sub-drainage basins (Cumberland, Ohio, and Tennessee River basins) and suggested gene flow occurred across drainage boundaries. Randomly Amplified Polymorphic DNA techniques were also used to examine within species variation; cluster analysis identified 4 molecular phenotypes located in the southern part of the range in the southern portions of both the Blue Ridge and Cumberland Plateau (i.e., the southern part of the Appalachian Plateau). Their results also suggest that the ancestral population likely originated in the southern part of the range and used 3 different migratory paths out of the Cumberland and southern Blue Ridge Mountains refugia via an initial southward path then northward recolonization during and after glaciation, respectively. Williams (2003) continued analysis of their samples using Inter-Simple Sequence Repeat variation and supported Anders and Murrell's (2001) conclusions that along short reaches among the Cumberland, Ohio, and Tennessee Rivers sub-drainage basins, there is a greater degree of similarity and that Virginia spiraea likely originated in the southern part of the range.

Bryzski (2010) developed genetic microsatellite markers based on 11 primers for Virginia spiraea and results indicated a moderate level of genetic variation for 3 populations (1 in Ohio, 2 in Tennessee). Brzyski and Culley (2011) continued the genetic microsatellite markers work on plants from 8 populations (or watersheds) and 43 sub-populations (or groupings of plants) in Ohio, Kentucky, and Tennessee and found low genetic diversity within populations with greater variability among populations and no relationship between genetic and geographic distance. The genetic results were representative of high clonal reproduction. However, they also found that reproduction for 4 populations may not be strictly asexual based on inbreeding coefficient values closer to 0; sub-populations within these populations demonstrated high differentiation from each other and most of them had unique genotypes.

UNCA and ASU researchers are conducting genetic analysis of diversity across all states in the geographic range of Virginia spiraea using microsatellite markers (Estep and Rhode Ward 2021). Preliminary analyses of plant samples collected at multiple populations (EOs and sub-EOs) in the New River and Cheoah River, NC, indicate low genetic diversity; most variation occurs within river basins (sub-EOs within the New River) vs. between river basins, and some of the genetic diversity patterns suggest downstream dispersal of propagules (Clark 2017, Estep and Rhode Ward 2021). Analyses also did not support high population differentiation, but further study of additional populations across the range is ongoing. Estep and Rhode Ward (2021) have observed tetraploid and triploid genotypes (4 or 3 alleles per locus, respectively) in some markers in the North Carolina sites and are planning more work to assess ploidy throughout the range using flow cytometry. Understanding ploidy is important because a common trait of triploids is sterility. In addition, knowing ploidy numbers makes accurate calculations of heterozygosity possible and will help to guide potential propagation efforts.

Because seedlings have not been observed in the wild rangewide, Bryzski and Culley (2013) conducted a study on conditions to promote germination of seeds from a population in Scioto County, OH. They found that pollen viability was high (approximately 90%) and seed germination was low (10%) overall, and made recommendations for substrate and cold treatment of the seeds to increase potential germination for propagation efforts. Bryzski et al. (2014) conducted controlled breeding experiments at a garden and results indicated that sexual reproduction may occur, but is rare with 13-15% of the hand pollinations producing seed and greater seed production for outcrossed treatments. The percentage of seeds that were viable (tetrazolium assays) by treatment varied from

43 to 100%. They also found low diversity at the self-incompatibility (SI)-locus and that it did not relate directly to the pollination results, but this specific SI-locus may not be the gene responsible for preventing self-fertilization. UNCA and ASU researchers are currently assessing the prevalence of s-alleles, which are self-sterility genes that prevent self-fertilization and inbreeding depression.

UNCA and ASU researchers have also been assessing potential barriers to sexual reproduction for Virginia spiraea. Wise (2018) analyzed pollen viability for plants in the North Fork of the New River, North Carolina, and found high viability ratios of almost 90%. Pate (2010) conducted pollination studies in a garden and in the wild and results suggested that Virginia spiraea can reproduce sexually. Emery et al. (2014) collected reproductive data from 3 North Carolina river systems (Cheoah, Little Tennessee, and New Rivers) and found lower pollen production in the Cheoah River, possibly due to light limitation, but seed production was not lower; these results suggest that seed production may not be limited by pollen. In this study, they also conducted controlled breeding experiments in the wild and analysis indicated no significant differences in seed production under 4 treatments: open (unassisted self-pollination), self (hand-assisted pollination using pollen from neighboring corymb in same clump), inbreeding within populations (hand-assisted pollination using pollen from different clump in same EO), and outbreeding among populations (hand-assisted pollination using pollen from different EO). Their analysis of seed viability (tetrazolium assays) indicated that seeds were not viable from the Little Tennessee and Cheoah Rivers and 28 of 6,314 seeds from the New River were viable. There was no germination of planted seeds after 4 weeks. They are planning further controlled breeding experiments using plants in UNCA and ASU gardens. Rhode Ward and Estep (2019) collected reproductive data in the summers of 2017 to 2019 at North Carolina sites and analysis of 2017 and 2018 data indicated no differences in reproductive effort (pollen and seed production) across sites; analysis of 2019 data and seed viability and germination tests are ongoing. To further understand potential barriers to sexual reproduction, Rhode Ward and Estep (2019) conducted studies to survey floral insect visitors of Virginia spiraea corymbs and assessed pollen on the insects to determine which of the insects could be effective pollinators; preliminary data analyses suggest that bee species carried higher percentages of Virginia spiraea pollen. Their research has also shown that Virginia spiraea and Japanese spiraea (*Spiraea japonica*) do not appear to cross-fertilize under field conditions (J. Rhode Ward, UNCA, email to J. Stanhope, Service, January 24, 2020).

Regarding seed dispersal, Ogle (2009) observed that Virginia spiraea produce very small, slightly winged seeds that may facilitate upstream seed dispersal via wind.

Summary of genetics, genetic variation, or trends in genetic variation

Results of studies conducted thus far suggest low genetic diversity, but differ in where most variation occurs. Brzyski and Culley (2011) found greater variability among populations (or watersheds) and no relationship between genetic and geographic distance, but UNCA and ASU researchers observed most variation occurs within river basins vs. between river basins and some of the genetic diversity patterns suggest downstream dispersal of propagules. Research related to genetic diversity and reproduction is currently ongoing at UNCA and ASU and will include additional populations across the range. Research supports that reproduction is primarily asexual, with some sexual reproduction occurring. Availability and viability of pollen do not appear to be barriers to sexual reproduction, but seed viability and germination are very low. Other potential genetic barriers to reproduction are being investigated by UNCA and ASU, including assessing polyploidy in the populations and prevalence of s-alleles. Knowing ploidy numbers makes accurate calculations of heterozygosity possible and will help to guide potential propagation efforts.

2.3.1.4 Taxonomic classification or changes in nomenclature:
No taxonomic changes or revisions of nomenclature have been published for this species since the recovery plan (Service 1992) was completed.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:
The historical distribution of Virginia spiraea is well known. Specimens have been deposited in herbaria collections and the species occurrence has been vouchered since the initial description in 1890. Virginia spiraea is widely scattered within 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) and recorded from historical locations in Pennsylvania and Alabama (Youghiogheny River and Cypress Creek, respectively). Historical records from both states have been examined and verified and periodic searches have occurred in both locations, but the species is not currently known from either state (Ogle 1991; Ogle 2008; R. Anderson, Service, email to J. Stanhope, Service, December 17, 2019; A. Schotz, Auburn University, email to J. Stanhope, Service, January 17, 2021). There is currently a question to the validity of the location of the historical Alabama collection in Cypress Creek (last verified observation in 1890s [Service 1992, p. 9]), because the stream is “fairly pristine” and may not have “conditions favorable to the species,” based on observations of the species at other sites and its habitat in Georgia, West Virginia, and Virginia (A. Schotz, Auburn University, email to J. Stanhope, Service, January 17, 2021). However, Ogle visited that the historical site and believes that it was likely flooded by backwaters of the Tennessee River/Wilson Lake and there continues to be suitable habitat for the species nearby and in adjacent drainages (D. Ogle, formerly VHCC, email to J. Stanhope, Service, July 15, 2021). A specimen reported from Louisiana (Thomas and Allen 1998 *in* Ogle 2008) was determined to be a misidentified specimen of a cultivated spiraea.

Since the recovery plan was published in 1992, 1 EO with historic documentation has been rediscovered (Cheoah River, North Carolina) and 38 additional EOs (32 extant as of 2019) and 74+ sub-EOs have been discovered across the range due to searches of rivers/streams with suitable habitat in known drainages, surveys of rivers/streams with known occurrences, and incidental finds when surveying for other species (Table 4, Figure 1) (Stine 1993; Wofford 2003; Gardner and Moser 2007; Ogle 2008; Shaw and C. Elam, TDEC-DNA, email to J. Stanhope, January 21, 2020; J. Rhode Ward, UNCA, email to J. Stanhope, January 24, 2020). However, as noted in section 2.3.1.2, 11 EOs have become presumed extirpated (F or X rank) since 1992, which include 6 EOs discovered since 1992.

Table 4. Number of element occurrences (EOs), extant EOs, and sub-EOs discovered since recovery plan was published in 1992. N/A = not applicable.

State	Number of EOs[1]	Number of extant EOs in 2019	Number of extant Sub-EOs in 2019	New extant rivers/creeks[2]
Georgia	0	N/A	N/A	
Kentucky [3]	4	3	3+	Laurel River, Marsh Creek
North Carolina	8	7	35	French Broad River, Lackey Creek, North Toe River, White Oak Creek
Ohio	3	3	3	
Tennessee [3]	17	14	26	North Chickamauga Creek, Emory River, Obed River, Big South Fork Cumberland River, Caney Fork River, White Oak Creek, White Creek, Piney Creek
Virginia	1	0	0	
West Virginia	5	5	7	Camp Branch
All States	38	32	74+	

[1] Number includes new EOs discovered since 1992 and includes EOs that are now F rank (failed to find), which are presumed to not be extant. For example, Kentucky had 4 total EOs discovered since 1992, but only 3 EOs are extant as of 2019.
[2] If new EOs or sub-EOs were discovered in the same rivers/creeks that were documented in 1992, then the river/creek name is not provided in this column.
[3] Does not include 4 new locations of Virginia spiraea found at BSFNRRA/OWSR, which may be in Tennessee or Kentucky, in 2016 because they could not provide any location information or if the new locations would be considered EOs or sub-EOs (M. Tackett, BSFNRRA/OWSR, email to J. Stanhope, February 19, 2020). We could not verify if these locations are included in EO databases from OKNP or TDEC-DNA.

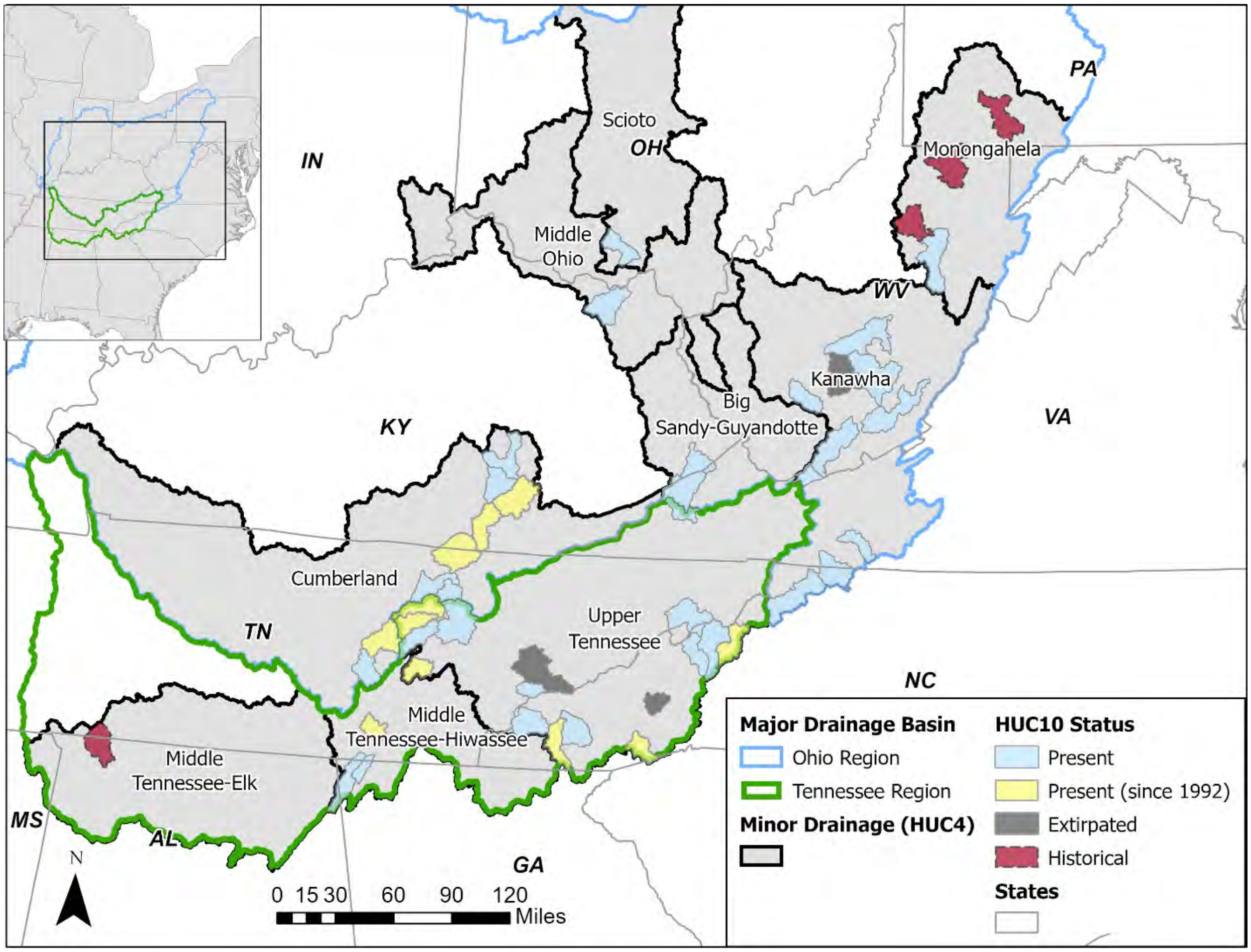

Figure 1. Historical and current range of Virginia spiraea as shown by HUC10 watersheds in major and minor drainage basins. Minor drainage basins are labeled. HUC10s with extant element occurrences (EOs) as of 2019 have "Present" status (e.g., discovered 1992 and earlier). HUC10s with EOs discovered since 1992 and still extant in 2019 are labeled as "Present (since 1992)." HUC10s with "Extirpated" or "Historical" status are based on the EO ranks assigned by the state natural resource agencies. Note: All EOs with F rank ("failed to find") occurred in HUC10s that also had EOs that are present (e.g., A, B, C, D, or E ranks).

Figure 1 provides the historical and current range of Virginia spiraea within major drainage basins (or regions) in the United States, which are the Ohio River basin (HUC2 #05) and Tennessee River basin (HUC2 #06) (https://water.usgs.gov/GIS/regions.html; accessed March 27, 2020). The major drainage basins may be further divided into HUC4 minor drainage basins (or subregions), HUC8 sub-basins (or cataloguing units), and HUC10 watersheds. Figure 1 also shows new Virginia spiraea locations in HUC10 watersheds discovered since the recovery plan was completed (Service 1992) and are still extant; Figure 1 does not show HUC8 sub-basin, but no new Virginia spiraea HUC8 sub-basin has been discovered. Within the Ohio River basin, all 6 historically occupied minor drainages have HUC10s with present status, but the Monongahela minor drainage basin only has 25% of its historically occupied HUC10s present. Within the Tennessee River basin, 2 of 3 of historically occupied minor drainages have HUC10s with present status, with the Middle Tennessee-Elk minor drainage basin continuing to be historical with the only occurrence found in Alabama. Overall, Virginia spiraea lost redundancy in the northern and southern portions of the historical range prior to 1992, but since then the species has increased redundancy in the middle part of the range with 11 new HUC10s due to increased searches for the species; however, the species has become presumed extirpated in 1 HUC10 in this area since 1992.

To better understand the distribution of EOs and attempt to address delisting criteria 1 and 2, Tables 5 and 6 provide a summary of HUC10s and extant EOs by sub-basin (HUC8) within the major and minor drainage basins, and their status in terms of A, B, or C rank and land management. In the Ohio River basin, 13 of 17 historically occupied HUC8 sub-basins (76.5%) have extant EOs. Fourteen of the 52 historically known EOs (26.9%) have an A or B rank and 8 of these 14 EOs (15.4% of historically known EOs) are on public or permanently managed/protected land. Assuming an EO represents a population (see Section 2.2.3), 2 of the 6 minor drainage basins (33.3%) have 3 or more EOs on public or permanently managed/protected land with A or B rank. There are also 16 C-ranked EOs (15.4% of historically known EOs), 8 of which are on public or permanently managed/protected land.

Table 5. Number of HUC10s with element occurrences (EOs) and EOs (total, extant, A, B, or C rank, land management) by minor drainage and watersheds in the Ohio River basin. Gray shaded rows are extirpated or historical watersheds.

		Number of HUC10s with EOs (any status)		**Number of EOs (all ranks)**	**Number of Extant EOs in 2019**			**Number of extant EOs located on public or permanently managed/ protected land**		
Major/Minor Drainage	**Sub-basin (HUC8)**	**Total[1]**	**Present**		**Total**	**A or B rank[2]**	**C rank[2]**	**Total**	**A or B rank[2]**	**C rank[2]**
Ohio River										
Cumberland	Rockcastle	2	2	7	6	2	2	4	1	2
	Upper Cumberland	2	2	4	3	0	1	3	0	1
	Caney	2	2	2	2	2	0	2	2	0
	South Fork Cumberland	3	3	8	7	1	4	6	1	4
Kanawha	Upper New	3	3	4	4	1	1	1	0	0
	Greenbrier	1	1	2	2	1	1	0	0	0
	Lower New	1 (X)	0	1	0	0	0	0	0	0
	Coal	1	1	2	2	0	1	0	0	0
	Gauley	2	2	4	4	3	0	2	2	0
	Middle New	1	1	1	1	1	0	1	1	0
Middle Ohio	Ohio Brush-Whiteoak	1	1	5	4	1	1	0	0	0
Scioto	Lower Scioto	1	1	6	6	0	5	1	0	1
Monongahela	Tygart Valley	1	1	1	1	1	0	0	0	0
	West Fork	1 (H)	0	1	0	0	0	0	0	0
	Upper Monongahela	1 (H)	0	1	0	0	0	0	0	0
	Youghiogheny	1 (H)	0	1	0	0	0	0	0	0
Big Sandy-Guyandotte	Upper Levisa	2	2	2	1	1	0	1	1	0
	Total	**26**	**22**	**52**	**43**	**14**	**16**	**21**	**8**	**8**

[1] If the HUC10 is historical or extirpated, it is noted in parenthesis.
[2] A or B rank includes B?- and BC-ranked occurrences, though there is uncertainty regarding the rank. C rank includes CD- and BCD-ranked occurrences. See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology.

Table 6. Number of HUC10s with element occurrences (EOs) and EOs (total, extant, A, B, or C rank, land management) by minor drainage and watersheds in the Tennessee River basin. Gray shaded rows are extirpated or historical watersheds.

Major/Minor Drainage	Sub-basin (HUC8)	Number of HUC10s with EOs (any status)		Number of EOs (all ranks)	Number of Extant EOs in 2019			Number of extant EOs located on public property or permanently managed/ protected land		
		Total[1]	Present		Total	A or B rank[2]	C rank[2]	Total	A or B rank[2]	C rank[2]
Tennessee River										
Middle Tennessee-Elk	Pickwick Lake	1 (H)	0	1	0	0	0	0	0	0
Middle Tennessee-Hiwassee	Middle Tennessee-Chickamauga	3	3	5	5	4	1	5	4	1
Upper Tennessee	Lower Little Tennessee	2	2	2	2	2	0	2	2	0
	Nolichucky	4	4	7	5	3	1	1	1	0
	Upper French Broad	2 (1 X)	1	2	1	1	0	0	0	0
	Upper Little Tennessee	2	2	5	5	2	1	1	0	0
	Emory	4	4	12	9	5	3	5	4	0
	Watts Bar Lake	2 (1 X)	1	2	1	0	1	0	0	0
	Upper Clinch	1	1	1	1	1	0	1	1	0
	Total	**21**	**18**	**37**	**29**	**18**	**7**	**15**	**12**	**1**

[1] If the HUC10 is historical or extirpated, it is noted in parenthesis.
[2] A or B rank includes B?- and BC-ranked occurrences, though there is uncertainty regarding the rank. C rank includes CD- and BCD-ranked occurrences. See the NatureServe Element Occurrence Data Standard (2002) for more details on ranking methodology

In the Tennessee River basin, 8 of 9 historically occupied HUC8 sub-basins (88.9%) have extant EOs. Eighteen of the 37 historically known EOs (48.6%) have an A or B rank and 12 of these 18 EOs (32.4% of historically known EOs) are on public or permanently managed/protected land. Two of the 3 minor drainage basins (66.6%) have 3 or more EOs on public property or permanently managed/protected land with A or B rank. The minor drainage basin (Middle Tennessee-Elk) that does not meet this criterion had 1 historical occurrence in Alabama from the 1890s, as discussed above.

If we consider EOs with A or B rank as populations that are sufficiently healthy and have adequate habitat to likely persist for the foreseeable future, based on the detailed EO rank definitions (NatureServe 2020b), Figure 2 provides a map of the percentage and number of healthy EOs within HUC8 sub-basins. Healthy EOs are found throughout the range, but are not evenly distributed in some areas. There are fewer healthy EOs in specific areas of the middle portion of the range and northern and southern extents of range. The number of C-ranked EOs are also included in Figure 2. Although their probability of persistence is uncertain under current conditions, they may persist for the foreseeable future if managed or protected.

In terms of distribution of Virginia spiraea across physiographic province, almost all historical and present HUC10 watersheds occur in the Appalachian Plateau and Blue Ridge (Figure 3). There are 2 exceptions, the historical occurrence in Alabama in the Interior Low Plateaus and 1 extant EO in Virginia in the Valley and Ridge.

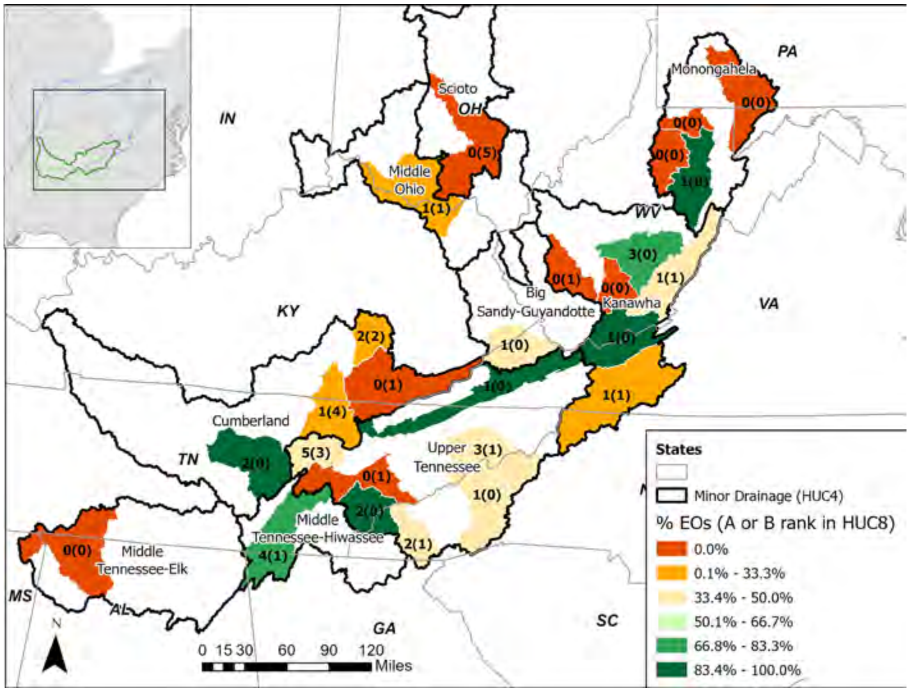

Figure 2. Percentage of element occurrences (EOs) that have A or B rank (i.e., considered healthy) within the HUC8 sub-basin. Minor drainage basins are labeled. Numbers denote number of A or B-ranked EOs with C-ranked EOs in parenthesis within HUC8 sub-basin.

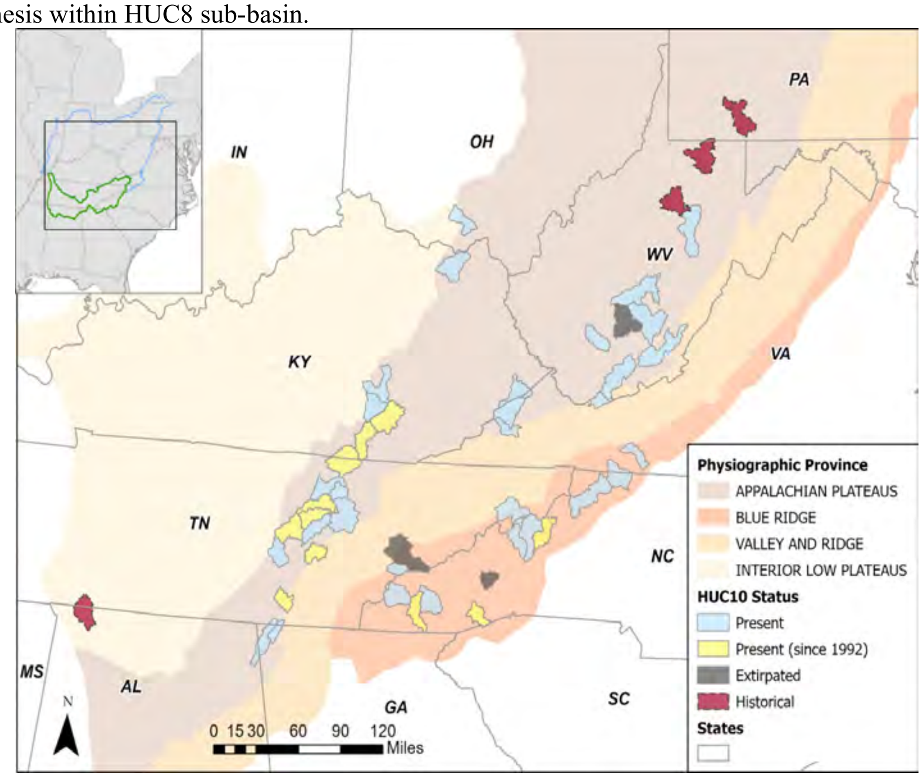

Figure 3. Historical and current range of Virginia spiraea as shown by HUC10 watersheds in physiographic provinces. HUC10s with extant element occurrences (EOs) as of 2019 have "Present" status (e.g., discovered 1992 and earlier). HUC10s with EOs discovered since 1992 and still extant in 2019 are labeled as "Present (since 1992)." HUC10s with "Extirpated" or "Historical" status are based on the EO ranks assigned by the state natural resource agencies. Note: All EOs with F rank ("failed to find") occurred in HUC10s that also had EOs that are present (e.g., A, B, C, D, or E ranks).

Ogle (2008) estimated that approximately 60% of potential habitat in states with present or past collections, specifically in the Blue Ridge and Appalachian Plateau physiographic provinces, had been surveyed for additional populations by 2007. Since then, additional surveys in HUC8 sub-basins where the species is known to occur have found 12 new EOs and 3 new HUC10s, as well as re-discovered an EO in the Buckhannon River, WV, in 2019, which was thought to have been extirpated in 2007 (A. Silvis, WVDNR, email to J. Stanhope, Service, January 24, 2021). If not for the discoveries of EOs in 2 new HUC10s, the Upper French Broad and Watts Bar Lake HUC8 sub-basins, in the Upper Tennessee minor drainage basin would have been considered extirpated. WVDNR noted that they have not found new populations during additional minimal searches of drainages not known to have occurrences (A. Silvis, WVDNR, email to J. Stanhope, Service, January 24, 2021). State natural resource agencies, federal agencies, and researchers anticipate finding more EOs and sub-EOs with additional comprehensive surveys of potential habitat in known drainages (M. Tackett, BSFNRRA/OWSR, email to J. Stanhope, Service, February 19, 2020; R. Gardner, ODNR-DNAP, email to J. Stanhope, Service, January 17, 2020; J. Amoroso, NCNHP, email to J. Stanhope, Service, February 25, 2020; C. Elam, TDEC-DNA, email to J. Stanhope, Service, January 21, 2020; A. Silvis, WVDNR, email to J. Stanhope, Service, January 24, 2021; J. Rhode Ward, UNCA, email to J. Stanhope, Service, January 24, 2020). However, with the possible exception of some Blue Ridge areas of South Carolina, it is unlikely the species range will expand to more states (Ogle 2008). It would be difficult to provide an updated percent of potential habitat surveyed in states with any collections, but we expect it is more than 60% given the new occurrences found. In addition, there is the potential for additional suitable habitat, based on the species distribution model, as described below in Section 2.3.1.6 (Habitat or Ecosystem Conditions).

Summary of spatial distribution, trends in spatial distribution, or historic range

The current range of Virginia spiraea is generally unchanged since the recovery plan was completed (Service 1992), occurring in 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) within the Ohio and Tennessee River basins; the species remains extirpated from Pennsylvania and Alabama. One EO with historic documentation has been rediscovered (Cheoah River, North Carolina) and 38 additional EOs (32 of them extant as of 2019) and 74+ sub-EOs have been discovered due to searches of rivers/streams with suitable habitat in known drainages, surveys of rivers/streams with known occurrences, and incidental finds when surveying for other species. Prior to 1992, Virginia spiraea had lost redundancy in the northern and southern portions of the historical range. Since 1992, however, the species has increased redundancy in the middle part of the range with extant EOs/sub-EOs in 10 new HUC10 watersheds due to increased searches for the species but also has 1 HUC10 become presumed extirpated in this area. In the Ohio River basin, 13 of the 17 historically occupied HUC8 sub-basins (76%) have extant EOs and 2 of the 6 minor drainage basins (33.3%) have 3 or more EOs on public or permanently managed/protected land with A or B rank. In addition, 14 of the 52 historically known EOs (26.9%) have an A or B rank. In the Tennessee River basin, 8 of the 9 historically occupied HUC8 sub-basins (89%) have extant EOs and 2 of the 3 minor drainage basins (66.6%) have 3 or more EOs on public or permanently managed/protected land with A or B rank. In addition, 18 of the 37 historically known EOs (48.6%) have an A or B rank. Although more than 60% of potential habitat in states with present or past collections, specifically in the Blue Ridge and Appalachian Plateau physiographic provinces, has been surveyed for additional populations, many biologists anticipate finding more EOs and sub-EOs with additional comprehensive surveys.

2.3.1.6 Habitat or ecosystem conditions:
Horton et al. (2015) found that Virginia spiraea in western North Carolina occurred on steep, south-facing slopes with "higher percentage of large substrate, lower herbaceous and vine cover, higher non-[Virginia spiraea] shrub density, lower tree influence, and higher visible sky than" areas without the species. Analysis of Virginia spiraea data suggested that the species had greater growth in area and height when there were fewer competing trees, shrubs, vines, and herbs and increasing light availability.

Studies have been conducted to help manage and increase growth and flowering of Virginia spiraea populations. Clarke et al. (2014) examined the effects of long-arm mowing (during the dormant season) on a population along a road on the Cheoah River, North Carolina, and observed greater survival rates of tagged stems in the treatment group (mowed; 55% of stems alive) vs. the control group (not mowed; 29% of stems alive) 2 years after treatment. They also observed that there were no significant differences in stem lengths between treatments at the beginning and end of the study. The results suggested that Virginia spiraea growing along roadsides may benefit from dormant season mowing every other year due to increased survival rates, as well as benefit from cutting of trees and shrubs shading Virginia spiraea to increase light availability; however, the researchers cautioned that the results were based on a short-term study and limited sample size and recommended a longer duration study and using genets instead of stems. There was also a potential confounding factor of beaver (*Castor canadensis*) grazing in the study.

At a sub-EO in the Pound River, Ogle (2003) removed above-ground biomass of non-native, invasive species, mostly multiflora rose (*Rosa multiflora*) and honeysuckle (*Lonicera* spp.) by hand, to reduce arboreal competition and applied fertilizer/nutrients to mimic deposition by normal riverine processes in April 2003. When the site was revisited in September 2003, the original colony had increased vertical growth and vigor, with the following observations: wider and more numerous leaves; longer/thicker canes; and more maturing follicles for seed production on the corymbs, but not more corymbs.

This summer (2021), UNCA is conducting a light physiology study in their common gardens to assess effects of shade on photosynthetic rates.

A species distribution model for Virginia spiraea for the entire range was developed by Dr. Crystal Krause (Davis & Elkins College and WVDNR staff) using Maximum Entropy modelling that predicts potential suitable habitat for the species at a 90-meter pixel resolution based on occurrence data (Krause and Harmon 2018 *in* Tessel 2018, pp. 3-4; K. O'Malley and P.J. Harmon, WVDNR, letter to J. Stanhope, Service, January 23, 2020). The model variables most important in predicting suitable habitat were: distance to water, elevation, temperature seasonality, solar radiation, geology, canopy cover, temperature, and precipitation (Krause and Harmon 2018 *in* Tessel 2018). This model showed new potential areas for suitable habitat throughout Virginia spiraea's current and historical range within the Appalachian Plateau and Blue Ridge physiographic provinces. It also includes areas in the Interior Low Plateaus and Valley and Ridge physiographic provinces where few Virginia spiraea EOs have been located, which are 1 historical occurrence in Alabama in the Interior Low Plateaus and 1 extant EO in Virginia in the Valley and Ridge. WVDNR shared the model with state agencies and federal agencies to review its accuracy and no comments/responses were received (K. O'Malley and P.J. Harmon, WVDNR, letter to J. Stanhope, Service, January 23, 2020). WVDNR is refining the model for West Virginia to a higher resolution of 30-meter pixel and to include the rediscovered Buckhannon River EO (A. Silvis, WVDNR, email to J. Stanhope, Service, January 24, 2021).

Summary of habitat or ecosystem conditions
New research supports that Virginia spiraea habitat is improved when there are fewer competing trees and invasive plant species (non-native and native) and greater light availability. Prior to alteration of flow regimes at some sites, reduction in competition occurred naturally during high-volume scouring floods. A species distribution model that predicts potential suitable habitat shows new potential areas throughout Virginia spiraea's current and historical range within the Appalachian Plateau and Blue Ridge physiographic provinces, but also includes areas in the Interior Low Plateaus and Valley and Ridge physiographic provinces where only 2 EOs are located. Efforts to solicit review of the model by state and federal agencies were unsuccessful and have been discontinued, but WVDNR is continuing to refine the model for West Virginia.

2.3.2 Five-Factor Analysis:

The purpose of a 5-Year Review is to recommend whether a listed taxon continues to warrant protection under the ESA and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

2.3.2.1 Factor A. Present or threatened destruction, modification, or curtailment of its habitat or range:

The final listing rule described threats to Virginia spiraea to include competition by both native and non-native species and anthropogenic disturbances to habitat (e.g., development, railroads, roads, clearing, mowing, recreational use of rivers, dam construction). In particular, loss of suitable habitat due to dam construction was listed as a threat due to flooding of populations in the upstream impoundment and stabilization of flows, which would eliminate or reduce scouring action necessary to maintain downstream open habitat for the species (55 FR 24241-24247). At the time of listing, hydroelectric facilities were proposed at the Summersville Dam on the Gauley River in West Virginia and John Flanagan Dam on the Pound River in Virginia; both dams upstream of Virginia spiraea populations (additional information about these dams are discussed further below under subsection “Anthropogenic disturbance and habitat modification”). Recent information shows that most of the threats described in the final listing remain ongoing and occur throughout the species range, in particular invasive plant species, habitat loss due to land disturbances, and changes in hydrologic flow regime, and that they are expected to continue in the future.

<u>Invasive, native and non-native plant species</u>: Invasive non-native plant species, such as Japanese knotweed (*Polygonum cuspidatum*), purple loosestrife (*Lythrum salicaria*), Japanese spiraea, multiflora rose, honeysuckle, and bamboo are significant threats to Virginia spiraea by competing with the species, in particular by shading and reducing light. Native plant species, such as poison ivy (*Toxicodendron radicans*), may also compete with Virginia spiraea, as noted in the final listing (55 FR 24241-24247). When state natural resource agencies, federal agencies, and researchers were surveyed in 2019 by the Service, the majority of the respondents listed invasive species as a primary threat in their region. Of 38 EO records where threats were noted or described in the occurrence data provided, 21 indicated competing vegetation or invasive species as one of their threats (note: many EO records noted multiple threats). For example, competition from invasive plant species is the primary reason for decline of the EO in White Oak Creek, North Carolina, from 50-75 stems (number of plants not provided) to 1 plant with 1 stem (G. Kauffman, USFS, email to J. Stanhope, Service, July 30, 2021). In addition, this threat was noted for 3 EOs that became presumed extirpated since the 1992 recovery plan was written. In many cases, the agencies have been focused on reducing invasive plant species when managing a Virginia spiraea population, including the NPS (Gauley River, Meadow River, Abrams Creek) and USFS (Cheoah River, White Oak Creek). However, herbicide (triclopyr 3A) applied to manage invasive Japanese knotweed has been observed to spread and impact a few adjacent Virginia spiraea stems across 3 populations in

the Little Tennessee River, White Oak Creek, and Nolichucky River (G. Kauffman, USFS, email to J. Stanhope, Service, July 30, 2021). As noted below, this threat is also related to flood control and reduction of normal hydrologic flows that would scour competing invasive plants and allow for colonization by Virginia spiraea. The threat of invasive plant species may increase with global climate change due to increasing air temperature and atmospheric carbon dioxide (Liu et al. 2017), but there is large uncertainty about the scale of effects of climate change on invasive plants (https://www.fs.usda.gov/ccrc/topics/invasive-plants; accessed March 23, 2021).

Anthropogenic disturbance and habitat modification: Anthropogenic factors include many types of development such as construction and maintenance of roads, railroads, sewer systems, electric and gas lines, dams, and watershed flow control systems. Land disturbance due to development of streamside habitat, such as clearing, mowing, filling, or herbicide application, can directly kill or crush plants and alter habitat by creating conditions conducive to invasive plants. Under some circumstances, roadside mowing may benefit the species by controlling woody competitors and promoting asexual production. Of 38 EO records where threats were noted or described in the occurrence data provided, 11 EOs records indicated land disturbance activities as one of their threats. For 1 EO that became presumed extirpated since the 1992 recovery plan was written, the plants were removed in association with the replacement of a bridge.

Changes in hydrologic flow regime was the second most frequently listed threat by respondents when surveyed in 2019. Dams, constructed for flood control and/or generating power, limit downstream dispersal of Virginia spiraea through the alteration of pre-impoundment hydrologic regimes. Since the species is dependent on scour, regulating the flow of water below a dam has the effect of eliminating normal erosion and deposition cycles upon which the plant depends for maintenance, reduction of arboreal/invasive species competition, and possibly any reproduction that may be associated with dispersal. At the time of final listing, hydroelectric facilities were proposed at the John Flanagan Dam and Summersville Dam. Construction of a hydroelectric facility was completed at the Summersville Dam in 2001, but construction has not started at John Flanagan Dam, although it has been licensed by the Federal Energy Regulatory Commission (FERC). For the sub-EO downstream of the John Flanagan Dam on the Pound River in Virginia, Virginia spiraea was observed to be negatively affected by invasive, non-native plants due to competition, likely as a result of the regulation of flow (Ogle 2003). However, in the Gauley River, Summersville Dam may potentially reduce seasonal streamflow fluctuations and provide some stability for plants (i.e., ameliorate severe flooding events that may wash Virginia spiraea from habitat; see below for additional discussion) (K. O'Malley and P.J. Harmon, WVDNR, letter to J. Stanhope, Service, January 23, 2020).

For the EO downstream of the Nantahala Hydroelectric Project on White Oak Creek in North Carolina, Duke Energy, as part of its Virginia Spiraea

Management Plan, is required to monitor and manage the population, which is currently a single plant, and continue recreational, high flow releases, which likely incidentally help maintain Virginia spiraea habitat and control the growth of invasive plants (Duke Energy Carolinas, LLC et al. 2015) (see Section 2.3.2.4 for additional information about FERC regulation of hydroelectric projects). For 2 sub-EOs on the Cheoah River, downstream of the Santeetlah Dam in North Carolina, occurrence data indicate Virginia spiraea habitat may have been impacted by the dam (e.g., lack of substrate, increased non-native species and arboreal competition). As a result of FERC relicensing in 2005, the Tapoco Hydroelectric Project is required to maintain minimum flows with periodic recreational, flow increases in the Cheoah River. Monitoring is on-going to determine if the increased flows are improving streamside habitat, but more sub-EOs have been discovered in this river (Kauffman 2021). There may be additional EOs affected by dams that are not documented in occurrence data or that the Service is not aware of (e.g., EO on Laurel River downstream of Laurel Dam in Kentucky). While construction of new dams is unlikely a current threat, flow regulation for flood control and/or generating power continues to be a threat. It is unknown what level and frequency of high flow events would be sufficient to maintain Virginia spiraea habitat but not cause long-term adverse effects to populations. As discussed below, flow events that are too high and/or frequent are also a threat to Virginia spiraea.

For multiple EOs throughout the range, severe and repeated flooding events were noted as a threat due to extreme scour and erosion of the habitat, washing away plants, or large debris piles accumulating on the habitat (i.e., exceeding the unknown threshold of beneficial scour that removes competing vegetation). Of 38 EO records where threats were noted or described in the occurrence data provided, 16 EO records indicated scour and flooding as one of their threats. For 3 EOs that became presumed extirpated since the 1992 recovery plan was written, scouring and flooding were noted as one of their primary threats. Although these flooding events are natural, land use changes, in particular increased development and impervious surface in watersheds, alter flow regimes and contribute to greater frequency and intensity of severe flood events (https://www.usgs.gov/special-topic/water-science-school/science/impervious-surfaces-and-flooding; accessed May 5, 2021). Development in the southeastern United States is predicted to increase, thus a greater percentage of impervious surface in watersheds and more severe flood events are likely. Terando et al. (2014) projected urban sprawl changes for the next 50 years for the southeastern United States and the extent of urbanization in the region is projected to increase 101 to 192%. Climate change is also predicted to contribute to greater flooding events (see Section 2.3.2.5).

Another concern is the increasing number of river access locations for recreational boating (e.g., fishing, rafting) as well as other outdoor recreation activities (e.g., ATV, hiking) disturbing habitat and/or crushing plants. Possible effects have been noted in Kentucky, North Carolina, Tennessee, West Virginia, and Virginia in the 2019 survey responses or occurrence data. Of 38 EO records where threats were noted or described in the occurrence data provided, 3 EO records indicated recreational activities as one of their threats. In one specific case, it is suspected that a fence placed around a Virginia spiraea plant was removed and the plant was cut to the ground to provide quicker access to the river to fish (G. Kauffman, USFS, email to J. Stanhope, Service, July 30, 2021).

Water quality is a threat to the species only as it relates to acid mine drainage and water release temperatures below dams (Ogle 2008). Water temperatures often decrease at dam outflows and 2 populations located in Kentucky and Virginia may have been negatively affected by this habitat modification.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:
At the time of listing there was no specific information available to suggest that this factor presented a threat to Virginia spiraea (55 FR 24241-24247). This continues to be accurate. There is no new relevant information regarding overutilization.

2.3.2.3 Factor C. Disease or predation:
The final listing rule described aphid and caterpillar herbivory at several Virginia spiraea populations, but effects were unknown (55 FR 24241-24247). The recovery plan (Service 1992) concluded that "there is little evidence of anything other than local damage by insect pest." Dr. Rhode Ward has observed aphid infestations on Virginia spiraea in the UNCA common gardens and in the field, but they did not appear to cause long-term consequences (J. Rhode Ward, UNCA, email to J. Stanhope, Service, July 26, 2021); therefore, this new information does not change the conclusion in the recovery plan.

There is new information to indicate beaver herbivory as a potential threat to Virginia spiraea (Ogle 2008). Continuous beaver herbivory may kill less established, smaller populations. Grazing by beavers led to an outplanted plant in the Cranesnest River to be in very poor condition and it was moved to a new location (Ogle 2006; D. Ogle, formerly VHCC, email to J. Stanhope, Service, March 5, 2021). Rossell et al. (2013, 2014) found that Virginia spiraea was a preferred food source for beaver, but overall browsing levels along the Cheoah River, North Carolina, were relatively low due to this river being turbulent and high gradient. They also observed that beaver herbivory may promote asexual production by causing rhizomatous growth and dispersing stem cuttings. Beaver population numbers could not be found to determine if this could be an increasing threat.

Herbivory by other animals, such as white-tailed deer (*Odocoileus virginianus*), has also been observed. At several outplanted sites in the Pound and Cranesnest rivers, stems were observed to be cut or browsed, but plants were still alive (Ogle 2006). White-tailed deer population have been decreasing in some areas in the southeastern United States due to disease and hunting, but also increasing in suburban and urban areas where hunting is more limited (Webster et al. 2005; Hanberry and Hanberry 2020; https://www.ncwildlife.org/Learning/Species/Mammals/Whitetail-Deer, accessed August 20, 2021). White-tailed deer herbivory may be a potential, increasing threat in the future for Virginia spiraea in these areas.

In summary, herbivory by animals is currently a minor and localized threat to Virginia spiraea.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:
The final listing rule indicated that the species was state listed as endangered in Tennessee, North Carolina, and Virginia and described limited protections provided by these designations within each state (55 FR 24241-24247). Since final listing, states with extant Virginia spiraea EOs have listed the species as endangered (Ohio) or threatened (Georgia, Kentucky, North Carolina), except West Virginia, which does not have a state endangered species law. Kentucky's Rare Plant Recognition Act provides no protection to state listed plant species. The laws in the other states provide varying levels of limited protections, with some states prohibiting some activities (e.g., digging, removing, collecting, transporting, or selling) only on public lands until receiving approval from their designated state agency. None of the states endangered plant laws regulate destruction or alteration of habitat. If this species is delisted, removing state protections might occur after independent state review, but would not automatically change with Federal status.

FERC regulates hydropower activities, including building, maintenance, and operation of hydroelectric dams. Pursuant to the ESA, FERC is required to consult with the Service on new or amended hydropower activities that may affect federally listed species, including Virginia spiraea. If a hydroelectric dam was licensed prior to listing of the species, FERC will consider the effects of the hydropower operations during the relicensing process. For example, as part of relicensing for the Franklin and Nantahala Hydroelectric Projects, Duke Energy was required to prepare and implement Virginia Spiraea Management Plans on the Little Tennessee River and White Oak Creek, respectively (i.e., through Memorandum of Agreements with the Service and other stakeholders), which include measures to remove invasive and competing plants. Without ESA protection for Virginia spiraea, FERC would likely approve activities without requiring measures to avoid or minimize impacts to the species and there would likely be a further reduction in Virginia spiraea habitat quality and quantity and a resultant decrease in number of EOs and sub-EOs downstream of hydroelectric dams. FERC regulates a small number of large dams in the United States (approximately 1,700 non-federal dams that affect navigable waters) (https://www.ferc.gov/industries-data/hydropower, accessed March 24, 2021). There are approximately 91,500 large dams tracked in the U.S. Army Corps of Engineers' National Inventory of Dams and the majority (63%) are privately owned and 4.2% are federally owned (Gonzales and Walls 2020). Therefore, most existing large dams (i.e., those expected to affect Virginia spiraea) are not regulated by FERC or federally owned (i.e., does not undergo ESA consultation) and Virginia spiraea does not receive any regulatory protections for these dams.

There are other regulations and policies that protect plants on USFS property. USFS regulation 36 CFR 261.9 prohibits removing or damaging any plant that is classified as a threatened, endangered, sensitive, rare, or unique species. Additionally, Forest Service Manual 2673 establishes policy that prohibits the removal and collection of any threatened or endangered plants on lands under Federal jurisdiction except when authorized by permits. Although these regulations and policies should protect Virginia spiraea on USFS property (e.g., from recreational activities, as described in Section 2.3.2.1), lack of resources prevents monitoring of compliance and enforcement. If this species is delisted, removing USFS protections might occur after independent USFS review, but would not automatically change with Federal status. The USFS has additional categories of regional forester sensitive species, forest concern species (i.e., locally rare), and species of conservation concern that offer protections.

As described above, removal of ESA protections would likely exacerbate the extent of the primary threats of invasive plant species and habitat loss or degradation due to changes in flow regime.

2.3.2.5 Factor E. Other natural or manmade factors affecting its continued existence:

The final listing rule described threats to Virginia spiraea to include biological factors limiting the establishment and colonization of new sites because of very low sexual reproduction (based on observations of low seed production, lack of seedlings, low germination rates, and very old plants with well-established root systems) and low genetic variability (e.g., 1 genotype per population) (55 FR 24241-24247). In addition, severe floods could potentially eliminate populations, in particular those that are small- to moderate-sized (less than 10 clumps and 10-50 clumps, respectively, as defined in the final listing rule); at the time of listing 88% of known populations were small to moderate in size. Recent information shows that low sexual reproduction and low genetic diversity likely remain ongoing sources of inherent vulnerability and occur throughout the species range, and asexual reproduction may be the dominant mechanisms for maintenance and establishment of sites. There is insufficient information to determine if the new EOs or sub-EOs found since 1992 is due to increased survey effort or due to new sites being establish via asexual reproduction. In addition, the threat of severe floods will likely remain ongoing and occur throughout the species range and is predicted to increase in the future with climate change.

Reproduction and low diversity

As described in Sections 2.3.1.3, reproduction for Virginia spiraea is primarily asexual (e.g., when clumps or stems break off and lodge themselves in a downstream, suitable location favorable for establishment), which is likely contributing to Virginia spiraea's low genetic diversity. Although new populations have been found since 1992, it may be due to additional searches of suitable habitat vs. establishment of new sites via asexual reproduction; there is not sufficient data to make that assessment. Low genetic diversity is well documented as a threat to a species because it decreases the ability of the species to adapt to short- and long-term changes in physical and biological environments. This ability to adapt to new environments–referred to as adaptive capacity–is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015). Virginia spiraea may not be able to adapt to changes, such as those caused by climate change, as discussed below. The genetic analyses of Virginia spiraea populations have been conducted in a subset of the populations across the range and are ongoing in additional populations.

Climate change

Since the 1950s, the North American climate trends demonstrate an increase in overall temperature and an increase in the number of heavy precipitation events (IPCC 2014, Wuebbles et al. 2017). Temperatures are expected to continue rising, and heat waves and extreme precipitation events are predicted to become more frequent, last longer, and become more intense by the mid-21st century (IPCC 2014, Wuebbles et al. 2017). Climate projections downscaled to the Ohio Valley region, which overlaps with the Virginia spiraea range and are based on 11 global climate models, indicate that the following climate variables will increase during the 2011-2050 period when compared to 1981-2005: average annual temperature (median of about 1.4ºC), number of extreme hot days (median of about 12 days), percent change of annual precipitation (median of about 2.5%), and percent change of number of precipitation extremes (mean of about 10%; precipitation extreme is when "daily precipitation magnitude exceeds the climatological value of the 95th percentile of the baseline precipitation") (Ashfaq et al. 2016). With a warming climate, some studies predict an increase in the frequency of more intense hurricanes (e.g., category 4 and 5) by the end of the 21st century, in particular in the western Atlantic Ocean north of 20ºN latitude (i.e., Cuba and north), which would likely cause periodic, extreme inland flooding events, potentially resulting in loss of Virginia spiraea habitat and populations through extreme scouring events (Bender et al. 2010, Knutson et al. 2010). The projected periods of extreme drought may negatively affect Virginia spiraea by reducing river flow and decreasing beneficial scouring of habitat that removes competing vegetation and disperses propagules. Virginia spiraea may also be stressed by drought and temperature increases, although we are unaware of information about their drought or temperature tolerances. As discussed in Section 2.3.2.1, increasing temperatures and atmospheric carbon dioxide associated with the global change may increase the spread and growth of invasive plant species (Liu et al. 2017).

Other

Feral hogs have been observed along a few riparian areas in the BSFNRRA, but their potential impact to Virginia spiraea is unknown (M. Tackett, BSFNRRA/OWSR, email to J. Stanhope, Service, February 19, 2020).

2.4 Synthesis

The current range of Virginia spiraea is generally unchanged since the 1992 recovery plan, occurring in 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) within the Ohio and Tennessee River basins; the species remains extirpated from Pennsylvania and Alabama. One EO with historic documentation has been rediscovered (Cheoah River, North Carolina) and 38 additional EOs (32 of them extant as of 2019) and 74+ sub-EOs have been discovered due to searches of rivers/streams with suitable habitat in known drainages, surveys of rivers/streams with known occurrences, and incidental finds when surveying for other species. However, 11 EOs became presumed extirpated (F or X rank) since 1992 when the species' recovery plan was completed.

Data gathered since the 1992 recovery plan provide additional information on the abundance and number of populations of Virginia spiraea throughout its range, but it is difficult to assess population trends due to different monitoring approaches for abundance and definitions for populations over time and among the states. Although population trends and accurate counts of populations cannot be determined, the current data suggest that at least 72 of the 89 historically known EOs (81%) are extant, and 32 EOs (36.0% of historically known EOs) have an A or B rank, which indicates that the EO has excellent or good viability and are very likely or likely to persist, respectively, if current conditions prevail. However, 23 EOs (25.8% of historically known EOs) have an uncertain probability of persisting (fair viability; C rank) and 15 EOs (16.9% of historically known EOs) have a poor probability of persisting (D rank) and a high risk of extirpation, if current conditions prevail. Of the extant EOs, 36 (40.4% of historically known EOs) are located on public or permanently managed/protected lands and 20 of these 36 EOs (22.5% of historically known EOs) have an A or B rank. Populations are currently assessed by the state natural resources agencies as stable (Georgia, Kentucky, North Carolina, Ohio, Tennessee, and Virginia) or stable to decreasing (West Virginia). Propagation efforts have been successful in reintroducing Virginia spiraea to new or known rivers and rescuing them from construction and herbicide application; new propagation efforts are proposed or recently funded in Georgia, West Virginia, and Tennessee. Collections of living Virginia spiraea are maintained at multiple gardens, including plants from 26 of 72 extant EOs (36.1%) and 2 of 7 historical/extirpated EOs (28.6%), across the species range. Seeds collected from 5 EOs in the wild are stored at NLGRP.

Prior to 1992, Virginia spiraea had lost redundancy in the northern and southern portions of the historical range. Since 1992, however, the species has increased redundancy in the middle part of the range with extant EOs/sub-EOs in 10 new HUC10 watersheds due to increased searches for the species but also has 1 HUC10 become presumed extirpated in this area. In the Ohio River basin, 13 of the 17 historically occupied HUC8 sub-basins (76.5%) have extant EOs and 2 of the 6 minor drainage basins (33.3%) have 3 or more EOs on public or permanently managed/protected land with A or B rank. In addition, 14 of the 52 historically known EOs (26.9%) have an A or B rank and 8 of these 14 EOs (15.4% of historically known EOs) are on public or permanently managed/protected land. In the Tennessee River basin, 8 of the 9 historically occupied HUC8 sub-basins (88.9%) have extant EOs and 2 of the 3 minor drainage basins (66.7%) have 3 or more EOs on public or permanently managed/protected land with A or B rank. In addition, 18 of the 37 historically known EOs (48.6%) have an A or B rank and 12 of these 18 EOs (32.4% of historically known EOs) are on public or permanently managed/protected land. Although more than 60% of potential habitat in states with present or past collections, specifically in the Blue Ridge and Appalachian Plateau physiographic provinces, has been surveyed for additional populations, many biologists anticipate finding more EOs and sub-EOs with additional comprehensive surveys.

New research supports that Virginia spiraea habitat is improved when there are less vegetation competition and increased light availability. Prior to alteration of flow regimes at some sites, reduction in competition occurred naturally during high-volume scouring floods. A species distribution model that predicts potential suitable habitat shows new potential areas throughout Virginia spiraea's current and historical range within the Appalachian Plateau and Blue Ridge physiographic provinces, and includes areas in the Interior Low Plateaus and Valley and Ridge physiographic provinces, where only 2 EOs are located.

Results of genetics studies conducted thus far suggest low genetic diversity in the populations sampled, but differ in where most variation occurs. Brzyski and Culley (2011) found greater variability among populations (or watersheds) and no relationship between genetic and geographic distance, but UNCA and ASU researchers observed most variation occurs within river basins vs. between river basins and some of the genetic diversity patterns suggest downstream dispersal of propagules. Research related to genetic diversity and reproduction is currently ongoing at UNCA and ASU and will include additional populations across the range. Research supports that reproduction is primarily asexual, with some sexual reproduction occurring. Availability and viability of pollen do not appear to be barriers to sexual reproduction, but seed viability and germination are very low. Other potential genetic barriers to reproduction are being investigated by UNCA and ASU, including assessing polyploidy in the populations and prevalence of s-alleles. Understanding ploidy is important because a common trait of triploids is sterility. In addition, knowing ploidy numbers makes accurate calculations of heterozygosity possible and will help to guide potential propagation efforts.

The final listing rule described threats to Virginia spiraea to include competition by both native and non-native plant species, anthropogenic disturbances to habitat (e.g., development, railroads, roads, clearing, mowing, recreational use of rivers, dam construction), and changes in hydrologic regime. These threats remain ongoing, occur throughout the species range, and are expected to continue in the future. Although 38 additional EOs (32 extant as of 2019) have been found since 1992 due to searches/surveys, 11 EOs have become presumed extirpated since then as a result of these threats. When state natural resource agencies, federal agencies, and researchers were surveyed in 2019 by the Service, the majority of the respondents listed invasive species as a primary threat in their region. Of 38 EO records where threats were noted or described in the occurrence data provided, the following are the number of EO records indicating one of the above described threats (note: many EO records noted multiple threats): 21 (55%) indicated competing vegetation or invasive species; 11 (29%) indicated land disturbance activities; 16 (42%) indicated scour and flooding. Efforts to manage competing vegetation or invasive species are occurring for some EOs. The threat of invasive plant species may increase in the future with increased anthropogenic disturbances and global climate change due to increasing air temperature and atmospheric carbon dioxide (Liu et al. 2017), but there is large uncertainty about the scale of effects of climate change on invasive plants. The threats of land disturbance activities are likely to increase in the future with the extent of urban sprawl projected to increase 101 to 192% in the next 50 years for the southeastern United States. Scour and flooding are potentially exacerbated by increased development and impervious surfaces in watersheds and global climate change, with extreme precipitation events predicted to increase. New dam construction, which will alter flow regimes and cause habitat loss, is not expected across the species range. Minor threats to the species that are not widespread are recreational activities disturbing habitat and/or crushing plants (3 (8%) EO records indicated this as a threat) and herbivory by beavers and white-tailed deer. Existing regulatory mechanisms without ESA protections continue to be inadequate to protect Virginia spiraea from the primary threats of invasive plant species and habitat loss or degradation due to changes in flow regime.

The final listing rule described natural threats to include biological factors of low sexual reproduction and low genetic variability. Recent information shows that these risk factors likely remain ongoing and occur throughout the species range, and asexual reproduction may be the dominant mechanism for maintenance and establishment of sites. Low genetic diversity is well documented as a threat to a species because it decreases the ability of the species to adapt to short- and long-term changes in physical and biological environments. This ability to adapt to new environments–referred to as adaptive capacity–is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015). Virginia spiraea may not be able to adapt to changes, such as those caused by climate change.

The Service established a framework in which we consider what a species needs to maintain viability over time by characterizing the biological status of the species in terms of its Resiliency, Redundancy, and Representation ("the 3 Rs"; Smith et al. 2018). **Resiliency** means having sufficiently healthy populations for the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, population size, if that information exists. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), or the effects of human activities. **Redundancy** means having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. Generally, the greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events. **Representation** means having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. Table 7 summarizes the information provided in this report in terms of the 3 Rs.

Table 7. Resiliency, redundancy, and representation (3Rs) for Virginia spiraea and its currents condition.

3Rs	Requisites	Description	Current Condition
Resiliency (ability to withstand stochastic events)	Healthy populations and habitat.	Populations with: • High gradient streams/rivers with scoured banks, meander scrolls, point bars, natural levees, or other braided features; • Normal hydrologic flows to maintain habitat integrity and reduce competing arboreal and invasive vegetation; • Connectivity — waterways without impoundments and significant barriers to allow dispersal.	Each population or EO with excellent or good (A or B rank) current condition is thought to be healthy and have adequate habitat, thus has high or moderate resiliency, respectively. • 72 of 89 EOs (80.9%) are known to be extant. • EO status: – 32 EOs (36.0%) excellent/good condition – 23 EOs (25.8%) fair condition (C rank) – 15 EOs (16.9%) poor condition (D rank) – 2 EOs (2.2%) unknown condition (E rank) – 17 EOs (19.1%) presumed extirpated (F or X rank) or historical
Redundancy (ability to withstand catastrophic events)	Sufficient distribution of healthy populations.	Sufficient distribution of healthy populations to prevent catastrophic losses of species' adaptive capacity due to severe flood events. Multiple healthy populations and occupied HUC10s (watersheds) distributed within the species range are important for the species' redundancy.	• Healthy EOs (good to excellent condition) throughout range, but not evenly distributed in some areas: fewer healthy EOs in specific areas of middle portion of the range and northern and southern extents of range. • Loss of occupied HUC10s in the northern and southern extents of the range (historically; prior to 1992) • Increase in occupied HUC10s in the middle portion of the range due to increased searches for the species.
	Sufficient number of healthy populations.	Sufficient number of healthy populations and occupied HUC10s to prevent catastrophic losses of adaptive capacity.	• 32 of 89 EOs (36.0%) are good to excellent condition across the range. – Ohio basin: 14 of 52 (26.9%) are good to excellent condition. 16 of 52 (30.8%) are fair condition. – Tennessee basin: 18 of 37 (48.6%) are good to excellent condition. 7 of 29 (24.1%) are fair condition. • 40 of 47 HUC10 watersheds (85%) currently occupied.
Representation (ability to adapt)	Sufficient capacity to adapt to new, continually changing environments.	Genetic diversity within and among populations contribute to and maintain adaptive capacity. Occupied HUC10s distributed across the range, including the ecological diversity of river basins and physiographic provinces that contribute to and maintain adaptive capacity. Adequate dispersal ability for the species to migrate to suitable habitat and climate over time.	Low genetic diversity documented among populations analyzed thus far, but able to reproduce asexually. Connected, occupied HUC10s found in both river basins and physiographic provinces. **River basin:** • Ohio – 22 of 26 HUC10s (84.6%) occupied. • Tennessee – 18 of 21 HUC10s (85.7%) occupied. **Physiographic province:** • Appalachian Plateau – 28 of 32 HUC10s (87.5%) occupied. • Blue Ridge – 12 of 14 HUC10s (85.7%) occupied. • Interior Low Plateau – 0 of 1 HUC10 (0%) occupied.

Overall, Virginia spiraea is facing ongoing and likely increasing threats to its continued existence throughout its range. We are unable to assess trends in abundance and number of populations or EOs since the recovery plan, but based on the assumptions that an EO is a population, stable populations are those with an A or B rank, and drainage system is a minor drainage basin based on HUC4 basins, none of the recovery criteria have been met. When assessing the 3 Rs, 36.0% of historically known EOs are considered healthy (e.g., moderately to highly resilient) and 22.5% of historically known EOs are both considered healthy and located on public or permanently managed/protected lands. However, 25.8% of historically known EOs have an uncertain probability of persisting (fairly resilient) and 16.9% of historically known EOs have a high risk of extirpation (poorly resilient), if current conditions prevail. If we predict that approximately half of the EOs with an uncertain probability and all the EOs with a high risk of extirpation will not persist in the future, there is a potential for 48.3% of historically known EOs to become extirpated in the future when including EOs that are currently presumed extirpated or historical. Although redundancy has increased in the middle portion of the range, Virginia spiraea continues to have reduced redundancy in the northern and southern portions of the historical range. In addition, there are fewer healthy EOs in specific areas of middle portion of the range. Research is ongoing to assess genetic diversity and genetic barriers to reproduction and results will help inform recovery options, including the planned/proposed propagation efforts. When evaluating the status of the species and current and future threats, we conclude that the Virginia spiraea continues to meet the definition of a threatened species under the ESA.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ Extinction
____ No longer meets the definition of threatened or endangered
____ No longer meets the definition of a species
__X__ No change is needed

3.2 New Recovery Priority Number: No change; retain priority 8

Brief Rationale: The species continues to experience a moderate degree of threat and has a high recovery potential, if recommendations for future actions are implemented.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Clarify recovery criteria 1 and 2 to support consistent evaluation and to reflect current information. Specifically, both recovery criteria should be clarified in terms of population assessment measures (e.g., what factors determine a "stable" population) and definition of "population." In addition, the definition of "drainage system" should be clarified as it relates to this species' recovery and definition of a population.

Recommendations for specific recovery actions and priority number (1-3, based on priority number definitions in the Virginia spiraea recovery plan [Service 1992]):

1. Continue genetic analysis of Virginia spiraea across its range and within collections to determine genotypes and ploidy numbers, which will help guide potential propagation efforts and determine which localities/genotypes should be added to cultivated collections to provide genetic representation [Priority 1].
2. Develop specific guidance on the treatment of invasive species that threaten this species and recommendations for habitat management to increase viability of the populations, in particular EOs with C or D ranks. Include invasive species specialists and encourage practical application of invasive species and habitat management in populations across the range [Priority 1].
3. If deemed necessary based on the genetic analysis, develop a rangewide propagation and reintroduction plan [Priority 2].
4. Coordinate with natural resource agencies to complete rangewide review and revision, if needed, of the Virginia spiraea species distribution model to help identify potential suitable habitat [Priority 2].
5. Conduct comprehensive surveys of potential habitat in streams/rivers with known occurrences and no known occurrences, but identified in a species distribution model, to find

new populations. Efforts should focus within the Blue Ridge and Appalachian Plateau physiographic provinces, where almost all EOs occur [Priority 2].

6. Conduct surveys of extant EOs that have not been surveyed for more than 10 years to verify presence and update their EO ranks [Priority 2].
7. Determine if there is suitable habitat in areas where the species has been historically documented or extirpated and search these areas. Some areas that should receive priority ranking for survey work include, but are not limited to: Cypress Creek, AL; Youghiogheny River, MD and PA; Little River, TN; Hominy Creek, NC; Monongahela River, WV; and New River, WV [Priority 3].
8. Coordinate with natural resources agencies and Service Field Offices to develop methods and resolve nomenclature for accurately counting/measuring individual plants, population size, and populations to provide consistency and allow objective assessment of populations. Also coordinate to define appropriate ecological units (e.g., HUC units) to assist with organizing populations as it relates to species' recovery [Priority 3].
9. Coordinate with natural resource agencies and NatureServe to utilize consistent definitions of EO and EO rank for Virginia spiraea across the range to allow analysis of population trends and consistent assessment of status [Priority 3].
10. Develop educational materials for local government and public use aimed at increasing public awareness of the species, in particular in areas where development and recreational activities may impact Virginia spiraea [Priority 3].

5.0 REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Virginia spiraea, *Spiraea virginiana*

Current classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Jennifer Stanhope, Virginia Field Office

LEAD REGIONAL OFFICE APPROVAL

Assistant Regional Director, Fish and Wildlife Service

Approve ____ Date _________

APPENDIX A: COORDINATION LIST OF PARTNERS AND EXPERTS

The following partners and experts were contacted for information to support the 5-year review and provided responses, in addition to those listed in Section 1.1 (Reviewers):

Federal agencies

- National Park Service, Big South Fork National River and Recreation Area (KY & TN) & Obed Wild & Scenic River (TN) (Marie Tackett [Kerr])
- National Park Service, Great Smoky Mountains National Park (Kristine Johnson*, Joshua Albritton*)
- National Park Service, New River Gorge National Park and Preserve, Gauley River National Recreation Area, Bluestone National Scenic River (Doug Manning*, Bryan Wender)
- US Forest Service, George Washington and Jefferson National Forest (Tom Brumbelow)
- U.S. Forest Service, National Forests in North Carolina (Gary Kauffman*)

State agencies

- Alabama Department of Conservation and Natural Resources, States Land Division, Natural Heritage Section (Wayne Barger)
- Georgia Department of Natural Resources, Wildlife Resources Division (Laci Pattavina, Lisa Kruse, Nathan Thomas)
- Kentucky Energy and Environment Cabinet, Office of Kentucky Nature Preserves (Tara Littlefield, Nour Salam, Elizabeth Mason)
- North Carolina Natural Heritage Program (Jame Amoroso, Suzanne Mason*)
- North Carolina Department of Agriculture and Consumer Services (Lesley Starke*)
- Ohio Department of Natural Resources, Division of Natural Areas and Preserves (Richard Gardner)
- Tennessee Department of Environment and Conservation, Division of Natural Areas (Caitlin Elam)
- Virginia Department of Conservation and Recreation, Division of National Heritage (Rene' Hypes*, Johnny Townsend)
- West Virginia Division of Natural Resources (Kieran O'Malley*, Alexander Silvis)

Other

- Atlanta Botanical Garden (Carrie Radcliffe)
- University of North Carolina – Asheville (Jennifer Rhode Ward*)
- Appalachian State University (Matt Estep*)
- Seton Hill University (Jessica Bryzski*)
- Holden Living Collections (Ethan Johnson)
- Harvard Arnold Arboretum (Kathryn Richardson)
- Auburn University (Alfred Schotz)
- North Carolina Botanical Garden (Michael Kunz)
- Virginia Highlands Community College (Doug Ogle* [retired]; Ben Casteel)

*All federal and state partners and most "other" partners were provided the opportunity to review a draft 5-year review document. Those with an * reviewed the draft 5-year review and provided comments.

APPENDIX B: SPECIFIC AND GENERAL EO RANKS DEFINITIONS

Specific EO Rank Definitions for Virginia spiraea
(from
https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.135631/Spiraea_virginiana;
accessed June 21, 2021)

Excellent Viability:
Colonies of plants totaling ca 100 sq. m in areal coverage and occurring at several locations along 2 or more river miles, river bank communities stable and mostly dominated by native vegetation.

Good Viability:
Colonies of plants totaling ca 50 sq m in areal coverage and occurring at several locations along 1-2 river miles, river bank communities stable and mostly dominated by native vegetation.

Fair Viability:
Colonies of plants averaging smaller than 5 sq m in size and occurring at fewer than 5 locations along a water course, much of the river bank is native vegetation but may be disrupted by cleared areas or disturbance.

Poor Viability:
Any occurrence where the total coverage of all colonies is less than 15 sq m.

Justification:
Based on a review of occurrences and habitat rangewide.

Date:
January 25, 2005

Author:
White, D.

General Element Occurrence Rank Definitions
(from NatureServe 2020b)

A: Excellent viability
Occurrence exhibits optimal or at least exceptionally favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; and, if current conditions prevail, the occurrence is very likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. These occurrences have characteristics (e.g., size, condition, landscape context) that make them relatively invulnerable to extirpation or sustained population declines, even if they have declined somewhat relative to historical levels. For species associated with habitat patches or ephemeral or particularly dynamic habitats, occurrences warranting an A rank generally consist of metapopulations rather than single demes (unless exceptionally large and robust). Occurrences of this rank typically include at least 1,000 mature individuals but may be smaller (100s) or might require larger populations (10,000s), depending on the species and its demographic characteristics. However, occurrences can be ranked A even if population size is not known. For example, for occurrences lacking information on population size, an A rank may be appropriate under the following circumstances: the population is clearly very large but it is not known how large; the area of occupied habitat is exceptionally large; or the occurrence has excellent condition and landscape context and a long history of occurrence persistence. Occurrences with excellent estimated viability are ranked A even if one or more other occurrences have a much larger population size and/or much greater quantity of occupied habitat. In most cases, occurrences ranked A will occupy natural habitats. However, "natural" is an ambiguous concept, and occurrences in "unnatural" conditions (e.g., somewhat modified by human actions) may still be assigned a rank of A if they otherwise meet the criteria.

B: Good viability
Occurrence exhibits favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; and, if current conditions prevail, the occurrence is likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. B-ranked occurrences have good estimated viability and, if protected, contribute importantly to maintaining or improving the conservation status of threatened or declining species. For species associated with habitat patches or ephemeral or particularly dynamic habitats, a high-quality occurrence may warrant a B rank if it consists of a single deme rather than a metapopulation (unless the single deme is exceptionally large and robust, in which case an A rank may be appropriate).

C: Fair viability
Occurrence characteristics (size, condition, and landscape context) are non-optimal such that occurrence persistence is uncertain under current conditions, or the occurrence does not meet A or B criteria but may persist for the foreseeable future with appropriate protection or management, or the occurrence is likely to persist but not necessarily maintain current or historical levels of population size or genetic variability. This rank may be applied to relatively low-quality occurrences with respect to size, condition, and/or landscape context if they still appear to have reasonable prospects for persistence for the foreseeable future (at least 20-30 years). Examples include very small non-degraded relict occurrences as well as some remnant

occurrences of former landscape-level species such as many extant occurrences of tall-grass prairie insects. These occurrences represent the lower bound of occurrences worthy of protection.

D: Poor viability
If current conditions prevail, occurrence has a high risk of extirpation (because of small population size or area of occupancy, deteriorated habitat, poor conditions for reproduction, ongoing inappropriate management that is unlikely to change, or other factors). Questionably viable occurrences that could be restored to at least fair viability should not be ranked D if restoration is deemed feasible and plausible; in most such cases CD should be used. Very small occurrences that may be vulnerable to deleterious stochastic events may be ranked as follows: If the stochastic event is highly theoretical or of very low probability in the appropriate time frame (e.g., 20-30 years), then a C or CD rank may be appropriate. If a minority of other similar occurrences have disappeared as a result of, say, disease or inbreeding, then perhaps CD is best. If most of these small occurrences have been extirpated or are disappearing due to such events, then D is probably appropriate. The D rank also applies if the population is so small that there will inevitably be a year (or generation) in the near future in which by chance all adults will be the same gender.

E: Verified extant
Occurrence recently has been verified as still existing, but sufficient information on the factors used to estimate viability of the occurrence has not yet been obtained. Use of the E rank should be reserved for those situations in which the occurrence is thought to be extant, but an A, B, C, D, or combination rank cannot be assigned.

H: Historical
Recent field information verifying the continued existence of the occurrence is lacking. Examples of this rank include occurrences based only on historical collection data, or occurrences that previously were ranked A, B, C, D, or E but that are now, without field survey work, considered to be possibly extirpated due to general habitat loss or degradation of the environment in the area. H may be applied to recently verified occurrences if two or more competent subsequent efforts that should have found the species did not, or if there has been a known major disturbance since the last observation such that continued existence of the occurrence is in doubt (for example, an isolated Lepidoptera occurrence that was sprayed with Dimilin®).

In the absence of known disturbance and with the habitat still extant, H is generally recommended for occurrences that have not been reconfirmed for 20 or more years, but for many short-lived insects a shorter interval may be appropriate, and for unusually stable habitats (like undisturbed caves), or for certain plants whose seeds may persist and remain viable in the soil for decades, a longer interval, up to 40 years, may be used. With very few exceptions, occurrences are to be regarded as H after 40 years without confirmation, even with no effort to locate the species. The time frame for H occurrences is necessarily arbitrary, and the values specified here should be regarded as generally appropriate but somewhat flexible rules. The professional judgment of the assessor should determine when resurveys with negative results have been sufficient in quantity and quality to warrant updating an occurrence rank from F to H or from H to X. Deviations from the suggested time frame should be explained in the EO RANK Comment field.

In some cases, H may indicate occurrences with imprecise locational information such that it may be difficult or impossible to determine whether subsequent observations are of the same occurrence; many of these occurrences may remain H indefinitely. Nevertheless, occurrences with imprecise locational information sometimes may be mapped using an appropriate and reasonable indication of the degree of locational uncertainty.

F: Failed to find

Occurrence has not been found despite a search by an experienced observer at a time and under conditions appropriate for the Element at a location where it was previously reported, but the occurrence still might be confirmed to exist at that location with additional field survey efforts. For occurrences with vague locational information, the search must include areas of appropriate habitat within the range of locational uncertainty.

X: Extirpated

Adequate surveys by one or more experienced observers at times and under conditions appropriate for the species at the occurrence location, or other persuasive evidence, indicate that the species no longer exists there or that the habitat or environment of the occurrence has been destroyed to such an extent that it can no longer support the species.

Unrankable

An occurrence rank (including E) cannot be assigned due to lack of sufficient information on the occurrence. As currently defined, this category is not clearly distinguishable from H, and use of U is discouraged until this issue is resolved (perhaps by elimination of the U category). Occurrences that currently cannot be surveyed because of access issues (e.g., a cave entrance has been permanently sealed, or an uncooperative landowner denies access) may be ranked A, B, C, D, E, F, H, or X if the rank is based on recent survey data obtained when access was still possible. Currently inaccessible occurrences that are based only on old (historical) information should be ranked H. Note that access issues often are temporary and may be overcome by negotiation, change in ownership, use of novel survey techniques, or other methods. The U code sometimes has been used to indicate occurrences with "unknown" viability, but such occurrences generally should be coded as H, F, or NR, depending on the circumstances.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 89

February 21, 2023

James Spinymussel
(*Parvaspina collina*)

5-Year Review:
Summary and Evaluation

James spinymussel
(Credit: Jennifer Stanhope, U.S. Fish and Wildlife Service)

U.S. Fish and Wildlife Service
Virginia Field Office
Gloucester, Virginia

November 2022

5-YEAR REVIEW
James spinymussel (*Parvaspina collina*)

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5-YEAR REVIEW
James spinymussel (*Parvaspina collina*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Field Office: Jennifer Stanhope, Virginia Field Office, 804-824-2408, Jennifer_stanhope@fws.gov

Lead Region: Martin Miller, Region 5, Hadley, MA, 413-253-8615, martin_miller@fws.gov

Cooperating Field Offices:
Jason Mays, Asheville Field Office, 828-747-2394, jason_mays@fws.gov
Jennifer Archambault, Raleigh Field Office, 919-856-4520, jennifer_archambault@fws.gov
Elizabeth Stout, West Virginia Field Office, 304-679-1619, elizabeth_stout@fws.gov

Cooperating Regional Offices:
Carrie Straight, Region 4, Atlanta, GA, 404-679-7226, carrie_straight@fws.gov

Technical Reviewers/Experts:
See Appendix A (Coordination List of Partners and Experts) for list of technical reviewers and experts.

1.2 Methodology Used to Complete This Review:

This 5-year review, conducted primarily by the lead recovery biologist for James spinymussel (JSM) (*Parvaspina collina*; formerly *Pleurobema collina* [see section 2.3.1.4]), summarizes and evaluates new information relevant to the listing status of the species under the Endangered Species Act (ESA). New data and information regarding the species' population status and habitat used in this report were based on: peer-reviewed literature; survey reports; and information and occurrence data from state natural resource agencies, mussel hatcheries, and researchers. In 2008, the U.S. Fish and Wildlife Service (Service) drafted a 5-year review document but did not finalize it. In early 2021, Service offices (e.g., Field Offices, Service hatcheries), state natural resource agencies, Federal agencies, and researchers were contacted for up-to-date information on species' occurrences, threats, and recovery activities (see appendix A for list of partners and experts who provided responses). Since the 2008 5-year review was not finalized, this review provides the first comprehensive status review of the species since the 1990 recovery plan was written (Service 1990). All pertinent literature and documents on file at the Virginia Field Office were used for this review.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: 85 FR 64527-64529 (October 13, 2020)

1.3.2 Listing history:
FR notice: 53 FR 27689-27693
Date listed: July 22, 1988
Entity listed: species
Classification: endangered

1.3.3 Associated rulemakings: None

1.3.4 Review history:
Previous 5-Year Review
Initiated: 73 FR 3991-3993 (January 23, 2008)
Date Finalized: review drafted but not finalized and signed
Results: not applicable

Initiated: 56 FR 56882-56900 (November 6, 1991)
Date Finalized: No record or documentation of review being drafted or finalized.
Results: not applicable

1.3.5 Species' Recovery Priority Number at start of review: 8. This designation corresponds to a species experiencing a moderate degree of threat and a high recovery potential.

1.3.6. Recovery Plan:
Name of plan: James spinymussel (*Pleurobema collina*) Recovery Plan
Date issued: September 24, 1990

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? No. The JSM is an invertebrate, and the DPS policy does not apply.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes, the species has an approved plan containing objective, measurable criteria. However, criterion 1C, is too general and merits clarification to support objective evaluation and achievability. Criterion 2E is too specific and also merits clarification to support objective evaluation and achievability.

2.2.2 Adequacy of recovery criteria

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes, the biology and habitat of the species are relatively unchanged. There is an expansion of the range of the species to the Roanoke River basin in North Carolina that is not reflected in criterion 2D, which merits clarification to include waterbodies in the Roanoke River basin.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)? Yes.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The criteria for delisting are:

<u>Objective 1. Reclassify *P. collina* from endangered to threatened status when the likelihood of extinction in the foreseeable future has been eliminated by meeting the following criteria:</u>

A. <u>Populations of *P. collina* throughout the Craig Creek Drainage (including Johns Creek) and 80 percent of all other known populations are stable or expanding (as shown by monitoring over 10-year period) and show evidence of recruitment (specimens age five or younger).</u>
This criterion has not been met as stated. From the recovery plan (Service 1990), known populations of JSM in the Craig Creek Drainage were described as: Craig Creek (three subpopulations or areas), Johns Creek (two subpopulations or areas), Dicks Creek, and Patterson Creek. For these waterbodies as of 2021, only the Dicks Creek population and one subpopulation in Johns Creek are stable or expanding based on monitoring over a 10-year period and show evidence of recruitment; thus only 50 percent of the waterbodies (2 of 4) and 29 percent of subpopulations or areas (2 of 7) in the Craig Creek Drainage meet this criterion, based on known populations at the time of the recovery plan (see tables 1, 4, and 6 in section 2.3.1.2). The Patterson Creek population and two subpopulations in Craig Creek are possibly extirpated or their population status is unknown (see table 1 in section 2.3.1.2). One new JSM waterbody, Little Oregon Creek, has been discovered in the Craig Creek Drainage since 1990, but it does not meet this criterion because the population trend is decreasing mainly due to raccoon (*Procyon lotor*) predation.

For populations noted as historical or present in the recovery plan outside of the Craig Creek Drainage, two waterbodies meet this criterion, South Fork Potts Creek and Mill Creek[1] (VA), representing 17 percent (2 of 14) of known populations in 1990 (see tables 1, 4, and 6 in section 2.3.1.2). Since the 1990 recovery plan, many new waterbodies have been discovered with JSM; however, none of them meet this

[1] [1]There are two Mill Creeks with JSM, one in Virginia and one in North Carolina. Hereafter, references to Mill Creek are assumed to be in Virginia, except when noted as in North Carolina.

criterion. Rocky Creek in Virginia is a new population that is stable (with large variations in number of JSM) and has evidence of recruitment, but the status is not based on monitoring over a 10-year period.

Therefore, only four waterbodies across the range meet this criterion. When including all JSM historically occupied waterbodies as of 2021 (e.g., including those in the expanded range in the Roanoke River basin), only 10.8 percent (4 of 37) meet this criterion. If based on all currently present (i.e., extant) waterbodies, only 16.7 percent (4 of 24) meet this criterion (see tables 4 and 6 in section 2.3.1.2).

B. Populations in at least four rivers (or creeks) are distributed widely enough within their respective habitats such that it is unlikely a single adverse event in the river would result in the total loss of that population.

The probable locations of these four populations are:

- Craig Creek and its larger tributaries from Webbs Mill downstream to its confluence with the James River, and Johns Creek from its headwaters to its confluence with Craig Creek
- Potts Creek
- Pedlar River
- Mechums River

This criterion has been met as stated. The overarching trend across the species' range is that JSM usually numbers less than 10 individuals at any site or reach, and often just one individual is found. For most waterbodies that have moderate to high approximate abundance (e.g., greater than 100 live individuals observed cumulatively in past 20 years or estimated from repeated surveys, mark-recapture study, or other quantitative/semiquantitative approach), JSM is predominately found in single, small reaches, ranging from 0.1 to 1.4 kilometers (km) in length (appendix B), making them susceptible to an adverse event that could eliminate high density reaches of JSM within a waterbody. Depending on the type, scale, and location of the adverse event (e.g., spill, flash flood, dam breach, hurricane) and waterbody characteristics (e.g., width, stream flow), small reaches of habitat with few JSM may remain and the population may not be a total loss; however, they may not be considered viable, as defined under criterion 2D (see below). If we assume that an adverse event will not affect JSM more than 8 km downstream of an event[2] and consider the total river length of where all live JSM were found in the last 20 years (2002-2021; appendix B), there are 10 waterbodies with live JSM distributed widely enough within their habitats such that it is unlikely a single adverse event would result in total loss of

[2] To help define adverse events in terms of length of waterbody affected, we conducted a brief review of published literature and readily available reports/information about spills and other events that impacted mussels. Due to limited, reliable data about the length of waterbodies where mussels were affected, we also included fish kill data due to spills related to the federally listed endangered Roanoke logperch (*Percina rex*) provided in Roberts et al. (2016). We conservatively assumed these spills that killed Ronoanke logperch would have also killed mussels. The average length of stream affected is 8 km, with a range of 0.1 to 19 km (n=9) (Jones et al. 2001; The Catena Group 2007; Roberts et al. 2016; B. Watson, VDWR, email to R. Mair, Service, October 25, 2018).

population (Cowpasture River, Johns Creek, Craig Creek, Mill Creek, Pedlar River, Buck Mountain Creek, Swift Run, Dan River, South Fork Mayo River, and Mayo River).

C. All known populations of the species are protected from present and foreseeable anthropogenic and naturals threats that may interfere with their survival.
Based on documentation that anthropogenic and natural threats have occurred and may continue to occur in nearly all JSM occurrence watersheds and interfere with their survival (see section 2.3.2, e.g., dams, severe flooding, land modification causing water quality degradation, predation), criterion 1C as stated has not been met. However, this criterion is not objective or measurable and quite possibly not achievable.

Objective 2. Remove *P. collina* from the Federal list of endangered and threatened species when the following criteria has been met, in addition to A - C above:

D. Through reestablishment and/or discoveries of new populations, viable populations[1] of the species exist in two additional rivers or three river segments within the James River drainage. Each river or river segment will contain at least three population centers[2] which are dispersed to the extent that a single adverse event would be unlikely to eliminate *P. collina* from its natural or reestablished location. For a reestablished population, surveys must show that three year-classes, including one year-class of age 10 or older, have been naturally produced within each of the population centers.
Footnotes:
1. viable population – a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitats.
2. population center – a single shoal or grouping of shoals which contain P. collina in such close proximity that they can be considered as belonging to a single breeding unit.
This criterion has not been met as stated. Since the 1990 recovery plan, many new occurrences of live JSM and shells have been found, increasing the number of waterbodies (rivers, streams, tributaries) currently and likely occupied by JSM from 11 to 26 total (136-percent increase), and expanding the current range to the Roanoke River basin in North Carolina (see section 2.3.1.2, tables 1 and 4). The new discoveries are due to a greater number of surveys being conducted rather than new populations being established. With the expansion in range, this criterion should be clarified to include the Roanoke River basin. Genetic analyses are in progress, and we do not have sufficient information to help assess and define what is a viable population (e.g., large enough population to maintain sufficient genetic variation). Recognizing the lack of sufficient genetic analyses and data to conduct a population viability analysis, we made an assessment based on the assumptions that a viable population is a waterbody with (1) moderate to high approximate abundance, (2) evidence of recruitment, and (3) stable or increasing population trend. Based on these assumptions, Rocky Creek is a new waterbody with a viable population (see tables 1 and 6, appendix B); however, with all JSM occurrences within a 3-km stream reach, Rocky Creek does not have three population centers dispersed to the extent that a

single adverse event would be unlikely to eliminate JSM from this waterbody. In addition, Mill Creek is a rediscovered waterbody with a viable population (considered historical in 1990 and rediscovered in 1996), but it has only one known population center that is considered viable with most JSM occurrences within a 1.3-km reach (see tables 1 and 6, appendix B). These two waterbodies do not meet the second elements of this criterion.

If we expand the criteria to include multiple waterbodies instead of focusing on single rivers or river segments, there is one area with three streams with moderate to high JSM approximate abundance, Little Oregon Creek, Dicks Creek, and Johns Creek, located within a 1-km radius circle (i.e.., less than 2 km apart), that may meet the definition of three "population centers" and Little Oregon Creek is a newly discovered stream. Due to their close proximity to each other, they are more susceptible to a wide-scale adverse event, such as hurricane or drought; however, a single adverse event, such as a spill or dam breach, may only affect up to two of these waterbodies. Little Oregon Creek drains to Dicks Creek and the high JSM abundance stream reach in Johns Creek is upstream of the confluence with Dicks Creek (e.g., Dicks Creek drains into Johns Creek downstream of the reach with high JSM abundance). However, Little Oregon Creek has a decreasing population trend, and therefore these three streams as a group would not meet the first element of this criterion.

E. <u>Habitat protection strategies have been successful, as evidenced by recruitment and an increase in population density and/or an increase in the population size and length of river reach inhabited at 75 percent of the sites with viable populations.</u>
This criterion has not been met as stated. As discussed above, we assumed that a viable population is a waterbody with (1) moderate to high approximate abundance, (2) evidence of recruitment, and (3) stable or increasing population trend. Based on these assumptions, five waterbodies are potentially viable: South Fork Potts Creek, Dicks Creek, Johns Creek, Mill Creek, and Rocky Creek (see table 6). Only Mill Creek has had an increase in population size, but this was due to augmentation with propagated juveniles, not habitat protection strategies. This criterion is too specific and merits clarification to support objective evaluation and achievability. This criterion should be clarified to include other recovery tools, such as propagation, augmentation, stream restoration, predator trapping, and modification or removal of dams, because protecting habitat may not be sufficient to address the main threats to these waterbodies.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Basic biology and life history requirements are found in the JSM recovery plan (Service 1990). Since 1990, research has been conducted on multiple topics to provide new information on JSM's biology and life history. See section 2.3.1.3

for research related to genetics and section 2.3.1.6 for research about habitat characterization. Below is a summary of research and observations related to morphological features, reproduction, fish hosts, lengths vs. age relationships, population structure, detection rates, and propagation.

Life History Strategy, Morphology, Host Fish, and Glochidia
Moore et al. (2021) confirmed that JSM's previously described life history strategy by Haag (2012) is "equilibrium," which are mussel species that "tend to have longer life spans, mature more slowly and have a moderate to large body size and (with some notable exceptions) lower fecundity."

Petty (2005) provided the following new information: (1) contrary to earlier observations that adults rarely have spines (Service 1990, Hove and Neves 1994), Petty reported that JSM adults in the Dan and Mayo Rivers (164 individuals) generally have spines, up to 8 spines in one individual; (2) no consistent differences were observed among JSM anatomy, fecundity, shell material morphology, and fish hosts (or fish host specificity) between the James and Roanoke River drainages; and (3) glochidia of Roanoke River populations were statistically significantly ($p<0.05$) longer than James River populations.

A North Carolina Wildlife Resources Commission (NCWRC) biologist reported that the vast majority of JSM found in the Dan River subbasin since 2015 do not have spines (M. Perkins, NCWRC, email to J. Stanhope, Service, May 20, 2022). Ostby, who has conducted many JSM surveys and studies, also reported that spines are rare (< 5 percent of JSM he has monitored) and are usually nubs (B. Ostby, DC, email to J. Stanhope, Service, May 30, 2022).

Hove (1990) identified the following seven host fish species based on laboratory experiments: bluehead chub (*Nocomis leptocephalus*), rosyside dace (*Clinostomus funduloides*), satinfin shiner (*Cyprinella analostana*), rosefin shiner (*Lythurus ardens*), central stoneroller (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), and mountain redbelly dace (*Phoxinus oreas*). NCWRC biologists identified two additional host fish species for JSM: white shiner (*Luxilus albeolus*) and crescent shiner (*Luxilus cerasinus*) (M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021). These host fish species are common in both the James River and Roanoke River basins and overlap with JSM range (M. Perkins, NCWRC, email to J. Stanhope, Service, and T. Russ, NCWRC, November 4, 2022; M. Pinder, VDWR, email to J. Stanhope, Service, and B. Watson, VDWR, November 4, 2022).

The recovery plan identified the following species to co-occur with JSM: creeper (*Strophitus undulatus*), notched rainbow (*Venustaconcha* [formerly *Villosa] constricta*), triangle floater (*Alasmidonta undulata*), yellow lance (*Elliptio lanceolata*), Atlantic pigtoe (*Fusconaia masoni*), green floater (*Lasmigona subviridis*), and eastern elliptio (*Ellptio complanata*). Additional mussel species identified to co-occur with JSM include: eastern floater (*Pyganodon cataracta*), Northern lance (*Elliptio fisheriana*), and yellow lampmussel (*Lampsilis cariosa*) (Virginia Department of Wildlife Resources [VDWR] 2020a, 2020b; M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021). Atlantic spike (*Elliptio producta*) and Carolina lance (*Elliptio angustata*) were also documented to co-occur with JSM surveys; however, with potential taxonomic changes related to the *Elliptio* complex, it is believed that these species may actually be northern lance and yellow lance (B, Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). Therefore, if Atlantic spike or Carolina lance are indicated to occur at a survey site, they may be northern lance or yellow lance.

Shell Length, Age, and Population Structure

Although shell lengths of JSM were not reported in the 1990 recovery plan, Petty (2005) indicated maximum length of approximately 70 to 74 millimeters (mm), which agrees with maximum length of 75 mm in Hove (1990). Larger JSM have been observed in Rocky Creek and Johns Creek in Virginia, with shell lengths up to 84 mm and 92 mm, respectively (Ostby 2015;B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022).). Ostby (2019a) evaluated the relationship of shell length vs. external growth rings of live and predated shells of JSM from Rocky Creek. The modeled relationship was somewhat similar to Hove (1990) but suggested "more rapid growth rate in Rocky Creek than observed by Hove (1990) in Dicks and Johns Creek (Craig County, VA) [figure 1]. It must be noted that the Hove (1990) dataset was based on internal annuli [i.e., thin-sectioning], whereas our charted relationships were based on external growth rings assumed to be annual."

The shell length-age relationship is not accurate for larger and older JSM because incremental growth rates decrease with age (Hove 1990). Brian Watson, VDWR state malacologist, indicated he is still observing tagged JSM from 2006 in Mill Creek during ongoing mark-recapture studies (B. Watson, VDWR, emails to J. Stanhope, Service, January 24, 2022 and June 24, 2022). The JSM that were tagged in 2006, with an approximate length of 50 mm and age of 8 to 9 years old, are likely 25 years old now, according to B. Watson. Based on these and other observations of JSM in the field, he estimated the typical lifespan for JSM is 15 to 20 years with a maximum age of at least 30 years. Thin-sectioning of JSM shells from Mill Creek and other sites will help to verify the average and maximum lifespan of JSM.

There are a few new studies with information about population structure. Petty (2005) observed size range of 16.9 to 66.8 mm for 98 JSM in South Fork Mayo River and estimated the age range to be 0 to 18 years, with mean age of about five years (mean length 38.1 mm) (age based on Hove 1990). For JSM in Rocky Creek, Ostby (2015) observed mean length was 47.7 mm (n=31, range: 14-84 mm) in 2011-2012 and 46.9 mm (n=50, range: 30-62 mm) in 2015; mean age would be about seven to eight years (age based on Hove 1990). For JSM collected in 2017, mean and range for lengths were not provided, but Ostby (2019a) indicated that the "[p]opulation structure for Rocky Creek *P. collina* has shifted slightly to larger and older individuals since 2011-2012…[and s]ampling in 2017 demonstrated continued recruitment in recent years."

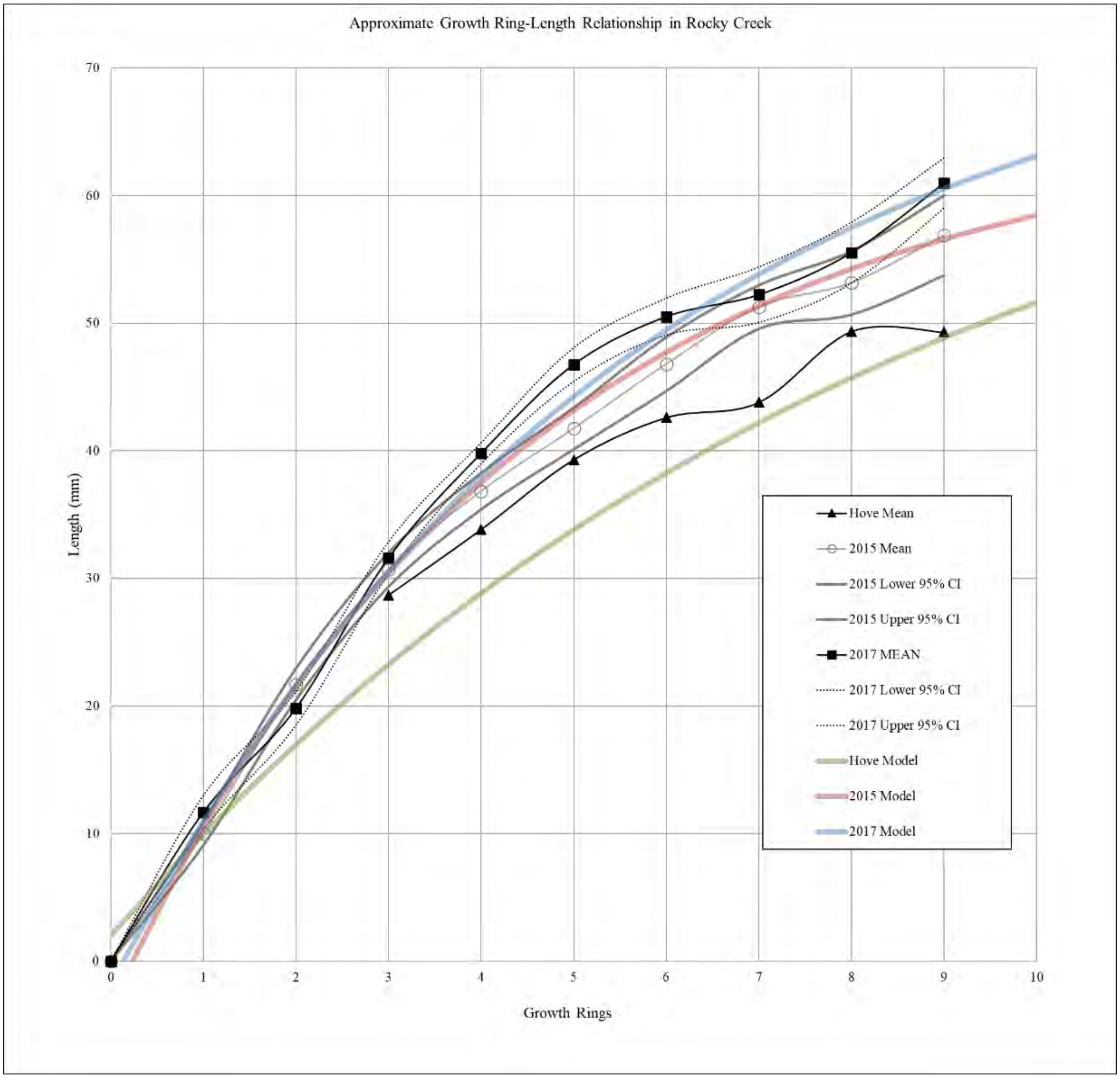

Figure 1. Shell length (mm) versus external growth ring (mean and 95-percent confidence intervals) for Rocky Creek JSM in 2015 and 2017 (figure from Ostby 2019a) Mean values and modeled von Bertalanffy growth values from Hove (1990) are included for reference; however, the modeled line (green) in this figure does not appear to match the modeled line in Hove (1990) and should be viewed with caution. In addition, Hove (1990) values are based on internal growth rings from Dicks and Johns Creek JSM in Craig County, VA.

Surveying and Detection Factors and Rates

As with many native freshwater mussels, JSM is difficult to detect during visual surveys because of its small size, color (tan to brown) being similar to stream substrates, and behavior of burying in the substrate. Numerous studies have examined factors that may affect detection (e.g., when mussels are at the surface, which increases the probability of detection during visual surveys) and measured detection probabilities. Key results are provided below:

- Ostby and Angermeier (2012) assumed that only 20 percent of JSM are at the surface and detectable during visual surveys based on previous work in the James River basin, when calculating probability of detecting JSM during semiquantitative surveys.
- Esposito (2015) found that a PIT tag reader could detect on average 76 percent of PIT-tagged mussels, including JSM, but only 7.5 percent of the mussels were visible at the surface during repeated surveys from July to October 2014 in Swift Run in Virginia. For JSM (n=21), the best-fitting logistic regression model predicted that the probability for visual detection (e.g., at the surface) was 0.14 in the summer and 0.02 in the fall. The author hypothesized that JSM are at the surface more during the summer months because it is breeding season.
- During quantitative sampling (using excavation sampling method) in Rocky Creek in Virginia in Spring 2012, 40 percent of all freshwater mussels found were observed at the surface, while in October 2015, only 3.2 percent of all freshwater mussels and no JSM were observed at the surface (Ostby and Angermeier 2012, Ostby 2015). Ostby (2015) also noted that mussels were found only when disturbing the surface layer of substrate in Rocky Creek during informal survey effort in 2014.
- Based on mark-recapture studies at multiple sites, detection rates of JSM for visual surveys were affected the most by season, with the lowest detection rates in October (survey months of April-October), as low as 0 percent in Johns Creek and 5 percent in Little Oregon Creek (Three Oaks Engineering [TOE] and Daguna Consulting [DC] 2016). Detection rates for JSM varied by site and date, as described below:
    - Little Oregon Creek: From August 3, 2010, to September 29, 2010, during six surveys, modeled mean detection rates ranged from approximately 7.5 to 30 percent and the lowest detection rate occurred when there was higher flow and surveyors used primarily viewscopes instead of direct visual detection.
    - For six sites (Dicks Creek, Mills Creek, Johns Creek, Little Oregon Creek, Craig Creek-Anderson Ford, Craig Creek-Carters Ford): From August 2010 to April 2013 during eight surveys, modeled mean detection rates range from approximately 2.5 to 34 percent, with the lowest detection rate occurring in October 2011 and October 2012 and the highest rate in April 2013. Estimated mean detection rates were approximately 11 to 17 percent in the other sampling months (August 2010, August 2011, April 2012, July 2012, August 2012).

    - Mill Creek: During three surveys in October 2012, July 2013, and September 2013, estimated mean detection rate for all dates was approximately 8 percent, and detection rate by event did not appear to be related to flow, weather, or temperature. In this same analysis, estimated mean detection rates for eastern elliptio and creeper (approximately 30 percent) were significantly greater than for JSM.
- In an updated analysis of detection rates for Mill Creek, based on the mark-recapture study from October 2012 to September 2016 during 14 surveys, the revised estimated mean detection rate for all dates was 28 percent and ranged from <0.1 to 60 percent, with the lowest rate observed in October 2012 and highest rate in April 2016 (B. Ostby, DC, email to J. Stanhope, Service, July 13, 2017).
- In a field study with JSM and notched rainbow in Swift Run in Virginia, Boisen (2016) observed a pattern of more mussels at the surface after higher stream flows than during lower flows; the author hypothesized that mussels may burrow during flooding events to avoid displacement but then resurface to feed after being suppressed. Patterns of surfacing were not related to water temperature.
- Ostby (2019a) indicated that JSM were easier to detect in Rocky Creek than in Swift Run, possibly due to higher density or greater mean particle size of streambed substrate in Rocky Creek. "Sand-dominated habits typical for occupied habitats of Swift Run also presented detection problems. Mussels may have buried deeply into these habitats. During quantitative sampling of site replicate S7, Ostby and Angermeier (2012) found that sampling units had no definable depth that demarcated suitable from unsuitable habitat. They stopped excavation [at] an arbitrary depth. A mussel could have burrowed deeper" (Ostby 2019b). However, in some cases, mussels may be easier to observe because of sand trails (Esposito 2015).
- In updated analyses of all datasets and sites in the 2010-2019 mark-recapture studies, Ostby (2022a) made the following conclusions regarding modeled detection rates:
    - positively related to JSM length (size), in which younger JSM are more difficult to find. For example, the modeled relationship estimates that a 60 mm (adult) is approximately 2.5 times more likely to be detected than a 10 mm juvenile (detection rates of approximately 20 percent and 7.5 percent, respectively);
    - weak or no significant relationships with stream flow, temperature, and weather;
    - lowest during surveys in late September and October; and
    - varied from 1 to 38 percent for individual survey dates for Dicks Creek, Johns Creek, and Little Oregon Creek, with mean monthly rates generally higher in April through August and average monthly detection rates across all months (April through October) of approximately 17, 14, and 14 percent for Dicks Creek, Johns Creek, and Little Oregon Creek, respectively (figure 2) (B. Ostby, DC, email to J. Stanhope, Service, April 22, 2022).

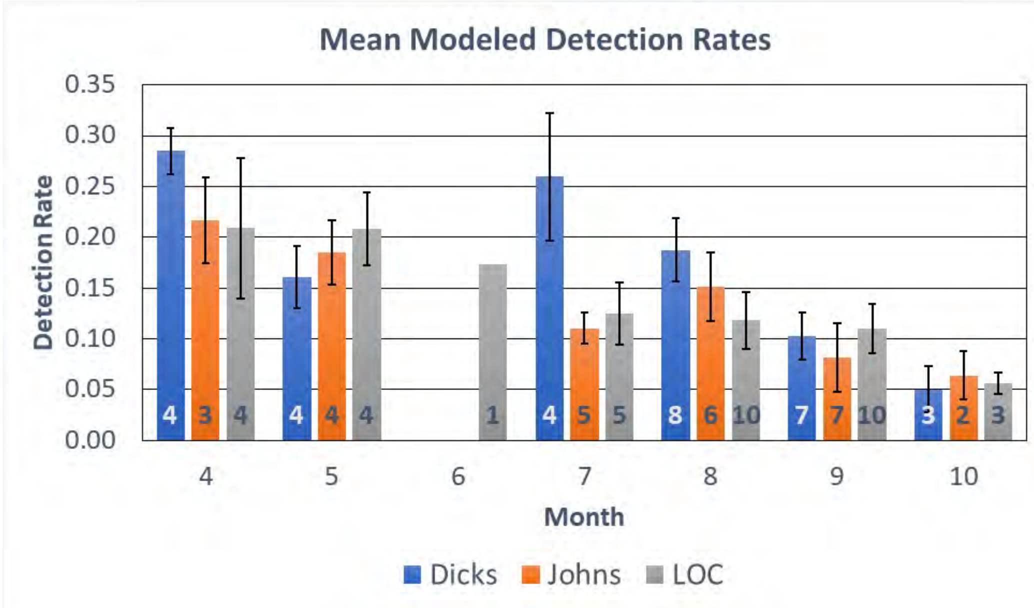

Figure 2. Mean modeled detection rate by site and month with standard error bars from 2010-2019 in Dicks Creek, Johns Creek, and Little Oregon Creek (LOC) (based on model results provided by B. Ostby, DC, email to J. Stanhope, April 22, 2022). Number in bar indicates number of surveys during that month.

Studies suggest that at some sites, JSM may not remain at a specific site or mussel bed and there is movement in and out of sites due to high streamflows, which will affect detection rates when revisiting a site. Ostby (2015) hypothesized a "source-sink metapopulation dynamic" for Swift Run because of the changes in occupancy of stream reaches throughout the survey area; JSM may be "detected in 'sink' habitats, where reproduction is insufficient to balance local mortality…[but are] being locally maintained by continued immigration from more productive 'sources' nearby (Pulliam, 1988)." Based on modeled results and observations from mark-recapture studies, there is movement of JSM into (immigration) and out of (emigration) sites at Mill Creek, Rock Island Creek, Craig Creek, and Swift Run (Verdream 2020, Ostby 2022a). At Swift Run, Verdream (2020) found that immigration and emigration were both significantly greater after flood events (≥ 3,500 cubic feet per second). At Rock Island Creek, Watson found tagged, propagated JSM in the lower site that were released at an upstream site, which likely moved downstream due to flood events (B, Watson, VDWR, email to J. Stanhope, Service, June 6, 2022).

The low detection rates for JSM during qualitative, visual surveys suggest caution when interpreting results of presence-absence surveys for the species, in particular in October.

Environmental DNA (eDNA) methods have been developed specifically for JSM based on primers targeting the genetic region surrounding the mitochondrial gene ND-1 (NADH dehydrogenase-1). At three sites with an estimated abundance of 10 to 20 JSM based on prior qualitative mussel surveys, the eDNA analysis was able to detect JSM DNA, with 17 to 33 percent of eDNA filters yielding positive detections (Dyer and Roderique 2017, Dyer et al. 2021). The methodology was unable to detect JSM DNA at two sites with estimated abundances of four to five JSM based on prior qualitative mussel surveys, suggesting the limited ability of the methodology to detect JSM eDNA when there are very low numbers of JSM. In addition, Polymerase Chain Reaction (PCR) inhibition from organic and/or inorganic compounds in the water samples was observed at four sites (Johns Creek, Dicks Creek, and Mill Creek, Little Oregon Creek), which reduced DNA amplification and detection (Dyer and Roderique 2017). For Little Oregon Creek, the study site with the highest density and abundance of JSM, PCR inhibition resulted in no detection of JSM DNA (i.e., false negative likely cause by samples that contained inhibitory compounds). Dyer et al. (2021) developed methods to reduce PCR inhibition to some degree but recommended that any negative eDNA result be tested for inhibition to identify potential false negatives. The eDNA methods are still being developed and evaluated and have not been used to determine presence or absence of JSM in subsection 2.3.1.2 “Abundance and populations” below.

Propagation technology for augmentation and reintroduction
Efforts to develop propagation techniques for JSM by the Service and VDWR have been successful, beginning in 2008 at the Service’s White Sulphur Springs National Fish Hatchery, then in 2015 at the Virginia Fisheries and Aquatic Wildlife Center (VFAWC). VFAWC is a cooperative mussel propagation facility managed by VDWR and the Service, located at the Service’s Harrison Lake National Fish Hatchery. Gravid females have been collected from multiple sites and propagated juveniles (two to three years old) released to augment JSM populations, as described below (B. Watson, VDWR, emails to J. Stanhope, December 10, 2021 and June 6, 2022):

- Mill Creek (Bath County, VA) source population: propagated JSM released to Mill Creek and Cowpasture River (Bath County, VA)
- Johns Creek (Craig County, VA) source population: propagated JSM released to Craig Creek (at Carters Ford, Botetourt County, VA) and Pedlar River (Amherst County, VA). Future releases are planned to the same two locations, Craig Creek (at Oriskany, Botetourt County, VA), and the James River (at Scottsville, Albemarle County, VA) in 2022.
- Rock Island Creek (Buckingham County, VA) source population: propagated JSM released to Rock Island Creek and Tye River (Nelson County, VA).
- Rocky Creek (Albemarle County, VA) source population: propagated JSM will be released to Rocky Creek in 2022.

NCWRC’s Conservation Aquaculture Center at Marion, NC also propagated JSM using broodstock from the Dan River in North Carolina in 2018 and 2019 (M. Perkins, NCWRC, emails to J. Stanhope, Service, November 13, 2020, March 2, 2021, and March 15, 2022; NCWRC 2019, 2020a, 2021). Four JSM adults, held in captivity for propagation since 2018, died in April to May 2019, and the remaining JSM were returned to the collection site soon after health screening.

Propagation efforts in 2019 were unsuccessful due to protozoan (*Vortecilla* sp.) and fungal outbreaks. Approximately 30 juvenile JSM from the 2018 propagation effort survived and were released to Mill Creek (NC) in 2021 to augment the population.

Genetic analysis of JSM has been ongoing and considered before release to sites (See section 2.3.1.3 for additional information); in addition, distance from the source population, isolation of the release sites (e.g., dams), and approximate abundance at the release site were considered.

Monitoring surveys at Mill Creek, Cowpasture River, and Rock Island Creek indicate that many of the released propagated juvenile JSM are found in years after release. At Mill Creek, the estimated annual survival rates of wild JSM (0.87-0.98) were similar to survival rates of propagated JSM (0.88-0.96) from 2014 to 2020 (Ostby 2022b).

<u>Summary of new information on the species' biology and life history</u>

Since 1990, new information on JSM's biology and life history clarified and provided additional details about its life history strategy, morphological features, reproduction including host fish species, and population structure at different sites, but overall, most information about the species is unchanged. The JSM may be more long-lived than originally expected, with the typical lifespan for JSM estimated at 15 to 20 years with a maximum age of at least 30 years. Thin-sectioning of JSM shells from Mill Creek and other sites will help to verify the average and maximum lifespan. Multiple studies confirmed the difficulty in detecting JSM, with estimated or modeled detection rates varying by site and month, as low as 0 percent and as high as 60 percent but frequently less than 20 percent; however, common patterns among the studies indicate that October has the lowest rates of detection and that smaller, juvenile JSM are more difficult to detect. These low detection rates for JSM during qualitative, visual surveys suggest caution when interpreting results of presence-absence surveys for the species, in particular when detection rates are low. Propagation technologies for JSM have been developed and proven successful based on initial monitoring surveys in several sites in Virginia.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

Abundance and populations

The following subsection provides a summary of new records for the JSM and negative surveys in rivers where the species occurred at the time the 1990 recovery plan was issued. The species has also been discovered in new rivers and drainages since the 1990 recovery plan, which is described below. *Unless noted as a shell, observations of JSM discussed below are of live individuals.* Table 1 provides a summary of the waterbodies where JSM has been documented and its population status in 1990, 2008, and 2021 and approximate abundance based on the last 20 years (2002-2021). This timeframe was chosen because the typical lifespan for JSM is estimated to be 15 to 20 years, as discussed in section 2.3.1.1 above. Appendix B provides a table of detailed information for each JSM occurrence waterbody.

The following terms were used to describe population/sub-population status in 2021:

- **Present**: Live JSM observed 2007 and later (less than 15 years ago);
- **Likely present:** JSM last observed 2002-2006 (approximately 15 to 20 years ago) and may still be present based on typical lifespan, but few surveys have been conducted to verify presence;
- **Unknown**: Most known JSM sites within the waterbody have not been surveyed in more than 20 years and limited survey effort overall in this river.
- **Possibly extirpated:** Last live JSM observed 30 to 50 years ago or only shell observed, but limited survey effort recently and/or throughout waterbody.
- **Historical/presumed extirpated:** Last live JSM observed more than 50 years ago; categorized as historical occurrence in the 1990 recovery plan (Service 1990).

Many of the mussel surveys were qualitative and conducted at a limited number of sites and/or on a limited number of dates; surveyors typically recorded the number of live individuals or dead shells observed at a location or reach and sometimes total time surveyed and number of surveyors (i.e., catch per unit effort [CPUE]). CPUE may be an indirect measure of abundance, but with varying detection rates for JSM as discussed above (see section 2.3.1.1), the varying types of survey data are not conducive for providing accurate abundance estimates. For some sites, quantitative or semiquantitative approaches to surveys were conducted (e.g., mark-recapture studies, quadrat sampling to estimate density, repeated surveys along multiple reaches), which allowed improved estimates of mussel abundance (e.g., range of estimated abundance based on the lower and upper 95 percent confidence intervals of modeled results or density estimates; range of number of JSM observed during repeated surveys). Thus, for waterbodies when survey data were predominantly qualitative, we used the cumulative record of the total number of live individuals observed within a waterbody to provide an approximate estimate of abundance; however, when estimates of abundance were available, we used those numbers for assigning the waterbody to the approximate abundance categories. The following are the criteria for the approximate abundance categories:

- **High**: High numbers (over 300) of live individuals observed cumulatively in past 20 years *or* estimated from repeated surveys, mark-recapture study, or other quantitative/semiquantitative approach;
- **Moderate**: Moderate numbers (101 to 300) of live individuals observed cumulatively in past 20 years *or* estimated from repeated surveys, mark-recapture study, or other quantitative/semiquantitative approach;

- **Low**: Low numbers (11 to 100) of live individuals observed cumulatively in past 20 years *or* estimated from repeated surveys, mark-recapture study, or other quantitative/semiquantitative approach;
- **Very Low**: Low numbers (1 to 10) of live individuals observed cumulatively in past 20 years *or* estimated from repeated surveys, mark-recapture study, or other quantitative/semiquantitative approach; and
- **None**: No live JSM observed in last 20 years.

Table 1. Summary of occurrence waterbodies of JSM and their population status, approximate abundance, and year live JSM was last observed and surveyed. Not reported=JSM was not discovered yet. See appendix B for additional information. Shaded rows indicate historical (i.e., presumed extirpated) or possibly extirpated status.

Basin/Sub-basin (HUC8)	Waterbody	Area/ Subpopulation[1]	County	State	Population Status in			Approximate Abundance[3]	Live JSM Last Observed	Last Surveyed
					1990 Recovery Plan[1]	2008 Draft 5-Year Review[2]	2021[3]			
James River basin										
Upper James	South Fork Potts Creek		Monroe	WV	Present	Present	Present	Low to high	2021	2021
Upper James	Potts Creek		Craig, Alleghany	VA	Present	Possibly extirpated	Possibly extirpated	None	1990	2006
Upper James	Cowpasture River		Bath, Alleghany	VA	Not reported	Present	Present	Low	2006 (wild); 2021 (propagated)	2017 (wild); 2021 (propagated)
Upper James	Bullpasture River		Highland	VA	Not reported	Present	Likely present	Very low	2006	2019
Upper James	Little Oregon Creek		Craig	VA	Not reported	Present	Present	High	2021	2021
Upper James	Dicks Creek		Craig	VA	Present	Present	Present	Moderate to high	2021	2021
Upper James	Johns Creek	Near Maggie	Craig	VA	Present	Present	Present	High	2021	2021
Upper James	Johns Creek	Along Sevenmile Mountain	Craig	VA	Present	Present	Present	Low	2007	2021
Upper James	Craig Creek	Near New Castle	Craig	VA	Present	Unknown	Possibly extirpated	None	1987	2012
Upper James	Craig Creek	Near Silent Dell	Botetourt	VA	Present	Present	Present	Low	2019	2019
Upper James	Craig Creek	Near Eagle Rock	Botetourt	VA	Present	Unknown	Unknown	None	1988	1999
Upper James	Patterson Creek		Botetourt	VA	Present	Possibly extirpated	Possibly extirpated	None	1988	2004
Upper James	Catawba Creek		Botetourt	VA	Present	Possibly extirpated	Possibly extirpated	None	1988	2007
Maury	Calfpasture River		Rockbridge	VA	Historical	Historical	Historical	None	1845	2017
Maury	Maury River		Rockbridge	VA	Historical	Historical	Historical	None	1845	2017
Maury	Mill Creek		Bath	VA	Historical	Present	Present	Moderate to high	2021	2021
Middle James-Buffalo	Pedlar River		Amherst	VA	Present	Present	Present	Low	2021	2021
Middle James-Buffalo	Hardware River		Fluvanna, Albemarle	VA	Not reported	Present	Present	Very low	2019	2021
Middle James-Buffalo	Rock Island Creek		Buckingham	VA	Not reported	Not reported	Present	Low	2021	2021
Middle James-Buffalo	Tye River		Nelson	VA	Not reported	Not reported	Present	Low	2019	2019
Middle James-Buffalo	Totier Creek (relic shells)		Albemarle	VA	Not reported	Not reported	Possibly extirpated	None	Unknown	2017

Basin/Sub-basin (HUC8)	Waterbody	Area/ Subpopulation[1]	County	State	Population Status in			Approximate Abundance[3]	Live JSM Last Observed	Last Surveyed
					1990 Recovery Plan[1]	2008 Draft 5-Year Review[2]	2021[3]			
Rivanna	Mechums River		Albemarle	VA	Present	Present	Present	Very low	2021	2021
Rivanna	Moormans River		Albemarle	VA	Present	Possibly extirpated	Possibly extirpated	None	1990	2005
Rivanna	Wards Creek (mis-identified as Rocky Run [Moormans River])		Albemarle	VA	Present	Present	Present	Low	2011	2017
Rivanna	Rocky Creek		Albemarle	VA	Not reported	Present	Present	Moderate to high	2021	2021
Rivanna	Buck Mountain Creek		Albemarle	VA	Not reported	Present	Present	Very low	2021	2021
Rivanna	Piney Creek		Albemarle	VA	Not reported	Present	Present	Very low	2012	2021
Rivanna	Ivy Creek		Albemarle	VA	Not reported	Present	Present	Very low	2011	2012
Rivanna	NF Rivanna River		Albemarle	VA	Not reported	Present	Present	Very low	2015	2015
Rivanna	Swift Run		Albemarle, Greene	VA	Not reported	Present	Present	Low	2019	2019
Rivanna	Unnamed tributary to Swift Run				Not reported	Not reported	Present	Very low	2017	2019
Rivanna	Welsh Run		Greene	VA	Not reported	Present	Likely present	Very low	2005	2019
Rivanna	Rivanna River	Near Columbia, Palmyra, and Crofton	Fluvanna	VA	Historical	Historical	Historical	None	1968	2011
Rivanna	Mechunk Creek (relict shell)		Fluvanna	VA	Not reported	Not reported	Possibly extirpated	None	Unknown	2007
Upper James	James River	at Buchanan	Botetourt	VA	Historical	Historical	Historical	None	pre-1967	2021
Upper James		near Natural Bridge	Rockbridge	VA	Historical	Historical	Historical	None	pre-1967	2005
Middle James-Buffalo		at New Canton	Buckingham, Fluvanna	VA	Historical	Historical	Historical	None	1966	2018
Middle James-Willis		at Columbia	Fluvanna, Cumberland	VA	Historical	Historical	Historical	None	1966	2012
Middle James-Willis		at Pemberton and Cartersville	Goochland, Cumberland	VA	Historical	Historical	Historical	None	1966	2012
Middle James-Willis		at Rock Castle	Goochland, Powhatan	VA	Historical	Historical	Historical	None	1966	2013
Middle James-Willis		opposite Maidens	Goochland, Powhatan	VA	Historical	Historical	Historical	None	1966	2012
Middle James-Willis		at Maidens	Goochland, Powhatan	VA	Historical	Historical	Historical	None	1966	2012

Basin/Sub-basin (HUC8)	Waterbody	Area/ Subpopulation[1]	County	State	Population Status in			Approximate Abundance[3]	Live JSM Last Observed	Last Surveyed
					1990 Recovery Plan[1]	2008 Draft 5-Year Review[2]	2021[3]			
Roanoke River basin										
Upper Dan	Dan River		Stokes, Rockingham	NC	Not reported	Present	Present	Moderate	2019	2019
Upper Dan	Big Creek (shell)		Stokes	NC	Not reported	Present	Possibly extirpated	None	Unknown	2019
Upper Dan	Mill Creek		Stokes	NC	Not reported	Not reported	Present	Very low	2018	2019
Upper Dan	South Fork Mayo River		Patrick, Henry (VA); Rockingham (NC)	VA, NC	Not reported	Present	Present	Moderate	2012	2016
Upper Dan	Mayo River		Rockingham	NC	Not reported	Present	Present	Low	2016	2019

[1] From 1990 recovery plan (Service 1990), Table 1, Historic and Present occurrences of the James spinymussel in 1990.
[2] From 2008 draft 5-year review for James spinymussel (Service 2008), appendix 1, Present occurrence rivers of the James spinymussel in 2008
[3] See definitions for status and approximate abundance above.

James River major drainage basin

Upper James subbasin (VA; HUC8 02080201)

South Fork Potts Creek (Monroe County, WV) – Six surveys have been conducted over the past 30 years (approximately once every five to six years) by various agencies, including the Service and West Virginia Division of Natural Resources (WVDNR). There are six survey reaches of various lengths (265 to 1,800 meters [m]) along an approximately 7-km stretch of South Fork Potts Creek (Everhart and Clayton 2016). Table 2 provides a summary of survey efforts and results since 1983.

Table 2. Summary of surveys conducted in South Fork Potts Creek (based on Table 1 in Eliason and Everhart 2021)

Survey Year	Total Number of Live JSM Collected	Number of Reaches Surveyed	Number of Reaches with JSM	Percent of JSM Located in One Reach	Report Authors (as cited *in* Eliason and Everhart 2021)
1983-1984	present (number not provided)	2	2	n/a	Zeto and Schmidt 1984
1987-1989	168	not provided	not provided	n/a	Hove and Neves 1994
1995	82	5	3	89.0	Ensign and Neves 1995
2000	62	4	3	85.5	Ensign and Neves 2000
2006	339	5	2	97.3	Kane et al. 2006
2011	31	6	2	54.8	Smith and Kane 2013
2016	80	5	3	88.8	Everhart and Clayton 2016
2021	85	6	2	98.8	Eliason and Everhart 2021

One reach was not surveyed in 1996, 2006, and 2016 because of access issues, but when access was granted, 14 JSM were observed in 2011 and none in 2021. Another stream reach was not surveyed in 2000 because it was determined to be unsuitable mussel habitat and no JSM have been found when this stream reach was surveyed in other years (Eliason and Everhart 2021). Most of the JSM occurrences have been documented in a single reach (1.4 km), representing 54.8 to 98.8 percent of observations. Within this reach, some recruitment likely occurred in the five years prior to 2021 based on six JSM measuring approximately 35 to 40 mm in length (based on length vs. age relationship in

Hove 1990); the average length was 52.45 mm for 84 JSM (Eliason and Everhart 2021). In summary, the survey results suggest a stable, but highly variable population located primarily in one reach and in up to three reaches total, and that recruitment is likely occurring.

Potts Creek (Craig and Alleghany Counties, VA) – No JSM have been found in Potts Creek during surveys since the 1990 recovery plan (McGregor and Baisden 2002, Petty and Neves 2006, VDWR 2020a). The last known survey for JSM in Potts Creek in Craig and Alleghany Counties, VA, was conducted by Petty and Neves (2006) in 2006, which was a qualitative and intensive effort over 25 km (25 sites of approximately 1,000 m length) and no JSM were found; other native freshwater mussels were observed, including notched rainbow and creeper. A site in Potts Creek in Monroe County, WV (not previously known for JSM), was surveyed in 2021, downstream of the confluence of the North and South Fork Potts Creek, but no JSM were found (Eliason and Everhart 2021). In summary, JSM is possibly extirpated in this creek and has not been observed since 1990, but this is not confirmed because there has been limited survey effort in the Potts Creek since 2006 (VDWR 2020a).

Cowpasture River (Bath and Alleghany Counties, VA) – The Cowpasture River is a new occurrence river for JSM[3] since the 1990 recovery plan. One JSM was found each in 2002 and 2003 within 0.5 km of each other in Bath County, VA by a Service biologist (VDWR 2020a, b). In 2004, two JSM were found approximate 1.3 km upstream from the previous occurrences. In 2006, the JSM's documented range in the river was extended 42 km downstream into Alleghany County with one JSM found; however, this occurrence is the last time the species was observed in this river (VDWR 2020a, b). Survey effort in Cowpasture River is limited, where surveys at seven other sites of the Cowpasture River (Bath and Alleghany Counties, VA) by VWDR and permittees in 1993, 2000, 2001, 2008, 2009, 2010, and 2017 found no JSM but other native freshwater mussels (e.g., notched rainbow, creeper, eastern elliptio, triangle floater, Carolina lance, Atlantic spike) (Petty et al. 2008, Environmental Solutions & Innovations, Inc. [ESI] 2017, VDWR 2020a). There is no information available indicating if the known JSM sites have been resurveyed. Fish kills were reported in the Cowpasture River from 2007-2010, but the cause of the mortality/disease events were not determined (https://dwr.virginia.gov/fishing/fish-kill/; accessed March 28, 2022).

In 2018, 278 propagated JSM (from Mill Creek [Bath County, VA] broodstock) were released in the Cowpasture River on U.S. Forest Service (USFS) land (Bath County, VA), between the documented occurrences in Bath and Alleghany Counties. Monitoring found 61 JSM in 2019 before the pit tag reader stopped working and 111 JSM in 2021. An additional 35 propagated JSM were released in 2021 (B. Watson, VDWR, email to J. Stanhope, Service, June 24, 2022). In summary, for the wild Cowpasture River population, there is insufficient data to evaluate stability, recruitment, and approximate abundance. Propagation efforts

[3] Hereafter, a "new occurrence river for JSM" refers to being discovered since the recovery plan was issued in 1990.

have created a low- to moderate-sized population in one area that is surrounded by protected USFS land, and future monitoring will evaluate its success in being established.

Bullpasture River (Highland County, VA) – The Bullpasture River is a new occurrence river for JSM. In 2006, five adult JSM were discovered in two sites of the Bullpasture River, approximately 0.9 km apart (VDWR 2020a, b). A relict shell was also found approximately 1.4 km downstream and 9.5 km upstream of the JSM occurrences. Survey effort appears to be very limited in this river since 2006, with only one of the two sites with JSM resurveyed in 2019; VDWR did not find JSM but did observe a few notched rainbows (B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). Surveys at two sites of the upper Bullpasture River (>8.5 km upstream of known JSM site) did not find any freshwater mussels in 2000 and 2001 (McGregor and Baisden 2002). A survey at one site in 2008 by VDWR did not find JSM but did observe creeper (VDWR 2020a). In summary, JSM is likely present in Bullpasture River, but there is insufficient data to evaluate status, stability, recruitment, and approximate abundance of the population due to lack of survey effort.

Little Oregon Creek (Craig County, VA) – The Little Oregon Creek, a tributary to Dicks Creek, is a new occurrence river for JSM. Gatenby and Neves (1994) discovered seven JSM in the Little Oregon Creek prior to its confluence with Dicks Creek. Multiple surveys since 1994 have documented most of the species in a 0.2-km reach of Little Oregon Creek (VDWR 2020a, b). Within this area, a 100-m reach is part of an ongoing mark-recapture study since 2010; this mark-recapture site in Little Oregon Creek and the mark-recapture sites in Dicks Creek, Johns Creek, Rock Island Creek, and Mill Creek, were selected because they are "population centers [for JSM] having disproportionately greater density than found elsewhere in the James River basin" (B. Ostby, DC, email to J. Stanhope, Service, December 3, 2021). Based on the mark-recapture study, modeled abundance estimates were highly dynamic and as high as 2,003 JSM in 2016 but declined to 646 JSM in 2018 and 771 JSM in 2019 (table 3) (Ostby 2022a). This significant decline was likely due to high rates of raccoon predation observed in 2015 and 2016, impacting JSM originally tagged in 2010 and 2011, based on a large number of fresh dead shells with claw and teeth marks found during surveys. Low to moderate rates of raccoon predation were also observed in 2013, 2017, and 2018 (Ostby 2022a). The modeled survival rates were also explained by raccoon predation. Anecdotal observations and analysis of 2019 data suggest that the JSM population may be recovering and stable. More than 10 years of mark-recapture surveys have been completed at Little Oregon Creek as of 2021, and data analysis is in progress and will provide more information on recovery and stability of the site.

Table 3. James spinymussel mark-recapture study analyses in Virginia from Ostby (2022a, 2022b) and TOE and DC (2019). Abundance (N) point estimates and 95 percent confidence intervals (CI) for wild and propagated JSM in reaches surveyed, based on Robust Design Huggins Models.

Waterbody	Year	Wild N	CI Lower	CI Upper	Propagated N	CI Lower	CI Upper
Little Oregon Creek [1]	2010	1769	1696	1855	n/a	n/a	n/a
	2011	1785	1611	1992	n/a	n/a	n/a
	2012	1616	1477	1779	n/a	n/a	n/a
	2013	2003	1866	2163	n/a	n/a	n/a
	2014	1691	1483	1944	n/a	n/a	n/a
	2015	1613	1468	1785	n/a	n/a	n/a
	2016	1537	1161	2058	n/a	n/a	n/a
	2017	833	692	1022	n/a	n/a	n/a
	2018	646	469	911	n/a	n/a	n/a
	2019	771	701	860	n/a	n/a	n/a
Dicks Creek [1]	2011	197	122	350	n/a	n/a	n/a
	2012	302	274	343	n/a	n/a	n/a
	2013	440	394	500	n/a	n/a	n/a
	2014	446	355	573	n/a	n/a	n/a
	2015	544	496	605	n/a	n/a	n/a
	2016	445	368	550	n/a	n/a	n/a
	2017	416	333	533	n/a	n/a	n/a
	2018	432	309	618	n/a	n/a	n/a
	2019	373	329	434	n/a	n/a	n/a
Johns Creek [1]	2012	398	287	593	n/a	n/a	n/a
	2013	911	793	1064	n/a	n/a	n/a
	2014	1009	849	1218	n/a	n/a	n/a
	2015	1043	878	1255	n/a	n/a	n/a
	2016	685	592	806	n/a	n/a	n/a
	2017	694	548	895	n/a	n/a	n/a
	2018	791	570	1119	n/a	n/a	n/a
	2019	758	672	870	n/a	n/a	n/a
Craig Creek - Anderson Ford [2]	2012	2	2	5	n/a	n/a	n/a
	2013	2	2	5	n/a	n/a	n/a
	2014	2	1	10	n/a	n/a	n/a
	2015	0	0	1	n/a	n/a	n/a
	2016	4	2	11	n/a	n/a	n/a
	2017	0	0	1	n/a	n/a	n/a
	2018	0	0	1	n/a	n/a	n/a
Craig Creek - Carters Ford [2]	2012	3	3	6	n/a	n/a	n/a
	2013	3	3	6	n/a	n/a	n/a
	2014	6	3	18	n/a	n/a	n/a
	2015	1	1	3	n/a	n/a	n/a
	2016	5	3	14	n/a	n/a	n/a
	2017	4	4	7	n/a	n/a	n/a
	2018	3	2	10	n/a	n/a	n/a
Mill Creek [1,3]	2012	65	65	65	n/a	n/a	n/a
	2013	161	100	439	n/a	n/a	n/a
	2014	208	196	238	138	115	223
	2015	105	101	118	99	69	205
	2016	155	148	174	132	101	248
	2017	152	143	193	183	138	303
	2018	214	197	274	309	250	430
	2019	168	167	204	209	199	484
	2020	122	116	167	117	112	159
	2021	171	171	171	197	197	197
Rock Island Creek Reach 1 [2]	2013	54	38	90	n/a	n/a	n/a
	2014	47	44	55	n/a	n/a	n/a
	2015	53	44	71	n/a	n/a	n/a
	2016	46	35	68	n/a	n/a	n/a
	2017	40	32	56	n/a	n/a	n/a
	2018	58	43	88	n/a	n/a	n/a
Rock Island Creek Reach 2 [2,4]	2013	83	59	131	n/a	n/a	n/a
	2014	109	103	121	n/a	n/a	n/a
	2015	105	89	131	n/a	n/a	n/a
	2016	132	107	174	n/a	n/a	n/a

Waterbody	Year	Wild N	CI Lower	CI Upper	Propagated N	CI Lower	CI Upper
	2017	81	67	104	n/a	n/a	n/a
	2018	88	67	129	n/a	n/a	n/a

[1] Ostby 2022a and 2002b
[2] TOE and DC 2019
[3] 2012 estimate for Mill Creek is likely an overly conservative underestimate and violated model assumptions because no recaptures were made over 2 sampling events the first year of sampling (B. Ostby, DC, email to J. Stanhope, Service, January 5, 2022).
[4] This reach is no longer suitable due to high flows from Hurricane Florence and/or Michael in 2018 significantly degrading the instream habitat

In 2016, a large number of juvenile JSM (approximately 20 mm long) were observed during a mark-recapture survey, indicating reproduction had likely occurred within the previous two years (based on length vs. age relationship; Hove 1990).

Prior to the high predation years, Little Oregon Creek had the highest documented density and abundance of JSM of all populations. It is thought that a small impoundment and predominantly forested watershed upstream of the population provide habitat stability (e.g., thermal and stream flow), good water quality, and high primary production for feeding (TOE and DC 2016). In addition, the invasive Asian clam (*Corbicula fluminea*) was detected in Little Oregon Creek in the mid-2010s and increased to high density in the late 2010s, potentially competing for resources with JSM; however, effects from the Asian clam have not been assessed (B. Watson, VDWR, email to J. Stanhope Service, January 24, 2022; see section 2.3.2.5 for additional information about the Asian clam). In summary, the JSM population appears to have declined due to the high raccoon predation but is potentially recovering; analyses of monitoring data collected since 2019 will be informative in assessing its ability to recover from the predation and coexist with the Asian clam.

Dicks Creek (Craig County, VA) – The JSM occurrence in Dicks Creek (a tributary to Johns Creek) noted in the 1990 recovery plan was reconfirmed by Gatenby and Neves (1994) with a find of three JSM. Multiple surveys since 1994 have documented most of the species in a 1-km reach of Dicks Creek (VDWR 2020a, b). This area is part of an ongoing mark-recapture study since 2010 and modeled abundance estimates were highly dynamic and as high as 544 JSM in 2015 and as low as 197 in 2011; however, the confidence intervals indicate that these estimates over 9 years are generally not significantly different (table 3) (Ostby 2022a). Juvenile JSM (less than 30 mm) were detected in 2019. There is an impoundment upstream of the JSM occurrences that may be beneficial to this population, similar to the impoundment in Little Oregon Creek. The JSM population appears stable with large variation and has evidence of recruitment. Ten years of mark-recapture surveys have been completed at Dicks Creek as of 2021, and data analysis is in progress.

Johns Creek (Craig County, VA) – In Johns Creek, a tributary to Craig Creek**,** JSM were noted as present in the 1990 recovery plan in two areas or subpopulations: (1) near Maggie, VA and (2) along Sevenmile Mountain (i.e., downstream of Maggie, VA to the confluence with Craig Creek).

Near Maggie, VA: Multiple surveys since 1999 have documented JSM at 10 sites in Johns Creek from Maggie to approximately 8.3 km upstream of its confluence with Dicks Creek, with observations of 3 to 83 JSM at a site (VDWR 2020b, Orcutt 2021). One site, a 100-m reach, is part of an ongoing mark-recapture study since 2012, and modeled abundance estimates were as high as 1,043 JSM in 2015 and as low as 398 JSM in 2012; the most recent estimated abundance was 758 JSM in 2019 (Ostby 2022a). High raccoon predation rates on JSM have been observed in this reach in different years, affecting this subpopulation; most recently in 2020, 250 JSM shells with signs of predation were found during three survey events (B. Watson, VDWR, email to J. Stanhope, Service, September 16, 2020). There is an impoundment upstream of the JSM occurrences that may be beneficial to this subpopulation, similar to the impoundment in Little Oregon Creek. This site is used as a source of broodstock for propagation and as an augmentation site for the resulting propagated, juvenile JSM. In Giles County, VA, there was a documented occurrence upstream of the impoundment in 1984 (22 live JSM and one shell); however, when revisited in 2019, no JSM were observed ((Virginia Department of Conservation and Recreation-Division of Natural Heritage [VDCR-DNH] 2021). This subpopulation in Johns Creek (near and upstream of Maggie) appears stable with large variation in JSM numbers and has evidence of recruitment. Ten years of mark-recapture surveys have been completed as of 2021, and data analysis is in progress.

Along Sevenmile Mountain: For the subpopulation in Johns Creek downstream of Maggie along Sevenmile Mountain to the confluence Craig Creek, surveys found two JSM at one site in 2001 and 12 JSM at another site in 2007; the two sites are approximately 4.8 km apart (VDWR 2020b). One shell was also found each in 2004 and 2021 at sites 0.9 km and 1.7 km downstream of the 2007 site, respectively (VDWR 2020b, Orcutt 2021). Survey effort in Johns Creek downstream of Maggie is limited (within the 11-km reach downstream of Maggie), where surveys at nine additional sites by VWDR, VDCR-DNH and permittees in 1999, 2000, 2004, 2007, 2010, and 2019 found no JSM, but found other native freshwater mussels (e.g., notched rainbow, creeper, eastern elliptio, triangle floater, Atlantic spike, yellow lance, Atlantic pigtoe) (VDWR 2020a). From 2019 to 2021, the number of sites surveyed along this portion of Johns Creek increased when VDCR-DNH surveyed 10 reaches (some overlap with previously surveyed sites; 450-m long reaches) and found no JSM (except the one shell as noted above) but found other native freshwater mussels (Orcutt 2021).

For the remainder of Johns Creek (approximately 32.2 km to the confluence with Craig Creek) and since 1990, we are aware of seven sites surveyed. For one of these sites, six JSM were previously documented in 1989, and the site was resurveyed in 1991, 1999, 2001, and 2019, finding other native freshwater mussels, but not JSM (VDWR 2020a, b; VDCR-DNH 2021; Orcutt 2021); this specific site may be extirpated. For a second site, no JSM or other native freshwater mussel were found during surveys in 2010 and 2014. From 2019 to 2021, VDCR-DNH surveyed six reaches along this portion of Johns Creek (including the 1989 site, as described above) and found no JSM but found other native freshwater mussels (e.g., eastern elliptio, notched rainbow) (Orcutt 2021). Orcutt (2021) noted that large portions of Johns Creek remain unsurveyed.

In summary, this subpopulation of Johns Creek appears to have low abundance, but there is insufficient data to evaluate stability and recruitment.

Craig Creek (Craig and Botetourt Counties, VA) – In Craig Creek, a tributary to the James River**,** JSM were noted as present in the 1990 recovery plan in three areas or subpopulations: (1) near New Castle (Craig County, VA), (2) near Silent Dell (Botetourt County, VA), and (3) near Eagle Rock (Botetourt County, VA).

Near New Castle (Craig County, VA): For this subpopulation prior to the 1990 recovery plan, JSM was documented at one site approximately 23.3 km upstream of New Castle (one JSM in 1987) and at two sites approximately 3.9 km and 10.4 km downstream of New Castle (respectively, 11 and 2 JSM in 1984 and 1987). Since 1990, surveys at six sites as far as 28.8 km upstream of New Castle found no JSM (1991 and 1999) and did not appear to revisit the previous site with JSM; surveys at four of the six sites did find other native freshwater mussels (e.g., creeper, notched rainbow, and eastern elliptio). Downstream of New Castle in Craig County, a survey at one site in 1999 found one shell of JSM (approximately 5.2 km downstream from the 1987 JSM occurrence) and a resurvey of a JSM site in 1999 found no JSM but found other native freshwater mussels (e.g., eastern elliptio and notched rainbow). Surveys at two additional sites further downstream on Craig Creek (one site in 1999 and the other site in 1992 and 2012) found no JSM, but other native freshwater mussels were found (e.g., notched rainbow and Atlantic pigtoe). In summary, JSM is possibly extirpated in this subpopulation of Craig Creek, and a live JSM has not been observed since 1987, but it is not confirmed because there has been limited survey effort since 2012 with most surveys conducted in 1999 (VDWR 2020a).

Near Silent Dell (Botetourt County, VA): Near Silent Dell was listed in the recovery plan as a JSM occurrence location in Craig Creek from 1984. There were also two JSM sites from 1987 approximately 15 km and 16 km upstream (near Oriskany) in the same county (VDWR 2020b). Since then, surveys have found JSM in four reaches within an approximately 17.6-km section of Craig Creek in Botetourt County and confirmed the presence of JSM at or near the three sites identified before 1990. JSM occurrences for these four reaches are described below.

In a 1.4-km reach of Craig Creek west and southwest of Oriskany, JSM have been observed at five sites from 2003 to 2019, where one to three JSM were found (VDWR 2020a, b). A 0.5-km reach within this area, which includes a ford crossing maintained by VDOT (Reid’s Ford), was monitored annually from 2006 to 2017 as part of biological opinion (BO) requirements, and only one JSM was documented in 2012, but other native freshwater mussels were observed (e.g., Atlantic pigtoe, northern lance [*Elliptio fisheriana*], notched rainbow, eastern elliptio) (Wolf 2019). One JSM site near Oriskany was impacted by a debris jam that built up behind a sycamore tree, which had fallen into the creek in 2019 or 2020, likely due to high storm flow or flooding events eroding the streambank (B. Watson, VDWR, email to J. Stanhope, Service, April 6, 2022). The USFS in coordination with VDWR removed the tree and debris jam in April 2022. VDWR revisited the site and found that habitat was slightly altered but somewhat similar to conditions prior to the debris jam (B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022).

In a 0.5-km reach southeast of Oriskany, JSM have been observed from 2006 to 2016, where one to three JSM were found (VDWR 2020a, b). One site (<0.1-km reach) was part of the mark-recapture study from 2012 to 2018 (Craig Creek - Anderson Ford) and was a mussel bed upstream of a ford crossing of the creek. The modeled abundance estimates were variable, from zero to four JSM, but zero JSM recently in 2018 (table 3) (TOE and DC 2019). This 0.5-km reach was monitored annually from 2006 to 2017 as part of BO requirements discussed above. After the mark-recapture study was initiated, only the downstream portion (0.4 km) was monitored, and no JSM were found from 2012 to 2017, but other native freshwater mussels were observed (e.g., northern lance, notched rainbow) (Wolf 2019).

In a 0.5-km reach, approximately 9 km downstream of the reach described above, JSM have been observed from 2000 to 2018, where one to three JSM were found (VDWR 2020a, b). One site in this reach (<0.1-km reach), a mussel bed downstream of a ford crossing of the creek, was part of the mark-recapture study from 2012 to 2018 (Craig Creek - Carter Ford). The modeled abundance estimates were variable, from one to six JSM (table 3) (TOE and DC 2019). This 0.5-km reach was monitored annually from 2006 to 2017 as part of BO requirements discussed above. After the mark-recapture study was initiated, a portion (0.4 km) was monitored, and no JSM were found from 2012 to 2017, but other native freshwater mussels were observed (e.g., Atlantic pigtoe, northern lance, notched rainbow, creeper) (Wolf 2019). In October 2021, 274 propagated, juvenile JSM were released at the mark-recapture site (B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). Without information about the success of the release, the number of propagated JSM was not included in the assessment of approximate abundance.

In a 0.7-km reach, near Silent Dell, JSM have been observed from 1999 to 2012, where one to three JSM were found (VDWR 2020a, b). A 0.5-km reach within this area was monitored annually from 2006 to 2017 as part of BO requirements discussed above (Hannah’s Ford), and no JSM were documented 2013 to 2017, but other native freshwater mussels were observed (e.g., northern lance, notched rainbow, creeper, triangle floater, eastern elliptio) (Wolf 2019).

In summary, the subpopulation appears to have patchy distribution and low abundance and may be decreasing based on the lack of JSM observed during recent annual surveys. There is insufficient data to evaluate stability and recruitment.

Near Eagle Rock (Botetourt County, VA): No live JSM have been found in this subpopulation of Craig Creek since the 1990 recovery plan was completed (last observed in 1988); however, there appears to be limited survey effort in this area (VDWR 2020a, b; VDCR-DNH 2021). One survey in 1999 at a known JSM site did not observe any JSM but found eastern elliptio (VDWR 2020a). A site approximately 8.4 km upstream (i.e., not previously known for JSM) was surveyed in 1995, and two shells of JSM were found (VDCR-DNH 2021). With most known sites with JSM not being surveyed in more than 20 years and limited survey effort, the status of this JSM subpopulation in Craig Creek is unknown.

Patterson Creek (Botetourt County, VA) – No JSM have been found in Patterson Creek, a tributary to Craig Creek, since the 1990 recovery plan was completed. Surveys at four sites in Patterson Creek by VDWR and permittees in 1992, 2000, and 2004 found no JSM and no other native freshwater mussels (O'Connell and Neves 1992, McGregor and Baisden 2002, Johnson and Neves 2004a, VDWR 2020a). The 2004 survey appears to be near the previously documented JSM site, and surveyors observed suitable mussel habitat, but found only relict shells of notched rainbow. Due to live individuals not being observed since 1988 (VDWR 2020b, VDCR-DNH 2021), JSM appears extirpated in this creek, but it is not confirmed because survey effort has been limited throughout Patterson Creek.

Catawba Creek (Botetourt County, VA) – No live JSM have been found in Catawba Creek, a tributary to Craig Creek, since the 1990 recovery plan was completed. Surveys at three sites in 1999 and 2007, including a previously documented JSM site, found shells of JSM (VDWR 2020b, VDCR-DNH 2021). Surveys at four sites in 1991, 2004, and 2007 found no JSM, but other native freshwater mussels were found (e.g., notched rainbow, eastern elliptio, many relict shells of notched rainbow and eastern elliptio), and surveys at two sites in 1999 found no native freshwater mussels (Johnson and Neves 2004a, VDWR 2020a). In 2006, surveys for mussels following a diesel spill in Catawba Creek, yielded no JSM. Surveys at three other sites in Catawba Creek by VDWR and permittees in 1991, 2000, and 2004 found no JSM and no other native freshwater mussel (VDWR 2020a). Due to live individuals not being observed since 1988 (VDWR 2020b, VDCR-DNH 2021), JSM appears extirpated in this creek, but it is not confirmed because survey effort has been limited throughout Catawba Creek.

Maury sub-basin (VA; HUC8 02080202)

Calfpasture River (Rockbridge County, VA) – JSM was listed as a historical occurrence in the Calfpasture River in Rockbridge County in the 1990 recovery plan. Surveys at two sites of the Calfpasture River (Rockbridge and Augusta Counties, VA) by VWDR and permittees in 1996, 2001, and 2005 found no JSM, but found other native freshwater mussels (e.g., notched rainbow, creeper, eastern elliptio, triangle floater) (McGregor and Baisden 2002, VDWR 2020a). Surveys at three sites of the upper Calfpasture River (Augusta County, VA) did not find any freshwater mussels in 2016 and 2017 (ESI 2016, 2017). In summary, JSM appears extirpated in this river and has not been observed since 1845 (VDCR-DNH 2021), but it is not confirmed because survey effort has been limited throughout the Calfpasture River.

Maury River (Rockbridge County, VA) – JSM was listed as a historical occurrence in the Maury River in the 1990 recovery plan. Surveys of four sites in the Maury River in 2001 by McGregor and Baisden (2002) found no JSM but found other native freshwater mussels (e.g., notched rainbow, eastern elliptio, northern lance) (VDWR 2020a). VDWR surveyed downstream and upstream of the Jordan Point Dam in 2017 prior to its removal and found no JSM but did find other native freshwater mussels (e.g., northern lance) (B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). JSM appears extirpated in this river and has not been observed since 1845, but it is not confirmed because survey effort has been limited throughout the Maury River.

Mill Creek (Bath County, VA) – JSM was listed as historical in the 1990 recovery plan but multiple surveys since 1996 have documented the species in three sites/reaches of Mill Creek with most observations occurring within a 1.3-km reach (VDWR 2020a, VDCR-DNH 2021). Within this area, a 155-m reach is part of an ongoing mark-recapture study since 2012, and modeled abundance estimates in 2021 were 171 JSM, with some fluctuations over the years (65-214 JSM) (table 3) (Ostby 2022b). This area is also a source for propagation broodstock since 2011 and an augmentation site for the 532 propagated juvenile JSM in 2013, with modeled abundance estimates of 99 to 309 JSM (see section 2.3.1.1 for information about propagation efforts). Based on the abundance estimates, estimated high survival rates (0.87 to 0.95), and observations of wild juvenile JSM (VDWR 2020b), the wild JSM population appears stable with some variation and evidence of recruitment. With augmentation, the JSM population is increasing overall. Ten years of mark-recapture surveys have been completed as of 2021.

Middle James-Buffalo sub-basin (VA; HUC8 02080203)

Pedlar River (Amherst County, VA) – Multiple surveys since the 1990 recovery plan was completed have confirmed the occurrence of JSM in the Pedlar River, a tributary to the James River, at more than 13 sites from 1992 to 2021 (i.e., 1992, 1999, 2000, 2004, 2005, 2009, 2011, 2016, 2017, 2018, 2019, 2020, 2021) within an approximately 11.6-km section of the Pedlar River (from about 4.6 km upstream of the confluence with the James River to about 8.8 km downstream of the Pedlar River Dam); one to seven JSM were observed at these sites (VDWR

2020a, J. Alderman, Alderman Environmental Services, Inc., email to S. Dressler et al., VDWR, April 7, 2020; VDCR-DNH 2021; B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). During more recent surveys conducted in 2017 to 2020, no more than two JSM have been observed at a site. Some of these surveys took place due to VDOT bridge replacement work and proposed pipeline crossings (e.g., maintenance, replacement) on the Pedlar River. There is no information to indicate if a JSM site from 1989, upstream of Pedlar River Dam, has been resurveyed. Subadult JSM (less than 30 mm in length) have been observed, one in 2004 and one in 2019, suggesting some reproduction is occurring in the Pedlar River. In summary, JSM is distributed throughout the Pedlar River with low abundance and some recruitment, but there is insufficient data to evaluate stability.

Hardware River (Fluvanna and Albemarle Counties, VA) – The Hardware River, a tributary to the James River, is a new occurrence river for JSM. In 1999 a JSM shell was found at one site, and in 2004, eight JSM total were discovered within a 1-km reach at three sites in Fluvanna and Albemarle Counties (Johnson and Neves 2004b, VDWR 2020b). Four JSM from the two sites downstream of a bridge were prematurely relocated to the 3rd JSM site upstream of the bridge during a survey conducted for VDOT. In 2019, one JSM was found within this 1-km reach, confirming presence of JSM (VDWR 2020b). Surveys in the Hardware River are limited with one survey in 2011 immediately upstream of the 1-km reach and another survey in 2021, conducted 0.1 km upstream and 0.9 km downstream of a mill dam (survey ended approximately 1.3 km upstream of the 1-km reach); both surveys in Albemarle County did not observe any JSM, but did find other native freshwater mussels (e.g., eastern elliptio, notched rainbow) (VDWR 2020b, Ostby and Carey 2021). In the latter survey, Ostby and Carey (2021) observed that the reach downstream of the mill dam appeared to be degraded with no crayfish and less fish and aquatic invertebrates in comparison to other streams in this county. Surveys downstream of the JSM 1-km reach, from approximately 7.4 km downstream of this reach to the confluence with the James River, found no freshwater mussels at one site in 1997 and other native freshwater mussels at three sites in 1999 and 2011 (e.g., eastern elliptio). In summary, the Hardware River appears to have very low abundance, but there is insufficient data to evaluate stability and recruitment of the population.

Rock Island Creek (Buckingham County, VA) – Rock Island Creek, a tributary to the James River, is a new occurrence river for JSM. Surveys in 2011 found 75 JSM in two reaches of the creek within an approximately 2.1-km section of the creek (Chazal et al. 2012, VDWR 2020b). An additional reach with JSM was found within this section, and two of these reaches were part of the mark-recapture study from 2013 to 2018; after 2018, only reach #1 is included in the ongoing mark-recapture study. Modeled abundance estimates in 2018 were 58 and 88 JSM in reach #1 (approximately 175-m long) and #2 (approximately 100-m long, upstream of reach #1), respectively, with some fluctuations over the years (table 3) (TOE and DC 2019). These reaches were also a source for propagation broodstock since 2015 and are augmentation sites for the resulting propagated juvenile JSM since 2017 (see section 2.3.1.1 for information about propagation efforts). However, in 2018 as a result of high flows from Hurricane Florence and/or Michael, multiple trees fell along a bank in reach #2, which severely degraded the instream habitat (B. Watson, VDWR, email to R. Mair, Service, October 25, 2018). Very few tagged JSMs could be found during the October 2018 survey, and the VDWR biologist thought that the JSM were either washed downstream, buried under sand, or remained in small areas of suitable habitat. Coarse sand appeared to have been carried downstream to the lower reach. The surveys in 2019 of reach #1 observed 41 JSM (7 recaptured, which included propagated JSM, 34 new individuals) in May and 100 JSM in September (62 were pit-tagged in previous surveys and found subsurface using the pit tag reader; therefore, this count is not comparable to previous surveys). A few tagged JSM from reach #2 were found in reach #1, indicating some JSM were washed downstream and found suitable habitat. Due to the loss of reach #2 as a healthy JSM site, Rock Island Creek was removed from the mark-recapture study and will not be used as a source for propagation broodstock. Propagated JSM have been released to reach #1, but mark-recapture data for these individuals have not been analyzed and there are no estimates of survival rates or their abundance; therefore, propagated JSM was not included in the assessment of approximate abundance. In summary, based on the abundance estimates, the JSM population appears stable at reach #1 with some variation and evidence of recruitment, but the population has declined overall with the loss of suitable habitat in reach #2. Nine years of mark-recapture surveys have been completed at reach #1 as of 2021, and data analysis is in progress.

Tye River (Nelson County, VA) – The Tye River, a tributary to the James River, is a new occurrence river for JSM. A fresh shell of JSM was found in a 2010 survey and a second fresh shell was found in the same general area in 2011 (Chazal et al. 2012). VDCR-DNH conducted 26 surveys in a 10-km reach of the Tye River in 2016 to 2017 and found JSM at six sites (1 to 2 JSM per site) within an approximately 2.2-km reach (Orcutt 2017). It was noted that all the observed native mussels occurred within a 3.1-km reach (which contains the 2.2 km-reach with JSM). Some of these sites were revisited in 2018 and 2019 to swab the JSM for DNA samples, and one to four JSM per site were found, with some JSM recaptured after being tagged on earlier surveys (VDWR 2020b). The JSM individuals found at these sites were older, and none were less than 30 mm in length. In 2019, 650 propagated juvenile JSM (broodstock from Rock Island Creek) were released to three sites in the Tye River, two sites within the 2.2-km reach with known JSM occurrences and a new site with suitable habitat, potentially extending the total range 31.7 km. Post release monitoring is planned for 2022; due to the lack of information about the success of the release, the number of propagated JSM was not included in the assessment of approximate abundance. Upstream of the confluence with the James River, surveys in the Tye River at five sites in 2001, 2006, 2007, 2010, and 2011 found no JSM but found other native freshwater mussels (e.g., green floater, eastern elliptio) (VDWR

2020a). In summary, the Tye River JSM population is mainly located within a 2.2-km reach and appears to have low abundance, but there is insufficient data to evaluate stability and recruitment.

Totier Creek (Albemarle County, VA) – Totier Creek, a tributary to the James River, is a new occurrence river for JSM. Two relict shells of JSM were found in 2011 and 2012 in an approximately 0.4-km reach, as well as two to three live notched rainbows (Chazal et al. 2012, Chazal 2013). High sedimentation was observed at the JSM reach, with all substrate surfaces covered with sediment. There appears to be limited survey effort in this creek, with surveys in two sites in 2011-2012, 4.8 km upstream and 3.5 km downstream of the JSM reach, which found no native freshwater mussels (Chazal et al. 2012, Chazal 2013). A survey in 2017 at a site 1.5 km upstream of the JSM reach found only notched rainbow (VDWR 2020a). There is an impoundment downstream of the site, reducing connectivity to the James River. JSM is possibly extirpated in this creek, but it is not confirmed because survey effort has been limited.

Rivanna sub-basin (VA; HUC8 02080204)

Mechums River (Albemarle County, VA) – Surveys in Mechums River, a tributary to the South Fork Rivanna River, since 1990 have found JSM at three sites in 1992 and 1999 within an approximately 0.9-km reach and at one site about 5.3 km downstream (near the confluence with Lickinghole Creek) in 1998; one to three JSM were observed at these sites (VDWR 2020b, VDCR-DNH 2021). A relict JSM shell was found in 1991 at the confluence of Mechums River and Lickinghole Creek, and it is unclear which waterbody was the source of the shell. A site where JSM was previously found in 1990, approximately 9 km downstream from the confluence with Lickinghole Creek, was surveyed in 2004 and no JSM was found (VDCR-DNH 2021). In 2020 and 2021, four JSM (two each year) were found by a St. Anne's-Belfield School teacher (VDWR permittee) and students upstream of a known JSM site and were photo verified by VDWR malacologist B. Watson (B. Watson, VDWR, email to J. Stanhope, Service, January 21, 2022). There appears to be limited survey effort in Mechums River in the past 20 years, with three additional sites surveyed in 2004, 2007, and 2008 (none at JSM sites) and no JSM found; other native freshwater mussels were observed at one site (e.g., creeper) (VDWR 2020a). In summary, Mechums River appears to have very low abundance, but insufficient data to evaluate recruitment and stability, with most known sites with JSM not surveyed in more than 22 years and limited survey effort overall.

Moormans River (Albemarle County, VA) – No live JSM have been found in the Moormans River, a tributary to the South Fork Rivanna River, since the 1990 recovery plan was completed. JSM was observed at only one site in 1990 downstream of a bridge (7 JSM), and surveys in 1992, 1995, 1998, and 2003 did not find any JSM (VDWR 2020a, VDCR-DNH 2021). It appears this bridge may have been replaced, based on notes in the element occurrence record (VDCR-

DNH 2021). Surveys at three sites in 1998 and 2005, upstream of the confluence with the South Fork Rivanna River, and at one site in 1998 more than 5.6 km upstream of the JSM site, detected no JSM, but other freshwater mussels were found (species not indicated) (VDWR 2020a). In summary, JSM appears extirpated in this river, but it is not confirmed because survey effort has been limited throughout the Moormans River.

Wards Creek (Albemarle County, VA) – Wards Creek, a tributary to Moormans River, was mis-identified as "Rocky Run (Moormans River)" in the 1990 recovery plan and Hove (1990). Based on the site description provided in Hove (1990), the two JSM were found in Wards Creek in 1989. Multiple surveys since 1990 have confirmed the occurrence of JSM at this site in 1992, 1998, 2003, and 2004, with 2 to 11 JSM found (VDWR 2020a, b). JSM was found at a new site in 1992 in Wards Creek before the confluence with South Fork Rivanna River. In 2011, Ostby and Angermeier (2012) conducted semiquantitative surveys at 31 reaches within 6.6 km of Wards Creek and found one JSM each at two new sites. One shell was found at another site approximately 0.7 km upstream of the 1989 occurrence site. Juvenile JSM were observed in the 2003 survey at the 1998 occurrence site and at another site in 2011. Ostby reported that he surveyed a small section of Wards Creek in 2017 with James Madison University and Virginia Commonwealth University students (upstream and downstream of the mouth of Rocky Creek) and found no JSM (B. Ostby, DC, email to J. Stanhope, Service, May 30, 2022). In summary, Wards Creek appears to have low abundance, patchy distribution, and some recruitment, but insufficient data to evaluate stability.

Rocky Creek (Albemarle County, VA) – Rocky Creek, a tributary to Wards Creek, is a new occurrence river for JSM. Two JSM and four shells of JSM were found in 1998 at one site (VDWR 2020b). In 2011, Ostby and Angermeier (2012) conducted semiquantitative surveys at reaches within 3 km of Rocky Creek and found 17 JSM total at 15 sites within an approximately 1.3-km reach. The goals of these surveys were to detect presence of JSM and understand probabilities of detection. They also conducted quantitative sampling in a 0.35 km-reach in 2012 using a systematic random sampling approach because there was no clear spatial pattern for occupied quadrats (e.g., 0.25 m^2 quadrats in suitable habitat with freshwater mussels) and estimated a density of 0.52 JSM/m^2. Ostby and Angermeier (2012) noted that JSM were usually found in aggregations in Rocky Creek compared to other streams where the species are usually found as single specimens.

In 2015 and 2017, Ostby (2015, 2019a) resurveyed the same reaches in Rocky Creek applying the same methods of Ostby and Angermeier (2012) and found that JSM was observed in many of the same 2011 and 2012 sites. They also expanded surveys upstream to near a manmade impoundment, a farm pond, and downstream to the confluence with Wards Creek and found new sites downstream, increasing the range of the species to 3.0 km total of Rocky Creek

(VDWR 2020a). No mussels were detected upstream of the impoundment, which reduces connectivity. The impoundment may provide beneficial effects to JSM as those described for Little Oregon Creek, Johns Creek, and Dicks Creek, but may also limit minimum flows because the farm pond may have less regulatory oversight. Rocky Creek was also resurveyed in 2019 at the same reaches and the number of live JSM observed in 2015, 2017, and 2019 were 6, 39, and 80, respectively (B. Ostby, DC, email to J. Stanhope, Service, January 5, 2022). Predation was also observed based on 5 to 25 JSM shells with claw and teeth marks each year in 2015-2019. The density of JSM observed during quantitative sampling of one reach in 2015 was similar to density in 2012, with mean density of approximately 0.6 and 0.5 JSM individuals/m^2, respectively (Ostby 2015). Based on extrapolating the density estimate to the 1,100 m^2 sample area, Ostby (2015) estimated the population size to be 236 to 1,153 JSM (95 percent confidence intervals) in this area. Ostby (2019a) indicated that individuals of the species were highly detectable in Rocky Creek, suggesting either that they exist at a high density or are easier to detect in a stream with greater mean particle size. Ostby and Angermeier (2012) observed that "its stream bottom was bedrock covered by at most 10 cm [centimeters] of cobble, gravel, and sand," while for streams nearby (e.g., Wards Creek, Swift Run, Buck Mountain Creek, and Piney Creek), sand was the dominant substrate, and JSM were more difficult to find because they are more likely to be subsurface. The repeated sampling in 2015 and 2017 indicated that the JSM population had grown older and larger since 2011-2012, but there is recruitment with a small number of individuals detected that are less than 30 mm in length (Ostby 2019a). This site is used as a source of broodstock for propagation and will be an augmentation site for the resulting propagated juvenile JSM.

Since 2016, a site in Rocky Creek, which overlaps with the high density reach where quantitative sampling was conducted as indicated above, is part of an ongoing mark-recapture study being conducted by a St. Anne's-Belfield School teacher and students, but no data have been provided. However, immediately downstream of the site is a failing double culvert, and it was reported that debris falling through the holes was creating a dam effect and possibly impacting JSM by causing low flows in the riffle habitat they inhabit; the debris was cleared (B. Watson, VDWR, email to J. Chiles, M. Hartman, and S. Alexander, VDOT, January 2, 2022). VDOT is planning to replace the culverts in 2022-2023, which will likely adversely affect JSM during construction. A second mark-recapture site was added in 2020, downstream of the impoundment (B. Watson, VDWR, email to J. Stanhope, Service, February 18, 2022).

In summary, the Rocky Creek population appears stable with large variation and evidence of recruitment, based on nine years of available monitoring data (2011-2019).

Buck Mountain Creek (Albemarle County, VA) – Buck Mountain Creek, a tributary to South Fork Rivanna River, is a new occurrence river for JSM. Ten

JSM and four shells of JSM ("4 paired valves") were found in 1996 at eight sites over approximately 2.9 km of Buck Mountain Creek (P. Stevenson, consultant, letter to P. Nickerson, Service, January 24, 1997). In 1999, JSM was observed (number of individuals not indicated) approximately 3 km upstream from the previous occurrences (VDWR 2020b). In 2004, the JSM's documented range in the creek was extended 1.8 km downstream with one JSM found. In 2011, Ostby and Angermeier (2012) conducted semiquantitative surveys at 39 reaches within 14.4 km of Buck Mountain Creek and found five JSM and one shell total at four new sites, which were located within the known range of the species. They also conducted quantitative sampling in a 0.09-km reach in 2012 using a stratified sampling approach because there was a clear spatial pattern for occupied quadrats (i.e., 0.25 m^2 quadrats in suitable habitat with freshwater mussels) and estimated a density of 0.26 JSM/m^2. In 2021, a survey found three JSM at a previously documented site (Alexander 2021). In summary, Buck Mountain Creek appears to have very low abundance and patchy distribution, but insufficient data to evaluate stability and recruitment.

Piney Creek (Albemarle County, VA) – Piney Creek, a tributary to Buck Mountain Creek, is a new occurrence river for JSM. Two shells of JSM ("2 paired valves") were found in 1996 at one site (P. Stevenson, consultant, letter to P. Nickerson, Service, January 24, 1997). Ostby and Angermeier (2012) conducted semiquantitative surveys at seven reaches within 1.4 km of Piney Creek and found one JSM in 2012 at another site approximately 0.4 km downstream of the JSM shells. Ostby reported that he surveyed several kms of the upstream reaches of Piney Creek in 2019 and found no JSM (B. Ostby, DC, email to J. Stanhope, Service, May 30, 2022). In 2021, a survey downstream of the 2012 site did not find JSM (Alexander 2021). In summary, Piney Creek appears to have very low abundance, but there is insufficient data to evaluate stability and recruitment.

Ivy Creek (Albemarle County, VA) – Ivy Creek, a tributary to the South Fork Rivanna River, is a new occurrence river for JSM. In 1997, three JSM and six shells of JSM (one fresh dead, five relict) were found at four sites in an approximately 1.4-km reach in Ivy Creek, and two more relict shells were found within this reach in 1999 (VDWR 2020b, VDCR-DNH 2021). The range in Ivy Creek was extended by approximately 8.2 km upstream when three JSM were found in a 1998 survey (VDWR 2020b). In 2011, Ostby and Neves (2011) conducted a survey in a 3.0-km reach of Ivy Creek and found two JSM approximately 0.3 km upstream of the 1.4-km reach from 1997. There appears to be limited survey efforts since 2011, with a survey in 2012 of a 1-km reach in Ivy Creek upstream of the confluence with Little Ivy Creek (i.e., not the same area where JSM were previously detected) that found no freshwater mussels (Ostby et al. 2012). Ivy Creek joins the South Fork Rivanna River in a transition zone (e.g., slow flow and greater depth, silt, and organic matter on stream bottom) with the South Fork Rivanna Reservoir, restricting connectivity to other JSM rivers. Ostby and Neves (2011) observed that the lower portion of Ivy Creek (1.4-km-long starting at the transition zone and upstream) is very unstable and degraded, likely due to intense land use activities in the watershed and/or nearby. In summary, Ivy Creek appears to have very low abundance, but there is insufficient data to evaluate stability and recruitment.

North Fork Rivanna River (Albemarle County, VA) – The North Fork Rivanna River, a tributary to the Rivanna River, is a new occurrence river for JSM. In 1998, six sites were surveyed in the North Fork Rivanna River, and one JSM was found at one site more than 2 km upstream of the confluence with Swift Run (McGregor 1999). Surveys in 2005 and 2013 that found one JSM each at two sites total extended the range in the North Fork Rivanna River approximately 13.0 km downstream (VDWR 2020b), and another survey in 2015 detected two JSM between the 2005 and 2013 occurrences (The Catena Group 2015, VDWR 2020a). For the new 2015 site, a survey was conducted in the same reach in 2010 and did not find any JSM, highlighting the difficulty in detecting JSM (Creek Laboratory, LLC 2010). It also supports resurveying reaches if there is suitable mussel habitat and JSM is known to occur in the waterbody. The JSM found in 2013 was less than 35 mm in length and possibly four to five years old, which suggests some recruitment in the previous five years. There has been limited survey effort in the North Fork Rivanna River, with surveys in 2006, 2008, and 2018 at four sites that found no JSM but other native freshwater mussels (e.g., notched rainbow), and a survey in 2008 found no native freshwater mussels (VDWR 2020a). The negative JSM survey in 2018 was conducted at a site where JSM was previously documented in 2005 and Alexander (2018) observed "severe flooding caused erosion and excessive sediment deposition within the river channel." In summary, the North Fork Rivanna River appears to have very low abundance and some recruitment, but there is insufficient data to evaluate stability.

Swift Run (Greene and Albemarle Counties, VA) – Swift Run, a tributary to the North Fork Rivanna River, is a new occurrence river for JSM. First discovered in 1998, multiple surveys in 2003, 2004, 2007, 2008, and 2009 found JSM at multiple sites in approximately 7.4 km of Swift Run, with 1 to 15 JSM, including juveniles, observed at individual sites (VDWR 2020a, b). The surveys conducted in 2007 and 2008 were required monitoring after frac-out (i.e., discharge of sediment/bentonite-laden water) occurred during horizontal directional drilling for a pipeline crossing, where the closest known JSM occurrence was more than 15 km downstream (Dickinson 2007). Twelve sites were surveyed from downstream of the crossing to the confluence with Welsh Run, and three sites detected JSM, approximately 11.5 km downstream of the pipeline crossing (VDWR 2020b). Based on four monitoring periods, Dickinson (2008) did not detect observable changes in stream condition related to the frac out and concluded that there were minimal to no impacts on native mussels monitored at the JSM sites.

In 2011 and 2012, Ostby and Angermeier (2012) conducted semiquantitative surveys at 21 reaches within 8.7 km of Swift Run and found 24 JSM, 4 shells, and 1 fresh dead shell total at 14 new sites, expanding the downstream range of the species to a total of 9.1 km in Swift Run (B. Ostby, DC, email to J. Stanhope, Service, January 5, 2022). They also conducted quantitative sampling in a 0.05-km reach in 2012 using a stratified sampling approach because there was a clear spatial pattern for occupied quadrats (i.e., 0.25 m^2 quadrats in suitable habitat with freshwater mussels) and estimated a density of 0.21 JSM/m^2.

In 2015 and 2017, Ostby (2015, 2019a) resurveyed the same 21 reaches in Swift Run applying the same methods of Ostby and Angermeier (2012) and JSM (live and shells) were not observed in many of the same 2011/2012 sites. For only two reaches, JSM (live and shells) was detected in all three survey years (i.e., 2012/2012, 2015, 2017), and for six reaches, JSM was detected in two of the three survey years. The number of live JSM observed in 2015 and 2017 were 6 and 12, respectively (B. Ostby, DC, email to J. Stanhope, Service, January 5, 2022). These studies, along with those conducted by James Madison University researchers (e.g., Esposito 2015, Boisen 2016, Draper 2016, Verdream 2020) indicate that JSM have "highly variable spatio-temporal occupancy and detection patterns in Swift Run [and] [n]o single habitat in Swift Run appeared to support a robust and definable population center" (Ostby 2019b). Many of the JSM sites in Swift Run, including mussel beds, appear to be transient and occur in unstable stream reaches, in contrast to typical JSM sites that are stable and typically not transient, as observed in Rocky Creek and Little Oregon Creek (Ostby 2019b, Verdream 2020). In 2019, Ostby (2019b) repeated the study by surveying the same 21 reaches in Swift Run and additional areas in Swift Run and its tributaries in 2019 (total 27.5 km). Only five JSM were observed in the 21 reaches, the lowest number detected in all four surveys. For only six reaches, JSM (live and shells) was detected in three of the four years. JSM mussel beds/aggregates were previously observed in 2011, but now JSM is only found as individuals. Ostby (2019b) was unable to find a stable, source population center in Swift Run.

Juvenile JSM have been observed in Swift Run in 2003 and 2014, with lengths of 24.85 and 32.51 mm in the latter date (Esposito 2015, VDWR 2020b), indicating recruitment had likely occurred in the four years before 2014 (based on length vs. age relationship in Hove 1990).

In summary, the JSM population in Swift Run appears to have low abundance, some recruitment, and highly variable and patchy distribution. It is not clear if the lower number of JSM observed in 2019 was due to lower detection rates or if the population in Swift Run is declining. High flows in 2018 and 2019 may have displaced and moved JSM to downstream locations.

Unnamed Tributary to Swift Run (Greene County, VA) – The unnamed tributary to Swift Run is a new occurrence stream for JSM. This unnamed, perennial tributary flows from the north-northwest direction and joins Swift Run approximately 1.3 km upstream of the confluence of Quarter Creek and Swift Run. Surveys in 2017 and 2019 found one JSM and one JSM shell, respectively, in close proximity to each other (Ostby 2019a and 2019b). The 2019 survey, which searched the lower 3.1 km of the tributary, also found many other native freshwater mussels, including notched rainbow and creeper. In summary, the JSM population in the unnamed tributary to Swift Run appears to have very low abundance, but there is insufficient data to evaluate stability and recruitment.

Welsh Run (Greene County, VA) – Welsh Run, a tributary to Swift Run, is a new occurrence stream for JSM. In 2005, VDWR biologists found two JSM and one JSM shell at two sites in Welsh Run (VDWR 2020b). Surveys in 2017 and 2019 (on the latter date the lower 2.8 km of Welsh Run was surveyed) did not observe JSM but found other native freshwater mussels (Ostby 2019a and 2019b). In summary, the JSM population in the Welsh Run is likely present, but there is insufficient data to evaluate status, recruitment, stability, and approximate abundance due to limited survey effort.

Rivanna River (Fluvanna County, VA) – No live JSM have been found in the Rivanna River, a tributary to James River downstream of Charlottesville, VA, since the 1990 recovery plan was completed. The recovery plan noted three areas or subpopulations in the Rivanna River in Fluvanna County (near Columbia, near Palmyra, and at Crofton); survey efforts in the Rivanna River as a whole are described below.

Surveys at multiple sites (>40 sites, including previously documented JSM sites) throughout the Rivanna River in both Albemarle and Fluvanna Counties in 1991, 1992, 1996, 1997, 1998, 2000, 2001, 2006, 2007, 2009, and 2011 found no JSM, but other native freshwater mussels were found (e.g., notched rainbow, eastern elliptio, creeper, green floater, Carolina lance, triangle floater, northern lance, Atlantic pigtoe) (McGregor 1999, VDWR 2020a). Due to live individuals not being observed since 1968 (VDWR 2020b, VDCR-DNH 2021), JSM is presumed extirpated in this river; however, it is not confirmed due to difficulty in surveying a large river (67.8 km), surveys sites did not occur in all reaches of the Rivanna River, low detection rates for JSM, and there continues to be suitable mussel habitat.

Mechunk Creek (Fluvanna County, VA) – Mechunk Creek, a tributary to the Rivanna River, is a new occurrence river for JSM. One relict shell of JSM was found in 2004 (VDWR 2020b). In 2007, surveys were conducted at two sites by VDWR biologists and found no JSM, but did observe other native freshwater mussels (e.g., Atlantic spike, eastern elliptio, notched rainbow) (VDWR 2020a). JSM appears extirpated in this creek, but it is not confirmed because survey effort has been limited.

James River mainstem

In the James River mainstem, the population was noted as historical and the species has not been found since the 1990 recovery plan was completed. The recovery plan noted eight areas or subpopulations in the James River, and surveys conducted by sub-basin from west to east (upstream to downstream) on the river since 1990 (numbers indicate the subpopulation identified in the recovery plan) are summarized below.

Upper James (HUC8 02080201): James River near (1) Buchanan (Botetourt County, VA) and (2) Natural Bridge (Rockbridge County, VA) – Surveys in 2001 at Buchanan and near Natural Bridge by VWDR found no JSM or other native freshwater mussels (McGregor and Baisden 2002). Ostby and Angermeier (2009) conducted reconnaissance surveys by canoe and land to identify suitable mussel habitat in six reaches of the James River in Botetourt County (40.6 km of 80 km in this county) and conducted semiquantitative mussel surveys at 15 sites in 2009 (47,200 m^2 total of stream bottom). No live native freshwater mussels were detected at these sites, with only one shell of eastern elliptio found. Other surveys conducted in the James River, in 1997 near the confluence with Craig Creek and in 2005 near the confluence with the Maury River, found other native and nonnative freshwater mussels (e.g., eastern elliptio and other *Elliptio* species) (VDWR 2020a). A small area (approximately two 100 m-long reaches near piers) in the James River at Buchanan was surveyed in 2021 for a VDOT bridge project, and no JSM were found (Carey 2021). In summary, JSM appears extirpated in this area of the James River and has not been observed since before 1967 (date unknown) (VDWR 2020b, VDCR-DNH 2021), but it is not confirmed because large rivers are difficult to survey, surveys sites did not occur in all reaches of the river, and JSM has low detection rates.

Middle James-Buffalo (HUC8 02080203): James River near (3) New Canton (Buckingham and Fluvanna Counties, VA) – Surveys at and downstream of the historical JSM site (approximately 2.1-km reach) in 1994, 2001, 2006, 2007, 2008, 2011, 2012, 2013, and 2018 by VWDR and permittees found no JSM but did find other native freshwater mussels (e.g., creeper, eastern elliptio, green floater, Carolina lance, triangle floater, Atlantic spike). In 2011 and 2012, Chazal et al. (2012) conducted qualitative and semiquantitative surveys at 43 sites in 10 reaches in the James River (greater than 136,000 m^2 total of stream bottom) from Warren (about 1 km upstream of confluence with Rock Island Creek) to Powhatan Correctional Facility (about 3 km downstream of Maidens), including all historical areas/subpopulations in the Middle James-Buffalo and Middle James-Willis subbasins. No JSM were found during these surveys, but Chazal et al. (2012) noted that they “sampled a relatively small amount of the suitable habitat at each location, which does not include large areas of the river that were not surveyed.” The New Canton historical area is adjacent to the Bremo Power Station, and its mixing zone for the station’s thermal discharge may cause adverse impacts to mussels. In summary, JSM appears extirpated in this area of the James River and has not been observed since before 1966 (VDWR 2020b), but it is not confirmed because large rivers are difficult to survey, surveys sites did not occur in all reaches of the river, and JSM has low detection rates.

Middle James-Willis (HUC8 02080205): James River near (4) Columbia (Fluvanna and Cumberland Counties, VA), (5) Pemberton and Cartersville (Goochland and Cumberland Counties, VA), (6) Rock Castle (Goochland and Powhatan Counties, VA), and (7, 8) Maidens and opposite Maidens (Goochland and Powhatan Counties, VA) – Surveys at the historical JSM sites and other areas of the James River in 1997, 1998, 2001, 2005, 2007, 2009, 2010, 2011, 2012, and 2013 by VWDR and permittees found no JSM but did find other native freshwater mussels (e.g., creeper, eastern elliptio, green floater, Carolina lance, eastern floater, Atlantic spike) (VDWR 2020a). As described above for Chazal et al. (2012), no JSM were detected during surveys of 43 sites in 10 reaches of the James River. In summary, JSM appears extirpated in this area of the James River and has not been observed since before 1966 (VDWR 2020b), but it is not confirmed because large rivers are difficult to survey, surveys sites did not occur in all reaches of the James River, and JSM has low detection rates.

<u>Roanoke River major drainage basin</u>

Upper Dan sub-basin (VA, NC; HUC8 03010103)

Dan River (Stokes and Rockingham Counties, NC) – The Dan River is a new occurrence river for JSM, and the first time the species was documented outside of the James River drainage basin. First discovered in 2000, multiple surveys in 2000-2010 found JSM at multiple sites in approximately 57 km of the Dan River in Stokes County, with 1 to 76 JSM observed at individual sites/dates and cumulatively 370 JSM over this time period (NCWRC 2020b). In 2003, more than 170 JSM were relocated due to a North Carolina Department of Transportation (NCDOT) bridge replacement project; however, after a major flood event in fall 2004, only 15 JSM were initially detected and then none were detected during followup monitoring after the first year (M. Perkins, NCWRC, email to J. Stanhope, Service, November 13, 2020 and March 2, 2021).

Surveys efforts increased in 2015, and NCWRC biologists observed approximately 80 JSM throughout the upper Dan River from 2015-2019; four new sites in Rockingham County extended the range of the species 85.4 km downriver in the Dan River to near the Virginia-North Carolina border (NCWRC 2020b; M. Perkins, NCWRC, email to J. Stanhope, Service, November 13, 2020). One live JSM was observed at each of three sites and one JSM shell at one site, suggesting very low density and patchy distribution of JSM in the lower portion of the Dan River in North Carolina. NCWRC biologists also observed three JSM less than five years old during the surveys in Stokes County, NC, which suggests some recruitment in the last five years. Based on catch per unit effort and occupancy area from 2016-2020 in the Dan River within an approximately 35-km reach in Stokes County, "NCWRC biologists have estimated a total number of extant individuals in NC at approximately n=200 and a decline of approximately 70% from the period of 2001-2017 (NCWRC unpublished data)" (M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021 and January 7, 2022). On the Dan River, primary threats to the JSM and its habitat are hydrologic disturbances from hydroelectric dam operations (e.g., peak releases to generate energy) and natural flood events (e.g., in 2004, 2018, 2019) (M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021) (see section 2.3.2.1 and 2.3.2.5 for additional information about these threats).

Petty (2005) surveyed the Dan River in Patrick County, VA, at 11 sites in 2003-2004 (2 of these sites were also surveyed in 2002) and found no JSM but did observe other native freshwater mussels at six sites (e.g., eastern elliptio and notched rainbow). Petty and Neves (2007) surveyed one additional site in the Dan River and observed no JSM but did observe other native freshwater mussels. In 2014, four of the six sites with native freshwater mussels were resurveyed by Chazal (2014), and no JSM were observed, but other species of native freshwater mussels were observed.

In summary, the JSM population in the Dan River appears to have moderate, but declining abundance and some recruitment.

Big Creek (Stokes County, NC) – Big Creek, a tributary to the Dan River, is a new occurrence river for JSM. One JSM shell ("2 valves in good condition") was found in 2012, and live notched rainbows within a 1- to 2-km reach (NCWRC 2020b; M. Perkins, NCWRC, email to J. Stanhope, Service, January 7, 2022). High sedimentation and "flashy" flows are observed upstream of this reach. Additional surveys over a 1-km reach were conducted in 2016 and 2019, and no JSM were found. JSM is possibly extirpated in this creek with no live individuals found but is not confirmed due to limited survey effort throughout Big Creek.

Mill Creek (Stokes County, NC) – Mill Creek, a tributary to Town Fork Creek (tributary to the Dan River), is a new occurrence river for JSM (NCWRC 2020b). One JSM was found in 2017, and the site was resurveyed in 2018 and 2019 (survey effort and distance varied each year), with the same individual found in 2018 only, but hundreds of eastern elliptio have been observed (M. Perkins, NCWRC, email to J. Stanhope, Service, January 7, 2022). There is a large earthen dam upstream of the JSM occurrence, possibly providing instream stability, similar to small dams in Little Oregon Creek and near other JSM populations. Upstream of the dam in Mill Creek has not been surveyed. In 2021, 30 propagated juvenile JSM (broodstock from the Dan River) were released to Mill Creek (M. Perkins, NCWRC, email to J. Stanhope, Service, March 15, 2022); these JSM are not included in the assessment of approximate abundance because we do not know if they have survived and successfully established. Town Fork Creek was last surveyed in 2015, and no JSM detected, but there are few native freshwater mussel records, and the creek is considered to have a low-quality watershed. In summary, the JSM population in Mill Creek appears to have very low abundance and there is insufficient data to evaluate stability and recruitment.

South Fork Mayo River (Patrick and Henry Counties, VA; Rockingham County, NC) – The South Fork Mayo River, a tributary to the Mayo River, is a new occurrence river for JSM. Petty (2005) discovered JSM in 2002 at 12 sites in both Virginia and North Carolina (approximately 18.9 km total), with 1 to 57 JSM observed at individual sites and 96 JSM total (note: VDWR [2020b] indicates 107 JSM total were observed in the South Fork Mayo River in 2002). Based on the lengths of 98 JSM (range: 16.9-66.8 mm), JSM were estimated to be 0 to 18 years old, with mean age of about five years (mean length 38.1 mm) (age based on Hoves 1990); reproduction was likely occurring with four juveniles (less than 15 mm, not measured) observed (Petty 2005). Additional surveys were conducted further upriver of the JSM sites in 2003-2004 (12 sites), 2006 (3 sites), and 2013 (2 sites) in Patrick County, VA, and no JSM were found but other native freshwater mussels were found (e.g., eastern elliptio and notched rainbow) (Petty 2005, Petty and Neves 2007, Chazal 2014). Petty (2005) observed "a large, extensive falls area (height approximately 1.2 m)" that may serve as a barrier to upstream dispersal of host fish and may be the upstream end of the JSM range in the South Fork Mayo River. Since 2006, additional surveys reconfirmed JSM at two sites in 2012 (three JSM) in Henry County, VA (VDCR-DNH 2021) and one site in 2008 (four JSM) in Rockingham County, NC (NCWRC 2020b). In 2016, only one JSM shell each were detected at two sites in 2016 near the 2008 occurrence (NCWRC 2020b). It is unknown if other JSM sites in Virginia have been resurveyed since 2002. In summary, the JSM population in the South Fork Mayo River appears to have moderate abundance and some recruitment, but there is insufficient data to evaluate stability with limited survey effort throughout occupied areas of the river since the species was discovered in 2002.

Mayo River (Rockingham County, NC) – The South Fork Mayo River, a tributary to the Dan River, is a new occurrence river for JSM. First discovered in 2001, multiple surveys in 2001-2002 found JSM at multiple sites in approximately 21.3 km of the Dan River in Stokes County, NC, with 1 to 11 JSM observed at individual sites and 35 JSM total (NCWRC 2020b). During surveys conducted in 2008-2009, eight JSM were observed at four sites within a 1.3-km reach of the upper Mayo River. NCWRC biologists conducted intensive surveys in 2016 at seven sites in approximately 1.5 km of the Mayo River and found only two older JSM from the same area as the 2008-2009 occurrences, suggesting possible declining abundance in the Mayo River (M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021 and January 7, 2022). Other native freshwater mussels were observed (e.g., eastern elliptio, notched rainbow, and green floater). Three sites were surveyed in 2019-2021, one near a JSM site and two downstream of the known JSM range in the Mayo River, and no JSM were found. NCWRC noted threats of declining habitat and water quality due to sedimentation from agricultural watersheds, in particular from the North Fork Mayo River, and two dams in the lower Mayo River creating barriers to host fish dispersal. In summary, the JSM population in the Mayo River appears to have low abundance and may be declining based on the lack of JSM observed during annual surveys. There is insufficient data to evaluate recruitment.

Lower Dan subbasin (NC; HUC8 03010104)

County Line Creek (Caswell County, NC) – An individual mussel was collected in 1998 in County Line Creek, a tributary to the Dan River, and vouchered with the North Carolina Science Museum (NCWRC 2020b). It was initially identified as Atlantic pigtoe by B. Watson because the foot was pink and not orange, when he worked for NCWRC and collected the specimen, but then other biologists later thought it to be JSM (B. Watson, VDWR, email to J. Stanhope, June 6, 2022). , NCWRC biologists now think "it more closely resembles *F. masoni* [Atlantic pigtoe]" and repeated attempts to conduct DNA analysis have failed (M. Perkins, NCWRC, email to J. Stanhope, Service, January 7, 2022). They also noted the "stream is highly degraded although other rare mussel species including *A. undulata* [triangle floater] and *S. undulatus* [creeper] are still present in small numbers." Surveys in the waterbody, including in 2018, have not detected JSM or additional unidentified specimens. Due to the unconfirmed individual collected in 1998 and no confirmed JSM found, County Line Creek is not considered a new population.

Summary of abundance, population trends, demographic features, or demographic trend

Since the 1990 recovery plan, many new occurrences of live JSM and shells have been found, increasing the number of waterbodies (rivers, streams, tributaries) currently and likely occupied by JSM (i.e., present and likely present) from 11 to 26 total (136-percent increase) and expanding the current range to the Roanoke River basin in North Carolina (table 4). The new discoveries are due to a greater number of surveys being conducted rather than new populations being established. Mill Creek was considered historical in 1990 and rediscovered in 1996. Based on number of waterbodies (not river miles), approximately 70 percent of all historically occupied waterbodies (26 of 37) are currently or likely occupied by JSM Although there are newly discovered occupied waterbodies, approximately 30 percent of all historically occupied waterbodies (11 of 37) are presumed or possibly extirpated, which is an increase from 5 to 11 waterbodies from 1990 to 2021 (120-percent increase). JSM is presumed extirpated from four large rivers with historical occurrences in the James River basin (James River, Maury River, Rivanna River, and Calfpasture River) and is possibly extirpated from four other waterbodies, in which the species has not been found since 1990 (Patterson Creek, Catawba Creek, Potts Creek, and Moormans River). For the four waterbodies that are possibly extirpated, survey effort for mussels has been limited and surveys were last conducted 2007 or earlier. In addition, there are three waterbodies in which only shells have been found since the 1990 recovery plan (Totier Creek, Mechunk Creek, and Big Creek), in most cases relict shells, and the species may be extirpated. Additional surveys should be conducted to verify the status of the JSM in these waterbodies.

Table 4. Number of JSM waterbodies by status in 1990, 2008, and 2021 in the James and Roanoke River basins.

Basin	1990 Historical	1990 Present	1990 Total	2008 Historical	2008 Possibly Extirpated	2008 Present	2008 Total	2021 Historical	2021 Possibly Extirpated	2021 Likely Present	2021 Present	2021 Total
James River	5	11	16	4	4	19	27	4	6	2	20	32
Roanoke River	0	0	0	0	0	3	3	0	1	0	4	5
Total	**5**	**11**	**16**	**4**	**4**	**22**	**30**	**4**	**7**	**2**	**24**	**37**

The overarching trend across the range is that JSM usually numbers less than 10 individuals at any site or reach, and often just one individual is found. Of historically occupied waterbodies (37 total), 27.0 percent have very low approximate abundance (1 to 10 individuals), 21.6 percent have low approximate abundance (11 to 100 individuals), and 21.6 percent have moderate and higher approximate abundance (>100 individuals), based on the last 20 years (2002-2021) (table 5). The waterbodies with very low or low approximate abundances usually have low density and patchy distribution over the river or stream. Low density populations may lead to a loss of recruitment because the distance between the mussels is too great for reproduction and may contribute to loss of genetic variability. Rock Island Creek has a low abundance estimate in 2018 because of high flows from hurricanes severely degrading an occupied reach and washing away JSM. The eight waterbodies with the moderate and higher abundance estimates are: South Forks Potts Creek in West Virginia (note: the range [31 to 339 individuals from 2000 to 2021] includes low approximate abundance); Little Oregon Creek, Dicks Creek, Johns Creek, Mill Creek, and Rocky Creek in Virginia; Dan River in North Carolina; and South Fork Mayo River in Virginia and North Carolina.

Table 5. Number of JSM waterbodies by approximate abundance category in 2021 in the James and Roanoke River basins.

Basin	None	Very low	Low[1]	Moderate[2]	Moderate to High	High	Total
James River	10	9	7	1	3	2	32
Roanoke River	1	1	1	2	0	0	5
Total	**11**	**10**	**8**	**3**	**3**	**2**	**37**

[1] Includes Cowpasture River with low to moderate approximate abundance because site was recently augmented with propagated JSM

[2] Includes South Forks Potts Creek with low to high approximate abundance.

Based on multiple years of monitoring over at least a 10-year time period, the species is reproducing and considered stable (with large variations in number of individuals) or increasing in four waterbodies in the James River basin (South Fork Potts Creek, Dicks Creek, Johns Creek, and Mill Creek) (table 6). Rocky Creek also has a JSM population that is reproducing and considered stable, but monitoring has not been conducted for the 10-year period. The Mill Creek population has doubled due to augmentation with propagated juvenile JSM. The abundance in Cowpasture River has significantly increased from 5 to at least 111 individuals due to augmentation with propagated juvenile JSM, but evidence of recruitment has not been observed, and monitoring has not been conducted for the 10-year period. JSM is decreasing or possibly decreasing in four waterbodies: two in the James River basin (Little Oregon Creek, Rock Island Creek) and two in the

Roanoke River basin (Dan River, Mayo River). For most of the waterbodies described above, JSM is predominately found in single, small reaches, ranging from 0.1 to 1.4 km in length (appendix B), making them susceptible to an adverse event that could eliminate the high density reaches of JSM within a waterbody. The high density reaches in Little Oregon Creek, Dicks Creek, and Johns Creek are located within a 1-km radius circle (i.e., less than 2 km apart) and are connected (i.e., Little Oregon Creek drains to Dicks Creek), making them more susceptible to a wide-scale adverse event, such as hurricane or drought. However, a single adverse event, such as an oil spill or dam breach, may only affect up to two of these waterbodies because only Little Oregon Creek drains to Dicks Creek and the high JSM abundance stream reach in Johns Creek is upstream of the confluence with Dicks Creek (i.e., Dicks Creek drains into Johns Creek downstream of the reach with high JSM abundance). More than half of the waterbodies with JSM present (13 of 24) have an unknown population trend due to the lack of sufficient monitoring data.

Table 6. Summary of approximate abundance, recruitment, population trend, and if based on 10 years of monitoring for JSM waterbodies that are present in 2021 (see table 1 and appendix B). Bolded waterbodies have evidence of recruitment and stable or increasing population trend based on 10 years of monitoring. Gray-shaded rows have decreasing population trend. Unknown = insufficient monitoring data to qualitatively assess the population trend.

Basin/ Sub-basin (HUC8)	Waterbody	Area/ Subpopulation[1]	Approximate Abundance	Evidence of Recruitment	2021 Trend (unknown, increasing, stable, decreasing)	Based on 10 Years of Monitoring[2]
James River basin						
Upper James	**South Fork Potts Creek**		**Low to high**	**Yes**	**Stable, large variation**	**Yes**
Upper James	Cowpasture River		Low to moderate	No	Increasing due to augmentation with propagated juveniles; wild population unknown	No
Upper James	Little Oregon Creek		High	Yes	Decreasing, large variation and possible recovery	Yes
Upper James	**Dicks Creek**		**Moderate to high**	**Yes**	**Stable, large variation**	**Yes[3]**
Upper James	**Johns Creek**	**Near Maggie**	**High**	**Yes**	**Stable, large variation**	**Yes[3]**
Upper James	Johns Creek	Along Sevenmile Mountain	Low	No	Unknown	No
Upper James	Craig Creek	Craig Creek near Silent Dell	Low	No	Decreasing	Yes[3]
Maury	**Mill Creek**		**Moderate to high**	**Yes**	**Increasing due to augmentation with propagated juveniles; wild population is stable, large variation**	**Yes**
Middle James-Buffalo	Pedlar River		Low	Yes	Unknown	No
Middle James-Buffalo	Hardware River		Very low	No	Unknown	No
Middle James-Buffalo	Rock Island Creek		Low	Yes	Decreasing	No[4]
Middle James-Buffalo	Tye River		Low	No	Unknown	No
Rivanna	Mechums River		Very low	No	Unknown	No
Rivanna	Wards Creek		Low	Yes	Unknown	No
Rivanna	Rocky Creek		Moderate to high	Yes	Stable, large variation	No[4]
Rivanna	Buck Mountain Creek		Very low	No	Unknown	No
Rivanna	Piney Creek		Very low	No	Unknown	No
Rivanna	Ivy Creek		Very low	No	Unknown	No
Rivanna	NF Rivanna River		Very low	Yes	Unknown	No
Rivanna	Swift Run		Low	Yes	Not clear because of large variation and low detection rates	Yes
Rivanna	Unnamed tributary to Swift Run		Very low	No	Unknown	No

Basin/ Sub-basin (HUC8)	Waterbody	Area/ Subpopulation[1]	Approximate Abundance	Evidence of Recruitment	2021 Trend (unknown, increasing, stable, decreasing)	Based on 10 Years of Monitoring[2]
Roanoke River basin						
Upper Dan	Dan River		Moderate	Yes	Possibly decreasing	Yes
	Mill Creek (NC)		Very low	No	Unknown	No
	South Fork Mayo River		Moderate	Yes	Unknown	No
	Mayo River		Low	No	Possibly decreasing	Yes[5]

[1] From 1990 recovery plan, Table 1, Historic and Present occurrences of the James spinymussel in 1990.
[2] Monitoring data collected over a 10-year time period, but frequency of surveys varies - annually at some waterbodies and every four to seven years at other waterbodies.
[3] There is at least 10 years of available monitoring data, but only 7 to 9 years of data analyzed from mark-recapture studies for abundance estimates.
[4] Nine years of available data (2011-2019).
[5] At low frequency (e.g., 7 to 8 years apart over 15 years).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

Population structure

Petty (2005) conducted a genetic analysis of four JSM populations (Dan River, South Fork Mayo River, Wards Creek, and South Fork Potts Creek), based on phenotypic variation and sequencing of mitochondrial (357 bp of cytochrome-b [CYT-B], 916 bp of ND-1) and nuclear (502 bp of internal transcribed spacer-1 [ITS-1]) DNA; the following is a summary of key findings: (1) Based on morphological, anatomical reproductive similarities, similar fish host specificity, and many shared mitochondrial and nuclear DNA genetic sequences, the JSM is the same species throughout its range in the Dan River subbasin of the Roanoke River basin and James River basin; (2) at this time the Dan River subbasin of the Roanoke River basin and James River basin populations should be managed as separate management units because they are subject to reduced gene flow with no potential for exchange, and evidence of genetic distinctiveness of several haplotype frequencies; (3) genetic haplotype frequency data indicate no reason to restrict reciprocal exchanges of JSM from the Dan and South Fork Mayo Rivers in the Roanoke drainage; (4) Ward's Creek JSM appears to be isolating and evidences a loss of genetic diversity (smallest number of haplotypes); and (5) analysis of allele frequency at microsatellite loci is recommended before reciprocal exchanges among the South Fork Mayo, Dan, and South Fork Potts populations is recommended.

Virginia Commonwealth University researchers, Dr. Rodney Dyer and Bonnie Roderique, conducted a spatial analysis of genetic structure of JSM based on 5 microsatellite loci/primers of nuclear DNA from 12 and 2 waterbodies, respectively, in the James River and Roanoke River basins (Dyer 2019). Their findings indicate: (1) within population estimates of inbreeding are generally high, suggesting populations are likely isolated and have had small breeding populations for sustained periods of time; (2) genetic differences among populations in the James River basin are likely due to dams, habitat fragmentations, and smaller population size; (3) Dicks Creek, Johns Creek, and Little Oregon Creek are the most genetically similar, based on structure analysis; and (4) the James River and Roanoke River sites were not fully genetically distinct. Due to small sample size at four sites (≤ eight individuals; Tye River, Pedlar River, Craig Creek, and Wards Creek), drawing conclusions on their genetic structure will be difficult and limited. Further analysis of the data is required to make additional conclusions on genetic diversity and structure of the populations.

As part of ongoing population genetics work, Dr. Jamie Roberts (Georgia Southern University), Scott Meyer, and other collaborators have successfully developed ~4,900 single-nucleotide-polymorphism (SNP) markers to assess fine-scale trends in genetic diversity (M. Perkins, NCWRC, email to J. Stanhope, Service, November 13, 2020; Meyer 2021). SNP markers are nuclear-based and provide more contemporary information regarding population structure, while mitochondrial-based markers provide historical structure. A total of 34 JSM in the Roanoke River basin (Dan River, NC [Dan River n=28, Mill Creek n=1]; South Fork Mayo River, VA n=5) and 5 JSM in the James River basin (South Fork Potts Creek, WV) were genotyped in this study. “Their findings suggest that at the population-scale, the Dan and [South Fork] Mayo populations exhibit relatively high differentiation, possibly as a result of small effective population size (estimates are not finalized) and genetic drift i.e., limited recent gene flow. Heterozygosity is higher in the Dan River population when compared to the [South Fork] Mayo and is not an effect of sample size.” (M. Perkins, NCWRC, email to J. Stanhope, Service, November 13, 2020, and March 2, 2021). The genetic differentiation between the Dan and South Fork Mayo populations may be due to long-term evolutionary isolation or two large dams between the two waterbodies on the Mayo River, NC: the Mayo Dam and the Avalon Dam, built in 1898 and 1900, respectively (Meyer 2021). Additional research on potential outbreeding depression is recommended before mixing these populations. Not surprisingly, the Dan and South Fork Mayo populations were also highly differentiated from the South Fork Potts population. Additional JSM from the James River basin have been collected for continued population genetics work.

Species delineation

In examining the three only known Atlantic Slope freshwater mussel species with spines, Perkins et al. (2017) conducted a genetic analysis, sequencing of mitochondrial (Cytochrome oxidase-1 [CO-1] and ND-1) and nuclear [ITS-1] DNA, of four JSM populations (same rivers as Petty [2005]), two Tar River spinymussel (TRS) populations (*Elliptio steinstansana*), and one Altamaha spinymussel population (*Elliptio spinosa*), and the following is a summary of key findings: (1) all three spinymussel species do not form a monophyletic group; (2) JSM and TRS are sister species and form a monophyletic clade; and (3) this clade with JSM and TRS is genetically distinct from both *Elliptio* and *Pleurobema*, thus merits a new unique genus, named *Parvaspina*, which includes both JSM (*Parvaspina collina*) and TRS (*Parvaspina steinstansana*).

In examining the mitochondrial DNA CO-1 sequences from 110 recognized species in the Pleurobemini tribe to understand phylogenetic relationships, Inoue et al. (2018) found that yellow lance “formed a distinct cluster sister to [JSM]” and thus are closely related; however, these results do not change species delineations for JSM. Lohmeyer's (2020) analysis using both mitochondrial (CO-1 and ND-1) and nuclear (ITS-1 and 28S) DNA sequences supported this conclusion.

Summary of genetics, genetic variation, or trends in genetic variation
Results of genetic studies conducted thus far suggest that the JSM is the same species throughout its range in the Dan River subbasin of the Roanoke River basin and James River basin, but the species should be managed as separate units. Although initial genetic analyses suggested that JSM from the Dan River and South Fork Mayo River in the Roanoke River basin may be exchanged, new genetic analyses suggest that they are relatively highly differentiated. Additional research on potential outbreeding depression is recommended before mixing these populations. Initial analysis indicates there are also some genetic differences among populations in the James River basin, and inbreeding is generally high across all populations in both basins; further analysis of the data is required to make additional conclusions on genetic diversity and structure of the populations. JSM is a distinct species from other freshwater mussels with spines and other freshwater mussels in the Pleurobemini tribe and forms a new monophyletic clade with the TRS in a new genus named *Parvaspina*.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Perkins et al. (2017), as described above in section 2.3.1.3, concluded that JSM and TRS formed their own clade based on genetic analysis and described a new genus, *Parvaspina,* in the tribe Pleurobemini. Williams et al. (2017) provided a revised list of freshwater mussels in the United States and Canada and updated the taxonomy and nomenclature of many mussels, including the change of genus name for JSM from *Pluerobema* to *Parvaspina*. Therefore, the commonly accepted scientific name for JSM is *Parvaspina collina*. On February 17, 2022, the Service formalized the taxonomic change in the Federal Register (87 FR 8960-8967).

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

The species has a wider spatial distribution than previously known, extending to the Upper Dan subbasin the Roanoke River basin (NC, VA) and adding additional waterbodies and HUC12 subwatersheds in the Upper James, Middle James-Buffalo, and Rivanna subbasins (VA) (figure 3). Therefore, JSM's historical and current range is in the James River basin in Virginia and West Virginia and the Roanoke River basin in Virginia and North Carolina. Notable range extensions due to increased survey effort include an about 140-km reach in the Dan River (NC), 21-km reach in the Mayo River (NC), 19-km reach in the South Fork Mayo River (VA, NC), 50-km reach in the Cowpasture River (VA), 9.1-km reach in Swift Run (VA), and 5.2-km reach in North Fork Rivanna River (VA) (see appendix B for estimated river length of all live JSM in last 20 years [2002-

2021]). Although there is an increased spatial distribution of the species, JSM generally occurs in relatively low density and abundance (< 10 individuals) at many sites across the range. JSM lost redundancy in the James River basin in the eastern and some central portions of the range prior to 1990 (14 HUC12s with "Historical" status) and continued to lose redundancy since 1990, mostly in the western portion of the range with 11 HUC12s with "Possibly Extirpated" status total across the range (figure 3). However, the species increased redundancy overall, predominantly in the northern and southern parts of the range, with 32 currently or likely occupied HUC12 total, of which 23 discovered since 1990 due to increased survey effort.

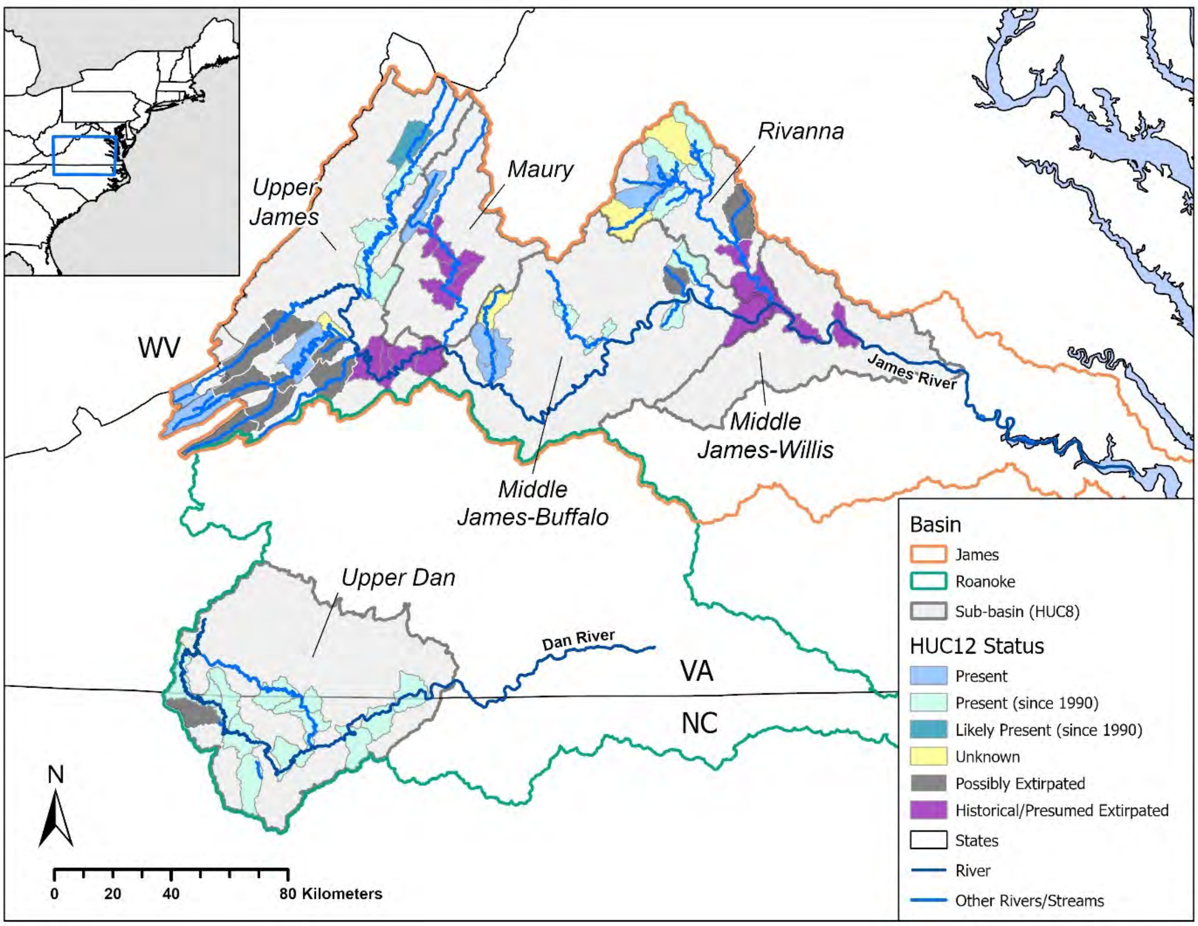

Figure 3. Historical and current range of JSM as shown by basin, subbasin, and HUC12 subwatersheds with documented occurrences. Subbasins are labeled. HUC12s with JSM occurrences since 2007 have "Present" status, and if they were discovered since the 1990 recovery plan, have "Present (since 1990)" status. "Likely Present" = last JSM occurrence was 2002-2006 (approximately 15 to 20 years ago). "Unknown" = most known JSM sites within the HUC12 have not been surveyed in more than 20 years and limited survey effort overall in this river. "Possibly extirpated" = last live JSM observed 30 to 50 years ago or only shell observed, but limited survey effort recently and/or throughout waterbody. "Historical/presumed extirpated" = last live JSM observed more than 50 years ago; categorized as historical occurrence in the 1990 recovery plan (Service 1990).

The range limits for JSM are generally well defined, but additional surveys in the James and Roanoke River basins may find new waterbodies or rediscover JSM in presumed or possibly extirpated waterbodies. Petty (2005) and Petty and Neves (2007) surveyed both qualitatively and quantitatively in the Roanoke River basin and did not detect live JSM or shells in the Dan, Smith, and Banister Rivers in Virginia and upstream of an extensive falls area in the South Fork Mayo River. They concluded that "sufficient effort (~ 6 person-hours per site) was expended to state with ~95 percent confidence that the James spinymussel does not occur in the 48 km of stream reaches sampled in this drainage (Petty 2005)." With new information since these surveys indicating low and variable detection rates of JSM, especially in the fall season (e.g., when Petty and Neves [2007] conducted their surveys in 2006), the probability of detection or confidence percentage is likely lower, and additional surveys are recommended to better define the range limits for JSM in the Roanoke River basin. For some of the larger rivers in the James River basin, such as the Maury, Rivanna, and James Rivers, surveys are minimal and may be difficult to conduct due to its size, depth, and/or topography, and JSM may be rediscovered where there is suitable mussel habitat. For example, Chazal et al. (2012) noted that "[w]hile Ostby and Angermeier (2009) did not find any mussels in the James River in Botetourt County, we know good numbers of mussels exist at the boat ramp in Lynchburg which is at least 40 river miles upstream of Warren. The reach from Warren to Botetourt County should be surveyed since minimal past surveys have been conducted."

To better understand the distribution of JSM occurrences by its status, table 7 provides a summary of HUC12s and waterbodies/subpopulations by basin and subbasin (HUC8) and their status and approximate abundance in 2021. Because some waterbodies cross multiple subbasins, such as the James River, subpopulations as defined in the 1990 recovery plan were counted in place of waterbody. Within the James River basin, JSM is extant in 80 percent of its subbasins (four of five) and occupies only 42 percent of the historically occupied HUC12s; the Middle James-Willis subbasin remains unoccupied with all HUC12s "Historical/Presumed Extirpated" (table 7 and figure 3). For the Maury subbasin, JSM occupies only 20 percent of the historically occupied HUC12s. Within the Roanoke River basin, with one subbasin, JSM is extant and occupies 92 percent of the historically occupied HUC12s. Across the range, JSM occupies 52 percent (32 of 61) of the historically occupied HUC12s, and its status is unknown in 7 percent of the historically occupied HUC12s due to limited of survey effort.

Table 7. Summary of HUC12s and waterbodies/subpopulations by basin and subbasin (HUC8) and their status and approximate abundance in 2021. See section 2.2.1.2 for definitions of status and approximate abundance category. Gray shaded row is historical/presumed extirpated subbasin.

Basin/Sub-basin (HUC8)	Number of HUC12s with JSM Occurrences in 2021 by Status				Number of Waterbodies/Subpopulations[1] by Approximate Abundance in 2021							
	Historical/ Presumed or Possibly Extirpated	Unknown	Likely Present/ Present	Total	Unknown	None[2]	Very low	Low[3]	Moderate[4]	Moderate to high	High	Total
James River basin												
Upper James	12	1	7	20	1	7	0	3	1	1	2	15
Maury	4	0	1	5	0	2	0	0	0	1	0	3
Middle James-Buffalo	2	1	6	9	0	2	1	3	0	0	0	6
Middle James-Willis	3	0	0	3	0	5	0	0	0	0	0	5
Rivanna	3	2	6	11	0	3	7	2	0	1	0	13
Total	**24**	**4**	**20**	**48**	**1**	**19**	**8**	**8**	**1**	**3**	**2**	**42**
Roanoke River basin												
Upper Dan	1	0	12	13	0	1	1	1	2	0	0	5
Total - All	**25**	**4**	**32**	61	**1**	**20**	**9**	**9**	**3**	**3**	**2**	**47**

[1] Waterbodies and subpopulations/areas from 1990 recovery plan, Table 1, Historic and Present occurrences of the James spinymussel in 1990.

[2] Waterbodies/subpopulations that are historical/presumed extirpated or possibly extirpated.
[3] Includes Cowpasture River with low to moderate approximate abundance.
[4] Includes South Forks Potts Creek with low to high approximate abundance.

Figure 4 provides approximate abundance by waterbody/subpopulation within HUC12s occupied by JSM. When examining the distribution of waterbodies/subpopulations by approximate abundance in 2021 in the James River basin (table 7), the Upper James subbasin has the most waterbodies/ subpopulations with moderate or greater approximate abundance, which are concentrated in the southwestern portion of the subbasin (four total; 26.7 percent of historically occupied waterbodies/subpopulations in the subbasin) (figure 4). The Maury and Rivanna subbasins have only one waterbody/subpopulation each with moderate approximate abundance (33.3 percent and 7.7 percent of historically occupied waterbodies/subpopulations, respectively in their subbasin). The Middle James-Buffalo subbasin has only waterbodies with low (50.0 percent), very low (16.7 percent), and none (33.3 percent) approximate abundance. The Roanoke River basin's only subbasin, the Upper Dan, has two waterbodies with moderate approximate abundance (40.0 percent of historically occupied waterbodies in the subbasin; note: there are no subpopulations designated in the Roanoke River basin). The waterbodies/subpopulations with moderate or greater approximate abundance are widely distributed throughout JSM's range (Figure 4).

In terms of distribution of JSM across physiographic province, historical and present HUC12 subwatersheds occur in the Valley and Ridge, Blue Ridge, and Piedmont (figure 5). Upper portions of the HUC12s in the Rivanna subbasin and the HUC12 containing the Tye River in the Middle James-Buffalo subbasin cross into the Blue Ridge; however, JSM occurrences in those HUC12s occur only in the Piedmont; therefore, these HUC12s are considered to occur in the Piedmont.

Within the Valley and Ridge, JSM currently occupies 33.3 percent of the historically occupied HUC12s (8 of 24; includes HUC12s with "Likely Present" status and does not include "Unknown" status). Within the Blue Ridge, JSM occupies 50 percent of the historically occupied HUC12s (2 of 4). Within the Piedmont, JSM occupies 66.7 percent of the historically occupied HUC12s (22 of 33).

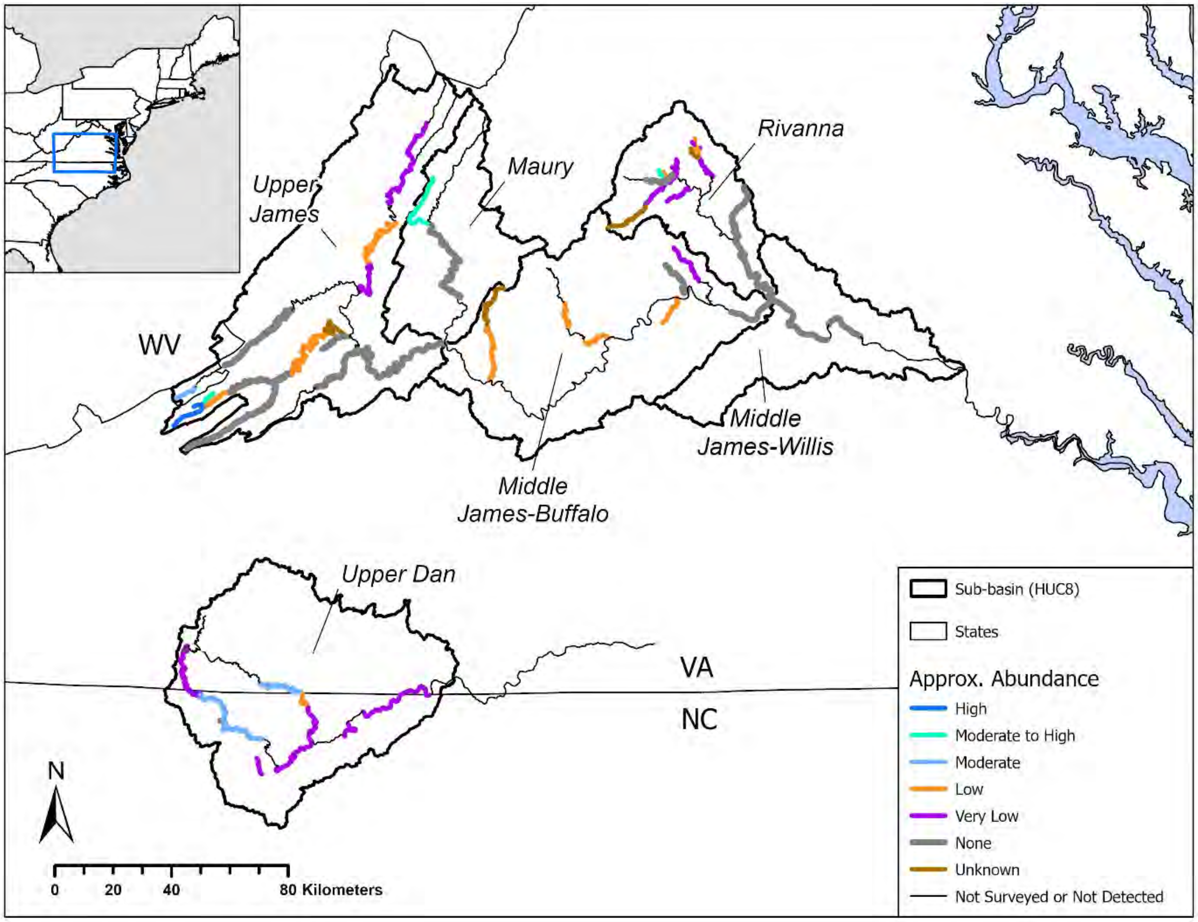

Figure 4. Approximate abundance for JSM waterbodies/subpopulations within HUC12 subwatersheds identified in figures 3 and 5. Note that the stream reaches shown should not be used to determine total stream length occupied by JSM (e.g., may be shorter), but provides a maximum approximation. Subbasins are labeled. See section 2.3.1.2 for definitions of approximate abundance category. One stream reach of Cowpasture River is categorized as low because it was recently augmented with propagated juvenile JSM and South Fork Potts Creek is categorized as moderate because it has low to high approximate abundance.

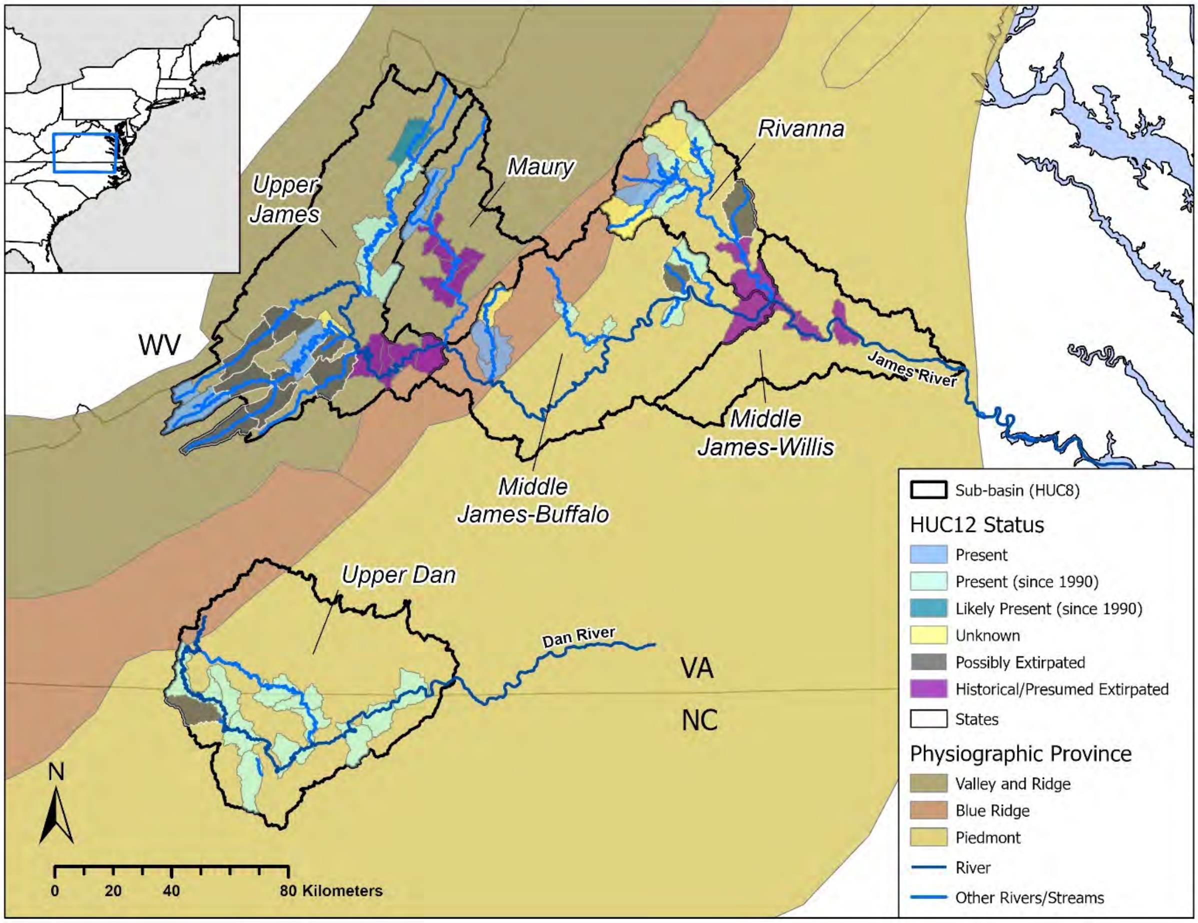

Figure 5. Historical and current range of JSM by physiographic province. Subbasins are labeled. See figure 3 caption for description of HUC12 status.

Summary of spatial distribution, trends in spatial distribution, or historic range

The species has a wider spatial distribution than previously known, extending to the Upper Dan subbasin the Roanoke River basin (NC, VA) and adding additional waterbodies and HUC12 subwatersheds in the Upper James, Middle James-Buffalo, and Rivanna subbasins (VA). Therefore, JSM's historical and current range is in the James River basin in Virginia and West Virginia and the Roanoke River basin in Virginia and North Carolina. Although there is an increased spatial distribution of the species, JSM generally occurs in relatively low density and abundance (< 10 individuals) at many sites across the range and has lost redundancy in some portions of the range, both prior to and since 1990, with 14 HUC12s with "Historical" status and 11 HUC12s with "Possibly Extirpated" status across the range. However, the species has increased redundancy overall, predominantly in the northern and southern parts of the range, with 32 currently or likely occupied HUC12s total, of which 23 were discovered since 1990 due to increased survey effort.

Across the range, JSM occupies 52 percent (32 of 61) of the historically occupied HUC12s. Within the James River basin, JSM is extant in 80 percent of its subbasins (4 of 5) and occupies only 42 percent of the historically occupied HUC12s; the Middle James-Willis subbasin remains unoccupied with all HUC12s "Historical/Presumed Extirpated." For the Maury subbasin, JSM occupies only 20 percent of the historically occupied HUC12s. Within the Roanoke River basin, with one subbasin, JSM is extant and occupies 92 percent of the historically occupied HUC12s. When examining the distribution of waterbodies/ subpopulations by approximate abundance in 2021, the Upper James subbasin has the most waterbodies/subpopulations with moderate or greater approximate abundance, which are all concentrated in the southwestern portion of the subbasin (four total; 26.7 percent of historically occupied waterbodies/ subpopulations in the subbasin). The Maury and Rivanna subbasins have only one waterbody/subpopulation each with moderate approximate abundance (33.3 percent and 7.7 percent of historically occupied waterbodies/subpopulations, respectively in their subbasin). The Middle James-Buffalo subbasin has only waterbodies with low (50.0 percent), very low (16.7 percent), and none (33.3 percent) approximate abundance. The Roanoke River basin's only subbasin, the Upper Dan, has two waterbodies with moderate approximate abundance (40.0 percent of historically occupied waterbodies in the subbasin). The waterbodies/subpopulations with moderate or greater approximate abundance are widely distributed throughout JSM's range. In terms of distribution across physiographic provinces, JSM currently occupies 33.3 percent, 75.0 percent, and 66.7 percent of the historically occupied HUC12s in the Valley and Ridge, Blue Ridge, and Piedmont, respectively.

2.3.1.6 Habitat or ecosystem conditions:

The habitat requirements for JSM described in the 1990 recovery plan and Hove (1990) appear relatively unchanged since then. It was indicated that JSM occupies streams varying from 1.5-m to 23-m wide and 0.15-m to 2-m deep. Historically, JSM occurred in the James River, which was much wider (up to 155 m) and deeper. With the discovery of the JSM in the Roanoke River basin (e.g., Dan, Mayo, and South Fork Mayo Rivers), JSM currently occupies rivers with greater widths (e.g., up to 80 m, based on aerial image of site) than observed before 1990. The species is found in a range of substrates, including sand, gravel, and cobble with or without boulders, pebbles, or silt (Service 1990, Hove 1990). The water velocity at sites supporting this species is slow to moderate, in pools to riffles/runs. Petty (2005) also observed JSM in a range of habitat types in the South Fork Mayo River, including "shallow riffle, run, slack or low-velocity areas and pool (50 to 70 percent < 61 cm depth) with abundant sand/gravel bars present in the riffle, run, and slack stream segments."

Ostby and Angermeier (2012) visually assessed the biological and physical habitat qualities of reaches occupied and unoccupied by JSM and other native mussels in the upper Rivanna subbasin and found no significant differences in the quality metrics, including those based on scores from the U.S. Environmental Protection Agency's "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers" (EPA RAPID). The overall pattern was that the habitat increased in quality (i.e., greater EPA RAPID scores) moving upstream from the mouth of each creek. "[They] often found JSM in habitats considered poor quality and rarely found mussels in habitats considered high quality in that basin. Further testing that observation using the same dataset, Lane (2012) found little support that visually assessed habitat metrics were associated with [JSM] detection or occupancy" (Ostby 2015). The EPA RAPID method appears to not be appropriate for assessing suitable JSM and other native freshwater mussel habitat, particularly in the Rivanna subbasin. Verdream (2020) analyzed freshwater mussel occupancy in Swift Run and Little Oregon Creek and found that maximum water depth was the only significant predictor of occupancy, not water velocity or substrate size, predicting 60 percent of patches in Swift Run and 85 percent of patches in Little Oregon Creek. The highest likelihood of occupancy occurred at 15 cm water depth and decreased with greater water depth and no occupancy occurred at less than 15 cm water depth. In Swift Run, occupied and unoccupied patches had a median water depth of approximately 35 cm and 55 cm, respectively.

Dams are known to reduce connectivity for freshwater mussels and their host fish and reduce suitable habitat. However, some dams or impoundments (e.g., low-head dams, earthen dams, farm ponds) on lower order streams (e.g., in the headwater area) appear to be providing beneficial effects to JSM and its habitat such as in Little Oregon Creek, Dicks Creek, Johns Creek, and Rocky Creek, which are streams with documented higher JSM density and abundance. The dams are potentially providing hydraulic stability, greater food availability, and increased water temperature from the impounded water. JSM downstream of the low-head dam on John Creek are atypically large, up to 92 mm in length, likely related to the increased primary productivity in the impoundment and increased water temperature (TOE 2016; B. Watson, VDWR, email to J. Stanhope, Service, June 6, 2022). The Rocky Creek impoundment is a farm pond, different from the low-head dams on Little Oregon Creek, Dicks Creek, and Johns Creek, and there are concerns about the pond limiting minimum stream flows, especially during droughts (B. Watson, VDWR, email to J. Stanhope, February 18, 2022). Studies on effects of small dams on other mussel species in Alabama, North Carolina, and St. Croix streams have documented beneficial effects immediately downstream of these dams, including higher mussel density and growth rate due to greater geomorphic stability, increased water temperature, and greater food availability (Gangloff et al. 2011, Singer and Gangloff 2011, McCormick 2012, Hornback et al. 2014).

Ostby (2021) compiled a list of streams in the James River basin with small dams and impoundments similar in size to those in Rocky Creek and Little Oregon Creek (e.g., "Rocky Creek was at most 5 m wide flowing out from a 19,000 m^2 impoundment, and Little Oregon Creek was 5 to 6 m wide flowing out from a

40,000 m^2 impoundment”). After prioritizing the streams, 20 were surveyed in 2019-2020 (most in the Rivanna subbasin), but no JSM were found.

A species distribution model (SDM) for JSM for the James River basin in Virginia was developed by VDCR-DNH using Random Forest modeling that predicts potential suitable habitat for the species in stream reaches based on occurrence data (VDCR-DNH 2015). The model variables most important to predicting suitable habitat were annual precipitation, baseflow, annual streamflow, drainage area, and percent of forest and shrub landcover in the watershed. This model showed new potential areas for JSM suitable habitat within the James River basin and the Service’s Virginia Field Office previously used the model results to inform ESA Section 7 project reviews. Another SDM for JSM for the James River basin in Virginia was developed by Roderique (2018) using Maximum Entropy modeling, and model variables most important to predicting suitable habitat were associated with landcover and anthropogenic effects. “[JSM] preferred locations with a low percentage of the catchment area classified as agriculture and occurred more often in areas with low to moderate gradients and low levels of forest loss within the watershed. They appear to avoid areas with high levels of colluvial sediment and open water (i.e., less tree cover over waterways)” (Roderique 2018). Host fish distribution was not an important variable. This model also showed new potential areas for JSM suitable habitat and VDWR utilizes the results to help inform recovery actions and some regulatory review. A rangewide SDM was developed by the Service, based on multiple modeling techniques and reviewed by state agencies and Service field offices in Virginia, West Virginia, and North Carolina. Flow rate was found to be the dominant predictor variable for all the models with some landcover variables (e.g., less developed landcover, greater watershed integrity) having importance (Service 2022). The Service is currently using the model results to inform ESA Section 7 project reviews rangewide.

Summary of habitat or ecosystem conditions

The habitat requirements for JSM described in the 1990 recovery plan and Hove (1990) appear relatively unchanged since then. It was indicated that JSM occupies streams varying from 1.5 m to 23 m wide and 0.15 m to 2 m deep, and with the discovery of JSM in the Roanoke River Basin, JSM currently occupies rivers with greater width (e.g., up to 80 m). The species continues to be found in a range of substrates, including sand, gravel, and cobble with or without boulders, pebbles, or silt (Service 1990, Hove 1990). The water velocity at sites supporting this species is slow to moderate, in pools to riffles/runs. An evaluation of biological and physical habitat qualities of reaches occupied and unoccupied by JSM, including EPA RAPID, found no significant differences. The EPA RAPID method appears to not be appropriate for assessing suitable JSM and other native freshwater mussel habitat, particularly in the Rivanna subbasin. Some dams or impoundments (e.g., low-head dams, earthen dams, farm ponds) on lower order streams (e.g., in the headwater area) appear to be providing beneficial effects to JSM and its habitat in Little Oregon Creek, Dicks Creek, Johns Creek, and Rocky

Creek, which are streams with documented higher JSM density and abundance. The dams are potentially providing hydraulic stability, greater food availability, and increased water temperature from the impounded water. Multiple species distributions models for JSM have been developed, with predictor variables related to streamflow and landcover (e.g., less agriculture and developed landcover).

2.3.2 Five-Factor Analysis:

The purpose of a 5-Year Review is to recommend whether a listed taxon continues to warrant protection under the ESA and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

2.3.2.1 Factor A. Present or threatened destruction, modification, or curtailment of its habitat or range:

The final listing rule described habitat modification as a major threat to JSM and the cause of its decline (53 FR 27689-27693). Adverse habitat changes were caused by dam construction, industrial pollution, chemical spills, channelization, agricultural runoff (including pesticides and fertilizers), and sewage discharges at multiple locations within the species' historical range in the James River basin. The final listing rule also indicated erosion and siltation from logging operations in the upper Craig Creek watershed and other locations as a threat to habitat. Recent information shows that some of the threats described in the final listing remain ongoing and occur throughout the species' range, in particular dams, industrial pollution, agricultural runoff, sewage discharges, and erosion/siltation (e.g., sedimentation/turbidity), and that they are expected to continue in the future. There are also additional anthropogenic disturbances that are adversely affecting habitat. The ongoing and new threats are described below.

<u>Dams:</u> Many existing dams, except some dams or impoundments (e.g., low-head dams, earthen dams, farm ponds) on lower order streams as described in section 2.3.1.6, continue to be a threat to JSM by (1) restricting movement of host fish and dispersal of JSM, which isolate JSM populations from each other and reduce genetic diversity (Watters 1996); (2) reducing habitat quality and quantity upstream and downstream of the dam; and (3) changing hydrologic flow regime downstream of the dam (Watters 1999). In reviewing existing resources for dams, including the U.S. Army Corps of Engineers' (USACE) National Inventory of Dams (NID) (USACE 2022) and the Southeast Aquatic Resources Partnership (SARP) inventory of aquatic barriers (SARP 2022), there are 40 dams on

waterbodies historically and currently occupied by JSM, with the largest numbers of dams on the Dan River and James River (figure 6). In these inventories, dates were provided for construction of 24 of the dams, which ranged from 1839 to 1975. At least five dams have been removed since 1990, including two on the Dan River and one each on the Maury River, Tye River, and Rivanna River. As noted in section 2.3.1.6, some dams on lower order streams (e.g., in the headwater area) appear to be providing beneficial effects to JSM and its habitat; however, most dams are likely negatively affecting JSM as described above. Fourteen dams are hydroelectric dams regulated by the Federal Energy Regulatory Commission (FERC) (figure 6) (see section 2.3.2.4 regarding existing regulatory mechanisms). Multiple dams located in the middle or near the mouth of waterbodies are likely restricting connectivity and isolating JSM populations, including those in the Tye River, Cowpasture River, Ivy Creek, North Fork Rivanna River, South Fork Mayo River, Mayo River, and Dan River; they may have also contributed to presumed or possible extirpation of JSM in the Maury River, Totier Creek, and James River. Genetic analyses of JSM also indicate genetic isolation and high inbreeding rates in many populations, likely due in part to dams (see section 2.3.1.3).

At the time of listing, JSM was not known in Roanoke River basin, including the Dan River in North Carolina, and the species was not considered during relicensing of the Pinnacles Dam in Virginia in 1991, a facility that generates electricity via peaking, especially during summer months (i.e., generally releasing water at higher rates to generate electricity during high or peak demand). The Service and NCWRC have observed increased turbidity in the Dan River in North Carolina where JSM occur after peak releases have occurred. They are currently assessing the factors contributing to poor observed reproduction in the Dan River and evaluating possible effects of peaking flows on the JSM recruitment and increased and prolonged turbidity. The critical period for successful reproduction and recruitment of JSM is from mid-June through August. The NCWRC and Service have been conducting preliminary studies on effects of peaking operations on JSM and communicating with FERC and owners of Pinnacles Dam about modifying flow regimes prior to the next relicensing in 2031. Hydrological disturbance from dam operations and floods is a primary threat to the JSM and its habitat for the Dan River, along with decline of habitat quality due to sediment input from land use practices (M. Perkins, NCWRC, email to J. Stanhope, Service, March 2, 2021).

While construction of new dams is unlikely a current threat, most dams continue to be a threat by reducing connectivity and habitat quality and quantity.

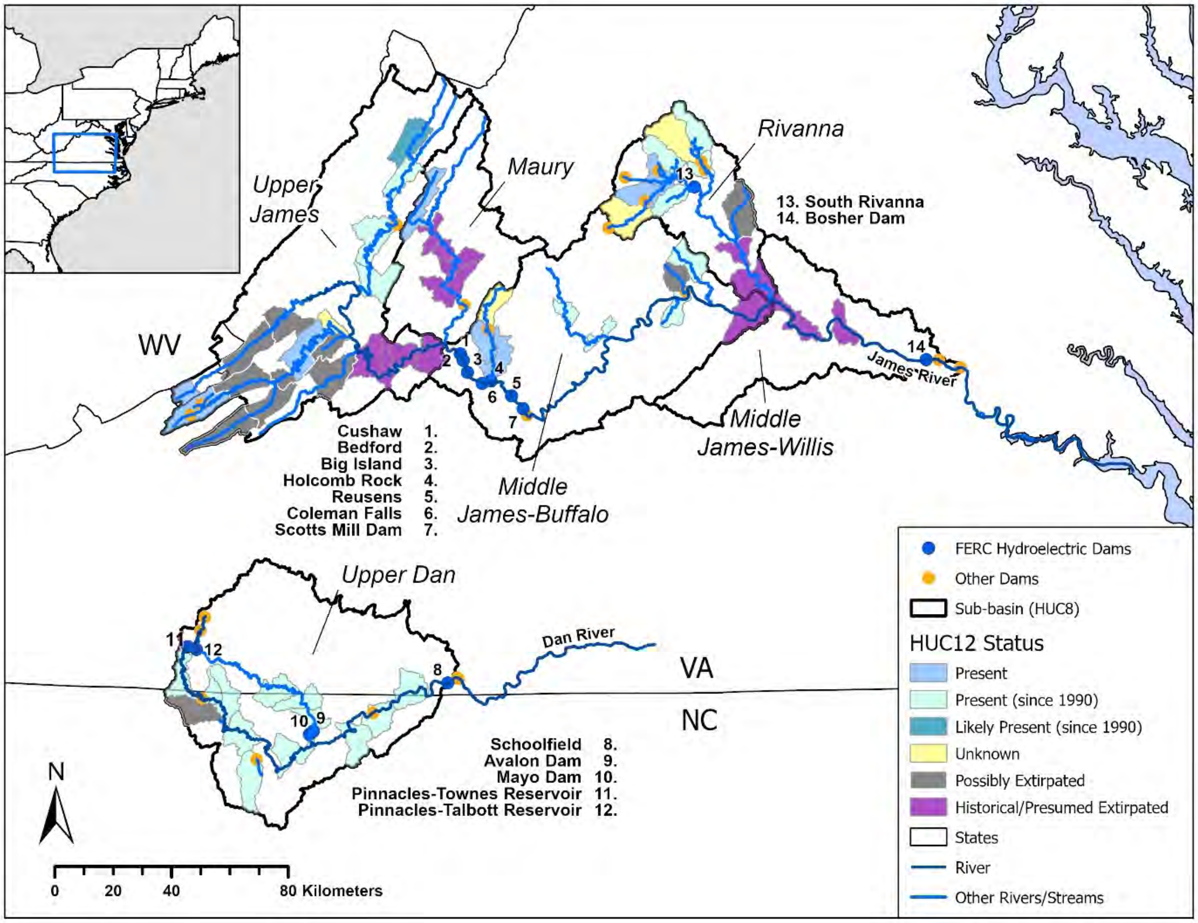

Figure 6. Location of FERC-regulated hydroelectric dams and other dams throughout the historical and current range of JSM. FERC-regulated dams and subbasins are labeled. See figure 4 caption for description of HUC12 status.

Land Use Modification: We use the term "land use modification" to refer to the alteration of the natural landscape, including (but not necessarily limited to) land conversion for development and its associated infrastructure (roads, bridges, utilities), forestry activities, and agriculture. Activities associated with land use modification continue to be a threat to JSM and its habitat, in particular the effects on water quality and direct disturbances to JSM and its instream habitat.

Specific water quality threats include sediment, nutrients, and contaminants (e.g., copper, pesticides, herbicides). Sedimentation/turbidity were noted as threats in the final listing and 1990 recovery plan. Since then, research continues to confirm adverse effects of suspended sediments on freshwater mussels (not specifically tested on JSM), including reduced feeding efficiency and reproductive success (Gascho Landis et al. 2013, Gascho Landis and Stoeckel 2016, Tuttle-Raycraft et al. 2017). Sedimentation/turbidity have also been well documented in adversely affecting fish, and host fish are essential for reproductive success of freshwater mussels (Service 2020). Pesticides were also noted as threats in the final listing. Research since then confirms adverse effects of pesticides (including, fungicides herbicides, and surfactants) on freshwater mussels (not specifically tested on JSM) including reduced growth and death (Bringoff et al. 2007a, b, c; Jardak et al. 2016).

Nutrients were not specifically mentioned as a threat related to water quality in the final listing or recovery plan except indirectly as “fertilizers,” but they are likely a threat to JSM. New research since 1990 has found that inorganic nitrogen pollution (e.g., ammonia) is harmful to freshwater mussels, in particular during early life stages, through multiple pathways (e.g., direct toxicity, lethal effects) (Augspurger et al. 2003; Wang et al. 2007a, b). Ammonia (NH_3) toxicity in fish and invertebrates may cause asphyxiation, reduction in blood oxygen, disruption of osmoregulatory activities in the liver and kidneys, repression of the immune system, and increased disease susceptibility (Hernandez et al. 2016). Sensitivity to ammonia and other contaminants has not been tested on JSM but has been tested on the TRS and other species (i.e., notched rainbow, yellow lance) that may serve as surrogates for JSM (Augspurger et al. 2014). These three species were found to be sensitive to ammonia and copper during acute toxicity tests (e.g., endpoint of death), thus JSM would likely be sensitive to these contaminants. Copper is a contaminant detected in municipal wastewater effluent.

While water quality has generally improved in the James River basin, with reductions in nitrogen and phosphorus loading primarily due to wastewater treatment plant upgrades and agricultural and forestry best management practices, water quality threats persist (James River Association 2021). These water quality threats include nutrients, sediment, and contaminants (pesticides, herbicides, Kepone, mercury, PCBs) and are caused by agricultural runoff, stormwater runoff from impervious surfaces in developed areas, failing septic tanks, streambank erosion, land disturbances (e.g., construction, development, loss of riparian buffer), and industrial discharges (Virginia Environmental Endowment 2018). Sediment (i.e., sedimentation and turbidity) is listed as the “greatest ongoing pollution problem in the James [River basin] (James River Association 2021). The long-term trend (1985-2020) for suspended sediment load delivered annually from the nontidal portion of the James River to the Chesapeake Bay is rated as “degrading,” which indicates that sediment loads are statistically higher at the end date (Mason et al. 2021).

In the Upper Dan subbasin, turbidity was documented as a water quality issue in the Dan River (three stations) and Mayo River (one station) (North Carolina Department of Environmental Quality [NCDEQ] 2010). At one station in the Dan River (at NC 704 near Francisco), the long-term trend (1980-2010) for ammonia and specific conductance (i.e., may indicate polluted water) was upward. The increasing long-term trend of specific conductance was also observed at the station in Mayo River and another station in the Dan River (at State Route 2150 near Wentworth). The potential causes of the water quality issues in the Upper Dan are “construction sites, mining operations, agricultural operations, logging operations, and excessive stormwater flow off impervious surfaces" (NCDEQ 2012).

Threats related to water quality have been observed at multiple JSM waterbodies (see appendix B) and are likely greater in watersheds with higher percentages of agriculture and developed land cover (figure 7).

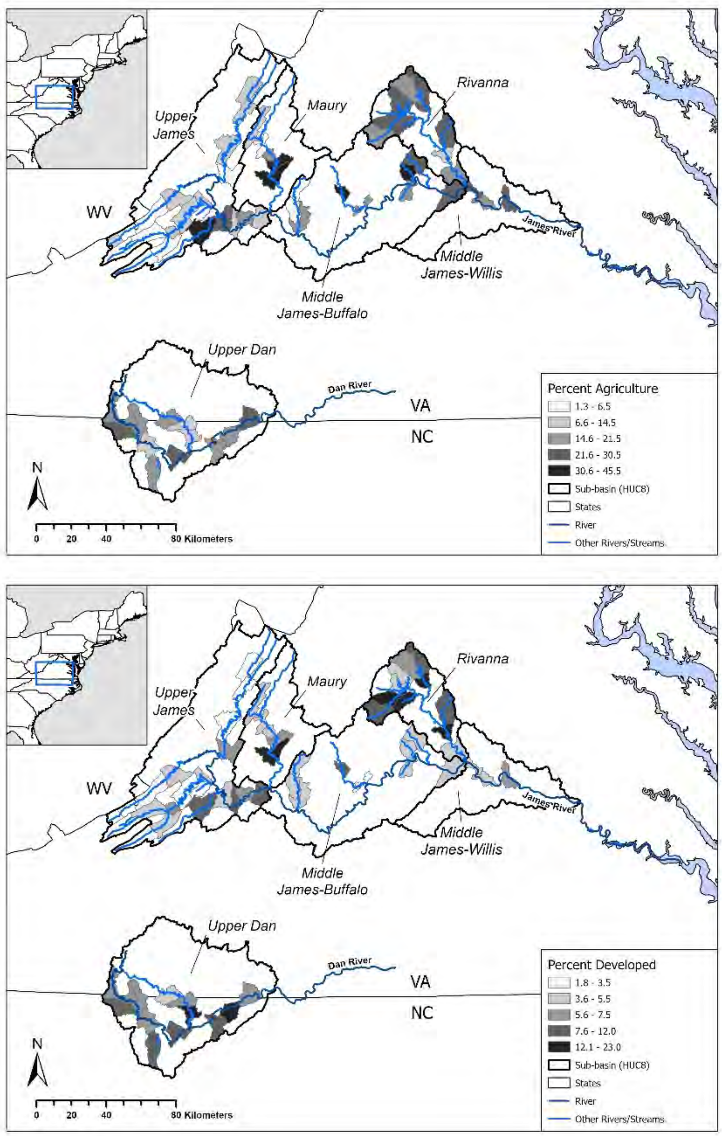

Figure 7. Percent of agriculture (top) and developed (bottom) land cover in the HUC12 subwatersheds based on the 2019 National Land Cover Database (NCLD) (USGS 2021). Percentages of land cover type by HUC12 provided by Doug Newcomb, Service, Raleigh Field Office.

Activities contributing to direct disturbances to JSM and instream habitat include: (1) instream work related to construction and maintenance of roads (culverts, bridges), sewer systems, and electric and gas lines; and (2) livestock accessing JSM waterbodies. Instream work related to bridge and culvert replacements and pipeline repairs has been documented and is currently planned at multiple JSM waterbodies (e.g., Dan River, Pedlar River, Rocky Creek, and Piney Creek), contributing to crushing/death of JSM not relocated during construction, stress to JSM when relocated out of the construction area, temporary and permanent loss of habitat (e.g., cofferdams, riprap), and increased sedimentation/turbidity (see appendix B). The threat to JSM of livestock accessing streams include crushing mussels and causing streambank erosion. This threat has been observed at South Fork Potts Creek, Craig Creek, Pedlar River, Little Oregon Creek, and possibly Buck Mountain Creek. For South Fork Potts Creek, this threat and sedimentation associated with agriculture are considered the largest threats (K. Eliason, WVDNR, *in* email from A. Silvis, WVDNR, to J. Stanhope, Service, March 8, 2021). WVDNR, the West Virginia Conservation Agency, and the Service have been working with private landowners on South Fork Potts Creek and in 2015 established fencing along the entire length of a property to exclude cattle from the highest JSM abundance stream reach, except for flash grazing (letter from A. Silvis, WVDNR, to J. Stanhope, Service, March 8, 2021). The West Virginia Land Trust also acquired a tract of land on South Fork Potts Creek that has documented JSM, and they plan to conduct habitat restoration in cooperation with the Service, pending funding.

For at least four JSM waterbodies (Rock Island Creek, Craig Creek, North Fork Rivanna River, and Dan River), severe flooding or stormflow events were noted as a threat due to extreme scour and erosion of the streambanks and JSM habitat, fallen trees in the stream blocking flow and accumulating debris, washing JSM out of suitable habitat, and introducing silt and different sized sediment to downstream suitable habitat. Although these flooding events are natural, land use changes, in particular increased development and impervious surface in watersheds, alter flow regimes and contribute to greater frequency and intensity of severe flood events (https://www.usgs.gov/special-topic/water-science-school/science/impervious-surfaces-and-flooding; accessed May 5, 2021). Development in the southeastern U.S. is predicted to increase, thus a greater percentage of impervious surface in watersheds and more severe flood events are likely. Terando et al. (2014) projected urban sprawl changes for the next 50 years for the southeastern U.S., and the extent of urbanization in the region is projected to increase 101 to 192 percent. Climate change is also predicted to contribute to greater flooding events (see section 2.3.2.5).

In summary, water quality issues, in particular sedimentation/turbidity and nutrients, are widespread threats to JSM, while instream construction activities and livestock access to streams are localized threats in numerous JSM waterbodies. Severe flooding/stormflow events are also localized but serious threats to JSM and may be increasing with greater development and climate change effects.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

At the time of listing there was no specific information available to suggest that this factor presented a threat to JSM (53 FR 27689-27693). This continues to be accurate. There is no new relevant information regarding overutilization.

2.3.2.3 Factor C. Disease or predation:

At the time of listing there was no specific information available to suggest that this factor presented a threat to JSM (53 FR 27689-27693). There is no new relevant information regarding disease specific to this species. However, there is new information to indicate that predation from raccoons and muskrats (*Ondatra zibethicus*) is a threat to JSM. Predation on JSM has been observed in multiple populations, including Little Oregon Creek, Dicks Creek, Johns Creek, Rocky Creek, and Swift Run. In Little Oregon Creek, at least two years of predation by raccoons has been documented in significantly reducing the JSM population in (see section 2.3.1.2 "Little Oregon Creek" and table 3). At the mark-recapture sites in Johns Creek, surveyors found 250 JSM shells (127 tagged and 123 untagged) with evidence of predation marks (i.e., claws and teeth marks by raccoons) during three survey dates between July 30, 2020, and September 16, 2020 (B. Watson, VDWR, email to J. Stanhope, Service, September 16, 2020). Further surveys and data analysis are needed to determine the effects of the high predation rate on the Johns Creek subpopulation. B. Watson indicated he observed very high density of JSM in May 2020 and hypothesized that this made the mussels easier to find by predators; this pattern of very high density followed by high predation rates occurred in Little Oregon Creek. VDWR has contracted with the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services to proactively trap for raccoons at Little Oregon Creek, Dicks Creek, and Johns Creek.

In summary, predation by raccoons and muskrats is currently a localized but serious threat to JSM.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

The final listing rule indicated that Virginia State Law required a scientific collection permit for freshwater mussels, and that JSM was state listed as endangered in Virginia; however, the rule described limited protections provided by this state law and designation because "State laws are difficult to enforce and do not protect the species' habitat from the potential impacts of federal projects" (53 FR 27689-27693). There is new relevant information regarding existing regulatory mechanisms.

VDWR continues to require permits for collection and surveys of all freshwater mussels (live or shells), including state and federally listed species. Virginia State Law prohibits the taking, transporting, processing, selling, or offering to sale endangered or threatened species without a permit (section 29.1-564; https://law.lis.virginia.gov/vacodefull/title29.1/chapter5/article6/, accessed March 31, 2022). Since discovery of JSM, North Carolina has listed the species as endangered. The North Carolina Endangered Species Act (NC ESA) generally prohibits killing, harming, possessing, or trading protected species without a permit (North Carolina General Statutes section 113-337; https://law.justia.com/citations.html, accessed March 31, 2022), and regulates collection and commercial trade of species listed under the statute. The Virginia and North Carolina State Laws do not protect the species' habitat, and the NC ESA does not "limit the rights of a landholder in the management of his lands for agriculture, forestry, development or any other lawful purpose without his consent" (North Carolina General Statutes section 113-332). West Virginia does not have a state endangered species law; however, it is illegal to possess mussels or any parts of them (K. Eliason, WVDNR, *in* email from A. Silvis, WVDNR, to J. Stanhope, Service, March 8, 2021). In addition, the WVDNR implemented a standardized mussel protocol in 2012, which lists South Fork Potts Creek as a Group 2 mussel stream and therefore requires mussel surveys and (if necessary) salvage of all mussels before instream work. If this species is delisted, removing state protections might occur after independent state review, but would not automatically change with Federal status.

Under the authority of the Clean Water Act, EPA revised the water quality criteria for ammonia in 2013 (EPA 2013). Acute and chronic criteria were developed to protect organisms from both immediate effects, such as mortality, and longer-term effects on reproduction, growth, and survival, respectively. EPA provides several supporting documents to aid states considering adoption of the updated criteria, but North Carolina and West Virginia have not undertaken this effort. The Virginia Department of Environmental Quality issued updated ammonia surface water quality criteria in 2020 designed to provide protection to freshwater mussels and early life stages of fish; permitted dischargers, including wastewater treatment plants, are provided an extended period of time for compliance with the criteria (http://register.dls.virginia.gov/details.aspx?id=8059, accessed March 31, 2022). Although reducing ammonia from point sources will likely help to improve water quality in Virginia, reducing the contributions from non-point sources are more difficult to manage and control.

Also, recent studies indicate that pharmaceuticals and personal care products are commonly being discharged into surface waters and may be having acute and chronic impacts on aquatic species. For example, Fluoxetine, an often prescribed antidepressant drug, is increasingly being detected in surface waters at high enough levels that it can cause female mussels to discharge/abort undeveloped glochidia and has the potential to disrupt numerous other aspects of native mussel reproduction (Bringolf et al. 2010). However, very few, if any, treatment plants monitor for these contaminants, and there are no Federal or state standards regulating the discharge of pharmaceuticals or numerous other pollutants commonly found in wastewater discharges. At present, it is unknown if these contaminants are a threat to JSM.

FERC regulates a relatively small number of large dams in the U.S. (approximately 1,600 non-Federal dams that affect navigable waters) (https://www.ferc.gov/administration-and-compliance, accessed March 23, 2022).

At these dams, FERC regulates hydropower activities, including building, maintenance, and operation of hydroelectric dams, which includes 13 of the 39 dams in JSM range. Pursuant to the ESA, FERC is required to consult with the Service on new or amended hydropower activities that may affect federally listed species, including JSM. If a hydroelectric dam was licensed before listing of the species or the presence of the species was unknown, FERC will consider the effects of the hydropower operations during the relicensing process. For example, the Service and NCWRC are currently coordinating with FERC and the owners of Pinnacles Dam on the Dan River, before license expiration in 2031 (the notice of intent for license renewal is scheduled to begin in 2026, and the license application is due in 2029), to revise flow requirements necessary for recruitment and survival of JSM juveniles and adults. Without ESA protection for JSM, FERC would likely approve activities without requiring measures to avoid or minimize impacts to the species, and there would likely be a further reduction in JSM habitat quality and quantity and a resultant decrease in abundance and recruitment downstream of hydroelectric dams. There are 26 dams in the JSM range that are not regulated by FERC, and besides the ESA no mechanisms exist that provide regulatory protections for the JSM from threats associated with these dams.

Neither state laws nor the local governments with jurisdictions within the watersheds of streams supporting populations of the JSM currently have regulations/ordinances that are adequate to protect the species from many of the adverse effects of residential and commercial development, agriculture, and private forestry activities. For example, they generally do not restrict development in JSM watersheds or removal of trees in the vegetated buffers, therefore not addressing impacts to the streams' hydrograph, stormwater runoff of sediments and other non-point source pollutants, or degradation and loss of riparian buffers. The one exception is for watersheds in the James River basin, in which the Chesapeake Preservation Act and Regulations generally protect existing vegetated buffers no less than 100 feet wide adjacent to waterbodies with perennial flow, providing some protection of the riparian buffer, but does not protect area outside of the riparian buffer in the watershed that also affect water quality.

As described above, existing regulatory mechanisms continue to be inadequate to protect JSM from primary threats, including degraded water quality (e.g., contaminants, nutrients, and sediment from runoff and other non-point source discharges) and most dams. However, removing ESA protections would exacerbate the threats by removing requirements to implement measures that avoid and minimize impacts to the species and their habitat for projects with a Federal nexus, including FERC-regulated dams and construction projects requiring Corps permits, and by removing resources/funding to support propagation and other recovery efforts.

2.3.2.5 Factor E. Other natural or manmade factors affecting its continued existence:

The final listing rule described competition from high densities of nonnative Asian clam as a threat by potentially reducing availability of phytoplankton (JSM food source) and interfering with reproduction by filtering JSM sperm from the water column (53 FR 27689-27693). This was based on the temporal correlation between the disappearance of JSM in the James River and appearance and proliferation of Asian clam. There is new relevant information regarding the Asian clam and its spread to additional JSM waterbodies and other natural or manmade factors potentially affecting JSM.

Asian Clam: Since listing of JSM, nonnative Asian clam has continued to spread throughout JSM range in the James River and Roanoke River basins. As described in section 2.3.1.2 for Little Oregon Creek, the species was detected there in the mid-2010s and increased to high density in the late 2010s; however, effects from the Asian clam have not been assessed, and the JSM population appears to be thriving except for predation effects (B. Watson, VDWR, email to J. Stanhope Service, January 24, 2022). B. Watson also indicated there are high densities of Asian clam in Johns Creek where JSM is not observed (i.e., not in the mark-recapture sites in Johns Creek), but there are also a high number of notched rainbows, which are native. In addition, JSM abundance in Dicks Creek appears stable even though Asian clam has been documented in this waterbody.

Yeager et al. (2000) found that high densities of Asian clam affected survival and growth of rainbow mussel (*Villosa iris*) glochidia and juveniles in laboratory experiments. Another mechanism for how Asian clams may negatively affect freshwater mussels is water quality degradation (ammonia release and low dissolved oxygen) during mass Asian clam die-offs, which typically occur during summer droughts (Cherry et al. 2005). Haag (2019) reviewed potential causes of enigmatic declines of freshwater mussels and indicated that research is providing greater evidence of food competition by Asian clam with native freshwater mussels, but it does not explain why some streams with Asian clam, in particular in the Coastal Plain, continue to support native mussels. Haag et al. (2021) also found that juvenile mussel growth rate for four species in the Rockcastle River system in Kentucky was positively related to water temperature and negatively related to Asian clam abundance, providing likely evidence of food competition in relatively unproductive streams.

In summary, with high densities of Asian clam coexisting with some JSM populations, it is unclear if Asian clams are a current threat to JSM populations, and additional research is needed.

Climate Change: The Intergovernmental Panel on Climate Change (IPCC) predicts that many freshwater species face a greater threat of extinction, along with irreparable changes to the structure and function of freshwater ecosystems under projected climate change (IPCC 2014). Since the 1950s, the North

American climate trends demonstrate an increase in overall temperature and an increase in the number of heavy precipitation events (IPCC 2014, Wuebbles et al. 2017). Temperatures are expected to continue rising, and heat waves and extreme precipitation events are predicted to become more frequent, last longer, and become more intense by the mid-21st century (IPCC 2014, Wuebbles et al. 2017). Climate projections downscaled to the Southeast region, which overlaps with the JSM range and are based on 11 global climate models, indicate that the following climate variables will increase during the 2011-2050 period when compared to 1981-2005: average annual temperature (median of about 1.2°C), number of extreme hot days (median of about 20 days), percent change of annual precipitation (median of about 1 percent), and percent change of number of precipitation extremes (mean of about 11 percent; precipitation extreme is when "daily precipitation magnitude exceeds the climatological value of the 95th percentile of the baseline precipitation") (Ashfaq et al. 2016). Models developed for Virginia project average temperature increases from about 3°C to 6°C by 2100 (Kane et al. 2013).

With a warming climate, some studies predict an increase in the frequency of more intense hurricanes (e.g., category 4 and 5) by the end of the 21st century, in particular in the western Atlantic Ocean north of 20°N latitude (i.e., Cuba and north), which would likely cause periodic, extreme inland flooding events (Bender et al. 2010, Knutson et al. 2010), potentially resulting in loss of JSM habitat and populations, such as when the following negative effects occur: trees fall and block and change the flow of streams; streams experience extreme scour; upstream sediments flow into JSM-occupied reaches and bury JSM; and JSM move out of suitable habitat. Hurricanes may also cause dam or impoundment failures, which could adversely affect important JSM populations such as Little Oregon Creek, Dicks Creek, Johns Creek, and Rocky Creek. Extreme drought may negatively affect JSM by reducing river flow and leaving JSM stranded when stream width decreases. However, minor temperature increases may be beneficial to JSM by promoting growth and increasing phytoplankton production (a food source), although we are unaware of specific information about JSM temperature tolerances. High temperature increases are likely harmful to JSM. When propagating JSM, mortality of juvenile JSM in culture was observed during two power outages in the summer and water temperatures increased significantly; the water temperatures were not measured but likely in the high 20ºC's (R. Mair, Service, email to J. Stanhope, Service, November 9, 2022). Based on modeled, downscaled projections of multiple climate variables, Kane et al. (2013) predicted that the modeled current species distribution in Virginia (i.e., percentage of mapped area in Virginia where the species is likely to be located) will increase from 4.6 percent to 18.7 percent and 24.2 percent by 2050 and 2100, respectively. They predicted that climate conditions will become more favorable for JSM, although they did not account for changes in water quality and quantity due to climatic effects (e.g., runoff, reduced baseflow). The effects on host fish will depend on whether they are cool- or warm-water species, with cool-water species having variable responses and warm-water species potentially benefiting and expanding distribution (Conte et al. 2013). If host fish have different thermal tolerances than JSM, increased stream temperatures may potentially decouple mussel-host relationships and cause mussel population decline (Pandolfo et al. 2012).

In summary, effects of climate change related to increased flooding have been observed and are likely to increase, but other effects, such as temperature increase, are less clear and may or may not have negative impacts on JSM.

2.4 Synthesis

Since the 1990 recovery plan, the JSM has a wider spatial distribution than previously known. Additional surveys have revealed that the spatial distribution extends to the Upper Dan subbasin in the Roanoke River basin (NC, VA) and HUC12 subwatersheds in the Upper James, Middle James-Buffalo, and Rivanna subbasins (VA). The JSM historical and current range is in the James River basin in Virginia and West Virginia and the Roanoke River basin in Virginia and North Carolina. Based on number of waterbodies (not river miles), approximately 70 percent of all historically occupied waterbodies (26 of 37) are currently or likely occupied by JSM. Conversely, approximately 30 percent of all historically occupied waterbodies (11 of 37) are presumed or possibly extirpated, increasing from 5 to 11 waterbodies from 1990 to 2021 (120 percent increase).

Although there is an increase in spatial distribution and number of currently occupied waterbodies, JSM generally occurs in relatively low density and abundance (<10 individuals) at many sites across its range, and often just one individual is found at a site or reach. Of the currently or likely occupied waterbodies (26 total), 27.0 percent have very low approximate abundance (1 to 10 individuals), 21.6 percent have low approximate abundance (11 to 100 individuals), and 21.6 percent have moderate and higher approximate abundance (>100 individuals), based on the last 20 years (2002-2021). This time frame was chosen based on the assumption that the lifespan for JSM is 15 to 20 years. The waterbodies with very low or low approximate abundances usually have low density and patchy distribution over the river or stream. Low density populations may lead to a loss of recruitment due to the distance between individual mussels being too great for successful reproduction and may contribute to loss of genetic variability. There are 8 waterbodies with the moderate and higher abundance estimates: South Forks Potts Creek in West Virginia (note: the range [31 to 339 individuals from 1987 to 2021] includes low approximate abundance); Little Oregon Creek, Dicks Creek, Johns Creek, Mill Creek, and Rocky Creek in Virginia; Dan River in North Carolina; and South Fork Mayo River in Virginia and North Carolina.

Based on multiple years of monitoring over at least a 10-year time period, the species is reproducing and considered stable (with large variation) or increasing in four waterbodies in the James River basin (South Fork Potts Creek, Dicks Creek, Johns Creek, and Mill Creek). The JSM population in Rocky Creek is reproducing and considered stable, but monitoring has occurred for less than 10 years. JSM is decreasing or possibly decreasing in four waterbodies: two in the James River basin (Little Oregon Creek, Rock Island Creek) and two in the Roanoke River basin (Dan River, Mayo River). For most of the waterbodies listed above, JSM is predominately found in single, small reaches, ranging from 0.1 to 1.4 km in length, making them susceptible to an adverse event that could eliminate the high density reaches of JSM within a waterbody. More than half of the waterbodies with JSM present have an unknown population trend due to the lack of monitoring data over time.

Across the range, JSM occupies 52 percent (32 of 61) of the historically occupied HUC12s, of which 23 were discovered since 1990 due to increased survey effort. Within the James River basin, JSM is extant in 80 percent of subbasins (4 of 5) and occupies 42 percent (20 of 48) of the historically occupied HUC12s; the Middle James-Willis subbasin remains unoccupied (0 of 3) and the Maury subbasin has only 20 percent (1 of 5) of its HUC12s occupied. Within the Roanoke River basin, with one subbasin, JSM is extant and occupies 92 percent (12 of 13) of the historically occupied HUC12s. When examining the distribution of waterbodies/subpopulations by approximate abundance in 2021, the Upper James subbasin has the most waterbodies/subpopulations with moderate or greater approximate abundance, which are concentrated in the southwestern portion of the subbasin (4 total; 26.7 percent of historically occupied waterbodies/subpopulations in the subbasin). For the Maury and Rivanna subbasins, they have only one waterbody/subpopulation each with moderate approximate abundance (33.3 percent and 7.7 percent of historically occupied waterbodies/subpopulations, respectively in their subbasin). The Middle James-Buffalo subbasin has only waterbodies with low (50.0 percent), very low (16.7 percent), and none (33.3 percent) approximate abundance. In the Roanoke River basin, its only subbasin, the Upper Dan, has two waterbodies with moderate approximate abundance (40.0 percent of historically occupied waterbodies in the subbasin). The waterbodies/subpopulations with moderate or greater approximate abundance are widely distributed throughout JSM's range. In terms of distribution across physiographic provinces, JSM currently occupies 33.3 percent, 75.0 percent, and 66.7 percent of the historically occupied HUC12s in the Valley and Ridge, Blue Ridge, and Piedmont, respectively.

Propagation efforts have been successful in augmenting populations with juvenile JSM. The Mill Creek population has doubled and the abundance in the Cowpasture River has significantly increased from 5 to at least 111 individuals. Other JSM waterbodies have been augmented with propagated juvenile JSM, but monitoring data are being analyzed or monitoring has not been conducted yet to assess success; these waterbodies include Craig Creek, Pedlar Creek, Rock Island Creek, and Tye River in Virginia and Mill Creek in North Carolina.

The habitat requirements for JSM described in the 1990 recovery plan and Hove (1990) appear relatively unchanged since then. It was indicated that JSM occupies streams varying from 1.5-m to 23-m wide and 0.15-m to 2-m deep, and with the discovery of JSM in the Roanoke River Basin, JSM currently occupies rivers with greater width (i.e., up to 80 m). The species continues to be found in a range of substrates, including sand, gravel, and cobble with or without boulders, pebbles, or silt (Service 1990, Hove 1990). The water velocity at sites supporting this species is slow to moderate, in pools to riffles/runs. Some dams or impoundments (e.g., low-head dams, earthen dams, farm ponds) on lower order streams (i.e., in the headwater area) appear to be providing beneficial effects to JSM and its habitat in Little Oregon Creek, Dicks Creek, Johns Creek, and Rocky Creek, which are streams with documented higher JSM density and abundance. The dams are potentially providing hydraulic stability, greater food availability, and increased water temperature from the impounded water. Multiple species distributions models for JSM have been developed, with predictor variables related to streamflow and landcover (e.g., less agriculture and developed landcover).

Results of genetic studies suggest that JSM is the same species throughout its range in the Dan River subbasin of the Roanoke River basin and James River basin, but the species should be managed as separate units. Although initial genetic analyses suggested that JSM from the Dan River and South Fork Mayo River in the Roanoke River basin may be exchanged, new genetic analyses suggest that they are relatively highly differentiated, likely due to two large dams between them on the Mayo River. Initial analysis indicates there are also some genetic differences among populations in the James River basin, and inbreeding is generally high across all populations in both basins; further analysis of the data is required to make additional conclusions on genetic diversity and structure of the populations. JSM is a distinct species from other freshwater mussels with spines and other freshwater mussels in the Pleurobemini tribe and forms a new monophyletic clade with the TRS in a new genus named *Parvaspina*.

The final listing rule described habitat modification as a major threat to JSM and the cause of its decline (53 FR 27689-27693). Adverse habitat changes were caused by dam construction, industrial pollution, chemical spills, channelization, agricultural runoff (including pesticides and fertilizers), and sewage discharges at multiple locations within the species' historical range in the James River basin. The final listing rule also indicated erosion and siltation from logging operations in the upper Craig Creek watershed and other locations as a threat to habitat. Recent information indicates that dams and activities related to land use modification remain threats throughout the species range and are expected to continue in the future. While construction of new dams is unlikely a current threat, most dams continue to be a threat by reducing connectivity and isolating JSM populations, reducing habitat quality and quantity, and changing hydrologic flow regime downstream of the dam. Water quality issues due to land use modification, in particular sedimentation/turbidity, nutrients, and contaminants, are widespread threats to JSM, while instream construction activities and livestock access to streams are localized threats in numerous JSM waterbodies. Severe flooding/stormflow events are also localized but serious threats to JSM for at least four JSM waterbodies (Rock Island Creek, Craig Creek, North Fork Rivanna River, and Dan River). Land use changes, in particular increased development and impervious surface in watersheds, alter flow regimes and contribute to greater frequency and intensity of severe flood events. The threats of land disturbance activities are likely to increase in the future with the extent of urban sprawl projected to increase 101 to 192 percent in the next 50 years for the southeastern United States.

The final listing rule described competition from high densities of nonnative Asian clam as a threat by potentially reducing food availability and interfering with reproduction. With high densities of Asian clam coexisting with some JSM populations, it is unclear if Asian clams are a current threat to JSM populations, and additional research is needed. Inadequacy of existing regulatory mechanisms was also described in the final listing rule. Existing regulatory mechanisms continue to be inadequate to protect JSM from primary threats, including degraded water quality (e.g., contaminants, nutrients, and sediment from runoff and other non-point discharges) and most dams. However, removing ESA protections would exacerbate the threats by removing requirements to implement measures that avoid and minimize impacts to the species and their habitat for projects with a Federal nexus, including FERC-regulated dams and construction projects requiring Corps permits, and providing resources/funding to support propagation and other recovery efforts.

New threats to JSM include predation and climate change effects. Predation by raccoons and muskrats is currently a localized but serious threat to JSM. Effects of climate change related to increased flooding have been observed and are likely to increase, but other effects, such as temperature increase, are less clear and may or may not have negative impacts on JSM.

The Service established a framework in which we consider what a species needs to maintain viability over time by characterizing the biological status of the species in terms of its Resiliency, Redundancy, and Representation ("the 3 Rs"; Smith et al. 2018). **Resiliency** means having sufficiently healthy populations for the species to withstand stochastic events (arising from random factors). We can measure resiliency based on metrics of population health; for example, population size, if that information exists. Resilient populations are better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in rainfall (environmental stochasticity), and the effects of human activities. **Redundancy** means having a sufficient number of populations for the species to withstand catastrophic events (such as a rare destructive natural event or episode involving many populations). Redundancy is about spreading the risk and can be measured through the duplication and distribution of populations across the range of the species. Generally, the greater the number of populations a species has distributed over a larger landscape, the better it can withstand catastrophic events. **Representation** means having the breadth of genetic makeup of the species to adapt to changing environmental conditions. Representation can be measured through the genetic diversity within and among populations and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes (natural or human caused) in its environment. Table 8 summarizes the information provided in this report in terms of the 3 Rs.

Table 8. Resiliency, redundancy, and representation (3Rs) for James spinymussel and its current condition

3Rs	Requisites	Description	Current Condition
Resiliency (ability to withstand stochastic events)	Healthy populations and habitat.	Populations (waterbodies) with: • Excellent water quality, • Suitable instream substrate: clean sand, gravel, and cobble, • Sufficient water quantity with slow-to-moderate current to maintain healthy habitat and water quality, • Healthy riparian and adjacent upland habitat, and • Connectivity — waterways without significant barriers between populations.	Each population (waterbody) with moderate to high approximate abundance is thought to be healthy and have adequate habitat, thus has moderate or high resiliency, respectively. • 26 of 37 waterbodies (70.3%) are likely or currently occupied by JSM. • Approximate abundance status: – 2 waterbodies (5.4%) high – 3 waterbodies (8.1%) moderate to high – 3 waterbodies (8.1%) moderate – 8 waterbodies (21.6%) low – 10 waterbodies (27.0%) very low – 11 waterbodies (29.7%) none (possibly extirpated or historical)

3Rs	Requisites	Description	Current Condition
Redundancy (ability to withstand catastrophic events)	Sufficient distribution of healthy populations.	Sufficient distribution of healthy populations to prevent catastrophic losses of species' adaptive capacity due to natural events (e.g., severe flood, drought). Multiple healthy populations and occupied HUC12s within the species' range are important for the species' redundancy.	• Healthy populations (waterbodies with moderate to high approximate abundance) found throughout range but limited in spatial extent and not evenly distributed: none in the central and eastern portions of the range. • In the James River basin – loss of occupied HUC12s mostly in the: o eastern and some central portions of range (historically; prior to 1990) o western portion of the range (since 1990) • Overall, increase in total number of occupied HUC12s, predominantly in the northern and southern portions of range due to new discoveries.
Redundancy (ability to withstand catastrophic events)	Sufficient number of healthy populations.	Sufficient number of healthy populations and occupied HUC12s to prevent catastrophic losses of adaptive capacity.	• 8 of 37 waterbodies (21.6%) have moderate to high approximate abundance across the range. – James basin: 6 of 32 (18.8%) have moderate to high approximate abundance. 7 of 32 (21.9%) have low approximate abundance. – Roanoke basin: 2 of 5 (40.0%) have moderate to high approximate abundance. 1 of 5 (20.0%) have low approximate abundance. • 32 of 61 HUC12s (52.5%) currently or likely occupied.
Representation (ability to adapt)	Sufficient capacity to adapt to new, continually changing environments.	Genetic diversity within and among populations contribute to and maintain adaptive capacity. Occupied subbasins and HUC12s distributed across the range, including the ecological diversity of river basins and physiographic provinces that contribute to and maintain adaptive capacity. Adequate dispersal ability for the species to migrate to suitable habitat and climate over time.	Connected and occupied HUC12s found in both river basins and in all physiographic provinces, but lower proportion of them in the James River basin and Valley and Ridge province. **River basin:** • James – 20 of 48 HUC12s (42.0%) occupied. 4 of 5 (80%) subbasins occupied. Middle-James Buffalo subbasin presumed extirpated and Maury subbasin only has 1 of 5 HUC12s occupied. • Roanoke – 12 of 13 HUC12s (92.3%) occupied. 1 of 1 subbasin occupied. **Physiographic province:** • Valley and Ridge – 8 of 24 HUC12s (33.3%) occupied. • Blue Ridge – 2 of 4 HUC12s (50.0%) occupied. • Piedmont – 22 of 33 HUC12s (66.7%) occupied.

When assessing the 3 Rs, 70.3 percent of historically occupied waterbodies (26 of 37) are currently or likely occupied by JSM; however, the health (resiliency) of those waterbodies varies across the range, with 21.6 percent of historically occupied JSM waterbodies (8 of 37) considered healthy (i.e., moderately to highly resilient, based on approximate abundance) (table 8). They are found throughout the range but are limited in number and spatial extent and not evenly distributed (redundancy). No healthy populations are found in the eastern and central portions of the range. There is a loss of occupied HUC12s in the eastern and some central portions of the range prior to 1990 and western portion of the range since 1990. However, there is an overall increase in the total number of occupied HUC12s, predominantly in the northern and southern portions of the range. With genetic analyses in progress, we assume that the species' representation requirements are best met by retaining its distribution within the river basins and physiographic provinces. The species occurs in connected HUC12s in both river basins and all physiographic provinces, but it occupies only 42.0 percent of the historically occupied HUC12s in the James River basin (20 of 48), with the Middle-James Buffalo subbasin presumed extirpated and Maury subbasin having only one HUC12 occupied (1 of 5). The Valley and Ridge province also lost the most representation with 33.3 percent of historically occupied HUC12s occupied (8 of 24).

The primary factors influencing the current status include existing dams, activities related to land use modification (e.g., alteration of the natural landscape, including, but not necessarily limited to, land conversion for development and its associated infrastructure [roads, bridges, utilities], forestry activities, and agricultural activities, including livestock access to streams), severe flooding/stormflow events, predation, and climate change effects. The threats with the most potential to increase and affect species viability in the future are development and impervious surfaces in watersheds (Terando et al. 2014) (i.e., affecting water quality and stormflow events) and flooding and droughts due to climate change (Bender et al. 2010, Knutson et al. 2010, Ashfaq et al. 2016). Applying the definitions of viability and probabilities of persisting for element occurrences from Nature Serve (2020), we assume that waterbodies with moderate to high approximate abundance have good to excellent viability and are likely to very likely to persist, respectively, if current conditions prevail. We assume waterbodies with low approximate abundance have fair viability and an uncertain probability of persisting and waterbodies with very low approximate abundance have poor viability and a poor probability of persisting and a high risk of extirpation, if current conditions prevail. In projecting a likely future scenario with predicted increased development and climatic changes and no conservation measures implemented, we predict good to excellent viability waterbodies will have sufficient resiliency to persist for the foreseeable future. We predict waterbodies with fair viability and greater developed landcover (e.g., ≥ 5 percent in a subwatershed in 2019) and waterbodies with poor viability are likely to be extirpated if further stressed by predicted changes in land cover and climatic patterns that may result in decreased water quality and increased floods/drought. We also predict HUC12s will likely become extirpated when the entire waterbody is predicted to become extirpated. There is significant uncertainty in the likelihood of the future scenario driven by many uncertainties associated with predicting climate effects (discussed in section 2.3.2.5) and land cover changes (Terando et al. 2014); however, we consider it a conservative approach by assuming waterbodies that currently have fair resiliency in more developed watersheds or poor resiliency in any watershed will not be able to tolerate the additional stress imposed by reduced water quality and climatic changes to their habitats and be extirpated. This is also a conservative approach because we are assuming no conservation measures will be implemented; however, we believe it is possible that efforts such as propagation, augmentation, and reintroduction will continue if there is funding because VDWR and the Service have been successfully conducting these efforts the past 10 years.

In our future scenario, we project 12 additional waterbodies in the James River basin and two additional waterbodies in the Roanoke River basin will likely be extirpated, leaving 12 of 37 waterbodies (32.4 percent of historically occupied waterbodies) remaining across three states. As a result, 22 waterbodies (68.8 percent) and 3 waterbodies (60.0 percent) total in the James and Roanoke River basins, respectively, will likely be extirpated when including waterbodies that are currently possibly extirpated or historical. We project a loss of 17 occupied HUC12 subwatersheds, leaving 29.5 percent (18 of 61) of the historically occupied HUC12s remaining, and redundancy will be reduced (figure 8). The species will continue to occur in both river basins, but representation will be lost in the Blue Ridge with no occupied HUC12s (0 of 4) and only 18.8 percent of the historically occupied HUC12s in the James River basin (9 of 48) will be extant. The Middle James-Buffalo and Rivanna subbasins will lose the most HUC12s, which are in the central and northeastern portions of the range, with 11.1 percent (1 of 9) and 9.1 percent (1 of 11) of historical occupied HUC12s remaining, respectively.

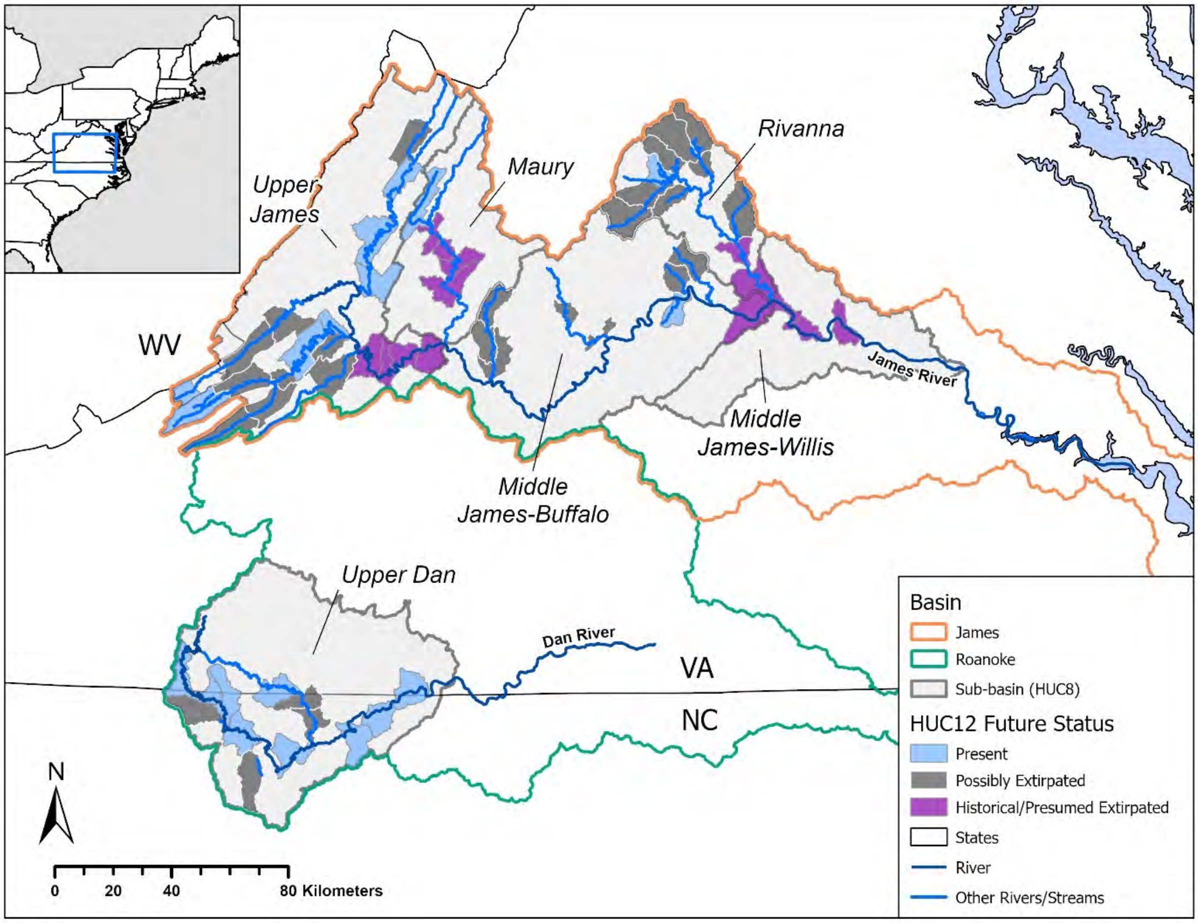

Figure 8. Future status of JSM by HUC12 subwatersheds. Subbasins are labeled.

In summary, as a whole, the rangewide status of the species has improved, with an increased number of waterbodies and HUC12 subwatersheds occupied by JSM and the range expanded to the Roanoke River basin. However, the JSM continues to face ongoing and likely increasing threats to its continued existence throughout its range. JSM population trends across the range are variable, ranging from stable/increasing in six waterbodies in the James River basin to decreasing or possibly decreasing in five waterbodies in both the James River and Roanoke basins. For more than half of the waterbodies with JSM present (13 of 24), the population trend is unknown due to the lack of sufficient monitoring data. Although only one of the three reclassification criteria has been met, the 3 Rs assessment provides additional information to characterize the biological status of the species. In addition, the third criterion (1C) is not objective, measurable, and quite possibly not achievable.

When evaluating the status of the species and current and future threats, we conclude that the JSM does not meet the definition of an endangered species but does meet the definition of a threatened species under the ESA[4].

[4] The ESA defines an endangered species as a species that is "in danger of extinction throughout all or a significant portion of its range," and a threatened species as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

3.0 RESULTS

3.1 Recommended Classification:

__X_ Downlist to Threatened
____ Uplist to Endangered
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11*):
____ *Extinction*
____ *No longer meets the definition of threatened or endangered*
____ *No longer meets the definition of a species*
____ No change is needed

3.2 New Recovery Priority Number: No change

Brief Rationale: The species continues to experience a moderate degree of threat and has a high recovery potential if recommendations for future actions are implemented.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Clarify recovery criteria 1C and 2E to support objective evaluation and achievability and 2D to reflect current information. Criterion 1C is too general and merits clarification because as written, it is quite possibly not achievable to protect all known populations of the species from present and foreseeable anthropogenic and natural threats that may interfere with their survival. Criterion 2E is too specific and is based on demonstrating success based on habitat protection strategies; this criterion should be clarified to include other recovery tools, such as propagation, augmentation, stream restoration, predator trapping, and modification or removal of dams. Criterion 2D should be clarified to include the Roanoke River basin.

Recommendations for specific recovery actions and priority number (1-3, based on priority number definitions in the JSM recovery plan [Service 1990]):

Recommendations for specific research and data needs

1. Continue long-term, systematic monitoring of JSM populations to improve measurement and understanding of demographic vital rates (e.g., population density and size, recruitment rate, survival rate, fecundity, maturity schedule, age structure, sex ratio), population trends, and changes in populations in response to threats and management actions [Priority 1].
2. Conduct a population viability analysis to define what is a viable population and to inform management decisions [Priority 1].
3. Continue genetic analyses of JSM populations to assess genetic diversity and to support development of propagation plans and a genetic management plan [Priority 2].
4. Continue to assess and survey occurrence streams for JSM, in particular sites that have not been surveyed in more than 15 years, and identify opportunities for JSM recovery [Priority 2].
5. Continue to conduct research and monitoring to determine the effects of water quality and other stressors/threats, including effects of hydropower peaking operations and Asian clam, on JSM population dynamics [Priority 2].

Recommendations for conservation actions:

1. Protect and maintain the dams on lower order streams, including Little Oregon Creek, Dicks Creek, and Johns Creek, that appear to be providing beneficial effects to JSM and its habitat [Priority 1].
2. With the state natural resource agencies, identify opportunities for population augmentation to extant waterbodies and reintroduction to historical waterbodies and finalize a captive propagation plan and site-specific augmentation/reintroduction plans for the JSM [Priority 2].
3. With State and Federal agencies and partners, work to reduce the impacts of dams restricting connectivity and affecting the hydrologic flow regime downstream of the dam, including FERC-licensed hydroelectric dams. Actions may include removing all or part of the dam, revising flow requirements during the FERC relicensing process, and reopening FERC licenses with exemptions (e.g., non-expiring) on waterbodies where JSM was discovered after the exemption was issued [Priority 2].
4. With the partners, actively promote water quality improvement, stream riparian buffer preservation and establishment, and stream preservation and restoration (if appropriate) projects in the James (i.e., Rivanna subbasin, Little Oregon Creek, Mill Creek, Johns Creek, Craig Creek, Rock Island Creek) and Roanoke River (i.e., Dan River, Mayo River, and South Fork Mayo River) basins. Focus on stream and riparian restoration projects that improve agricultural practices in areas that are somewhat degraded and can be improved, including but limited to: Little Oregon Creek, Mill Creek, South Fork Potts Creek, Pedlar River, Tye River, Johns Creek, Dan River, and South Fork Mayo River [Priority 2].
5. Maintain and increase the present populations through watershed-level conservation approaches that address sediment, nutrient, and contaminant loading and stormwater flows. Work with partners to preserve and improve ecological processes that provide the water quality and quantity and habitat required for the JSM and participate in watersheds planning with Virginia, North Carolina, and West Virginia [Priority 3].

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the James spinymussel *(Parvaspina collina)*

Current classification: Endangered

Recommendation resulting from the 5-Year Review:

__X_ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Jennifer Stanhope, Virginia Field Office

LEAD REGIONAL OFFICE APPROVAL

Assistant Regional Director, Fish and Wildlife Service

Approve ____ Date _________

APPENDIX A: COORDINATION LIST OF PARTNERS AND EXPERTS

The following partners and experts were contacted for information to support the 5-year review and provided responses, in addition to those listed in Section 1.1 (Reviewers):

State agencies

- North Carolina Natural Heritage Program (Judith Ratcliffe*)
- North Carolina Wildlife Resources Commission (Michael Perkins*)
- Virginia Department of Conservation and Recreation, Division of National Heritage (Rene' Hypes)
- Virginia Department of Wildlife Resources (Brian Watson*)
- West Virginia Division of Natural Resources (Alexander Silvis, Kevin Eliason*)

Other

- Daguna Consulting (Brett Ostby*)
- James Madison University (Christine May)

*All State and other partners listed above were provided the opportunity to review a draft 5-year review document. Those with an * provided comments or a response that they had no comments.

APPENDIX B: OCCURRENCE WATERBODIES OF JAMES SPINYMUSSEL

Table B-1. Part 1 of detailed population information on James spinymussel waterbodies and subpopulations/areas. Pop=population; Approx.=approximate ND=not detected; PoExt=Possibly Extirpated; PreExt=Presumed Extirpated.

Basin/Sub-basin (HUC8)	Waterbody	Area/Sub-population[1]	County	State	Pop status in 1990 recovery plan[1]	Pop status in 2008 draft 5-Year Review[2]	Pop status in 2021[3]	Approx. abundance size (if present) [3]	Live JSM last observed	Last Surveyed	Estimated river length (km) where all live JSM were found in last 20 years (2002-2021)	Number of live JSM found in last observation year	Cumulative number of live JSM observed in last 20 years (2002-2021). Range provided if based on estimates from (A) repeated surveys, (B) mark-recapture study (C) density.
James River Basin													
Upper James	South Fork Potts Creek		Monroe	WV	Present	Present	Present	Low to high	2021	2021	most within 1.4-km reach, all in 5.8 km	85	range: 31-339 (A) (# of reaches surveyed varied)
Upper James	Potts Creek		Craig, Alleghany	VA	Present	ND/ PoExt	ND/ PoExt	None	1990	2006	None	2	None
Upper James	Cowpasture River		Bath, Alleghany	VA	Not reported	Present	Present	Low to moderate	2006 (wild); 2021 (propagated)	2017 (wild); 2021 (propagated)	most within 0.1 km reach, all in 50 km (wild); 0.1 km (1 site; propagated)	1 (wild); 111 (propagated)	5 (wild); range (propagated): 61-111 (A)
Upper James	Bullpasture River		Highland	VA	Not reported	Present	Likely present	Very low	2006	2019	1.4 km	5	5
Upper James	Little Oregon Creek		Craig	VA	Not reported	Present	Present	High	2021	2021	0.2 km	estimated 771 in 2019 in 0.1-km reach[4]	range: 646-2003 (B)
Upper James	Dicks Creek		Craig	VA	Present	Present	Present	Moderate to high	2021	2021	1.0 km	estimated 373 in 2019 in 0.05-km reach[4]	range: 197-544 (B)
Upper James	Johns Creek	Near Maggie	Craig	VA	Present	Present	Present	High	2021	2021	most within 0.1-km reach, all in 8.3 km	estimated 758 in 2019 in 0.1-km reach[4]	range: 398-1043 (B)
Upper James		Along Sevenmile Mountain	Craig	VA	Present	Present	Present	Low	2007	2021	0.5 km	12	12
Upper James	Craig Creek	near New Castle	Craig	VA	Present	ND/ unknown	ND/ PoExt	None	1987	2012	None	3	None

Basin/Sub-basin (HUC8)	Waterbody	Area/Sub-population [1]	County	State	Pop status in 1990 recovery plan[1]	Pop status in 2008 draft 5-Year Review[2]	Pop status in 2021[3]	Approx. abundance size (if present) [3]	Live JSM last observed	Last Surveyed	Estimated river length (km) where all live JSM were found in last 20 years (2002-2021)	Number of live JSM found in last observation year	Cumulative number of live JSM observed in last 20 years (2002-2021). Range provided if based on estimates from (A) repeated surveys, (B) mark-recapture study (C) density.
Upper James		Craig Creek near Silent Dell	Botetourt	VA	Present	Present	Present	Low	2019	2019	17.6 km	2	17 in 2 reaches; range: 1-9 (estimated based on mark-recapture study at 2 additional sites)
Upper James		Craig Creek near Eagle Rock	Botetourt	VA	Present	ND/ unknown	ND/ unknown	None	1988	1999	None	19	None
Upper James	Patterson Creek		Botetourt	VA	Present	ND/ PoExt	ND/ PoExt	None	1988	2004	None	1	None
Upper James	Catawba Creek		Botetourt	VA	Present	ND/ PoExt	ND/ PoExt	None	1988	2007	None	3	None
Maury	Calfpasture River		Rockbridge	VA	Historical	ND/ PreExt	ND/ PreExt	None	1845	2017	None	Unknown	None
Maury	Maury River		Rockbridge	VA	Historical	ND/ PreExt	ND/ PreExt	None	1845	2017	None	Unknown	None
Maury	Mill Creek		Bath	VA	Historical	Present	Present	Moderate to high	2021	2021	most within 1.3-km reach, all in 9.7 km	estimated 171 (wild) and 197 (propagated) in 2021 within 0.16-km reach [4]	range (wild): 65-214; (propagated): 99-309 (B)
Middle James-Buffalo	Pedlar River		Amherst	VA	Present	Present	Present	Low	2021	2021	11.3 km	1	49
Middle James-Buffalo	Hardware River		Fluvanna, Albemarle	VA	Not reported	Present	Present	Very low	2019	2021	1.0 km	1	9
Middle James-Buffalo	Rock Island Creek		Buckingham	VA	Not reported	Not reported	Present	Low	2021	2021	most within 2 non-adjacent reaches (#1: 0.2 km, #2: 0.1 km); all occurrences in 2.1 km	estimated 58 native JSM in 2018 in 0.2-km reach (reach #1)[4, 5]	range: 40-58 (B) (at reach #1) [5]

Basin/Sub-basin (HUC8)	Waterbody	Area/Sub-population [1]	County	State	Pop status in 1990 recovery plan[1]	Pop status in 2008 draft 5-Year Review[2]	Pop status in 2021[3]	Approx. abundance size (if present) [3]	Live JSM last observed	Last Surveyed	Estimated river length (km) where all live JSM were found in last 20 years (2002-2021)	Number of live JSM found in last observation year	Cumulative number of live JSM observed in last 20 years (2002-2021). Range provided if based on estimates from (A) repeated surveys, (B) mark-recapture study (C) density.
Middle James-Buffalo	Tye River		Nelson	VA	Not reported	Not reported	Present	Low	2019	2019	2.2-km reach	4 in 2019; 12 in 2018	26 [6]
Middle James-Buffalo	Totier Creek (relic shells)		Albemarle	VA	Not reported	Not reported	ND/ PoExt	None	unknown	2017	None	None	None
Rivanna	Mechums River		Albemarle	VA	Present	Present	Present	Very low	2021	2021	0.1 km (1 site)	2	4
Rivanna	Moormans River		Albemarle	VA	Present	ND/ PoExt	ND/ PoExt	None	1990	2005	None	7	None
Rivanna	Wards Creek (mis-identified as Rocky Run [Moormans River])		Albemarle	VA	Present	Present	Present	Low	2011	2017	0.8 km	2	15
Rivanna	Rocky Creek		Albemarle	VA	Not reported	Present	Present	Moderate to high	2021	2021	3.0 km	36 in 2021; 80 in 2019	range: 236-1153 (C) (95% confidence interval in 0.35-km reach)
Rivanna	Buck Mountain Creek		Albemarle	VA	Not reported	Present	Present	Very low	2021	2021	7.8 km	3	9
Rivanna	Piney Creek		Albemarle	VA	Not reported	Present	Present	Very low	2012	2021	0.1 km (1 site)	1	1
Rivanna	Ivy Creek		Albemarle	VA	Not reported	Present	Present	Very low	2011	2012	0.1 km (1 site)	2	2
Rivanna	NF Rivanna River		Albemarle	VA	Not reported	Present	Present	Very low	2015	2015	5.2 km	2	4

Basin/Sub-basin (HUC8)	Waterbody	Area/Sub-population [1]	County	State	Pop status in 1990 recovery plan[1]	Pop status in 2008 draft 5-Year Review[2]	Pop status in 2021[3]	Approx. abundance size (if present) [3]	Live JSM last observed	Last Surveyed	Estimated river length (km) where all live JSM were found in last 20 years (2002-2021)	Number of live JSM found in last observation year	Cumulative number of live JSM observed in last 20 years (2002-2021). Range provided if based on estimates from (A) repeated surveys, (B) mark-recapture study (C) density.
Rivanna	Swift Run		Albemarle, Greene	VA	Not reported	Present	Present	Low	2019	2019	9.1 km	5	cumulative: 75 (2003-2012); range: 5-24 (A) (2011-2019)
Rivanna	Unnamed tributary to Swift Run				Not reported	Not reported	Present	Very low	2017	2019	0.1 km (1 site)	1	1
Rivanna	Welsh Run		Greene	VA	Not reported	Present	Likely present	Very low	2005	2019	0.7 km	2	2
Rivanna	Rivanna River	near Columbia, Palmyra, and Crofton	Fluvanna	VA	Historical	ND/ PreExt	ND/ PreExt	None	1968	2011	None	Unknown	None
Rivanna	Mechunk Creek (relict shell)		Fluvanna	VA	Not reported	Not reported	ND/ PoExt	None	unknown	2007	None	Unknown	None
Upper James (mainstem)	James River	James River at Buchanan	Botetourt	VA	Historical	ND/ PreExt	ND/ PreExt	None	pre-1967	2021	None	Unknown	None
Upper James (mainstem)		James River Bridge near Natural Bridge	Rockbridge	VA	Historical	ND/ PreExt	ND/ PreExt	None	pre-1967	2005	None	Unknown	None
Middle James-Buffalo (mainstem)		James River at New Canton	Buckingham, Fluvanna	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2018	None	Unknown	None
Middle James-Willis (mainstem)		James River at Columbia	Fluvanna, Cumberland	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2012	None	Unknown	None
Middle James-Willis (mainstem)		James River at Pemberton and Cartersville	Goochland, Cumberland	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2012	None	Unknown	None
Middle James-Willis (mainstem)		James River at Rock Castle	Goochland, Powhatan	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2013	None	Unknown	None

Basin/Sub-basin (HUC8)	Waterbody	Area/Sub-population [1]	County	State	Pop status in 1990 recovery plan[1]	Pop status in 2008 draft 5-Year Review[2]	Pop status in 2021[3]	Approx. abundance size (if present) [3]	Live JSM last observed	Last Surveyed	Estimated river length (km) where all live JSM were found in last 20 years (2002-2021)	Number of live JSM found in last observation year	Cumulative number of live JSM observed in last 20 years (2002-2021). Range provided if based on estimates from (A) repeated surveys, (B) mark-recapture study (C) density.
Middle James-Willis (mainstem)		James River opposite Maidens	Goochland, Powhatan	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2012	None	Unknown	None
Middle James-Willis (mainstem)		James River at Maidens	Goochland, Powhatan	VA	Historical	ND/ PreExt	ND/ PreExt	None	1966	2012	None	Unknown	None
Roanoke River Basin													
Upper Dan	Dan River		Stokes, Rockingham	NC	Not reported	Present	Present	Moderate	2019	2019	most within 35-km reach; all in 142.4 km	13	200 in about 35-km reach [7]
Upper Dan	Big Creek (shell)		Stokes	NC	Not reported	Not reported	ND/ PoExt	None	unknown	2019	None	None	None
Upper Dan	Mill Creek		Stokes	NC	Not reported	Not reported	Present	Very low	2018	2019	0.1 km (1 site)	1	1 [8]
Upper Dan	South Fork Mayo River		Patrick, Henry (VA); Rockingham (NC)	VA, NC	Not reported	Present	Present	Moderate	2012	2016	18.9 km	3	103-114 [9]
Upper Dan	Mayo River		Rockingham	NC	Not reported	Present	Present	Low	2016	2019	21.3 km	2	23

[1] From U.S. Fish and Wildlife Service 1990 recovery plan, Table 1, Historic and Present occurrences of the James spinymussel in 1990.

[2] From U.S. Fish and Wildlife Service 2008 Draft 5-year review for James spinymussel, appendix 1, Present occurrence rivers of the James spinymussel in 2008

[3] See definitions for status in Section 2.3.1.2.

[4] Estimated abundance based on modeling of mark-recapture study within a specific survey distance. Abundance is possibly larger because Johns Creek is augmented with propagated juveniles but we do not have post-release monitoring data.

[5] Estimated abundance for reach #2 not reported because site was heavy degraded after high flow events and fallen trees in stream. In addition, propagated JSM have been released in the creek, but abundance was not estimated.

[6] In 2019, 650 propagated juvenile JSM were released to 3 sites in the Tye River, potentially extending the total range to 31.7 km. These JSM are not included in the assessment of approximate abundance because we do not know if they have survived and been successfully established.

[7] Estimate based on catch per unit effort and area of occupancy from 2016-2020. Cumulative not provided because some counts are mark-recapture data.

[8] In 2021, 30 propagated juvenile JSM were released to Mill Creek; these JSM are not included in the assessment of approximate abundance because we do not know if they have survived and been successfully established.

[9] Range provided because the number of JSM observed in 2002 varied from 96 to 107, depending on data source (Petty and Neves 2005, VDWR 2020b).

Table B-2. Part 2 of detailed population information on James spinymussel waterbodies and subpopulations/areas. The first 5 columns are repeated from Table B-1. Pop=population; ND=not detected; PoExt=Possibly Extirpated; PreExt=Presumed Extirpated

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
James River Basin									
Upper James	South Fork Potts Creek		WV	Present	Yes, in past 5 years based on mussels in 35-45mm size class (Eliason and Everhart 2021)	Stable, large variation	Yes	lack of intact riparian zone, bank hardening, livestock entering stream/crushing mussels, agricultural watersheds, sedimentation	Everhart and Clayton 2016, Eliason and Everhart 2021
Upper James	Potts Creek		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort since 2006	No	bank erosion, cattle grazing in adjacent land, agricultural watersheds	VDWR 2020b
Upper James	Cowpasture River		VA	Present	No	Increasing due to augmentation with propagated juveniles	No	dam, past fish kills, ford crossing	VDWR 2020b
Upper James	Bullpasture River		VA	Likely present	Unknown	Unknown	No		VDWR 2020b
Upper James	Little Oregon Creek		VA	Present	Yes; in 2016, a large number of juvenile JSM (approximately 20 mm long) were observed during a mark-recapture survey	Decreasing, large variation and possible recovery	yes	predation, dam removal, invasive Asian clam, livestock entering stream/ damaging habitat and crushing mussels	Ostby 2022a
Upper James	Dicks Creek		VA	Present	Yes; juvenile JSM (less than 30 mm) were detected in 2019	Stable, large variation	Yes, but only 9 years of data analyzed from mark-recapture study.	predation, dam removal	Ostby 2022a
Upper James	Johns Creek	Near Maggie	VA	Present	Yes; site used as source of broodstock for propagation	Stable, large variation	Yes, but only 8 years of data analyzed from mark-recapture study.	predation, dam removal, eroding banks, agricultural watersheds, invasive Asian clam	VDWR 2020b, Ostby 2022a
Upper James		Along Sevenmile Mountain	VA	Present	No	Unknown	No	livestock entering stream/ damaging habitat, causing siltation, and crushing mussels; invasive Asian clam	VDWR 2020b, Orcutt 2021

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Upper James	Craig Creek	near New Castle	VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort since 2012 and most surveys occurring in 1999	No	livestock entering stream/ damaging habitat and crushing mussels.	VDWR 2020b, VDWR 2020
Upper James		Craig Creek near Silent Dell	VA	Present	No	Decreasing	Yes, but only 7 years of data analyzed from mark-recapture study.	road/ford crossings, flooding/storms causing fallen trees and debris jams	VDWR 2020b
Upper James		Craig Creek near Eagle Rock	VA	ND/ unknown	n/a	Unknown; most known sites with JSM have Not been surveyed in more than 20 years	No		VDWR 2020b, VDCR-DNH 2021
Upper James	Patterson Creek		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout creek	No		VDWR 2020b, VDCR-DNH 2021
Upper James	Catawba Creek		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout creek	No	agricultural watersheds	VDWR 2020b, VDCR-DNH 2021
Maury	Calfpasture River		VA	ND/ PreExt	n/a	Presumed extirpated; limited survey effort throughout river	No		Service 1990; VDCR-DNH 2021
Maury	Maury River		VA	ND/ PreExt	n/a	Presumed extirpated; limited survey effort throughout river	No	dams	VDCR-DNH 2021; Watson pers. comm. 2022
Maury	Mill Creek		VA	Present	Yes; site used as source of broodstock for propagation	Increasing due to augmentation with propagated juveniles	Yes		Ostby 2022a
Middle James-Buffalo	Pedlar River		VA	Present	Yes; 2 sub-adults found in 2004 and 2019	Unknown	No	bridge replacement, pipeline crossing maintenance/replacement, agricultural watersheds, past livestock access (Ostby 2009 survey report)	VDWR 2020b, VDCR-DNH 2021, Alderman 2020 pers. comm.
Middle James-Buffalo	Hardware River		VA	Present	No	Unknown	No		VDWR 2020b

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Middle James-Buffalo	Rock Island Creek		VA	Present	Yes; site used as source of broodstock for propagation	Decreasing	No, only 9 years of available data (2011-2019)	sedimentation, bank erosion, high stormflow/flooding event caused falling trees into stream changing habitat, mowing to rivers edge	TOE and DC 2019, VDWR 2020b, Ostby 2022a
Middle James-Buffalo	Tye River		VA	Present	No	Unknown	No	wastewater discharge, heavy siltation and sedimentation, possible herbicides from adjacent agricultural land.	VDWR 2020b
Middle James-Buffalo	Totier Creek (relic shells)		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout creek	No	heavy siltation and sedimentation, agricultural land adjacent to stream, dam	Chazal et al. 2012, Chazal 2013, VDWR 2020
Rivanna	Mechums River		VA	Present	No	Unknown	No		VDWR 2020a, b; VDCR-DNH 2021
Rivanna	Moormans River		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout river	No	agricultural watersheds	VDWR 2020a, b; VDCR-DNH 2022
Rivanna	Wards Creek (mis-identified as Rocky Run [Moormans River])		VA	Present	Yes, juvenile JSM were observed in 2003 and 2011.	Unknown	No	residential development, eroding banks, pasture/agricultural runoff	Ostby and Angermeier 2012, VDWR 2020a. Ostby pers. comm. 2022
Rivanna	Rocky Creek		VA	Present	Yes; juvenile JSM (<30 mm) were detected in 2015 and 2017; site used as source of broodstock for propagation	Stable, large variation	No (only 9 years of available data 2011-2019)	failing culverts, lumber harvest, predation, farm pond restricting flow	Ostby 2015 and 2019, VDWR 2020b, Alexander 2021
Rivanna	Buck Mountain Creek		VA	Present	No	Unknown	No	possible livestock access to stream, pasture/agricultural runoff, clearing of riparian buffer, pipeline crossing, bridge replacement	Ostby and Angermeier 2012, Alexander 2021
Rivanna	Piney Creek		VA	Present	No	Unknown	No		Ostby and Angermeier 2012, Alexander 2021

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Rivanna	Ivy Creek		VA	Present	No	Unknown	No	reservoir/dam downstream restricting flow/connectivity; residential development	Ostby and Neves 2011, VDWR 2020b, VDCR-DNH 2021
Rivanna	NF Rivanna River		VA	Present	Yes, 1 small JSM (<35 mm) detected in 2013.	Unknown	No	flooding, urban expansion of Charlottesville	The Catena Group 2015, VDWR 2020
Rivanna	Swift Run		VA	Present	Yes, 2 juvenile JSM less than 4 years old detected in 2014.	Not clear because of large variation and low detection rates	Yes	muskrat and raccoon predation, eroding banks, pasture/agricultural runoff	Ostby 2019a and 2019b, VDWR 2020b, Ostby pers. comm. 2021
Rivanna	Unnamed tributary to Swift Run			Present	No	Unknown	No		Ostby 2019a and 2019b, VDWR 2020b
Rivanna	Welsh Run		VA	Likely present	Unknown	Unknown	No		Ostby 2019a and 2019b, VDWR 2020b
Rivanna	Rivanna River	near Columbia, Palmyra, and Crofton	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		VDWR 2020a, b
Rivanna	Mechunk Creek (relict shell)		VA	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout creek	No		VDWR 2020a, b
Upper James (mainstem)	James River	James River at Buchanan	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Ostby and Angermeier 2009 VDWR 2020a, b; Carey 2021

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Upper James (mainstem)		James River Bridge near Natural Bridge	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		VDWR 2020a, b
Middle James-Buffalo (mainstem)		James River at New Canton	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No	power plant discharges, coal ash ponds	Chazal et al. 2012, VDWR 2020a, b
Middle James-Willis (mainstem)		James River at Columbia	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Chazal et al. 2012, VDWR 2020a, b
Middle James-Willis (mainstem)		James River at Pemberton and Cartersville	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Chazal et al. 2012, VDWR 2020a, b

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population [1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Middle James-Willis (mainstem)		James River at Rock Castle	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Chazal et al. 2012, VDWR 2020a, b
Middle James-Willis (mainstem)		James River opposite Maidens	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Chazal et al. 2012, VDWR 2020a, b
Middle James-Willis (mainstem)		James River at Maidens	VA	ND/ PreExt	n/a	Presumed extirpated; difficult to survey a large river, surveys sites did not occur in all reaches of the river, low detection rates for JSM, and there continues to be suitable mussel habitat.	No		Chazal et al. 2012, VDWR 2020a, b
Roanoke River Basin									
Upper Dan	Dan River		NC	Present	Yes, 3 JSM less than 5 years old observed.	Possibly decreasing	Yes	natural flood events, hydroelectric dam operations, bridge replacement, sediment and nutrients from construction sites, mining operations, agricultural operations, logging operations, and excessive stormwater flow off impervious surfaces	NCWRC 2020; Perkins pers. comm. 2020, 2021, 2022

Basin/Subbasin (HUC8)	Waterbody	Area/Sub-population[1]	State	Pop status in 2021[2]	Evidence of recruitment (if yes, explain)	2021 Trend (unknown, increasing, stable, decreasing, or presumed extirpated)	Based on 10 years of monitoring (yes or no)	Primary threats to JSM	references
Upper Dan	Big Creek (shell)		NC	ND/ PoExt	n/a	Possibly extirpated; limited survey effort throughout creek	No		NCWRC 2020b, Perkins pers. comm. 2022
Upper Dan	Mill Creek		NC	Present	No	Unknown	No		NCWRC 2020; Perkins pers. comm. 2021, 2022
Upper Dan	South Fork Mayo River		VA, NC	Present	Yes, 4 juveniles (<15 mm) observed in 2002.	Unknown	No	agricultural watersheds	Petty 2005, VDWR 2020b, NCWRC 2020b, VDCR-DNH 2021
Upper Dan	Mayo River		NC	Present	No	Possibly decreasing	Yes, but at low frequency (e.g., 7-8 years apart over 15 years)	agricultural watersheds, sedimentation, dams, treatment plant discharges	NCWRC 2020b, Perkins pers. comm. 2021

[1] From U.S. Fish and Wildlife Service 1990 recovery plan, Table 1, Historic and Present occurrences of the James spinymussel in 1990.
[2] See definitions for status in Section 2.3.1.2.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 90

February 21, 2023

SOUTHERN ENVIRONMENTAL LAW CENTER

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November 9, 2020

Via Web Comment Portal and First-Class U.S. Mail

Jim Hubbard
Under Secretary
U.S. Department of Agriculture
c/o Jefferson National Forest, MVP Project
5162 Valleypointe Parkway
Roanoke, VA 24019

RE: Mountain Valley Pipeline Draft Supplemental Environmental Impact Statement Comments

Dear Mr. Hubbard:

Thank you for the opportunity to comment on the Draft Supplemental Environmental Impact Statement for the Mountain Valley Pipeline. Please accept these comments on behalf of the Virginia Wilderness Committee and the Southern Environmental Law Center.

The Mountain Valley Pipeline ("MVP") "would be the largest pipeline of its kind to cross the Jefferson National Forest. American citizens understandably place their trust in the Forest Service to protect and preserve this country's forests, and they deserve more than silent acquiescence to a pipeline company's justification for upending large swaths of national forestlands." *Sierra Club, Inc. v. U.S. Forest Serv*., 897 F.3d 582, 605–06 (4th Cir. 2018), *reh'g granted in part*, 739 F. App'x 185 (4th Cir. 2018). Yet here we are again. The Draft Supplemental Environmental Impact Statement ("DSEIS") proposes reapproving effectively the same pipeline, along the same route, using the same Forest Plan amendments verbatim.[1] Where the Forest Service previously found its 2012 Forest Planning Rule ("2012 Rule") had no application to this project, the DSEIS confirms that it does apply—but to no effect. The end result is the same. As applied here, the 2012 Rule generates additional paperwork but no environmental benefits. The National Forest Management Act ("NFMA") and 2012 Rule require more.

The Forest Service proposes to re-approve MVP while facing a flood of evidence that the project cannot be constructed without violating water quality laws. The West Virginia Department of Environmental Protection has issued at least 46 notices of violation to MVP's

[1] With the exception that "MVP" is now "MVP Project."

developer, including for violations of state water quality standards for turbidity.[2] The Virginia Department of Environmental Quality filed suit against Mountain Valley for hundreds of violations of state water quality requirements.[3] The Forest Service's response: to waive the requirements in its Forest Plan intended to protect water quality that apply to every other activity on the national forest.

One departure from its previous approval attempt is that this time the Forest Service proposes to reapprove the project with even more haste. The agency's ability to approve MVP's crossing of the Appalachian Trail was stalled pending a decision in *U.S. Forest Serv. v. Cowpasture River Pres. Ass'n*, 140 S. Ct. 1837 (2020). Within two weeks of the Supreme Court's decision, the agency noticed in the Federal Register its intent to reapprove the project. *See* Notice of Intent to Prepare SEIS, 85 Fed. Reg. 45,863 (July 30, 2020). The agency continues to bend over backward to avoid the 90-day comment period applicable to forest-wide forest plan amendments by refusing to apply its plan standard requiring the MVP right-of-way to be reallocated to the "Designated Utility Corridor" management prescription and instead attempting to authorize a series of project-specific amendments. *See* 36 C.F.R. § 219.16(a)(2) (requiring 90-day comment period for plan amendments necessitating an EIS). Amending the Forest Plan does not have to be this difficult—or as discussed below, error-ridden—but it might require providing the public a longer period to submit comments. Now the Forest Service has devised a new strategy to avoid any administrative objections, speeding up the project timeline but ensuring that it will have no opportunity to resolve concerns raised by its stakeholders—save one: MVP.

Indeed, just last week, before this comment period had even ended, MVP's developers reported that they expect the Forest Service to reapprove the pipeline in its current form within the month.[4]

Any effort to reapprove this project will require fixing the substantial errors discussed below. Of particular note, correctly disclosing the Forest Plan standards that must be amended, and provisions of the 2012 Rule that are directly related to those amendments, will trigger further public notification and comment. *See* 36 C.F.R. § 219.13(b)(2) (requiring public participation in forest plan amendments). The non-amendment issues are also weighty enough to deserve further public comment through re-publication of a revised DSEIS. *See id.* § 218.22 (requiring notice

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[2] Copies of the Notices of Violations were attached as Exhibit D to the Sierra Club et al.'s August 27, 2020, Motion to Supplement Environmental Impact Statement filed with the Federal Energy Regulatory Commission ("FERC"). Exhibit D is *available at* https://elibrary ferc.gov/eLibrary/filelist?document_id=14887019&optimized=false.

[3] The Complaint by the State of Virginia was attached as Exhibit E to the Sierra Club et al.'s August 27, 2020 Motion to Supplement Environmental Impact Statement filed with FERC. *See supra* note 2.

[4] *See* Transcript of November 3, 2020, Equitrans Midstream quarterly earnings call with financial analysts *available at* https://www fool.com/earnings/call-transcripts/2020/11/03/equitrans-midstream-corp-etrn-q3-2020-earnings-cal/.

and comment on Forest Service projects). The agency's ultimate obligation here is to the "American citizens [who] understandably place their trust in the Forest Service to protect and preserve this country's forests." *Sierra Club*, 897 F.3d at 606. Those citizens are best served through forthright application of the laws intended to meet those ends.

I. **<u>The Forest Service must consider all issues raised in comments</u>**

To the extent the Forest Service is tempted to think otherwise, we begin by clarifying that the Forest Service must consider all issues relevant to its approval of MVP, even those outside the scope that the agency has attempted to carve out for itself. The Forest Service hints in the DSEIS that its task is limited to analyzing "effects related to the Court-identified deficiencies" in *Sierra Club* and "changed circumstances or new information . . . which result from actions occurring on NFS lands, including those effects off NFS lands resulting from actions on NFS lands." DSEIS at 12. This assertion is misplaced. To avoid arbitrary and capricious decisionmaking, the Forest Service must grapple with issues raised in comments even if they are outside the agency's self-identified categories, because the DSEIS must be able to support a new administrative approval process following vacatur of the initial special use permit and Record of Decision; the DSEIS is "supplemental" only in the sense that it incorporates by reference information from earlier administrative action. *See, e.g.*, *High Country Conservation Advocates v. U.S. Forest Service*, 333 F. Supp. 3d 1107, 1118 (D. Colo. 2018), *rev'd on other grounds*, 951 F.3d 1217 (10th Cir. 2020). Here, the Forest Service proposes to make a new decision[5] in response to a new application from MVP,[6] obligating the agency to consider all issues necessary to support that decision, regardless of whether those issues were, or could have been, raised earlier.

II. **<u>The Forest Service's self-contradictory decision to forgo pre-decisional administrative review on remand is arbitrary and capricious</u>**

Pre-decisional administrative review is a "vital" tool for land managers. Project-Level Predecisional Administrative Review Process, 77 Fed. Reg. 47,337, 47,342 (August 8, 2012) (notice of proposed rulemaking). It not only helps authorities "avoid[] potential disputes," but also creates opportunities to "identify and correct any errors" and "fine-tune the design of proposed actions . . . *before* final decisions are made." *Id.* (emphasis added). Perhaps not coincidently, adequate pre-decisional review can also relieve land managers from "the criticism

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[5] *See, e.g.*, Emily Hammond Meazell, *Deference and Dialogue in Administrative Law*, 111 Colum. L. Rev. 1722, 1738 (2011) ("When an agency action is vacated, it is essentially extinguished; if the agency wishes to try again, it must initiate procedures anew.").

[6] *See* DSEIS at 2 ("On May 1, 2020, the Mountain Valley Pipeline, LLC . . . submitted a revised MLA ROW application . . . .").

sometimes leveled against postdecisional appeals that reviewers are unfairly disposed to a particular or predetermined outcome." *Id.* at 47,341.

The Forest Service seemed to appreciate these benefits when it originally agreed to amend the Forest Plan for the Jefferson National Forest ("JNF") for MVP. It found that its decision was "subject to the pre-decisional objection process pursuant to 36 [C.F.R.] § Part 218" and opened a 45-day objection filing period on June 23, 2017. Record of Decision: Mountain Valley Project Land and Resource Management Plan Amendment for the Jefferson National Forest at 36 (2017) (hereinafter "ROD"). Yet only three years later, the *same agency* is refusing to conduct *any* pre-decisional administrative review of the *same project* on remand from the Fourth Circuit. DSEIS at 3 ("This project will not be subject to . . . [a] pre-decisional administrative review process."). Instead, it now claims that as the Under Secretary of Agriculture, Natural Resources and Environment is "responsible" for the project, it can evade review pursuant to 36 C.F.R. § 218.13(b). DSEIS at 3. Yet doing so requires twisting the plain meaning of this provision beyond what its words can bear.

To begin with, since the beginning of this project the Forest Service has been clear: the "Forest Supervisor for the George Washington and Jefferson National Forests is the Responsible Official for the [Forest Plan] Amendments," not the Secretary or Under Secretary. *See* Notice of Availability of Forest Plan Amendments, 81 Fed. Reg. 71,041, 71,042 (Oct. 14, 2016). As recently as *this July*, the Forest Service reconfirmed that "the responsible official [for these amendments] is the Forest Supervisor of the George Washington and Jefferson National Forests." Notice of Intent to Prepare SEIS, 85 Fed. Reg. 45,863, 46,864 (July 30, 2020). The Forest Service has provided no basis to claim—in the face of four years of consistent contrary claims—that the Under Secretary is somehow now responsible for this project. The Forest Service has a careful and explicit delegation of authority to ensure that resource values and impacts are weighed by the most appropriate line officer. *See generally* Forest Service Manual 2704. The agency is not free to change responsible-official horses whenever it pleases in an effort to evade pre-decisional review.

Regardless, being designated the responsible official at the eleventh hour does not accomplish what the agency apparently thinks it does. On its face, 36 C.F.R. § 218.13(b) only permits "[p]rojects and activities *proposed* by the Secretary of Agriculture or the Under Secretary, Natural Resources and Environment" to avoid pre-decisional administrative review. 36 C.F.R. § 218.13(b) (emphasis added). To "propose" means "to form or put forward a plan or intention." *Propose*, Merriam-Webster (11th ed. 2003). But MVP is not the Secretary's or Under Secretary's proposal at all. The Forest Service's only role here was "to respond *to a proposal from Mountain Valley*." DSEIS, ii (emphasis added). That fact is confirmed repeatedly in the DSEIS. *See* DSEIS at i–ii ("*Mountain Valley* requested that the Forest Service amend the Forest Plan consistent with the issues identified by the Court." (emphasis added)); DSEIS at 2

("Mountain Valley [Pipeline, LLC] requested that the Forest Service amend the Forest Plan."). Neither the Secretary, Under Secretary, nor Forest Service have proposed anything.

What's more, 36 C.F.R. § 218.13(b) is only available for projects and activities proposed by the Secretary or Under Secretary but there is no evidence that either of them formed or put forward the initiative to amend the Jefferson Forest Plan Neither official is mentioned in the 2017 Final Environmental Impact Statement ("FEIS") or the Forest Service's original ROD. *See generally* ROD; *see also* FERC, Mountain Valley Project and Equitrans Expansion Project Final Environmental Impact Statement (2017). How the Under Secretary could "propose" amending the Forest Plan if he was not involved in the pipeline's genesis and route selection is confusing, to say the least.

In fact, the DSEIS itself never suggests that the Under Secretary "proposed" the action; it merely notes he is the "responsible official" – a title he apparently assumed sometime between July 30th and September 25th of this year. *Compare* DSEIS at 1.5 (naming Under Secretary as responsible official) *with* 85 Fed. Reg. 45,863 (naming Forest Supervisor as responsible official). But 36 C.F.R. § 218.13(b) does not ask which official is "responsible;" it asks who proposed the project. Naming the Under Secretary the "responsible official" sometime in the fifty-five days leading up to the agency's second attempt to approve a project it has been working on for years in a calculated strategy to unnecessarily avoid pre-decisional review does not convert the Under Secretary into the project proponent.

The reason 36 C.F.R. § 218.13(b) is limited to activities *actually proposed* by the Secretary or Under Secretary is not hard to fathom. Congress ordered the Forest Service to create a pre-decisional administrative review program because it believed it was valuable. 77 Fed. Reg. at 47,342. Requiring the direct initial involvement of the Secretary or Under Secretary helps ensure that § 218.13(b)'s exception to this "vital" regime will only be used on "rare occurrences." National Forest System Land Management Planning, 77 Fed. Reg. 21,162, 21,248 (Apr. 9, 2012) (addressing identical wording in 36 C.F.R. § 219.51). But if the Secretary or Under Secretary could invoke the administrative-review exception just by signing off on a project (which they may know little about, since they did not *propose* it), then there is nothing preventing the administrative-review exception from swallowing the rule.[7] Congress could not have intended such an outcome.

It makes even less sense to allow projects to dodge pre-decisional review when—as here—the Forest Service already found that such review was required. As noted above, in 2017

[7] There would also be nothing preventing blatant political cronyism. Put simply, corporate entities with access or ties to the Secretary or Under Secretary could avoid troublesome pre-decisional administrative review, while those lacking similar political capital would be left out in the cold. If Mountain Valley successfully avoids pre-decisional review by going straight to the Under Secretary, it may embolden others to do so as well.

the Forest Service determined its decision to amend the Jefferson National Forest Plan for the Mountain Valley Project—which is the *exact same decision* before the agency today—"was subject to the pre-decisional objection process." *See* ROD at 36. The Forest Service does not explain why it has now come to a different conclusion, much less recognize that it previously made a contradictory finding. *See* DSEIS at 3. Failing to explain a change in position, especially one that directly contradicts the agency's previous position, is a hallmark of arbitrary and capricious action. *FCC v. Fox Television Stations, Inc.*, 556 U.S. 502, 515–16 (2009).

Ultimately, the Forest Service's failure to engage in pre-decisional review violates its own regulations and the statutory intent of Congress, and contradicts its prior findings without adequate explanation. Therefore, its action is arbitrary, capricious, and not in accordance with law. 5 U.S.C. § 706(2)(A).

III. The Forest Service must ensure compliance with all Forest Plan standards

All activities on a national forest "shall be consistent with the [forest plan]." 16 U.S.C. § 1604(i). Although the Forest Service proposes to modify eleven plan standards that MVP cannot satisfy, there are other Forest Plan standards that MVP would likely (and in some cases concededly) violate, but that the Forest Service has not addressed. The Forest Service must ensure that these standards are met.

- 4A-004. In Management Prescription Area 4A—the Appalachian National Scenic Trail Corridor—vegetation may be managed "only to enhance the trail environment." JNF LRMP at 3-21. In particular, Standard 4A-004 provides in relevant part:

  > Vegetation is managed only to enhance the trail environment. . . . Vegetation management activities are limited to:
  > - Maintain open area, old field habitats, and vistas that enhance the scenic qualities of the Appalachian Trail;
  > - Control insects and diseases;
  > - Maintain or improve threatened, endangered, sensitive, and locally rare species habitat;
  > - Maintain rare communities, species dependent on disturbance, and wildlife viewing opportunities;
  > - Meet trail construction and maintenance needs, including shelters;
  > - Manage fuels;
  > - Restore, enhance, or mimic historic fire regimes;
  > - Control non-native invasive vegetation;
  > - Provide for public safety or resource protection.

JNF Forest Plan at 3-21 to 3-22. This standard loosely tracks the types of activities allowed under Standard 6C-007, which the Forest Service has proposed to amend because MVP cannot comply. The same is required here. GIS analysis reveals that, at the site MVP crosses the Appalachian National Scenic Trail ("ANST"), Management Prescription Area 4A is roughly 750 feet wide in its narrowest place. Even crediting the DSEIS's statement that there would be "no need for vegetation removal within 300 feet" of either side of the trail, DSEIS at 101, some vegetation removal within Management Prescription Area 4A would evidently be necessary. However, Standard 4A-004 prohibits such vegetation removal.

- 4A-020. Management Prescription Area 4A consists of the "foreground area visible from the Appalachian National Scenic Trail." JNF Forest Plan at 3-19. Standard 4A-020 provides that "[a]ll management activities" in Management Prescription Area 4A "will meet or exceed a Scenic Integrity Objective of High." JNF Forest Plan at 3-23. The DSEIS acknowledges that MVP cannot meet this standard. *See* DSEIS at 102 ("It is not possible or practical to modify the MVP construction methods and achieve consistency with high and moderate SIOs.").

- FW-63. Standard FW-63 requires that "[a] minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer." JNF Forest Plan at 2-20. The FERC FEIS states that "[k]arst topography is not located along the MVP pipeline route in the Jefferson National Forest." FERC FEIS at 4-135. However, since publication of the FERC FEIS, a citizen group documented sinkholes and subsidence along the right-of-way ("ROW") in Giles County, Virginia, adjacent to NFS lands.[8] If similar activity occurs on the ROW on NFS land, the Forest Service must require buffers in accordance with Standard FW-63.

The Forest Service must require that construction of MVP adhere to all relevant plan standards, including the standards above, or the agency must, at a minimum, propose further amendments. Any further amendments will, of course, require adherence to the 2012 Rule and will also require the Forest Service to provide a new comment period on any such amendments. *See* 36 C.F.R. §§ 218.22; 219.13(b)(2).

[8] *See generally* Cave Report, Mountain Valley Watch (May 2020), *available at* https://bit.ly/350xA1r.

IV. The agency's attempt to amend its Forest Plan violates NFMA and the 2012 Rule

A) Legal background relevant to the Forest Plan amendments

The National Forest Management Act requires the Forest Service to "develop, maintain, and, as appropriate, revise land and resource management plans for units of the National Forest System." 16 U.S.C. § 1604(a). After promulgating a "forest plan," any activity that happens on that national forest "shall be consistent with the [forest plan]." *Id.* § 1604(i). NFMA requires that forest plans be revised "at least every fifteen years" and allows their amendment at any time. *Id.* § 1604(f)(4-5).[9] Forest plans—amended or otherwise—must "form one integrated plan . . . incorporating in one document or one set of documents, available to the public at convenient locations, all of the features required by [NFMA]." *Id.* § 1604(f)(1). An integrated plan is one in which "plan components are internally consistent," such that "[o]ne plan component [does] not directly conflict with another plan component or prevent its accomplishment." Forest Service Handbook 1909.12 Sec. 22. Forest Plans "must comply with all applicable laws and regulations." 36 C.F.R. § 219.1(f).

The Forest Service implements NFMA's requirements through regulations. *See* 16 U.S.C. § 1604(g) (instructing the Forest Service to develop NFMA regulations). Initial regulations were issued in 1979 and superseded in 1982 (the "1982 Rule"). After a series of failed attempts to revise the 1982 Rule, the Forest Service successfully issued a new planning rule in 2012. *See* 2012 Forest Planning Rule, 77 Fed. Reg. 21,162 (April 9, 2012). The 2012 Rule includes substantive protections for forest resources such as plant and animal diversity, soil and water quality, riparian areas, and scenery, among other things. *See* 36 C.F.R. §§ 219.8–219.11.

In 2016, the Forest Service revised its 2012 Rule to clarify how forest plans developed under the 1982 Rule would be amended using the 2012 Rule. The clarification was necessary because of "confusion about how responsible officials should apply the substantive requirements for sustainability, diversity, multiple use, and timber set forth in 36 CFR 219.8 through 219.11 when amending 1982 rule plans." Proposed Revision to 2012 Rule, 81 Fed. Reg. 70,373 (Oct. 12, 2016). The Forest Service sought specifically to resolve two incorrect interpretations of its 2012 Rule.

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[9] Last revised in 2004, the JNF Forest Plan is now out of date. Failure to revise a Forest Plan within the required fifteen year timeframe is a violation of NFMA. *See Biodiversity Assocs. v. U.S. Forest Serv.*, 226 F. Supp. 2d 1270, 1316 (D. Wyo. 2002). Congress typically includes language in annual appropriations bills stating that the Forest Service "shall not be considered to be in violation of . . . 16 U.S.C. 1604(f)(5)(A)) solely because more than 15 years have passed without revision of the plan for a unit of the National Forest System." *See* H.R. 1865. However, if the Forest Service "is not acting expeditiously and in good faith, within the funding available, to revise a plan for a unit of the National Forest System, this section shall be void with respect to such plan and a court of proper jurisdiction may order completion of the plan on an accelerated basis." *Id.*

The first interpretation claimed that all of the substantive provisions of the 2012 Rule at 36 C.F.R. § 219.8–11 must be applied every time the 2012 Rule was used to amend a 1982 Rule forest plan. *Id*. The second interpretation took the opposite view: that the 2012 Rule gave the Forest Service "discretion to selectively pick and choose which, if any, provisions of the rule to apply, allowing the responsible official to avoid 2012 rule requirements" entirely when amending 1982 Rule forest plans. *Id*. The agency revised the portions of the 2012 Rule applying to plan amendments "to clarify that neither of these interpretations is correct." *Id.*

Following this 2016 amendment to the 2012 Rule, the Forest Service "shall" do the following for plan amendments:

> Determine which specific substantive requirement(s) within §§ 219.8 through 219.11 are directly related to the plan direction being added, modified, or removed by the amendment and apply such requirement(s) within the scope and scale of the amendment. The responsible official is not required to apply any substantive requirements within §§ 219.8 through 219.11 that are not directly related to the amendment.

36 C.F.R. § 219.13(b)(5).

This is a two-step process. First, the Forest Service determines which of the substantive requirements at 36 C.F.R. §§ 219.8–219.11 are "directly related" to the proposed amendment. *Id*. Second, the agency applies those requirements within the scope and scale of the amendment. *Id.*

Whether a substantive provision of the 2012 Rule is directly related to a proposed amendment turns on one of two factors: 1) "the purpose of the amendment," or 2) "the effects (beneficial or adverse) of the amendment." 36 C.F.R. § 219.13(b)(5)(i). Either factor invokes application of the 2012 Rule. The purpose of an amendment is determined by "the need to change the plan." *Id*. An amendment is directly related based on "adverse effects" when "NEPA effects analysis for the proposed amendment reveals substantial adverse effects associated with that requirement, or when the proposed amendment would substantially lessen protections for a specific resource or use." 36 C.F.R. § 219.13(b)(5)(ii)(A) (emphasis added).

Once a "directly related" determination has been made, the Forest Service must apply the substantive provisions of the 2012 Rule to develop new plan components within the scope of the amendment that meet NFMA's substantive requirements. These new plan components must "[f]ollow the applicable format for plan components set out at § 219.7(e)." 36 C.F.R. § 219.13(b)(4); *see also* 81 Fed. Reg. 90,730 (noting that § 219.13(b)(4) was added "as a clarification that each plan component added or changed by a plan amendment must conform to the applicable definition for desired conditions, objectives, standards, guidelines, and suitability of lands set forth in § 219.7(e).”). Relevant here, a forest plan “standard” is “is a mandatory constraint on project and activity decisionmaking, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.” 36 C.F.R. § 219.7(e)(iii).

Altogether, to amend a forest plan, the Forest Service must: 1) determine the purpose and effects of a proposed amendment, 2) based on the purpose and effects, determine whether the proposed amendment is “directly related” to substantive provisions of the 2012 Rule, 3) apply any directly related substantive provisions of the 2012 Rule to the amendment, and 4) create new forest plan components based on application of those directly related substantive provisions of the 2012 Rule, including mandatory standards and guidelines as required by 36 C.F.R. §§ 219.8 through 219.11.

B) Factual background relevant to the Forest Plan amendments

The Mountain Valley Pipeline “is a proposed 303.5-mile interstate natural gas pipeline that would cross about 3.5 miles of the Jefferson National Forest (JNF), in Monroe County, West Virginia and Giles and Montgomery counties, Virginia.” DSEIS at i. Constructing the pipeline will cause adverse environmental impacts as documented throughout the FEIS and now DSEIS. As summarized in the DSEIS, the project “may result in substantial adverse environmental effects to the utility corridor management area and several resources including soil; riparian; water; threatened and endangered species; old growth; the [Appalachian National Scenic Trail]; and scenic integrity.” DSEIS at 12.

This is the Forest Service’s second attempt at authorizing MVP. Consistent with 36 C.F.R. § 219.13(b)(2), on June 5, 2017, the Forest Service published in the Federal Register notice of which substantive requirements of the 2012 Rule were likely to be directly related to Forest Plan amendments necessary to facilitate pipeline construction. *See* Notice of Updated Information for MVP, 82 Fed. Reg. 25,761 (June 5, 2017). In that notice the Forest Service proposed amending standards FW-247, FW-248, FW-5, FW-8, FW-9, FW-13, FW-14, Standard 11-003, Standard 6C-007, Standard 6C-026, Standard 4A-028, and FW-184. *Id*. The Forest Service determined that the following substantive provisions of the 2012 Rule were likely to be directly to these amendments: §§ 219.10(a)(3), 219.8(a)(2)(ii), 219.8(a)(2)(iv), 219.8(a)(3)(i), 219.8(a)(1), 219.11(c), 219.10(b)(1)(vi), and 219.10(b)(i). *Id*.

By the time the agency issued its MVP-authorizing ROD in December 2017, it had changed course. There the Forest Service found that for the same proposed amendments (except for the amendment to FW-247 which was not carried forward to the ROD) either “substantive rule provisions are not directly related to the amendment . . . [or] there is no need to analyze whether or not there are substantive rule provisions directly related to the amendment." ROD at 18. The agency reached this determination despite clear evidence to the contrary and its approval was ultimately vacated by the U.S. Court of Appeals for the Fourth Circuit. *See Sierra Club*, 897 F.3d 582.

The agency has now re-proposed amending the same Forest Plan standards included in its now vacated December 2017 ROD. The proposed amendments are identical to those proposed in 2017 (with the exception that "MVP" is now referred to as the "MVP Project"). *Compare* DSEIS, 93–96, *with* ROD, 8–10.

As required by 36 C.F.R. § 219.13(b)(2), the Forest Service again published in the Federal Register on July 30, 2020, that the "substantive Planning Rule provisions that are likely to be directly related to the amendments are: § 219.8(a)(1) (terrestrial ecosystems); § 219.8(a)(2)(ii) (soils and water productivity); § 219.8(a)(2)(iv) (water resources); § 219.8(a)(3)(i) (ecological integrity of riparian areas); § 219.9(b) (contributions to recovery of threatened and endangered species); § 219.10(a)(3) (utility corridors); § 219.10(b)(1)(vi) (other designated areas); § 219.10(b)(1)(i) (scenic character); and § 219.11(c) (timber harvesting for purposes other than timber production)." *See* Notice of Intent to Prepare DSEIS, 85 Fed. Reg. 45,863 (June 30, 2020).

The DSEIS confirms that the amendments are "*likely* to be directly related" to these same substantive provisions, DSEIS at 7–8 (emphasis added), but later provides a different list of substantive provisions that "*are* directly related" to the amendments, *id*. at 96 (emphasis added). This latter list is limited to: "219.8(a)(2)(ii) –Soils and soil productivity; 219.8(a)(3)(i) –Ecological integrity of riparian areas; 219.8(b)(3) –Multiple uses that contribute to local, regional, and national economies; 219.9(a)(2) –Ecosystem diversity of terrestrial and aquatic ecosystems; 219.10(a)(3) –Utility Corridor; 219.10(b)(i) –Sustainable recreation, including recreation setting, opportunities, access, and scenic character; 219.10(b)(vi) –Other designated areas or recommended designated areas; and 219.11(c) –Timber harvest for purposes other than timber production." DSEIS at 96.

We assume that the citations to §§ 219.10(b)(vi) and 219.10(b)(i) in this latter list are referring to §§ 219.10(b)(1)(vi) and 219.10(b)(1)(i) as cited in the former list. The DSEIS does not apply "§ 219.8(a)(2)(iv) (water resources)," "§ 219.8(a)(1) (terrestrial ecosystems)," or "§ 219.9(b) (contributions to recovery of threatened and endangered species)" though they are included in the "likely to be directly related" list. The final list also adds § 219.8(b)(3). The only explanation for these changes is the conclusory (and confusing) statement that they are "based on subsequent analysis and addressing of the substantive requirements based on 36 CFR 219.10." DSEIS at 97.

The agency then purports to apply the substantive provisions identified in the latter list to the proposed amendments. *See* DSEIS at 96–103. For four of the standards (FW-248, Standard 6C-007, Standard 6C-026, Standard 4A-028), the agency fully exempts the MVP project. For six standards (FW-5, FW-8, FW-9, FW-13, FW-14, and Standard 11-003), the agency exempts MVP but requires implementation of the "approved POD and MVP design requirements." And for one standard (FW-184), the agency provides MVP an extended period of time to come into compliance with the existing standard.

While the approaches in 2017 and 2020 to amending the forest plan are diametrically different—one relies on *no* substantive provisions of the 2012 Rule being directly related to the amendments, while the other finds *several* substantive provisions to be directly related—the end result is the same: MVP is approved and the Forest Plan is amended using identical language in 2017 and 2020. Whether the Forest Service ignores or applies the 2012 Rule makes no difference. But the 2012 Rule is not as toothless as the Forest Service's practice suggests. The agency has once again violated NFMA, the 2012 Rule, and the Administrative Procedure Act ("APA") in numerous ways.

C) The Forest Service must apply all directly related provisions of the 2012 Rule

The 2012 Rule leaves no discretion for the Forest Service to disregard substantive provisions of the rule that are directly related to proposed amendments. Here, the Forest Service violates that requirement for several provisions.

The Fourth Circuit has already found that "there is no question that the 2012 Rule requirements for soil, water, and riparian resources are directly related" to the proposed MVP Forest Plan amendments (identical in 2017 and 2020) *pointing explicitly to the substantive requirement* related to "water resources (36 C.F.R. § 219.8(a)(2)(iv))." *Sierra Club,* 897 F.3d at 603. While the DSEIS identifies 36 C.F.R. § 219.8(a)(2)(iv) as "likely to be directly related" to the proposed amendments, DSEIS at 7, the provision is unexplainably omitted from the list of requirements that the agency ultimately determines "*are* directly related" to the amendments, DSEIS at 96 (emphasis added). The substantive requirement at 36 C.F.R. § 219.8(a)(2)(iv) related to water resources is never discussed, much less applied, in the DSEIS despite repeated confirmation that the amendments will affect water resources. *See, e.g.*, DSEIS at 12, 63–69. This is textbook arbitrary and capricious decisionmaking and is fatal to the agency's attempt to amend its Forest Plan.

We do not doubt that application of the requirement to "maintain or restore . . . [w]ater resources in the plan area" will be difficult with MVP. MVP developers have repeatedly demonstrated an inability to construct this pipeline in compliance with water quality laws. The

West Virginia Department of Environmental Protection has issued at least 46 notices of violation to MVP's developer, including for violations of state water quality standards for turbidity.[10] The Virginia Department of Environmental Quality filed suit against Mountain Valley for hundreds of violations of state water quality requirements.[11] But if the Forest Plan cannot be amended to facilitate MVP construction while meeting the substantive requirements of 36 C.F.R. § 219.8(a)(2)(iv) then the Forest Plan cannot be amended at all. If this project is to move forward, the Forest Service must go back and apply 36 C.F.R. § 219.8(a)(2)(iv) while taking into account MVP's long history of water quality violations.

Closely related, the substantive requirement to "maintain or restore . . . water quality" at 36 C.F.R. § 219.8(a)(2)(iii), as opposed to "water resources" at § 219.8(a)(2)(iv), is also directly related to the proposed amendments and must be applied to comply with the 2012 Rule. *See, e.g.*, DSEIS at 64 ("The Proposed Action includes four proposed amended Forest Plan standards that would affect . . . water quality"). That provision is never discussed in the DSEIS.

Earlier this year, the Forest Service announced in the Federal Register that 2012 Rule provision "§ 219.9(b) (contributions to recovery of threatened and endangered species)" was "likely to be directly related" to the proposed amendments. 85 Fed. Reg. 45,864. This same "likely to be directly related" determination is repeated in the DSEIS along with an acknowledgement that the "Plan amendment may result in substantial, adverse environmental effects to . . . threatened and endangered species." DSEIS at 7, 12. And the DSEIS discusses many of these adverse effects. *See* DSEIS at 69–89. Yet the Forest Service fails to apply § 219.9(b) to the proposed amendments. We are unaware of any basis to refuse to apply that substantive provision in light of the other findings in the FEIS and DSEIS.

In its 2017 ROD, the Forest Service determined that its effort to amend Standard 6C-026 was "relevant" to "planning rule requirement . . . § 219.8(a)(1)." ROD at 22. This year's Federal Register notice announcing 2012 Rule provisions "likely to be directly related" to the proposed amendments likewise identifies "§ 219.8(a)(1) (terrestrial ecosystems)." 85 Fed. Reg. at 45,864, and that finding is repeated in the DSEIS (at 7). But § 219.8(a)(1) is not applied anywhere in the DSEIS. To the extent the Forest Service failed to apply that provision in 2017 based on a lack of substantial adverse effects it must revisit that conclusion in light of additional effects analysis. The agency must also properly apply the "purpose" prong of the directly related test which it did not do in 2017.

Moreover, the agency has recognized that a 2012 Rule provision can be directly related to the amendments based on the overall effect of the activity the amendments authorize. The Forest

[10] *See supra* note 2.

[11] *See supra* note 3.

Service applies "§ 219.8(b)(3) – multiple uses that contribute to local, regional, and national economies" based on the pipeline's general "contribution to social economic sustainability." DSEIS at 98. Just as the amendments collectively authorize a project that has some relationship with local economics, they also authorize a project that significantly affects "terrestrial ecosystems" as contemplated in § 219.8(a)(1). Indeed, the amendments allow the clearing of a 3.5-mile, fragmenting ROW with the potential to affect the habitat of 14 locally rare terrestrial invertebrates on Forest Service lands. FEIS at 4-252. Thus, even if application of § 219.8(a)(1) is not triggered by the amendment of Standard 6C-026, it is triggered based on the effects associated with the amendments collectively. This is particularly important because the MVP ROW represents an "irretrievable loss of forested wildlife habitat." DSEIS at 117.

Other substantive provisions of the 2012 Rule that are directly related to the proposed amendments appear to have been missed by the Forest Service entirely. For instance, if the amendment of Standard 4A-028 is directly related to "§ 219.10(b)(1)(i) – sustainable recreation, including recreation setting, opportunities, access, and scenic character," DSEIS at 101, it must also be directly related to "§ 219.8(b)(2) - sustainable recreation; including recreation settings, opportunities, and access; and scenic character." Critically, these two substantive requirements serve different purposes so applying one is not the same as applying the other. Section 219.10 is related to multiple uses while § 219.8 is related to sustainability. Moreover, § 219.10 is clear that it takes a backseat to meeting the requirements of § 219.8. *See* 36 C.F.R. § 219.10 (multiple uses are only considered "while meeting the requirements of §§ 219.8 and 219.9"). At the very least, the Forest Service must explain why it chose to apply § 219.10(b)(1)(i) but not § 219.8(b)(2).

Finally, in light of its amendments to FW-5, FW-8, FW-9, FW-13, FW, 14, Standard 11-003, Standard 6C-007, and Standard 6C-026, and the recognition that § 219.9(c) is directly related to those amendments, the Forest Service must also apply § 219.9(d) or explain why it is not directly related. The prohibition on timber harvest of any type "where soil, slope, or other watershed conditions [will] be irreversibly damaged" and requirement to carry out timber harvests is a "manner consistent with the protection of soil, watershed, fish, wildlife, recreation, and aesthetic resources," 36 C.F.R. § 219.11(d)(2–3), are directly related to those amendments.

D) The Forest Service continues to misapply the purpose prong of the directly related test

Given the Fourth Circuit's previous finding that "the clear purpose" of some of these very same amendments "is to lessen requirements protecting soil and riparian resources," *Sierra Club*, 897 F.3d at 603, the Forest Service's continued insistence that "the purpose of the proposed amendment is to make the project consistent with the [Forest Plan]," DSEIS at 19, is baffling and wrong. The agency's begrudging acquiescence to use of the purpose identified by the court for purposes of the DSEIS is cold comfort. *See* DSEIS at 19 (trying to distinguish between the purpose of the amendment and how the purpose will be achieved). Failure to correctly apply the purpose prong of the directly related test is not harmless error and is grounds for vacatur.

What's more, the agency's articulation of the purpose of the amendments makes no sense. The agency is not making *MVP* consistent with its *Forest Plan*. That would require changing MVP to meet the standards of the existing plan. The agency is making its *Forest Plan* consistent with construction of *MVP* by amending the Plan *instead* of the project. The agency's articulation of the purpose of the amendments must be wrong for the additional reason that it cannot be used in the process to amend forest plans. That process requires the agency to apply the directly related substantive provisions of the 2012 Rule to the amendments based on the purpose of the amendments. If the purpose of this project-specific amendment is to "make the project consistent with the Forest Plan," then the purpose of *all* project-specific amendments is to make projects consistent with forest plans. But none of the §§ 219.8–11 requirements are related to making projects consistent with existing forest plans, so no part of the rule would ever be applied based on the purpose prong of the directly related test. That cannot be right.

This matters. If the Forest Service cannot correctly identify the purpose of its amendments then it cannot comply with its regulations regarding plan amendments. The agency's failure to grasp the actual purpose of its amendments may be why it failed to apply several directly related substantive provisions of the 2012 Rule as noted above. The agency must forthrightly disclose the purpose of its amendments and faithfully apply the directly related substantive provisions of the 2012 Rule.

E) Application of 2012 Rule substantive requirements outside the scope and scale of an amendment is irrelevant to application of those requirements within the scope and scale of the amendment

To amend forest plans the Forest Service applies directly related 2012 Rule provisions "within the scope and scale of the amendment." 36 C.F.R. § 219.13(b)(5). Here, the agency repeatedly points to application of rule provisions in other parts of the forest, unaffected by MVP, to argue that the rule's provisions are satisfied. For example, the agency asserts that the "scope and scale of the amendment of FW-248 is limited to the MVP project" and that § 219.10 is directly related to that amendment. DSEIS at 97–98. The agency then applies that substantive provision by pointing out that it is satisfied through "forest-wide goals, objectives, and standards" that apply *in other parts of the forest* as well as "specific utility corridor standards associated with individual management prescriptions" that have no relation to MVP. *Id*. But achievement of a substantive provision's requirements in an unaffected, random part of the forest is not necessarily relevant to application of the provision "within the scope and scale of the amendment" which "is limited to the MVP project." DSEIS at 98; *see also* 81 Fed. Reg. 90,731 ("application of directly related substantive requirements [must] be commensurate with the scope and scale of the amendment."). Restated, satisfaction of substantive requirements *outside* the scope and scale of an amendment does not establish that they are met *within* that scope and scale.

Unfortunately, the agency commits this error repeatedly. In its "application of the substantive requirements" to amend soil and riparian standards it points to "numerous forest-wide goals, objectives, and standards . . . that are not subject to modification as part of this proposed amendment" but appear to have little application to the MVP project area and predominantly apply in other parts of the forest. DSEIS at 99 (citing the Jefferson Forest Plan pp.2-5 to 2-9 for these other standards). Similarly, when applying 2012 Rule requirements to amendments to old-growth standards the agency points to "numerous goals, objectives, standards for old growth, rare communities, wildlife, and listed species . . . at the forest-wide level." *Id*. at 101. And when amending standards related to the Appalachian Trail, the agency points generally to "forest-wide goals, objectives, and standards for recreation." *Id*. at 102. Applying 2012 Rule provisions "within the scope and scale of the amendment" by pointing to their application outside the scope and scale of that amendment is arbitrary, capricious, and violates the 2012 Rule.[12]

F) The Forest Service may not wholly exempt projects from Forest Plan requirements on a case-by-case basis

Forest plans—amended or otherwise—must "form one integrated plan" and all activities on a forest must be consistent with that plan. 16 U.S.C. §§ 1604(f)(1), 1604(i). In combination, these provisions prohibit wholly exempting projects from specific plan requirements on a case-by-case basis. That practice would eviscerate both the integrated plan and consistency requirements. If application of a project cannot achieve compliance with a particular provision, the Forest Service can: 1) require the applicant to change the project, 2) revise the plan standard for the entire forest if that can be accomplished in compliance with NFMA, or 3) pursue a project-specific amendment to the standard which results in a modified standard that achieves the objectives of the any directly related 2012 Rule provisions. Waiving Forest Plan requirements is not an option and it was error for the Forest Service to do so for four plan standards (FW-248, 6C-007, 6C-026, 4A-028) here.

A hypothetical helps explain this error. The 2012 Rule requires the Forest Service to develop plan components "to maintain or restore the diversity of ecosystems and habitat types throughout the plan area." 36 C.F.R. § 219.9(a)(2). This requirement is directly related to the

[12] We understand that each provision of the 2012 Rule does not have to be applied uniformly across the forest. But the agency cannot dismiss local impacts based on landscape-level assertions without knowing how the relevant substantive requirement is being achieved at the landscape-level. Simply pointing to the existence of a condition elsewhere, such as old growth, does not satisfy that obligation.

proposed amendment to Standard 6C-026 which makes Management Prescription Area 6C "unsuitable for designation of new utility corridors, utility rights-of-way, or communication sites." DSEIS at 101. The DSEIS proposes exempting MVP from this requirement. The agency must realize that it cannot come back and repeatedly waive this requirement to serially authorize utility corridors in this management area. The standard would be meaningless if it could be waived project-by-project, precluding application of the requirement to "maintain or restore the diversity of ecosystems," and the one integrated plan and consistency requirements would be unmet. But it is not the *repeated* practice of waiving plan standards for specific projects that is problematic, it is the practice itself.

To be clear, that does not prohibit construction of MVP. It leaves the agency three options. First, it can come up with a new plan standard that applies § 219.9(a)(2) without wholly waiving Standard 6C-026. Second, it can require MVP to avoid this management prescription. Third, it can go through the process of re-designating the ROW in this area so it is no longer part of management prescription 6C. This third option was in fact the agency's plan for some time. *See* 82 Fed. Reg. at 25,762 (conveying that the agency "reconsidered" the necessity of re-designating the area). Bypassing the Forest Plan by waiving standards for specific projects is not a fourth option.

G) The agency's effort to substitute Plan standards for POD compliance violates the 2012 Rule

The Forest Service proposes to amend six standards (FW-5, FW-8, FW-9, FW-13, FW-14, and 11-003) by exempting MVP and requiring implementation of "the applicable mitigation measures identified in the approved POD and MVP design requirements." DSEIS at 93–95. This falls short of planning rule requirements for three reasons.

First, it fails because this is simply using different language to waive plan standards which the agency cannot do. Requiring implementation of the Plan of Development ("POD") and design criteria is no different than requiring construction of the project because the POD and design criteria *are part of the project*. Phrased differently, MVP, the POD, and relevant design requirements are a package deal. There is no difference between saying that, for example, FW-5 does not apply to this project and that compliance with FW-5 turns on implementation of the POD because the POD will be implemented either way. The Forest Service has already found that construction of MVP with the POD does not meet NFMA's requirements as implemented through the Forest Plan. Otherwise plan amendments would not be necessary. It is arbitrary for the Forest Service to determine that MVP (with the POD) does not comply with NFMA as implemented through Forest Plan standards but then substitute those same standards for compliance with the POD—the standards are just being waived.

Imagine how this would work with a timber sale: the Forest Service designs a timber sale complete with mitigation but that cannot be implemented without violating six forest plan standards even with that mitigation. Nevertheless, to implement the timber sale the Forest Service replaces the plan standards with the mitigation that was already a part of the timber sale and was already insufficient to meet those same plan standards. Whether the timber sale or MVP, this is nothing more than waiving the plan standards to allow the project to be implemented as designed. This violates NFMA.

Second, the POD is far too vague to ensure compliance with the substantive standards of the planning rule. The POD is nearly one hundred pages with thirty appendices. In amending plan standards related to soils and riparian areas the agency asserts that the "substantive requirements related to 219.8" are met because the "design requirements and mitigation measures identified in the POD will be required." DSEIS at 100. Which requirements in the POD or its numerous appendices is the agency referring to? The public certainly has no clue. This throw-it-against-the-wall-and-see-what-sticks strategy to meeting the requirements of the 2012 Rule does not cut it. The agency must specifically explain how, if at all, the POD meets the substantive provisions of the 2012 Rule.

Third, the POD cannot substitute as a Forest Plan standard because it is not a standard. A standard for forest planning purposes "is a mandatory constraint on project and activity decisionmaking, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements." 36 C.F.R. § 219.7(e)(iii). At first blush, requiring compliance with the POD may seem like a mandatory constraint but the POD belies that conclusion; it is "is an iterative document that *will evolve throughout the design and implementation process*." POD at 1-2 (emphasis added). An evolving document cannot serve as a forest plan standard. The public and the agency cannot evaluate compliance with an evolving standard. This would violate all the procedural requirements for public involvement when plan components are changed. *See* 36 C.F.R. § 219.13(b)(2). Nor can the agency determine if the POD's application satisfies NFMA. This is akin to having a self-amending forest plan which the planning rule prohibits.

H) The agency's application of § 219.10 is arbitrary and capricious

According to the agency, "the substantive requirement [at § 219.10] specific to utility corridors is consideration of appropriate placement and sustainable management of infrastructure, including utility corridors." DSEIS at 98. The Forest Service's application of this requirement is arbitrary and capricious because the agency fails to grapple with the fact that has already designated several areas crossed by MVP as inappropriate for utility corridors which is the reason several of the proposed Forest Plan amendments are necessary. In other words, the Forest Service has already applied this provision (or the 1982-rule equivalent) and determined that MVP's preferred route across the forest is not viable. It must at least acknowledge its change in position in re-applying the provision.

The clearest example of this problem relates to Standard 6C-026. That standard prohibits "new utility corridors" in Management Prescription Area 6C. Restated, the agency has already "consider[ed] [the] appropriate placement . . . of infrastructure, including utility corridors" and determined that utility corridors are not appropriate in Management Prescription Area 6C. Now the agency is waiving that requirement without explaining its reversal in position.

The agency makes the same error in amending Standard 4A-028. That standard restricts "new public utilities and rights-of-way" across the Appalachian Trail to areas "where major impacts already exist." DSEIS at 96. As with Standard 6C-026, the agency previously considered the appropriate placement of new utility corridors, determined it was inappropriate to place them in areas that would require a crossing of the Appalachian Trail in an undisturbed area, and developed a plan standard accordingly. The agency is now reversing its position by waiving Standard 4A-028 which it cannot do with no explanation.

Application of § 219.10 to exempt MVP from FW-248 also comes up short because it is unsupported by the record. That standard provides that "decisions for new authorizations [of utility corridors] outside of existing [utility] corridors and designated communication sites will include an amendment to the Forest Plan designating them as Prescription 5B or 5C." DSEIS at 93. The agency has given no valid reason why MVP cannot comply with that standard. According to the agency, this standard was designed to "reduce fragmentation and minimize visual effects by encouraging collocation of any future utility corridors." DSEIS at 97. The agency then exempts MVP from the requirement because "collocation of future utilities . . . is too speculative." DSEIS at 97. But collocation of utilities is always speculative; application of the standard cannot hinge on foreseeing the need to collocate another utility because the agency would likely never have sufficient information to evaluate that possibility when designating an area as Prescription Area 5B or 5C in the first place. Similar concerns about the logistical feasibility and environmental preference of constructing another future pipeline in the same right-of-way are too speculative to justify exempting MVP from this requirement. *See* DSEIS at 97. The agency has provided no justifiable basis to exempt MVP from FW-248. *See also League of Wilderness Defs./Blue Mountains Biodiversity Project v. Connaughton*, No. 3:12-CV-02271-HZ, 2014 WL 6977611, at *27 (D. Or. Dec. 9, 2014) (requiring the Forest Service to "articulate a rational connection between the characteristics of the project area and the choice to adopt site-specific, rather than forest-wide, amendments").

The failure to re-designate the right of way as Management Prescription Area 5C or 5B may create additional problems for the agency. By requiring that new utility corridors be re-assigned to those prescriptions, the Forest Plan FEIS assumes that new utility corridors will not be placed in other prescriptions. Where the Forest Service is depending on those other prescriptions to ensure, for example, species diversity requirements are met at the landscape-level, it must account for the fact that those prescriptions may no longer be serving that function if they are operating as utility corridors. Changing management area allocations (from 6C to 5C, for example) should prompt that question but it is not clear that the Forest Service has considered it here.

Finally, a forest-wide amendment re-designating the ROW as Prescription Area 5C is particularly appropriate because MVP is not a short-lived project. Project-specific amendments are expected expire when the project is complete. But MVP has no "completion" date. Construction would end at some point, but maintenance of the right-of-way would be ongoing, with resulting impacts on management opportunities in the area.

I) The Forest Service has not demonstrated that the revised Plan standards "maintain or restore" various resources

The Forest Service proposes to amend six standards (FW-5, FW-8, FW-9, FW-13, FW-14, and 11-003) related to soils and riparian areas. Amending these standards requires application of § 219.8(a)(2)(ii). DSEIS at 99. "The substantive requirement [under § 219.8] specific for soils and soil productivity is to include plan components to maintain or restore soils and soil productivity." DSEIS at 99. "The substantive requirement specific to riparian is to include plan components to maintain or restore the ecological integrity of riparian areas." *Id.* But the agency has not shown that FW-5, FW-8, FW-9, FW-13, FW-14, and 11-003, as amended, "maintain or restore" these resources.

Publication of the 2012 Rule was accompanied by an environmental impact statement which explained how the phrase "maintain or restore" was to be applied. The phrase is interchangeable with "maintain, protect, or restore" because "'protection' is inherent in maintaining resources that are in good condition and restoring those that are degraded, damaged, or destroyed," which is the root requirement.[13] Thus, when revising or amending a forest plan and applying § 219.8, the end result is plan components that protect resources by maintaining those that are in good condition and restoring those that are damaged. The agency cannot develop a plan component that facilitates the long-term degradation of a resource. Of course a project may have some local or temporary adverse impacts, but the *plan* must be internally consistent (*i.e.*, integrated) and it must maintain or restore soil and water resources.

Here, the Forest Service has not shown that the amended plan standards will not lead to long-term degradation. Simply pointing to the existence of the POD does not satisfy that

[13] 2012 Planning Rule FEIS, App'x O, O-81 *available at* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5349162.pdf.

requirement, particularly in light of MVP's repeated and significant erosion and sedimentation problems. In fact, the DSEIS suggests that some resources will not be maintained or restored, acknowledging that "it is unlikely that [pipeline ROW land areas and their associate resources] would be restored to original conditions and functionality." DSEIS at 117.

Proper application of the "maintain and restore" standard is particularly important for FW-5. That standard "requires that at least 85% of the organic layers, topsoil, and root mat be left in place over an activity area." DSEIS at 98. NFMA prohibits activities where "soil, slope, or other watershed conditions will . . . be irreversibly damaged," 16 U.S.C. § 1604(g)(3)(E), and FW-5 appears to be the primary way the Forest Service implemented that requirement when it last revised the JNF Forest Plan. Then, the "only threshold value used in the [Draft Plan], the DEIS and in site specific analysis for impacts to soils is Standard FW-3 [now FW-5] . . . This Standard was used in the DEIS and will be used in site specific project environmental analysis to determine effects to soil productivity. We feel the 85% standard in FW-3 of the [Draft Plan] is adequate protection."[14] If the 85% standard was the "only threshold" incorporated into the plan to ensure compliance with NFMA, the agency must explain why amending that standard does not threaten a NFMA violation.

J) The agency must ensure an amended plan will not violate water quality standards

Forest plans "must comply with all applicable laws and regulations." 36 C.F.R. § 219.1(f). Given MVP's repeated water quality violations in both Virginia and West Virginia, the Forest Service must ensure that its plan amendments do not facilitate violations of Virginia's water quality standards including its narrative turbidity standard. In particular the Forest Service should explain why a 31.3% increase in sediment delivery to a 1.16-mile stretch of stream would not violate that standard. *See* DSEIS at 76.

V. The Forest Service cannot authorize the MVP ROW if the pipeline can be reasonably accommodated off the forest

A) The Forest Service has a legal duty to consider off-forest alternatives under NEPA and NFMA

MVP will cross the Jefferson National Forest at two places along its route, from approximately Milepost 196.2 to 198.5 and Milepost 218.5 to 220.9. Under NFMA, the Forest Service must ensure that all activities on a national forest are consistent with the governing forest plan. 16 U.S.C. § 1604(i). Forest Plan Standard FW-244 requires the Forest Service to limit

[14] JNF Forest Plan FEIS, App'x J, J-47 *available at* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3834580.pdf.

special uses to "needs that cannot be reasonably met on non-NFS lands or that enhance programs and activities." JNF Forest Plan at 2-60. It further requires that the Forest "[l]ocate uses where they minimize the need for additional designated sites and best serve their intended purpose," and "[r]equire joint use on land when feasible." *Id.* Where the Forest Service fails to make a showing that the need cannot be reasonably met off the forest, issuance of or concurrence with a special use permit would violate FW-244 and therefore violate NFMA. Further, Forest Plan Goal 34 states: "Utility corridors and communication sites on National Forest System lands minimize negative environmental, social, or visual impacts; minimize acres of land affected; are designed using good engineering and technological practices; and clearly benefit society."[15] *Id.* at 2-59.

As explained by the Fourth Circuit, Forest Service regulations similarly state that "'[a]n authorized officer shall reject any proposal . . . if, upon further consideration, the officer determines that: . . . the proposed use would not be in the public interest.' 36 C.F.R. § 251.54(e)(5)(ii). The Forest Service Manual provides further guidance on § 251.54(e)(5)(ii), directing that a proposed use should be authorized as 'in the public interest' 'only if . . . the proposed use cannot reasonably be accommodated off of National Forest System lands.'" *Cowpasture*, 911 F.3d at 168 (citing Forest Serv. Manual 2703.2). "The Forest Service Manual further directs, '[d]o not authorize the use of National Forest System lands solely because it affords the applicant a lower cost or less restrictive location.'" *Id.*

Separate from these NFMA-based requirements, the Forest Service is required under the National Environmental Policy Act ("NEPA") to consider alternatives to proposed actions, 40 C.F.R. § 1502.14,[16] and "take a hard look at environmental consequences." *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989). Although FERC was the lead agency on the FEIS for MVP, as a cooperating agency at the time, the Forest Service was required to undertake "an independent review" of the FEIS and "conclude[] that its comments and suggestions have been satisfied." 40 C.F.R. § 1506.3(c); *see also Sierra Club*, 897 F.3d at 590.

More to the point, the Forest Service is the lead agency on this DSEIS which must provide sufficient analysis to support its new administrative approval process following vacatur of its prior approval. DSEIS at 8. While the Forest Service can incorporate relevant portions of FERC's FEIS, that analysis does not restrict the Forest Service's authority (or obligations) here. Restated, the Forest Service is starting on a blank slate, though it can fill portions of that slate by incorporating the earlier FEIS as appropriate. Regardless of FERC's FEIS, the Forest service has

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[15] While goals are not directly binding like standards and no one project can allow the Forest Service to meet a goal, the Forest Service "is not free to disregard the goal entirely." *Cowpasture*, 911 F.3d at 169.

[16] The Council on Environmental Quality recently released an update to its NEPA regulations that became effective on September 14, 2020. However, given that this DSEIS was prepared under the 1978 NEPA regulations, we cite the 1978 version here.

independent responsibility to ensure it has complied with NEPA's and NFMA's requirements and their implementing regulations. In sum, the Forest Service alone is responsible for ensuring that the analysis for this project adequately addresses alternatives and impacts related to forest resources.

To that end, the agency's assertion that it is "not within the jurisdiction of the Forest Service" "[t]o determine and compare the environmental effects associated with avoidance alternatives as well as the alternative modes" is incorrect. DSEIS at 34.[17] Ensuring NEPA and NFMA compliance for use of forest resources is *the* jurisdiction of the Forest Service. It is agency's responsibility to ensure that impacts to forest resources have been fully analyzed, allowing opportunities for mitigation of harm, including by moving the route off the forest, and ensuring the public has the chance to review and comment on those alternatives. .

B) Off-forest alternative routes have not been adequately considered

FERC's FEIS does not satisfy the Forest Service's NEPA and NFMA obligations with regard to the two forest crossings along MVP's current route. As described in the DSEIS, "FERC used key criteria to evaluate the identified alternatives," including technical and economic feasibility and practicality and whether an alternative offered a "significant environmental advantage over the proposed action." DSEIS at 25. But as explained in *Cowpasture*, "[t]his is a significantly different standard than whether the proposed use '*cannot reasonably be accommodated* off of National Forest System lands.'" 911 F.3d at 168. As such, off-forest alternative routes for MVP were never adequately considered in FERC's FEIS for purposes of NEPA or NFMA.[18] The DSEIS as drafted does not close that gap.

The DSEIS recognizes the necessity to analyze off-forest routes "to ensure consistency with the Jefferson Forest Plan and agency policy." DSEIS at 11. But it never undertakes the analysis required. The DSEIS considered off-forest route alternatives using a 3-part evaluation: "(1) Whether all reasonable alternatives that would avoid NFS lands had been reviewed; (2) How special use screening requirements found at 36 CFR 251.54(d)(e) supported a review of alternatives; and (3) Whether the JNF Forest Plan standard FW-244 had been adequately addressed." DSEIS at 26.

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[17] We understand that were the Forest Service to choose an off-forest route, those effects would also have to be considered by FERC before the route could be authorized. But FERC's role does not strip the Forest Service of its obligations. Regardless, the Forest Service cannot reject an off-forest alternative as unreasonable if it does not know the effects associated with that alternative.

[18] In fact, the single Forest Avoidance Alternative addressed in the DSEIS has never been analyzed under NEPA at all. That alternative was "developed by MVP in their SF-299 application . . . [and] submitted to the Forest Service on April 8, 2016." DSEIS at 31. But it "was not included in the 2017 FERC FEIS." *Id.* Because the Forest Service adopted the FERC FEIS without supplementation in 2017, that avoidance alternative has not been reviewed under NEPA.

The crux of the agency's analysis is its evaluation of the first criterion: "[w]hether all reasonable alternatives that would avoid NFS lands had been reviewed." To satisfy this criterion, the Forest Service recites a list of existing alternatives, sourced from FERC's 2017 FEIS or the updated SF-299 submitted by MVP in 2020. None of these route alternatives are new,[19] and they do not take into consideration the Forest Service's independent NFMA obligations, nor any changed circumstances since 2017. Instead, they are a recitation of routes already considered. Effectively: (1) the Forest Service adopted in 2017 the analysis of routes in FERC's FEIS, (2) *Cowpasture* clarified that FERC's FEIS did not apply the correct standard applicable to the Forest Service, (3) the Forest Service acknowledges the effect of *Cowpasture* in the DSEIS, and (4) then points back to FERC's FEIS to argue that standard is satisfied, seemingly forgetting (2).

One off-forest route copied from a 2016 filing by the pipeline, but abandoned even before FERC prepared MVP's NEPA documents, receives the most page space in the DSEIS. The Forest Service's consideration of this single off-forest route is insufficient for multiple reasons. First, the agency claims that it "does not have jurisdiction over an alternative that avoid NFS lands." DSEIS at 31. This markedly misstates the Forest Service's obligation. The agency is not required to choose a new route for the entire pipeline but to consider off-forest routes and deny the special use permit if reasonable off-forest route are available. To be sure, the agency would have to inform FERC of such a finding, which may in turn require FERC to reassess pipeline routes. But that does not enable the Forest Service to throw up its hands and fail to look for potential off-forest routes. Second, the agency states that the "No Action Alternative effectively addresses avoidance of NFS lands." DSEIS at 31. At most, that is accurate for NEPA effects purposes, but not as a mechanism to comply with the Forest Plan and the agency's special use regulations requiring consideration of off-forest routes. Third, the fact that "a majority of the MVP has already been constructed" does not diminish the agency's obligation to consider off-forest alternatives. MVP has long been aware of the risks of continuing construction in the absence of all necessary permits. Any adverse consequences of that decision fall on MVP, not the Forest Service or the public. But neither did the Forest Service evaluate off-forest alternatives that account for the current status of MVP construction. The Forest Service cannot hold up MVP's construction problem as a reason to skip necessary analysis, but ignore the fact that the same construction is new information requiring analysis under the law. Moreover, FERC has not allowed construction in a buffer zone surrounding the national forest with the understanding that the route across the forest could change. Finally, the single off-forest alternative seems to have been rejected in part because it is supposedly longer than the preferred

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[19] *Compare* 2017 MVP SF-299 at 10-12, https://www fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd810358.pdf, *with* 2020 MVP SF-299 at 11-12, https://eplanning.blm.gov/public_projects/2000356/200388039/20027703/250033905/MVP%20SF299%20App%2005092020%20RevisedCompressed.pdf.

route. *See* DSEIS at 33. But as displayed in Figure 2 of the DSEIS, the route parallels the existing Trancso pipeline for dozens of miles. Building new, parallel pipe here appears unnecessary. At the least, the Forest Service should explain why MVP could not connect to Transco at the northern terminus reflected on Figure 2 and fulfill the goals of the project. That route would entirely avoid Forest Service land, and it appears to be shorter than the preferred route.

Returning to the 3-part evaluation used in the DSEIS to consider off-forest routes, for evaluation of both criteria 2 and 3, the DSEIS cites to 36 C.F.R. § 251.54 and related sections of Forest Service Handbook 2709.11, Sections 12.2 and 12.4. Use of this screening criteria in 2016 "included initial evaluations of…if the proposed use could be reasonably accommodated on non-NFS lands," and it was used again in 2020 "as a consideration in whether the Forest Service should concur on the Bureau of Land Management's issuance of a ROW." DSEIS at 35. Section 251.54 and the related portions of the Handbook present primary and secondary screening criteria for special uses, a separate obligation that must be satisfied before a permit can be granted. One of those criteria specifies that a proposed use may not be permitted where it is not in the public interest, which is defined in the Forest Service Manual to include routes that can be reasonably accommodated off the forest. *See* 36 C.F.R. § 251.54(e)(5)(ii); FSM 2703.2(2). In determining that the requirement of Forest Plan standard FW-244 to not authorize special uses that can be reasonably met on non-NFS lands was "adequately addressed," the DSEIS *then cites back to the analysis of criteria 1*, which entirely fails to make the necessary showing, as discussed above. This is circular and does not meaningfully contribute to analysis of off-forest routes.

Somewhat bizarrely, also in the analysis under criteria 3, the DSEIS addresses whether MVP satisfies FW-244 as a special use meeting "needs that . . . enhance programs and activities." DSEIS at 35. The DSEIS seems to argue that because the Forest Service has signed on to an Interagency Agreement to process natural gas pipeline proposals, and because policies exist at the federal executive level to "recognize the importance of domestic energy production and transmission,"[20] this pipeline is part of the programs and activities the Forest Plan would be referencing. *Id.* But the Forest Plan does not take a stance on the importance of natural gas infrastructure and, in fact, contains numerous standards to ensure that such infrastructure has minimal negative impact on the forest. The DSEIS goes on to say that "[i]in deference to FERC's decision" (to issue a Certificate of Public Convenience and Necessity), "and the agency's commitment to the Interagency Agreement" (that is, how to process pipelines applications, not the programs and activities of the forest), "the Forest Service determined the portion of the MVP route on the JNF enhances programs and activities *of the federal government*

[20] The Forest Service's citation to these policies also begs the question whether the pipeline would violate this standard if those policies were to change.

and therefore is consistent with Forest Plan standard FW-244." DSEIS at 35–36 (emphasis added).

This argument completely misses the point. First, Forest Plan standards do not "defer" to the desires of other agencies. They are about use and protection of the forest, as governed by the Forest Service, not FERC. Second, the "programs and activities" that are of concern in the Jefferson National Forest Plan are the programs and activities *of the Jefferson National Forest*, not the entire federal government. The DSEIS's broad reading suggests that *any* program of the federal government would be a reasonable special use on the forest, regardless of the damage the activity would inflict. That runs directly counter to the language and binding standards of the Forest Plan, which seek to *minimize* impacts from special use, not allow any special use imaginable on the forest.

The Forest Service goes on to state it cannot perform an impacts analysis for the off-forest alternative at all, because "determin[ing] and compar[ing] the environmental effects associated with the avoidance alternatives . . . is not within the jurisdiction of the Forest Service." This is the same excuse the Forest Service provides for failing to consider any new or modified alternatives that account for new information and changed circumstances; it is "not within the jurisdiction of the Forest Service." DSEIS at 34.

But the responsibility of the Forest Service under the law is not to analyze only the alternatives offered by MVP or FERC and then wash its hands of the problem. The Forest Service *cannot* permit a special use that can be reasonably met on non-NFS lands. If alternatives exist that either minimize or remove completely Forest Service lands from the project, the Forest Service must consider them independently, whether the applicant or FERC has offered them or not; if those alternatives are reasonable, the Forest Service must select them, again regardless of FERC's route determinations. This analysis is nowhere to be found but must be undertaken before the Forest Service can concur with permit issuance.

Aside from "new" pipeline routes, the Forest Service's consideration of system alternatives in the DSEIS is also lacking. The Forest Service appears to rely solely on analysis in FERC's FEIS to reject those alternative, but FERC's analysis is now stale. In particular, the Forest Service should consider whether a connection with the WB XPress Pipeline would meet the project purpose while avoiding national forest system lands, and take into account the fact that Transco is now bidirectional. The Forest Service's statement that system alternatives would require "construction of additional facilities and pipelines to connect and utilize these systems [with] similar or greater environmental effect than the proposed MVP Project" is entirely conclusory and falls well short of NEPA's requirements. *See* DSEIS at 34. And as discussed above, the Forest Service cannot reject these options as "outside the scope and jurisdiction of the

JNF." DSEIS at 30. The alternatives "[w]ould avoid NFS lands;" they must be considered by the Forest Service even if the agency does not have ultimate authority to choose them. *Id*.

And total avoidance of National Forest lands is not the only type of route that the Forest Service must analyze here. Based on Table 3, which lists the alternatives analyzed, only one alternative "meet[s] the intent of the Court issue" by eliminating the forest crossing entirely. Other alternatives that "reduced the overall project length crossing NFS lands" were "not pertinent" to the analysis. DSEIS at 28, 34. This dramatically oversimplifies the Fourth Circuit's rulings. *Cowpasture* did rule that under NFMA, Forest Service regulations, and Forest Plans, the Forest Service must reject a special use that can reasonably be accommodated off NFS lands, and that the Forest Service must ensure that analysis has occurred. But in both *Cowpasture* and *Sierra Club*, the Court also held that the Forest Service has an obligation under NFMA to abide by Forest Plans generally. *Cowpasture*, 911 F.3d at 160; *Sierra Club*, 897 F.3d at 600. Jefferson Forest Plan Goal 34 requires that "[u]tility corridors . . . minimize negative environmental, social, or visual impacts; [and] minimize acres of land affected." And Standard FW-244 states special use permits should "[r]equire joint use on land when feasible." Jefferson National Forest Plan, 2-60. It is therefore not enough to look only at routes that would entirely avoid National Forest lands; the Forest Service must also analyze, and choose, routes that minimize environmental impacts or acreage of forest utilized. That may be a route that crosses a shorter distance on the forest, collocates with existing utility right-of-ways on the forest, or another option entirely.

C) Routes that avoid or reduce forest crossings must be analyzed

Possible alternatives do exist. Even allowing that trees have been cleared in the pipeline ROW under permits that, in violation of NEPA and NFMA, never properly analyzed off-forest alternatives, construction activities through and between the forests have been restricted. This leaves an area in which the Forest Service must, and can relatively easily, examine whether the pipeline can be reasonably accommodated off the forest. *See* Attachment 1 (map showing substantial gaps in Forest Service ownership between mileposts 195-221). Gaps in Forest Service ownership exist southwest of both current crossings, and the Forest Service must consider whether re-routing around the forest is reasonable by modifying some or all of the route currently planned near or in the construction exclusion zone (approximately MP 196.0 to 221.0).

Routes that avoid the forest altogether are not the only option. As explained above, the Forest Service must also look at routes that would minimize acreage of forest in the ROW, reduce environmental impacts, or both. Existing utility corridors cross the forest close to both current MVP crossings, and no agency has considered whether collocation with those crossings might reduce impacts on the forest by reducing disturbance, particularly in areas designated as old growth or that may affect rare species. MVP is already collocating with one of these utility corridors between the two forest crossings. While the MVP SF-299 Form and the FEIS considered collocation routes on a larger scale, like Alternative 1 (DSEIS at 27), they did not consider smaller route changes meant specifically to eliminate or reduce forest crossings in the exclusion zone roughly between Mileposts 196–221. This exclusion zone is new information that has not been considered in any analysis. The final SEIS must consider these options in order to satisfy NEPA and NFMA.

This is no mere technicality. By skipping the analysis of off-forest routes, the Forest Service not only fails to comply with the law, it also fails to provide the public an opportunity to view these alternatives and comment on whether and how impacts to forest resources might be mitigated. The final SEIS must, at minimum, analyze routes including the exclusion zone that avoid or minimize the use of forest land. If any such route is reasonable or feasible, the Forest Service must insist on its adoption by FERC. Only if the Forest Service shows the pipeline cannot reasonably be accommodated off-forest in whole or in part may it concur in BLM's issuance of the ROW permit on the current route.

VI. BLM failed to consult with the National Park Service on whether to grant a right-of-way under the Appalachian Trail

Under the Mineral Leasing Act ("MLA"), BLM is authorized to "to grant or renew rights-of-way or permits through the Federal lands" when the surface of those lands is "administered . . . by two or more Federal agencies." 30 U.S.C. § 185(c)(2). Translated through BLM's regulations, when the ROW "application involves lands managed by two or more Federal agencies, BLM will not issue or renew the grant or TUP until the heads of the agencies administering the lands involved have concurred." 43 C.F.R. § 2882.26. Here, management responsibility for the Appalachian National Scenic Trail is shared between the Forest Service and the National Park Service but while BLM consulted with the Forest Service, DSEIS at 2, it appears to be neglecting the National Park Service, in violation of the MLA.

Cowpasture does not change this conclusion. In that case, the Supreme Court considered whether the Forest Service could use MLA § 185(a) to grant a pipeline right-of-way under the Appalachian National Scenic Trail. *Cowpasture*, 140 S. Ct. at 1841. Though that section generally allows an "appropriate agency head" to grant ROWs for oil and gas pipelines through "any Federal lands," Congress expressly excluded "lands in the National Park System" from the statute's scope. 30 U.S.C. § 185(b)(1). The Court, however, found that the ANST is not "land[] in the National Park System." *Cowpasture*, 140 S. Ct. at 1846 ("A trail is a trail, and land is land."). Instead, the Trail is a right-of-way "easement that is separate from the underlying land." *Id.* at 1847. Because the Park Service's easement "did not divest the Forest Service of jurisdiction over the lands that the Trail crosses," the Forest Service could properly grant a ROW across those lands. *Id.* at 1846; *see also id.* at 1844 ("We conclude that the lands that the Trail crosses remain under the Forest Service's jurisdiction and, thus, continue to be 'Federal lands' under the Leasing Act.").

But while the Court was adamant that the ANST is not Park Service "land," it was forced to admit that the Park Service shares management and administration responsibilities for the ANST. *See id.* at 1845 n.3 (noting that both the Park Service and Forest Service "have positive grants of authority" regarding the ANST). Thus, while BLM may use the MLA to authorize a crossing of the ANST where it is located Forest Service lands, that does not relieve BLM of its obligation to obtain written concurrence from the Park Service. How could the Park Service ensure that "a pipeline segment [does not] interfere[] with [its] rights of use"—a right recognized in *Cowpasture*—if BLM never obtains its concurrence? *Id.* at 1850 n.7.

Yet concurrence does not appear to have happened. The DSEIS explicitly notes that BLM obtained written concurrence from the Forest Service and Army Corps of Engineers, but makes no representation regarding concurrence from the Park Service. *See* DSEIS at 1 (noting receipt of written concurrence from the Forest Service and Army Corps).

This is not a harmless oversight. The Forest Service is proposing to amend Forest Plan standards that were designed specifically to protect the ANST. *See* DSEIS at 22 (proposing to amend Standard 4A-028). As a result, construction of MVP will have substantial impacts on the ANST, and on the ANST viewshed in particular.[21] Failing to obtain the concurrence of the very entity[22] tasked with conserving the Trail and its viewshed is arbitrary, capricious, and violates both the MLA and BLM's regulations.

VII. <u>BLM's Eastern States Director lacks the authority to issue a right-of-way for MVP</u>

BLM has delegated the authority to "[a]pprove all actions required for the granting and management of Rights-of-Way" under "Sec. 28 of the Minerals Leasing Act [sic], as amended" to the BLM State Directors. BLM Manual § 1203. MVP is located in the Eastern States region. However, the current Eastern States Director—Mitchell Leverette—lacks the authority to issue such a right-of-way because he was appointed by William Perry Pendley in violation of the Federal Vacancies Reform Act ("FVRA") and the APA.

The FVRA generally prescribes the "exclusive means for temporarily authorizing an acting official to perform the functions and duties" of a vacant Senate-confirmed office. 5

[21] *See* https://www.backpacker.com/news-and-events/appalachian-trail-pipeline.

[22] In deciding whether to concur with BLM's proposed right-of-way, the Park Service should consider the impact of the pipeline on the *full* trail corridor through the George Washington and Jefferson National Forests, not merely impacts to the viewshed at the specific location of the crossing.

U.S.C. § 3347. Unless the FVRA's strictures are followed, the office in question "shall remain vacant," and in the case of a sub-cabinet agency like the BLM, "only the head of [the] Executive agency"—here the Secretary of the Interior—can perform the functions of duties of the vacant office. *Id.* § 3348(b).

To police this requirement, the FVRA also provides that any "action" taken by an individual illegally performing "any function or duty" of a vacant Senate-confirmed office "shall have no force or effect" and "may not be ratified." 5 U.S.C. § 3348(d); *see, e.g.*, *L.M.-M. v. Cuccinelli*, 442 F. Supp. 3d 1, 34 (D.D.C. 2020) (invalidating two directives issued by an official illegally serving as Acting Director of the U.S. Citizenship and Immigration Service in contravention of the FVRA); *see also SW Gen., Inc. v. NLRB*, 796 F.3d 67, 78 (D.C. Cir. 2015), *aff'd*, 137 S. Ct. 929 (2017) ("The FVRA renders any action taken in violation of the statute void ab initio."). An "action" includes the "whole or a part of an agency rule, order, license, sanction, relief, or the equivalent or denial thereof, or failure to act." 5 U.S.C. § 551(13). The FVRA defines "function or duty" as one "established by statute" or "by regulation" and "required by statute" or "by such regulation to be performed by the applicable officer (and only that officer)." *Id.* § 3348(a)(2)(A)–(B) (emphasis added).

Here, BLM has operated without a Senate-confirmed Director since January 19, 2017. *Bullock v. U.S. Bureau of Land Mgmt.*, No. 4:20-CV-00062-BMM, 2020 WL 5746836, at *3 (D. Mont. Sept. 25, 2020). Thanks to a series of temporary authorizations and self-delegated orders, BLM Acting Director William Pendley has exercised the powers of the Director since July 29, 2019. *Id.* at *4–5. This "matryoshka doll of delegated authorities" notwithstanding, Pendley's "previous and ongoing service as Acting BLM Director violates the Appointments Clause of the U.S. Constitution and the FVRA." *Id.* at *8, *11.

Pendley appointed Eastern States Director Mitchell Leverette while unlawfully serving as BLM's Acting Director.[23] This "action" could only be performed by the BLM Director. *See* 235 Department Manual ch. 3 (General Administrative Delegation); *see also* BLM Manual § 1201.04 ("The State Director is the principal BLM line official at the State level and is directly accountable to the BLM Director."). Therefore, Pendley's appointment of Leverette has "no force or effect" under the FVRA.

But even if Leverette's appointment somehow passed FVRA muster, it would still violate the APA. This statute requires courts to set aside agency actions that are "not in accordance with law" or that are "in excess of statutory jurisdiction, authority, or limitations." 5 U.S.C. §

[23] *Compare* BLM Names Mitchell Leverette as Eastern States Director, Bureau of Land Mgmt., https://www.blm.gov/press-release/blm-names-mitchell-leverette-eastern-states-director#:~:text=Bureau%20of%20Land%20Management%20Deputy,new%20position%20on%20July%206 (June 23, 2020) (announcing Leverette's appointment by Pendley on June 23, 2020), *with Bullock*, 2020 WL 5746836, at *12 (finding that by September 25, 2020, Pendley had served unlawfully for "424 days").

706(2)(A). Therefore, any actions taken without lawful authority pursuant to the FVRA are at least "voidable," if not "void ab initio," under the APA. *SW General*, 796 F.3d at 79; *Bullock*, 2020 WL 5746836, at *12 ("The Secretary's failure to perform the functions and duties of BLM Director as required under the FVRA and instead delegate those decisions to an improperly appointed Acting BLM Director would render any decisions issued by that Acting BLM Director arbitrary and capricious as not issued 'in accordance with law.'"); *Cuccinelli*, 442 F. Supp. 3d at 34 ("[B]ecause Cuccinelli was exercising the authority of the USCIS Director in violation of the FVRA, the directives were not issued 'in accordance with law,' and must, accordingly, be set aside under the APA."). William Pendley appointed Leverette while exercising the authority of the BLM Director in violation of the FVRA. *See supra*. Therefore, this appointment was "not in accordance with law" and must be set aside.

Since Leverette was appointed unlawfully, he lacks the authority to act as the Eastern States Director. Any attempt to wield the powers of his office would also be "not in accordance with law" or "in excess of statutory jurisdiction, authority, or limitations." 5 U.S.C. § 706(2)(A). Therefore, Leverette cannot issue the MLA ROW for the Mountain Valley Pipeline without violating the APA.

VIII. <u>The Forest Service must account for additional cumulative effects</u>

Where, as here, the Forest Service has an independent obligation to comply with NEPA, it is arbitrary and capricious for the agency to cabin its review solely to acquiesce in the decisions of other agencies. *E.g.*, *Sierra Club*, 897 F.3d at 594. Yet the Forest Service explains that it limited the spatial boundary of its cumulative effects analysis "for consistency with the FERC FEIS cumulative [sic] analysis" because "the FERC FEIS uses HUC-10 watersheds for the cumulative effects analysis area." DSEIS at 103–04. Put different, the *only* reason that the Forest Service offers for constraining the spatial boundary of its analysis is that it is doing what FERC did. That is simply not enough. The Forest Service must independently ensure that the SEIS is adequate under NEPA. *Sierra Club*, 897 F.3d at 594. At a bare minimum, the Forest Service must provide a sufficient reason for limiting its cumulative effects analysis area to HUC-10 watersheds—instead of hiding behind what FERC did.

Moreover, there are good reasons to think that using HUC-10 watersheds is *not* an appropriate way to define the spatial boundary for the cumulative effects analysis. The DSEIS addresses cumulative effects to "soil productivity, erosion, and sedimentation; water quality, threatened and endangered species and their habitat; Forest Service RFSS; vegetation; and scenery." DSEIS at 104. Although impacts to some affected resources (like water quality) may largely adhere to watershed boundaries, impacts to other resources (like TES species and their habitat, Forest Service RFSS, vegetation, and scenery) need not be similarly limited. Indeed, Figure 4 in the DSEIS reveals that the pipeline route would pass within roughly one mile of NFS lands within the Poverty Creek watershed (HUC-12 050500011804), and it is conceivable that impacts, like those to species, will not stop at the watershed boundary; yet impacts on those NFS lands receive no analysis. The Forest Service must choose an appropriate spatial boundary.

Likewise, the Forest Service will need to revisit its cumulative impacts analysis once the agency selects an appropriate spatial boundary. Currently, the DSEIS identifies numerous past, present, and reasonably foreseeable projects that were considered but eliminated from detailed study because they lie outside the cramped, watershed-based spatial boundary. These include (but are not limited to) FERC-regulated natural gas projects like WB XPress, Rover Pipeline, and Virginia Southside Expansion II; the non-FERC-regulated Columbia Gas Pipeline Replacement Project; and the Eastern Divide Phase II Project, No Business Project, and Dings Branch Project. *See* DSEIS at 107–08. Because the agency agrees that these are past, present, or reasonably foreseeable actions, those that fall within an appropriate spatial boundary will require detailed study. This is especially likely to be true of the vegetation management projects that were excluded from detailed study at DSEIS, 108, such as the Eastern Divide Phase II Project, which partially lies about ten miles from the proposed pipeline route. Similarly, the Forest Service must consider the cumulative effect of the proposed action in combination with the reasonably foreseeable impacts of the FERC-approved MVP Southgate Project (CP19-14).

Even if the Forest Service did not need to revise the spatial boundary for its cumulative impacts analysis (and it does), the Forest Service still must consider the reasonably foreseeable impacts from a vegetation management project that it has omitted. The George Washington and Jefferson National Forests are proposing a forestwide project to manage white pine up to 1,100 acres annually on the George Washington National Forest and 700 acres annually on the Jefferson National Forest.[24] The Forest Service has proposed design criteria for this project based on forest type, management prescription, proximity to roads, and more. *See* White Pine Scoping Letter at 3. Although the Forest Service has not proposed specific sites for treatment,[25] it is clear that the Forest Service has the tools at its disposal to forecast which stands will be eligible for treatment and which are likely to receive treatment, and that many of those stands may be within the existing spatial boundary of the cumulative impacts analysis area. In fact, because the White Pine Scoping Letter proposes up to 700 acres of vegetation management—with no limit on how much of that acreage may be subject to regeneration harvest—it is conceivable that the Forest Service could be omitting 1,400 of regeneration harvest on the Jefferson National Forest during the temporal timeframe that the agency has chosen for short-

[24] *See* Project page, George Washington and Jefferson National Forests Oak and Woodland Restoration Project, *available at* https://www.fs.usda.gov/project/?project=58928 (last visited Nov. 5, 2020); Scoping letter, George Washington and Jefferson National Forests Oak and Woodland Restoration Project at 3 (Oct. 13, 2020), https://www.fs.usda.gov/nfs/11558/www/nepa/114575_FSPLT3_5400823.pdf ("White Pine Scoping Letter").

[25] The practical and legal problems with this approach are beyond the scope of these comments.

term analysis, and many thousands more during the long-term timeline of 30 years. *See* DSEIS at 104. The Forest Service must account for these impacts.

IX. The Forest Service should not reapprove MVP without knowing the final route

Construction of MVP requires Clean Water Act § 404 permits from the Army Corps of Engineers. The Army Corps issues two types of permits: individual permits and general permits. MVP's developers have chosen to use a general permit, but that decision has been challenged. *See Sierra Club v. U.S. Army Corps of Engineers*, No. 20-2039(L) (4th Cir). If MVP is not able to use a general permit, it will have to obtain individual permits to construct the pipeline. To obtain an individual permit, a project applicant must show that there are no "practicable alternative[s] to the proposed discharge which would have less adverse impact on the aquatic ecosystem." 40 C.F.R. § 230.10(a). To comply with that requirement, Mountain Valley may have to reroute its pipeline. The Forest Service should refrain from issuing any further approvals until it knows if the current pipeline route can be permitted by its sister federal agencies.

X. Conclusion

To satisfy the requirements of its implementing regulations the agency must face this possible outcome: forthright application of those rules may require changes to the Mountain Valley Pipeline including its route. So long as the agency tries to make its rules fit the pipeline, rather than the pipeline fits its rules, it will run into problems in the application of those rules. This second attempt at approving MVP is no different. We ask that the agency correct the errors discussed above and issue a new DSEIS for public review. As always, if we can answer questions about our concerns, please let us know.

Sincerely,

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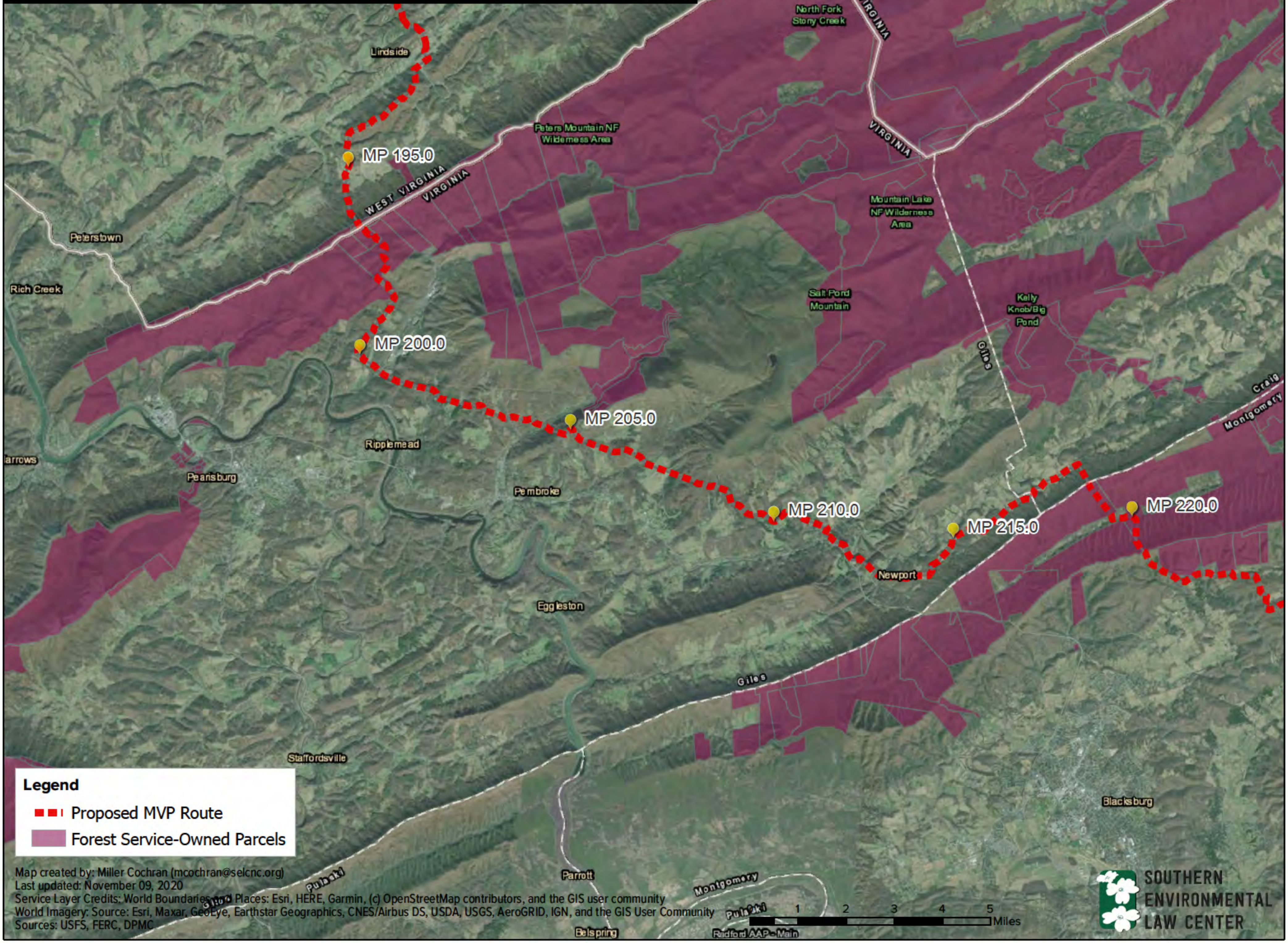
ATTACHMENT 1

Mountain Valley Pipeline - National Forest Impacts



The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 91

February 21, 2023

November 9, 2020

Jim Hubbard, Under Secretary
U.S. Department of Agriculture
c/o Jefferson National Forest
MVP Project
5162 Valleypointe Parkway
Roanoke, VA 24019

RE: Comment on the Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

Dear Mr. Hubbard:

The Wilderness Society, Protect Our Water Heritage and Rights, Save Monroe, Inc., Preserve Montgomery County VA, Preserve Salem, Preserve Franklin, Preserve Craig, Inc., Preserve Giles County, Indian Creek Watershed Association, Preserve Bent Mountain, and Preserve Monroe respectfully submit the following comments on the Draft Supplemental Environmental Impact Statement for the Mountain Valley Pipeline and Equitrans Expansion Project (DSEIS). The Mountain Valley Pipeline is proposed to cross the Jefferson National Forest (JNF) in parts of Giles, Craig, and Montgomery Counties, Virginia, and parts of Monroe County, West Virginia.

As stated in the DSEIS Abstract:

> The DSEIS responds to the July 27, 2018 United States Court of Appeals for the Fourth Circuit decision that vacated and remanded the Forest Service's decision approving the JNF's plan amendment. The Court also vacated the BLM's ROW decision and ROW grant/temporary use permit across National Forest System (NFS) lands. The supplemental analysis addresses the issues identified by the Court and any relevant new information and changed circumstances. The DSEIS evaluates the no action and the proposed action alternative.[1]

The Forest Service again proposes to amend the Revised Land and Resource Management Plan (LRMP or Forest Plan) for the Jefferson National Forest (JNF) to exempt the MVP Project (MVP) from certain standards, or otherwise prevent achievement of standards prescribed by the LRMP. Rather than making the pipeline project comply to the standards in the Forest Plan, the action would unlawfully make the Forest Plan consistent with the adverse impacts that will be caused by the MVP. With an amended Forest Plan, the Bureau of Land Management (BLM) would then act on the application for the grant a right-of-way to MVP for the construction and operation of the pipeline. The DSEIS violates the National Environmental Policy Act (NEPA), the National Forest Management Act (NFMA), and the Forest Service Planning Regulations. BLM's right-of-way Practicality Analysis violates the Mineral Leasing Act (MLA). As such, the Forest Service must, at the least, further supplement its environmental

[1] Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement, U.S. Dep't of Agric., Abstract (Sept. 2020).

analysis and, moreover, should not amend the JNF Forest Plan. BLM must, at the least, reassess its Practicality Analysis and should not grant a right-of-way across the JNF to MVP.

Construction of the MVP began in 2018 and was then stopped by legal challenges. As a result of construction already occurring both on and off the National Forest, there is an abundance of information for the Forest Service to consider in the supplemental analysis that was only speculative at the time the Forest Service and BLM adopted FERC's Final Environmental Impact Statement in June 2017, amended the LRMP, and granted a right-of-way. Nevertheless, the Forest Service fails to acknowledge, let alone incorporate into its analysis, what is already widely known about the harm caused by the construction of the MVP. Despite this, following vacatur, remand, and reanalysis, the Forest Service is still proposing to amend the Forest Plan for the JNF to make it conform to the harm that MVP will cause. This not only sets a terrible precedent, but also violates the Forest Service's own regulations and the JNF Forest Plan.

The Fourth Circuit Court of Appeals found that MVP "would be the largest pipeline of its kind to cross the Jefferson National Forest. American citizens understandably place their trust in the Forest Service to protect and preserve this country's forests, and they deserve more than silent acquiescence to a pipeline company's justification for upending large swaths of national forestlands."[2] Although the Forest Service has written more words this time, the analysis is nonetheless blind to the glaring adverse environmental impacts.

The Planning Rules require the Forest Service to use an interdisciplinary team of resource specialists to perform the LRMP amendment analysis.[3] It is both striking and telling that when the Forest Service is tasked with weakening a Forest Plan to accommodate the harm caused by the construction of a 42-inch gas pipeline, that the Interdisciplinary Team of 20 individuals includes only two individuals who are specifically assigned to the JNF. The other 19 persons on the team are assigned to Forest Service posts in Georgia, the Midwest, and Western states such as Colorado and Utah.[4] The team members' lack of knowledge of the JNF shows in the analysis. There is no record that any of the ID Team members, except Ginny Williams, have ever set foot in the JNF or grasp its extraordinary value to the surrounding communities, and instead the analysis is almost solely a result of digitized cogitation.

The DSEIS is significantly flawed and reanalysis is required. The Forest Service, however, is anticipating the "impending" start of pipeline construction according to information provided to homeowners on Brush Mountain by the President of the Preston Forest Homeowners Association.[5] Even setting aside the unlawfulness of the attempted Forest Plan amendments, before any further construction could take place and in order to meet its duty to fully address all comments, the Forest Service would need to correct the omissions to the Forest Plan standards

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[2] *Sierra Club, Inc. v. United States Forest Serv.*, 897 F.3d 582, 605–06 (4th Cir.), *reh'g granted in part*, 739 F. App'x 185 (4th Cir. 2018).

[3] 36 C.F.R. § 219.5(b).

[4] Results of internet research on Interdisciplinary Team members [Ex. 1].

[5] Email communication from Bill Dooley, November 6, 2020 ("I have learned that the Forest Service crews are actively working on the firebreaks for the impending burn within the Jefferson National Forest bordering the Preston Forest neighborhood along Jefferson Forest Lane. This burn was scheduled to happen last fall/early spring. The burn is highly dependent on weather conditions and is expected to occur as soon as weather conditions allow. *Also, the fire road gate will remain closed this season due to impending work on the pipeline*.") [Ex. 2].

that require amendment, and correct provisions of the 2012 rule that are likely to be directly related to those amendments—all of which will require additional public participation.[6] At a minimum, these are the steps the Forest Service would need to take if the Forest Service still believes that it can lawfully degrade resources by making a Forest Plan conform to anticipated harm.

In a rush to serve only the interests of the MVP, the Forest Service arbitrarily granted the public only 45 days to review and comment on thousands of pages of documents on a process that has been conducted without collaboration with the public that is mandated by the Forest Planning Rules and agency directives. The Forest Service is keeping the gate closed on the fire road on Brush Mountain in anticipation of impending construction of the pipeline.[7] MVP is warming the diesel engines, primed to get on the pipeline corridor before the ink dries on the agency decisions in a race between the project's financial backers and the public interests. This hardly fulfills the solemn duty owed as contemplated by the Fourth Circuit Court of Appeals when it admonished that "American citizens understandably place their trust in the Forest Service to protect and preserve this country's forests."[8]

I. THE SIGNATORIES AND THEIR INTERESTS.

Indian Creek Watershed Association's (ICWA's) mission is the preservation and protection of Monroe County's abundant, pure water. Education that leads to citizens' involvement with watershed issues and local planning efforts are the key to Monroe water protection. We continue to expand our outreach in the community to increase our membership and participation in ICWA preservation activities.

Preserve Craig's nonprofit purpose is to preserve and protect natural, historical, and cultural resources, conduct research and compile and publish information concerning natural, historical, and cultural resources, and conduct public education programs.

Preserve Franklin County is a group of concerned citizens protecting landowner rights against the abuse of eminent domain by companies and against the environmental and safety risks of gas pipelines.

Preserve Giles County is a citizens group organized to oppose interstate gas pipelines, and the hydraulic fracturing they sustain, and to preserve our natural heritage and the way of life it provides. We exist to empower citizens of our county, consistent with the principles of environmental democracy.

Preserve Monroe is a coalition of landowners, residents, businesses and organizations in Monroe County, WV. Preserve Monroe encourages citizens to participate in the responsible stewardship of our resources and to actively oppose projects that threaten the healthy and prosperous future of Monroe County and our families.

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[6] 36 C.F.R. § 219.13(b)(2) (requiring public participation in Forest Plan amendments).
[7] According to residents on Brush Mountain, the fire road gate has previously always been open during hunting season. This impact to recreation has not been identified in either the FEIS or DSEIS.
[8] *Sierra Club*, 897 F.3d at 606.

Preserve Montgomery County VA's (PMCVA's) mission is to stop the Mountain Valley Pipeline and proliferation of high pressure gas transmission pipelines and to promote environmental justice. PMCVA's on-going mission is vigilance, education, and mobilization for and by citizens of Montgomery County about issues that affect the county.

Protect Our Water, Heritage, Rights (POWHR) is an interstate coalition representing individuals and groups from counties in Virginia and West Virginia dedicated to protecting the water, local ecology, heritage, land rights, human rights of individuals, communities and regions from harms caused by the expansion of fossil fuel infrastructure.

Preserve Salem exists to maintain Salem's environmental, civic and economic quality of life without the burden of assuming externalized costs of MVP.

Save Monroe, Inc. is a nonprofit community-based organization consisting of private citizens and landowners who will be impacted by the Mountain Valley Pipeline. It is focused on the preservation of community and landowner rights; preserving safe and clean water for both private and public water supplies; addressing issues of safety concerns to the public; preserving historical and cultural values and landmarks; addressing impact on wildlife, farming, and woodlands; addressing concerns pertaining to disruption of caves, karst topography, and sinkholes and their effects on water supplies and landowners.

Summers County Residents Against the Pipeline is a group of Summers County, WV, residents opposed to the Mountain Valley Pipeline and any other pipelines proposing to cross Summers County.

The Wilderness Society (TWS) has a mission to unite people to protect America's wild places. We envision a future where people and wild nature flourish together, meeting the challenges of a rapidly changing planet, and where these lands are protected for future generations. We believe that the 640 million acres of our country's land belong to and should benefit all of us, and when public lands are protected as part of big, connected landscapes, they provide us with the best hope of helping natural systems and human communities thrive and adapt to climate change. Further, we believe that people from all backgrounds should be able to connect to nature, share in the benefits of our public lands, and be inspired to care for these places.

II. THE FOREST SERVICE SHOULD CONTINUE TO APPLY LONG-STANDING NEPA LAWS AND POLICIES.

As an initial matter, the Forest Service does not rely on the Council on Environmental Quality's (CEQ's) revised NEPA regulations.[9] We urge the Forest Service to adhere to this position throughout the continuation of its environmental review.

Since 1978, regulations promulgated by the Council on Environmental Quality (CEQ) have guided every federal agency's implementation of NEPA, our nation's environmental "Bill

[9] DSEIS at i n.1.

of Rights."[10] These regulations codified early judicial opinions based on language of the statute, provided the basis for a substantial body of judicial precedent spanning over four decades, and formed the foundation for more specific regulations and policies enacted by individual agencies to implement their particular missions. The Forest Service's NEPA procedures are at 36 C.F.R. part 220 (2008), Forest Service Manual 1950, and Forest Service Handbook 1909.15.

Over the vociferous objections of states, members of Congress, myriad conservation, environmental justice, and public health organizations, and the general public, on July 16, 2020, CEQ issued a final rule rewriting the entirety of its 1978 regulations.[11] The final CEQ rule upends virtually every aspect of NEPA and its longstanding practice, contradicts decades of court interpretations of NEPA's mandates, and undercuts the reliance placed on NEPA by the public, decision-makers, and project proponents. It does so by limiting the scope of actions to which NEPA applies, eviscerating the thorough environmental analysis that lies at the heart of the statute, reducing the ability of the public to participate in federal agency decision-making, and seeking to limit review of agency NEPA compliance. The legality of the final rule is being challenged in a number of federal lawsuits, including one brought by TWS, as part of a diverse coalition of national and regional environmental justice, outdoor recreation, public health, and conservation organizations that rely on NEPA to protect their varied interests in human health and the environment. Indeed, given its immediate, far-reaching consequences and facial invalidity, the final rule is the subject of a pending motion to enjoin its implementation or stay its effective date pending resolution of the lawsuit.

After September 14, 2020, agencies are required to apply the final rule only to new NEPA processes initiated after that date. Agencies have discretion to continue applying existing regulations in place before the final rule to ongoing NEPA processes begun before that date.[12] The final CEQ rule directs agencies to revise their NEPA procedures to eliminate inconsistencies with the final rule by September 14, 2021, and prohibits agencies from imposing more stringent NEPA procedures, representing a massive change from the past 40 years where the regulations functioned as a floor, not a ceiling.[13] In the interim, where existing agency NEPA procedures are inconsistent with the revised regulations, the final CEQ rule purports to control.[14]

While the Forest Service proposed a significant revision of its part 220 regulations in June 2019[15], both the agency's existing regulations and its proposed regulations are inconsistent with CEQ's final rule in numerous respects.

With respect to this process, the Forest Service should not apply the final CEQ rule. Doing so would change the rules of the game midstream, creating significant chaos and confusion for the agency and the public, legal liability, and harm to the public's interest in a stable regulatory environment.

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[10] 40 C.F.R. Part 1500 (1978).
[11] 85 Fed. Reg. 43,304 (July 16, 2020) (to be codified at 40 C.F.R. Part 1500).
[12] 40 C.F.R. § 1506.13 (2020).
[13] *Id.* § 1507.3(b).
[14] *Id.* § 1507.3(a).
[15] 84 Fed. Reg. 27,544 (June 13, 2019).

First, it would be manifestly unwise and highly inefficient for agencies to begin implementing such sweeping changes in the absence of agency policies, procedures, guidance, and training. Agency data – which was ignored throughout CEQ's rulemaking process – demonstrates that existing inefficiencies in the NEPA process are largely attributable to inadequate training, budget, and other institutional challenges and factors external to NEPA procedures.

Layer on top of those inefficiencies the massive challenges with interpreting and applying the Trump Administration's significant and far-reaching rollback, and it is a recipe for chaos, wasted taxpayer dollars, and litigation. That is especially true because the final CEQ rule creates conflict with governing case law, agency regulations and guidance, and longstanding practices that the public, decision-makers, and the courts have relied on for the past four decades.

Finally, given the highly uncertain fate of the final rule—with pending legal challenges and a potential change in administrations—agencies and project proponents would be wise not to inject additional and unnecessary uncertainty. In short, as the Forest Service has done in this process so far, continuing to apply the 1978 regulations is the path to certainty, given the agency's clear discretion to do so with respect to this process, which was clearly initiated before September 14, 2020.

III. THE FOREST SERVICE FAILS TO ACKNOWLEDGE THAT THE NATIONAL FORESTS IN THE EASTERN UNITED STATES, INCLUDING THE JEFFERSON NATIONAL FOREST, WERE ESTABLISHED TO RESTORE AND PROTECT WATER RESOURCES.

The national forests in the eastern United States, including the JNF, were established by Congress for the protection of water resources.[16] The Forest Service is responsible for managing the JNF consistent with the Forest Plan. In the LRMP, the Forest Service declares its intent "to continue the tradition of watershed restoration, protection and stewardship begun on [the Jefferson] national forest over 65 years ago. . . .Watershed, riparian, and aquatic species protection goals, objectives, desired conditions, and standards do not vary across the forest."[17]

The construction and operation of the MVP is inconsistent with the Plan for the JNF.[18] The Forest Service, therefore, proposes to amend the Plan to make it consistent with the harm that the MVP will cause. The Fourth Circuit Court of Appeals identified that "the clear purpose of the amendment is to lessen requirements protecting soil and riparian resources so that the pipeline project could meet those requirements."[19] The Forest Service proposes to weaken eleven Plan standards for management of utility corridors, riparian areas, soil resources, old growth forests, the Appalachian Scenic Trail, and scenery integrity objectives.[20] The proposal to "lessen

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[16] 16 U.S.C. § 552.
[17] *Revised Land and Resource Management Plan Jefferson National Forest*, at 2-2, Management Bulletin R8-MB 115A (January 2004).
[18] DSEIS at 5.
[19] *Id.* at 19 (quoting *Sierra Club*, 897 F.3d 582 at 603) (quotation marks omitted).
[20] *Id.*at 19–22.

requirements protecting soil and riparian resources so that the pipeline project could meet those requirements" unlawfully frustrates the purpose for which the JNF was created.[21]

A. The Forest Service Has an Extraordinary Duty to Conserve Both Forest and Water Resources.

The acquisition of the lands within the JNF was facilitated by an act of Congress that created the Eastern National Forests. The Weeks Law was enacted in 1911. The express purpose of the Weeks Act is to protect watersheds and conserve forests and water supplies.[22] The purpose for creating the JNF is straightforward: to protect watersheds and conserve water supplies. The Weeks Act established a responsibility to the public for watershed and water supply protection that is paramount, taking primacy over other uses of forest resources.

Information about the lands that would become the Eastern National Forests was gathered to support the acquisition of those lands. In the early 1900s, the lands were described as follows:

> The entire region is characterized by extremely heavy rainfall in very short periods of time, and owing to the steep slopes and the absence of lakes, ponds, or marshes, which could act as reservoirs and hold back the storm waters, protracted heavy precipitation is followed by a rather rapid increase in the flow of the streams, the rise lasting generally for only a few hours, and the stream soon assuming its normal stage of flow. This is more especially the case where there are forest clearings. Consequently these violent rains, under certain conditions, *i. e.*, where rains are excessive and clearings extensive, or where forest areas are burned over so as to destroy the humus and undergrowth-give rise to floods which are very destructive to property and which cause occasionally the loss of human life. To a certain extent the forest acts as a reservoir, for it keeps the soil porous, allows it to absorb and hold the water for a time, and gradually gives it forth in the form of springs and rivulets. Where the areas have been deforested, however, the rain water forms small but swift-flowing torrents down the sides of the mountains, and quickly reaches the streams below. Deep channels are cut in the mountain sides, and all of the top fertile soil is carried off, leaving only the underlying clays, which are of poor quality and do not yield to cultivation.
>
> After a storm the streams rising in the deforested areas are extremely turbid with mud from the mountain sides, while those from the forest areas are comparatively clear. This erosion can be noted by the most casual observer, and it forms one of the greatest menaces to the region. The soil is deep and fertile, as is shown by the splendid growth of forest trees and by its yield under the first cultivation, but it is only a question of time, if the forests are wantonly cut, when all of the soil and vegetation will be washed from the mountain sides and nothing will remain but the bare rock.

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[21] *Id.* at 19 (citation omitted).
[22] 16 U.S.C. § 552.

> These floods, due to protracted rains, are also destructive in strips of valley lands bordering the streams in the mountain region and in the wider valleys along their courses across the lowlands beyond. Bridges, mills, settlements, public roads, dams for developing water power, indeed, everything in the course of such a mountain stream is liable to be swept away by its rapidly increasing force.[23]

The scientists who investigated the lands that would become the Eastern National Forests recognized the environmental harm of erosion and stream sedimentation and were skilled in its description. This excerpt from the Report of the Secretary of Agriculture in Relation to the Forests, Rivers, and Mountains of the Southern Appalachian Region is descriptive of impacts that have been and will be caused by the MVP, and was the basis for conserving the Eastern National Forests. The MVP would create a scar that will never heal and cause permanent soil erosion conditions that the JNF was established to prevent.

The Forest Service adopted additional duties to protect watersheds and conserve water supplies in the agency's most recent Strategic Plan, which sets forth a Strategic Objective to provide abundant clean water as a component of delivering benefits to the public. The means and strategies to achieve the objective to provide abundant clean water are to:

> Conserve, maintain, and restore watersheds, ecosystems, and the services they provide to people.
>
> Use the Forest Service's Watershed Condition Framework to classify watershed conditions, identify restoration priorities, and monitor program accomplishments.
>
> Maintain water of sufficient quantity and quality to sustain aquatic life and support terrestrial habitats, domestic uses, recreation opportunities, and scenic character.
>
> Deliver the knowledge, tools, and technologies to restore, sustain, and enhance watersheds in a changing future.
>
> Facilitate partnerships that foster water conservation and citizen stewardship.
>
> Illustrate the importance of the link between forests and faucets from both surface and groundwater sources through educational programs.[24]

The Forest Service Manual requires Regional Foresters and Supervisors to ensure that: (1) each land management plan or amendment complies with laws, regulations, and policy, including 36 CFR part 219, FSM 1920, and FSH 1909.12, and including requirements for threatened and

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[23] Senate Document 84, Message from the President of the United States Transmitting A Report of the Secretary of Agriculture in Relation to the Forests, Rivers, and Mountains of the Southern Appalachian Region, THE HYDROGRAPHY OF THE SOUTHERN APPALACHIANS, PHYSIOGRAPHIC FEATURES OF THE REGION, http://npshistory.com/publications/usfs/region/8/sen-doc-84/appc1.htm.

[24] USDA Forest Service Strategic Plan 2015-2020, https://www.fs.fed.us/sites/default/files/strategic-plan%5B2%5D-6_17_15_revised.pdf.

endangered species; and (2) each land management plan is aligned with the goals and objectives of the Forest Service Strategic Plan.[25]

The Revised Land and Resource Management Plan for the JNF is a blueprint for water resource protection and restoration. In the Record of Decision for the Revision of the Land and Resource Management Plan for the Jefferson National Forest, the Regional Forester stated:

> Clean water for drinking, swimming, fishing, or quietly sitting beside, is a very important resource the Jefferson National Forest provides. Clean water is vital for our survival. . . . The riparian corridor is designed to not only maintain water quality and protect aquatic species, but to also maintain the actual riparian area and the terrestrial species that use this area. . . . Very little difference between alternatives is evident in Chapter 3 of the FEIS related to watershed or aquatic species. *This was done deliberately to ensure the protection of these resources under all circumstances*.[26]

Although the MVP would cross what might seem to the casual observer to be a small distance—about 3.5 miles of the JNF—the route impacts extraordinary public resources, including the two river systems, complex hydrologic systems that feed those rivers, two Wilderness Areas and an Inventoried Roadless Area, the Appalachian Scenic Trail, and threatened, endangered and sensitive aquatic, plant, and mammal species.

Not only would the MVP impact forest and water resources, authorizing the construction of the MVP will undermine the values upon which the LRMP was developed and the partnerships that foster water conservation and citizen stewardship. Any goodwill that has been cultivated between the Forest Service and the communities whose water supplies flow cleanly from the National Forest will be degraded. The same is true of the values to recreational resources set forth in the Strategic Plan. The MVP makes a mockery of the tag line "Leave No Trace" and will also degrade goodwill between the public and the Forest Service.

The Forest Service has a multi-faceted duty to manage the JNF to protect watersheds and conserve water resources in the public interest. The residents in the areas surrounding the JNF rely on the water resources, as well as those downstream, and are those for whom the Eastern National Forests exist.

IV. THE FOREST SERVICE HAS SIGNALED A PREDETERMINED OUTCOME.

As noted in the DSEIS, in the fall of 2018 FERC halted construction across the entire pipeline corridor due to violations of the Endangered Species Act.[27] After a new Biological Opinion and Incidental Take Statement were issued, FERC lifted the stop-work instruction except for work between mile posts 196.0 and 221.0, which encompasses the parts of the JNF

[25] FSM 1921.12.
[26] Record of Decision, at 6–7, EIS, Revised LRMP, Jefferson National Forest, Management Bulletin R8-MB 115C, January 2004 (emphasis added) [Ex. 3].
[27] *See* DSEIS at 70.

that the MVP would be cross.[28] The construction exclusion zone, therefore, extends to all the route in Giles and Craig Counties, and part of Montgomery County, including the JNF lands.

On October 15, 2020, MVP asked FERC to limit the construction exclusion zone to only the National Forest land; this request, if granted, would allow MVP to construct up to the boundaries of the national forest.[29] MVPs request obviously presupposes the outcome of this supplemental NEPA process in the developer's favor. The Forest Service has, to date, remained silent about MVPs request to FERC to limit the construction exclusion zone to the National Forest. By remaining silent, the Forest Service is acting in bad faith and signaling a predetermined outcome.

Similarly, both the Forest Service and BLM undermine their own authorities in the analyses in regard to alternative routes because portions of the pipeline have already been constructed. In addition, the agencies assert that they have no authority to delineate a route not on the National Forest instead of considering what is lawful and least harmful to the National Forest itself. Yet, in the alternatives analysis, the Forest Service does address impacts beyond the National Forest boundaries. For example, the agency considers the overall length of the pipeline and the number of private landowners impacted, giving those impacts great weight compared to the impacts to the JNF, ignoring impacts to the JNF such as the viewshed from the Appalachian Trail.

In sum, the Forest Service has never contemplated any action other than amending the LRMP to make it consistent with the harm that the MVP will cause. It took Forest Service specialists from across the United States to draft a deficient and legally unsupportable document to paper over the unjustifiable use of our National Forest.

V. RELIANCE ON THE SEDIMENTATION ANALYSIS TO ASSESS IMPACTS TO WATER QUALITY IS ARBITRARY AND CAPRICIOUS, VIOLATING NEPA AND THE ADMINISTRATIVE PROCEDURE ACT.

On remand, the Fourth Circuit Court of Appeals directed the Forest Service to explain its previous reliance on a predictive model.[30] Instead, the Forest Service relies on new predictive modeling in the supplemental analysis. Our experts' assessments of the Hydrologic Analysis upon which the Forest Service now relies show that the current sediment modeling also is flawed and unreliable. Most fundamentally, current reliance on predictive modeling alone is unjustifiable where there is empirical evidence of harm caused by ineffective mitigation of pipeline construction on terrain that is less steep and landslide prone than the route through the JNF. The DSEIS also fails to analyze the impacts from a new off-forest access road, the runoff from which will flow into Stoney Creek, downstream of the pipeline crossing.

In addition to the hydrologic assessments by a hydrogeologist and a stormwater engineer, we also rely on the opinion of a licensed professional soil scientist who identifies the deficiencies in the analysis with respect to soils identification and impacts.

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[28] FERC letter [Ex. 4].
[29] MVP letter [Ex. 5].
[30] *Sierra Club*, 897 F.3d at 596.

Reliance on predictive modeling that is based on generalized soils information and unsupportable assumptions, as demonstrated in the experts' reports, is arbitrary and capricious, particularly in the absence of analysis by the Forest Service of the abundance of available information about the failures to control erosion and sedimentation in the construction of the MVP.

In violation of NEPA, the Forest Service also fails to analyze impacts on the watershed on the east side of Peters Mountain, and the addition of an off-forest access road, specifically to Stony Creek, which supports the listed endangered Candy Darter.

A. The Hydrologic Analysis Is Based on Flawed Assumptions, Misrepresentative Data, and Mischaracterizations of the Resources.

Dr. Pam Dodds, Hydrologeologist, and Kirk Bowers, P.E., each performed critiques and assessments of the Hydrologic Analysis relied upon by the Forest Service.[31, 32] The predictive modeling—RUSLE and RUSLE 2—that undergirds the Hydrologic Analysis strains to achieve the requisite sediment loads and does so on a scale that ignores the impacts to the first order streams in the watershed. In its failure to address the impacts to first order streams, the Forest Service also fails to consider the connectivity requirements in the Forest Service Planning Rules.

According to Nan Gray, Licensed Professional Soil Scientist, the soil information used to develop and run the models is too generalized to pick up the variations in soil characteristics that inform the erodibility factors in the modeling equations.[33] Order 1 soil surveys are necessary where the different soil units join because different soils transfer water differently. The contractors whom Nan Gray has observed in the field do not appear to be qualified and there are no qualifications listed in the Forest Service record. Order 1 soil survey must be done by experienced, trained Appalachian soil scientists. In her comment letter, Nan Gray describes her experience performing Order 1 soil surveys for a pipeline project in West Virginia and the extraordinary rigor at which such surveys are performed.

Nan Gray notes the modeling limitations related to the soil characteristics and that rainfall data use in the model has not kept up with the increasing frequency and intensity of rainfall in the area. But elsewhere the Forest Service acknowledges: "A higher frequency of storm events and above average precipitation fell on the Project area in 2018."[34]

The Forest Service pays little attention to the inherent limitations of the predictive models used. For example, "RUSLE2 provides robust estimates of average annual sheet and rill erosion from a wide range of land use, soil, and climatic conditions, but it cannot calculate channel erosion, including ephemeral gully erosion."[35] Gully erosion has been documented in various

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[31] Hydrologic Assessment by Pamela C Dodds, Ph.D., Licensed Professional Geologist [Exs. 6A-1, 6A-2 & 6A-3].
[32] Kirk Bower's Report [Ex. 7].
[33] Comment Letter, Nan Gray [Ex. 8].
[34] Hydrologic Analysis, App. F at F-2.
[35] D.C. Yoder et al., Predicting runoff for a RUSLE2 ephemeral gully calculator Dabney, S.M., 1 USDA-ARS National Sedimentation Laboratory, 1, Abstract [Ex. 9].

locations along the pipeline construction corridor.[36] The steeper the slope and the more unstable the soils, the more likely gullies are to form.

Likewise, the RUSLE and RUSLE2 cannot predict sedimentation from mass wasting, slips, and landslides. Landslides or slips have already occurred on the MVP construction route and the landslide mitigation plan has proven ineffective to arrest the slope failures. Weekly reports to FERC document repeated failures, including slips.[37] In addition, the Petition for Review of the USFWS Biological Opinion filed in the Fourth Circuit on October 27, 2020, includes a table of loss of additional trees when land is cleared in attempts to control slips.[38]

The risk of mass wasting and landslides are predictable, depending on slope steepness, concavity, and rock competence. Models assessing risk of mass wasting and landslide risk are available. In fact, JNF appears to have developed such a model with Virginia Tech in the past. Monitoring and incident reports give data on when construction and weather events lead to these mass wasting and landslide events. This provides sufficient information to estimate expected sedimentation from mass wasting and landslides in JNF. The slopes in areas of national forest that the pipeline will traverse, particularly areas adjacent to Craig Creek, are steep, highly dissected (concavity) and have bedrock layers that are not very competent. The risk from sedimentation due to mass wasting and landslides must be analyzed and addressed.

The hydrologic model and analysis depend on average yearly rainfall. In reality, much of the erosion and sediment delivery is from high intensity rainfall events that may occur during any month of the year. Again, there is sufficient data available to assess this risk and estimate impacts. Rainfall gauges have been installed along the MVP right-of-way as required for project monitoring.[39] This represents Best Available Scientific Information, as opposed to average annual rainfall, to evaluate sedimentation. However, it does not appear that this data has been utilized to calibrate the model parameters. Nor does the data appear to have been used to assess the impacts of severe rainfall storm events in this record that resulted in erosion and sediment transport. The data on severe rainfall storm events could be associated with events that resulted in erosion and sediment transport events documented in state water quality violations. This in turn would give a way to assess the hydrologic model for accuracy and adjust coefficients to better reflect reality. This must be done to lend any credibility to the models.

Access road impacts to sediment yield are inadequately accounted for. Relevant literature demonstrates that sediment losses from pipeline corridor segments were small in comparison to losses from forest road corridors, even though roads tend to be much less steep than cross-country pipeline corridors.[40] However, the hydrologic analysis states that *"project impacts are a*

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36 Photographic Evidence [Ex. 10].

37 Slips noted in MVP Weekly report #155 Oct 10-16, see page 8 of 62; slips on spread A, see page 9 of 62; slips on spread A, see page 17 of 62; slips on spread A; Weekly report #156 Oct 17–23, see page 29 of 62; slips on spread A repeat..not resolved, see page 30 of 62; slips on spread A repeat not resolved [Ex. 11].

38 Petition for Review, *Appalachian Voices, et al., v. U.S. Fish & Wildlife Serv.*, Exhibit A at 15 Table 5 [Ex. 12].

39 High-priority stream crossings along the proposed Atlantic Coast (ACP) and Mountain Valley (MVP) pipelines, Virginia Department of Environmental Quality (VDEQ), Monitoring Plan, www.deq.virginia.gov [Ex. 13].

40 Edwards, Pamela J., Bridget M. Harrison, Karl W.J. Williard and Jon E. Schoonover. 2017. Erosion from a Cross-Country Natural Gas Pipeline Corridor: The Critical First Year. Water Air Soil Pollut (2017) 228: 232. DOI 10.1007/s11270-017-3374-9 [Ex. 14].

result of only the activities conducted within the LOD."[41] MVP's stated intent is to essentially create access roads along the LOD for construction. Sedimentation in this corridor is modeled using RUSLE2, which only predicts sheet and rill erosion. An additional model feature only minimally accounts for roads through a revised cover factor. However, this is inadequate in light of the Edwards et al. study that quantifies that roads can have up to ten times the sediment impact compared to just the pipeline corridor.[42] There are standardized modeling tools that quantify sediment from roads. In fact, the Forest Service recently used one of these modeling tools, GRAIP lite, to predict road-related sediment impacts across watersheds.[43]

The DSEIS fails to disclose, quantify, or analyze, the substantial sediment impacts that would be expected due to construction of access roads along the LOD. The Transcon inspection report from April 16, 2018, clearly documents the detrimental impacts of access road sediment transport to nearby waterbodies.[44]

To be credible, modeling must check assumptions and calibrate predictions using best available scientific information consisting of available research studies and field data. Moyer and Hyer with USGS conducted a water-quality monitoring effort indicating that values of turbidity in Indian Creek increased significantly during the construction of the Jewell Ridge pipeline. As identified in this study, a primary source of sediment was runoff from the pipeline construction right-of-way.[45] The Virginia Department of Environmental Quality (VDEQ) has documented turbidity and other water quality measures along MVP using continuous stream gauges.[46] JNF should also have habitat monitoring data and aquatic biota data that could be utilized. This data should be correlated with past erosional events and used to calibrate model parameters to create more accurate model predictions.

Besides problems with the model, a simple percent increase in sediment yield that results from the model by itself is not adequate to evaluate the environmental impact of MVP. This measure fails to address direct and indirect effects on water quality, drinking water, threatened and endangered (T&E) aquatic species, and critical habitat. This is particularly pertinent for aquatic species that will be impacted by sediment resulting from MVP impacts.

Research published in the Transactions of the American Fisheries Society documents levels of substrate, embeddedness, and silt cover data that is highly correlated to robust Candy Darter populations compared to extirpated populations. They documented that suitability and

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[41] Geosyntec Consultants, Hydrologic Analysis of Sedimentation for the Jefferson National Forest, Virginia and West Virginia 21 (May 8, 2020) [hereinafter "Hydrologic Analysis"].

[42] Edwards, Pamela J., Bridget M. Harrison, Karl W.J. Williard and Jon E. Schoonover. 2017. Erosion from a Cross-Country Natural Gas Pipeline Corridor: The Critical First Year. Water Air Soil Pollut (2017) 228: 232. DOI 10.1007/s11270-017-3374-9 [Ex. 15].

[43] US Forest Service (USFS). 2019. Geomorphic Road Analysis and Inventory Package (GRAIP) Lite Manual: A System for Road Impact Assessment. Rocky Mountain Research Station. Boise, ID https://www.fs.fed.us/GRAIP/GRAIP_Lite/downloads/GRAIP_Lite-Manual2019.pdf [Ex. 16].

[44] Transcon. 2018. Mountain Valley Pipeline Project - CIC Daily Inspection Report. D. Danko on 4/16/18. Giles County, VA. Transcon Environmental, Inc. [Ex. 17].

[45] Moyer, Douglas L. and Kenneth E. Hyer. 2009. Continuous Turbidity Monitoring in the Indian Creek Watershed, Tazewell County, Virginia, 2006–08. U.S. Geological Survey. Scientific Investigations Report 2009–5085 [Ex. 18].

[46] Virginia Department of Environmental Quality (VDEQ). 2017. Monitoring Plan. High-priority stream crossings along the proposed Atlantic Coast (ACP) and Mountain Valley (MVP) pipelines. www.deq.virginia.gov [Ex. 19].

habitat availability depends on levels of embeddedness and silt cover for all life stages. And suitability decreased with greater average embeddedness and silt cover across the four study streams.[47] This study provides critical information that should be a basis for determining direct, indirect, and cumulative impacts for this species. There is sufficient data to correlate turbidity monitoring data from stream gauges with rainfall data from gauges along MVP. This could be used to calibrate the model to give better indications of how rain events of different magnitudes and different circumstances would affect sedimentation in habitat for T&E species. There are five units of Candy Darter critical habitat. Four of these units are considered secure and one unit is considered generally insecure. Candy Darter occurs in Big Stoney Creek, which will be impacted directly by sedimentation from construction.

The main factors determining security are a high percentage of forest cover and low levels of siltation and embeddedness of stream substrate.[48] As the monitoring reports demonstrate[49, 50], MVP poses major challenges to these factors. Considerations of impacts to sedimentation must also take into account the expectation of more extreme precipitation events due to climate change.

The opinions and statements of Dr. Pamela Dodds, Kirk Bowers, and Nan Gray further document the arbitrary and capricious reliance on the predictive modeling in the Forest Service's assessment of adverse impacts, as well as violations of the Forest Planning Rules.

B. Reliance on the Modeling Projections that the Erosion Control Devices in the Construction Plans are Adequate, and Enhanced Devices Will Provide Extra Control, Is Arbitrary and Capricious Given the Voluminous Record of Erosion Control Failures.

In the appendices to the Geosytec Hydrologic Analysis, the consultant states the following about the efficacy of the pollution control devices and the predicted sedimentation:

> **F-4. EXPECTED ENHANCED BMP PERFORMANCE**
>
> During excessive rainfall events, deposited sediment and stormwater can accumulate behind the barrier until the barrier is inundated and its effectiveness is decreased due to overtopping. The representation of the barriers in RUSLE2 is solely based on the hydraulics within the effective width of the barrier itself and does not account for the temporal and hydraulic component of overtopping during a rainfall event.

[47] Dunn, Corey G. and Paul L. Angermeier. 2016. Development of Habitat Suitability Indices for the Candy Darter, with Cross-Scale Validation across Representative Populations, Transactions of the American Fisheries Society, 145:6, 1266-1281, DOI:10.1080/00028487.2016.1217929 [Ex. 20].
[48] U.S. Fish and Wildlife Service (USFWS). 2020. MVP Biological Opinion. Virginia Field Office. Gloucester, VA [Ex. 21].
[49] Transcon. 2019. Mountain Valley Pipeline Project - CIC Daily Inspection Report. Dan Danko, Mike Tripp and Steve Milauskason on 4/17/19. Giles County, VA. Transcon Environmental, Inc. [Ex. 22].
[50] Transcon. 2018. Mountain Valley Pipeline Project - CIC Daily Inspection Report. D. Danko on 4/16/18. Giles County, VA. Transcon Environmental, Inc. [Ex. 23].

> In the field, however, the enhanced BMPs are reasonably expected to provide additional benefit beyond what the RUSLE2 model can predict. Because the RUSLE2 model is an idealized uniform slope, it cannot precisely represent smaller-scale topography changes or concentrated flow paths/stormwater routing. . . .
>
> Although enhanced BMPs are useful to provide redundancy and provide additional support to the approved suite of BMPs, based on the modeling results, the effectiveness of the approved BMPs is sufficient to achieve a reduction in sediment yield as required by regulatory agencies.[51]

First, the consultant recognizes that the control devices can be overtopped with sediment laden runoff. It obtusely recognizes that the model cannot predict gully erosion "concentrated flow paths/stormwater routing." And then the contractor incredibly asserts that the approved control measures are sufficient to achieve a reduction in sediment yield as required by regulatory agencies; but nowhere does the consultant identify or describe the requirements of the regulatory agencies. Reliance on the model is unjustifiable where it cannot predict impacts that are reasonably expected.

The best available science is the investigation and documentation of what has already occurred on the project as a whole. The Forest Service completely ignores the failures of the MVP that have already occurred and continue to accrue, which is new information since the adoption of the FEIS. The extensive documentation across the MVP corridor shows that the "approved suite of BMPs" are ineffective, as are the enhanced BMPs.

On December 17, 2018, the Virginia Department of Environmental Quality bypassed the administrative enforcement process that would have required public participation and sued MVP in state court for violations of the Clean Water Act.[52] The Complaint alleged improper installation of BMPs, the failure to install BMPs, the failure to maintain BMPs, and the failure of the controls, the plans for which had been approved by the Virginia DEQ and made a component of compliance with the Section 401 certificate under the Clean Water Act.[53] The enforcement action was settled but the terms and conditions did not require MVP to amend its erosion and sediment control plans.[54]

The state of West Virginia also has cited MVP with numerous Clean Water Act violations and prosecuted an administrative enforcement action.[55]

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[51] Hydrologic Analysis, App. F at F-4.

[52] Complaint, *Paylor, et al. v. MVP*, http://files.constantcontact.com/bfcd0cef001/7500afad-9981-4107-805e-28a0563b0fa6.pdf [Ex. 24]. The Attorney General chose not to sue MVP in federal court where intervention procedures may have enabled public participation in the litigation.

[53] *See id.*

[54] *See* Consent Decree, *Paylor, et al. v. MVP*, https://www.deq.virginia.gov/Portals/0/DEQ/Water/Pipelines/MVPConsentDecree12-19.pdf [Ex. 25].

[55] *See* West Virginia Dep't of Environmental Protection, Notices of Violations [Exs. 26 & 27].

Citizen monitors have reported hundreds of incidents of BPM failures and stream sedimentation.[56] The reports include evidence of overtopped controls, improperly installed and maintained controls, failed controls, gully erosion, and slips. The affidavit of Freeda Cathcart documents events at a single site over a two-year period that shows that MVP conducted ground disturbing activity after FERC ordered work to stop, that the approved erosion and sediment control plans fail, and that the enhanced BMPs are no assurance against continued sedimentation events.[57] The site that Ms. Cathcart has monitored also has experienced slips.

The modeling prediction that the approved sediment and erosion control plans are sufficiently effective is absurd, arbitrary, and capricious and is not based on the best available science.[58] Rather, it is a contrived justification for not rejecting the project and the harm it will cause.

Furthermore, the Forest Service notes the existence of the reports of the construction monitoring activity of its contractor (Transco) on the JNF since the construction started in 2018. The Forest Service selectively uses its own knowledge of the records, which are not included in the NEPA/Forest Plan amendment documents. Nor are any actual Planning decision records, such as meeting notes, in the publicly available Plan amendment documents, all in violation of the regulations for amending Forest Plans:

> *Planning records.* (1) The responsible official shall keep the following documents readily accessible to the public by posting them online and through other means: assessment reports (§ 219.6); the plan, including the monitoring program; the proposed plan, plan amendment, or plan revision; public notices and environmental documents associated with a plan; plan decision documents; and monitoring evaluation reports (§ 219.12). (2) The planning record includes documents that support analytical conclusions made and alternatives considered throughout the planning process. The responsible official shall make the planning record available at the office where the plan, plan amendment, or plan revision was developed.[59]

The Forest Service has failed to provide the monitoring reports to the public since construction started, despite the mandate in the Planning Rules to give the public access to monitoring records. "The responsible official shall provide opportunities to the public for … reviewing the results of monitoring information."[60] The Forest Service has failed to make

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[56] Citizen Monitoring Reports [Ex. 28].
[57] Affidavit of Freeda Cathcart [Ex. 29].
[58] *See* 36 CFR § 219.3. ("The responsible official shall use the best available scientific information to inform the planning process required by this subpart for assessment; developing, amending, or revising a plan; and monitoring. In doing so, the responsible official shall determine what information is the most accurate, reliable, and relevant to the issues being considered. The responsible official shall document how the best available scientific information was used to inform the assessment, the plan or amendment decision, and the monitoring program as required in §§ 219.6(a)(3) and 219.14(a)(3). Such documentation must: Identify what information was determined to be the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered."
[59] 36 C.F.R. § 219.14(b).
[60] *Id.* § 219.4.

monitoring records available for public review since 2018, the monitoring records are not in the plan amendment records that have been posted on the Forest Service website with the decision documents, and the DSEIS does not document the opportunities that the Forest Service will establish to make the monitoring records available for review.

C. The Forest Service Failed to Properly Monitor Sedimentation and Thus Failed to Properly Analyze Impacts of Sedimentation.

The USFS has failed to use available technology to monitor sedimentation in Craig Creek and tributaries that are directly affected by the corridor clearing and grading that has already occurred in the Montgomery County section of the JNF. The USFS has been well aware since the July 2018 Fourth Circuit Court of Appeals decision that sedimentation caused by right-of-way erosion is a significant legal issue. Despite that knowledge and the availability of technology that is readily available, widely used, and capable of monitoring sedimentation impacts to surface water streams,[61] the USFS has failed to implement such or equivalent monitoring procedures along Craig Creek or elsewhere within the JNF.

The USFS failure to either install water monitoring adequate to assess water-resource of sedimentation, or to require Mountain Valley Pipeline to install such, has occurred despite the fact that:

- The Fourth Circuit court decision made it clear that sedimentation concerns were central to its decision to vacate the JNF crossing permit.
- Erosion modeling, with no field verification, was the primary and only support provided by the FERC FEIS for its conclusions concerning sedimentation impacts to water resources generally.
- The Fourth Circuit court decision made clear the court's concern with lack of environmental-monitoring data for validation of FERC FEIS erosion model assumptions.[62]
- Construction had been initiated within the Montgomery County segment of the JNF in a manner that created ideal conditions for erosion and sedimentation to occur: Trees had been felled, vegetation cleared; topsoil removed; erosion control BMPs installed; the pipeline

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[61] The use of turbidity sensors to monitor sedimentation impacts of pipelines is illustrated by the following study: Moyer DL, Hyer KE. 2009. Continuous Turbidity Monitoring in the Indian Creek Watershed, Tazewell County, Virginia, 2006–08. US Geological Survey Scientific Investigations Report 2009–5085 [Ex. 30]. Other agencies have installed turbidity sensors and are using them to monitoring sedimentation impacts of Mountain Valley Pipeline at locations outside of Jefferson National Forest: Virginia DEQ, Water Monitoring Plans for Pipelines, https://www.deq.virginia.gov/Programs/Water/ProtectionRequirementsforPipelines/WaterMonitoringPlanforPipelines.aspx [Ex. 31]; US Geological Survey. Monitoring High-Priority Stream Crossings Along Proposed Natural Gas Pipeline Routes. https://www.usgs.gov/centers/va-wv-water/science/monitoring-high-priority-stream-crossings-along-proposed-natural-gas?qt-science_center_objects=0#qt-science_center_objects [Ex. 32].

[62] *Sierra Club*, 897 F.3d at 592–93 ("In turn, the Forest Service urged MVP to provide 'additional supporting documentation for how MVP came up with their model assumptions, in particular containment efficiency.' One of the Forest Service officials 'stressed' that 'good plans aren't enough and must be bolstered by consistent monitoring and accurate implementation.'" (internal citation omitted)).

corridor has been in this condition since 2018. Because of the stay, those conditions have persisted until the present.

- Craig Creek is habitat for federally protected species downstream from the area of direct pipeline-construction impact.

- Forest Service personnel responsible for the pipeline crossing of JNF stated numerous concerns with potential sedimentation impacts in response to Mountain Valley's application to construct the pipeline.[63] These comments stated a need for "monitoring" of pipeline construction water impacts.[64]

- Numerous severe impacts to surface waters due to excessive erosion and sedimentation have occurred throughout the pipeline construction area due to the interaction of terrain and climate with pipeline construction practices and, in many cases, Mountain Valley's failure to maintain adequate erosion controls (see below).

- Although the Forest Service is not required to implement monitoring for a project, the Forest Service proposes to replace standards with mitigation for which monitoring is an element. Therefore, the Forest Service should follow the Planning Rules that apply to monitoring and it would be arbitrary and capricious to ignore the Planning Rules.[65]

- The Planning Rules require the responsible official to "document how the best available scientific information was used to inform the assessment, the plan decision, and the monitoring program as required in §§ 219.6(a)(3) and 219.14(a)(4). Such documentation must: Identify what information was determined to be the best available scientific information, explain the basis for that determination, and explain how the information was applied to the issues considered."[66]

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[63] The USFS submitted "Comments on Final Resource Reports for the Mountain Valley Pipeline project" to FERC Docket CP16-10, dated 9 March 2016 [Ex. 33]. Multiple comments in stated concerns with potential sedimentation impacts; those quoted below are just a small sample of those comments:
Comment on Resource Report 1, Section 1-G: "Project-Specific Erosion and Sediment Control Plan is absent from the report."
Comment on Resource Report 2, pages 2-52 and 2-53: "There is a general discussion on Impacts to Waterbodies from Crossings and Mitigation Measures in this section; however there has been no site specific analysis of potential impacts to waterbodies or aquatic biota. There has not been a sediment analysis done on the pipeline, access roads, or staging areas, therefore there is not quantitative data with which to do an effects analysis or alternative comparison. A sediment analysis should be completed to determine the potential amount of sediment delivered to the stream systems and subsequent effect on fisheries, and downstream mussels."
Comment on Resource Report 2, page 2-72: "An accurate and complete picture of the project needs to be generated and a more thorough analysis of potential sedimentation and effects needs to be done so that an informed decision can be made."
[64] *Id.* Look in particular at Comment on Resource Report 2, page 2.55: "Recent experience with pipelines on the Forest has shown that frequent E&S [erosion and sedimentation] inspection and maintenance is necessary to help control off-site erosion. Site specific monitoring and mitigation plans will be necessary to adequately address effects." An extensive comment labeled "throughout" and appearing on pages 8 and 9 of 31 states: "Selection of the appropriate assessment and monitoring strategy should be coordinated in advance with a FS specialist."
[65] 36 CFR §§ 219.3, 219.4, 219.12.
[66] *Id.* § 219.3.

- The Forest Service Handbook also contains specific direction for using the best available science to inform monitoring decisions. "The Responsible Official shall document in the decision document for the plan how the best available scientific information is used to inform development of the plan monitoring program. Documentation should identify what best available scientific information was used, explain the basis for the determination of the best available scientific information, and describe how it was applied (see 36 C.F.R. Section 219.3 and FSH 1909.12, zero code, sec. 07). See section 32.1 of this Handbook for other information that may be used in developing the plan monitoring program." [67]

- The Forest Planning Rules require public participation in the development and results of monitoring.[68]

Mountain Valley's failure to maintain adequate control of sedimentation and erosion in other segments of the project area are well documented in venues easily accessible to USFS personnel with responsibilities for the pipeline project. These include:

- Decisions by Virginia and West Virginia environmental agencies to require substantial penalties for erosion and sediment control failures.[69]

- Weekly Status Reports submitted by Mountain Valley Pipeline to FERC, many of which describe numerous environmental compliance problems including erosion and sediment control failures.[70]

- Notifications by citizen volunteers and non-profit organizations to the FERC Docket concerning extreme sedimentation events emanating from landscape disturbances caused by Mountain Valley Pipeline construction.[71]

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[67] FSH 1909.12 – LAND MANAGEMENT PLANNING HANDBOOK, CHAPTER 30 – MONITORING 31.1 - Best Available Scientific Information for Monitoring, p 5 of 42.
[68] 36 C.F.R. § 219.4.
[69] *See* Exs. 25–27.
[70] *See, e.g.*, Weekly Status Report Nos. 35, 36, and 37 of Mountain Valley Pipeline, LLC under CP16-10, Document Accession #: 20180726-5154, Filed 07/26/2018 [Ex. 34]. Appendix B of these reports document problems with environmental compliance. These three reports, collectively, document more than 400 such problems over a three-week period, many of which concerned erosion and sedimentation. A small sample of those problems, as stated by the Weekly Compliance Reports, are copied below:
6/4/2018 - Sediment off of the LOD along with some timber that is stacked off of the ROW without landowner permission.
6/5/2018 - Silt and sedimentation off of the LOD at 6816+10, 6810+00, 6812+50, 6793+70, and 6794+10. Inadequate waterbars resulting in ROW erosion and silt discharge off of the LOD from MPs 128.6 to 129.7.
6/22/2018 - Sediment left ROW and impacted karst feature.
6/22/2018 - Turbid stormwater and fine sediment traveled from ROW to roadside ditch depositing in RCE of MLV 26 with turbid water entering S-IJ52. Stormwater event occurred on 6/22/18.
6/23/2018 - Stream S-G40 was impacted with sediment due to improper installation of slope breakers and ECD failure.
6/23/2018 - Sediment went off LOD due to major rain event.
6/29/2018 - ECD failure. Sediment left the ROW.
[71] Letter to FERC from Sierra Club on behalf of multiple organizations concerning court decision to vacate JNF crossing permit; FERC Docket CP16-10 Document Accession 20180801-5004, filed 1 August 2018 ("The Court

- Reports by Mountain Valley Watch, a citizen's organization, to Virginia Water Control Board which were also posted to FERC Docket CP16-10.[72]

- Notifications to U.S. Fish and Wildlife Service, and federal agency that interacts with USFS for the DSEIS and other matters, concerning erosion and sedimentation impacts of Mountain Valley Pipeline construction documenting that such impacts were "causing substantially more sedimentation than contemplated in FERC's Final EIS or the Service's BiOp".[73]

- Field inspection reports of Mountain Valley Pipeline's failure to maintain adequate sedimentation controls prepared by Virginia Department of Environmental Quality[74] and by West Virginia Department of Environmental Protection[75] and submitted to FERC Docket CP16-10 by citizen organizations.

- Court filings by citizen organizations challenging federal agency decisions on Mountain Valley Pipeline permitting documenting erosion and sedimentation impacts to water resources, a topic of direct relevance to the DSEIS.[76]

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explained that not only did the record fail to support the EIS's conclusions about the effectiveness of sediment mitigation efforts, but that the EIS's conclusion was 'counter to the evidence before the agenc[ies].'") [Ex. 35]; Citizen Reports Of Mountain Valley Pipeline Project Environmental Violations In Monroe And Summers County, WV; submitted by Indian Creek Watershed Association to FERC Docket CP16-10; document accession 20190321-5008; filed 03/21/2019 [Ex. 36]; Letters to FERC from Sierra Club on behalf of multiple organizations to FERC Docket CP16-10:

- Document Accession 20191002-5030, filed 2 October 2019, see esp. Exhibit D, Declaration by Tina Badger [Ex. 37];
- Document Accession 20191105-5127, filed 5 November 2019 [Ex. 38];
- Document Accession 20191203-5113, filed 3 December 2019 (see photos) [Ex. 39];
- Document Accession 20200210-5196, filed 10 February 2020 (see photos) [Ex. 40];

Submittal by Kirk A Bowers and others to FERC concerning excessive sedimentation, FERC Docket CP16-10 Document Accession 20190904-5019 [Ex. 41];

[72] See, for example: Mountain Valley Watch Comments to State Water Control Board August 10, 2018 (REVISED - August 13, 2018). FERC Docket CP16-10 Document Accession #: 20180827-5118 [Ex. 42]; Mountain Valley Watch September Report 2019. FERC Docket CP16-10 Document Accession #: 20190909-5016 [Ex. 43]. Both these and other Mountain Valley Watch reports contain extensive photographic evidence of erosion and sedimentation control failures.

[73] Letter to US Fish and Wildlife Service from Sierra Club on behalf of multiple organizations, filed to FERC Docket CP16-10 as Document Accession 20190501-5307, filed 1 May 2019 (see esp. Section 1.B) [Ex. 44]; *see* Letter to US Fish and Wildlife Service from Sierra Club on behalf of multiple organizations, filed to FERC Docket CP16-10 as Document Accession 20190813-5013, filed 13 August 2019 [Ex. 45].

[74] Letter to FERC from Sierra Club on behalf of multiple organizations, FERC Docket CP16-10 Document Accession 20191203-5113, filed 3 December 2019 (see esp. Exhibits A and B) [Ex. 46]; *see* letter to FERC from Sierra Club on behalf of multiple organizations, FERC Docket CP16-10 Document Accession 20200210-5196, filed 10 February 2020, Exhibit A [Ex. 47].

[75] See letter to FERC from Sierra Club on behalf of multiple organizations, FERC Docket CP16-10 Document Accession 20190813-5013, filed 13 August 2019 [Ex. 48].

[76] *E.g., Wild Virginia et al. vs. US Department of Interior, Fish and Wildlife Service*; United States Court of Appeals for the Fourth Circuit: 19-1866 Doc: 16-2 Filed: 08/21/2019 (see esp. Exhibits D, N, O, P, S, V, W, X for sedimentation impacts) [Ex. 49].

- News reports in the Roanoke Times, the primary newspaper serving Roanoke Virginia, location of a US Forest Service Office that supervises Jefferson National Forest,[77] concerning erosion and sedimentation control failures and resulting water resource impacts.[78]

If USFS had installed water monitoring technology that is readily available and is being utilized by other agencies with responsibility for monitoring Mountain Valley's environmental effects, field-generated data on water-quality effects of the pipeline construction activities that have occurred to date within JNF would be available. Such data could be used as a means of assessing the modeling results for accuracy and validity. Since those data are not available, the USFS is relying upon results of non-field-validated erosion modeling for its assessment of potential "erosion, sedimentation, and adverse water quality effects" (quoting from the DSEIS) within the JNF. We believe that modeling to be inadequate, and its results to be an inaccurate reflection of the Proposed Action's true effects.

D. The Hydrologic Analysis on which the Forest Relies is Not Truly Independent.

The Fourth Circuit court decision states: "The Forest Service may adopt FERC's EIS only if it undertakes 'an *independent* review of the [EIS]' and 'concludes that its comments and suggestions have been satisfied.'"[79]

The DSEIS asserts that the Forest Service review of Mountain Valley's erosion and sedimentation analysis is independent of FERC's review but provides no evidence to support that assertion.[80]

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[77] *See* Ex. 33. The comments addressed potential impacts to the Jefferson National Forest and were submitted under signature by J.P. Timm, Forest Supervisor.

[78] *E.g.*, "Mountain Valley Pipeline cited for environmental violations in West Virginia", Roanoke Times (May 16, 2018) ("[A]n inspection in early April found flaws in erosion and sediment control measures at two construction sites in Wetzel County. . . . Work crews failed to prevent sediment-laden water from leaving a site. . . . At another site, erosion caused by heavy rains was not properly channeled down a hillside, causing a portion of the slope to give way") [Ex. 50]; "Virginia files lawsuit against Mountain Valley Pipeline", Roanoke Times (Dec. 7, 2018) ("The company building a natural gas pipeline through Southwest Virginia violated environmental regulations more than 300 times. . . . [I]nspections have found that crews failed to prevent muddy water from flowing off pipeline construction easements, often leaving harmful sediment in nearby streams and properties.") [Ex. 51]; Criminal Investigation of Mountain Valley Pipeline Underway, Document Shows," Roanoke Times (Feb. 15, 2019) (noting that since construction started "crews have repeatedly run afoul of regulations meant to keep muddy runoff from contaminating nearby streams and rivers") [Ex. 52]; "Work continues on Mountain Valley Pipeline, Despite Repeated Problems," Roanoke Times (Mar. 31, 2019) [Ex. 53]; "Mountain Valley agrees to pay $266,000 for pollution problems in W.Va.", Roanoke Times (May 14, 2019) ("The consent order from West Virginia documents a variety of improper steps taken by Mountain Valley to control erosion. Sediment-laden water often left the construction sites and made its way into nearby streams and rivers, the order states") [Ex. 54]; "Mountain Valley Pipeline to pay $2.15 million in lawsuit over environmental problems", Roanoke Times, (October 11, 2019) ("Digging trenches for the buried pipeline along steep mountainsides has led to widespread runoff, washing harmful sediment into nearby streams and onto the property of adjacent landowners.") [Ex. 55]; "Judge approves $2.15 million settlement of lawsuit against Mountain Valley Pipeline", Roanoke Times, (December 12, 2019) [Ex. 56]; "Environmental problems continue with Mountain Valley Pipeline, group says," Roanoke Times, (February 7, 2020) [Ex. 57].

[79] *Sierra Club*, 897 F.3d at 594 (quoting 40 C.F.R. § 1506.3(c)).

[80] DSEIS at ii.

The Forest Service asserts that it "has conducted an independent agency review of this analysis and incorporated it into this SEIS"[81] but presents no evidence that such review is, in fact, "independent" of the FERC analysis. The Forest Service is an agency within U.S. Department of Agriculture, while FERC is an agency within the U.S. Department of Energy. Hence, both agencies are within the U.S. Government's Executive Branch; and therefore both under supervision by the same President of the United States. The DSEIS presents no evidence to demonstrate that the two entities (FERC and the Forest Service) are, in fact, "independent". Likely that is because the DSEIS cannot do so given that the two agencies are under the same supervision. In fact, the executive supervisor of both agencies (the President of the United States) has made multiple statements and taken multiple actions intended to advance oil and natural gas pipeline projects.[82]

Further on the topic of independence, the DSEIS asserts:

> The updated erosion modeling conducted by an ***independent*** third-party contractor was submitted to Federal Agencies – including the Forest Service – with jurisdiction for review (Forest Service, FERC, FWS, NRCS, and BLM). A concurrent review was conducted and a series of discussions, phone calls, and teleconferences (questions and answers, comment, feedback) took place. This reviewed and updated Hydrologic Analysis (Geosyntec Consultants 2020) is incorporated into this SEIS.

The DSEIS provides no evidence that the contractor was, in fact, independent of these proceedings. The Fourth Circuit ruling referenced three prior versions of the "Hydrologic Report".[83] Presumably, all three were prepared under contract by Mountain Valley Pipeline LLC. The DSEIS findings concerning erosion and sedimentation rely on a fourth report prepared by a different contractor, also likely paid for by Mountain Valley. Neither the DSEIS nor Hydrologic Report describe any contractor-selection procedures intended to ensure that the entity preparing the fourth version would act in a manner that is "independent" of the interests of Mountain Valley Pipeline and FERC.

Also, entities preparing an "independent" study might solicit reviews of a draft version of such report by individuals who have subject-matter expertise but no direct connection to the sponsor or the client. Neither the DSEIS nor the Hydrologic Report provides evidence of such. The fourth version of the Hydrologic Report, which the Forest Service relied upon for its DSEIS, does state:

> Geosyntec received additional written comments from USFWS, United States Geological Survey (USGS), USFS, Natural Resources Conservation Service

[81] *E.g.*, DSEIS Section 3.3.10, Aquatic Species ("The Forest Service has conducted an independent agency review of this analysis and incorporated it into this SEIS.").
[82] *E.g.*, "President Trump Takes Action to Expedite Priority Energy and Infrastructure Projects", https://www.whitehouse.gov/briefings-statements/president-trump-takes-action-expedite-priority-energy-infrastructure-projects/ [Ex. 58].
"Trump Signs Orders to Speed Up Oil and Gas Pipeline Construction". New York Times, 10 April 2019, https://www.nytimes.com/2019/04/10/business/energy-environment/trump-oil-gas-pipelines.html [Ex. 59].
[83] *Sierra Club*, 897 F.3d at 591.

> (NRCS), and Bureau of Land Management reviewers in response to the version of the Hydrologic Analysis of Sedimentation for Streams near Suitable Habitat for Threatened and Endangered Aquatic Species, Virginia and West Virginia, Report of Findings (Geosyntec, 2019) dated June 21, 2019. Mountain Valley submitted a revised version of that sedimentation analysis to address those comments on May 4, 2020 (Geosyntec, 2020).[84]

However, none of the entities providing such review are "independent" of the U.S. federal executive branch. No reviewer's independent of the U.S federal government are mentioned. Further, the fourth Hydrologic Report was prepared using methods similar to those used for preparation of the first three Hydrologic Reports, all of which were found lacking.

E. The Forest Service Has Failed to Analyze the Cascade of Impacts from the Evidence of Unhealthy Trees on the Edges of the Pipeline Corridor.

Since the clearing of the pipeline corridor in the JNF in 2018, trees along the edges of the corridor have developed a stressed appearance and may be dying. The exhibited aerial photographs, taken by Mountain Valley Watch, show the additional potential tree loss at the edges of the pipeline corridor.[85] The condition is difficult to assess from the air and the public has been excluded from access to our National Forest. The DSEIS does not analyze the impacts of the additional tree loss.

In addition, the additional tree loss is an indicator that the harm caused by compaction and disruption of the water regime may inhibit the plan to restore the corridor with tree plantings. The DSEIS also fails to address the potential for the restoration to fail, for which the evidence of that potential is already apparent. The potential failure to restore the corridor, as planned, will undermine the assertions that the visual qualities and recreation experiences will eventually be returned to purportedly acceptable conditions.

Tree loss and its causes at the edge of the corridor should have been anticipated by the Forest Service. The repercussions for the project, and the failure to acknowledge such impacts, are prime examples of both the inadequacies in the rush to welcome the MVP to our community's National Forest and the folly of allowing the project to go forward. It is past time for the Forest Service to cut our losses and escort MVP LLC off our National Forest.

F. The DSEIS Fails to Adequately Address the Hazards Associated with Degradation of the MVP Pipe.

The DSEIS does not adequately address the hazards associated with degradation of pipe that has been exposed to the elements for the multiple years during which pipeline construction has been delayed.

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[84] Hydrologic Analysis at 7.
[85] Aerial photographs, Mountain Valley Watch [Ex. 60].

In discussion of public safety risks, the DSEIS wrongly states: "Effects on public health and safety within the project area would be similar to those analyzed in the FERC FEIS."[86] In discussion of geologic risks, the DSEIS incorrectly states: "In conclusion, the FERC FEIS analysis remains accurate and the effects of implementing the No Action Alternative and Proposed Action in the SEIS are consistent with those described in the FERC FEIS."[87]

These statements are inaccurate because much of the pipe has been subjected to weathering and degradation for a period of more than two years as documented herein, and likely for more than three years, while the pipeline corridor itself has been affected by construction activity to date. The construction delay and associated pipe exposure have created enhanced risks of pipeline failure within the JNF. Given the reliance on pipe strength as an important component of plans to mitigate failure risks in steep terrain that are subject to soil and rock slippage within the Giles County Seismic Zone, this enhanced risk is especially acute within those steep slope areas. The effects of construction delay and resulting enhanced failure risk is not considered by the DSEIS in its comparison of the Proposed Action and the No Action alternatives.

A. Construction Delay Has Created Enhanced Risk of Pipeline Failure.

The DSEIS notes that "Sections of pipe have been delivered to the ROW and are being stored aboveground."[88] Multiple pipes along the Mountain Valley Pipeline corridor have been photographed with mid-2017 dates[89], suggesting a likelihood that pipes have been exposed to the elements for more than three years. Aerial imagery reveals pipes in the corridor on Brush and Sinking Creek Mountains within JNF in October 2018 and in November 2019 (Figures 1 and 2 below). Prior to placement in the corridor, pipes are often stored in outdoor areas. It is reasonable to expect that pipe is in an outdoor storage area and exposed to the elements.

Visits to the pipeline corridor in the JNF on October 28, 200, via Brush Mountain Road, a Forest Service road that crosses the pipeline corridor and is open to the public for lawful activities, revealed multiple pipes sitting in the pipeline corridor outside, exposed to the elements adjacent to Brush Mountain Road.

A recent article in Inside Climate News states that pipes for Mountain Valley Pipeline have been "stored above ground since (approx.) 2017."[90] Therefore, several lines of evidence lead to the conclusion that most if not all of the pipes planned for burial in the JNF have exposed to the elements for approximately three years, both in storage yards and in the JNF corridor segments on Brush and Sinking Creek Mountains.

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[86] DSEIS at 42.
[87] *Id.*
[88] *Id.* at 40.
[89] *E.g.*, *Delays Raise New Questions for Mountain Valley Pipeline*, Roanoke Times (June 15, 2019) https://roanoke.com/gallery/photos-delays-raise-new-questions-for-mountain-valley-pipeline/collection_41938103-7c04-5db3-9119-aef5d02abe13.html#1 [Ex. 61]; "Pipeline Chemical Coatings Are Serious Concerns", https://www.nrdc.org/experts/amy-mall/pipeline-chemical-coatings-are-serious-concerns [Ex. 62].
[90] McKenna P. Too Much Sun Degrades Coatings That Keep Pipes From Corroding, Risking Leaks, Spills and Explosions. Inside Climate News (Oct. 28, 2020), https://insideclimatenews.org/news/09102020/pipeline-coating-keystone-xl [Ex. 63].

Figure 1. Google Earth imagery of pipes exposed to the elements in Jefferson National Forest on the upper southeastern slope of Sinking Creek Mountain (left), the lower segment of that same slope and adjacent to Craig Creek (middle), and the northwestern slope of Brush Mountain (right). Imagery is dated 11/2019.

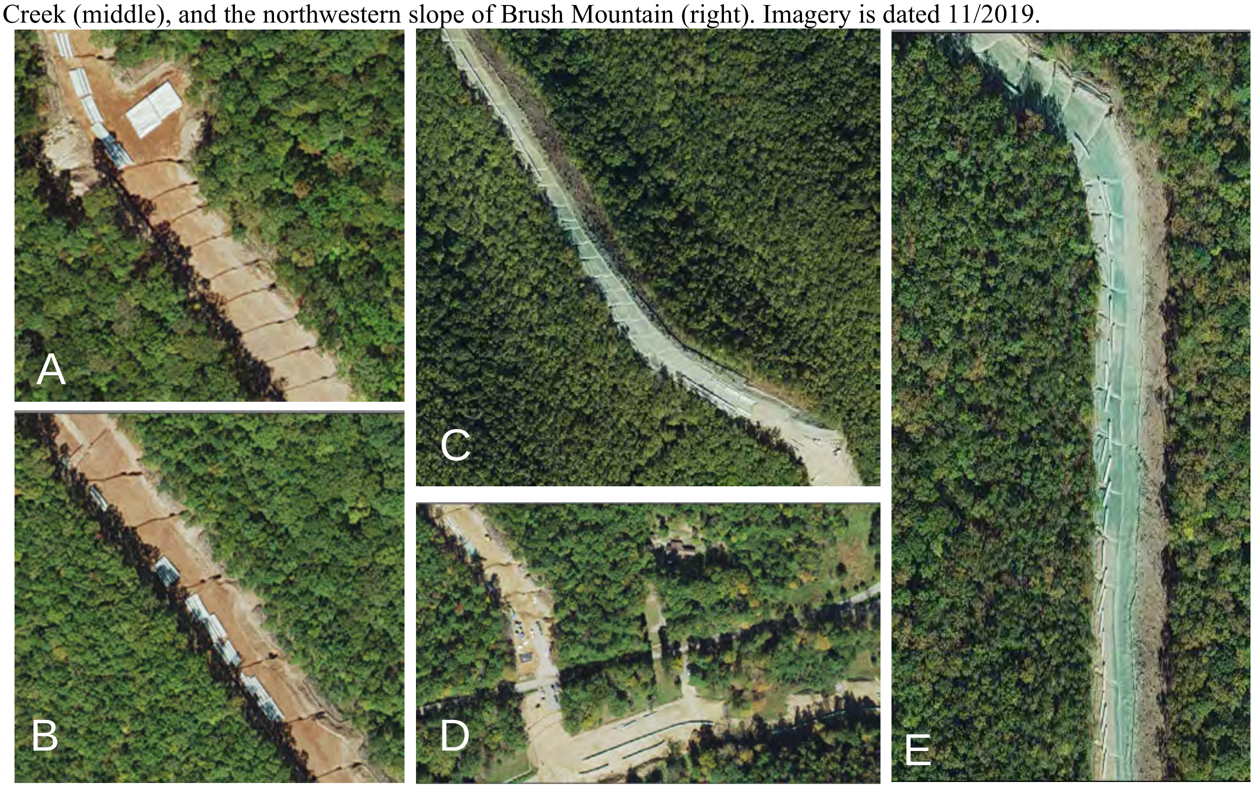

Figure 2. National Agricultural Imagery Program (NAIP)[91] imagery of pipes exposed to the elements in Jefferson National Forest on the upper (A), mid- (B), and lower southeastern slope of Sinking Creek Mountain with the Craig Creek Road crossing D); and on the lower (C) and upper northwestern slopes of Brush Mountain and the Forest Service Brush Mountain Road crossing (E). Imagery is dated 10/18/2018.

[91] Imagery obtained from Earth Explorer, https://earthexplorer.usgs.gov/ [Ex. 64].

Unused pipe sitting on the ground surface is subject to at least two forms of corrosion: internal and external.

Internal corrosion can occur due to exposure to rainwater and to atmospheric moisture. The pipes are constructed from a form of steel that is subject to corrosion by moisture. As noted in the FEIS: "The pipe would be delivered to the job site with a protective coating of fusion-bonded epoxy or other approved coating that would inhibit corrosion by preventing moisture from coming into direct contact with the steel."[92]

Hence, it is clear that the form of steel used to construct the pipes is vulnerable to corrosion caused through contact with moisture. The pipe interiors are not covered with FBE coating and, thus, are subject to corrosion by moisture. Most of the visible pipes have fabric-like coverings intended to prevent rainwater entry, but several do not. Coverings for several others were damaged in a manner that would enable rainwater entry (Figure 3).

The project area has a humid climate, and the pipes have been exposed to the elements for several moist years. The City of Roanoke experienced record rainfall in the year 2018, the highest annual total since recordkeeping began in 1912; and its year 2020 rainfall total through October 27, 2020, was ahead of that record pace. [93] Data from National Climate Data Center confirm that 2018 was a record rainfall year and that year 2019 rainfall total was above average.[94] The JNF corridors proposed for pipeline construction are close to Roanoke, Virginia, and experience similar weather and climate. Hence, these pipes have been exposed to a humid climate during a multiple-year period of extreme moisture. Also, the pipes are stored in narrow open corridors that run through predominantly wooded areas, which tend to be moister during the leaf-on season than open areas due to evapotranspiration from trees. Even if capped to prevent direct entry of rainfall, these pipes have been exposed to a moist atmosphere. Also, it is not clear that the capping material is sufficiently non-porous and sufficiently sealed so as to prevent exchange of internal air with the ambient environment.

Pipes can also degrade due to external corrosion. Although the pipes are covered with fusion-bonded epoxy (FBE), that material is subject to degradation by exposure to the sun's ultraviolet radiation and to rainfall.

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[92] FEIS at 2–39.
[93] "Weather Journal: Zeta to zip through Southwest Virginia on Thursday with heavy rainfall", Roanoke Times (Oct. 28, 2020) ("Through Tuesday, Roanoke has had exactly 51 inches of rain in 2020, trailing only 2018 with 51.30 inches of rain through the same date, Oct. 27. 2018, boosted by Hurricane Matthew's mid-month downpours, had 51.43 inches of rain by the end of October, on its way to a record 62.45 inches for the entire year.") [Ex. 65].
[94] Climate at a Glance, county time series, https://www.ncdc.noaa.gov/ [Ex. 66]. According to this source: 43.56 inches of precipitation were recorded at Roanoke, Virginia in 2019, greater than the 1901-2019 annual average precipitation at this location, 41.60 inches.

Figure 3. Photograph of pipes in the Jefferson National Forest adjacent to Forest Service Brush Mountain Road, taken from the road and looking toward the northwest. Holes in two of the pipe cappings are visible in the photo. The white arrow points to the top section of another pipe located behind those in the foreground that does not have a capping.

A technical article published under authorship by employees of pipeline-operator TC Energy states:

> When exposed to ultraviolet rays, FBE coatings undergo polymer degradation, commonly referred to as chalking. Previous studies of exposed weathering of FBE coating had identified that this UV exposure could have a serious deleterious effect on the inherent physical properties of the coating (1,2). This phenomenon is common to all FBE coatings that are primarily designed only for below ground service. Kehr (3) stated that, if undisrupted, this layer of chalked FBE will protect the underlaying FBE and enable the coating to retain most of its original properties. However, if this protective layer of chalked coating is removed by rain, wind or intense periods of UV exposure, then the new surface starts to suffer from the repeated process of chalking. As this breakdown and delamination of the outside layers continue, it is accompanied by a noticeable reduction in the coating thickness (2). Work by Cetiner and Kehr concluded that this coating thickness reduction could average between 10 to 40 microns per year.[95]

The report also notes that total coating thickness for pipes intended for use by the Keystone XL Pipeline, as specified by the manufacturer, is 406 to 457 microns. Those same authors reported a test conducted in an unspecified area, which appears to have been in western North America, revealed FBE coating loss was measured at 25.8 microns per year.

[95] K. Coulson et al.. Journal of the Institute of Corrosion Management, "Study of stockpiled fusion bond epoxy coated pipe," at 16–21, Issue 153 (January/February 2020) [Ex. 67].

The authors found that after prolonged exposure to the environment, the coatings "completely failed to retain their original properties and attributes" including thickness, flexibility, and both general adhesion and "water soak adhesion" to the pipe.[96] Adhesion to the pipe is an essential characteristic because lack of adhesion can allow moisture to enter the space between the non-adhered coating and the pipe, causing external corrosion. The coating's flexibility is also an essential characteristic because the pipes are subject to flexing during installation; if the coating is unable to flex with the pipes, it can develop cracks which will allow environmental moisture to contact the steel pipe's exterior once it is placed underground.

Pipe coating degradation has at least two serious consequences. Most obvious is that the coating degradation can allow environmental moisture to contact the exterior of the pipe, especially after the pipe is buried. Direct contact with moisture can accelerate exterior corrosion. Secondly, pipe coating degradation can impair the effectiveness of cathodic protection systems that are intended to prevent a form of pipe corrosion that results from its placement underground.

As stated by a pipeline industry consultant: "Cathodic protection, or CP, is usually intended to work in concert with a pipeline coating to help reduce the threat of external corrosion on buried pipelines."[97] Hence, coating degradation would reduce the effectiveness of cathodic protection. Also, sufficient loss of thickness by FBE coating can compromise its effectiveness. The Kuprewicz memo concludes by stating:

> Given the unusually long time that the stored pipe for the Keystone XL Pipeline was exposed to the elements, it is not surprising that a significant percentage of the coated pipe segments studied was determined not to be fit for their intended purpose" and they "should either be replaced or have the degraded FBE coating completely removed and recoated with new FBE. Otherwise, the risk of an oil release on the Keystone XL Pipeline goes up considerably.[98]

The extended exposure to the elements of pipes intended for installation within JNF contradicts recommended best practices. When describing proper handling of pipes coated with FBE such as Mountain Valley Pipeline pipes, the National Association of Pipe Coating Applicators states: "The intended use of these coatings is to provide corrosion protection for buried pipelines. Above ground storage of coated pipe in excess of 6 months without additional Ultraviolet protection is not recommended."[99]

The 3M Corporation, manufacturer of the FBE coating applied to Mountain Valley's pipes, describes the process of exposure-induced FBE-coating degradation and consequent loss of thickness as "chalking" and states:

> Efforts have been made to improve the UV stability of epoxy products; however, to date commercial success of epoxy resins with improved weatherability has

[96] *Id.*
[97] R.B. Kuprewicz, "Accufacts' Observations on the Use of Keystone XL Pipeline Pipe Exhibiting External Coating Deterioration Issues from Long Term Storage Exposure to the Elements, at 4, memo to: Ms. Jaclyn H. Prange Natural Resources Defense Council, Inc (Oct. 1, 2020) [Ex. 68].
[98] *Id.*
[99] NAPCA Bulletin 12-78-04. External application procedures for plant applied fusion bonded epoxy (FBE) coatings and abrasion resistant overlay (ARO) coatings to steel pipe. [Ex. 69].

> been limited … Since the degree of chalking is dependent on the intensity and duration of the UV radiation and the presence of moisture, it is not surprising that variations in the degree of chalking observed in the field appear to be geographic-location specific.
>
> The Cetiner study, which evaluated pipe that had been stored for approximately one year, showed no measurable reduction in performance in either the 48-hour cathodic disbondment test or hot water adhesion tests. There was however a measurable reduction in flexibility. . . .
>
> Based on this work, Cetiner and coworkers recommended that pipe stored for longer than one year should be protected from UV radiation.
>
> . . . [I]t is important to keep in mind that the rate of chalking/thickness loss can vary considerably and is dependent on the susceptibility of the specific FBE formulation to UV attack, the intensity and duration of the UV exposure, the availability of moisture, as well as the rate at which the protective chalk layer is removed.[100]

FERC recently released a report on pipeline coating degradation that concluded such degradation is not problematic.[101] However, that report addressed environmental contamination issues only, not corrosion.[102]

Federal regulations require inspection of pipe prior to its placement in the ground. FERC's FEIS states that such inspections would take place.[103] The general requirements for inspection, however, are somewhat vague, and do not address issues specific to extended exposure and weathering: "Each length of pipe and each other component must be visually inspected at the site of installation to ensure that it has not sustained any visually determinable damage that could impair its serviceability."[104]

Subsequent text referring to steel pipe describes "gouge, groove, arc burn, or dent"[105] as features requiring repair but does not refer to moisture-related forms of steel corrosion such as rust.

Federal regulations require inspections of pipe and pipeline coating before the pipe is placed in the ground: "Each external protective coating must be inspected just prior to lowering the pipe into the ditch and backfilling, and any damage detrimental to effective corrosion control must be repaired."[106]

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[100] Technical Brief UV Protection of Coated Line Pipe. 3M Corporation. https://multimedia.3m.com/mws/media/850794O/uv-protection-of-coated-line-pipe-technical-brief.pdf [Ex. 70].

[101] "Pipe Chalking Impact Assessment", prepared by ToxStrategies; released as part of FERC Document Accession #: 20201008-3001 [Ex. 71].

[102] *See id.*

[103] FEIS at 2–40.

[104] 49 C.F.R. § 192.307.

[105] 49 C.F.R. § 192.309.

[106] 49 C.F.R. § 192.461.

It is not clear, however, that such inspections would be adequate to ensure the pipeline's integrity, minimize failure risks, and protect public safety and the environment. For one thing, it is not clear that inspection procedures geared toward relatively new pipes that have been handled in accord with manufacturers' recommendations would be adequate for pipes that have been subjected to the elements for more than three years.

Also, should such weathering cause the pipe coating to lose flexibility[107] and should pipeline flexure during installation cause the coating to develop cracks that would compromise its integrity, such cracks would not be discovered during inspections conducted prior to its installation. The pipes themselves are designed to be flexible to enable the bending that is required for a non-linear pipeline. Hence, it is not unreasonable to expect that some flexure would occur as lengthy welded pipe segments are being placed into the ground.

Further, it is not clear that field-applied "repairs" immediately prior to placing the pipe sections in the ground would be adequate to address widespread and systemic degradation of pipe.

Multiple statements by the company indicate an intent to achieve rapid completion if all regulatory hurdles are lifted.[108] Such statements appear as intended to assure investors of a soon-to-be realized revenue stream.

Mountain Valley proposes to construct its pipeline on very steep slopes within the JNF, some in excess of 60 percent.[109] Some of these slopes are subject to soil slippage and/or landslide risk.[110] Those risks are enhanced by location within a zone of enhanced seismic risk known as the Giles County Seismic Zone (GCSZ).[111]

The DSEIS notes the existence of potential landslide areas within the JNF. For example: "In addition, the POD Appendix G identified six high hazard portions of the route on NFS lands (four on Peters Mountain, one on Brush Mountain, and one on Sinking Creek Mountain) and developed site-specific stabilization measures to mitigate for potential geohazards from pipeline construction."[112]

FERC's FEIS notes that the largest debris slide area in eastern North America occurs within the JNF, and that the JNF segment of the pipeline corridor occurs within the Giles County

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[107] As noted above, authoritative studies have found loss of coating flexibility to be a consequence of environmental weathering.
[108] *E.g.*, https://www.mountainvalleypipeline.info/wp-content/uploads/2020/06/Schedule-Cost-AppTrail-June-2020-FINAL3.pdf [Ex. 72].
[109] Mountain Valley's Plan of Development: Appendix G, Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the Proposed Mountain Valley Pipeline Project in the Jefferson National Forest; and Appendix F, Landslide Mitigation Plan.
[110] *Id.*
[111] *Id.* Appendix F.
[112] DSEIS at 47.

Seismic Zone.[113] A careful review of the POD's Appendix G reveals that this potential pipeline segment is a significant hazard.

The FEIS makes note of these risks. For example, it states:

> However, soil liquefaction and lateral spreading hazards do exist along the MVP in the general area of the GCSZ where peak ground acceleration greater than 12 percent g could occur. A PGA greater than 12 percent g depending on site conditions could be equivalent to a magnitude 5.0 earthquake. There is a 4 percent chance that an earthquake with a magnitude greater than 5 on the Richter scale could occur within 50 years, and a 1 percent chance that an earthquake with a magnitude greater than 6 could occur within 50 years (D.G. Honegger Consulting, 2015a).[114]

The FEIS places considerable reliance on the strength of pipe for mitigation of landslide, seismic, and slippage risks. For example, the FEIS states:

> Mountain Valley would use Class 2 pipe in areas where seismic hazards exist.[115]
>
> …
>
> There are 7.8 miles of Class 1 pipe in proximity to the GCSZ (MPs 178 to 186). PGAs in this area of the MVP are on the order of 12 percent. The remaining pipe in proximity to the GCSZ would be Class 2 or greater and thus have a thicker pipe wall than Class 1 pipe.[116]
>
> …
>
> The majority of pipe in the seismically active area near the GCSZ would be Class 2 or Class 3 thickness.[117]
>
> …
>
> Calculations by D.G. Honegger Consulting indicate that potential hazards exist for triggered slope displacement due to a higher potential for seismicity between MPs 161 and 239 should the length of soil displacement over the pipeline exceed 1,580 feet for parallel slopes. Mountain Valley has committed to using thicker Class 2 pipe in these areas in order to mitigate hazards from potential slope movement.[118]

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[113] FEIS at 4-45, 4-46.
[114] *Id.* at 4-26.
[115] *Id.* at ES-4 and p. 4-71.
[116] *Id.* at 4-26.
[117] *Id.* at 4-51.
[118] *Id.* at 4-51.

…

> Mountain Valley also identified two places where the pipeline would run perpendicular to a potential triggered slope displacement hazard: 1) between MPs 196.4 and 196.5; and 2) at approximate MP 197.0. In these areas Mountain Valley would use thicker Class 2 pipe to mitigate hazards to the pipeline from triggered slop displacement.[119]

A review of stabilization plans for JNF high-hazard areas reveals that they are quite vague. For example, language within the POD's Appendix G describing "Mitigation Plans" for the six areas makes repeated use of the term "may." The Plan does place heavy reliance on aerial surveys every six months for the first two years, then annually through the next five years, then every five years after that. This plan takes no account of the potential seismic risk, which is episodic and not of a gradual nature such that it can be addressed via measures such as periodic lidar monitoring.

The risk to pipeline integrity posed by the potential for significant seismic event is a major concern. Such risks are enhanced by accelerated corrosion, should such occur as a result the pipe and FBE coating degradation caused by extended exposure due to construction delay. The potential risks of minor tremors are also enhanced by the FBE coating degradation and associated loss of flexibility, given the potential of minor seismic-induced flexures to cause cracks in such coatings. The existence of coating cracks, of course, could enable accelerated corrosion and loss of pipe strength.

Subsequent to the FEIS, Mountain Valley has proposed to add another compression station.[120] Depending on location, that would increase pipeline pressure within the JNF. In addition to corrosion effects on pipeline strength and external stresses (e.g., soil slippage, seismic movement, landslides), internal pressure is a factor that contributes to failure risk. With all other factors being equal, increased internal pressure will create increased failure risk.

The DSEIS makes multiple references to Mountain Valley Pipeline's Plan of Development,[121] including Appendix G, "Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the Proposed Mountain Valley Pipeline Project in the Jefferson National Forest." This document describes plans intended for mitigation of slope-stability risks within six areas of the JNF where slopes are extremely steep, including the southeastern side of Sinking Creek Mountain, the location for the … "largest known landslides in eastern North America."[122]

The DSEIS states: "The FERC FEIS (Section 4.1.1.7, pp. 4-45 to 4-46) described geology conditions on the JNF, including geologic setting, bedrock geology, surface geology,

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[119] *Id.* at 4-51. Both of these perpendicular-to-slope locations are within the JNF.
[120] Equitrans plans capacity expansion on Mountain Valley Pipeline. https://www.bizjournals.com/pittsburgh/news/2020/08/04/equitrans-capacity-expansion-mvp.html [Ex. 73].
[121] The Plan of Development can be accessed at https://www.fs.usda.gov/project/?project=50036, Analysis.
[122] *See id.* at App. G.

mineral resources, geological hazards, and paleontological resources. The description of these conditions remains accurate, as there has been relatively little change since 2017."[123]

The second sentence of that statement is not correct. For one thing, it appears that explosives have been used to alter surface geologic structure within the JNF (Figure 4). The aerial imagery of Figure 1 (left) and Figure 2 (A), which show pipes being stored and stockpiled at relatively flat locations on the top of Sinking Creek Mountain, demonstrate that surface geologic structure has been altered by Mountain Valley pipeline construction activities within the JNF.

Figure 4. Photo of the pipeline corridor at the top of Sinking Creek Mountain, 16 June 2018. It appears that explosives have been used to fracture the rock formerly constituting the mountaintop. The photo was taken from a non-JNF location in Craig County but the JNF boundary runs across the top of Sinking Creek Mountain at the photo location. Hence, it is clear that surface geologic structure within the JNF has been affected similarly.[124]

More significantly, vegetation and surface soils have been removed from the proposed pipeline corridor on Sinking Creek and Brush Mountains for more than two years (Figures 1 and 2). It is clear that vegetation plays a role in maintaining surface soil and geologic stability in steeply sloping areas[125], especially those such as the southeastern face of Sinking Creek Mountain and its surface of unconsolidated geologic material that has been subject to prior slippage.[126] Numerous studies document the importance of vegetation, including tree roots, in maintaining the stability of sloping areas. For example:

> Landsliding is a recurring process in the southern Appalachian Highlands (SAH) region … Storms that trigger hundreds of debris flows occur about every 9 years

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[123] DSEIS at 46.
[124] Given the color and configuration of the equipment, it appears that the excavator is a Caterpillar, and is likely in the category of "large excavators" as classified by Caterpillar. Given the terrain it is likely track mounted. In order to estimate the dimensions of the fractured geologic material in the photo, comparison can be made to the size of the excavator. Among Caterpillar's smaller excavators within the category of "Large Excavators", track mounted, is model 374F. Dimensions posted at https://www.cat.com/en_US/products/new/equipment/excavators/large-excavators/1000027059.html indicated that excavator's cab height at 15 feet and its boom length at 23 feet.
[125] Multiple scientific studies have documented this fact, as can be ascertained entering "tree roots landslides" into Google Scholar.
[126] As noted above, largest debris slide area in eastern North America.

> and those that generate thousands occur about every 25 years … Forests on mountain slopes are critical in mitigating the impacts of recurring landslide events. Forest cover is an important stabilizing factor … Anthropogenic influences have increased the frequency of mass wasting for a given storm event above historical natural levels through changes in vegetation and disturbances on mountain slopes.[127]

In earlier years, the Forest Service expressed concern with geologic stability issues.[128] Nearly half of the 31 pages of comments submitted to FERC on Mountain Valley Pipeline's application concerned geologic stability. For example:

> Peak ground acceleration for the MVP pipeline crossing the JNF was estimated at 0.14 g … However, ridgetop amplification could increase this acceleration number by a factor of two or three times. … The pipeline corridor crosses three ridgetops on JNF (Peters Mountain, Sinking Creek Mountain, and Brush Mountain). Assess the potential for ridgetop amplification to increase seismic acceleration by a factor of two, three or more times."[129]
> "Draper Aden Associates 2015c report in Appendix 6-D states that the estimate 0.14 g is "expressed as a fraction of gravitational acceleration, g), with a 2 percent probability of occurring in 50 years (i.e., mean return period of approximately 2,500 years)". Return periods can be modeled and estimated for the [Giles County Seismic Zone] GCSZ or [Pembroke Fault Zone] PFZ, but the return periods are not known, and cannot be known without earthquake records for thousands of years for the GCSZ or PFZ. Moreover, earthquakes do not occur on regimented, clockwork return periods.[130]
>
> . . .
>
> Review and discuss the studies which have considered earthquakes as a triggering mechanism for the large rock block landslides on Sinking Creek Mountain . . . .[131]
>
> . . .
>
> Display the pipeline corridor (and any project facilities such as access roads) within the JNF surface ownership boundary overlaid on the most detailed scale published geologic maps available. Identify the types of landslides mapped in the vicinity of the pipeline corridor. Based on existing information, discuss the

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[127] Text from abstract of: R.M. Wooten et al. 2016. Frequency and Magnitude of Selected Historical Landslide Events in the Southern Appalachian Highlands of North Carolina and Virginia: Relationships to Rainfall, Geological and Ecohydrological Controls, and Effects. Chapter 9 in: C.S. Greenberg, B.S. Collins (eds). Natural Disturbances and Historic Range of Variation. Springer International Publishing [Ex. 74].
[128] Letter from Joby P. Timm, U.S. Forest Service, to Federal Energy Regulatory Commission, 9 March 2016. Comments on Final Resource Reports for the Mountain Valley Pipeline Project [Ex. 75].
[129] *Id.* at 12–13 of 31.
[130] *Id.* at 13 of 31.
[131] *Id.* at 14 of 31.

> geologic factors (such as lithology, surficial deposits, structure, discontinuities, etc.) relevant to potential landslides along the pipeline corridor on the JNF.[132]
>
> . . .
>
> Because of the overarching influence of geologic structures (dip slopes and antidip slopes) on both natural landslides and project-related slope failures, provide engineering geologic assessment … Assess the potential for debris flow type of landslides to impact the pipeline and associated facilities. … Assess the potential impacts on pipeline and access roads of swarms of debris flows, … Assess potential for seismically induced landslides to impact the pipeline. Assess potential for large bedrock rockslides, such as found along Sinking Creek Mountain, to occur on Peters Mountain as well as Sinking Creek Mountain. Assess potential for earthquakes to trigger cut slope failure or fill slope failures originating on slopes modified by MVP project.[133]

Clearly, the Forest Service concerns with geologic stability raised above are relevant to the primary issue addressed in this section: the potential for reduced strength and corrosion resistance by the pipeline as a result of prolonged and unplanned exposure by pipes to the elements. Such problems may be exacerbated by the likely inadequacy of industry standard quality control practices, which are geared toward installation of pipes that have not suffered such long exposures, to ensure maximum safety under this circumstance.

In sum, the DSEIS makes no mention of how pipeline failure risk and may have been enhanced by the construction delay and extended pipe exposure. The information presented here is new information and was not considered by the original FEIS. The FEIS did not anticipate the lengthy construction process and extended outdoor exposure of the pipe prior to its installation. The ensuing degradation has potential to affect the pipeline's structural integrity and by enabling accelerated corrosion.

Should the pipeline experience failure within the JNF, results would include release of hydrocarbon gases as well as solid/liquid phase impurities contained within the gas resulting in soil and water pollution hazards. High-pressure pipeline ruptures are commonly accompanied by explosions and intensive fires. The enhanced risk of pipeline failure resulting from the construction delay has direct environmental consequences and should have been considered by the DSEIS.

VI. THE DSEIS AND THE PROPOSED ACTION FAIL TO COMPLY WITH THE FOREST PLANNING RULES, IN VIOLATION OF NFMA.

A. NFMA and Its Implementing Regulations Do Not Authorize the Waiver of Compliance with Mandatory Management Standards.

[132] *Id.* at 16 of 31.
[133] *Id.* at 20–24 of 31.

NFMA imposes substantive constraints on management of forest lands, such as a requirement to assure biological diversity.[134] NFMA and its implementing regulations subject forest management to two stages of administrative decision-making. At the first stage, the Forest Service is required to develop a Land and Resource Management Plan (LRMP), also known as a Forest Plan, which establishes a long-term management scheme for an entire national forest. At the second stage, the Forest Service must approve or deny individual, site-specific projects. These individual projects must be consistent with the Forest Plan.[135]

The construction and operation of the MVP is inconsistent with the LRMP for the JNF.[136] The Forest Service, therefore, proposes to amend the LRMP to make it consistent with the harm that will be caused by the MVP. The Fourth Circuit identified that "the clear purpose of the amendment is to lessen requirements protecting soil and riparian resources so that the pipeline project could meet those requirements."[137] The Forest Service proposes to weaken or waive eleven forest management standards for utility corridors, riparian areas, soil resources, old growth forests, the Appalachian Scenic Trail, and scenery integrity objectives.[138] Reliance on site-specific Forest Plan amendments violates NFMA's requirement that forest plans "form one integrated plan for each unit of the National Forest System, incorporating in one document or one set of documents, available to the public at convenient locations, all of the features required by this section."[139]

The proposed pipeline corridor follows the boundaries of two Wilderness areas and an Inventoried Roadless Area, crosses the Appalachian Scenic Trail, and impacts water resources that support endangered species. The supplemental analysis remains deficient and the proposal to amend the plan violates NFMA and its implementing regulations where the proposed amendments are contrary to the requirements of the 2012 Planning Rule, as clearly stated by the Forest Service in the preamble to the 2016 amendments to the Rules.[140]

In 2012, the Forest Service revised its planning regulations applicable to all new, revised, and amended forest plans. In 2016, the Forest Service amended the 2012 Planning Rule to clarify how amendments of forest plans created under prior planning rules, like the LRMP for the JNF, must be undertaken.

The Planning Rule requires every Forest Plan to contain riparian standards to maintain or restore the ecological integrity of riparian areas.[141] The Rule also requires standards to maintain or restore soils and soil productivity, water quality, and water resources.[142] Each of these

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[134] *Native Ecosystems Council v. Dombeck*, 304 F.3d 886, 898 (9th Cir. 2002).
[135] *Great Old Broads for Wilderness v. Kimbell*, 709 F.3d 836, 851 (9th Cir. 2013) ("[T]he NFMA prohibits site-specific activities that are inconsistent with the governing Forest Plan."); *see also Neighbors of Cuddy Mtn. v. Alexander*, 303 F.3d 1059, 1062 (9th Cir.2002) ("Specific projects ... must be analyzed by the Forest Service and the analysis must show that each project is consistent with the plan.").
[136] *See* DSEIS at 5.
[137] *Sierra Club*, 897 F.3d at 603.
[138] DSEIS at 19–22.
[139] 16 U.S.C. § 1604(f)(1).
[140] Forest Service, *National Forest System Land Management Planning*, *Final Rule*, 81 Fed. Reg. 90273, 90276 (December 15, 2016).
[141] 36 C.F.R. § 219.8(3).
[142] *Id.* § 219.8(2).

requirements is related to the social, economic, and ecological sustainability of the Plan area. These are required elements of all Forest Management Plans. The purpose of assuring sustainability is in part to provide people and communities with ecosystem services.

The Forest Service's obligation does not stop at the boundary of the national forest:

> The purpose of this part is to guide the collaborative and science-based development, amendment, and revision of land management plans that promote the ecological integrity of national forests and grasslands and other administrative units of the NFS. Plans will guide management of NFS lands so that they are ecologically sustainable and contribute to social and economic sustainability; consist of ecosystems and watersheds with ecological integrity and diverse plant and animal communities; and have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future. These benefits include clean air and water; habitat for fish, wildlife, and plant communities; and opportunities for recreational, spiritual, educational, and cultural benefits.[143]

The duties of the Forest Service are broad, encompassing, and include not only the requirement to assure that our national forests provide the public with clean air, water, and healthy ecosystems, but also spiritual benefits. There is nothing science-based or collaborative about the proposal to weaken or waive riparian and soils standards to allow the JNF to be used as a pipeline corridor for corporate profit and against the public interest.

There is no legal mechanism to waive the required components of the LRMP. Rather, all projects are subject to the standards. A final rulemaking for a clarifying amendment to the Planning Rule was promulgated on December 15, 2016. The clarification does not change the substantive Plan requirements. Instead, it clarifies that the deciding officer does not have the discretion to eliminate required components:

> At the same time, the responsible official's discretion to tailor the scope and scale of an amendment is not unbounded; the 2012 rule does not give a responsible official the discretion to amend a plan in a manner contrary to the 2012 rule by selectively applying, or avoiding altogether, substantive requirements within §§ 219.8 through 219.11 that are directly related to the changes being proposed. *Nor does the 2012 rule give responsible officials discretion to propose amendments ''under the requirements'' of the 2012 rule that actually are contrary to those requirements*, or to use the amendment process to avoid both 1982 and 2012 rule requirements (§ 219.17(b)(2)).[144]

The proposed amendments to eliminate the requirement to comply with riparian standards is contrary to the requirements of the Planning Rule, which mandates the use of riparian

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[143] *Id.* § 219.1(c).

[144] Forest Service, *National Forest System Land Management Planning*, *Final Rule*, 81 Fed. Reg. 90723, 90726 (December 15, 2016) (emphasis added).

standards.[145] Waiving riparian and soils standards when it is known that the soils, geology, and steep terrain all put water resources at certain risk of harm is unlawful. Because the proposed Forest Plan amendments fail to comply with the 2012 Planning Rule as amended, the proposed amendments are arbitrary, capricious, and not in accordance with law.

The consistency requirement of the Planning Rules makes clear that proposed projects are to be made consistent with the Forest Plans, and the Forest Service has no authority to conform a Forest Plan to make it consistent with the impacts caused by a project:

> Every decision document approving a plan, plan amendment, or plan revision must state whether authorizations of occupancy and use made before the decision document may proceed unchanged. *If a plan decision document does not expressly allow such occupancy and use, the permit, contract, and other authorizing instrument for the use and occupancy must be made consistent with the plan, plan amendment*, or plan revision as soon as practicable, as provided in paragraph (d) of this section, subject to valid existing rights.[146]

Furthermore, replacement of standards with mitigation does not achieve the purpose of a standard. "While goals and objectives define where we are headed with management of the Jefferson National Forest, standards define the rules we will follow in getting there. Standards are specific technical resource management directions and often preclude or impose limitations on management activities or resource uses, generally for environmental protection, public safety, or resolution of an issue."[147] Standards are the specific practices that are designed to achieve the management goals and objectives. Substituting a standard with mitigation, or the implementation of unspecified parts of the Plan of Development, is not a "specific technical resource management direction." Mitigation measures may only minimize harm, and they do not provide specific resource management directions to achieve the goals, objectives, and desired conditions on the JNF.

B. The Forest Service Has Not Analyzed the Proposed Amendments for Consistency under the Requirements of the Planning Rules.

Even if the Forest Service believes it can jump over the bar in the consistency regulation that requires the project to conform to the Plan—rather than the Forest Service proposal to conform the Plan to the project—the proposed exemptions from standards, or modifications to impose mitigation, are unlawfully proposed in isolation from other Forest Plan components.

The Forest Plan organizes the resources that are present on the JNF into management prescriptions such as Riparian Corridors. The Plan describes the desired condition for each prescription and establishes goals and objectives to achieve the desired condition. The Forest Management Standards are the measurable directives in the Plan that assure progress toward the

[145] 36 C.F.R. § 219.8(a).
[146] *Id.* § 219.15 (emphasis added).
[147] Revised LRMP Jefferson National Forest, at 2-1, Management Bulletin R8-MB 115A (Jan. 2004).

goals, objectives, and desired condition of Riparian Corridors and Old Growth Forests, and so on.[148]

The Forest Service did not perform an analysis of the effects that eliminating Standards will have on achieving the goals, objectives, and desired condition. The Forest Service proposes to change Plan standards in isolation from other Plan components and without analysis of how these changed Plan standards would affect other Plan components including Forest-wide goals, desired conditions, and objectives, as well as Prescription Area goals, desired conditions, and objectives.

The failure to analyze related Plan components violates the consistency requirements of the Planning Rule.

> Every decision document approving a plan, plan amendment, or plan revision must state whether authorizations of occupancy and use made before the decision document may proceed unchanged. If a plan decision document does not expressly allow such occupancy and use, the permit, contract, and other authorizing instrument for the use and occupancy must be made consistent with the plan, plan amendment, or plan revision as soon as practicable, as provided in paragraph (d) of this section, subject to valid existing rights. . . .
>
> d) Determining consistency. Every project and activity must be consistent with the applicable plan components. A project or activity approval document must describe how the project or activity is consistent with applicable plan components developed or revised in conformance with this part by meeting the following criteria:
> (1) Goals, desired conditions, and objectives. The project or activity contributes to the maintenance or attainment of one or more goals, desired conditions, or objectives, or does not foreclose the opportunity to maintain or achieve any goals, desired conditions, or objectives, over the long term.
> (2) Standards. The project or activity complies with applicable standards.
> (3) Guidelines. The project or activity:
> (i) Complies with applicable guidelines as set out in the plan; or
> (ii) Is designed in a way that is as effective in achieving the purpose of the applicable guidelines (§ 219.7(e)(1)(iv)).
> (4) Suitability. A project or activity would occur in an area:
> (i) That the plan identifies as suitable for that type of project or activity; or
> (ii) For which the plan is silent with respect to its suitability for that type of project or activity.[149]

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[148] Revised LRMP at 2-2.

[149] 36 C.F.R. § 219.15; see also § 219.17(c)("None of the requirements of this part apply to projects or activities on units with plans developed or revised under a prior planning rule until the plan is revised under this part, *except that projects or activities on such units must comply with the consistency requirement of § 219.15 with respect to any amendments that are developed and approved pursuant to this part*.") (emphasis added)).

The Forest Service cannot eliminate riparian standards on some of the steepest, most hazard-ridden mountain sides on the JNF without affecting the desired condition of Riparian Corridors along 3.5 miles through the JNF. The Forest Service did not perform any analysis of whether or how eliminating the riparian standards affects the achievement of desired condition, goals, and objectives for Riparian Corridors, Old Growth, Scenic Integrity, Aquatic Habitat Areas, etc.

However, under provisions of the 2012 Planning Rule and USFS Handbook direction, the Forest Service cannot consider Plan standards in isolation of other Plan components.[150] The consistency provision of 36 C.F.R. Section 219.15, requires all plan components that will be affected by project decisions be addressed.

Neither the DSEIS nor the FEIS have analyzed the proposed project and standard amendments for consistency with relevant plan components. Nor has the DSEIS determined that the proposed Plan Amendment and amended Plan Standards are consistent with Plan and prescription area goals, desired conditions, objectives, and suitability for those types of activities. In fact, far from contributing "to the maintenance or attainment of one or more goals, desired conditions, or objectives, or . . . not foreclose[ing] the opportunity to maintain or achieve any goals, desired conditions, or objectives, over the long term," the MVP project, and the proposed MVP exclusion from meeting the eleven Plan Standards, would make the Plan and prescription area goals, desired conditions, and objectives more difficult to meet and possibly preclude meeting these Plan components. In addition, Plan suitability for types of activities that will be required by MVP have not been addressed.

For example, the Forest Service would amend Standard 6C-026 as follows: "These areas are unsuitable for designation of new utility corridors, utility rights-of-way, or communication sites, with the exception of the Mountain Valley Pipeline right-of-way. Existing uses are allowed to continue." [151] The Forest Service has not performed an analysis of the impact of excepting the MVP from the Old Growth standard on the desired condition for the management prescription. The same type of analysis is required for each and all proposed standard amendments.

Another example of LRMP components that the Forest Service has not analyzed for consistency includes the eligibility of Little Stony and Stony Creeks as Wild and Scenic Rivers.[152] The desired condition for Eligible Recreational Rivers primarily emphasizes "management of the river and river corridor [ ] to protect and enhance the outstandingly remarkable values of that river or river segment. The recreational river corridor provides outstanding opportunities for people to enjoy a wide variety of river oriented recreation opportunities in an attractive setting."[153] The Forest Service has not analyzed the consistency of the MVP with the desired condition for Eligible Recreational Rivers, that is, whether the MVP would diminish those values, potentially making Stony Creek ineligible for designation. The MVP is also inconsistent

[150] FSH 1909.12, § 21.33.
[151] DSEIS, p 21.
[152] Revised LRMP at 4-14.
[153] *Id.* at 3-16.

with management standard 2C3-001: "All management activities within this corridor must be compatible with the outstandingly remarkable values for the River."[154]

Similarly, the Forest Service has failed to address the suitability requirements for project planning in section 219.15(d), and the requirement in section 219.15(e) for the amendment to be consistent with all resource plans developed by the Forest Service that apply to the resources or land areas within the planning area. In cooperation with the U.S. Fish and Wildlife Service, the Forest Service developed, adopted, and agreed to implement the *Federally Listed Threatened and Endangered Fish and Mussel Conservation Plan* (March 2004).[155] The Conservation Plan establishes more protective riparian standards than the standards in the LRMP. There are two streams that are subject to the *Conservation Plan*, which are identified by stream code numbers 0208020108I19 and 0301010101L02, that are impacted by the proposed pipeline route.

The *Conservation Plan* demonstrates that "all the factors contributing to the jeopardized status of Southeastern native freshwater fishes, non-point source pollution (primarily siltation) and alteration of flow regimes (primarily impoundment) are the largest contributors to fish imperilment."[156]

> Fish are directly affected by sedimentation through abrasion on the gills and body surface. They are indirectly affected through reduced visibility for feeding, reduced oxygen in sediment-laden water, substrate alteration for spawning sites, and increased egg mortality (Jenkins and Burkhead 1994). McDougal et al. (2001) state that:
>
> > Sediment is probably the most pervasive nonpoint pollution that affects streams on national forests. Sedimentation is caused by soil erosion from ground-disturbing activities such as roads, poorly designed or nonbuffered land use activities, mining, and construction. Many historic roads on national forest were built in poor locations (i.e. along streams): many of which are still in use today. Sedimentation can negatively affect aquatic ecosystems by reducing habitat complexity and diversity.[157]

The *Conservation Plan* goes on to describe the negative impacts from compaction from vehicles and cattle. The compaction that will occur from pipeline construction far exceeds that from cattle operations.[158]

The *Conservation Plan* succinctly describes the interconnected conservation values of a riparian area. The impacts to these values are not assessed in the DSEIS, particularly with respect to the connectivity analysis requirements in 36 C.F.R. Section 219.8.

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154 *Id.* at 3-17.
155 *Id.* at 2-4; U.S. Fish and Wildlife Serv., *Federally Listed Threatened and Endangered Fish and Mussel Conservation Plan* (March 2004) [Ex. 76].
156 Ex. 76 at 6.
157 *Id.* at 8.
158 *Id.*

> Forests within the Conservation Zone are important because they provide aquatic coarse woody debris recruitment, aquatic particulate and dissolved organic matter input, water temperature and light regulation, bank stability, regulation of sediment, nutrient, and organic matter movement or uptake, and terrestrial habitat for riparian species. They also provide conditions for natural floodplain function. The Conservation Zone will serve as a 1) filter strip to impede surface runoff, trap sediment, and filter and adsorb pollutants, 2) vehicle exclusion zone to prevent major ground disturbance adjacent to stream channels, and 3) shade strip to help maintain ambient stream water temperatures, moist habitats, and sources for large woody debris.[159]

The DSEIS fails to acknowledge the obligations the Forest Service made in partnership with the U.S. Fish and Wildlife Service, which did not address the *Conservation Plan* in its Biological Opinion. And the Forest Service must obtain authorization from the U.S. Fish and Wildlife Service to be allowed to violate the *Conservation Plan*.

The required consistency analysis that has not been performed impossibly directs the Forest Service to amend the Endangered Fish and Mussel Conservation Plan if necessary. This aspect of the consistency requirements alone reinforces the initial direction of the consistency requirements where "if a plan decision document does not expressly allow such occupancy and use, the permit, contract, and other authorizing instrument for the use and occupancy must be made consistent with the plan, plan amendment, or plan revision" rather than making the plan conform to the harm caused by the project. [160]

Given that the Forest Service properly admits that "the Plan amendment may result in substantial, adverse environmental effects to the utility corridor management area and several resources including soil; riparian; water; threatened and endangered species; old growth; the ANST; and scenic integrity,"[161] the Forest Service cannot propose to amend management standards without also preforming the required consistency analyses.

C. The Forest Service Inconsistently Identifies the Related Substantive Requirements of the Planning Rule Without Rationale for the Determination of Which Substantive Requirements Apply.

Even if the Forest Service can legally weaken the plan for the construction of a privately owned gas pipeline and limit its analysis to just the proposed changes to certain forest management standards, the Forest Service inconsistently identifies the related planning factors within the DSEIS, and different from the Notice of Intent, without rationale. The Forest Service identifies the related planning factors ("substantive requirements") in various sections of the DSEIS. The lists in within the DSEIS differ, and they differ from the list in Notice of Intent. The Forest Service does not include a rationale for changing the planning factors.

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159 *Id.* at 10.
160 36 CFR § 219.15(e).
161 DSEIS at 12–13.

> "The responsible official must provide early notice to the public of which substantive requirements are likely to be directly related to the amendment, and must clearly document the rationale for the determination of which substantive requirements apply and how they were applied as part of the decision document."[162]

The substantive Planning Rule provisions identified in the NOI as *likely* to be directly related to the amendments are: § 219.8(a)(1) (terrestrial ecosystems); § 219.8(a)(2)(ii) (soils and water productivity); § 219.8(a)(2)(iv) (water resources); § 219.8(a)(3)(i) (ecological integrity of riparian areas); § 219.9(b) (contributions to recovery of threatened and endangered species); § 219.10(a)(3) (utility corridors); § 219.10(b)(1)(vi) (other designated areas); § 219.10(b)(1)(i) (scenic character); and § 219.11(c) (timber harvesting for purposes other than timber production)."[163]

The Forest Service identifies this same list of substantive requirements as "likely to be directly related" on pages 7–8 of the DSEIS. Then on page 96, the Forest Service lists a different set of substantive provisions that "*are* directly related" to the amendments. The list on page 96 more limited: "219.8(a)(2)(ii) –Soils and soil productivity; 219.8(a)(3)(i) –Ecological integrity of riparian areas; 219.8(b)(3) –Multiple uses that contribute to local, regional, and national economies; 219.9(a)(2) –Ecosystem diversity of terrestrial and aquatic ecosystems; 219.10(a)(3) –Utility Corridor; 219.10(b)(i) –Sustainable recreation, including recreation setting, opportunities, access, and scenic character; 219.10(b)(vi) –Other designated areas or recommended designated areas; and 219.11(c) –Timber harvest for purposes other than timber production."

Assuming that the Forest Service listing of §§ 219.10(b)(vi) and 219.10(b)(i) on page 96 are meant to refer to §§ 219.10(b)(1)(vi) and 219.10(b)(1)(i) as listed on pages 7-8, the Forest Service does not include the requirements for "§ 219.8(a)(2)(iv) (water resources)," "§ 219.8(a)(1) (terrestrial ecosystems)," or "§ 219.9(b) (contributions to recovery of threatened and endangered species)" in the analysis even though the Forest Service identifies these requirements as "likely to be directly related" earlier in the DSEIS. The final list also adds Section 219.8(b)(3).

The only "rationale"[164] offered by the Forest Service for the difference in the applicable substantive requirements is that the changes are "based on subsequent analysis and addressing of the substantive requirements based on 36 CFR 219.10."[165] Without any "rationale for the determination of which substantive requirements apply"[166], even this flawed identification of the applicable substantive requirements violates the Planning Rule.

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[162] 81 Fed. Reg. 90726 (December 15, 2016).
[163] 85 Fed. Reg. 45864 (June 30, 2020).
[164] 81 Fed. Reg. 90726 (December 15, 2016) ("The responsible official … and must clearly document the rationale for the determination of which substantive requirements apply and how they were applied as part of the decision document.")
[165] DSEIS, 97.
[166] 81 Fed. Reg. 90726 (December 15, 2016).

D. The Assessment of the Substantive Requirements Fails to Address the Overarching Purpose to Provide for Sustainability and the Maintenance and Restoration of Soil and Water Resources.

After identifying applicable requirements, the DSEIS addresses each substantive requirement in the Planning Rules identified on page 96 of the DSEIS in the context of the proposed amendments.[167] The Forest Service misses the forest for the trees.

Four of the proposed amendments to the standards would exempt MVP from performing to the standard: FW-248, Standard 6C-007, Standard 6C-026, Standard 4A-028. Six of the proposed amendments would exempt MVP from performing to the standard and instead require implementation of the "approved POD and MVP design requirements": FW-5, FW-8, FW-9, FW-13, FW-14, and Standard 11-003. For FW-184, MVP would be allowed an extended time period for achieving compliance with the existing standard.

Again, these are the forest management standards that are designed to achieve the goals, objectives, and desired conditions set forth in the Forest Plan. Exempting the MVP from compliance with standards may have consequences to the achievement of relevant Forest Plan components, but the Forest Service has not analyzed the potential for consequences, otherwise known as plan consistency, which is the subject of other comments herein.

Similarly, the Forest Service avoids the direction and intent of the sustainability component in the Planning Rules in 36 C.F.R. Section 219.8 where DSEIS addresses each subsection of the regulation in isolation from the others, and without addressing the overarching purpose of the requirements which is to provide for sustainability. Section 219.8 requires more:

> A plan developed or revised under this part must provide for social, economic, and ecological sustainability within Forest Service authority and consistent with the inherent capability of the plan area, as follows:
>
> (a) Ecological sustainability.
>
> (1) Ecosystem Integrity. The plan must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity, taking into account:
>
> (i) Interdependence of terrestrial and aquatic ecosystems in the plan area.
>
> (ii) Contributions of the plan area to ecological conditions within the broader landscape influenced by the plan area.
>
> (iii) Conditions in the broader landscape that may influence the sustainability of resources and ecosystems within the plan area.
>
> (iv) System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability

167 DSEIS, 96-103.

of terrestrial and aquatic ecosystems on the plan area to adapt to change.
(v) Wildland fire and opportunities to restore fire adapted ecosystems.
(vi) Opportunities for landscape scale restoration.

(2) Air, soil, and water. The plan must include plan components, including standards or guidelines, to maintain or restore:

(i) Air quality.
(ii) Soils and soil productivity, including guidance to reduce soil erosion and sedimentation.
(iii) Water quality.
(iv) Water resources in the plan area, including lakes, streams, and wetlands; ground water; public water supplies; sole source aquifers; source water protection areas; and other sources of drinking water (including guidance to prevent or mitigate detrimental changes in quantity, quality, and availability).

(3) Riparian areas.

(i) The plan must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity, taking into account:
(A) Water temperature and chemical composition;
(B) Blockages (uncharacteristic and characteristic) of water courses;
(C) Deposits of sediment;
(D) Aquatic and terrestrial habitats;
(E) Ecological connectivity;
(F) Restoration needs; and
(G) Floodplain values and risk of flood loss.
(ii) Plans must establish width(s) for riparian management zones around all lakes, perennial and intermittent streams, and open water wetlands, within which the plan components required by paragraph (a)(3)(i) of this section will apply, giving special attention to land and vegetation for approximately 100 feet from the edges of all perennial streams and lakes.
(A) Riparian management zone width(s) may vary based on ecological or geomorphic factors or type of water body; and will apply unless replaced by a site-specific delineation of the riparian area.
(B) Plan components must ensure that no management practices causing detrimental changes in water temperature or chemical composition, blockages of water courses, or deposits of sediment that seriously and adversely affect water conditions or fish habitat shall be permitted within the riparian management zones or the site-specific delineated riparian areas.

> (4) Best management practices for water quality. The Chief shall establish requirements for national best management practices for water quality in the Forest Service Directive System. Plan components must ensure implementation of these practices.
>
> > (b) Social and economic sustainability. The plan must include plan components, including standards or guidelines, to guide the plan area's contribution to social and economic sustainability, taking into account:
> > (1) Social, cultural, and economic conditions relevant to the area influenced by the plan;
> > (2) Sustainable recreation; including recreation settings, opportunities, and access; and scenic character;
> > (3) Multiple uses that contribute to local, regional, and national economies in a sustainable manner;
> > (4) Ecosystem services;
> > (5) Cultural and historic resources and uses; and
> > (6) Opportunities to connect people with nature.

The purpose of this part of the planning directives is to provide for sustainability. The only instances in the DSEIS where the word sustainability is used is in quoting the purpose of this part of the regulation. The Forest Service has not addressed how the proposed amendments to the Forest Plan standards provide for the ecological sustainability of the enumerated factors in the regulation, which is the base requirement of this planning component.

Citizens have long described impacts that are interrelated, such as the effects of disrupting the hydrology on the slopes to the disconnected water regime and the aquatic species supported in those regimes. However, the Forest Service never addresses these components of sustainability.

Furthermore, the purpose of the substantive requirements for addressing soils and soil productivity, water quality, water resources is to provide for the maintenance and restoration of these resources which the Forest Service has not addressed in the DSEIS. As commented herein, the imposition of riparian standards is mandatory and the Forest Service has no authority to waive them, and certainly has not addressed the enumerated factors in 219.8(a)(3).

The Forest Service denies that there is karst geology on the national forest lands[168] even though the east side of Brush Mountain is documented to be comprised of a unique karst complex[169] and the construction corridor on the west side of Sinking Creek Mountain has been documented as being comprised of sink holes and caves.[170] Karst geology flanks the portions of the route through the national forest and yet the Forest Service has not addressed the ecosystem integrity, interdependence, and connectedness of sink holes and caves to water resources and the species that may be associated with those resources.

168 FEIS, p 4-135.
169 *See* Comments submitted by Linda Parsons Sink [Ex. 77].
170 *See* Mountain Valley Watch Report [Ex. 78].

The Forest Service must anticipate that karst features may be discovered because the project components include a karst mitigation plan in Appendix L to the POD. The Sink family's land, which is on the east side of Brush Mountain, downslope from the JNF boundary, has been the subject of this so-called karst mitigation plan for two years and the karst mitigation plan is a complete failure.[171]

The LRMP includes a standard for the protection of sinkholes and caves that has not been proposed for amendment. Standard FW-63 requires that "[a] minimum of 200 foot buffers are maintained around cave entrances, sinkholes, and cave collapse areas known to open into a cave's drainage system. There are no soil-disturbing activities or harvest of trees within this buffer."[172] Therefore, the Forest Service must enforce this standard in the construction process.

The Forest Service does not recognize or address the base requirement of sustainability and the purpose of the sustainability components, which is to maintain and restore ecological functions. The Forest Service cannot set aside the directives in the Planning Rules "to lessen requirements protecting soil and riparian resources so that the pipeline project could meet those requirements."[173]

E. The Proposed Forest Plan Amendment Is Inconsistent with Forest Plan Direction for Management to Protect the Orangefin Madtom.

The DSEIS states: "The orangefin madtom is currently under review for federal listing under the ESA and is considered a state-threatened species in Virginia. The orangefin madtom was considered in the 2017 BE resulting in a **May Impact Individuals – Is Not Likely to Cause a Trend Toward Federal Listing or Loss of Viability** determination. While the species is known to occupy the Upper James River and Upper Roanoke River subbasins, no collection records for the species exist in the Trout Creek-Craig Creek or Dry Run-North Fork Roanoke River subwatersheds."[174]

Regardless of whether there are collection records for the Orangefin Madtom in Upper Craig Creek, the LRMP designates Upper Craig Creek as a priority watershed for the habitat of the Orangefin Madtom. When the Forest Plan was revised in 2004, "priority watersheds were selected because they either have a below average Watershed Condition Ranking (WCR), impaired stream segments (Table 2-1) or outstanding aquatic biodiversity (Table 2-2).[175] Then in Table 2-2, Upper Craig Creek is identified as a priority watershed which possesses Outstanding Biodiversity for the presence of the Orangefin Madtom.

The Forest Service proposal is inconsistent with LRMP in regard to its duty to manage a priority watershed. The LRMP describes its planning objectives for priority watersheds on page 2-4:

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[171] *See* Ex. 77.
[172] Revised LRMP at 2-20.
[173] DSEIS at 19.
[174] Revised LRMP at 79.
[175] Revised LRMP at 2-2 to 2-3 (footnote omitted).

> Within these watersheds, we will seek opportunities for dialog with adjacent private landowners and work collaboratively with local governments and other Federal government agencies to restore water quality or maintain and restore aquatic habitat. In addition to identification of these priority watersheds, the Forest has developed a Federally Listed Fish and Mussel Conservation Plan in collaboration with the U.S. Fish and Wildlife Service, and continues to work with the Virginia Department of Game and Inland Fisheries to protect and recover federally listed and sensitive aquatic species.
>
> Priority Watershed activities will include: 1) public education and awareness; 2) new partnerships and coordinating efforts; 3) information collection through monitoring and research; 4) establishment of plans and priorities; 5) funding and technical assistance; 6) implementation of solutions; and 7) evaluation of results.[176]

As argued herein, the Fish and Mussel Conservation Plan has been unlawfully set aside by the Forest Service in the impact analysis process. Landowners are not likely to be persuaded to work with the Forest Service to conserve the Orangefin Madtom if the Forest Service amends the LRMP as proposed and the MVP is permitted to continue to impact Craig Creek and its tributaries. The fact is that the Forest Service has not analyzed the ability to achieve the Forest Plan objectives for the Orangefin Madtom or considered whether amending the Forest Plan as proposed would cause an irretrievable commitment of resources, in violation of NEPA.[177]

F. The Forest Service Omitted Applicable Standards from Amendment.

The DSEIS does not include any rationale for the decision on which standards would be violated and therefore need to be amended to make the LRMP comply with the harms caused by the MVP. The Forest Service omitted the following standards from consideration of potential amendment of the LRMP:

- FW-2: Locate all facilities (e.g. trails, trail shelters, restrooms, designated campsites, etc.) in a manner that minimizes the possibility of contamination of water sources. Educate users on “leave no trace” camping practices, including sanitation practices that minimize the potential for contamination of water sources.
- FW-3: Prior to authorizing or re-authorizing new or existing diversions of water from streams or lakes, determine the instream flow or lake level needs sufficient to protect stream processes, aquatic and riparian habitats and communities, and recreation and aesthetic values.
- FW-4: Water is not diverted from streams (perennial or intermittent) or lakes when an instream flow needs or water level assessment indicates the diversion would adversely affect protection of stream processes, aquatic and riparian habitats and communities, or recreation and aesthetic values.
- FW-6: Locate and design management activities to avoid, minimize, or mitigate potential erosion.

[176] Revised LRMP at 2–4.
[177] 40 CFR § 1502.16.

- FW-14: Up to 50% of the basal area may be removed down to a minimum basal area of 50 square feet per acre. Removal of additional basal area is allowed on a case-by-case basis when needed to benefit riparian-dependent resources.
- FW-17: The removal of large woody debris is allowed if it poses a risk to water quality, degrades habitat for aquatic or riparian wildlife species, impedes water recreation (e.g. rafting), or when it poses a threat to private property or Forest Service infrastructure (e.g. bridges). The need for removal is determined on a case-by-case basis.
- FW-20: When crossing channeled ephemeral streams, culverts, temporary bridges, hardened fords, or corduroy are used where needed to protect channel or bank stability.
- FW-21: Construction of crossings is completed on all channeled ephemerals as soon as possible after work has started on the crossing. Permanent and temporary roads on either side of crossings within the channeled ephemeral zone are graveled.
- FW-33: Potential black bear den trees will be retained during all vegetation management treatments. Potential den trees are those that are greater than 20” diameter breast height. Potential den trees also include those that are hollow with broken tops or those with limbs greater than 12 inches diameter broken near the bole of the tree.
- FW-35: Control non-native invasive species where they are causing negative effects to threatened, endangered, or sensitive species. Do not intentionally introduce non-native species that are known or suspected of causing negative effects to federally listed threatened and endangered species in or near sites supporting these species.
- FW-41: Known occurrences of Virginia spirea, small-whorled pogonia, northeastern bulrush, and Virginia round-leaf birch are allocated to Management Prescriptions 4D or 9F to ensure protection and maintenance of their current populations and surrounding habitat conditions.
- FW-214: Locate and design facilities and management activities to avoid, minimize, or mitigate negative effects on geologic resources with identified values (scientific, scenic, paleontologic, ecological, recreational, drinking water, etc.).
- FW-46: In order to promote potential summer roost trees and maternity sites for the Indiana bat throughout the Forest, planned silvicultural practices in hardwood-dominated forest types will leave all shagbark hickory trees greater than 6 inches d.b.h.3 and larger, except when they pose a safety hazard. In addition:
  - Clearcut openings 10 to 25 acres in size will also retain a minimum average of 6 snags or cavity trees per acre, 9 inches d.b.h. or larger, scattered or clumped.
  - Group selection openings and clearcuts less than 10 acres in size have no provision for retention of a minimum number of snags, cavity trees, or residual basal area due the small opening size and safety concerns.

  All other harvesting methods (and clearcut openings 26-40 acres in size) will retain a minimum residual 15 square feet of basal area per acre (including 6 snags or cavity trees) scattered or clumped. Residual trees are greater than 6 inches d.b.h. with priority given to the largest available trees, which exhibit characteristics favored as roost trees by Indiana bats.
- FW-75: “In order to maintain future restoration opportunities, do not cut live Carolina hemlock. Exceptions may be made to provide for public safety, protection of private resources, insect and disease control, or research.”

- FW-76: During silvicultural treatments, retain all live butternut with more than 50% live branches. Record the approximate location of these trees and notify the Forest Silviculturist.

VII. THE DSEIS FAILS TO ADEQUATELY ASSESS IMPACTS OF NEW INFORMATION AND CHANGED CIRCUMSTANCE ON LANDS OUTSIDE THE JNF BOUNDARIES.

The DSEIS for the proposed Mountain Valley Pipeline project through 3.5 miles of National Forest lands on the JNF is insufficient and misleading with regard to impacts that must be accounted for in the Forest Services' decision on whether to amend the JNF Forest Plan standards. The July 30, 2020 announcement of the Forest Service [action] specifies the need to apply Forest Service Planning Rule requirements to resolve Court-identified NFMA issues[178] and NEPA deficiencies.[179] The Forest Service 2020 DSEIS inadequately addresses these issues and deficiencies as they pertain to impacts on land and resources outside JNF boundaries, and this inattention overlooks serious problems with MVP's 2020 Plan of Development.

The Forest Service fails to fulfill its obligation to assess the impacts of its decision and plan amendments on land and water resources *outside* the JNF, including critical aquatic habitats for threatened and endangered species.

(*Note: Throughout this section, underlining of text in quoted material has been added for emphasis.)*

According to Forest Service Planning Rule requirements and directives, the decisions and actions of the Forest Service must consider the impacts of those decisions on non-JNF land and shared watersheds. For example:

- The National Forest System Land Management Planning regulation 36 CFR 219.8(a)(1)(ii) states that considerations of a new or revised plan should include: "Contributions of the plan area to ecological conditions <u>within the broader landscape influenced by the plan area.</u>"
- The USFS 2012 Planning Rule Final Directives state: "Watersheds relevant to the plan <u>should include those lands outside the National Forest System</u> that contribute surface or subsurface water flows to the plan area, and those that receive surface of subsurface water frow the plan area. Groundwater-dependent ecosystems should also be considered."

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[178] The July 30, 2020 Federal Register announcement of the FS states: "To resolve the Court's NFMA issues, there is a need, at a minimum, to apply FS Planning Rule requirements to soil and riparian resources and evaluate both the purpose and the effects of the amendment to threatened and endangered aquatic species, consistent with 36 CFR 219.13(b)(5)."

[179] The announcement further states: "The Court also identified NEPA deficiencies. There is a need for the FS, at a minimum, to demonstrate that an independent review of the sedimentation analysis has occurred, that predicted effects are supported with rationale, and that previous concerns and comments related to erosion and its effects have been satisfied. To meet this objective, there is a need to evaluate and assess erosion, sedimentation, and water quality effects in relation to anticipated mitigation effectiveness."

Also directing that particular attention should be paid to "the influence on aquatic species at risk … in proximity to the area of analysis."[180]

- The Revised JNF LRMP lists Stony Creek in its discussion of Aquatic Habitat Areas in the JNF. Its description of Desired Conditions includes: "Forest management activities within these areas are designed to protect habitat for threatened, endangered, and sensitive fish and mussels in streams adjacent to, or immediately downstream from, National Forest System lands."[181]

In its description of the Scope of Analysis for the DSEIS, the Forest Service claims that "effects related to the Court-identified deficiencies, changed circumstances or new information, and which result from actions occurring on NFS lands, including those effects off NFS lands resulting from actions on NFS lands, are addressed in this SEIS."[182]

Instead of complying with these directives and guidelines, however, the DSEIS ignores or dismisses significant impacts beyond its borders. This section focuses on the portion of the JNF on the Virginia side of Peters Mountain. Other adjacent lands have also received inadequate analysis and quantification of impacts, including impacts to water resources such as Craig Creek in Virginia and the Rich Creek Cave and Spring in West Virginia, impacts to Wilderness areas on Peters and Brush Mountain, and impacts to private lands.

Failures of the DSEIS with regard to Peters Mountain impacts in Virginia: The MVP route travels through about 1.65 miles of the JNF on Peters Mountain in Virginia, directly affecting Kimballton Branch and other tributaries of Stony Creek, which the MVP crosses below the JNF at about MP 200.4.

1. **The DSEIS fails to adequately assess the proposed changed circumstance to discontinue use of FR#92 Pocahontas Road** in terms of its negative impacts, including but not limited to erosion and sedimentation impacts, on areas within the JNF sphere of influence.

2. **The DSEIS fails to adequately assess recent new information provided in the 2020 US Fish and Wildlife Biological Opinion (BiOp)** regarding the recent designation of the candy darter as an endangered species and the identification/designation of Stony Creek as critical aquatic habitat for the candy darter.

The following sections address these failures and deficiencies in more detail.

A. The DSEIS Fails to Assess Negative Impacts in Affected Off-Forest Service Land, Including Erosion and Sedimentation Impacts, of the Proposed Changed Circumstance to Discontinue Use of FR#92 Pocahontas Road as an Access Road.

[180] FSH 1909/12 – Land Management Planning Handbook, chapter 10 – the Assessments: 12.23 – Assessing Watersheds and Water Resources.

[181] JNF Land Resource Management Plan, Chapter 3 9A4 – Aquatic Habitat Areas (revised JNF LRMP p. 3-163).

[182] DSEIS at 12.

1. Background

Pocahontas Road was included as an access road in the original FEIS and in the 2017 ROD of the Forest Service. During public comment periods preceding those decisions, ICWA and many others warned of the significant erosion and sedimentation vulnerabilities of that curving 5.5-mile access route through the JNF across the steep slopes of Peters Mountain.

Despite those warnings, MVP and the Forest Service and FERC apparently determined that Pocahontas Road was the best alternative to transport equipment and personnel to the JNF ROW, including equipment and materials to complete a proposed 600-foot bore underneath the Appalachian National Scenic Trail (ANST) at the top of Peters Mountain. The inclusion of the Pocahontas access road was a significant factor in the decision by the Forest Service so that it could accommodate the current MVP route over Peters Mountain. Did MVP and the FERC consider alternatives? Was the current proposed alternate evaluated in 2017?

The Geosyntec Report that was commissioned by MVP as the Court-ordered "independent" hydrological analysis of sedimentation and issued on May 8, 2020, includes access use of the Pocahontas Road in its analysis. Subsequent to issuance of the Geosyntec Report, the MVP Plan of Development (POD) dated July 31, 2020, and the 2020 DSEIS dated September 2020 state that MVP has now determined that it can abandon the JNF Pocahontas Road in favor of a public road access to the ROW.

As described in the POD at Section 6.5 Access to and Along Right-of-Way during Construction, all MVP traffic to the JNF ROW – including construction and operation equipment and personnel – would shift to a new transport access route.

> Construction and operations traffic will not be permitted to use FR# 972 Pocahontas Road, FR#11080 Mystery Ridge Road, or FR#188 Brush Mountain Road. Mountain Valley construction and operation personnel and equipment will be required to access the ROW via crossings from public roads. … Mountain Valley will utilize several ROW access points from Rogers Road on the south side of Peters Mountain. Equipment will travel the ROW from Rogers Road onto JNF lands.[183]

The DSEIS irresponsibly claims that it can reduce the MVP's projected impacts to the JNF simply by making this change:

> Removing Pocahontas and Mystery Ridge roads from the proposed action is a reduction of 12 stream crossings compared to the FERC FEIS (FERC FEIS Table 4.3.2-9). This changed condition would eliminate project-related effects on water resources from the use of NFS roads and result in a reduction of hydrological effects compared to those identified and analyzed within the FERC FEIS. Therefore, further assessment of project access roads is not considered to be necessary.[184]

Lost in this analysis is the fact that erosion and sedimentation impacts have already been caused

[183] Plan of Development, at 6-26, Mountain Valley Pipeline Project (July 31, 2020).
[184] DSEIS at 68.

by preparation and use of Pocahontas Road and Mystery Ridge Roads as access roads for tree-cutting and other MVP teams between January and July 2017. Also ignored is that new impacts to Kimballton Branch and Stony Creek, including areas within the JNF, will now significantly increase along the proposed new access route, which uses Rogers Road and a segment of the MVP ROW that is closely bordered by JNF land on both sides for more than a half mile.

The decision to substitute a public road/private land access route for Pocahontas Road does not eliminate impacts. It shifts them barely outside the JNF boundary but not outside the JNF's shared watersheds and area of influence. The Forest Service has an obligation to undertake a careful and cumulative assessment of those impacts in determining whether the proposed action is an acceptable alternative.

2. **Description of the Rogers Road-ROW Access/Transport Route that will replace Pocahontas Road.**

A closer look at maps and MVP construction plans reveals that the Rogers Road-ROW Access/Transport Route has significant environmental and safety challenges.

- Rogers Road is a short public road that parallels Kimballton Branch just before Kimballton enters Stony Creek. Exhibit 1, an annotated map of the area, shows the Rogers Road access to the ROW, its relation to the JNF boundary and other details of the affected area. The route along the ROW itself is approximately one mile from the upper Rogers Road access point to where the ROW enters the JNF. From the access point to the main road at the bottom of Kimballton Branch is another 0.6 mile.
- For more than a half-mile of this transport route on the ROW, winches will be required to transport pipes, construction equipment, materials and personnel over steep slopes that range up to 74%, according to MVP's Detail Figures for Construction Techniques and Average Slopes from MVP-POD Appendix B (see Exhibit 2). Typically, a segment like this would be completed and restored as quickly as possible to minimize environmental impacts. As the only access route to the JNF ROW, however, this section will need to remain open for transport and travel during the entire JNF construction – and according to the POD, also during restoration and operation of the pipeline itself.
- This use of the ROW will significantly reduce (if not eliminate) the ability of construction crews to properly install and maintain water bars across the slope -- the primary ESC "best management practice" for steep slopes – and significantly increase soil disturbance and compaction.
- How long will this ROW be used as an Access/Transport Route? To date, trees have been felled but not cleared on the JNF ROW on Peters Mountain and no pipes have been transported to the area. No time estimate has been given for a 600-foot bore under the Appalachian National Scenic Trail (ANST) on the top of Peters Mountain.
- The DSEIS states: "Multiple passes by equipment used in the initial phases (i.e., tree clearing, vegetation removal, topsoil stripping, and pipe stringing) contributed a substantial portion of the overall effects on soil resources."[185] This section will suffer

[185] *Id.*

sustained heavy equipment traffic for an undetermined length of time, with water bars in a constant state of "reinstallment".

- Kimballton Branch is singled out for mention in its own section of MVP's Landslide Mitigation Plan: *Section 10.2, Debris Flow Potential along Kimballton Branch.* "Debris flows are a type of mass movement comprised of soil and rock … often associated with steep gullies and may be triggered by significant precipitation events. …During construction, an engineering geologist or geotechnical engineer familiar with debris flows will evaluate the area and will be present during pipeline construction to observe the trench and earth materials." [186] Yet there is no mention of debris flow potential associated with Kimballton Branch in the DSEIS.

3. Hazards and impacts of the alternate ROW Access/Transport Route not addressed or assessed by JNF's DSEIS.

The DSEIS fails to assess the increased negative impacts that result from the decision to shift activity off the JNF. These impacts include, but are not limited to, erosion and sedimentation impacts to Kimballton Branch and Stony Creek not addressed in the DSEIS nor properly assessed in the "Hydrologic Analysis of Sedimentation for the Jefferson National Forest, Report Findings" prepared for MVP by Geosyntec Consultants as a supporting document to the DSEIS.

Significant hazards and impacts that need rigorous cumulative assessment include:

- The feasibility of maintaining a transport corridor on the non-JNF and JNF portions of the ROW.
    - This means of construction access appears to be in contrast with the erosion and sediment control plan for Virginia (Plan of Development, Appendix C-2) and Geosyntec's Hydrologic Report, both of which describe placement of water bars across the right-of-way in areas where the corridor is running perpendicular to landscape contours (meaning up and down the slope), which is the case of the vast majority of ROW within the JNF. The corridor cannot be used for construction access with water bars in place. Hence, water bars must be removed, at least partially, to allow for traffic when the corridor is in use for construction access. Since the water bars are a primary erosion-and-sedimentation control device, that essential control will be lacking during times when the corridor is in use for construction access.
    - Since the pipeline corridor would be the primary means for construction throughout the JNF, this means that there will either be frequent instances (daily in many places) of water-bar removal at the beginning of the work day and replacement of the workday and/or nights when the corridor will be left without the protection of water bars. Under this circumstance, the rapid or unexpected onset of a heavy rain, or decisions to continue working during times when heavy rain is expected with the intent of taking action immediately before its onset, will risk excessive erosion and sedimentation events should rain come before the site has been evacuated so that water bars can be replaced.

[186] MVP POD Appendix F at F-28.

- o Three of six "High Hazard Priority Sites" identified in the 2017 DSEIS documents and included in the 2020 POD Appendix G are located along this access route. (See Exhibit for site map and slope figures.) In a hydrogeological report assessing the Forest Service DSEIS and the Geosyntec Report Findings, licensed professional geologist Pamela Dodds, Ph.D., directly addresses the issue of using this portion of the JNF ROW for transport:

  > High Hazard Priority Sites #1 and #4 are located upgradient of the access road parallel to Kimballton Branch to be used for continuous traffic on the MVP ROW. The heavy traffic and heavy equipment traversing the MVP ROW will degrade the diversions/waterbars because diversions/waterbars are intended for use where there is minimal traffic. The heavy traffic will cause erosion of the diversions/waterbars. Although the diversions/waterbars direct water flow away from the MVP ROW, the water still flows outside of the ROW/LOD toward receiving streams, transporting sediment laden water to the receiving streams. Kimballton Branch will receive sediment laden water both at the headwater area near High Hazard Priority Site #3 and also at the lower segment of Kimballton Branch, which flows into Stony Creek, known for sustaining the Threatened and Endangered Candy Darter. Failure of the dewatering mitigation will result in more sediment laden stormwater being transported to Kimballton Branch and Stony Creek, causing greater embeddedness and thereby impacting the Candy Darter. The Candy Darter must have free flowing water through the pebbly/cobbly stream substrate in order to have its needed habitat for feeding on macroinvertebrates and also surfaces for laying eggs as well as protective hiding areas for juveniles.[187]

- Significantly increased construction activity on Rogers Road along Kimballton Branch and close to Stony Creek leading to pollution from fuel spills and intensive use of refueling areas, mud, dirt, dust, etc.
- Safety for construction personnel and inspectors requiring daily transport up this route, as well as for the Rogers Road neighborhood due to significantly increased construction traffic.
- Increased degradation of Stony Creek's critical aquatic habitat for the endangered candy darter, as discussed more fully in the Section 2.
- Viability of the alternate route for indefinite use, including potentially extended delays caused by construction difficulties, coronavirus-related restrictions, loss of required permits or other unforeseen events.

4. Importance of a thorough assessment of all relevant impacts and potential problems.

The Forest Service must assess all relevant impacts and potential problems of this ROW Access/Transport Route change so that MVP cannot fall back on variances that cancel out the environmental benefits claimed to justify the proposal.

MVP has a record of requesting variances to restrictions and plans that were part of the original Certificate – restrictions and plans that were part of the FEIS and which the FERC

[187] Ex. 6 at 28.

assured the public would help minimize negative impacts. Protect Our Water, Heritage, Rights (POWHR), a coalition of community groups in Virginia and West Virginia, has been tracking all MVP variance requests. As described in a June 2020 report:

> Through the process of formal and in-field variances, MVP has been allowed to drastically alter the permitted project from what was originally approved by FERC in 2017. The 281 total variances submitted as of June 12, 2020 allow the company to expand the scope of their construction on a whim and circumvent vacated and suspended permits, and swift FERC approval prevents any other project stakeholders from getting a chance to provide information on the project as it changes. … Along the MVP, it is apparent that variances are being used to push the project forward at all costs, in a manner that is constantly enabled by the process at FERC.[188]

The original FEIS (upon which the Forest Service relied) did not include an assessment of this proposed change and its potential negative effects on JNF-related land. Therefore, the JNF must complete that analysis or the FERC must undertake a supplemental EIS.

If this route has so many advantages, why was it not considered and adopted in the original FEIS and the 2017 POD? In fact, there are serious problems with this alternative solution.

B. The DSEIS Fails to Adequately Assess Effects of MVP Pipeline Construction on Federally Listed Aquatic Species as Provided in the 2020 U.S. Fish and Wildlife Biological Opinion (BiOp).

The DSEIS acknowledges its responsibility to address "effects off NFS lands resulting from actions on NFS lands" and includes new information on Federally Listed Aquatic Species, including the Candy Darter. The DSEIS states: **"**This SEIS is narrow in scope to address only those aspects of the proposed pipeline within the JNF. Actions outside of NFS lands are beyond the jurisdiction of the Forest Service and the BLM, and thus, are covered within the FERC FEIS. <u>However, effects related to the Court-identified deficiencies, changed circumstances or new information, and which result from actions occurring on NFS lands, including those effects off NFS lands resulting from actions on NFS lands, are addressed in this SEIS</u>."[189]

Included among the new information listed in the DSEIS 1.7 Scope of Analysis discussion are:

- New information regarding the candy darter *(Etheostoma osburni).* In December 2018, the candy darter was listed as endangered under the Endangered Species Act by the U.S. Fish and Wildlife Service (FWS).
- Change in potential effects to 12 species and to the mitigation measures and/or requirements that are part of the FWS BO.

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[188] *Report on MVP Variances through FERC*, at 4, Protect Our Water, Heritage, Rights (POWHR) (June 12, 2020) [Ex. 78].
[189] DSEIS at 12.

- Update of the 2017 cumulative effects analysis to reflect a change in status or the addition of new projects that are reasonably foreseeable within the watersheds affected by the proposed pipeline.
- FWS issued a new BO for the project on September 4, 2020.[190]

The DSEIS also includes new information that lists the Candy Darter as federally endangered with proposed Critical Habitat, Likely to be Adversely Affected. Section 3.4.3.2 Environmental Consequences**,** under the Proposed Action, includes "Table 8. Determination of Effects for Aquatic ESA Listed Species" lists the effects for the candy darter determined by the July 9, 2020 FWS Consultation Letter as: *May Affect, Likely to Adversely Affect; May Affect; Likely to Adversely Affect Proposed Critical Habitat.*[191] The same section includes the description of the change in status of the Candy Darter:

> Candy Darter (*Etheostoma osburni*)
> At the time of the 2017 FERC FEIS and BA, the candy darter was not federally listed but was proposed for ESA listing. Formal Conferencing was requested, and it was determined that the action was not likely to jeopardize the species. Since that time, the species has been listed as federally endangered with proposed Critical Habitat.[192]

In acknowledgement of the need to protect the habitat of the Candy Darter, the DSEIS states, "The candy darter, however, does not occur on JNF lands but may occur downstream in watersheds that overlap with the JNF."[193]

On September 4, 2020, the U.S. Fish and Wildlife Service (FWS) issued a Biological Opinion and Conference Opinion for the Mountain Valley Pipeline Project (BiOp). That government agency document is available on the FERC Docket CP16-10 Accession No. 20200904-3027.

According to this FWS 2020 BiOp:

- "**Presence/absence surveys for Candy Darter were not conducted for the proposed action. Candy Darter presence is assumed throughout Stony Creek and the Gauley River within the action area."** (p. 72)
- The Candy Darter populations in Stony Creek and the Gauley River "are considered to be among the most genetically pure populations….This gives added importance to these particular populations for the future conservation and recovery of the species." (p. 74)
- Candy Darters "are generally intolerant of excessive stream sedimentation and resulting cobble embeddedness." (p. 49)
- The FWS "anticipate[s] adverse effects to CD from upland sediment contribution" in both Stony Creek and the Gauley River. (p. 73)

[190] *Id.* at 12.
[191] *Id.* at 73.
[192] *Id.* at 73–74.
[193] *Id.* at 77.

The BiOp warns of the effects of MVP construction activities on the Candy Darter:

- Increased sedimentation/turbidity and increased embeddedness will, or is expected to occur as a result of MVP construction activities such as clearing, grading, trenching, access roads and right of way repairs and will affect Stony Creek. (p.137)
- According to the BiOp, even under the best of circumstances, pipeline construction will result in an increase in sedimentation with potential effects on the population of Candy Darters as the FWS "assumes effects to benthic invertebrates in aquatic areas that receive significant increased sedimentation as a result of the MVP will persist for up to 4 years." (p.139)
- Candy Darters "have a relatively short life cycle, reaching sexual maturity by age 2 and often dying their third year" (p. 49), putting them more at risk for sedimentation caused by the MVP route.[194]

1. The DSEIS fails to consider the cumulative effects of the proposed ROW Access/Transport Corridor as changed circumstance that relates to the new information on the Candy Darter and its Critical Habitat Potential.

Kimballton Branch is in the Stony Creek watershed and enters Stony Creek approximately 1.1 km upstream from MP 200.3 where the MVP will cross Stony Creek. As discussed above, the Kimballton Branch will sustain significant new impacts from construction-related activity of the proposed ROW Access/Transport Corridor as discussed above.

The JNF is required to consider cumulative effects of their actions on lands inside and outside the forest boundary: "Watersheds relevant to the plan should include those lands outside the National Forest System that contribute surface or subsurface water flows to the plan area, and those that receive surface of subsurface water frow the plan area. Groundwater-dependent ecosystems should also be considered." The directive further states that particular attention should be paid to "the influence on aquatic species at risk … in proximity to the area of analysis."[195]

However, neither the JNF/MVP Geosyntec hydrologic analysis nor the FWS BiOp includes analyses of the sediment load effects of the new corridor either on or off JNF land respectively.

- **On JNF land:** In contradiction to the directives of the scope of this DEIS and the requirement that the Forest Service MUST consider the impact of its actions on non-Forest Service land, which would include habitat of endangered species, the DSEIS states:
    - No direct effects are anticipated for the candy darter on the JNF since the pipeline does not cross any waterbodies in the JNF known to harbor the species. Indeed,

[194] U.S. Fish and Wildlife Service 2020 Biological Opinion and Conference Opinion for the Mountain Valley Pipeline, September 4, 2020 under CP16-10. Accession No. 20200904-3027.

[195] FSH 1909/12 – Land Management Planning Handbook, chapter 10 – the Assessments: 12.23 – Assessing Watersheds and Water Resources.

none of the stream crossings on NFS lands are for streams that contain federally listed species. Therefore, these crossings are outside the scope of the 2020 BO and are not mentioned in that document.[196]

- **The DSEIS does not provide an adequate analysis of the sedimentation that would enter Kimballton Branch as a result of using the MVP ROW as a construction corridor.** Relying on Enhanced E&S controls to eliminate sedimentation migration has been shown to be ineffective, both on the ground (e.g., failures to control sedimentation on Pocahontas Road on Forest Service land and multiple violations cited by WVDEP and VADEQ) **and** in the independent analyses of the POD by Pamela Dodds, Ph.D.[197], Kirk Bowers and others.
- Although the Forest Service eliminated the effects of the future use of Pocahontas Road access to the sedimentation load that it is considering, **the present and past use of Pocahontas does currently and will continue to contribute sedimentation that must be included in a full analysis of the totality of sedimentation that enters Kimballton Branch.**

- **Off JNF land: The DSEIS is clear that it does not provide any analysis of the sedimentation that would enter Kimballton Branch as a result of using the MVP ROW as a construction transportation corridor off the JNF land, leaving that responsibility to the FERC.**
  - In its BiOp, the FWS does not provide a current analysis of sources of sedimentation that enters Stony Creek from Kimballton Branch. The BiOp itself does not contemplate the increase of sedimentation that will enter Kimballton Branch from the off-NFS ROW transportation corridor below the junction of the Pocahontas Road and the MVP ROW. In fact, it is not clear that the FWS was actually informed by MVP that the pipeline ROW would now serve as part of the transport corridor, with increased heavy traffic; thereby possibly allowing the FWS to inadvertently underestimate increases in upland sedimentation caused by that change.[198]
  - The FERC's reliance on Enhanced Erosion & Sedimentation controls to eliminate sedimentation migration has been shown to be ineffective as evidenced by multiple violations cited by WVDEP and VADEQ, FERC inspector compliance reports, citizen complaints, etc.)
  - Moreover, the FWS BiOp produced in consultation with the FERC **now may be shown to be deficient in its analyses of impacts to the candy darter's critical habitat.** (see Appalachian Voices, et al Motion for Stay of Biological Opinion[199])
  - Focusing on habitat protection of the endangered candy darter, Sierra Club describes the deficiency of the FWS BiOp in providing analyses of three Physical

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[196] *Id.* at 74.
[197] Ex. 6.
[198] Because as of this date MVP has filed no variance at the FERC; and because private citizens access to discussions between FWS and MVP have been limited to heavily redacted FOIA requests, there may be no public record of MVP having advised FWS of the major modification of the use of the pipeline ROW.
[199] Appalachian Voices et al., Petitioners Motion for Stay of Respondent U.S. Fish and Wildlife Services Biological Opinion and Incidental Take Statement in the US Court of Appeals for the Fourth Circuit, USCA4 Appeal: 20-2159, Filed 11/02/2020 [Ex. 79].

or Biological Features (PBFs) which are habitat features necessary for the survival of the Candy Darter:

> The BiOp makes vague and conclusory statements regarding the effects to CD proposed critical habitat. For example, the BiOp states that PBF 2 (a blend of unembedded gravel and cobble that allows for normal breeding, feeding, and sheltering behavior) "will still function as required by the species, but at a reduced level … until after restoration is completed…." BiOp at 138. This leaves more questions than answers regarding the degree and duration of this "reduced function." Similarly, the BiOp states that PBF 3 "will still function as required by the species within the impacts areas, but at a reduced level" and that "[t]hese changes are expected to be limited in duration to the length of time that construction and restoration activities are actively contributing excess sediment to the watershed." Id. But this does not explain the degree of reduced function or the anticipated duration of active contribution of excess sediment. Similarly, while the BiOp discusses the duration of impacts to PBF 4, the assertion that this PBF "will still function as required by the species within the impacts areas, but at a reduced level" is vague and inadequate. Cf. id. at 138-39 (discussing PBF 4 (an abundant, diverse benthic macroinvertebrate community that allows for normal feeding behavior) and explaining that FWS is "assuming effects to benthic invertebrates in aquatic areas that receive significant increased sedimentation as a result of the MVP will persist for up to 4 years").[200]

The JNF muddies the water so to speak by ignoring the fact that no agency has performed a sedimentation analysis at the confluence of Stony Creek and Kimballton Branch that includes the cumulative effects of both on-NFS and off-NFS portions of the new Transportation Corridor.

Moreover, a letter from FERC to FWS makes clear the rationale for listing the Candy Darter in spite of the MVP analysis:

> As part of the supplement to the BA, Mountain Valley filed additional information regarding Project impacts on the candy darter. Candy darter populations in the Project area are found within the Gauley River and Stony Creek. Direct impacts to these streams would be avoided through the use of trenchless stream crossing methods currently proposed by Mountain Valley (the original crossing method approved was a dry open- cut). Mountain Valley's sedimentation analysis did not show a measurable increase in sedimentation to the Gauley River or Stony Creek due to the Project. However, based on further discussions with FWS, sedimentation effects from the Project in candy darter habitat cannot be ruled out due to the relative location of Project activities and nature of the tributaries that feed into the streams that contain candy darter. Therefore, our Project determination for the candy darter is *May Affect, Likely to Adversely Affect*.

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[200] *Id.* at Appendix G, 6f (Letter from Sierra Club, October 27, 2020 to US Fish and Wildlife Service).

> In conversations with FWS, we have also determined that the Project May Affect, Likely to Adversely Affect proposed critical habitat for the candy darter. ERC is requesting formal conference for the effects on proposed critical habitat.[201]

Until further analysis is performed, the DSEIS cannot evaluate the effects of the added sediment load on the Candy Darter habit. Certainly, the pipeline construction cannot be allowed to proceed until all federal agencies can consult to determine that the habitat of the Candy Darter will not be diminished.

Of most significance is the fact that future projections of adverse effects on the critical habitat of the Candy Darter from cumulative sedimentation levels caused by construction upland of Stony Creek and its tributaries would be prone to underestimation given the record of failures of erosion and sedimentation controls during all phases of MVP pipeline construction.

VIII. THE FOREST SERVICE HAS FAILED TO DEMONSTRATE THAT THE PROJECT CANNOT BE REASONABLY ACCOMMODATED ON NON-NFS LANDS IN VIOLATION OF NEPA AND NFMA.

The DSEIS acknowledges that in *Cowpasture*[202], the Fourth Circuit "determined that no evidence was provided as to why the project cannot be reasonably accommodated on non-NFS lands. For the Forest Service, the Court ruled this was a violation of NEPA and NFMA."[203]

The DSEIS also acknowledges that it must analyze non-NFS routes to ensure consistency with agency policy and the Jefferson Forest Plan.[204]

It also acknowledges that FSM 2703.2(2) states:

> In applying the second-level screening criterion regarding the public interest (36 CFR 251.54(e)(5)(ii)), consider the following: … Authorize use of NFS lands other than noncommercial group uses only if … the proposed use cannot reasonably be accommodated off of NFS lands.[205]

It also acknowledges that the Jefferson Plan standard FW-244 states:

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[201] Updated Effected Determinations of the Mountain Valley Pipeline Project, at 2, FERC, (July 8, 2020) (letter to FWS) [Ex. 80].

[202] *See Cowpasture River Pres. Ass'n v. Forest Serv.*, 911 F.3d 150, 167–69 (4th Cir. 2018) (remanding to the Forest Service to analyze whether the pipeline project's needs could be met on non-national forest lands), *cert. granted sub nom. United States Forest Serv. v. Cowpasture River Pres. Ass'n*, 140 S. Ct. 36, 204 L. Ed. 2d 1193 (2019), and *cert. granted sub nom. Atl. Coast Pipeline, LLC v. Cowpasture River Pres. Ass'n*, 140 S. Ct. 36, 204 L. Ed. 2d 1193 (2019), and *rev'd and remanded for other reasons sub nom. United States Forest Serv. v. Cowpasture River Pres. Ass'n*, 140 S. Ct. 1837 (2020).

[203] DSEIS at 13 (citation omitted).

[204] *Id.* at 11.

[205] *Id.* at 25.

> Evaluate new special use authorizations using the criteria outlined in 36 CFR 251.54 and according to Forest Service policy. Limit to needs that cannot be reasonably met on non-NFS lands or that enhance programs and activities.[206]

In response, the DSEIS sets up three criteria to evaluate this issue:

> (1) Whether all reasonable alternatives that would avoid NFS lands had been reviewed; (2) How special use screening requirements found at 36 CFR 251.54(d)(e) supported a review of alternatives; and (3) Whether the JNF Forest Plan standard FW-244 had been adequately addressed.[207]

However, in the section of the DSEIS that seeks to address the first criteria, the DSEIS simply repeats alternatives from the 2017 FERC FEIS, the updated 2020 SF-299 from MVP, or the BLM Practicality Analysis. The comments and findings in Table 3 are simply summaries from the 2027 FEIS and the BLM Practicality Analysis.[208] This table does not address the Forest Service's independent obligation to establish that the project cannot be reasonably accommodated on non-NFS lands. The comments and findings in Table 3 are recitations from the FERC FEIS, which fails under *Cowpasture* to establish that the project cannot be reasonably accommodated on non-NFS lands, and the BLM Practicality Analysis, which fails to establish that these other routes are not practical (see below).

The DSEIS does include consideration of a single NFS-Avoidance route sourced from a 2016 filing by MVP and included in the 2020 SF-299 from MVP. However, this analysis in the DSEIS is inadequate to address the Forest Service obligation to demonstrate that the project cannot be reasonably accommodated on non-NFS lands.

The DSEIS states that "the Forest Service does not have jurisdiction over an alternative that avoids NFS lands, and the No Action Alternative effectively addresses avoidance of NFS lands."[209] The statement is true but misleading in its disclosure of the actual Forest Service obligations. The agency's obligation is to consider potential non-NFS routes and to determine whether a non-NFS route can be reasonably accommodated. If reasonable non-NFS routes are available, the Forest Service would have to deny a special use permit and notify FERC. It would be FERC's responsibility to re-evaluate alternate routes. It is not the Forest Service's responsibility to choose and new route for MVP, but the Forest Service cannot reject non-NFS routes on the basis that it doesn't have jurisdiction of non-NFS lands – this is its specific and clear responsibility under FSM 2703.2(2).

Neither can the Forest Service shirk this responsibility by claiming that "… the No Action Alternative effectively addresses avoidance of NFS lands." The No Action alternative might address NEPA effects of the pipeline crossing Jefferson National Forest, but it does not address obligations under FSM 2703.2(2), nor does it address obligations of consistency with Jefferson Plan standard FW-244.

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206 *Id.* at 26.
207 *Id.*
208 *Id.* at 26–30 Table 3.
209 *Id.* at 31.

The DSEIS also uses the argument that: "Although the Court stated that the Forest Service must consider alternatives that avoid NFS lands, a majority of the MVP has already been constructed . . . ."[210] The fact that much of the pipeline has been constructed does not diminish the Forest Service obligation to determine if the proposed use cannot reasonably be accommodated off of NFS lands. MVP should have been aware of risks involved in proceeding with construction without all required permits and authorizations. In fact, it would appear that they have rushed forward with construction to make it appear that more of the pipeline has been constructed. This was MVP's gamble and risk. The fact that MVP took this risk does not remove Forest Service obligations. These obligations are clear under FSM 2703.2(2) and under JNF Plan standard FW-244.

The remainder of the review if the NFS-Avoidance route in the DSEIS consists of cherry picking of factors to emphasize environmental downsides and construction challenges that are benefited through the proposed route without identifying why these factors are more important than other environmental factors that indicate the FS Avoidance Route has environmental advantages nor why construction challenges enumerated are more important than construction challenges along the proposed route. And this selective recitation of facts fundamentally ignores and does not answer the *Cowpasture* holding that "*no evidence was provided as to why the project cannot be reasonably accommodated on non-NFS lands*."

The DSEIS includes Table 4, which, shows factors, some of which are advantages of the NFS Avoidance route while others are disadvantages of the NFS Avoidance route. This list is clearly not a comprehensive list of comparisons as it leaves out many environmental impacts of the proposed route documented in the FEIS and DSEIS of impacts to national forest lands that would not occur on the non-NFS alternative. But the DSEIS even cherry-picks environmental factors and construction constraints from Table 4 to argue that the proposed route is somehow preferable, ignoring the direction by the Fourth Circuit that the charge is to determine why the project cannot be reasonably accommodated on non-NFS lands, not to determine which route is "preferable" by some environmental factors or construction challenges:

> In effect, all actions that would have occurred on NFS would be transferred to other lands. This alternative would increase the length of the pipeline from approximately 303 miles to 351 miles and the acres of land that are disturbed from the ROW during construction increases by 745 acres. The number of populated areas that are within ½ mile of the pipeline increase from 8 to 31, and the number of private lands crossed would increase by about 248 parcels. Relatedly, the number of residences that are in close proximity (within 50 feet) to the ROW would increase from 63 to 168. The ANST and the Blue Ridge Parkway, important features on this landscape, would still be crossed but not on NFS lands.
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> In terms of sensitive resources, the route would include approximately 11 additional large waterbody crossings, and perennial waters affected by the route would increase by over 50%. There would be an increase of about 15,000 feet of

[210] *Id.*

> wetland crossings, including approximately 6,000 feet of forested wetlands. The area affected by the route would increase over 50% for perennial waters. Table 4 compares the proposed action alternative to this alternative.[211]

This list of supposed advantages fails to address the core issue identified by the Fourth Circuit for why the project cannot be reasonably accommodated on non-NFS lands. It is not even clear that the NFS Avoidance alternative would involve more construction than the proposed route as claimed in the DSEIS. Figure 2 in the DSEIS shows the NFS Avoidance alternative paralleling the Transco pipeline for a significant amount of the distance of the NFS Avoidance route.[212] It is unclear why this NFS Avoidance route could not reasonably tie in to the Transco pipeline, thus avoiding this duplication of routes. Certainly, this might not coincide with MVP's plans, but it would seem to satisfy the purposes of the project as identified in the DSEIS and be a reasonable alternative. This pipeline alternative would also clearly make pipeline construction shorter than the proposed route and would entirely avoid adverse impacts on USFS lands. The DSEIS does not address this or explain why that would not be a reasonable alternative.

In evaluation of criteria 2 the DSEIS claims:

> How the 2016 and 2020 Forest Service special uses initial and second-level screening checklist for the MVP proposal initially addressed alternatives was reviewed. In both cases, the Forest Service complied with special use screening requirements per 36 CFR 251.54 and Forest Service policy (FSH 2709.11, Sec. 12.2; 12.4).
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> As noted above in the "Background" section, the 2016 screening included initial evaluations of, among other things, the location of the proposed use; collocation opportunities; route alternatives and variations; if the proposed use could be reasonably accommodated on non-NFS lands; and if the proposed use would be consistent with the mission of the Forest Service to manage NFS lands and resources in a manner that will best meet the present and future needs of the American people. The screening served to help inform whether a Plan Amendment was needed for the project (251.54(e)(1)(ii) and whether the project would be in the public interest 251.54(e)(5)(ii) (i.e., can be accommodated off of NFS lands).[213]

The section 251.54 requirements cited by the DSEIS address screening criteria for special uses, a separate responsibility that must be satisfied before a permit can be granted. These criteria include the provision that a proposed use may not be permitted where it is not in the public interest.[214] The Forest Service Manual provides:

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[211] *Id.* at 32–33.
[212] *Id.* at 32.
[213] *Id.* at 35.
[214] 36 C.F.R. § 251.54(e)(5)(ii).

> Authorize use of National Forest System lands other than noncommercial group uses only if: b. The proposed use cannot reasonably be accommodated off of National Forest System lands . . . .[215]

The DSEIS evaluation then seems to imply that the USFS application of this criteria was complete and appropriate but was stopped:

> The application process stopped at the application processing and response stage (36 CFR 251.54 (2)(g)) because only the BLM had the authority to approve Mountain Valley's ROW application and the authority to issue a decision on whether to approve, approve with modifications, or deny the application (30 U.S.C. § 185 et seq and 43 CFR Part 2880).[216]

However, the DSEIS fails to address how the analysis in the DSEIS seeks address the failure of analysis in the FERC FEIS to properly apply this criteria or how the DSEIS solves this deficiency.

To satisfy the criteria for whether the JNF Forest Plan standard FW-244 had been adequately addressed the DSEIS refers to the 2016 MVP application for a special use permit, the concurrence on the BLM's issuance of a ROW in 20120, and to the re-evaluation of alternate routes in the DSEIS.[217] But the DSEIS presents no new evidence from the first two processes that would argue that these needs "cannot be reasonably met on non-NFS lands or that enhance programs and activities" as required by FSM 2703.2(2)(b). And as pointed out above the analysis of criteria 1 in the DSEIS does not establish that this proposed special use cannot be met on non-NFS lands.

The DSEIS also states for justification of not complying with JNF FW-244 standard that:

> There are a number of complementary laws, Executive Orders, and policy documents that recognize the importance of domestic energy production and transmission to the American people and have established federal policy to support projects that will increase the production, transmission, or conservation of energy. Also, the USDA was one of ten Federal departments or agencies that is a signatory to a May 2002 Interagency Agreement for processing interstate natural gas pipeline proposals. The Interagency Agreement establishes a framework for cooperation and participation among the signatories to statutory responsibilities are met in connection with the authorizations that are required to construct and operate interstate natural gas pipeline projects certificated by FERC. FERC is responsible for authorizing the construction and operation of interstate natural gas pipelines. FERC decides whether a proposed project is in the public interest and whether to issue a certificate of public convenience and necessity for such pipeline under section 7 of the Natural Gas Act.

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[215] FSM 2703.2(2)(b).
[216] DEIS at 35.
[217] *Id.*

> . . .
>
> In deference to FERC's decision and the agency's commitment to the Interagency Agreement, the Forest Service Draft Supplemental Environmental Impact Statement determined the portion of the MVP route on the JNF enhances programs and activities of the federal government and therefore is consistent with Forest Plan standard FW-244.[218]

Contrary to this argument the Forest Plan does not endorse pipeline infrastructure ahead of any other considerations. The Plan contains numerous Plan standards and other plan components (including JNF FW-244) to assure that natural gas infrastructure would have limited environmental impact on the forest. The Forest Service cannot defer this obligation and responsibilities to other agencies or interagency agreements. Forest Plan standards are for use and protection of the National Forest as determined by USFS regulations and Laws pertinent to National Forest management. The laws and regulations governing the National Forest and application of National Forest Plans are distinct from laws and regulations governing FERC and other agencies. The Forest Service cannot defer decisions on Plan standards to FERC decisions or interagency agreements.

IX. THE FOREST SERVICE SHOULD NOT RELY ON—AND THE BLM SHOULD REASSESS—THE BLM'S FLAWED PRACTICALITY FINIDNG FOR THE RIGHT-OF-WAY ACROSS THE JEFFERSON NATIONAL FOREST, AND THE BLM SHOULD DENY THE RIGHT-OF-WAY UNDER THE MINERAL LEASING ACT.

The BLM should deny MVP's request for a right-of-way (ROW) across the JNF pursuant to the Mineral Leasing Act (MLA). The BLM's Practicality Analysis fails to establish that other routes are impractical, as the Fourth Circuit's decision mandated. Because there are practical alternative routes that avoid the environmentally sensitive JNF crossing and make greater use of existing ROWs—or completely bypass the need for an ROW across Federal lands—granting the requested ROW would violate both the MLA and the BLM's implementing regulations. The analysis that the BLM devised to assess whether an alternative route is practical misinterprets the plain language of the MLA.

Even assuming its analysis is appropriate, the BLM inconsistently and arbitrarily applies this analysis to determine whether a route—and thus a different ROW—is impractical. Ultimately, granting the proposed ROW across JNF would offend the express purpose of the ROW program as codified in BLM's own regulations. We urge the Forest Service not to rely on the BLM's practicality finding. The BLM should reassess its finding and deny the requested JNF ROW.

A. The BLM's Analysis for Determining Whether an Alternative Route and Associated Right-of-Way Is Impractical Misinterprets the Plain Language of the Mineral Leasing Act.

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[218] *Id.*

As an initial matter, the MLA does not require BLM to grant an ROW.[219] Both the MLA and BLM's ROW regulations mandate and prioritize resource protection in order for any ROW to be granted.[220] The objective of BLM's ROW program is to grant ROWs in a manner that, *inter alia*, "[p]rotects the natural resources associated with Federal lands and adjacent lands," "[p]revents unnecessary or undue degradation to public lands," and "[p]romotes the use of rights-of-ways in common considering engineering and technological compatibility, national security, and land use plans."[221] These priorities should inform the Practicality Analysis.

Section 28(p) of the MLA requires the BLM to collocate ROWs to the extent practical.[222] In *Sierra Club*, the Fourth Circuit found that the FEIS and the BLM had not established that the utilization of an existing ROW would be *impractical*.[223] BLM seeks to address this deficiency with the Practicality Analysis submitted to the Forest Service to accompany the DSEIS.

In order to minimize both "adverse environmental impacts and the proliferation of separate rights-of-ways across Federal lands," the MLA requires the pipeline route to use existing ROWs "to the extent practical."[224] Three interrelated criteria must be analyzed: minimization of adverse environmental impacts; minimization of the proliferation of separate ROWs; and practicality. If an alternative route to the applicant's proposed route and ROW meets these criteria, collocation with the existing ROW along that alternative route "shall be required."[225]

The analysis that the BLM devised, however, is inconsistent with the plain language of Section 28(p). Under its analysis, the BLM considers only two criteria: whether an alternative route with an ROW in common is practical and whether it "results in greater collocation with other ROWs."[226] The analysis completely disregards the primary reason for collocation and the objective of its own ROW program: minimization of adverse environmental impacts.

In a single footnote, the BLM attempts to dispense with analysis of whether a route would minimize adverse environmental impacts.[227] Without discussion, the BLM simply relies entirely on the FERC FEIS, which concluded that no route alternative would "'provide a significant environmental advantage' over the previously approved route."[228] That is not the

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[219] 30 U.S.C. § 185(a) ("Rights-of-way through any Federal lands *may* be granted . . . ." (emphasis added)). True, the MLA grants BLM discretion in determining whether to grant a ROW. But that discretion is not unbounded. *See* 5 U.S.C. § 706 (establishing that an agency action is unlawful if it is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with the law").

[220] 30 U.S.C. § 185(h), (p); 43 C.F.R. § 2881.2.

[221] 43 C.F.R. § 2881.2(a)–(c).

[222] *See* 30 U.S.C. § 185(p).

[223] *Sierra Club, Inc.*, 897 F.3d at 605.

[224] *Id.* ("In order to minimize adverse environmental impacts and the proliferation of separate rights-of-way across Federal lands, the utilization of rights-of-way in common shall be required to the extent practical . . . .").

[225] *Id.* While the Fourth Circuit discussed in dicta how the FEIS weighed environmental impacts as part of its NEPA analysis, the Court never reached the question of environmental impacts related to the collocation mandate in Section 28(p) because "the BLM did not make a practicality finding" at all. *Sierra Club*, 897 F.3d at 605.

[226] *See* Mineral Leasing Act Section 28(p) Analysis for the Mountain Valley Pipeline, at 1, U.S. Dep't of the Interior, Bureau of Land Management (Aug. 23, 2018) [hereinafter "2018 Practicality Analysis"].

[227] *See id.* at 4 n.14.

[228] *Id.* (citing and quoting FEIS at 3-20, 3-22, 3-25, 3-32, 3-47, 3-51, 3-55, 3-62, 3-65, 3-70).

standard contemplated by Section 28(p). The Practicality Analysis is concerned with *minimizing* adverse environmental impacts through ROWs in common. Though some alternatives may do so, nowhere does the statute require that an alternative ROW provide a "significant environmental advantage."[229] The BLM's method for analyzing and determining practicality is not in accordance with the MLA.

B. The BLM's Practicality Analysis of Alternative Routes and Associated ROWs Is Arbitrary and Inconsistent.

Even assuming the BLM's analysis methodology were sound, the application of its analysis to the alternative routes in comparison to the proposed route is flawed. The BLM determined whether a route alternative is practical based on the purpose of the pipeline, "construction challenges," "safety hazards," "environmental consequences," "increase in the pipeline's length and footprint," "the ability of the route to serve the MVP's mid-route delivery points, costs," and any other specific purpose for a given route.[230] These criteria are reasonable indicators of practicality. However, as discussed below, the BLM applies them inconsistently, providing no basis for meaningful comparison between the various alternatives and the proposed route, and thus making the practicality determination itself an arbitrary exercise.

In its 2018 Practicality Analysis, the BLM cites an IBLA decision opining on Section 28(p) in an attempt to establish what constitutes impracticality.[231] There, the IBLA found that 39 additional miles of pipeline at an estimated cost of $37.5 million, along with an additional compressor station and temporary disturbance of "substantially greater acreage," meant that a route was impractical.[232] Unlike here, however, in that case "[n]o party . . . identified another existing right-of-way available for common use within which Altamont could place its pipeline."[233] That is a critical distinction that undermines the BLM's use of these figures to support impracticality. Regardless, the BLM makes no attempt to compare the factors it seems to consider dispositive for alternative routes to the factors in this IBLA decision or even craft a reasonable threshold for practicality. Instead, the BLM appears to operate under the presumption that it has unbounded discretion to determine whether a route is impractical. It does not. The Administrative Procedure Act requires reasoned analysis that is not arbitrary, capricious, or an abuse of discretion.[234]

Importantly, as explained extensively throughout this comment, MVP's proposed route through JNF *does* pose significant adverse environmental impacts not analyzed in the FEIS. Many of these impacts have occurred after FERC issued the FEIS and after the Fourth Circuit's ruling. By its own standards, the "environmental consequences" of a route inform the BLM's determination of whether that route (and associated ROW) is practical. BLM has abdicated its statutory obligation by failing to consider these subsequent adverse environmental impacts of the proposed route (and ROW) when comparing it to alternative routes in terms of determining

[229] 30 U.S.C. § 185(p); *see Sierra Club*, 897 F.3d at 604–05.
[230] *See* 2018 Practicality Analysis at 3–4.
[231] *Id.*
[232] 2018 Practicality Analysis at 2–3 (quoting and citing *Wyo. Indep. Producers Ass'n*, 133 IBLA 65, 82 (1995)).
[233] 133 IBLA 65, 82.
[234] 5 U.S.C. § 706.

whether a route is impractical. Moreover, as noted above, and particularly in light of substantial evidence of degradation to the JNF, the BLM's failure to seriously examine whether an alternative route with a common ROW would minimize adverse environmental impacts to a greater extent than the proposed route contravenes Section 28(p) and the purpose of the ROW program.

1. The BLM's Analysis of Alternative Routes Provides No Meaningful Standard to Determine Whether an Alternative Route is Impractical, Minimizes Adverse Environmental Impacts, or Minimizes Proliferation of Separate ROWS.

Examining the BLM's analyses of various alternative routes shows that the agency inconsistently applies even its own flawed methodology and provides no meaningful standard to determine whether a route meets the requisite criteria of Section 28(p).

i. MVP Proposed Route.

According to MVP in 2017, the project would cost approximately $3.7 billion.[235] But since then, the project has accrued significant cost overruns. The latest estimate is that the total project will run up to $6 billion.[236] Nowhere in the Practicality Analysis does BLM discuss the current or projected mounting cost of the MVP along its proposed route, nor attempt to measure this construction cost against the vague and indeterminate proxies for cost it uses—pipeline length and construction challenges[237]—when evaluating the practicality of alternative routes.

The project's proposed route entails two separate ROWs—an approximately 3.6-mile long ROW across the JNF and a roughly 60-foot ROW across USACE land—with about 1.05 miles of collocation.[238] The route crosses 1,710 feet of Forest Service-designated old growth forest, with another 4.9 acres affected by construction, two National Forest trails, 5,030 feet of inventoried roadless areas, 14,170 feet of semi-primitive acres, and 10 miles of NRHP-designated or eligible historical districts. In terms of Federal and non-Federal resources impacted, the proposed route crosses 248.7 miles of forest with another 3,771.9 acres affected during construction and 1,507.1 acres during operation; 2,463.6 acres of interior forest; 3,601 feet of wetlands; 95 perennial waterbodies; five major water bodies; 216.4 miles of shallow bedrock; 128.6 miles of steep slope; 158.2 miles of side slope; 225.6 miles of area with landslide potential; and 41.7 miles of karst.[239] This data is merely quantitative, however. As discussed throughout this comment, the qualitative environmental impacts to the JNF are significant.

In analyzing the various alternative routes for collocation practicality, BLM fails in three distinct ways. First, it blithely ticks off quantitative metrics for alternative routes without providing any attempt to determine a bar for impracticality. The BLM summarily concludes after

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[235] FERC, 161 ¶ 61,043, at 6, Docket Nos. CP16-10-000, CP16-13-000 (Oct. 13, 2017).
[236] Equitrans Midstream Corporation, Q3 2020 Earnings Conference Call Transcript, at *3 (Nov. 3, 2020, 10:30 AM (ET)) [Ex. 81].
[237] 2018 Practicality Analysis at 4 n.17.
[238] *See* Plan of Development, Mountain Valley Pipeline Project, at 1-6 &1-7 (Nov. 30, 2017).
[239] *See* MVP, LLC, Form SF-299, Attach. A, at 5 Table 1 (May 1, 2020).

a short discussion for each alternative that it is "impractical."[240] Second, for some alternative routes, BLM misapplies the anti-proliferation criterion and, for others, inconsistently applies this criterion. Finally, the BLM offers but the barest of qualitative analysis of whether an alternative minimizes environmental impacts. And nowhere does the BLM properly grapple with the significant adverse environmental impacts of the proposed route as a means of determining whether an alternative route would indeed minimize impacts compared to the proposed route. Critically, the BLM fails to take a hard look at how construction challenges, environmental consequences, and the other quantitative criteria it uses to determine practicality for the alternative routes applies to the proposed route itself.

Put differently, BLM appears to presume from the outset that the proposed route itself is practical. But Section 28(p) allows no such presumption. It states clearly that collocation is "required to the extent practical."[241] Without a proper Practicality Analysis of the proposed route's practicality, including whether it minimizes adverse environmental impacts or proliferation of separate ROWs in comparison to the alternative routes, the BLM has failed to provide the public with a meaningful opportunity to comment. Therefore, by failing to analyze whether the proposed route itself meets the requisite criteria through a Practicality Analysis and by shirking its responsibility to make an express determination about whether the proposed route itself is impractical, the BLM has "entirely failed to consider an important aspect of the problem."[242]

As discussed throughout this comment, the BLM and the Forest Service—being led by the nose by FERC—seem to have predetermined that the MVP will be built straight across the environmentally sensitive JNF along the proposed route. An internal "USDA Report on Actions" responding to "Executive Order 13927, Accelerating the Nation's Economic Recovery from the CVOID-19 Emergency by Expediting Infrastructure Investments" points disturbingly to the USDA attempting to stack the deck for MVP approval irrespective of the findings of the DSEIS or the Practicality Analysis.[243] This severely undermines the environmental review process, public participation, and the public's trust in the agencies that safeguard our public lands.

ii. Conceptual Forest Service Avoidance Alternative.

The Conceptual Forest Service Avoidance Alternative (CFSA) would entirely avoid crossing Forest Service lands. FERC never analyzed this alternative route in the FEIS.[244] The Forest Service and the BLM now attempt a cursory analysis of it for the first time in the DSEIS

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[240] *See, e.g.*, 2018 Practicality Analysis at 14.
[241] 30 U.S.C. § 185(p).
[242] *See Sierra Club*, 897 F.3d at 605 (quoting *Defs. of Wildlife v. N.C. Dep't of Transp.*, 762 F.3d 374, 396 (4th Cir. 2014) (internal quotation marks omitted).
[243] Executive Order (EO) 13927, Accelerating the Nation's Economic Recovery from the COVID-19 Emergency by Expediting Infrastructure Investments, USDA Report on Actions, at 3, USDA (Sept. 25, 2020) [Ex. 82] (showing that MVP is a on a fast track to approval and updating the July 2, 2020, Report, which showed the same fast-track); *see also* Executive Order (EO) 13927, Accelerating the Nation's Economic Recovery from the COVID-19 Emergency by Expediting Infrastructure Investments, USDA Report on Actions, at 4, USDA (July 7, 2020) [Ex. 83] (highlighting MVP for fast track). The Wilderness Society obtained this correspondence through a Freedom of Information Act request.
[244] DSEIS at 31.

and the Practicality Analysis without the benefit of this alternative route having gone through the requisite NEPA process.

As discussed above and as background that informed the BLM's analysis of the CFSA, the Forest Service provides almost no additional environmental or other analysis of this route.[245] It summarily concludes that this "alternative encompasses a broad array of route deviations and, therefore, impacts"[246] with almost no further elaboration. The Forest Service merely lists data about the route with no qualitative analysis or discussion.[247]

In its Practicality Analysis, the BLM provides a similarly paltry discussion. It ticks off several metrics, including that the CFSA would increase pipe length by about 48 miles, increase land disturbance by 745 acres, and involve 11 large waterbody crossings and 15,000 feet of wetland crossings.[248]

The BLM, like the Forest Service, has cherrypicked data to support its finding. The agency neglects to meaningfully compare environmental impacts with the proposed route, either quantitatively or qualitatively. Section 28(p) requires this comparison because it plainly mandates *minimization* of adverse environmental impacts and *minimization* of proliferation of *separate* ROWs and therefore collocation *to the extent practical*.[249] Without a proper comparison, the BLM cannot accurately determine which route minimizes impacts, minimizes separate ROWs, and can do so to the extent practical.

Aside from the few impacts the BLM lists without elaboration, the CFSA would cross only 0.1 miles of NRHP designated or eligible historic districts (compared to 10.1 miles for the proposed route). As far as resources, the CFSA would cross 39.2 fewer miles of forest lands, affect 836.3 fewer acres of forest land, and cross 88.7 fewer miles of interior forest. Most importantly, it would cross *zero* miles of National Forest lands.

Many environmental factors have not even been analyzed. Impacts to Forest Service inventoried roadless areas would be reduced to zero. And impacts to threatened and endangered species are not analyzed at all in the DSEIS. The CFSA should have been fully analyzed so that the public would have been fully informed and would have had a meaningful opportunity to comment. The BLM makes no attempt to discuss how its cherrypicked data somehow demonstrate that the CFSA does not minimize adverse environmental impacts.[250]

[245] *See id.*
[246] *Id.*
[247] *See id.* at 31–33.
[248] Mountain Valley Pipeline Project – Revised Mineral Leasing Act Application, Addendum to the BLM's 2018 Practicality Analysis of Collocation Route Alternatives for the MVP Project Consistent with 30 U.S.C. § 185(p), at *2–3, U.S. Dep't of the Interior, Bureau of Land Management (Sept. 2, 2020) [hereinafter "2020 Practicality Analysis"].
[249] *See* 30 U.S.C. § 185(p).
[250] SF-299, Attach. A, at 10–11 table 3.

The CFSA is also collocated for 332 miles compared to a mere 22 miles for the proposed route.[251] The BLM appears to dismiss this collocation because it is not on Federal lands.[252] While Section 28(p) is concerned with minimizing the proliferation of separate ROWs "across Federal lands,"[253] the mandate to collocate does not specify that those common ROWs need be solely on Federal lands. That makes sense. If the intent of Section 28(p) and the BLM's ROW program is to minimize adverse environmental impacts and minimize proliferation of separate ROWs across Federal lands, a route that *completely eliminates* impacts and ROWs across Federal lands surely would be preferable. The BLM fails to acknowledge this, as discussed below.

In fact, it is not even clear that the CFSA alternative would need to involve more construction than the proposed route. Figure 2 in the DSEIS shows the CFSA paralleling the Transco pipeline for a significant amount of the distance of its route.[254] BLM makes no attempt to explain why the CFSA could not tie in to the Transco pipeline, entirely avoiding this duplication of routes. Certainly, this might not coincide with MVP's plan, but it would seem to satisfy the purposes of the project as identified in the DSEIS and the Practicality Analysis and would clearly make pipeline construction shorter than the proposed route, while entirely avoiding adverse impacts on Forest Service lands.

As far as determining whether the CFSA is impractical, the BLM claims that an increase in pipeline route length of 48 miles contributes to its impracticality. But it neglects to discuss or analyze factors that it appears to find disturbing for other alternatives. For example, the CFSA would cross 134 fewer miles of shallow bedrock and 33.7 fewer miles of steep slope than the proposed route.[255] BLM has failed to establish any meaningful threshold for when added construction mileage or challenges become impractical.

Worse, the BLM seems to dismiss the importance of the JNF lands by stating that the factors it listed (which, as noted, are paltry and poorly explained) are more important than the 3.6 miles of National Forest land, justifying cutting across it. The entire reason for the DSEIS and the Practicality Analysis are those miles over JNF. Yet, BLM desires to flick away the critical importance of this Federal land with a barebones assessment of its worth.

The BLM (like the Forest Service) further supports its impracticality finding for this alternative route by essentially claiming its hands are tied. BLM asserts that FERC already issued a certificate of public convenience and necessity for the proposed route and that "nearly 84 percent of the pipeline is already constructed."[256] This thumb-on-the-scales justification flies in the face of reasoned agency decision-making and the law. As the BLM asserts, its jurisdiction lies with Federal lands.[257] Clearly, construction is not complete within the JNF. Simply because the BLM and other agencies unlawfully authorized[258]—and MVP constructed—some of the

[251] *Id.* at 11 table 3. The entire proposed route appears to collocate for 25.4 miles. *See id.* at 8 table 2.
[252] *See* 2020 Practicality Analysis at *3.
[253] 30 U.S.C. § 185(p).
[254] *See* DSEIS at 32 fig. 2.
[255] *Id.* at 11 table 3.
[256] *See* 2020 Practicality Analysis at *3; DSEIS at 31.
[257] *See* 2020 Practicality Analysis at *3.
[258] *See Sierra Club*, 897 F.3d at 603, 605–06.

pipeline route already, this does not permit the BLM to ignore its statutory obligation to protect the natural resources on Federal lands.[259]

Equally problematic, the DSEIS attempts to dismiss the CFSA because "the Forest Service does not have jurisdiction over an alternative that avoids NFS lands, and the No Action Alternative effectively addresses avoidance of NFS lands."[260] BLM makes essentially the same assertion:

> [T]his route alternative would not require the collocation of federal land within the BLM's jurisdiction under the MLA and thus does not offer a comparison between alternatives that provide for collocation on federal land. . . . [T]his route alternative is beyond the BLM's authority and essentially would represent the no action alternative; it would not require Mountain Valley to obtain an MLA ROW from the BLM.[261]

The Forest Service and the BLM misapprehend the scope of their responsibility. As noted above, the primary purposes of Section 28(p) and the BLM's ROW program are to minimize adverse environmental impacts and proliferation of separate ROWs across Federal lands.[262] A route that eliminates impacts and ROWs across Federal lands best achieves those purposes. For determining whether a route is impractical, the BLM does not state that it must look only to the route's crossing of Federal lands even though it has no jurisdiction over the non-Federal land portions of the route. The BLM seems to assume that it *must* approve some ROW over Federal lands. Not so. Its responsibility is to protect those natural resources, which is why the MLA gives the BLM the discretion to deny an ROW.[263]

True, neither agency has jurisdiction over a route on non-Federal lands. But that is precisely the point. Both agencies *do* have jurisdiction over Federal lands. It is incumbent upon the agencies to safeguard those lands. While the agencies cannot permit or otherwise approve a route that completely avoids crossing the JNF, they can most certainly decide *not* to permit or approve a route that *does* cross the JNF when a viable alternative exists.[264]

The CFSA is also distinct from the no-action alternative. By definition, the no-action alternative involves *no action*. This alternative route, while not involving action on Federal land, would still allow the project to proceed on non-Federal land. Thus, it is "no action" in relation to the Federal agencies but certainly not in regard to the project proponent.

The BLM must either properly analyze and explain why the CFSA is impractical or deny the ROW.

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[259] *See* 43 C.F.R. § 2881.2(a).
[260] DSEIS at 31.
[261] *See* 2020 Practicality Analysis at *3.
[262] 30 U.S.C. § 185(h), (p); 43 C.F.R. § 2881.2.
[263] *See* 30 U.S.C. § 185(a); 43 C.F.R. 2884.23.
[264] *See Cowpasture*, 911 F.3d at 167–69.

iii. Burnsville Weston Gauley Alternative; Alternative 1/Hybrid Alternative 1A; CGV Variation; Brush Mountain Alternatives 1 and 2.

The BLM's Practicality Analysis of these alternative routes and associated ROWs suffer from and illustrate additional flaws in BLM's assessment. When analyzing the Burnsville alternative route, the BLM again constructs a strawman argument by stating that the route is "beyond the BLM's authority because, aside from the MLA ROW across USACE lands, it would not cross federal lands."[265] The agency further attempts to dismiss responsibility by pointing to the completed construction across USACE land.[266] This does not relieve BLM of its obligation to conduct a properly thorough practicality analysis of this alternative.

Analysis for the Burnsville Weston Gauley Alternative also fails to acknowledge that the route does collocate more pipeline along an existing ROW. As explained above, Section 28(p) does not distinguish between collocation on Federal versus non-Federal lands. In fact, this alternative would avoid the proliferation of *separate* ROWs because it would require *one* ROW—across the JNF—instead of *two* ROWS—across the JNF and the USACE land. The Practicality Analysis also does not offer more than cursory review of a few route statistics and summary conclusions about its impracticality.[267]

Alternative 1 (along with the similar Alternative Hybrid 1A) results in much greater collocation (101.0 miles versus 29.4 miles for the proposed route) with many fewer miles and acreage of forest land disturbed.[268] The BLM lists a few construction challenges for the route but offers almost no discussion of why some but not other factors weigh against this alternative and in favor of the proposed route. Nor does the BLM even attempt to compare these factors to the ones the IBLA discussed previously concerning Section 28(p).

The CGV Variation increases collocation on Federal lands. But the BLM disregards this alternative as impractical in a single paragraph, citing "9 more miles of total pipeline . . . including 4.1 more miles of steep slope and 4.6 more miles of side slope."[269] Based on "136.3 more acres of construction disturbance, including 60.8 more acres on forested land" along with "potential" impacts on a water supply and possible visual impacts closer to the ANST, the BLM deems the CGV Variation impractical.[270] Nowhere does the BLM address the adverse environmental impacts to the JNF from the proposed route that would be avoided by this variation. Nor does the BLM attempt to analyze or explain how nine more miles of pipeline compares to the nearly doubling of the MVP's current cost that has already occurred along its proposed route.

The BLM similarly disregards the Brush Mountain Alternatives in a single paragraph with an even more cursory analysis.[271] Brushing aside 0.22 miles of greater collocation as de

[265] 2020 Practicality Analysis at *4.
[266] *Id.* at *4 n.20.
[267] *See id.* at *3–4.
[268] SF-299, Attach. A at 5 table 1.
[269] 2018 Practicality Analysis at 13–14.
[270] *See id.*
[271] *See id.* at 15–16.

minimis, the BLM contends that 0.3 additional miles of pipeline, 0.4 more miles of side slope, and 0.3 miles of landslide potential somehow make the route impractical.[272] Here, the BLM has engaged in almost no reasoned explanation for why these minor increases result in impracticality.

C. The BLM Failed to Consult the National Park Service on Whether to Grant an ROW under the Appalachian Trail.

It is unclear whether BLM has consulted with the National Park Service regarding impacts to the ANST. Under BLM's regulations, when a ROW "involves lands managed by two or more Federal agencies, BLM will not issue or renew the grant or TUP until the heads of the agencies administering the lands involved have concurred."[273] BLM consulted with the Forest Service and Army Corps of Engineers in 2017[274] but makes no representation regarding concurrence from the Park Service. While *Cowpasture* established that that Forest Service has jurisdiction under the MLA to grant rights of way across the ANST where it crosses Forest Service lands, the Court also held that the Park Service retained significant administration and management responsibility for the ANST.[275] In other words, the Trail includes "lands managed by two or more federal agencies" even if they are not "Park Service lands" for MLA purposes. Thus, BLM must obtain concurrence from the Park Service before issuing a ROW.

D. The BLM Should Deny the ROW or Reevaluate Its Practicality Finding.

The BLM's Practicality Analysis is inconsistent and arbitrary, failing to provide a meaningful basis with which to comply with the Fourth Circuit's directive to determine whether alternative routes are impractical. As explained throughout this comment, the DSEIS neglects to properly analyze the significant environmental impacts caused by MVP and its proposed route across the JNF. The MVP pipeline has resulted in substantial environmental degradation, including that which has occurred after the FEIS and after the Fourth Circuit's ruling, which requires greater environmental review under NEPA, violates NFMA, the Forest Planning Rule, and the JFN Forest Plan, and is contrary to Section 28(p) of the MLA and the purpose of BLM's ROW program.

BLM should deny the requested ROW. The application is "inconsistent with the purpose for which [the Forest Service] manage[s] the lands."[276] The "proposed use [is] not . . . in the public interest."[277] The proposed route fails to "[p]rotect the natural resources associated with Federal lands and adjacent lands," fails to "[p]revent unnecessary and undue degradation to public lands," and fails to "[p]romote[] the use of rights-of-way in common considering . . . land use plans."[278] Alternative routes are not impractical and would minimize adverse environmental

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[272] *Id.*
[273] 43 C.F.R. § 2882.26
[274] DSEIS at 1.
[275] *See, e,g., Cowpasture*, 140 S. Ct. at 1845 n.3 (recognizing that the Park Service has a "positive grant[] of authority" regarding the ANST).
[276] 43 C.F.R. § 2884.23(a)(1).
[277] *Id.* § 2884.23(a)(2).
[278] *Id.* § 2881.2(a)–(c).

impacts and minimize proliferation of separate ROWs.[279] BLM need not approve this ROW. To do so would violate its responsibility to safeguard our public lands.

We strongly urge the BLM to reconsider its Practicality Analysis and findings and deny the ROW.

X. CONCLUSION.

The DSEIS is indefensible in light of the extraordinary evidence that the construction and operation of the Mountain Valley Pipeline will cause harm to the values and resources for which the Jefferson National Forest was created and is managed. Despite the volumes of evidence that erosion and sedimentation controls are inadequate, even if properly installed, the Forest Service limits the analysis to theoretical, predictive modeling—and improper modeling at that. The decision record unlawfully omits even the Forest Service's monitoring records prepared by the agency's contractor.

The Forest Planning Rules cannot be manipulated to amend the Forest Plan to make the Plan consistent with the harms that MVP will cause. A holistic reading of the Planning Rules shows that Forest Plans are the blueprint for maintenance and restoration of ecological conditions such as riparian areas and forest soils. The standards proposed to be waived and replaced with unspecified mitigation are the foundation stones of the maintenance and restoration framework in the Forest Plan.

We strongly urge the Forest Service to supplement its environmental review based on the many issues this comment identifies, and strongly urge the BLM to deny the ROW. As the Fourth Circuit rightly opined: "American citizens understandably place their trust in the Forest Service to protect and preserve this country's forests. . . . Citizens also trust in the [BLM] to prevent undue degradation to public lands by following the dictates of the MLA."[280] We implore the agencies to put the best interests of the lands they are so privileged to safeguard and the public they serve before the interests of a failed pipeline that will leave permanent scars on our shared and treasured National Forest.

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[279] 30 U.S.C. § 185(p).
[280] *Sierra Club*, 897 F.3d at 605–06.

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 92

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National Best Management Practices for Water Quality Management on National Forest System Lands

Volume 1: National Core BMP Technical Guide

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Department of
Agriculture

Forest Service

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Front cover photo: *Taylor Fork Creek, Gallatin National Forest, near Big Sky, MT, by David Scovell, engineer, Rogue River-Siskiyou National Forest. Photo taken in August 2005 in the Madison Range, just west of Yellowstone National Park.*

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Preface

This technical guide is the first volume of guidance for the Forest Service, U.S. Department of Agriculture, National Best Management Practices (BMP) Program. The National BMP Program was developed to improve agency performance and accountability in managing water quality consistent with the Federal Clean Water Act (CWA) and State water quality programs. Current Forest Service policy directs compliance with required CWA permits and State regulations and requires the use of BMPs to control nonpoint source pollution to meet applicable water quality standards and other CWA requirements.

The Forest Service has a long history of working with States and other partners to carry out BMP programs, including agreements with the U.S. Environmental Protection Agency (EPA) and many States to use and monitor BMPs. Each Forest Service region has a BMP guidance document consistent with its respective State BMP programs. Most national forests and grasslands monitor and report on BMPs. The regional or forest BMP programs, however, are not standardized to allow efficient cross-regional application, evaluation, or reporting. The National BMP Program, which includes the National Core BMPs detailed in this guide, will enable the agency to readily document compliance with the nonpoint source management strategy at national or regional scales. The National BMP Program is modeled after a successful 20-year-old regional BMP program in the Forest Service Pacific Southwest Region (Region 5).

A standardized National BMP Program is needed as an effective tool for the agency to accomplish the following:

- ***Improve water quality to restore impaired waters***—National Forest System (NFS) lands in the United States contain 3,126 CWA 303(d) listed waterbodies; nearly every Forest Service administrative unit (96 percent) has at least one impaired waterbody within its boundaries. BMPs identified in Total Maximum Daily Load restoration plans will improve water quality conditions in impaired waters.
- ***Improve relationships with EPA, States, and the public***—Improved Forest Service BMP program performance and accountability will better demonstrate compliance with CWA permit requirements and State nonpoint source programs and build trust between the agency and our partners and stakeholders.
- ***Improve the agency's ability to demonstrate results in watershed management***—The Forest Service has made a commitment to implement several accountability tools, including a National BMP Program, to document improvements in watershed condition as a result of management and restoration actions.
- ***Improve the agency's ability to use adaptive management in land management plan implementation***—The National BMP Program will provide a consistent, credible, and affordable agencywide BMP monitoring program with coordinated data collection; monitoring information that can be aggregated at any scale; a database accessible to all Forest Service users; and reports that will be shared with EPA, States, and other partners. This type of monitoring program provides a continuous feedback loop for a successful adaptive management process.
- ***Improve National Environmental Policy Act analyses and compliance with other Federal laws***—Improved accountability for water quality management will lead to improved National Environmental Policy Act analysis and documentation and better demonstration of compliance with other Federal laws, such as Endangered Species Act habitat protections for aquatic threatened and endangered species. The agency's ability to respond successfully to water-quality-related appeals and lawsuits will be improved, and management flexibility in decisionmaking will be maintained.

The National BMP Program will provide consistency among Forest Service administrative units to efficiently administer the program and demonstrate improvements in performance and accountability at multiple scales. The National BMP Program consists of four main components: (1) a set of National Core BMPs, (2) a set of standardized monitoring protocols to evaluate implementation and effectiveness of those BMPs, (3) a data management and reporting structure, and (4) corresponding national direction.

The National Core BMPs integrate individual State and Forest Service regional BMPs under one umbrella to facilitate an agencywide BMP monitoring program. The national core set provides general, nonprescriptive BMPs for the broad range of activities that occur on NFS lands. Nearly every BMP in the national core set already exists in current regulations, guidance, or procedures. Adopting a standard national core set of BMPs may change what some national forests and grasslands refer to as their BMPs, but it will not change the substance of site-specific BMP prescriptions. Those prescriptions will continue to be based on State BMPs, regional Forest Service guidance, land management plan standards and guidelines, BMP monitoring information, and professional judgment. Standardization will improve consistency, ensure that Forest Service resource professionals use best available science to develop site-specific BMP prescriptions, and, ultimately, improve water quality on and downstream of NFS lands.

The national BMP monitoring protocols will be used to supplement existing national forest or grassland BMP monitoring programs for those units that already have programs and provide a foundation for those units that do not. Each national forest and grassland will complete a small number of national BMP monitoring evaluations each year for each of the national core BMPs implemented on the unit. This information will be aggregated over time to provide national- and regional-scale evaluations of BMP performance. Identified deficiencies in either BMP implementation or effectiveness will be used to adjust land and resource management activities and the BMPs to improve water quality protection.

In summary, the Forest Service National BMP Program is the agency's nonpoint source pollution control program for achieving and documenting water resource protection. The National BMP Program demonstrates the agency's commitment to land stewardship and protection of water quality consistent with the CWA, State regulations, and other requirements. The National BMP Program is not intended in any way to circumvent or interfere with State and tribal CWA programs, rather it is intended to support and assist the States and tribes in their efforts to ensure compliance on NFS lands. The ultimate goal is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters located within or near the national forests and grasslands

List of Abbreviations

AMP—Allotment Management Plan

AMZ—Aquatic Management Zone

AOI—Annual Operating Instructions

BAER—Burned Area Emergency Response

BLM—Bureau of Land Management

BMP—Best Management Practice

CFR—Code of Federal Regulations

COE—U.S. Army Corps of Engineers

CWA—Clean Water Act

CWE—cumulative watershed effects

DSR—Damage Survey Report

EPA—U.S. Environmental Protection Agency

ERFO—emergency relief for federally owned roads

FERC—Federal Energy Regulatory Commission

FY—fiscal year

FSH—Forest Service Handbook

FSM—Forest Service Manual

IDT—interdisciplinary team

IMT—incident management team

MVUM—Motor Vehicle Use Map

NEPA—National Environmental Policy Act

NFS—National Forest System

NPDES—National Pollutant Discharge Elimination System

NRCS—Natural Resources Conservation Service

RMOs—Road Management Objectives

ROS—Recreation Opportunity Spectrum

SPCC—Spill Prevention Control and Countermeasures

TMDL—total maximum daily load

USDA—U.S. Department of Agriculture

USGS—U.S. Geological Survey

Contents

Part 1. Introduction

High-quality water is one of the most important natural resources coming from the national forests and grasslands. National Forest System (NFS) lands, which represent about 8 percent of the land area of the contiguous United States, contribute 18 percent of the Nation's water supply (Brown et al. 2008; Sedell et al. 2000). About 124 million people rely on NFS lands as the primary source of their drinking water (USDA Forest Service 2008a). In addition to drinking water and other municipal needs, water on NFS lands is important to sustaining populations of fish and wildlife, providing various recreation opportunities, and providing supplies to meet agricultural and industrial needs across the country.

The national forests and grasslands were established to protect the land, secure favorable conditions of water flows, and provide a sustainable supply of goods and services (the Organic Administration Act of 1897). NFS lands are managed using a multiple-use approach with the goal of sustaining healthy terrestrial and aquatic ecosystems while addressing the need for resources, commodities, and services for the American people (USDA Forest Service 2008a). With a growing population and a finite fresh water resource, providing high-quality fresh water supplies is more critical than ever to the social and economic well-being of the United States.

Aquatic Management Zone (AMZ)

An AMZ is an administratively designated zone adjacent to stream channels and other waterbodies. Special management controls aimed at maintaining and improving water quality or other water- and riparian-dependent values, including groundwater-dependent ecosystems, should be applied in the delineated AMZ. The width of the AMZ is determined based on site-specific factors and local requirements. AMZ delineation may encompass the floodplain and riparian areas when present. AMZ designation can have synergistic benefits to other resources, such as maintaining and improving aquatic and riparian area-dependent resources, visual and aesthetic quality, wildlife habitat, and recreation opportunities.

A variety of names for the AMZ concept are used in the States and Forest Service regions: Water Influence Zone (WIZ), Rocky Mountain Region 2 (R2); Stream Environment Zones, Pacific Southwest Region (R5); Riparian Conservation Areas, R5; Riparian Reserves, R5 and Pacific Northwest Region (R6); Riparian Habitat Conservation Areas, R5 and R6; Streamside Management Unit (SMU), R6; Riparian Corridor, Southern Region (R8); Riparian Management Corridor (RMC), Eastern Region (R9); and Riparian Management Area, Alaska Region (R10). For purposes of the National Core BMPs, these areas will be referred to as AMZs.

Forests and grasslands generally produce high-quality water, especially when the ecosystems are healthy and functioning properly. Water quality is influenced by the pattern, magnitude, intensity, and location of land use and management activities. Some land uses can protect or restore water quality, while others may degrade or pose risks to clean water. Excess sediment (turbidity and bedload), nutrients, temperature, hazardous chemicals, and their resulting effects on water chemistry and aquatic habitats, are the most significant water quality issues resulting from land uses and management activities on NFS lands.

Preventing negative water quality impacts is more efficient and effective than attempting to restore the damage. To ensure water quality is protected, the Forest Service, an agency of the U.S. Department of Agriculture (USDA), has developed procedures, methods, and controls, consistent with Federal and State requirements, to address potential pollutants and pollution at their source. Implementation and monitoring of these Best Management Practices (BMPs) is the fundamental basis of the Forest Service water quality management program to protect, restore, or mitigate water quality impacts from activities on NFS lands.

National BMP Program Purpose and Objectives

The purpose of the National BMP Program is to provide a standard set of core BMPs and a consistent means to track and document the use and effectiveness of BMPs on NFS lands across the country. The objectives of the National BMP Program are as follows:

1. To establish uniform direction for BMP implementation to control nonpoint source pollution on all NFS lands to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that will meet the intent of the Federal and State water quality laws and regulations, Executive orders, and USDA and Forest Service directives.
2. To establish a consistent process to monitor and evaluate Forest Service efforts to implement BMPs and the effectiveness of those BMPs at protecting water quality at national, regional, and forest scales.
3. To establish a consistent and creditable process to document and report agency BMP implementation and effectiveness.

The National BMP Program has four components: a national core set of BMPs, a procedural guide for monitoring BMP implementation and effectiveness, a data management system, and corresponding national direction. This technical guide contains the national core set of BMPs to be used in the National BMP Program. The national BMP monitoring protocols will be contained in Volume 2 of this technical guide (FS-990b), which is currently being prepared.

Scope of Technical Guide

This technical guide provides information for implementing the National Core BMP portion of the Forest Service National BMP Program. The National Core BMPs were compiled from Forest Service manuals, handbooks, contract and permit provisions, and policy statements, as well as State or other organizations' BMP documents. The National Core BMPs are not intended to supersede or replace existing regional, State, forest, or grassland BMPs. Rather, the National Core BMPs provide a foundation for water quality protection on NFS lands and facilitate national BMP monitoring.

The National Core BMPs encompass the wide range of activities on NFS lands across the Nation. The primary intent of the National Core BMPs is to carry out one of the Clean Water Act (CWA) purposes to maintain the chemical, physical, and biological integrity of the Nation's waters. To that end, the National Core BMPs are focused on water pollution control. The National Core BMPs also address soil, aquatic, and riparian resources, but only to the extent that they contribute to maintenance of chemical, physical, and biological water quality.

The National Core BMPs in this technical guide are deliberately general and nonprescriptive. Because this document is national in scope, it cannot address all possible practices or practices specific to local or regional soils, climate, vegetation types, or State-specific requirements. The National Core BMPs require the development of site-specific BMP prescriptions based on local site conditions and requirements to achieve compliance with established State, tribal, or national water quality goals. It is expected that State requirements and BMP programs, Forest Service regional guidance, and the land management plan will provide the criteria for site-specific BMP prescriptions. The National Core BMPs provide direction on "what to do" and the local direction will provide direction on "how to do it." Table 1 contains two examples comparing the National Core BMP direction with Forest Service regional direction and State BMPs. Forest Service regions may supplement the National Core BMPs with additional practices or practices that are more specific to meet regional needs.

Table 1.—*Examples of how Forest Service regional direction and State BMPs fit within the National Core BMP framework*

National Core BMP	Region 2 WCP[1]	Region 5 BMP[2]	Montana BMP[3]	Wisconsin BMP[4]
BMP Plan-3 Aquatic Management Zone (AMZ) Planning • Determine width of AMZ for waterbodies in the project area that may be affected by the proposed activities. • Evaluate the condition of riparian habitat and estimated response to the activity to determine need for and width of AMZ. • Use stream class and type, channel condition, aspect, slope, and soils to determine appropriate AMZ width.	**Water Influence Zone (WIZ)** • The WIZ includes the geomorphic floodplain, riparian ecosystem, and inner gorge. • The minimum horizontal width is 100 feet or the mean height of mature dominant late-seral vegetation, whichever is most.	**Practice 1-8 Streamside Management Zone (SMZ) Designation** • Identify the SMZ requirements during environmental documentation process. Each forest's land and resource management plan identifies specific measures to protect these zones. At a minimum, forest requirements must be identified and implemented.	**Width of SMZ-Marking Boundary** • The SMZ width is a 50-foot slope distance on each side of streams, lakes, and other bodies of water measured from the ordinary high water mark. In all cases, except on Class 1 and 2 stream segments and lakes where the slope of the SMZ is greater than 35 percent, the SMZ width is 100 feet.	**Riparian Management Zone (RMZ)** • The RMZ for lakes, designated trout streams, and streams 3 feet wide or wider is a strip of land running along the shoreline of lakes and on each side of a stream. It begins at the ordinary high water mark and extends a minimum of 100 feet landward. • The RMZ for streams less than 3 feet wide is a strip of land on each side of a stream, beginning at the ordinary high water mark and extending a minimum of 35 feet.
BMP Veg-4 Ground-Based Skidding and Yarding Operations • Use ground-based yarding systems only where physical site characteristics are suitable to avoid, minimize, or mitigate adverse effects to soil and water quality. • Use local direction or requirements for slope, erosion potential, mass wasting potential, and other soil or site properties to determine areas suitable for ground-based yarding systems.	**WCP Management Measure 9** • Limit roads and other disturbed sites to the minimum feasible number, width, and total length consistent with the purpose of specific operations, local topography, and climate. • Avoid new roads or heavy equipment use on unstable or highly erodible soils. • Avoid ground skidding on sustained slopes steeper than 40 percent and on moderate to severely burned sustained slopes greater than 30 percent.	**Practice 1-9 Determining Tractor Loggable Ground** • Avoid tractor logging where the predicted post-logging erosion hazard cannot be reduced to either "low" or "moderate."	**Timber Harvesting** • Use the logging system that best fits the topography, soil types, and season while minimizing soil disturbance and economically accomplishing silvicultural objectives. • Topography considerations for "cut-to-length harvesting"—limited to terrain less than 40 percent slope.	**Timber Harvesting** • Avoid operating equipment where excessive soil compaction and rutting may cause erosion that affects water quality. The use of low ground pressure equipment may allow logging to continue. • Where possible, keep skid trail grades less than 15 percent. Grades greater than 15 percent should not exceed 300 feet in length.

[1] *Rocky Mountain Region (Region 2) Watershed Conservation Practices (WCP), Forest Service Handbook 2509.25 (2006).*

[2] *Pacific Southwest Region (Region 5) Water Quality Management for National Forest System Lands in California—Best Management Practices (USDA Forest Service 2000).*

[3] *Water Quality Best Management Practices for Montana Forests. (Logan 2001).*

[4] *Wisconsin's Forestry Best Management Practices for Water Quality (Holaday and Wagner 2010).*

Part 2. Managing Water Quality on National Forest System Lands

Federal Clean Water Act

The Federal Clean Water Act (CWA) (33 U.S.C. § 1251 et seq.) is the foundation for surface water quality protection in the United States. The objective of the CWA, as articulated in section 101, is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. This law uses a variety of regulatory and nonregulatory tools to control direct pollutant discharges from point sources and manage polluted runoff from nonpoint sources to waters of the United States.

In the CWA, Congress gave States and tribes the option for taking primary responsibility for water pollution control. (States will be used in the rest of this report to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the CWA.) As a result, most States and many tribes have taken on that responsibility and, therefore, water quality standards, procedures, rules, and regulations differ from one State to another. The Forest Service, as an agency of the Federal Government, is required to comply with all Federal, State, and local requirements for water pollution control in the same manner and to the same extent as any nongovernmental entity (CWA section 313).

Water Quality Standards

Water quality standards translate the broad goals of the CWA into specific objectives for an individual waterbody. Each State designates uses to be protected for each jurisdictional waterbody within its boundaries. State water quality standards must provide for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water, unless those uses have been shown to be unattainable. States must also adopt water quality criteria to protect such designated uses. In addition, each State must adopt an antidegradation policy. This policy is designed to prevent deterioration of existing levels of water quality, and must, in part, maintain existing uses and the level of water quality necessary to protect such uses. States review their water quality standards periodically and, at a minimum, every 3 years. The EPA reviews and approves State water quality standards to ensure consistency with CWA requirements.

States are required to identify all waters that do not meet water quality standards even after mandatory pollution controls are in place. These waterbodies are considered to be impaired and are placed on the States' biennial 303(d) list. A Total Maximum Daily Load (TMDL) must be developed by the State for all waterbodies on its approved 303(d) list. The TMDL represents the maximum amount of a pollutant that can enter a waterbody without exceeding the water quality standards. The TMDL amount is distributed among all the pollutant sources (point sources, nonpoint sources, and natural background levels) contributing to that particular waterbody. A margin of safety factor is also considered. A TMDL analysis must clearly identify the links between the waterbody use impairment, the causes of the impairment, and the pollutant load reductions needed to meet the applicable water quality standards. EPA reviews and approves TMDLs and must complete the TMDL if it disapproves the State-developed TMDL. TMDLs are used as planning tools by States to develop specific methods or controls used to meet water quality standards in the impaired waterbody. The point source components of a TMDL are implemented through existing enforceable Federal programs (e.g., National Pollutant Discharge Elimination System [NPDES]). Nonpoint source controls (e.g., Best Management Practices [BMPs]) required by a TMDL can be implemented through a voluntary approach or some State and local regulations or other authorities. A specific TMDL implementation plan is not required by the CWA; however, some States require a TMDL implementation plan or watershed restoration plan.

Point Source Pollution Control

Point source pollution is regulated through a permitting program as outlined in CWA sections 401, 402, and 404. Section 401 provides an opportunity for States to ensure that a permit or license issued by the Federal Government meets applicable State water quality requirements. Federal agencies may not issue permits for activities that "may result in any discharge into navigable waters" until the agency obtains certification from the State that the authorized activity will comply with water quality standards. Each State has its own rules and procedures for 401 Certification. Certification generally applies to point source discharges where a 402 or 404 permit is issued by the EPA or the U.S. Army Corps of Engineers (COE) and for Federal Energy Regulatory Commission licenses. Certification may also be required for some Forest Service special use authorizations and mining plan of operations where there would be a point source discharge. Section 401 is a "condition precedent;" that is, 401 Certification must be obtained and proof provided to the Federal agency before the permit or license can be issued.

The NPDES program is described in CWA section 402. NPDES permits, or the State equivalent, regulate point source discharges. A point source discharge is defined as any addition of a pollutant to waters of the United States from a point source (e.g., a discrete conveyance such as pipes or manmade ditches). Aside from stormwater discharge permits, in general, few types of Forest Service administrative activities would require a NPDES permit. The project proponent is responsible for obtaining permit coverage. Section 402 is "condition subsequent" (i.e., the Forest Service can approve the activity before the 402 permit being obtained).

Stormwater discharges occur when runoff generated by rain or snowmelt events flows over land or impervious surfaces and is discharged to waters of the United States through discrete conveyances such as ditches or channels. Stormwater runoff does not percolate into the ground and may pick up and transport debris, chemicals, sediment, or other pollutants as it flows over the land or impervious surfaces. These pollutants could adversely affect water quality if the runoff is not treated before it is discharged into a surface waterbody. Stormwater discharge permits are required for certain categories of industrial activities and construction activities. The "operator," defined as the one who has operational control over the construction plans and specifications and has day-to-day operational control over activities at the site, is the party that should obtain stormwater permit coverage. The contractor or permittee and the Forest Service may be required to obtain permit coverage if either or both are considered the operator. Permits for industrial or construction activities or other temporary disturbances generally require BMPs as a primary method of controlling and containing stormwater runoff to protect water quality.

CWA section 404 regulates the discharge of dredge or fill materials into waters of the United States. EPA and the COE jointly administer the 404 program. Unless a State has assumed 404 permitting authority, the COE is responsible for issuing 404 permits. Typical Forest Service activities that could require a 404 permit include stream crossings, stream restoration, habitat improvements, activities in wetlands, and spring developments. Certain silviculture activities are exempt from 404 permits (CWA §404[f][1][A], 33 CFR 323.4[a] [1] and 40 CFR 232.3[c][1]). Forest roads, as defined by COE guidance, are exempt from needing 404 permits as long as the BMPs detailed in the regulations are used to ensure that flow and circulation patterns and chemical and biological characteristics of the waters of the United States are not impaired (CWA § 404[f][1][E], 33 CFR 323.4[a] [6] and 40 CFR 232.3[c] [6][i-xv]). General 404 permits (nationwide or regional) have been established for many categories of activities. If a proposed activity cannot be covered by a general 404 permit, an individual 404 permit is required. The project proponent or permittee is responsible for obtaining the 404 permit. Like section 402, section 404 is "condition subsequent," so the activity, either a Forest Service project or a third-party activity proposed on National Forest System (NFS) lands, can be approved by the Forest Service before the 404 permit coverage is obtained. The project cannot be implemented until permit coverage is acquired.

Nonpoint Source Pollution Control

The CWA does not regulate nonpoint source pollution. Instead, sections 208 and 319 require States to develop a process to identify, if appropriate, agricultural, silvicultural, and other categories of nonpoint sources of pollution and to set forth procedures and methods, including land use requirements, to control to the extent practicable such sources. Each State has a Nonpoint Source Management Program and Plan that directs how the State will control nonpoint source pollution. The Nonpoint Source Management Plan describes the process, including intergovernmental coordination and public participation, for identifying BMPs to control identified nonpoint sources and to reduce the level of pollution from such sources. States often use these same sets of BMPs as the best approach to control point source discharges, such as stormwater discharges.

After BMPs have been approved by a State, the BMPs may become the primary mechanism for meeting water quality standards from nonpoint source pollution sources in that State. Proper installation, operation, and maintenance of State approved BMPs are presumed to meet a landowner or manager's obligation for compliance with applicable water quality standards. If subsequent evaluation indicates that approved and properly installed BMPs are not achieving water quality standards, the State should take steps to revise the BMPs, evaluate and, if appropriate, revise water quality standards (designated uses and water quality criteria), or both. Through the iterative process of monitoring and adjusting BMPs and water quality standards, it is anticipated and expected that BMPs will lead to attainment of water quality standards (EPA 1987).

State Nonpoint Source Management Programs

Each State develops a set of BMPs as part of its Nonpoint Source Management Program. In many States, use of BMPs is voluntary; that is, it is encouraged but not required by regulation. Other States have a regulatory framework for nonpoint sources, either through their water quality laws and regulations or forest practices laws and regulations, where use of BMPs is required.

All national forests and grasslands have adopted BMPs consistent with or approved by State nonpoint source management programs. In some States, the Forest Service uses the State BMPs as written, in addition to land management plan direction. In some Forest Service regions, the Forest Service has established BMPs, and the States have agreed that those practices conform to State requirements. In a few instances, Forest Service BMPs have gone through a formal public review process, Forest Service BMPs have been approved by the State and EPA, and the Governor of the State has designated the Forest Service as the water quality management agency for NFS lands within the State. In many States, the Forest Service has entered into an agreement that outlines how the Forest Service will implement that particular State's Nonpoint Source Management Plan on NFS lands (see table 2).

Table 2.—*Forest Service water quality agreements with States as of November 2011*

MAA	MOA	MOU		LOC
AL (1990)	AK (1992)	AZ (2008)	NV (2009)	AR (1990)
CA (1981)	WA (2000)	GA (1991)	OR (2002)	FL (1990)
MS (1990)		ID (2008)	SC (1990)	MS (1990)
		KY (1990)	SD (2009)	OK (1991)
		LA (1993)	TN (1997)	VA (1990)
		MI (2011)	TX (1991)	
		MT (2008)	UT (2009)	
		NC (1992)	WV 2010	
		NM (2011)	WY (2011)	

LOC – Letter of Certification. MAA – Management Agency Agreement.
MOA – Memorandum of Agreement. MOU – Memorandum of Understanding.

Forest Service Policy for Water Quality Management

Forest Service Manual (FSM) Direction

Forest Service policy for watershed management is contained in FSM 2500. Watershed management activities on national forests and grasslands are to be implemented in accordance with the general objectives of multiple use and the specific objectives in the land management plan. All management activities of other resources are to be designed to minimize short-term impacts on the soil and water resources and to maintain or enhance long-term productivity, water quantity, and water quality (FSM 2503).

Forest Service policy for watershed management also includes monitoring to assess the degree to which planning, management operation, and maintenance of renewable resources meet established goals and standards (FSM 2525). Soil and water resource monitoring is to be designed and implemented to evaluate effects of each forest management activity or program on basic soil and water quality and productivity. The objectives of monitoring are to secure data sufficient to assist line officers and resource managers in evaluating the effects of management activities on the soil and water resources and to support changes in management activities to protect soil and water quality.

FSM 2532 provides policy and direction specific to water quality management on NFS lands. The objective of water quality management on NFS lands is to protect and, where needed, improve the physical, chemical, biological, and aesthetic quality of the water resource consistent with the purposes of the national forests and national water quality goals. BMPs are to be promoted and applied to all management activities as the method for control of nonpoint sources of water pollution to achieve established State or national water quality goals. BMPs applied should be based on site-specific conditions and political, social, economic, and technical feasibility. Application of the National BMP Program should constitute compliance with water quality standards. Monitoring methods that reflect nonpoint source conditions should be used to measure effectiveness of those BMPs.

Forest Service Nonpoint Source Strategy

The Forest Service strategy for control of nonpoint source pollution is to apply appropriate BMPs using adaptive management principles. This strategy involves applying approved BMPs, monitoring the implementation and effectiveness of the BMPs, and using the monitoring results to inform and improve management activities. This process is illustrated in figure 1 and outlined in the following list.

1. Approved BMPs are applied to all management activities to control nonpoint sources of water pollution and are used for compliance with established State or national water quality goals.
    a. Site-specific BMP prescriptions, consistent with the National Core BMPs, are developed using regional or State BMPs and land management plan direction.
    b. BMP prescriptions are properly installed and maintained to minimize impacts of current management activities to protect and maintain water quality.
2. BMP implementation and effectiveness are monitored using National Core BMP monitoring protocols and reporting systems.
    a. Field evaluations are used to monitor BMP implementation to determine whether appropriate site-specific BMP prescriptions were planned and implemented as intended.

b. Field evaluations of appropriate parameters or surrogates are used to monitor BMP effectiveness to determine if the applied practices met the desired objective(s).

c. BMP monitoring data is managed in the established corporate data system and analyzed at national, regional, and forest or grassland levels.

3. BMP monitoring results are used to inform and improve management activities.

   a. The results of BMP monitoring and best available science are used, in collaboration with Federal, State, and local agencies and partners as appropriate, to improve administrative procedures and BMP practices and applications.

   b. Corrective actions are initiated where implementation monitoring indicates that BMPs have been implemented, but effectiveness monitoring indicates that BMP objectives were not met.

   c. Changes in water quality designated uses and standards are recommended as necessary, in coordination with the appropriate agency.

4. Monitoring results and findings are documented and shared with appropriate Federal, State, and local agencies.

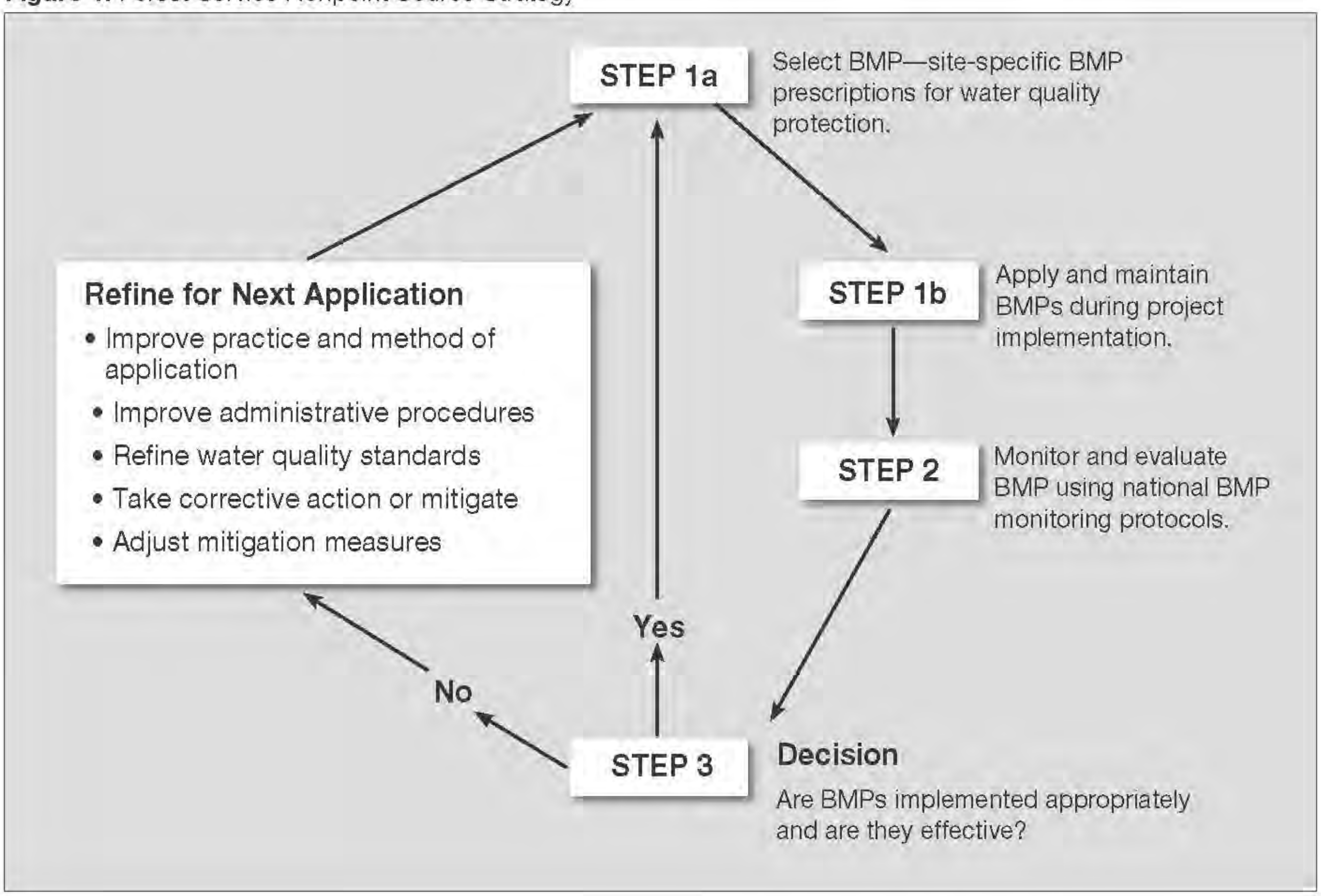
Plan to Project: Forest Service BMP Process

The Forest Service BMP Process consists of the following steps to incorporate BMPs into project planning and on-the-ground implementation to ensure water quality is protected.

BMP Selection and Design

Water quality goals and objectives are established in the land management plan (see BMP Plan-1 Forest and Grassland Planning). These goals are specific to each individual national forest or grassland and are intended to meet or exceed applicable legal requirements including the CWA and State water quality regulations. A land management plan may also specify BMPs as standards and guidelines to be used to meet those goals and objectives.

Figure 1. Forest Service Nonpoint Source Strategy



The project planning process starts when a project or resource management activity is proposed. A project may be initiated by the Forest Service to implement some aspect of the land management plan, or may be proposed by an outside party that wants to occupy or use NFS lands for a specific purpose, such as for mining, a commercial recreation development, or a utility facility. When a project is initiated, the responsible official, usually the local district ranger or forest supervisor, appoints an interdisciplinary team (IDT) to complete the appropriate environmental analysis as required by the National Environmental Policy Act (NEPA) to inform the decision on the project or activity.

In the project planning and environmental analysis process, the IDT selects appropriate or required BMPs to be used to achieve land management plan water quality goals and objectives (see BMP Plan-2 Project Planning and Analysis). BMPs are selected to fit local conditions, resource values, and designated uses of water. Site-specific BMP prescriptions are developed based on the proposed activity, water quality objectives, soils, topography, geology, vegetation, climate, and other site-specific factors and are designed to avoid, minimize, or mitigate potential adverse impacts to soil, water quality, and riparian resources. State BMPs, regional Forest Service guidance, land management plan standards and guidelines, monitoring results, and professional judgment are all used to develop site-specific BMP prescriptions. During the planning process, CWA or other State-required permits or certifications are also identified. The site-specific BMP prescriptions and other permit requirements are described and disclosed in the NEPA analysis document or project file. The responsible official considers the information provided by the IDT and makes a decision on which site-specific BMP prescriptions will be applied to the project.

BMP Application

The site-specific BMP prescriptions are translated into contract provisions, special use authorization requirements, project plan specifications, and other similar documents. This ensures that the operator or person responsible for applying the BMPs is required to do so. Implementation of projects or other management activities are supervised by Forest Service personnel to ensure the site-specific BMP prescriptions are implemented according to the contract, permit, or plan. During project or activity implementation, site-specific BMP prescriptions are adjusted as needed to better fit current site conditions. As part of project, contract, or permit administration, project or activity inspections are completed as needed to identify BMP deficiencies or maintenance needs. BMP application is documented in the appropriate project-related documents.

BMP Monitoring and Adjustment

Implementation and effectiveness of applied BMPs are monitored to inform and improve future management activities. BMP implementation monitoring asks the question: "Did we do what we said we were going to do?" BMP effectiveness monitoring evaluates whether the BMPs were effective in meeting management objectives and protecting designated uses.

Programmatic BMP Monitoring in
The Pacific Southwest Region
Best Management Practices Evaluation Program

The Forest Service Pacific Southwest Region has a Management Agency Agreement with the State of California requiring the Forest Service to incorporate BMPs into land and resource management activities and to monitor their implementation and effectiveness. Since 1992, the region has been monitoring BMPs using its BMP Evaluation Program. The Forest Service evaluates BMP implementation and effectiveness at randomly selected sites using 29 different monitoring protocols. Every year, the region assigns each national forest system unit a certain number of evaluations to complete. From fiscal year (FY) 2003 to FY 2007, the Forest Service completed 2,861 onsite evaluations; an average of 572 per year. The Forest Service rated BMPs as implemented on 86 percent of those evaluations and effective on 89 percent. Overall, 93 percent of the BMPs that were rated as implemented were also judged effective.

This monitoring has shown that BMPs are effective at protecting water quality when they are properly implemented. From this monitoring, the Pacific Southwest Region has concluded that the greatest opportunity for improving water quality is to improve implementation of the BMPs, particularly for recreation activities and mining. The region has planned steps to improve BMP implementation and effectiveness including BMP implementation checklists for projects, reviews of national forest staffing levels, and revision of BMPs that have relatively low effectiveness when implemented properly (USDA Forest Service 2009a).

The Forest Service Nonpoint Source Strategy uses "programmatic monitoring" to evaluate BMP implementation and effectiveness; that is, aside from project administration described above, BMPs are not monitored on every project or activity that occurs on NFS lands. Projects to monitor or specific monitoring sites are selected in a manner that results in objective and representative data on BMP implementation and effectiveness. Often, a random or systematic random selection procedure is used to choose monitoring locations across a forest or grassland where specific activities or BMPs are targeted. In some cases, a national forest or ranger district will choose a small number of projects to review using an IDT process. BMP monitoring results are summarized in land management plan monitoring reports.

Programmatic BMP monitoring is used for a variety of purposes. The adequacy of specific BMPs or management activities at protecting water quality can be evaluated. These results can be used to inform future environmental analysis of similar projects under similar conditions. For example, programmatic BMP monitoring on the Flathead and Kootenai National Forests in Montana has found that, since 1988, BMPs were effective 99.3 percent of the time when properly applied on glacial till soils (USDA Forest Service 2009b).

Programmatic BMP monitoring can assess administrative processes for selecting and applying appropriate BMPs over time or geographic area. After several years of BMP monitoring on silviculture activities, the Black Hills National Forest in South Dakota and Wyoming found that BMPs were generally being implemented and, when implemented, were effective in the timber sale units that were inspected. The BMP monitoring identified some issues with road drainage, however. As a result, the forest engineering and watershed staff together developed recommendations to improve their BMPs for road drainage (USDA Forest Service 2010a). In another example, the North Carolina National Forests compared BMP implementation and effectiveness on timber sales as monitored from 1992 to 2000 to BMP monitoring results in 2009 and 2010 (USDA Forest Service 2010b). Overall BMP implementation improved from 68 percent in the earlier monitoring period to 92 percent in 2009 and 2010. BMP effectiveness also improved from 73 percent in 1992 to 2000 to 93 percent in 2009 and 2010.

Montana's Forestry BMP Audits

The Montana Department of Natural Resources and Conservation, Forestry Division, has evaluated forest practices for BMP implementation and effectiveness every 2 years since 1990 (Ziesak 2010). The Forestry Division has evaluated timber harvest sites on Federal, State, and private lands. Over all ownerships, BMP implementation has improved from 78 percent rated as "meets or exceeds criteria" in 1990 to 97 percent in 2010. Similarly, BMP effectiveness has also improved, from 80 percent rated as providing "adequate protection" in 1990 to 98 percent in 2010. BMP implementation and effectiveness on timber harvest sites on NFS lands has been consistently rated high over the past few audit cycles.

	2010	2008	2006
BMP Implementation	96%	96%	93%
BMP Effectiveness	98%	96%	95%
Streamside Management Zone (SMZ) Implementation	94%	99%	100%
SMZ Effectiveness	95%	99%	100%

In addition to BMP monitoring by the Forest Service, many States monitor BMP implementation and effectiveness on timber sale projects on NFS lands. These State audits are generally completed every 3 to 5 years, or annually in some States. The audit teams are comprised of State employees, Forest Service and other Federal agency employees, representatives from the timber industry, and landowners. Selected timber sale projects on private and State lands are audited along with projects on NFS lands. In general, BMP implementation and effectiveness on NFS lands as rated by these State audit teams compares favorably with, and often exceeds, the BMP performance on private or State lands.

Summary

The Forest Service policy for control of nonpoint sources of pollution is to use BMPs, monitor the implementation and effectiveness of those BMPs, and adjust management practices using monitoring results. An administrative unit IDT identifies the appropriate BMPs for a project during the planning process and develops site-specific BMP prescriptions based on site conditions, State BMPs, and other local guidance or requirements. The responsible official considers the information provided by the IDT and makes a decision on which site-specific BMP prescriptions will be applied to the project. Unit staff monitor BMPs and summarize monitoring data at the forest or grassland level in either project documentation or the land management plan monitoring reports.

The National BMP Program provides core BMPs and BMP monitoring protocols for all activities on NFS lands. In the past, most of the BMP monitoring has focused on timber harvest sites and associated roads. The National BMP Program expands that to include all activities by providing consistent monitoring protocols for recreation, livestock grazing, fire and fuels, and minerals, in addition to vegetation management and roads. The National BMP Program will also have an associated data management system that will facilitate documentation and reporting of BMP monitoring results at national forest or grassland, regional, or national scales.

Part 3. National Core Best Management Practices

This part describes the Forest Service National Core Best Management Practices (BMPs). The National Core BMPs are intended for use on National Forest System (NFS) lands as part of the Forest Service strategy for water quality management. The National Core BMPs are grouped into the following resource categories:

- Plan General Planning Activities
- AqEco Aquatic Ecosystems Management Activities
- Chem Chemical Use Management Activities
- Fac Facilities and Nonrecreation Special Uses Management Activities
- Fire Wildland Fire Management Activities
- Min Minerals Management Activities
- Range Rangeland Management Activities
- Rec Recreation Management Activities
- Road Road Management Activities
- Veg Mechanical Vegetation Management Activities
- WatUses Water Uses Management Activities

With the exception of the General Planning Activities being listed first, the sequence in which these resource categories are presented has no intended significance. Planning is important to managing potential management activity impacts to achieve water quality goals and objectives and, therefore, is listed first.

Each BMP is organized according to the following format:

Title	Includes the sequential number of the BMP within the resource category and title of the BMP.
Reference	Identifies the Forest Service Manual or Handbook direction pertinent to the BMP.
Objective	Describes the desired results or attainment of the BMP as it relates to maintaining chemical, physical, and biological water quality.
Explanation	Provides background information to provide context for the BMP. Describes criteria or standards used when applicable.
Practices	Lists recommended methods to achieve the BMP objectives.

The National Core BMPs are deliberately general and nonprescriptive. Although some impacts may be thought of as characteristic of a management activity, the actual potential for a land use or management activity to impact water quality depends on:

1. The physical, biologic, meteorological, and hydrologic environment where the activity takes place (e.g., topography, physiography, precipitation, stream type, channel density, soil type, and vegetative cover).
2. The type of activity imposed on a given environment (recreation, mineral exploration, and vegetation management) and the proximity of the activity area to surface waters.
3. The magnitude, intensity, duration, and timing of the activity (grazing system used, types of silvicultural practices used, constant use as opposed to seasonal use, recurrent application, or one-time application).

4. The State designated beneficial uses of the water in proximity to the management activity and their relative sensitivity to the potential impacts associated with the activity.

These four factors vary throughout the lands administered by the Forest Service. It follows then, that the extent and kind of potential water quality impacts from activities on NFS lands are variable, as are the most appropriate mitigation and pollution control measures. No solution, prescription, method, or technique is best for all circumstances.

The National Core BMPs cannot include all possible practices or techniques to address the range of conditions and situations on all NFS lands. **Each BMP in this document has a list of recommended practices that should be used, as appropriate or when required, to meet the objective of the BMP. Not all recommended practices will be applicable in all settings, and there may be other practices not listed in the BMP that would work as well, or better, to meet the BMP objective in a given situation.** The specific practices or methods to be applied to a particular project should be determined based on site evaluation, past experience, monitoring results, new techniques based on new research literature, and other requirements. **State BMPs, Forest Service regional guidance, land management plans, BMP monitoring information, and professional judgment should be used to develop site-specific BMP prescriptions.**

For example, BMP Road-4 (Road Operations and Maintenance) dictates that roads should be correctly maintained to drain and disperse water runoff to minimize the erosive effects of concentrated water flow. Some methods for draining a road are to outslope the road prism, install dips, and lead out ditches or inslope the road to a ditch line and install culverts. It is during the onsite evaluation of a specific road project that the appropriate method or combination of methods to drain the road correctly is identified. The practice is, thereby, custom fit to the physical and biological environment of the project area.

After the site-specific BMP prescription is developed, it must then be included in the appropriate National Environmental Policy Act decision document and project contract or operation plan. For example, if roadwork is part of a timber harvest project, the timber sale contract is used to implement the methods for road drainage. For a hard rock mine operation, the roadwork BMP prescriptions would be included in the mining plan of operation. Roadwork BMP prescriptions would be implemented via a ski area's operation and maintenance plan for roads within a ski resort.

The National Core BMPs are grouped by resource category for ease of organization. The applicable BMPs should be used for an activity regardless of which resource grouping the BMP is listed in. For example, BMPs for Mechanical Vegetation Management Activities should be used, as appropriate, for tree removal activities in developed campgrounds. Likewise, Road Management Activity BMPs apply whether the road is for timber harvesting, mining, recreation access, or some other purpose. The specific implementing document and responsible individual will differ by resource area (e.g., recreation development plan and recreation staff officer for a recreation project, and a timber sale contract and timber sale administrator for a timber sale), but the responsibility to maintain and improve water quality is shared by all and not necessarily vested with a given resource functional area.

At the end of each resource category is a listing of additional BMP resources, including publications and Web sites, applicable to the subject resource category. The resources listed are not all inclusive; other technical resources should be consulted as needed and required.

General Planning Activities

Planning is an important Best Management Practice (BMP) for water quality management. In the planning process, potential impacts to water quality, and impacts to other resources like soils or riparian areas that may affect water quality, can be identified. In addition, requirements from laws or regulations, the land management plan, State BMPs, or other documents can be incorporated into the project design. This information can be used to shape the proposed action, develop alternatives to the proposed action, and determine appropriate site-specific BMP prescriptions to avoid, minimize, or mitigate impacts to meet water quality objectives.

Three National Core BMPs are in the General Planning Activities category. These planning BMPs are to be used during Forest Service planning processes for projects and activities on National Forest System (NFS) lands. BMP Plan-1 (Forest and Grassland Planning) contains guidance on what to include in a land management plan to provide direction for management of water quality within a plan area. BMP Plan-2 (Project Planning and Analysis) contains planning practices common to most Forest Service resource management activities. BMP Plan-2 should be used for all Forest Service activities and authorizations that could affect water quality. BMP Plan-3 (Aquatic Management Zone Planning) contains planning practices common to management of Aquatic Management Zones (AMZ).

In addition, each resource category section in this technical guide includes a planning BMP specific to the management activities addressed in that section. The activity-planning BMPs provide additional practices specific to those management activities.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

General Planning BMPs	
Plan-1	Forest and Grassland Planning
Plan-2	Project Planning and Analysis
Plan-3	Aquatic Management Zone Planning

Plan-1. Forest and Grassland Planning

Manual or Handbook Reference Forest Service Manual (FSM) 1900, FSM 1920, Forest Service Handbook (FSH) 1909.12, and FSM 2511.

Objective Use the land management planning and decisionmaking processes to incorporate direction for water quality management consistent with laws, regulation, and policy into land management plans.

Explanation The overall goal of managing NFS lands is to sustain the multiple uses of renewable resources in perpetuity while maintaining the long-term productivity of the land. Federal laws, such as the National Forest Management Act and the CWA, provide additional goals to protect or maintain and improve or restore the quality of soil and water on NFS lands. These goals are codified as policy in the Forest Service manuals and handbooks.

Forest Service planning is an integrated process composed of discrete parts—the strategic plan, land management plans, and project and activity plans. The Forest Service Strategic Plan identifies long-term strategic priorities and is the basis for integrated delivery of the agency's mission. The land management plan blends national and regional priorities from the strategic plan with local forest or grassland capability and needs. The land management plan establishes desired conditions to be achieved through management of NFS lands in the planning area to best meet the needs of the American people. The land management plan provides desired conditions, objectives, and guidance for site-specific project and activity decisions. Project-level plans describe on-the-ground projects and activities designed to achieve long-term objectives and desired conditions described in the land management plan while reflecting current local needs and issues.

The land management plan provides integrated direction for the management, protection, and use of all resources in the planning area under the principles of multiple use and sustained yield. In the land management plan, issues, concerns, and opportunities related to soil and water resources are resolved; desired conditions, goals, and objectives for soil, water, and riparian resources are established; and standards and guidelines for management of soil, water quality, and riparian resources are provided.

Practices

- Establish desired conditions, goals, and objectives for soil, water quality, and riparian resources that contribute to the overall sustainability of social, economic, and ecological systems in the plan area consistent with established State or national water quality goals for the plan area.
  - Consider the water quantity, quality, location, and timing of flows needed to provide water supplies for municipal, agricultural, commercial, and industrial uses; hydropower generation; water recreation, transportation, and spiritual uses; aesthetic appreciation; and tourism to contribute to social and economic sustainability.
  - Consider the water quantity, quality, location, and timing of flows needed to provide the ecological conditions to support diversity of native and desired nonnative plants and animal species in the plan area to contribute to ecological sustainability.
- Include plan objectives to maintain or, where appropriate, improve or restore watershed conditions to achieve desired conditions of soil, water quality, and riparian resources.
- Consider watershed characteristics, current and expected environmental conditions (including climate change), and potential effects of land uses when determining suitability of NFS lands within the planning area for various uses.
- Include standards and guidelines to maintain and, where appropriate, improve over time the quality of soil, water resources, and riparian areas when implementing site-specific projects and activities.
- Include monitoring questions and associated performance measures to address watershed condition and water quality goals and objectives.

Plan-2. Project Planning and Analysis

Manual or Handbook Reference FSM 1950, FSH 1909.15, and FSM 2524.

Objective Use the project planning, environmental analysis, and decisionmaking processes to incorporate water quality management BMPs into project design and implementation.

Explanation The project planning, environmental analysis, and decisionmaking process is the framework for incorporating water quality management BMPs into project design and implementation. The process should identify likely direct, indirect, or cumulative impacts from the proposed project or management activities on soils, water quality, and riparian resources in the project area. Project documents (plans, contracts, permits, etc.) should include site-specific BMP prescriptions to meet water quality objectives as directed by the environmental analysis. Project planning should ensure that activities are consistent with land management plan direction; State BMPs, floodplain, wetland, coastal zone; and other requirements including CWA 401 certification, CWA 402 permits. and CWA 404 permits; wilderness or wild and scenic river designations; and other Federal, State, and local rules and regulations.

Practices

- Include watershed specialists (hydrologist, soil scientist, geologist, and fish biologist) and other trained and qualified individuals on the interdisciplinary team for project planning, environmental analysis, and decisionmaking to evaluate onsite watershed characteristics and the potential environmental consequences of the proposed activity(s).
- Determine water quality management objectives for the project area.
    - Identify water quality management desired conditions and objectives from the land management plan.
    - Identify and evaluate the condition of water features in the project area (e.g., streams, lakes, ponds, reservoirs, wetlands, riparian areas, springs, groundwater-dependent ecosystems, recharge areas, and floodplains).
    - Identify State-designated beneficial uses of waterbodies and the water quality parameters that are critical to those uses.
    - Identify locations of dams and diversions for municipal or irrigation water supplies, fish hatcheries, stockwater, fire protection, or other water uses within the project area.
    - Identify any impaired (e.g., 303[d] listed) waterbodies in the project area and associated Total Maximum Daily Load (TMDL) analyses or other restoration plans that may exist.
    - Identify threatened, endangered, or sensitive species in or near water, wetlands, and riparian areas in the project area and their habitat needs related to water quality.
- Determine potential or likely direct and indirect impacts to chemical, physical, and biological water quality, and watershed condition from the proposed activity.
    - Always assume hydrological connections exist between groundwater and surface water in each watershed, unless it can reasonably be shown none exist in a local situation.
    - Consider the impacts of current and expected environmental conditions such as atmospheric deposition and climate change in the project area when analyzing effects of the proposed activities.
    - Evaluate sources of waterbody impairment, including water quantity, streamflows, and water quality, and the likelihood that proposed activities would contribute to current or future impairment or restoration to achieve desired watershed conditions.
    - Identify and delineate unstable areas in the project area.
    - Identify soil limitations and productivity impacts of proposed activities.
    - Verify preliminary findings by inspecting the sites in the field.
    - Develop site-specific BMP prescriptions, design criteria, and mitigation measures to achieve water quality management objectives. Consult local, regional, State, or other agencies' required or recommended BMPs that are applicable to the activity.
    - Consider enhanced BMPs identified in a TMDL or other watershed restoration plan to protect impaired waterbodies within the project area.

- Use site evaluations, professional experience, monitoring results, and land management plan standards, guidelines, and other requirements.
- Identify Federal, State, and local permits or requirements needed to implement the project Examples include water quality standards, CWA 401 certification, CWA 402 permits (including stormwater permits), CWA 404 permits, and Coastal Zone Management Act requirements.
- Plan to limit surface disturbance to the extent practicable while still achieving project objectives.
- Designate specific AMZs around water features in the project area (see BMP Plan-3 [AMZ Planning]).
- Design activities on or near unstable areas and sensitive soils to minimize management-induced impacts.
- Use local direction and requirements for prevention and control of terrestrial and aquatic invasive species.

• Use suitable tools to analyze the potential for cumulative watershed effects (CWE) to occur from the additive impacts of the proposed project and past, present, and reasonably foreseeable future activities on NFS and neighboring lands within the project watersheds.
  - Consider the natural sensitivity or tolerance of the watershed based on geology, climate, and other relevant factors.
  - Consider the existing condition of the watershed and water quality as a reflection of past land management activities and natural disturbances.
  - Estimate the potential for adverse effects to soil, water quality, and riparian resources from current and reasonably foreseeable future activities on all lands within the watershed relative to existing watershed conditions.
  - Use land management plan direction; Federal, State, or local water quality standards; and other regulations to determine acceptable limits for CWE.
  - Modify the proposed project or activity as necessary by changing project design, location, and timing to reduce the potential for CWE to occur.
  - Consider including additional mitigation measures to reduce project effects.
  - Identify and implement opportunities for restoration activities to speed recovery of watershed condition before initiating additional anthropogenic disturbance in the watershed.
  - Coordinate and cooperate with other Federal, State, and private landowners in assessing and preventing CWE in multiple ownership watersheds.

• Integrate restoration and rehabilitation needs into the project plan.
  - Consider water quality improvement actions identified in a TMDL or other watershed restoration plan to restore impaired waterbodies within the project area.

• Identify project-specific monitoring needs.

• Document site-specific BMP prescriptions, design criteria, mitigation measures, and restoration, rehabilitation, and monitoring needs in the applicable National Environmental Policy Act (NEPA) documents, design plans, contracts, permits, authorizations, and operation and maintenance plans.
  - Delineate all protected or excluded areas, including, for example, AMZs and waterbodies, 303(d) listed and TMDL waterbodies, and municipal supply watersheds, on the project map.

Plan-3 Aquatic Management Zone Planning

Manual or Handbook Reference FSM 2526.

Objective To maintain and improve or restore the condition of land around and adjacent to waterbodies in the context of the environment in which they are located, recognizing their unique values and importance to water quality while implementing land and resource management activities.

Explanation The land around and adjacent to waterbodies plays an important ecologic role in maintaining the structure, function, and processes of the aquatic ecosystem. These areas provide shading, soil stabilization, sediment and water filtering, large woody debris recruitment, and habitat for a diversity of plants and animals. The quality and quantity of water resources and aquatic habitats may be adversely affected by ground-disturbing activities that occur on these areas. Because of the importance of these lands, various legal mandates have been established pertaining to management of these areas, including, but not limited to, those associated with floodplains, wetlands, water quality, endangered species, wild and scenic rivers, and cultural resources. Protection and improvement of soil, water, and vegetation are to be emphasized while managing these areas under the principles of multiple use and sustained yield. Riparian-dependent resources are to be given preferential consideration when conflicts among land use activities occur.

Designation of a zone encompassing these areas around and adjacent to a waterbody is a common BMP to facilitate management emphasizing aquatic and riparian-dependent resources. These management zones are known by several common terms such as streamside management area or zone, riparian management area, stream environment zone, and water influence zone. For purposes of the National Core BMPs, these areas will be referred to as AMZs.

AMZs are intended to be large enough to protect a waterbody and its associated beneficial uses and aquatic and riparian ecosystems. AMZs along streams and rivers may be linear swaths extending a prescribed distance from a bank, though widths are usually adjusted to include features such as riparian vegetation and unstable landforms as well as critical floodplain components necessary to sustain waterbody integrity and protect beneficial uses. AMZ areas around wetlands, lakes, and other nonlinear features may be irregular in shape to encompass sensitive riparian areas and other water-dependent features.

Local regulation often stipulates the area and extent of AMZs and may be listed in land management plans; biological opinions, evaluations, or assessments; and other regional or State laws, regulations, and policies. Virtually all States have BMPs that include AMZs, as do most land management plans.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Proactively manage the AMZ to maintain or improve long-term health and sustainability of the riparian ecosystem and adjacent waterbody consistent with desired conditions, goals, and objectives in the land management plan.
    - Balance short-term impacts and benefits with long-term goals and desired future conditions, considering ecological structure, function, and processes, when evaluating proposed management activities in the AMZ.
- Determine the width of the AMZ for waterbodies in the project area that may be affected by the proposed activities:

- Evaluate the condition of aquatic and riparian habitat and beneficial riparian zone functions and their estimated response to the proposed activity in determining the need for and width of the AMZ.
- Use stream class and type, channel condition, aspect, side slope steepness, precipitation and climate characteristics, soil erodibility, slope stability, groundwater features, and aquatic and riparian conditions and functions to determine appropriate AMZ widths to achieve desired conditions in the AMZ.
- Include riparian vegetation within the designated AMZ and extend the AMZ to include steep slopes, highly erodible soils, or other sensitive or unstable areas.
- Establish wider AMZ areas for waters with high resource value and quality.

- Design and implement project activities within the AMZ to:
    - Avoid or minimize unacceptable impacts to riparian vegetation, groundwater recharge areas, steep slopes, highly erodible soils, or unstable areas.
    - Maintain or provide sufficient ground cover to encourage infiltration, avoid or minimize erosion, and to filter pollutants.
    - Avoid, minimize, or restore detrimental soil compaction.
    - Retain trees necessary for shading, bank stabilization, and as a future source of large woody debris.
    - Retain floodplain function.
    - Restore existing disturbed areas that are eroding and contributing sediment to the waterbody.
- Mark the boundaries of the AMZ and sensitive areas like riparian areas, wetlands, and unstable areas on the ground before land disturbing activities.

Resources for General Planning Activities

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U.S. Environmental Protection Agency, Office of Federal Activities. 1999. Considering ecological processes in environmental impact assessments, July 1999. Washington, DC. 90 p. Available at http://www.epa.gov/compliance/resources/policies/nepa/index.html.

Riparian Management Committee on Riparian Zone Functioning and Strategies for Management, Water Science and Technology Board, National Research Council. 2002. Riparian areas: functions and strategies for management. ISBN: 0-309-12784-X. Washington, DC: National Academies Press. 444 p. Available at http://www.nap.edu/catalog/10327.html.

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Verry, E.S.; Hornbeck, J.W.; Dolloff, C.A., eds. 2000. Riparian management in forests of the continental Eastern United States. ISBN: 9781566705011. Boca Raton, FL: Lewis Publishers CRC Press. 432 p.

Aquatic Ecosystems Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from construction and maintenance activities in flowing and nonflowing aquatic ecosystems. Properly functioning streams, lakes, riparian areas, and wetlands are critical in maintaining water quality, water quantity, riparian habitat, aquatic fauna populations and diversity, and downstream beneficial uses. Common management activities in waterbodies include constructing ponds and wetlands, restoring streambanks or channels, and improving or restoring aquatic habitat.

Four National Core BMPs are in the Aquatic Ecosystems Management Activities category. These BMPs are to be used for projects and activities in or near waterbodies on National Forest System (NFS) lands. BMP AqEco-1 (Aquatic Ecosystem Improvement and Restoration Planning) is a planning BMP for improvement or restoration activities in aquatic ecosystems. BMP AqEco-2 (Operations in Aquatic Ecosystems) covers practices for working in or near waterbodies. Applicable practices of this BMP should be used whenever working in or near waterbodies, regardless of the resource activity; for example, when constructing a stream crossing (BMP Road-7 [Stream Crossings]) or mining instream gravel deposits (BMP Min-5 [In-Stream Sand and Gravel Mining]). BMP AqEco-3 (Ponds and Wetlands) is for constructing ponds and wetlands and constructing or maintaining structures in these aquatic ecosystems. BMP AqEco-4 (Stream Channels and Shorelines) is for construction and maintenance activities in stream channels and shorelines. Note BMP Road-7 (Stream Crossings) provides additional direction specific to road-stream crossings.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Aquatic Ecosystems BMPs	
AqEco-1	Aquatic Ecosystem Improvement and Restoration Planning
AqEco-2	Operations in Aquatic Ecosystems
AqEco-3	Ponds and Wetlands
AqEco-4	Stream Channels and Shorelines

AqEco-1. Aquatic Ecosystem Improvement and Restoration Planning

Manual or Handbook Reference Forest Service Manual (FSM) 2020.

Objective Reestablish and retain ecological resilience of aquatic ecosystems and associated resources to achieve sustainability and provide a broad range of ecosystem services.

Explanation Every waterbody has unique characteristics that should be considered when developing a site-specific maintenance, improvement, or restoration strategy. Planning is critical to ensure that the project is conducted in a timely and cost-efficient manner and that the ecological and water quality goals are met. A rigorous approach that uses a combination of best available science and professional experience to inform planning is necessary to enhance the potential for long-term success. When planning aquatic ecosystem projects, it is important to understand all the factors that may affect the watershed currently and in the future. These factors include water quantity, quality, flow, or storage capacity; habitat suitability for native plants, fish, and wildlife; climate change; the primary uses of the watershed and waterbody by people, domestic animals, and wildlife; and past alterations to the waterbody.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use a watershed perspective and available watershed assessments when planning aquatic ecosystem improvement or restoration projects.
    - Consider how existing water quality and habitat conditions at the project site have been affected by past habitat alterations, hydrologic modification, and riparian area changes in the watershed.
    - Consider how past, current, and future land use patterns may affect the proposed project site.
    - Recognize that inhabitants and users at the site (beaver, deer, birds, and people) may change the current ecosystem state to suit their needs.
- Use desired future conditions to set project goals and objectives.
    - Establish desired future conditions that are consistent with the land management plan's goals and direction.
    - Use a reference condition to determine the natural potential water quality and habitat conditions of a waterbody.
    - Consider the potential for future changes in environmental conditions, such as changes in precipitation and runoff type, magnitude and frequency, community composition and species distribution, and growing seasons that may result from climate change.
    - Consider water quality and other habitat needs for sensitive aquatic or aquatic-dependent species in the project area.
- Favor project alternatives that correct the source of the degradation more than alternatives that mitigate, or treat symptoms of, the problem.
    - Consider the risk and consequences of treatment failure, such as the risk that design conditions could be exceeded by natural variability before the treatment measures are established, when analyzing alternatives.
    - Consider as a first priority treatment measures that are self-sustaining or that reduce requirements for future intervention.
- Use natural stabilization processes consistent with stream type and capability where practicable rather than structures when restoring damaged streambanks or shorelines.
- Prioritize sites to implement projects in a sequence within the watershed in such a way that they will be the most effective to achieve improvement or restoration goals.

AqEco-2. Operations in Aquatic Ecosystems

Manual or Handbook Reference None known.

Objective Avoid, minimize, or mitigate adverse impacts to water quality when working in aquatic ecosystems.

Explanation Common construction or maintenance operations in waterbodies often involve ground disturbance. The close proximity to, and contact with, the waterbody increases the potential for introducing sediment and other pollutants that can affect water quality. This BMP includes practices for minimizing direct and indirect water quality impacts when working in or adjacent to waterbodies.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (AMZ Planning) when planning operations in aquatic ecosystems.
- Identify the aquatic and aquatic-dependent species that live in the waterbody, Aquatic Management Zone (AMZ), or on the floodplain and their life histories to determine protection strategies, such as timing of construction, sediment management, species relocation, and monitoring during construction.
- Coordinate stream channel, shoreline, lake, pond, and wetland activities with appropriate State and Federal agencies.
    - Incorporate Clean Water Act (CWA) 404 permit requirements and other Federal, State, and local permits or requirements into the project design and plan.
- Use suitable measures to protect the waterbody when preparing the site for construction or maintenance activities.
    - Clearly delineate the work zone.
    - Locate access and staging areas near the project site but outside of work area boundaries, AMZs, wetlands, and sensitive soil areas.
    - Refuel and service equipment only in designated staging areas (see BMP Road-10 [Equipment Refueling and Servicing]).
    - Develop an erosion and sediment control plan to avoid or minimize downstream impacts using measures appropriate to the site and the proposed activity (see BMP Fac-2 [Facility Construction and Stormwater Control]).
    - Prepare for unexpected failures of erosion control measures.
    - Consider needs for solid waste disposal and worksite sanitation.
    - Consider using small, low ground pressure equipment, and hand labor where practicable.
    - Ensure all equipment operated in or adjacent to the waterbody is clean of aquatic invasive species, as well as oil and grease, and is well maintained.
    - Use vegetable oil or other biodegradable hydraulic oil for heavy equipment hydraulics wherever practicable when operating in or near water.
- Schedule construction or maintenance operations in waterbodies to occur in the least critical periods to avoid or minimize adverse effects to sensitive aquatic and aquatic-dependent species that live in or near the waterbody.

- Avoid scheduling instream work during the spawning or migration seasons of resident or migratory fish and other important life history phases of sensitive species that could be affected by the project.
- Avoid scheduling instream work during periods that could be interrupted by high flows.
- Consider the growing season and dormant season for vegetation when scheduling activities within or near the waterbody to minimize the period of time that the land would remain exposed, thereby reducing erosion risks and length of time when aesthetics are poor.

- Use suitable measures to protect the waterbody when clearing the site.
  - Clearly delineate the geographic limits of the area to be cleared.
  - Use suitable drainage measures to improve the workability of wet sites.
  - Avoid or minimize unacceptable damage to existing vegetation, especially plants that are stabilizing the bank of the waterbody.
- Use suitable measures to avoid or minimize impacts to the waterbody when implementing construction and maintenance activities.
  - Minimize heavy equipment entry into or crossing water as is practicable.
  - Conduct operations during dry periods.
  - Stage construction operations as needed to limit the extent of disturbed areas without installed stabilization measures.
  - Promptly install and appropriately maintain erosion control measures.
  - Promptly install and appropriately maintain spill prevention and containment measures.
  - Promptly rehabilitate or stabilize disturbed areas as needed following construction or maintenance activities.
  - Stockpile and protect topsoil for reuse in site revegetation.
  - Minimize bank and riparian area excavation during construction to the extent practicable.
  - Keep excavated materials out of the waterbody.
  - Use only clean, suitable materials that are free of toxins and invasive species for fill.
  - Properly compact fills to avoid or minimize erosion.
  - Balance cuts and fills to minimize disposal needs.
  - Remove all project debris from the waterbody in a manner that will cause the least disturbance.
  - Identify suitable areas offsite or away from waterbodies for disposal sites before beginning operations.
  - Contour site to disperse runoff, minimize erosion, stabilize slopes, and provide a favorable environment for plant growth.
  - Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Use suitable measures to divert or partition channelized flow around the site or to dewater the site as needed to the extent practicable.
  - Remove aquatic organisms from the construction area before dewatering and prevent organisms from returning to the site during construction.

- Return clean flows to channel or waterbody downstream of the activity.
- Restore flows to their natural stream course as soon as practicable after construction or before seasonal closures.

- Inspect the work site at suitable regular intervals during and after construction or maintenance activities to check on quality of the work and materials and identify need for midproject corrections.
- Consider short- and long-term maintenance needs and unit capabilities when designing the project.
    - Develop a strategy for providing emergency maintenance when needed.
- Include implementation and effectiveness monitoring to evaluate success of the project in meeting design objectives and avoiding or minimizing unacceptable impacts to water quality.
- Consider long-term management of the site and nearby areas to promote project success.
    - Use suitable measures to limit human, vehicle, and livestock access to site as needed to allow for recovery of vegetation.

AqEco-3. Ponds and Wetlands

Manual or Handbook Reference None known.

Objective Design and implement pond and wetlands projects in a manner that increases the potential for success in meeting project objectives and avoids, minimizes, or mitigates adverse effects to soil, water quality, and riparian resources.

Explanation Ponds and wetlands are developed for a variety of reasons including recreation, water sources, stock ponds, gravel extraction, wetland mitigation, and wildlife improvement. The excavation of material and construction of berms, dikes, dams, channels, wildlife water sources, and waterfowl nesting islands have the potential to introduce sediment and other pollutants into adjacent waterbodies, alter flows, and cause physical damage to the ponds and adjacent stream channels both during and after construction. Constructing the projects to withstand potential overflow and flooding is a primary consideration during project planning and design.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in or near waterbodies.
- Obtain and manage water rights.
- Clearly define goals and objectives in the project plan appropriate to the site for desired hydrology, wetland plant community associations, intended purpose, and function of the pond or wetland and expected values.
- Select sites based on an analysis of landscape structure and associated ecological functions and values.
    - Construct ponds and wetlands on sites that have easy construction access where practicable.
    - Construct wetlands in landscape positions and soil types capable of supporting desired wetland functions and values.

- Construct ponds outside of active floodplain to minimize overflow of groundwater-fed ponds into adjacent streams and avoid or minimize erosion of pond embankments by floods, unless location in the floodplain is integral to achieving project objectives.
    - Construct ponds with surface water supply off-channel rather than placing a dam across a stream.
    - Construct ponds and wetlands on sites with soils suitable to hold water with minimal seepage loss and that provide a stable foundation for any needed embankments.
    - Construct ponds and wetlands in locations where polluted surface water runoff or groundwater discharge do not reach the pond.
    - Consider the consequences of dam or embankment failure and resulting damage from sudden release of water on potentially affected areas.
- Ensure that the natural water supply for the pond or wetland is sufficient to meet the needs of the intended use and that it will maintain the desired water levels and water quality.
    - Design the wetland to create hydrologic conditions (including the timing of inflow and outflow, duration, and frequency of water level fluctuations) that provide the desired wetland functions and values.
    - Avoid or minimize drawdown effects in a stream source by limiting timing and rate of water withdrawal to allow sufficient downstream water flow to maintain desired conditions in the source stream (see BMP WatUses-1 [Water Uses Planning]).
- Design the wetland project to create a biologically and hydrologically functional system.
    - Design for function, not form.
    - Keep the design simple and avoid over engineering.
    - Design the project for minimal maintenance needs.
    - Use natural energies, such as gravity flow, in the design.
    - Avoid use of hard engineering structures or the use of supplemental watering to support system hydrology.
    - Plan to allow wetland system time to develop after construction activities are complete.
- Design the pond or wetland to be of sufficient size and depth appropriate for the intended use and to optimize hydrologic regimes and wetland plant community development.
    - Size the pond or wetland appropriately for the contributing drainage area such that a desired water level can be maintained during drought conditions and that excess runoff during large storms can be reasonably accommodated without constructing large overflow structures.
    - Size the pond or wetland to an adequate depth to store sufficient amounts of water for the intended use and offset probable evaporation and seepage losses.
    - Integrate design with the natural topography of the site to minimize site disturbance.
    - Design the pond or wetland to have an irregular shape to reduce wind and wave impacts, disperse water flows, maximize retention times, and better mimic natural systems.
    - Create microtopography and macrotopography in wetlands to mimic natural conditions and achieve hydrologic and vegetative diversity.
    - Avoid creating large areas of shallow water to minimize excessive evaporation losses and growth of noxious aquatic plants.

- Avoid steep-sloped shorelines in areas with potential substrate instability problems to reduce erosion and sedimentation.
- Include water control structures to manage water levels as necessary.
  - Design spillway or outlet to maintain desired water level under normal inflows from snowmelt, groundwater flow, and precipitation.
  - Design discharge capacity using a suitable hydrologic analysis of the drainage area to be sufficient to safely pass the flow resulting from the design storm event.
  - Size the spillway to release floodwaters in a volume and velocity that do not erode the spillway, the area beyond the outlet, or the downstream channel.
  - Consider the need for suitable measures to drain the pond or wetland.
  - Return overflow back to the original source to the extent practicable.
  - Use suitable measures to maintain desired downstream temperatures, dissolved oxygen levels, and aquatic habitats when water is released from the pond or impoundment.
- Use materials appropriate for the purpose of the pond and site.
  - Select materials for a dam or embankment that will provide sufficient strength and, when properly compacted, will be tight enough to avoid or minimize excessive or harmful percolation of water through the dam or embankment.
  - Design the side slopes appropriately for the material being used to ensure stability of the dam or embankment.
- Use wetland vegetation species and establishment methods suitable to the project site and objectives, consistent with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
  - Consider the timing of planting to achieve maximum survival, proposed benefit of each plant species, methods of planting, proposed use of mulch, potential soil amendment (organic material or fertilizer), and potential supplemental watering to help establish the plant community.
- Properly maintain dams, embankments, and spillways to avoid or minimize soil erosion and leakage problems.
  - Use suitable measures to avoid or minimize erosion of dams and shores due to wind and wave action.
  - Design sufficient freeboard to avoid or minimize overtopping by wave action or other causes.
  - Stabilize or armor spillways for ponds with continuous flow releases or overflow during heavy rainfall events.
- Manage uplands and surrounding areas to avoid or minimize unacceptable impacts to water quality in the pond or wetland.

AqEco-4. Stream Channels and Shorelines

Manual or Handbook Reference None known

Objective Design and implement stream channel and lake shoreline projects in a manner that increases the potential for success in meeting project objectives and avoids, minimizes, or mitigates adverse effects to soil, water quality, and riparian resources.

Explanation Instream projects are often conducted for a variety of purposes, including improving fish and wildlife habitat, stabilizing streambanks, reconnecting the stream channel to the historic floodplain, and removing or replacing culverts. Lakeshores may be degraded by storm events; constant wave action from boats; onshore uses, including recreation, mining, vegetation management, and development; water diversions; freezing and thawing; floating ice; drought; or a fluctuating water table. A shoreline problem is often isolated and may require only a simple patch repair. Methods to stabilize or restore lakeshores differ from streambank measures because of wave action and littoral transport.

Two basic categories of stabilization and protection measures exist: those that work by reducing the force of water against a streambank or shoreline and those that increase their resistance to erosive forces. Appropriate selection and application of stream channel and shoreline protection measures depend on specific project objectives and site conditions.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in or near waterbodies.

Stream Channels

- Determine stream type and classification using suitable accepted protocols.
- Determine need to control channel grade to avoid or minimize erosion of channel bed and banks before selecting measures for bank stabilization or protection.
  - ❑ Incorporate grade control measures into project design as needed.
- Determine design flows based on the value or safety of area to be protected, repair cost, and the sensitivity and value of the ecological system involved.
  - ❑ Obtain peak flow, low flow, channel forming flow, and flow duration estimates.
  - ❑ Use these estimates to determine the best time to implement the project, as well as to select design flows.
- Determine design velocities appropriate to the site.
  - ❑ Limit maximum velocity to the velocity that is nonscouring on the least resistant streambed and bank material.
  - ❑ Consider needs to transport bedload through the reach when determining minimum velocities.
  - ❑ Maintain the depth-area-velocity relationship of the upstream channel through the project reach.
  - ❑ Consider the effects of design velocities on desired aquatic organism habitat and passage.

- Avoid changing channel alignment unless the change is to reconstruct the channel to a stable meander geometry consistent with stream type.
- Design instream and streambank stabilization and protection measures suitable to channel alignment (straight reach versus curves).
  - Consider the effects of ice and freeze and thaw cycles on streambank erosion processes.
  - Consider the effects that structures may have on downstream structures and stream morphology, including streambanks, in the maintenance of a natural streambed.
- Design channels with natural stream pattern and geometry and with stable beds and banks; provide habitat complexity where reconstruction of stream channels is necessary.
  - Consider sediment load (bedload and suspended load) and bed material size to determine desired sediment transport rate when designing channels.
  - Avoid relocating natural stream channels.
  - Return flow to natural channels, where practicable.
- Include suitable measures to protect against erosion around the edges of stabilization structures.
  - Design revetments and similar structures to include sufficient freeboard to avoid or minimize overtopping at curves or other points where high-flow velocity can cause waves.
  - Use suitable measures to avoid or minimize water forces undermining the toe of the structure.
  - Tie structures into stable anchorage points, such as bridge abutments, rock outcrops, or well-vegetated stable sections, to avoid or minimize erosion around the ends.
- Add or remove rocks, wood, or other material in streams only if such action maintains or improves stream condition, provides for safety and stability at bridges and culverts, is needed to avoid or minimize excessive erosion of streambanks, or reduces flooding hazard.
  - Leave rocks and portions of wood that are embedded in beds or banks to avoid or minimize channel scour and maintain natural habitat complexity.
- Choose vegetation appropriate to the site to provide streambank stabilization and protection adequate to achieve project objectives.
  - Use vegetation species and establishment methods suitable to the project site and objectives, consistent with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Shorelines

- Use mean high- and low-water levels to determine the design water surface.
  - Consider the effects of fluctuating water levels, freeze or thaw cycles, and floating ice on erosion processes at the site.
- Design stabilization and protection measures suitable to the site.
  - Determine the shoreline slope configuration above and below the waterline.
  - Consider the effects of offshore depth, dynamic wave height, and wave action on shoreline erosion processes.
  - Determine the nature of the bank soil material to aid in estimating erosion rates.
  - Consider foundation material at the site when selecting structural measures.

- Use vegetation species and establishment methods suitable to the project site and objectives and consistent with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Consider the rate, direction, supply, and seasonal changes in littoral transport when choosing the location and design of structural measures.
- Consider the effect structures may have on adjacent shoreline or other nearby structures.
  - Adequately anchor end sections to existing stabilization measures or terminate in stable areas.

Resources for Aquatic Ecosystems Management Activities

General

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Olson, R.1999. Constructing wetlands in the Intermountain West: Guidelines for land resource managers. Laramie, WY: University of Wyoming. 52 p. Available at http://www.wyomingextension.org/agpubs/B-1078.pdf.

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Chemical Use Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid or minimize unacceptable impacts to water quality conditions that may result from application of chemicals used to manage biological and physical resources. Chemical treatments are applied to kill, attract, repel, defoliate, stimulate, or retard biologic growth with the intent to mitigate, control, grow, or kill the intended biota. They may also be applied to ameliorate, neutralize, or stabilize certain physical resources such as soil or water chemistry. Chemical treatments include application of pesticides such as insecticides, herbicides, fungicides, nematicides, rodenticides, and piscicides. Chemical treatments also include fertilizers, fire retardants (see BMP Fire-3 [Wildland Fire Control and Suppression]), dyes, or other materials used in tracer studies, aggregate additives like salt, magnesium chloride, and other substances used for dust abatement, roadbed stabilization, or de-icing of roadways, and other chemical products that can be used to fulfill specific Forest Service management objectives.

Six National Core BMPs are in the Chemical Use Management Activities category. These BMPs are to be used when chemicals are applied on National Forest System (NFS) lands. BMP Chem-1 (Chemical Use Planning) is a planning BMP for chemical applications. BMP Chem-2 (Follow Label Directions) specifies following label directions to meet legal requirements for chemical use. BMP Chem-3 (Chemical Use near Waterbodies) is for chemical applications on or over upland areas where chemicals may drift or runoff into waterbodies. BMP Chem-4 (Chemical Use in Waterbodies) is for chemical applications directly into waterbodies. BMP Chem-5 (Chemical Handling and Disposal) provides practices for proper transportation and storage of chemicals, cleaning equipment, and chemical containers and disposal of containers. BMP Chem-6 (Chemical Application Monitoring and Evaluation) provides guidance on designing and implementing monitoring plans to evaluate chemical applications.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Chemical Use BMPs	
Chem-1	Chemical Use Planning
Chem-2	Follow Label Directions
Chem-3	Chemical Use Near Waterbodies
Chem-4	Chemical Use in Waterbodies
Chem-5	Chemical Handling and Disposal
Chem-6	Chemical Application Monitoring and Evaluation

Chem-1. Chemical Use Planning

Manual or Handbook Reference Forest Service Manual (FSM) 2153; Forest Service Handbook (FSH) 2109.14, chapter 10.

Objective Use the planning process to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from chemical use on NFS lands.

Explanation Pollution risk from chemical use depends on chemical mobility and persistence, application mode and rate, and distance from water. Risk of entry to surface water is highest for broadcast and aerial treatments and for fine droplets. Risk to groundwater is highest over sandy soils, shallow water tables, and groundwater recharge areas. The planning process is the framework for incorporating measures to avoid or minimize impacts to soil and water resources into project design and management to reduce the risk of contamination from chemical use.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when planning activities that involve use of chemicals.
- Identify municipal supply watersheds; private domestic water supplies; fish hatcheries; and threatened, endangered, and sensitive aquatic dependent species and fish populations near or downstream of chemical treatment areas.
- Use Integrated Pest Management as the basis for all pesticide-use prescriptions in consultation with the unit Pesticide Use Coordinator.
- Select chemical products suitable for use on the target species or that meet project objectives.
  - Use chemicals that are registered for the intended uses.
- Consult the Materials Safety Data Sheet and product label for information on use, hazards, and safe handling procedures for chemicals products under consideration for use.
- Consider chemical solubility, absorption, breakdown rate properties, and site factors when determining which chemical products to use.
  - Use chemicals with properties such that soil residual activity will persist only as long as needed to achieve treatment objectives.
  - Consider soil type, chemical mobility, distance to surface water, and depth to groundwater to avoid or minimize surface water and groundwater contamination.
- Use a suitable pressure, nozzle size, and nozzle type combination to minimize off-target drift or droplet splatter.
- Use selective treatment methods for target organisms to the extent practicable.
- Specify management direction and appropriate site-specific response measures in project plans and safety plans (FSH 2109.14, chapter 60).
- Ensure that planned chemical use projects conform to all applicable local, State, Federal, and agency laws, regulations, and policies.
  - Obtain necessary permits, including Clean Water Act (CWA) 402 permit coverage.
  - Develop spill contingency plans.
  - Obtain or provide training and licensing as required by the label and State regulations.

Chem-2. Follow Label Directions

Manual or Handbook Reference FSH 2109.14, chapter 50.

Objective Avoid or minimize the risk of soil and surface water or groundwater contamination by complying with all label instructions and restrictions required for legal use.

Explanation Directions found on the label of each chemical are detailed, specific, and include legal requirements for use. In brief, "...the label is the law..." with respect to chemical use. Not following label directions increases the risk of adverse effects to surface water or groundwater as a result of using chemicals inappropriate to the site, an inappropriate method of application, and an inappropriate application rate (too much or too little) to meet project objectives.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Incorporate constraints identified on the label and other legal requirements of application into project plans and contracts.
    - Be aware that States may have more restrictive requirements than the label instructions.
- Use fully trained individuals equipped with appropriate personal protective equipment to apply chemical treatments.
- Obtain State or Federal Pesticide Application Certification for staff supervising or applying chemical treatment application if required by law.
- Notify contractor's field supervisor when violations of label or project requirements have occurred.
- Stop operations that pose a safety hazard or when violations of project requirements have not been rectified.
- Report label violations to the appropriate enforcement agency.
- Respond to and report spills and other accidents.

Chem-3. Chemical Use Near Waterbodies

Manual or Handbook Reference FSH 2109.14 Chapters 10, 50.

Objective Avoid or minimize the risk of chemical delivery to surface water or groundwater when treating areas near waterbodies.

Explanation Some chemicals used in terrestrial applications are toxic to aquatic flora and fauna, may overly enrich aquatic systems, and may pose a human health hazard if drinking water sources are contaminated during or after chemical applications. During application, chemicals may drift into waterbodies or other nontarget areas. After application, chemicals or chemical residues may enter surface water or groundwaters through runoff and leaching. Most State and local water quality standards include a general narrative standard that requires surface waters to be free from substances attributable to human-caused discharges in amounts, concentrations, or combinations that are toxic to humans, animals, plants, or aquatic life. To help protect surface waters and wetlands from contamination, a buffer zone of land and vegetation adjacent to the waterbody may need to be designated. Treatment within this zone may differ from that applied to upland areas or the buffer zone may be left untreated if necessary.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Identify during project planning those perennial and intermittent surface waters, wetlands, springs, riparian areas, and groundwater recharge areas that may be impacted by the chemical use.
    - Use field observations to verify the extent of these areas identified from aerial observations, maps, or geographic information system data, as needed.
- Determine the width of a buffer zone, if needed, based on a review of the project area, characteristics of the chemical to be used, and application method.
    - Consider the designated uses of water, adjacent land uses, expected rainfall, wind speed and direction, terrain, slope, soils, and geology.
    - Consider the persistence, mobility, toxicity profile, and bioaccumulation potential of any chemical formulation proposed for use.
    - Consider the type of equipment, spray pattern, droplet size, application height, and experience in similar projects.
- Prescribe chemicals and application methods in the buffer zone suitable to achieve project objectives while minimizing risk to water quality.
- Flag or otherwise mark or identify buffer zones as needed.
    - Clearly communicate to those applying the chemical what areas are to be avoided or where alternative treatments are to be used.
- Locate operation bases on upland areas, outside of wetlands or areas with channel or ditch connection to surface water and AMZs.
- Use clean equipment and personnel to collect water needed for mixing.
- Calibrate application equipment to apply chemicals uniformly and in the correct quantities.
- Evaluate weather conditions before beginning spray operations and monitor throughout each day to avoid or minimize chemical drift.
    - Apply chemicals only under favorable weather conditions as identified in the label instructions.
    - Avoid applying chemicals before forecasted severe storm events to limit runoff and ensure the chemical reaches intended targets.
    - Suspend operations if project prescription or weather limitations have been exceeded.
- Apply fertilizers during high nutrient-uptake periods to avoid or minimize leaching and translocation.
    - Base fertilizer type and application rate on soils and foliar analysis.
    - Use slow release fertilizers that deliver fertilizer to plants during extended periods in areas with long growing seasons when appropriate to meet project objectives.
- Monitor during chemical applications to determine if chemicals are reaching surface waters (see BMP Chem-6 [Chemical Application Monitoring and Evaluation]).
- Implement the chemical spill contingency plan elements within the project safety plan if a spill occurs (FSH 2109.14, chapter 60).

Chem-4. Chemical Use in Waterbodies

Manual or Handbook Reference FSH 2109.14.

Objective Avoid, minimize, or mitigate unintended adverse effects to water quality from chemical treatments applied directly to waterbodies.

Explanation Chemicals may be used to improve the growth of aquatic fauna and flora within lakes and streams, control invasive or other undesirable aquatic species, restore native biota, or remediate adverse atmospheric deposition. Chemicals may also be used as tracers for time of travel studies, dispersion studies, discharge measurement, and calculation of stream re-aeration, as well as for determining circulation and stratification within reservoirs, tagging pollutants, or many other applications. Several factors affect the type and degree of impacts on aquatic resources, including chemical type, concentration, application rate, residence time, and decay rate; waterbody chemistry, volume, substrate, turnover, inflow, outflow, hydrograph, geology, geomorphology, designated uses, and other limnologic characteristics; and biologic species composition, habitat requirements, food web, population dynamics, and desired condition. Chemical treatments to surface waters may also affect groundwater through leaching, translocation, or interchange.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Coordinate project with State water quality and fish and wildlife agencies as necessary.
- Use chemicals registered for application in aquatic systems.
- Use the minimum concentration of chemicals required to be reasonably certain that treatment objectives would be met.
    - Consider physical attributes of the waterbody, water flow and turbulence, waterbody mixing time, water chemistry, target species, label directions, percentage of active ingredient in the formulation to be used, application method, and project objectives to determine chemical concentration to use.
    - Follow label directions near critical points such as water intakes or, if label is silent on this issue, consider using lower concentrations or nontreatment buffers.
    - Consider using pretreatment bioassay tests to determine if the recommended concentration will be effective to meet treatment objectives.
    - Adjust chemical concentration and application methods to account for the effect of thermal stratification in lakes or reservoirs to achieve treatment objectives.
    - Adjust chemical concentration and application methods in streams and flowing water to account for the effect that any barriers, diversion structures, beaver dams, seeps, springs, and tributaries may have on chemical dilution and mixing to achieve treatment objectives.
- Avoid applying chemicals in situations where they could enter nontarget waters.
- Determine the need to treat tributaries to standing waterbodies to meet treatment objectives.
    - Apply chemical treatment to tributaries before treating the standing waterbody.
- Determine the need for neutralization of chemicals applied directly to water.
    - Evaluate the environmental advantages and disadvantages of natural degradation compared to the use of neutralizing agents.

- Use neutralization agents when the chemical treatment effects would cause unacceptable downstream impacts without intervention.
- For neutralization of flowing water, determine a neutralization zone (e.g., mixing zone) based on time of travel below the application point where potential flora or fauna mortality can be expected before the chemical is completely neutralized.

- Determine the need for collecting dead flora or fauna.
  - Dispose of dead flora or fauna in an approved manner that does not adversely affect water quality.
- Monitor water quality and sediments pre- and post-chemical treatment at representative locations to evaluate relevant water chemistry and chemical concentrations (see BMP Chem-6 [Chemical Application Monitoring and Evaluation]).
- Implement the pesticide spill contingency plan elements within the project safety plan if a spill occurs (FSH 2109.14, chapter 60).

Chem-5. Chemical Handling and Disposal

Manual or Handbook Reference FSH 2109.14, chapter 40.

Objective Avoid or minimize water and soil contamination when transporting, storing, preparing and mixing chemicals; cleaning application equipment; and cleaning or disposing chemical containers.

Explanation Handling chemicals, chemical containers, and equipment can lead to contamination of surface water or groundwater if not done carefully. Spills, leaks, or wash water can contaminate soil and leach into groundwater. Residue left on containers or equipment can wash off during precipitation events and enter surface waters. Preparing and mixing chemicals and cleaning and disposing of chemical containers must be done in accordance with Federal, State, and local laws, regulations, and directives. Specific procedures are documented in the Forest Service Pesticide Use Management and Coordination Handbook (FSH 2109.14, chapter 40) as well as in State and local laws.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Transport and handle chemical containers in a manner that minimizes the potential for leaks and spills.
  - Inspect containers for leaks or loose caps or plugs before loading.
  - Secure containers properly to avoid or minimize shifting in transport.
  - Check containers periodically enroute.
  - Ensure arrangements for proper storage are in place before transporting chemicals.
- Manage and store chemicals in accordance with all applicable Federal, State, or local regulations, including label directions.
  - Store chemicals in their original containers with labels intact.
  - Locate chemical storage facilities at sites that minimize the possibility of impacts to surface water or groundwater in case accidents or fires occur.
  - At a minimum, ensure that containment of a complete spill from the largest container being stored is possible with the spill-kit materials at the storage site.

- Check containers before storage and periodically during storage to ensure that they are properly sealed and not leaking.

- Locate operation bases in appropriate sites where possible spills would not enter surface waterbodies or groundwater aquifers.
- Ensure that mixing equipment, containers, and spill kits are in place and adequate for the project size and chemicals to be used.
- Follow label directions; applicable Federal, State, and local laws; and Forest Service direction for proper preparation and mixing of chemicals and cleaning and disposal of chemical materials and equipment.
    - When a contractor supplies the pesticide, the contractor is responsible for proper chemical preparation and mixing and container cleaning and disposal in accordance with label directions and Federal, State, and local laws.
    - Apply rinse water from empty chemical containers, mixing apparatus, and equipment clean up to the treatment area, not into the ground near streams.
    - Provide water from off site for cleaning equipment and application personnel rather than using onsite surface waters.
- Inspect application equipment to ensure that chemicals will not leak and the application prescription can be achieved.
- Implement the chemical spill contingency plan elements within the project safety plan if a spill occurs (FSH 2109.14, chapter 60).

Chem-6. Chemical Application Monitoring and Evaluation

Manual or Handbook Reference FSM 2150.1; FSH 2109.14, chapter 50.

Objectives

1. Determine whether chemicals have been applied safely, have been restricted to intended targets, and have not resulted in unexpected nontarget effects.
2. Document and provide early warning of possible hazardous conditions resulting from potential contamination of water or other nontarget resources or areas by chemicals.

Explanation Monitoring of chemical applications is used to evaluate and document chemical application accuracy, amount, and effects on soils and water quality to reduce or eliminate hazards to nontarget biological or physical resources. Monitoring can occur before, during, and after chemical application depending on treatment objectives and monitoring questions. Monitoring methods may include any of the following: visual observations; vegetation surveys; use of spray cards; dye tracing (fluorometry); and sampling of water, soil, sediment, flora, or fauna to measure chemical presence in or near water. Monitoring needs and methods are determined in the project planning process and should consider treatment objectives; resource values at risk; chemical properties; potential for offsite movement; Federal, State, and local requirements; monitoring costs; and available project funding.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Identify the following elements in all water resource monitoring plans and specify the rationale for each:
    - What are the monitoring questions?

- Who will be involved and what are their roles and responsibilities?
  - What parameters will be monitored and analyzed?
  - When and where will monitoring take place?
  - What methods will be used for sampling and analyses?
  - How will Chain of Custody requirements for sample handling be met?
  - What are the criteria for quality assurance and quality control?
- Consider the following factors when developing monitoring questions:
  - The physical or biological resource of concern, including human health.
  - Applicable Federal, State, and local laws and regulations.
  - Type of chemical.
  - Type of application equipment used and method of application.
  - Site-related difficulties that affect both application and monitoring.
  - Public concerns.
  - Potential benefits of the application.
  - Availability of analytic methods, detection limits, tools, and laboratories.
  - Costs of monitoring and resources available to implement monitoring plan.
- Choose monitoring methods and sample locations suitable to address the monitoring questions.
  - Consider the need to take random batch or tank samples for future testing in the event of treatment failure or an unexpected adverse effect.
- Monitor sensitive environments during and after chemical applications to detect and evaluate unanticipated events.
- Use U.S. Environmental Protection Agency-certified laboratories for chemical sample analysis.
  - Use appropriate containers, preservation, and transportation to meet Standard Methods requirements.
  - Implement proper Chain of Custody procedures for sample handling.
- Evaluate and interpret the results of monitoring in terms of compliance with, and adequacy of, treatment objectives and specifications.

Resources for Chemical Use Management Activities

Aquatic Pesticides

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Dye Tracers

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Monitoring

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Oregon Plan for Salmon and Watersheds, Water Quality Monitoring Team. 1999. Chapter 13—Pesticides and toxins protocol. P. 13-1 – 13-10. In: Water quality monitoring: technical guidebook version 2.0. Available at http://oregon.gov/OWEB/docs/pubs/wq_mon_guide.pdf.

Risk Assessments

U.S. Department of Agriculture, Forest Service, Forest Health Protection, Pesticide Management and Coordination. Human health and ecological risk assessments. Washington, DC. Available at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml.

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U.S. Environmental Protection Agency, Office of Water. 2005. Chapter 3I: Forest chemical management. p. 3-99 – 3-106. In: National management measures to control nonpoint source pollution from forestry. EPA 841-B-05-001. Washington, DC. Available at http://www.epa.gov/owow/nps/forestrymgmt/.

Facilities and Nonrecreation Special Uses Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from development, use, maintenance, and reclamation of facilities located on National Forest System (NFS) lands. Facilities include buildings, camps, towers, pipelines, stream gauging stations, water storage and conveyance facilities, or other permanent or semipermanent structures and infrastructure associated with Forest Service-administered facilities. Forest Service facilities normally encountered on NFS lands include fire stations, work centers, permanent field camps, ranger stations, visitor centers, public water systems, and sanitation systems. Other facilities on NFS lands may be operated by the private sector through easements or special use authorizations. Examples of these third-party facilities include work and organizational camps, concession sites, electronic and communication sites, public water and sanitation systems, power transmission lines, pipelines, research equipment and structures, and access routes to private land in-holdings.

Ten National Core BMPs are in the Facilities and Nonrecreation Special Uses Management Activities category. These BMPs are to be used in all facilities and nonrecreation special use authorizations on NFS lands. BMP Fac-1 (Facilities and Nonrecreation Special Uses Planning) is a planning BMP for facilities and nonrecreation special uses projects. BMP Fac-2 (Facility Construction and Stormwater Control) provides direction for erosion control and stormwater management during construction activities. This BMP applies to any ground-disturbing activity, regardless of the resource category; for example, constructing a campground, operating a mine, or reconstructing a road. BMP Fac-3 (Potable Water Supply Systems), BMP Fac-4 (Sanitation Systems), and BMP Fac-5 (Solid Waste Management) provide practices for drinking water, human sanitation, and trash or garbage disposal at facilities. BMP Fac-6 (Hazardous Materials) covers management of hazardous materials and applies to any activity that involves hazardous materials, not just at facilities. BMP Fac-7 (Vehicles and Equipment Wash Water) covers vehicle washing, which usually takes place at a facility. BMP Fac-8 (Nonrecreation Special Use Authorizations) and BMP Fac-9 (Pipelines, Transmission Facilities, and Rights-of-Way) provide practices for third-party uses on NFS lands that are not related to recreation activities. BMP Fac-10 (Facility Site Reclamation) provides direction for reclamation of developed sites that are no longer needed for their developed purposes.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Facilities and Nonrecreation Special Uses BMPs	
Fac-1	Facilities and Nonrecreation Special Uses Planning
Fac-2	Facility Construction and Stormwater Control
Fac-3	Potable Water Supply Systems
Fac-4	Sanitation Systems
Fac-5	Solid Waste Management
Fac-6	Hazardous Materials
Fac-7	Vehicle and Equipment Wash Water
Fac-8	Nonrecreation Special Use Authorizations
Fac-9	Pipelines, Transmission Facilities, and Rights-of-Way
Fac-10	Facility Site Reclamation

Fac-1. Facilities and Nonrecreation Special Uses Planning

Manual or Handbook Reference Forest Service Handbook (FSH) 7309.11, chapter 20; FSH 7409.11, chapter 10; FSH 2709.11, chapter 50.

Objective Use the applicable special use authorization and administrative facilities planning processes to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during construction and operation of facilities and nonrecreation special uses activities.

Explanation Facilities may be developed on NFS lands by the Forest Service for a variety of administrative and recreational purposes. Potential effects of the proposed facility construction and operation on water quality should be considered when new sites are created or existing sites are improved and operated. In the planning process, site-specific BMP prescriptions are developed to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Facilities developed and operated by others on NFS lands are administered through special use authorizations issued by the Forest Service to public or private agencies, a group, or an individual. Special use permits must include terms and conditions to protect the environment and otherwise comply with the requirements of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1752). These environmental protection requirements include the use of appropriate BMPs to control nonpoint source pollution.

State and local governments regulate many activities associated with facility development and operation, such as public water supplies, sanitation systems, waste disposal, and control of stormwater discharges. State or local requirements applicable to these activities should be incorporated into facility design, construction, and operation plans, and terms and conditions during the planning process.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when planning facilities or nonrecreation special use projects.
- Consider the following design criteria in facility planning.
    - Locate the facility away from the immediate vicinity of surface waters, AMZs, wetlands, sandy soils, shallow water tables, groundwater recharge areas, floodplains, and other sensitive areas to the extent practicable.
    - Avoid unstable slopes and soils.
    - Minimize the disturbance footprint.
    - Use and maintain proper erosion and sediment control practices during and immediately after construction activities (See BMP Fac-2 [Facility Construction and Stormwater Control]).
    - Incorporate suitable stormwater controls in the project design (See BMP Fac-2 [Facility Construction and Stormwater Control]).
    - Use applicable Road Management BMPs for access roads associated with facility sites.
    - Incorporate requirements from applicable Federal, State, and local permits into facility construction and operation plans.

- Consider the time necessary to complete facility development activities.
  - Develop a contingency plan for implementing appropriate prestorm or winterization BMPs before the grading permit expires.
- Determine the design capacity, if applicable, of the site for public or administrative use, considering needs for protecting soil, water quality, and riparian resources.
  - Ensure that the capacity of the site matches the ability of the site to withstand the use.
- Conform to all applicable Federal, State, and local regulations and permits governing water supply, sanitation, and underground injection systems (see BMP Fac-3 [Potable Water Supply Systems] and BMP Fac-4 [Sanitation Systems]).
- Determine instream flow needs to minimize damage to scenic and aesthetic values; native plant, fish, and wildlife habitat; and to otherwise protect the environment where the operation of the facility would modify existing streamflow regimes (See BMP WatUses-1 [Water Uses Planning]).

Fac-2. Facility Construction and Stormwater Control

Manual or Handbook Reference None known.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling erosion and managing stormwater discharge originating from ground disturbance during construction of developed sites.

Explanation During construction and operation of facility sites, land may be cleared of existing vegetation and ground cover, exposing mineral soil that may be more easily eroded by water, wind, and gravity. Changes in land use and impervious surfaces can temporarily or permanently alter stormwater runoff that, if left uncontrolled, can affect morphology, stability, and quality of nearby streams and other waterbodies. Erosion and stormwater runoff control measures are implemented to retain soil in place and to control delivery of suspended sediment and other pollutants to nearby surface water. This practice is initiated during the planning phase and applied during project implementation and operation.

This BMP contains practices for managing erosion and stormwater discharge that are generally applicable for any project that involves ground disturbance, including developed recreation, mineral exploration and production sites, pipelines, water developments, etc., and should be used for all such projects.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Obtain Clean Water Act (CWA) 402 stormwater discharge permit coverage from the appropriate State agency or the U.S. Environmental Protection Agency (EPA) when more than 1 acre of land will be disturbed through construction activities.
- Obtain CWA 404 permit coverage from the U.S. Army Corps of Engineers when dredge or fill material will be discharged to waters of the United States.
- Establish designated areas for equipment staging, stockpiling materials, and parking to minimize the area of ground disturbance (see BMP Road-9 [Parking Sites and Staging Areas] and BMP Road-10 [Equipment Refueling and Servicing]).

- Establish and maintain construction area limits to the minimum area necessary for completing the project and confine disturbance to within this area.
- Develop and implement an erosion control and sediment plan that covers all disturbed areas, including borrow, stockpile, fueling, and staging areas used during construction activities.
- Calculate the expected runoff generated using a suitable design storm to determine necessary stormwater drainage capacity.
  - Use site conditions and local requirements to determine design storm.
  - Include run-on from any contributing areas.
- Refer to State or local construction and stormwater BMP manuals, guidebooks, and trade publications for effective techniques to:
  - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion during construction or before the next growing season.
  - Maintain the natural drainage pattern of the area wherever practicable.
  - Control, collect, detain, treat, and disperse stormwater runoff from the site.
  - Divert surface runoff around bare areas with appropriate energy dissipation and sediment filters.
  - Stabilize steep excavated slopes.
- Develop and implement a postconstruction site vegetation plan using suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per Forest Service Manual (FSM) 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
- Do not use snow or frozen soil material in facility construction.
- Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur.
  - Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations.
  - Limit operation of equipment when ground conditions could result in excessive rutting, soil puddling, or runoff of sediments directly into waterbodies.
- Install suitable stormwater and erosion control measures to stabilize disturbed areas and waterways before seasonal shutdown of project operations or when severe or successive storms are expected.
- Use low-impact development practices where practicable.
- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning.
  - Prepare for unexpected failures of erosion control measures.
  - Implement corrective actions without delay when failures are discovered to prevent pollutant discharge to nearby waterbodies.
- Routinely inspect construction sites to verify that erosion and stormwater controls are implemented and functioning as designed and are appropriately maintained.
- Use suitable measures in compliance with local direction to prevent and control invasive species.

Fac-3. Potable Water Supply Systems

Manual or Handbook Reference Manual or Handbook Reference: FSM 7420 and FSH 7409.11, chapter 40.

Objective Provide potable water supplies of sufficient quality and quantity to support the use at facilities.

Explanation Many facilities provide potable water from a surface water or groundwater source. Water systems should supply an adequate volume of acceptably clean water as needed by the facility. A water system is comprised of collection, treatment, storage, and distribution facilities. Water systems are classified into categories (e.g., public versus nonpublic, community versus noncommunity, and transient versus nontransient) based on ownership, size, and permanence of the population served. Regulations are based on these different categories. Management requirements and controls to protect drinking water quality and provide potable water are incorporated into each facility's operation and maintenance plan (FSM 7410).

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Develop water systems only in places where the water source can be protected.
- Develop groundwater wells and facilities in a manner that reduces the potential of groundwater aquifer contamination in accordance with BMP WatUses-2 (Water Wells for Production and Monitoring).
- Use applicable practices of BMP WatUses-3 (Administrative Water Developments) and BMP WatUses-4 (Water Diversions and Conveyances) to manage surface diversions.
- Operate, monitor, and manage Forest Service-owned (public and nonpublic) drinking water systems in accordance with direction in FSM 7420.
    - Design, construct, operate, and maintain water systems in a manner that provides for physical protection of the water source and system.
    - Treat water as necessary to achieve desired water quality.
    - Conduct sanitary and condition surveys per required schedules.
    - Implement follow-up actions identified in the sanitary and condition surveys.
    - Minimize possible contaminating activities within Wellhead Protection Areas and Source Water Assessment Areas to protect drinking water sources.
    - Conduct required system monitoring and follow-up actions as needed.
- Perform water supply and system disinfection activities in a manner such that disinfectant residuals and byproducts will not affect nearby surface water or groundwater.
- Ensure that permit holder-owned and other authorized drinking water systems on NFS lands are operated and maintained according to direction in FSM 7423.

Fac-4. Sanitation Systems

Manual or Handbook Reference FSM 2330; FSM 7430; and FSH 7409.11, chapter 50.

Objective Avoid, minimize, or mitigate adverse effects to soil and water quality from bacteria, nutrients, and other pollutants resulting from collection, transmission, treatment, and disposal of sewage and wastewater at facilities.

Explanation Sanitation systems at facilities vary from a portable toilet to a sophisticated treatment plant. Facilities also may have wastewater systems for showers and washbasins. The type of sanitation system at a facility depends on the purpose and capacity of the site, available and needed infrastructure, Forest Service policy, and State or local regulations. Bacteria, nutrients, and other contaminants from sanitation systems can enter surface water or groundwater if the system is not properly designed and operated. Facilities are required to comply with State and local public health and sanitation ordinances. Management requirements and controls to minimize the possibility of water contamination from wastewater collection, treatment, and disposal are incorporated into each facility's operation and maintenance plan (FSM 7410).

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use qualified personnel to locate, design, inspect, operate, maintain, and manage sanitation systems.
- Coordinate all phases of sanitation system management (planning, design, installation, inspection, operation, and maintenance) with appropriate State and local agencies to ensure compliance with applicable regulations.
- Design and operate waste collection, treatment, and disposal systems appropriate for the type and volume of waste generated at the site consistent with direction in FSH 7409.11, chapter 50.
- Follow applicable regulations and guidelines when locating toilets, wastewater disposal, and leach fields.
    - Use suitable setback distances from water bodies or other sensitive areas when siting facilities.
    - Use proper field investigations and soil tests to determine suitable soils for onsite treatment and disposal systems.
- Prepare and maintain an operation and maintenance plan for all waste treatment or disposal facilities (FSM 7410).
    - Inspect vaults, septic tanks, and other wastewater systems at regular intervals to ensure that capacities are not exceeded and that the system is functioning properly and in compliance with applicable State and local regulations.
    - Implement follow-up actions identified in the inspections as needed to ensure that the system is working properly.
    - Include procedures in operation and maintenance plans to contain or avoid releases of pollutants in floods or other emergencies.
- Ensure that permit holder-owned and other authorized sanitation systems on NFS lands are operated and maintained according to applicable regulations and direction.

- Consider changes or improvements to existing sanitary systems that may be causing water quality impacts, such as poorly located pit toilets or drain fields, at opportune times such as facility remodeling or change in facility ownership or control.

Fac-5. Solid Waste Management

Manual or Handbook Reference FSM 2130; FSM 7460; and FSH 7409.11, chapter 80.

Objective Avoid, minimize, or mitigate adverse effects to water quality from trash, nutrients, bacteria, and chemicals associated with solid waste management at facilities.

Explanation Uncollected garbage and trash at developed facilities can contaminate water by introducing nutrients, bacteria, or chemicals to the water. Trash can be blown about by the wind or carried by runoff into waterbodies. In addition, uncollected garbage can attract wildlife, which are looking for an easy meal, to the facility.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Develop a Solid Waste System consistent with direction in FSM 7460 and FSH 7409.11, chapter 80 that defines and describes collection, transportation, storage, and final disposal methods for solid waste generated at facilities.
- Use suitable public relations and information tools and enforcement measures to encourage the public to use proper solid waste disposal measures.
  - Encourage recycling of materials where practicable.
  - Encourage the public to "pack it in-pack it out" in areas where practicable.
- Provide receptacles for trash at developed facilities.
  - Place trash and recycling receptacles in areas that are convenient to the facility's users.
  - Place trash and recycling receptacles in locations away from waterbodies.
  - Provide receptacles that discourage wildlife foraging as suitable for the area (e.g., bears, raccoons, birds) and suitably confine materials until collected.
  - Collect trash on a routine schedule to prevent the receptacles from overflowing.
- Dispose of collected garbage at properly designed and operated municipal-, county-, or State-authorized sanitary landfills or waste recycling sites where groundwater and surface water are adequately protected.
- Obtain necessary State or local permits for solid waste disposal sites.

Fac-6. Hazardous Materials

Manual or Handbook Reference 40 CFR 112; FSM 2160; and FSH 2109.14, chapter 60.

Objective Avoid or minimize short- and long-term adverse effects to soil and water resources by preventing releases of hazardous materials.

Explanation Constructing and operating facilities often involve the storage and use of hazardous materials. Improper storage and use can contaminate nearby soils and surface water or groundwater resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Ensure that all employees involved in the use, storage, transportation, and disposal of hazardous materials receive proper training.
- Limit the acquisition, storage, and use of hazardous, toxic, and extremely hazardous substances to only those necessary and consistent with mission requirements.
- Manage the use, storage, discharge, or disposal of pollutants and hazardous or toxic substances generated by the facility in compliance with applicable regulations and requirements.
- Monitor underground storage tanks and promptly address leaking tanks in consultation with the proper officials at State and Federal regulatory agencies.
- Construct and install new tanks in accordance with Federal, State, and local regulations.
    - Ensure that existing tanks meet performance standards for new tanks, meet upgrade requirements, or are taken out of service.
- Prepare a certified Spill Prevention Control and Countermeasure (SPCC) Plan for each facility as required by 40 CFR 112.
    - Install or construct the containment features or countermeasures called for in the SPCC Plan to ensure that spilled hazardous materials are contained and do not reach groundwater or surface water.
    - Ensure that cleanup of spills and leaking tanks is completed in compliance with Federal, State, and local regulations and requirements.
- Respond to hazardous materials releases or spills using the established site-specific contingency plan for incidental releases and the Emergency Response Plan for larger releases.
    - Train employees to understand these plans; the materials involved; and their responsibilities for safety, notification, containment, and removal.
    - Provide adequate communication to all downstream water users, such as municipal drinking water providers and fish hatcheries, as necessary.
- Ensure that hazardous spill kits are adequately stocked with necessary supplies and are maintained in accessible locations.

Fac-7. Vehicle and Equipment Wash Water

Manual or Handbook Reference None known.

Objective Avoid or minimize contamination of surface water and groundwater by vehicle or equipment wash water that may contain oil, grease, phosphates, soaps, road salts, other chemicals, suspended solids, and invasive species.

Explanation Washing vehicles and equipment is a common method used to maintain vehicles and minimize the spread of noxious and invasive species. Wash water and the resulting residue removed from vehicles and equipment may contain oils, chemicals, or sediment harmful to water and aquatic resources if not properly contained and treated. Work centers, ranger stations, fire stations, and other facilities may have washing equipment and locations designated for cleaning fleet or contracted vehicles and equipment. Temporary wash locations may also be installed during incident management or project work.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use commercial washing facilities that have proper wastewater treatment systems whenever possible.
  - Maintain a list of appropriate wash stations in the local area and provide the list to local offices, permit holders, and contractors.
- Install temporary wash sites only in areas where the water and residue can be adequately collected and either filtered on site or conveyed to an appropriate wastewater treatment facility.
  - Consider the use of a portable vehicle washer system, such as that designed by the Missoula Technology and Development System, to contain and filter the wash water.
  - Locate temporary wash sites out of AMZs, wetlands, groundwater recharge areas, floodplains, and other environmentally sensitive areas.
  - Use suitable measures to treat and infiltrate wash water to comply with applicable surface water and groundwater protection regulations.

Fac-8. Nonrecreation Special Use Authorizations

Manual or Handbook Reference FSM 2720 and FSH 2709.11, chapters 40 and 50.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from physical, chemical, and biological pollutants resulting from activities under nonrecreation special use authorizations.

Explanation This BMP covers all nonrecreation special use activities with the exceptions of pipelines; transmission facilities and other rights-of-ways; and water diversions, storage, and conveyance. BMP Fac-9 (Pipelines, Transmission Facilities, and Rights-of-Way), BMP WatUses-4 (Water Diversions and Conveyances), and BMP WatUses-5 (Dams and Impoundments) are provided for those activities.

The Forest Service role in defining and requiring the use of BMPs occurs during the development of the special use authorization and administration of the use. Discussions between the Forest Service and the permit holder concerning soil, water quality, and riparian resource impacts and appropriate BMPs to use should occur at the time of permit development or renewal. The special use authorization operation and maintenance plan details the conditions that must be met, including management requirements and mitigation measures to protect water quality. The permit holder will be required to conform to all applicable Federal, State, and local regulations and land management plan direction governing water resource protection and sanitation. State or Federal law may require that the permit holder obtain a pollution discharge permit or other authorization from a State, regional, or local government entity. Authorized uses often cover a wide range of activities and may require that BMPs from several management activity categories be included in the authorization.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Include in the authorization operation and maintenance plan the appropriate BMPs to control nonpoint source pollution from ground-disturbing activities, chemical use, and other activities that may adversely affect the physical, chemical, or biological integrity of surface water or groundwater.
- Update existing special use authorizations and operation and maintenance plans during annual renewal, or the next renewal, to be consistent with current requirements.
- Administer authorizations per the direction in FSM 2720 and FSH 2709.11 to ensure that water quality related terms and conditions are met.

Fac-9. Pipelines, Transmission Facilities, and Rights-of-Way

Manual or Handbook Reference FSM 2726 and FSH 2709.11, chapter 50.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during the construction and maintenance of pipelines, powerlines, transmission facilities, and other rights-of-way.

Explanation Powerlines and pipelines are constructed on NFS land by both public and private agencies under either an easement or special use authorization. Impacts to soil and water resources during transmission corridor and pipeline construction and maintenance include those originating from directional drilling, pipeline testing, soil disturbance, and erosion associated with vegetation removal and road construction. Other water quality impacts could occur from natural events, inappropriate or unauthorized activities, chemical spills, herbicide use, and other maintenance activities.

Measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources should be incorporated in the authorization terms and conditions, project plans for construction and design, and the right-of-way management plans for ongoing maintenance of vegetation along the corridor.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Consider soil and water impacts from factors such as stream head cutting and channel expansion, stream crossings, slope stability and steepness, and amount of riparian area, floodplain, and wetland acreage to be disturbed when determining corridor location.
    - ◻ Co-locate pipelines and transmission lines with roads or their rights-of-way where practicable.
    - ◻ Limit corridor disturbance, particularly in or near AMZs, surface waters, shallow groundwater, unstable areas, hydric soils, or wetlands.
- Consider service road location and standards, type of construction equipment (wheeled, tracked, and helicopter), size and location of footings and guy anchors, and revegetation requirements during project design.
    - ◻ Use applicable BMPs for Mechanical Vegetation Management Activities when using mechanical treatments to remove vegetation from the project corridor.
    - ◻ Use applicable practices of BMP Road-2 (Road Location and Design) for planning access roads.

- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control), BMP Road-3 (Road Construction and Reconstruction), and BMP Road-7 (Stream Crossings) when constructing pipelines, powerlines, and transmission facilities and associated roads.
- Use design and construction measures that sustain long-term wetland or stream function when a buried transmission line, pipeline, or tower support must be placed in a wetland or cross a stream (see BMP AqEco-2 [Operations in Aquatic Ecosystems]).
    - Use suitable measures for pipeline thickness, corrosion prevention, pipeline casing, cathodic protection and pipeline valves, and shut-off systems to prevent or minimize spills or leaks where pipelines cross waterbodies.
- Require suitable and regular inspections, testing, and leak detection systems to identify and mitigate pipeline deformities and leaks.
    - Use applicable practices of BMP WatUses-3 (Administrative Water Developments) and BMP Min-7 (Produced Water) when obtaining or disposing of water used for hydraulic testing of pipelines on NFS lands.
- Ensure that pipelines corridors, transmission lines, facilities, and other rights-of-ways are properly maintained to minimize damage to NFS resources in the event of an accident or natural disturbance.
    - Use applicable practices of BMP Fac-6 (Hazardous Materials), including preparation of an adequate Spill and Emergency Response Plan for pipelines carrying toxic or hazardous materials.
    - Use applicable BMPs for Mechanical Vegetation Management Activities when using mechanical treatments to manage vegetation within the corridor.
    - Use applicable BMPs for Chemical Use Activities when using chemicals for corridor maintenance or pipeline testing.
    - Use applicable practices of BMP Road-4 (Road Maintenance and Operations) for maintenance of access roads.
- Aggressively address unauthorized uses of the corridor, such as motorized vehicle use, that are exposing soils, increasing erosion, or damaging the facilities.

Fac-10. Facility Site Reclamation

Manual or Handbook Reference FSM 2020.

Objective Reclaim facilities and surrounding disturbed areas to as near to the predisturbed condition as is reasonably practicable following closure or completion of operations, or as necessary for mitigation purposes, to avoid, minimize, or mitigate long-term adverse effects to soil, water quality, and riparian resources.

Explanation Abandoned structures and wastes, particularly hazardous materials, at facility sites may pose a safety risk to the public. Lack of ongoing maintenance of facility sites can also threaten surface water and groundwater quality via erosion and chemical leaks as they fall into disrepair. Facility sites should be closed and reclaimed after the need for it ends or the recurrent impacts to resources indicate the site cannot be properly managed with available resources. Heavily used recreation sites will cause some areas to become denuded and compacted. These disturbed sites may become unstable and begin to erode at accelerated rates if not stabilized. Reestablishing stable grades, functional drainages, some level of site infiltration capacity, and effective ground cover on terrestrial sites and stabilizing substrates impacted by water flow or wave action are necessary to rehabilitate disturbed areas to avoid or minimize water quality and riparian resource degradation. Disturbances in and immediately adjacent to surface waters, riparian areas, and wetlands should be the highest priority for reclamation or rehabilitation.

Practices

Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Regularly review the need for and use of stockpiles, materials, supplies, and facilities.
- Surplus, repurpose, or recycle unneeded usable materials where practicable.
    - Dispose of unneeded materials through the appropriate solid waste handlers.
    - Consult the forest pollution prevention coordinator for proper disposal of hazardous materials.
- Develop and implement a reclamation plan to rehabilitate and restore, to the extent practicable, the natural ecological components, structures, and processes consistent with land management plan desired conditions, goals, and objectives at sites where structures or facilities have been permanently removed.
    - Remove unneeded structures.
    - Re-establish original slope contours, surface, and subsurface hydrologic pathways where practicable and as opportunities arise.
    - Improve infiltration capacity on compacted areas of the site.
    - Establish effective ground cover on disturbed sites to avoid or minimize accelerated erosion and soil loss.
    - Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
    - Stabilize disturbed streambed and banks (see BMP AqEco-4 [Stream Channels and Shorelines]).
    - Reconstruct or restore stream channels, wetlands, floodplains, and riparian areas to achieve desired conditions for aquatic ecosystem composition, structure, function, and processes (see BMP AqEco-3 [Ponds and Wetlands] and BMP AqEco-4 [Stream Channels and Shorelines]).
- Decommission unneeded roads, trails, and staging areas (see BMP Roads-6 [Road Storage and Decommissioning]).
- Consider long-term management of the site and nearby areas to promote project success.
    - Use suitable measures to limit human, vehicle, and livestock access to site as needed to allow for recovery of vegetation.

Resources for Facilities and Nonrecreation Special Uses Management Activities

Low Impact Development U.S. Environmental Protection Agency (EPA), Office of Water. Information and other resources on low impact development are available at http://water.epa.gov/polwaste/green/index.cfm.

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Wildland Fire Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from wildland fire management activities. Common wildland fire management operations include using prescribed fire, managing wildfire using a wide range of strategies from monitoring to aggressive control and suppression, and rehabilitating fire and suppression damage.

Firefighter and public safety is always the first priority in wildland fire activities. Implementation of BMPs to protect soil, water quality, and riparian resources, though important, must not compromise public or firefighter safety in wildland fire situations.

Four National Core BMPs are in the Wildland Fire Management Activities category. These BMPs are to be used during all wildfire management activities on National Forest System (NFS) lands. BMP Fire-1 (Wildland Fire Management Planning) is a planning BMP for wildland fire management at the land management-plan scale and at the project scale. BMP Fire-2 (Use of Prescribed Fire) provides direction for water quality protection during prescribed fire treatments. BMP Fire-3 (Wildland Fire Control and Suppression) provides guidance for avoiding or minimizing effects to soil, water quality, and riparian resources to the extent practicable during wildland fire suppression activities. BMP Fire-4 (Wildland Fire Suppression Damage Rehabilitation) has practices for rehabilitating fire lines, fire camps, staging areas, and burned areas.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Wildland Fire Management BMPs	
Fire-1	Wildland Fire Management Planning
Fire-2	Use of Prescribed Fire
Fire-3	Wildland Fire Control and Suppression
Fire-4	Wildland Fire Suppression Damage Rehabilitation

Fire-1. Wildland Fire Management Planning

Manual or Handbook Reference Forest Service Manual (FSM) 5120; FSM 5150; and Forest Service Handbook (FSH) 5109.19, chapter 50.

Objective Use the fire management planning process to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during wildland fire management activities.

Explanation Wildland fire is an essential ecological process and natural change agent for many vegetation communities and habitat types on NFS lands. The role of wildland fire is incorporated into the land management planning process through goals and objectives, desired conditions, standards, and guidelines in the land management plan. A forest or grasslands' fire management plan (FMP) describes the objectives and constraints to manage prescribed fires and wildfires within the context of the land management plan. The FMP is used to assist in developing the response to a wildland fire and is supplemented by operational plans.

Prescribed fire may be used to achieve a number of resource management objectives. These fires may occur across variously sized patches, from small slash piles to very large, landscape-scale broadcast burns. Properly planned and executed, these treatments can be very effective at managing natural resources while avoiding or minimizing adverse effects to soil, water quality, and riparian resources. A Prescribed Fire Burn Plan describes why the fire is needed, what the fire will accomplish, when conditions will permit achievement of desired effects, how specific fire application will occur, and how the progress and results will be monitored and evaluated. Soil and water protection objectives and measures should be written into the prescribed fire prescription.

Wildfires caused by natural ignition sources are managed to achieve a full range of land management plan objectives including protection and enhancement of resources. The decision to manage a wildfire for enhancement of resource objectives is made when the fire starts based on the objectives and constraints outlined in the land management plan. These fires cannot be planned beyond land management plan direction that determines areas where protection will be the only objective versus areas where enhancement of other resources may be considered as well. Watershed resource considerations may be incorporated into all wildfires, but objectives to manage the fire for beneficial effects may only be applied where authorized by the land management plan.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Land Management Plans

- Consider the beneficial and adverse effects of wildland fire on water quality and watershed condition when developing desired conditions and goals for the plan area.
  - Identify areas where the adverse effects of unplanned wildland fire to water quality and watershed condition outweigh the benefits.
- Include plan objectives and strategies that allow the use of wildland fire where suitable to restore watershed conditions.
- Include design criteria, standards, and guidelines for fire management activities to avoid or minimize adverse effects to soil, water quality, and riparian resources (see BMP Fire-2 [Use of Prescribed Fire] and BMP Fire-3 [Wildland Fire Control and Suppression]).
- Consider the need to establish a network of permanent water sources in the plan area for fire control and suppression (see BMP WatUses-3 [Administrative Water Developments]).

Prescribed Fire Plan

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when planning prescribed fire treatments.
- Consider prescription elements and ecosystem objectives at the appropriate watershed scale to determine the optimum and maximum burn unit size, total burn area, burn intensity, disturbance thresholds for local downstream water resources, area or length of water resources to be affected, and contingency strategies.
  - Consider the extent, severity, and recovery of fire disturbance a watershed has experienced in the past to evaluate cumulative effects and re-entry intervals.
- Identify environmental conditions favorable for achieving desired condition or treatment objectives of the site while minimizing detrimental mechanical and heat disturbance to soil and water considering the following factors.

- Existing and desired conditions for vegetation and fuel type, composition, structure, distribution, and density.
    - Short- and long-term site objectives.
    - Acceptable fire weather parameters.
    - Desirable soil, duff, and fuel moisture levels.
    - Existing duff and humus depths.
    - Site factors such as slope and soil conditions.
    - Expected fire behavior and burn severity based on past burn experience in vegetation types in the project area.
    - Extent and condition of roads, fuel breaks, and other resource activities and values.
- Develop burn objectives that avoid or minimize creating water-repellent soil conditions to the extent practicable considering fuel load, fuel and soil moisture levels, fire residence times, and burn intensity.
    - Use low-intensity prescribed fire on steep slopes or highly erodible soils when prescribed fire is the only practicable means to achieve project objectives in these areas.
- Set target levels for desired ground cover remaining after burning based on slope, soil type, and risk of soil and hillslope movement.
- Plan burn areas to use natural or in-place barriers that reduce or limit fire spread, such as roads, canals, utility rights-of-way, barren or low fuel hazard areas, streams, lakes, or wetland features, where practicable, to minimize the need for fireline construction.
    - Identify the type, width, and location of firebreaks or firelines in the prescribed fire plan.
- Use fire initiation techniques, control methods, and access locations for ignition and control (holding versus escape conditions) that minimize potential effects to soil, water quality, and riparian resources.
- Use prescribed fire in the AMZ only when suitable to achieve long-term AMZ-desired conditions and management objectives (see BMP Plan-3 [AMZ Planning]).

Fire-2. Use of Prescribed Fire

Manual or Handbook Reference FSM 5140.

Objective Avoid, minimize, or mitigate adverse effects of prescribed fire and associated activities on soil, water quality, and riparian resources that may result from excessive soil disturbance as well as inputs of ash, sediment, nutrients, and debris.

Explanation Prescribed fire, while a useful tool to achieve resource management objectives, can affect watershed condition by consuming vegetation, dead woody debris, humus, and duff; removing protective ground cover; contributing to creation of water-repellent soil conditions; damaging physical and biological soil quality from excessive heat; and releasing nutrients and metals to runoff into nearby streams. A prescribed fire may burn at a range of intensities, leaving a mosaic of burn severities within the fire perimeter. Actions to control and contain the prescribed fire, such as fireline construction, can also adversely affect watershed condition by creating a ground disturbance.

A Prescribed Fire Burn Plan guides the management of a prescribed fire. This plan contains the technical specifications for managing the fire and protecting other resources. Fire managers review these plans before fire ignition, briefing field crewmembers on practices and locations prescribed to avoid or minimize adverse effects to soil, water quality, and riparian resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Conduct the prescribed fire in such a manner as to achieve the burn objectives outlined in the Prescribed Fire Plan (see BMP Fire-1 [Wildland Fire Management Planning]).
- Locate access and staging areas near the project site but outside of AMZs, wetlands, and sensitive soil areas.
    - Keep staging areas as small as possible while allowing for safe and efficient operations.
    - Store fuel for ignition devices in areas away from surface water bodies and wetlands.
    - Install suitable measures to minimize and control concentrated water flow and sediment from staging areas.
    - Collect and properly dispose of trash and other solid waste.
    - Restore and stabilize staging areas after use (see BMP Veg-6 [Landings]).
- Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives.
    - Manage fire intensity to maintain target levels of soil temperature and duff and residual vegetative cover within the limits and at locations described in the prescribed fire plan.
- Construct fireline to the minimum size and standard necessary to contain the prescribed fire and meet overall project objectives.
    - Locate and construct fireline in a manner that minimizes erosion and runoff from directly entering waterbodies by considering site slope and soil conditions, and using and maintaining suitable water and erosion control measures.
    - Consider alternatives to ground-disturbing fireline construction such as using wet lines, rock outcrops, or other suitable features for firelines.
    - Establish permanent fireline with suitable water and erosion control measures in areas where prescribed fire treatments are used on a recurring basis.
    - Maintain firebreaks in a manner that minimizes exposed soil to the extent practicable.
    - Rehabilitate or otherwise stabilize fireline in areas that pose a risk to water quality.
- Alter prescribed fire prescriptions and control actions in the AMZs as needed to maintain ecosystem structure, function, and processes and onsite and downstream water quality.
    - Pretreat AMZs and drainage ways to reduce excessive fuel loadings.
    - Avoid building firelines in or around riparian areas, wetlands, marshes, bogs, fens, or other sensitive water-dependent sites unless needed to protect life, property, or wetlands.
    - Construct any essential fireline in the AMZ in a manner that minimizes the amount of area and soil disturbed.
    - Keep high-intensity fire out of the AMZ unless suitable measures are used to avoid or minimize adverse effects to water quality.

- Avoid or minimize complete removal of the organic layer when burning in riparian areas or wetlands to maintain soil productivity, infiltration capacity, and nutrient retention.
- Rehabilitate fireline in the AMZ after prescribed fire treatment is completed.
- Remove debris added to stream channels as a result of the prescribed burning unless debris is prescribed to improve fisheries habitat.

- Conduct prescribed fire treatments, including pile burning, for slash disposal in a manner that encourages efficient burning to minimize soil impacts while achieving treatment objectives.
  - Pile and burn only the slash that is necessary to be disposed of to achieve treatment objectives.
  - Locate slash piles in areas where the potential for soil effects is lessened (meadows, rock outcrops, etc.) and that do not interfere with natural drainage patterns.
  - Remove wood products such as firewood or fence posts before piling and burning to reduce the amount of slash to be burned.
  - Minimize the amount of dirt or other noncombustible material in slash piles to promote efficient burning.
  - Construct piles in such a manner as to promote efficient burning.
  - Avoid burning large stumps and sections of logs in slash piles to reduce the amount of time that the pile burns.
  - Avoid burning when conditions will cause the fire to burn too hot and damage soil conditions.
  - Avoid piling and burning for slash removal in AMZs to the extent practicable.
  - Minimize effects on soil, water quality, and riparian resources by appropriately planning pile size, fuel piece size limits, spacing, and burn prescriptions in compliance with State or local laws and regulations if no practical alternatives for slash disposal in the AMZ are available.
- Evaluate the completed burn to identify sites that may need stabilization treatments or monitoring to minimize soil and site productivity loss and deterioration of water quality both on and off the site.
  - Provide for rapid revegetation of all denuded areas through natural processes supplemented by artificial revegetation where necessary.
  - Use suitable measures to promote water retention and infiltration or to augment soil cover where necessary.
  - Use suitable species and establishment techniques to stabilize the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
  - Clear streams and ditches of debris introduced by fire control equipment during the prescribed fire operation.
  - Consider long-term management of the site and nearby areas to promote project success.
  - Use suitable measures to limit human, vehicle, and livestock access to site as needed to allow for recovery of vegetation.

Fire-3. Wildland Fire Control and Suppression

Manual or Handbook Reference FSM 5130.

Objective Avoid or minimize adverse effects to soil, water quality, and riparian resources during fire control and suppression efforts.

Explanation Wildland fire control and suppression activities are aimed at stopping and extinguishing the fire and often occur without full knowledge of potential effects to soil, water quality, or riparian resources. Suppression activities include constructing fire line and temporary access roads, opening closed or access-limited system roads, clearing and grubbing safety zones, falling hazard trees, retrieving water and applying it to the fire, performing back-fire operations, and applying aerial or ground-based fire retardant. Soil disturbance and loss of ground cover from these activities can lead to accelerated erosion and sediment delivery to waterbodies. Certain fire retardant formulations are toxic to aquatic fauna, including fish. Water quality objectives are included in strategic and tactical fire management plans, but are secondary to firefighter and public safety during suppression activities.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Assign a watershed resource advisor, or team of watershed resource advisors, to work with incident management teams to minimize damage to soil, water quality, and riparian resources from fire and fire control and suppression activities.
- Locate Incident Command Post, air resource bases, staging areas, and other fire management support areas outside of the AMZ and at a suitable distance from waterbodies to minimize the potential for adverse effects to water quality.
    - Protect surface and subsurface water resources from nutrients, bacteria, and chemicals associated with solid waste and sewage disposal.
    - Collect and properly dispose of trash and other solid waste.
    - Use applicable practices of BMP Road-10 (Equipment Refueling and Servicing) when servicing, refueling, and cleaning vehicles and equipment.
    - Install suitable measures to minimize and control concentrated water flow and sediment from support areas.
- Use Minimum Impact Suppression Tactics during wildland fire control and suppression activities when and where practicable considering the appropriate management response and land management plan direction.
- Use preexisting features for safety zones as practicable to avoid unnecessary ground disturbance.
- Construct fireline to the minimum size and standard necessary to contain the fire and meet overall resource objectives.
    - Locate and construct fireline in a manner that minimizes erosion and runoff from directly entering waterbodies by considering site slope and soil conditions, and using and maintaining suitable water and erosion control measures.
    - Avoid building firelines in or around riparian areas, wetlands, marshes, bogs, fens, or other sensitive water-dependent sites unless needed to protect life or property.

- Use natural or in-place barriers that reduce or limit fire spread, such as roads, canals, utility rights-of-way, barren or low fuel hazard areas, streams, lakes, or wetland features as firelines where practicable, to minimize the need for fireline construction.

- Use suitable measures to prevent or minimize runoff, erosion, and sediment delivery to waterbodies when using water for fire suppression activities.
- Use suitable measures, consistent with current Forest Service policy, to minimize adverse effects to water quality when applying fire retardant or foam.
    - Use fire retardant formulations that are least toxic to aquatic flora and fauna and shift to less lethal formulations as they become available and affordable.
    - Avoid, to the extent practicable, aerial application of fire retardant or foam within a buffer area around waterbodies of sufficient size to minimize the potential for entry into the waterbody.
- Conduct water drafting at suitable locations and in a manner that avoids or minimizes adverse effects to water quality (see BMP WatUses-3 [Administrative Water Developments]).
- Evaluate the need to close or restrict use of surface and shallow groundwater resources following fire control activities that may have adversely affected water quality.

Fire-4. Wildland Fire Suppression Damage Rehabilitation

Manual or Handbook Reference FSM 2523.4.

Objective Rehabilitate watershed features and functions damaged by wildland fire control and suppression-related activities to avoid, minimize, or mitigate long-term adverse effects to soil, water quality, and riparian resources.

Explanation Fire suppression and related activities can damage watershed features and functions by removing vegetation, exposing soil, and disrupting flow pathways. Corrective treatments are used to stabilize soil, control surface runoff and erosion, reduce flood potential, and stabilize the drainage network in areas directly affected by fire suppression and related activities. Fire incident management teams (IMTs) are responsible for rehabilitation of fireline, spike camps, roads, and other sites created and used to control and suppress the fire, where necessary, to protect resources. Resource advisors may assist the IMT in determining the sites in need of treatment as well as suitable corrective actions. Areas affected by the fire itself may require additional rehabilitation, including emergency treatments, (e.g., Burned Area Emergency Response [BAER] program) to protect watershed resources. These activities may be initiated by the affected management unit immediately following the fire or during a period of years after the fire to achieve desired objectives.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Conduct emergency stabilization assessments of fire damage that produces hazards to life or property as needed in accordance with BAER policy (FSM 2523 and FSH 2509.13).
- Reclaim and stabilize disturbed areas including safety zones, fireline, and base camps that have increased erosion potential or drainage patterns altered by fire suppression activities.
    - Reshape the ground surface and install suitable drainage features to promote dispersed runoff from the site.

- Mitigate soil compaction to improve infiltration and revegetation conditions.
- Use suitable species and establishment techniques to stabilize the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

• Repair roads, trails, and other facilities damaged by suppression activities that may adversely affect water quality and riparian resources.

- Repair damaged road and trail drainage structures and conveyances to a condition where they can function as designed (See BMP Road-3 [Road Construction and Reconstruction] and BMP Road-4 [Road Operations and Maintenance]).
- Reconstruct roads damaged by mechanized equipment to stabilize the road prism and running surface (See BMP Road-3 [Road Construction and Reconstruction]).
- Close or decommission roads opened for access in a condition that reduces the risk of adverse effects to hydrologic function and water quality (see BMP Road-6 [Road Storage and Decommissioning]).
- Repair and clear debris from water conveyance structures, such as ditches, to reduce the potential for failures and subsequent erosion.

• Clear suppression-created debris from critical points in streams channels to reduce the potential for flooding or bank erosion.

- Remove debris and sediment from existing drainage structures.
- Remove debris introduced by fire control equipment during fire suppression activities.
- Remove dams used to construct pools for water drafting into engines.

• Evaluate the burned area to identify sites that may need rehabilitation treatments or monitoring to minimize soil and site productivity loss and deterioration of water quality both on and off the site.

- Provide for rapid revegetation of critical denuded areas through natural processes supplemented by artificial soil surface cover or revegetation where necessary.
- Prioritize needed treatments to rehabilitate AMZ structure, function, and processes before treating uplands.
- Use suitable measures in compliance with local direction to prevent and control invasive species.

Resources for Wildland Fire Management Activities

Fire Retardant

U.S. Department of Agriculture (USDA), Forest Service, Fire and Aviation Management. 2011. National aerial application of fire retardant 2011 final environmental impact statement and associated documents. Washington, DC. Available at http://www.fs.fed.us/fire/retardant/eis_info.html.

USDA Forest Service; U.S. Department of the Interior, Bureau of Land Management, National Park Service, and Fish and Wildlife Service. 2000. Guidelines for aerial delivery of retardant or foam near waterways. 2 p. Available at http://www.fs.fed.us/fire/retardant/references/US_Forest_Service_et_al_2000_Guidelines_for_Aerial_Delivery.pdf.

Minimum Impact Suppression Tactics

National Wildfire Coordinating Group. 2010. Incident response pocket guide. PMS 461, NFES 1077. 130 p. Available at http://www.nwcg.gov/pms/pubs/nfes1077/nfes1077.pdf.

Wildland Fire Lessons Learned Center. Minimum impact suppression tactics guidelines. Tucson, AZ. 12 p. Available at http://wildfirelessons.net/documents/GB_MIST_Guidelines.pdf.

Prescribed Fire

Arkansas Forestry Commission. 2002. Arkansas forestry best management practices for water quality protection. Little Rock, AR. 60 p. Available at http://forestry.arkansas.gov/Services/ManageYourForests/Pages/bestManagementPractices.aspx.

USDA Natural Resources Conservation Service. National conservation practice standards—338 prescribed burning. Available at http://www.nrcs.usda.gov/technical/standards/nhcp.html.

U.S. Environmental Protection Agency, Office of Water. 2005. Chapter 3G: Fire management. In: National management measures to control nonpoint source pollution from forestry. EPA 841-B-05-001. Washington, DC. p. 3-89–3-92. Available at http://www.epa.gov/owow/nps/forestrymgmt/.

Water Sources

Napper, C. 2006. Water-source toolkit. 0625 1806. San Dimas, CA: USDA Forest Service, Technology and Development Program. 74 p. Available at http://www.fs.fed.us/eng/pubs/pdf/WaterToolkit/lo_res.shtml.

Sicking, L.P. 2002. Water ejectors for use in wildland firefighting. 0251 1205P. San Dimas, CA: USDA Forest Service, Technology and Development Program. 52 p. Available at http://www.fs.fed.us/eng/pubs/pdf/02511205.pdf.

Minerals Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from various mineral exploration, development, operation, and reclamation activities. Minerals on National Forest System (NFS) lands fall into four categories described in table 3.

Table 3.—*Categories of minerals on NFS lands.*

Locatable minerals (Forest Service Manual [FSM] 2810)	Metals and rare earth elements such as uranium. Uncommon varieties of sand, stone, gravel, pumice, pumicite, cinders, and clay.
Leasable minerals (FSM 2820)	Oil and gas, coal, phosphate, potassium, sodium, sulphur, gilsonite, oil shale, and geothermal resources. Hardrock minerals located on acquired lands.
Mineral materials (FSM 2850)	Common varieties of sand, stone, gravel, pumice, pumicite, cinders, and clay.
Mineral reservations and outstanding rights (FSM 2830)	Reserved rights—private mineral rights retained in private owner conveyance. Outstanding rights—private mineral rights in deed restrictions for some tracts of acquired forest land.

In general, the Forest Service's objective for managing mineral and energy resources on NFS lands is to encourage and facilitate the orderly exploration, development, and production of these resources in an environmentally sound manner integrated with the management of other national forest resources. In addition, NFS lands disturbed by mineral activities are to be reclaimed for other productive uses (FSM 2802). The extent to which the Forest Service has the authority to regulate mineral operations and require measures to avoid, minimize, mitigate, and reclaim surface disturbance varies with the mineral commodity in question and status of the land on which it is located. In all cases where there appears to be a conflict between applicable law, regulation, and suggested BMPs, the law or regulation takes precedence.

Eight National Core BMPs are in the Minerals Management Activities category. These BMPs are to be used during all minerals management activities on NFS lands, to the extent allowed by Federal and State minerals development laws and regulations. BMP Min-1 (Minerals Planning) is a planning BMP for minerals management at the land management plan scale and project scale. Mineral exploration and production activities are similar for many of the minerals managed by the Forest Service. Practices for exploration activities are in BMP Min-2 (Minerals Exploration) and practices for production activities are in BMP Min-3 (Minerals Production). BMP Min-4 (Placer Mining) provides direction for extracting metals from alluvial deposits in or near stream channels. BMP Min-5 (Minerals Materials Resource Sites) provides direction for extracting aggregate materials from waterbodies and upland sites. BMP Min-6 (Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds) covers onsite storage and disposal of solid and liquid mine wastes. BMP Min-7 (Produced Water) provides direction for treatment and disposal of water produced at drilling sites. BMP Min-8 (Minerals Site Reclamation) provides direction for reclamation of mines and drilling sites.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Minerals Activities BMPs	
Min-1	Minerals Planning
Min-2	Minerals Exploration
Min-3	Minerals Production
Min-4	Placer Mining
Min-5	Mineral Materials Resource Sites
Min-6	Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds
Min-7	Produced Water
Min-8	Minerals Site Reclamation

Min-1. Minerals Planning

Manual or Handbook Reference FSM 2810, FSM 2820, FSM 2830, and FSM 2850.

Objective Use the minerals planning process to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during minerals exploration, production, operations, and reclamation activities.

Explanation When minerals activities are proposed for NFS lands, the Forest Service conducts or participates in an analysis as required by the National Environmental Policy Act (NEPA) and the applicable approval or authorization procedures to comply with laws governing mineral disposal and environmental protection and to ensure consistency with the land management plan. During this analysis and approval process, the Forest Service consults and cooperates with other State and Federal agencies to identify the environmental impacts that will occur; to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources; and to determine reclamation needs and formulate appropriate bonding. These measures are implemented through the approved plan, contract, or other authorization.

Through the Bureau of Land Management (BLM), the U.S. Department of the Interior has the primary role in issuing mineral leases and permits and supervising operations for many mineral activities. The Forest Service coordinates with the BLM to ensure that land management plan resource management desired conditions, goals, and objectives are achieved; impacts to land surface resources are minimized or mitigated; and the affected land is promptly rehabilitated. Through the NEPA process the Forest Service and BLM make a determination as to whether an authorization or lease will be issued and identify stipulations needed to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when planning minerals activities.
- Identify potential environmental risks of the proposed minerals activities and include measures in project plans to manage risk by removing or eliminating the source of risk, changing the mining plan, or removing the resource at risk from harm's way.

- Inform proponent that a Clean Water Act (CWA) 402 permit may be required if the minerals operation causes a point source or stormwater discharge of any pollutant to waters of the United States.
- Inform proponent that a CWA 404 permit may be required if the mining operations will result in a discharge of dredge or fill material to waters of the United States.
- Evaluate plan of operations to ensure that reasonable measures, including appropriate BMPs, are included to avoid and minimize adverse effects to soil, water quality, and riparian resources from the mining activities.
    - Require suitable geotechnical or stability analyses to ensure that facilities are constructed to acceptable factors of safety using standard engineering practices and considering foundation conditions and material; construction materials and techniques; the seismicity of the area; and the water-related resources at risk.
    - Require suitable characterization of ore, waste rock, and tailings using accepted protocols to identify materials that have the potential to release acidity or other contaminants when exposed during mining.
    - Require suitable characterization of mine site hydrology commensurate with the potential for impacts to surface water and groundwater resources, to include physical and chemical characteristics of surface and groundwater systems, as needed, for the range of expected seasonal variation in precipitation and potential stormflow events likely to occur at the site for the duration of the minerals activities.
    - Stipulate suitable requirements, including water treatment as needed, to avoid or minimize the development and release of acidic or other contaminants.
    - Use applicable practices from the Minerals Management Activities BMPs.
    - Evaluate the consumptive use of water in the mining operation and its effect on water-dependent ecosystems.
    - Evaluate the potential for direct and indirect impacts to morphology, stability, and function of waterbodies, riparian areas, and wetland habitats.
    - Identify suitable measures to avoid impacts to waterbodies, riparian areas, and wetland habitats through appropriate location, design, operation, and reclamation requirements.
    - Identify suitable interim and post-project surface water and groundwater monitoring where needed to confirm predictions of impacts, detect adverse changes at the earliest practicable time, and develop appropriate changes in operations or recommend closure where needed.
    - Request a copy of operator's CWA 401 Certification from designated Federal, State, or local entity before approving a plan of operations that may result in any discharge into waters of the United States.
- As outlined in the Forest Service Training Guide for Reclamation Bond Estimation and Administration for Minerals Plans of Operation, consider the direct and indirect costs of stabilizing, rehabilitating, and reclaiming the area of mineral operations to the appropriate standards for water quality and watershed condition as determined from the land management plan, State and Federal laws, regulations, plans, or permits when determining the reclamation bond amount. Include costs for:
    - Operation and maintenance of facilities designed to divert, convey, store, or treat water.
    - Decontaminating, neutralizing, disposing, treating, or isolating hazardous materials at the site to minimize potential for contamination of soil, surface water, and ground water.
    - Water treatment needs predicted during planning and discovered during operations to achieve applicable water quality standards.

- Earthwork to reclaim roads; waste rock dumps; tailings; backfilling water features (diversions, ditches, and sediment ponds); and construction of diversion channels and drains, stream channels, and wetlands.
- Revegetation to stabilize the site and minimize soil erosion.
- Mitigation to restore natural function and value of streams, wetlands, and floodplains.
- Long-term operations, monitoring, and maintenance of mineral production-related facilities that must perform as designed to avoid or minimize contamination of surface or groundwater resources, including roads, diversion ditches, dams, and water treatment systems.
- Protection of the reclaimed area until long-term stability, erosion control, and revegetation has been established.

Locatable Minerals

- Evaluate Notice of Intent to Operate proposal to determine if it will likely cause significant disturbance to soil, water quality, and riparian resources.
    - Require a plan of operation from the mineral operator, lessee, or purchaser as required by law and regulation if proposed activities might cause significant disturbance of surface resources including soil, water quality, or riparian resources.

Minerals Leasing

- Include in the land management plan, or other areawide decision document, direction for surface occupancy. Use lease stipulations to avoid riparian areas, wetlands, and areas subject to mass soil movement; to avoid or minimize erosion and sediment production; and to avoid or minimize adverse effects to water quality and municipal supply watersheds, if these issues are not adequately addressed by provisions in regulations at 36 CFR 228.108.
- Use the applicable practices from the Minerals Activities BMPs for recommendations on post-lease approval of operations.
- Require or work with BLM to require appropriate contingency plans to avoid or minimize adverse impacts to surface waters.
- Coordinate with BLM to ensure the reclamation bond required for operations will be sufficient to guarantee reclamation work on NFS lands to the appropriate standards for water quality and watershed condition as determined from the land management plan, State and Federal laws, regulations, plans, or permits.

Mineral Materials

- Include reasonable conditions and applicable practices of BMP Min-3 (Minerals Production) and BMP Min-5 (Mineral Materials Resource Sites) in the operating plan to ensure proper protection of soil, water quality, and riparian resources and timely reclamation of disturbed areas.
- Consider the direct and indirect costs of stabilizing, rehabilitating, and reclaiming the area of mineral materials operations to the appropriate standards for water quality and watershed condition as determined from the land management plan, State and Federal laws, regulations, plans, or permits when determining the reclamation bond amount.

Mineral Reservations and Outstanding Mineral Rights

- Evaluate the Operating Plan for Mineral Reservation Operations to ensure that reasonable measures, including appropriate BMPs, consistent with the terms of the deed, are included to minimize damage to NFS surface resources that could affect soil, water quality, and riparian resources and that provide for restoration and reclamation of disturbed lands.

- Evaluate the Operating Plan for Outstanding Mineral Rights to ensure that reasonable measures, including appropriate BMPs, are included to control erosion, avoid or minimize water pollution, and reclaim the site consistent with land management plan direction for water quality management.

Min-2. Minerals Exploration

Manual or Handbook Reference FSM 2810, FSM 2820, and FSM 2850.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources caused by physical and chemical pollutants during minerals exploration activities.

Explanation Minerals exploration is the process of determining the location, extent, composition, and quality of deposits of minerals and energy resources that can be commercially developed. Exploration methods may include remote sensing, geochemical analysis of water, rock and soil samples, geophysical analysis, and ground-disturbing activities including drilling, bulldozing, trenching, and excavating shallow pits, exploration shafts, or adits. During construction of drill pads, trenches, pits, or shafts, land may be cleared of existing vegetation and ground cover, exposing mineral soil that may be more easily eroded by water, wind, and gravity. Underground activities may intercept groundwater, exposing these aquifers to potential contaminants.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Avoid or minimize long-term impacts to soil, water quality, and riparian resources to the extent permitted by the geologic target when selecting locations for exploration activities.
  - Avoid waterbodies, sensitive areas, unstable slopes, and highly erosive soils to the extent practicable.
- Limit clearing, excavation, and other surface-disturbing activities to the minimum necessary for exploration needs.
  - Consider using exploration drilling and support vehicles that do not require road construction.
- Design and construct all new roads and drilling pads to a safe and appropriate standard, no higher than necessary to accommodate their intended use (see BMP Road-2 [Road Location and Design], BMP Road-3 [Road Construction and Maintenance], and BMP Road-4 [Road Operations and Maintenance]).
- Employ suitable design and construction practices to avoid, minimize, or mitigate surface disturbances as well as maintain the reclamation potential of the site.
  - Use directional drilling techniques when practicable to avoid or reduce surface disturbance.
  - Plan and construct, to the extent practicable, exploration roads to be recontoured when operations are complete.
- Limit the extent of open exploratory areas at one time and restore one site before moving on to the next one, to the extent practicable.
- Use applicable practices from BMP Fac-2 (Facility Construction and Stormwater Control) to minimize erosion and stormwater discharge from ground disturbance at exploration sites.

- Use applicable practices from BMP Fac-4 (Sanitation Systems) and BMP Fac-5 (Solid Waste Management) to avoid contaminating surface water or groundwater from sanitation or solid waste facilities.
- Use applicable practices of Chemical Use Management Activities BMPs when chemicals are used in exploration activities.
- Use applicable practices of BMP Fac-6 (Hazardous Materials) and BMP Road-10 (Equipment Refueling and Servicing) to manage petroleum products and other hazardous materials used in exploration activities.
    - Require a transportation spill response plan, where applicable, that describes the petroleum products or other hazardous materials or chemicals that will be used in the operations, including the routes, amount and frequency of shipments, and containers and vehicles used. Describe in this plan the procedures, equipment, and personnel that would be used to respond to a spill.
- Properly manage all exploration-related wastes, including drilling fluids, produced water, and potentially acid-generating rock materials, to minimize the risk of groundwater and surface water contamination and to meet State and Federal requirements.
    - Use applicable practices of BMP Min-6 (Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds) and BMP Min-7 (Produced Water).
- Protect groundwater developments and groundwater-dependent ecosystems from the impacts of shock waves when using shot explosions to determine gas reserves or other energy development potential.
- Use applicable practices of BMP Min-8 (Minerals Site Reclamation) to reclaim the project site after exploration activities are completed.

Min-3. Minerals Production

Manual or Handbook Reference FSM 2810, FSM 2820, and FSM 2850.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources caused by physical and chemical pollutants resulting from mineral development, production, and associated activities.

Explanation Minerals production is the process of opening the mineral or oil and gas deposit; extracting the mineral resource (beneficiation); and processing the mineral resource to put it in a marketable condition. Minerals are extracted through surface mining (open pit or strip mining), underground mining (shafts or adits), or wells for fluid materials or solvent extraction. In addition to land clearing for mineral extraction, a minerals production site will also require clearing and ground disturbance for accessory buildings and facilities for minerals processing, storage, and transportation. Exposed soils may be subject to accelerated erosion if proper erosion controls are not used. Hazardous chemicals may be used in the process of extracting and processing minerals. Extraction and beneficiation operations associated with mining activities can generate acid mine drainage when sulfide rock materials are exposed to air and water. These materials may contaminate surface water or groundwater if not handled appropriately.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Avoid or minimize long-term impacts to soil, water quality, and riparian resources to the extent permitted by the geologic target when selecting locations for the mining operation, structures, roads, and ore and waste facilities.
  - Provide adequate buffers and setbacks from waterbodies to avoid or minimize impacts to water quality and aquatic ecosystems.
- Employ suitable design and construction measures to avoid, limit, or mitigate surface disturbances as well as maintain the reclamation potential of the site.
- Use applicable practices from BMP Fac-2 (Facility Construction and Stormwater Control) to minimize erosion and stormwater discharge from ground disturbance at minerals production sites and to keep production sites dry.
- Properly manage mining byproducts and wastes.
  - Minimize production of byproducts and wastes to the extent practicable.
  - Plan space to properly handle, store, and contain byproducts and wastes.
  - Find suitable onsite or offsite uses for mining byproducts.
  - Recycle or properly dispose of wastes (e.g., used petroleum products, site garbage, septic effluent, decommissioned equipment, and used barrels or containers).
  - Minimize handling of byproducts and wastes to the extent practicable.
- Use applicable Road Management Activity BMPs to manage roads and transportation at the project site.
- Use applicable practices from BMP Fac-4 (Sanitation Systems) and BMP Fac-5 (Solid Waste Management) to avoid contaminating surface water or groundwater from sanitation or solid waste facilities.
- Use applicable Chemical Use Management Activities BMPs, BMP Fac-6 (Hazardous Materials), and BMP Road-10 (Equipment Refueling and Servicing) to manage all chemicals, reagents, fuels, and other hazardous or toxic materials used for construction, operations, and beneficiation to avoid or minimize contaminating surface water or groundwater.
- Use applicable practices from BMP Min-8 (Minerals Site Reclamation) to reclaim the project site after minerals production operations are completed.
- Use applicable practices of BMP Min-6 (Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds) and BMP Min-7 (Produced Water) to protect soil, water quality, and riparian resources in minerals extraction and processing, geothermal energy, and oil and gas production activities.
- Require a transportation spill response plan, where applicable, that describes the petroleum products or other hazardous materials or chemicals that will be used in the operations, including the routes, amount, and frequency of shipments, and the containers and vehicles that are to be used. Describe in this plan the procedures, equipment, and personnel that would be used to respond to a spill.
- Make adjustments in the plans, authorizations, and bonds if conditions develop that are outside the design criteria and conduct adequate notification, emergency stabilization, or other activities to avoid effects before proceeding with additional mining.

Mining-Related Surface Activities

- Limit clearing, excavation, and other surface-disturbing activities to the minimum necessary for mining needs.
  - Limit amount of exposed or disturbed soil at any one time to the minimum necessary for efficient operations during minerals production activities.
  - Clearly delineate the geographic limits of the area to be cleared.
  - Install suitable drainage measures to improve the workability of wet sites.
  - Avoid or minimize damage to existing vegetation, particularly the vegetation that is stabilizing the bank of a waterbody.
  - Stabilize mined areas and surface disturbance activities as soon as practicable before moving and opening up new areas.
- Reduce surface-disturbing activities to the minimum necessary for efficient minerals production activities during periods of heavy runoff or saturated soil conditions, to the extent practicable, to decrease the potential for soil compaction and erosion.
- Stockpile biologically active topsoil removed during excavation for use in reclamation.
  - Store stockpiled topsoil separately from other vegetative slash or soil and rock materials and protect from wind and water erosion, unnecessary compaction, and contaminants.
- Conduct operations in such a manner as to avoid or minimize the production and transport of fugitive dust from the site.
- Use suitable measures in compliance with local direction to prevent and control invasive species.

Mining-Related Subsurface Activities

- Develop the mine plan to suitably address surface stability and avoid or minimize the unnecessary diversion of runoff or surface waters into the subsurface.
- Use suitable water management and control measures to minimize water inflow, use inflow for mineral operations to the extent practicable, and manage inflow to minimize the accumulation of contaminants including blasting residuals.
- Manage ventilation systems to minimize deposition of airborne contaminants on the ground surface.

Geothermal, Oil, and Gas Activities

- Locate well sites on level locations that will accommodate the intended use to reduce the need for vertical cuts and steep fill slopes.
  - Use directional drilling techniques when practicable to avoid or reduce surface disturbance.
- Use suitable measures to stabilize fill slopes and minimize potential of slope failures.
- Use suitable measures to provide surface drainage and manage runoff from the work areas used for mud tanks, generators, mud storage, and fuel tanks in a manner that avoids or minimizes pollutant contamination of surface waters or groundwater.
- Use nontoxic, nonhazardous drilling fluids whenever practicable.
- Construct suitable impervious containment structures with sufficient volume and freeboard to avoid or minimize spills or leakages of oil, gas, salt water, toxic liquids, or waste materials from reaching surface waters or groundwater.

- Avoid mixing of geothermal fluids with surface water or groundwater where the chemical and thermal properties of the geothermal fluids would damage aquatic ecosystems and contaminate drinking water supplies.

Mining-Related Instream Activities

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when conducting mining in waterbodies.

Min-4. Placer Mining

Manual or Handbook Reference FSM 2810.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when conducting placer mining operations in or near stream channels.

Explanation Placer mining involves mining and extracting gold or other heavy metals and minerals primarily from alluvial deposits. These deposits may be in existing streambeds or in ancient, often buried, stream deposits. Suction dredge placer mining is the most common in-channel operation and removes gold and other minerals from streambed substrates. All floating suction dredges are designed to work as a unit to dig, classify, and beneficiate ores and to dispose of waste within the stream channel. Placer mining operations can also occur adjacent to stream channels and other waterbodies. The essential components of placer mining include removing the overburden, mining the placer deposits, and processing the ore to recover the desired mineral. Overburden and placer deposits can be excavated by a variety of means ranging from hand tools to heavy equipment. Excavated placer pay gravels are typically processed using a variety of gravity separation techniques that yield gold or other heavy metal concentrates. Concentration of gold and other precious metals sometimes takes place onsite using mercury amalgamation or other techniques. Waste products from placer mining include tailings and process water. Effects to soil, water quality, and riparian resources from these operations include direct modification of the waterbody, release of contaminated waters, groundwater disruption, and increased levels of turbidity and sediment.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems), BMP AqEco-3 (Ponds and Wetlands), and BMP AqEco-4 (Stream Channels and Shorelines) when working in or near aquatic ecosystems to prevent or minimize adverse impacts to water quality.
- Use applicable practices of BMP Min-3 (Mineral Production) for sanitation, solid waste, and transport and storage of petroleum products or other hazardous materials.

Suction Dredge Mining

- Conduct dredging and excavation operations in such a manner as to avoid creating dams or diversions, including inadvertent damming caused by tailing placement.
- Conduct dredging and excavation operations only within the existing wetted perimeter (waterline) in the active stream channel and avoid mining or otherwise disturbing streambanks.

- Schedule dredging or excavation to avoid periods and locations where fish are spawning or where fish eggs or fry are known to exist at the time dredging occurs.
- Provide adequate passage for fish around and through the mining area.
- Provide space between current and recent dredging and excavation operations to avoid overlapping of water quality and habitat effects from concurrent or successive operations to provide areas of unimpacted substrate for fish and other aquatic organisms.
- Conduct dredging and excavation operations in such a manner as to retain large boulders, logs, or other natural obstructions in place to preserve large habitat-forming elements.
- Conduct dredging and excavation operations in such a manner as to avoid significant increases in downstream turbidity.

Mechanical Placer Mining in Riparian and Floodplain Areas

- Use applicable practices of BMP Min-3 (Minerals Production) in removing overburden to access placer deposits.
- Use applicable practices of BMP Min-6 (Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds) and BMP Min-7 (Produced Water) to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when processing materials.
- Use suitable measures to avoid or minimize the entrainment of fish when obtaining water from a fish-bearing stream for placer mining operations.

Min-5. Mineral Materials Resource Sites

Manual or Handbook Reference FSM 2850.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when developing and using upland mineral materials resource sites or instream sand and gravel deposits.

Explanation Mineral materials resource sites include upland and instream sites that are mined to obtain minerals materials such as sand, gravels, cobbles, and boulders. Upland aggregate deposits also include finer materials such as sand, silt, clay, and organic debris that can be mobilized during or following desired material extraction operations. The principal pollutant generated at quarries is total suspended solids and, therefore, erosion and sediment control should be the major focus during all phases of the quarry operation. The size and location of the deposit, as well as the amount and duration of need for materials, are commonly the key factors to consider when evaluating and designing an appropriate strategy to remove the materials and stabilize the site following mining operations.

Deposits of sand and gravel, the unconsolidated granular materials resulting from the natural disintegration of rock or stone, are generally found in near-surface alluvial deposits and in subterranean and subaqueous beds. Instream sand and gravel mining operations consist of extracting sand and gravel deposits from the stream channel and processing and stockpiling aggregate materials at a nearby site on land. Instream extraction is accomplished by dredging underwater deposits; mining point bars, lateral bars, and islands that are above the low-water level; mining of temporarily or permanently dewatered channels; or by creating instream harvest pits by placement of rock vortex weirs. Effects to water quality and aquatic ecosystems from these operations can include direct physical modification of the waterbody and hydraulics, reduction in bedload and change in bedload transport, release of contaminated waters, groundwater disruption, and increased levels of turbidity.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Allow upland and instream sand and gravel mining where consistent with land management plan desired conditions, goals, and objectives for soils, aquatic and riparian habitats, and water quality.
- Use applicable practices of BMP Min-3 (Minerals Production) and BMP Fac-2 (Facility Construction and Stormwater Control) for sanitation, solid waste, and transport and storage of petroleum products or other hazardous materials and to control erosion, manage stormwater, keep the site dry, and protect the waterbody when clearing the extraction and processing areas.
- Use applicable practices of BMP Min-6 (Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds) and BMP Min-7 (Produced Water) to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when processing materials.

Upland Gravel Pits

- Plan operations at the site in advance to minimize disturbance area and more effectively and efficiently open and operate the site.
    - Limit the area of the facility to the minimum necessary for efficient operations while providing sufficient area for materials processing and stockpiling.
    - Phase development where practicable.
    - Use suitable measures to avoid, mitigate, or treat metal leaching and formation of acid rock drainage.
- Conduct extraction activities in such a manner as to minimize the potential for slope failures, limit slope steepness and length, limit disturbed areas to those actively used for extraction, retain existing vegetation as long as possible, and allow for progressive reclamation of the site where practicable.

Instream Sand and Gravel Mining

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems), BMP AqEco-3 (Ponds and Wetlands), and BMP AqEco-4 (Stream Channels and Shorelines) when working in or near waterbodies to prevent or minimize adverse impacts to water quality.
- Consider channel type and effects of the proposed operation on channel morphology and function when approving instream sand and gravel mining operations.
- Limit access disturbance to designated areas on one streambank to reduce the effort required for site reclamation.
    - Use suitable measures to protect the streambank at access points to minimize bank erosion.
- Locate the material processing and stockpile site at a suitable distance from the active channel to leave a buffer zone along the waterbody to reduce risk of flooding.
    - Consider historic channel migration patterns and site elevation when locating mineral processing and stockpile sites.
    - Avoid or minimize disturbance to valuable riparian areas; wetlands; and aquatic-dependent threatened, endangered, and sensitive species habitat.
- Include suitable measures to protect channel morphology and function when extracting sand and gravel deposits.

- Specify the maximum depth of mining.
- Limit extraction depth to minimize slope changes along the stream, avoid or minimize channel and bank erosion, and retain existing natural channel armoring.
- Limit extraction amount to minimize upstream and downstream effects due to changes in bedload transport.
- Avoid modifying point bars to the extent where the resultant channel changes cause unacceptable reduced sinuosity or increased stream gradient, velocity, stream power, and bank instability.
- Schedule in-channel mining to occur during low-flow periods.
- Avoid or minimize changes to channel shape and reduce effects of mining on aquatic habitats by establishing a low-flow buffer.
- Avoid or minimize streambank erosion and instability during and after mining.
- Avoid or minimize headward erosion of the channel at the upstream end of the instream pit.

- Design and construct diversion channels to handle anticipated flow volumes and to minimize upstream and downstream effects of changes in stream grade, width, depth, bed characteristics, bank instability, and groundwater inflows when temporarily or permanently dewatering stream channels to extract sand and gravel.
  - Ensure barrier is able to adequately protect the dewatered mining area from flood flows.
- Conduct excavation operations in such a manner as to avoid significant increases in downstream turbidity.

Min-6. Ore Stockpiles, Mine Waste Storage and Disposal, Reserve Pits, and Settling Ponds

Manual or Handbook Reference FSM 2810, FSM 2820, and FSM 2850.

Objective Avoid, minimize, or mitigate adverse effects to soil, surface water, groundwater, and riparian resources from physical and chemical contaminants originating from ore stockpiles, storage and disposal of mine waste, and construction and use of reserve pits and settling ponds.

Explanation Minerals production and processing generates large amounts of materials including ore stockpiles, waste rock, tailings, drilling muds and cuttings, and process water. These materials may contain minerals, hazardous chemicals, and other potential pollutants that can have severe impacts on water resources.

This practice addresses the management of ore and mine wastes as well as construction and operation of reserve pits, settling ponds, slime ponds, process water ponds, and tailings impoundments. Most operations divert surface water and groundwater around a site, collect waters after passing through or under a site, or employ a combination of both. When water and waste are diverted, implementation focuses on isolating the wastes to contain, settle, control, stabilize, or otherwise minimize contamination, whereas practices for flow-through systems focus on methods to collect, store, and treat contaminated waters.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Ore Stockpiles and Mine Waste Facilities

- Locate ore stockpiles and waste facilities on stable, level sites with adequate drainage, away from surface water, shallow groundwaters, and poorly drained soils where practicable.
    - Establish adequate buffers and setbacks between the facility footprint and waterbodies to avoid or minimize adverse effects to water quality and aquatic ecosystems.
- Divert, control, collect, detain, and disperse surface runoff before contact with ore stockpiles and mine wastes.
    - Use suitable measures to ensure that pollutants are removed from runoff that was in contact with ore stockpiles or waste facilities and are not discharged or released into surface waters or groundwater.
- Properly characterize ore and waste rock to identify materials that have the potential to release acidity or other contaminants when exposed by mining.
- Use suitable measures to minimize development and prevent release of acidity or other contaminants.
    - Segregate and isolate potentially problematic materials from air and water.
    - Install impermeable caps, liners, and surface water diversions.
    - Blend acid-consuming materials, such as limestone, with the waste.
    - Require water treatment as needed.
- Limit slope steepness and length to interrupt surface runoff and reduce soil erosion.
- Install suitable support structures, such as retaining walls, in conjunction with a drainage system to support facility berms while draining excess water.
- Construct waste facilities in successive lifts where practicable to promote long-term stability and post-reclamation land productivity.
- Use suitable measures to stabilize stockpiles not scheduled for immediate processing to avoid or minimize wind and water erosion, oxidation of reactive materials, and runoff of toxic waters.
- Monitor containment dams and water and sediment control features to ensure contaminants are not reaching streams or other sensitive resources.

Reserve Pits

- Locate reserve pits in stable areas on the drill pad to the extent practicable.
- Locate pits away from natural watercourses, riparian areas, wetlands, floodplains, and areas of shallow groundwater wherever practicable.
    - Use suitable measures to ensure full containment of drilling fluids where the reserve pit must be placed in a sensitive location or in porous material.
- Design the reserve pit to contain all anticipated drilling muds, cuttings, fracture fluids, and precipitation while maintaining a suitable amount of freeboard to avoid or minimize overtopping.
- Use suitable measures to avoid or minimize seepage from the reserve pit contaminating groundwater.
- Remove any visible or measurable layer of oil from the surface of the reserve pit after cessation of drilling and completion of operations, and continue to keep the pit free of oil.
- Use suitable measures to avoid or minimize surface waters and groundwater from entering open pits.

Tailings, Settling, Process Water, and Slime Ponds

- Use the minimum amount of water necessary for efficient materials processing to reduce the volume of water requiring treatment, maximize the capacity of settling ponds, and avoid contaminating nonprocess water.
    - Recycle treatment water or used closed loop systems where practicable.
- Use suitable measures to treat, store, and dispose of wastewater from mine inflows and leaching and milling operations in a manner that avoids or minimizes adverse effects to soil, water quality, and riparian resources.
- Use suitable measures to ensure that pollutant materials removed from the process water and wastewater streams are retained in storage areas and are not discharged or released into surface waters or groundwater.
    - Design, construct, operate, and maintain water control devices, such as diversion structures and berms, and all solids retention structures, such as berms, dikes, pond structures, and dams, to function effectively through the life of the project with reduced risk of failure.
    - Locate storage ponds and storage areas in places where they will not be washed out by reasonably predictable flooding or return of a relocated stream to its original streambed.
    - Place materials removed from settling ponds in locations where liquids from the materials cannot flow overland into surface waters.
    - Provide for contingencies to avoid or minimize failure and release of untreated wastes and wastewater into waters of the United States or waters of the State.
- Design tailings facilities, dams, and berms to acceptable factors of safety using standard geotechnical engineering practices and considering foundation conditions and materials; construction materials and practices; the seismicity of the area; and the human and environmental resources at risk.
- Design ponds to contain all sediment-laden process water as well as surface runoff, seepage, and expected precipitation.
    - Use suitable measures to ensure that water is kept below the crest of the dam or berm.
    - Size the spillway to release overflows in a volume and velocity that does not erode the spillway, the area beyond the outlet or the downstream channel.
    - Use suitable measures to ensure water meets applicable Federal, State, and local water quality standards before discharge to waters of the United States or waters of the State.
- Divert surface water around the impoundment area before construction and, where appropriate, construct a drain field below dams and berms to reduce the water levels to maintain structural integrity.
- Install monitoring devices to measure water levels and mass movement within tailings or water retaining structures where human and environmental resources are at risk.
- Use suitable measures to minimize groundwater seepage into impoundments and avoid or minimize leaching of contaminated waters into the groundwater.
- Construct watertight impoundments for containment of mill process water, cyanide solutions, sulfide tailings, or phosphate slimes.
- Use closed-system ponds when water contains potentially hazardous materials such as cyanide or other beneficiation chemicals.
    - Ensure that solutions containing chemicals used in beneficiation, such as floatation reagents or cyanide, are properly treated or removed from process ponds and disposed of in accordance with applicable State and Federal requirements.

- Install and seasonally monitor groundwater quality monitoring wells if a risk of groundwater pollution exists (see BMP WatUses-2 [Water Wells for Production and Monitoring]).
- Establish a suitable inspection schedule to ensure that water diversion structures, conveyances, and storage facilities are performing as designed and appropriately maintained.

Min-7. Produced Water

Manual or Handbook Reference FSM 2820.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by appropriately managing water produced during the extraction of minerals, geothermal energy, oil, and gas.

Explanation Produced water is often a byproduct of oil and gas, geothermal energy, and mineral exploration and production due to the dewatering of underground aquifers. Disposal of produced water is a critical environmental impact to consider because of the large quantities produced and the potential low quality of the water. Potential impacts of produced water disposal include groundwater contamination, increased turbidity, addition of nutrients (primarily nitrogen from blasting residuals), sedimentation, erosion, altered hydrology, loss of aquatic habitat, reduced water quality, and loss of soil productivity. The BLM, States, or the U.S. Environmental Protection Agency (EPA) regulate disposal of produced water. Where water treatment and disposal is allowed on NFS lands, the Forest Service regulates all surface-disturbing activities and determines the conditions that are necessary to protect surface resources including soil and water.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Prepare a water management plan that is consistent with land management plan desired conditions, goals, and objectives for water quality.
- Contain and limit the amount of produced water by recycling water through the mineral beneficiation process.
- Use produced water for a beneficial use, such as for mineral beneficiation or agriculture, where practicable.
- Discharge or otherwise dispose of produced water in compliance with the CWA and Safe Drinking Water Act, with appropriate approvals from the State and EPA.
- Re-inject produced water of suitable quality into acceptable underground reservoirs when authorized and appropriate.
- Avoid, minimize, or mitigate surface discharge effects including headcuts, stream crossing washouts, impoundments, channel stability, and flooding.
- Use applicable practices of BMP AqEco-3 (Ponds and Wetlands) when constructing ponds or impoundments to store produced water on the surface.

Min-8. Minerals Site Reclamation

Manual or Handbook Reference FSM 2840 and FSM 2522.14.

Objective Reclaim minerals exploration and production sites and surrounding disturbed areas to as near to the predisturbed condition as is reasonably practicable after completion of exploration; production; or operations to avoid, minimize, or mitigate long-term adverse effects to soil, water quality, and riparian resources.

Explanation All lands disturbed by minerals exploration and production are required to be reclaimed to a condition consistent with the land management plan and applicable State soil and water quality requirements after all mining activities are completed. This practice will help ensure a systematic approach to reclaiming mineral, geothermal energy, and oil and gas operations. Although reclamation is usually thought of as the final step in managing mineral operations, reclamation measures must be considered during project planning; included in the approved plan, permit, or other authorization; and implemented during operations, as well as closure, to reduce potential resource impacts and facilitate the final reclamation effort.

Reclamation of abandoned mined lands sites poses additional problems to those associated with active sites. Typically these historical mineral operations were developed with little if any planning or operational controls to reduce environmental impacts. As a result, data about the environmental baseline—as well as the project facilities, equipment, and materials that are left onsite—may be minimal or absent. This information must be developed during analysis of the site so that restoration efforts are cost effective and achieve the desired results.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Develop and implement a reclamation plan to rehabilitate and restore, to the extent practicable, the natural ecological components, structures, and processes consistent with land management plan desired conditions, goals, and objectives at minerals sites.
- Reclaim facilities, activities, and associated surface disturbance as soon as practicable after completion of their intended use.
- Establish the optimal timing and scheduling of reclamation operations.
    - Reclaim and stabilize facilities, disturbed areas, surface water diversion structures, and transport and storage areas before the end of seasonal shutdown so that they will function as designed to prevent adverse impacts to surface water from erosion and sedimentation.
- Sample and test the site to identify hazardous materials and associated areas that may be contaminated by petroleum products, reactive materials, or other chemicals.
- Use suitable measures to isolate, neutralize, remove, or treat hazardous or contaminated materials, including chemicals, reactive materials, acidic wastes, fuels, pit fluids, sediment, and human waste, consistent with applicable Federal, State, and local regulations to achieve applicable standards.
    - Remove or stabilize materials in settling ponds in a manner suitable for the volume, type, toxicity, and hazards of the materials.

- Require removal or encapsulation of waste material as necessary to avoid or minimize contaminating nearby waterbodies before operator abandons site or reclamation is accepted as final.

- Remove facilities, materials, and equipment (including septic system) from NFS lands.
- Use suitable measures to control or minimize erosion and sedimentation and ensure the stability of project components, including water drainage, diversion, conveyance, and storage facilities, as well as surface erosion and landslide control measures. (see BMP Veg-1 [Vegetation Management Planning], BMP Veg-2 [Erosion Prevention and Control], BMP Veg-3 [Aquatic Management Zones], BMP WatUses-4 [Water Diversions and Conveyances], BMP WatUses-5 [Dams and Impoundments], and BMP WatUses-6 [Dam Removal]).
- Use suitable measures to divert, convey, and store surface water and groundwater away from mine (open pits or adits) and mine waste (tailings, waste rock, ore, and spent ore) facilities to the extent practicable to ensure stability and prevent formation of contaminated leachate or drainage.
    - Intercept and collect groundwater flows as needed to minimize potential for groundwater contamination and to maintain stability of reclaimed areas.
- Install and seasonally monitor groundwater wells in areas where a risk of groundwater pollution exists (see BMP WatUses-2 [Water Wells for Production and Monitoring]).
- Properly abandon, plug, and cap all drill holes, cores, and wells per applicable State or Federal requirements.
- Stabilize or restore stream channels, wetlands, floodplains, and riparian areas to achieve desired conditions for aquatic ecosystem composition, structure, function, and processes and to re-establish or rehabilitate aquatic habitats to the extent practicable (see BMP AqEco-3 [Ponds and Wetlands] and BMP AqEco-4 [(Stream Channels and Shorelines]).
- Construct passive or active water treatment facilities as needed.
- Use suitable measures to control aquatic or wetland invasive species.
- Back-fill and recontour disturbed areas, including exploratory trenches, pits, adits, or holes to the original contour, where practicable, or to an acceptable post-mining contour that blends with the surrounding topography to re-establish surface and subsurface hydrologic pathways to the extent practicable.
    - Stabilize benches around an open pit when backfilling is not practical.
- Confirm physical stability of project components including design slopes and factors of safety.
- Reconstruct, maintain, or decommission roads, trails, and staging areas consistent with land management plan desired conditions, goals, and objectives for the area (see Road Management BMPs).
- Establish effective ground cover on disturbed sites to avoid or minimize accelerated erosion and soil loss.
    - Use suitable measures to prepare or treat subsoil and overburden to improve infiltration capacity on the site.
    - Spread topsoil or growth medium and woody material on the disturbed areas.
    - Test and use suitable measures to ameliorate topsoil or growth medium as necessary to achieve revegetation and ground cover objectives.
    - Use suitable measures to prepare the seedbed improve infiltration and roughen surface for seed catch.

- Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

- Perform mitigation required by the Operating Plan to protect water quality and quantity.
- Consider long-term management of the site and nearby areas to promote reclamation success.
    - Use suitable measures to limit human, vehicle, and livestock access to site as needed to protect reclaimed areas and allow for recovery of vegetation.
    - Monitor reclaimed areas for a period sufficient to demonstrate that measures to protect surface water and groundwater are functional and effective over the long term.
    - Implement interim operation, monitoring, and maintenance as required to protect reclaimed areas using suitable measures like fencing, road closure, or invasive species control until long-term stability, erosion control, and revegetation have been successfully established.
- Accept reclamation as complete when all reclamation measures are determined to be functional and effective.
- Implement long-term operation, monitoring, and maintenance activities as necessary for facilities, including roads, diversion ditches, dams, water treatment plants, fencing, gates, and signs, that must perform as designed for an indefinite period to prevent adverse impacts to water resources.

Geothermal Energy, Oil, and Gas Activities

- Reclaim well sites in a timely manner following well completion or plugging to avoid or minimize adverse effects to soil, water quality, and riparian resources.
- Permanently seal abandoned wells using appropriate protective measures in compliance with local and State requirements.
- Reclaim reserve pits to a condition that blends with the rest of the reclaimed pad area and restore the pit area to a safe and stable condition.

Resources for Minerals Management Activities

Aggregate Mining

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Rangeland Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from rangeland management activities. Rangeland use includes grazing by cattle, sheep, goats, horses, and saddle stock used to manage the range and recreational stock. A primary purpose of the rangeland management program is to provide forage for commercial livestock operations. Grazing can also be a means of managing vegetation to meet other resource management objectives, such as fuels management, invasive species management, wildlife habitat improvement, and reduction of competing vegetation in plantations.

Three National Core BMPs are for Rangeland Management Activities. These BMPs are to be used when managing livestock grazing on National Forest System (NFS) lands. Each BMP is based on administrative directives that guide and direct the Forest Service planning and permitting of livestock grazing activities on NFS land. BMP Range-1 (Rangeland Management Planning) is a planning BMP for management of grazing allotments. BMP Range-2 (Rangeland Permit Administration) provides practices to be used when administering rangeland permits, including controlling overall livestock numbers, distribution, and season of use. BMP Range-3 (Rangeland Improvements) provides guidance for construction and maintenance of structural and nonstructural improvements and improvement of deteriorated rangeland soil and water resources.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Rangeland Management BMPs	
Range-1	Rangeland Management Planning
Range-2	Rangeland Permit Administration
Range-3	Rangeland Improvements

Range-1. Rangeland Management Planning

Manual or Handbook Reference Forest Service Manual (FSM) 2200 and Forest Service Handbook (FSH) 2209.13, chapter 90.

Objective Use the project-level National Environmental Policy Act (NEPA) planning process to develop measures to include in the Allotment Management Plan (AMP) to avoid, minimize, or mitigate adverse impacts to soil, water quality, and riparian resources from rangeland management activities.

Explanation Analysis of existing rangeland conditions and other resource values is conducted for each allotment as part of the project-level NEPA analysis and decision process for authorizing livestock grazing on NFS lands. The AMP is derived from the NEPA document and decision and is the primary document that guides implementation of land management plan direction for rangeland resources at the allotment (project) level. The AMP is included as part of the grazing permit and provides special management provisions, instructions, and terms and conditions for that permit.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when completing allotment management planning and analysis.
- Validate land management plan grazing suitability decisions for the allotment.
- Establish desired conditions for the allotment consistent with land management plan goals and objectives for water quality and AMZs.
  - Consider linkages between rangelands and soils, water quality, and riparian and aquatic systems when determining rangeland desired conditions.
  - Consider the ecological potential of riparian and aquatic systems when determining AMZ desired conditions.
- Evaluate current rangeland condition and trends using accepted protocols.
  - Review past management within the allotment.
- Determine management objectives and needs for livestock grazing and water resources affected by livestock grazing from management direction in the land management plan, biological opinions, or other binding direction and comparison of desired conditions with existing conditions.
- Identify potential management strategies and rangeland and riparian improvement needs to maintain or move resources in the allotment toward achieving desired conditions.
  - Establish management requirements such as the season of use, number, kind, class of livestock, and the grazing systems.
- Establish annual endpoint indicators of use (e.g., forage utilization, stubble height, streambank alteration, woody browse use) related to the desired conditions and triggers (thresholds) for management actions, such as modifying intensity, frequency, duration, and timing or excluding livestock use.
  - Set the indicator thresholds at levels suitable to maintain or achieve desired conditions for uplands, riparian areas, and aquatic ecosystems.
- Develop a monitoring strategy and plan for adaptive management of the allotment.
  - Use accepted protocols to evaluate compliance with annual indicators of use and other land management plan standards.
  - Use accepted protocols to evaluate ecological status and trend, including water quality, aquatic habitats, and beneficial uses.
- Document the following items from the project-level NEPA decision and analysis in the AMP, grazing permit, and Annual Operating Instructions (AOI):
  - Management objectives for livestock grazing and all resources affected by livestock grazing.
  - Management requirements for livestock grazing in the allotment.
  - Monitoring requirements to implement adaptive management in the allotment.
  - Schedules for rehabilitating rangelands that do not meet land management plan objectives, initiating range improvements, and maintaining existing improvements (see BMP Range-3 [Rangeland Improvements]).

Range-2. Rangeland Permit Administration

Manual or Handbook Reference FSH 2209.13.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when managing rangeland vegetation and livestock grazing through administration and monitoring of grazing permits and AOI.

Explanation Improper grazing can adversely affect the watershed condition in several ways. Loss of effective ground cover in the uplands leads to increases in overland flow and peak runoff. Soil compaction, loss of ground cover, and reduced plant vigor in riparian areas decreases the ability of the riparian area to filter pollutants and function as a floodplain. Streambank trampling increases stream channel width/depth ratio, resulting in a change in stream type and a lowering of the water table. Wider and shallower streams have higher stream temperatures and lower dissolved oxygen content and are often unable to move the sediment load effectively, resulting in increased flooding and bank stress. Introducing sediment, nutrients, and pathogens into waterbodies from grazing can lower water quality. Managing livestock numbers, distribution, timing, and season of use can reduce the potential for these impacts.

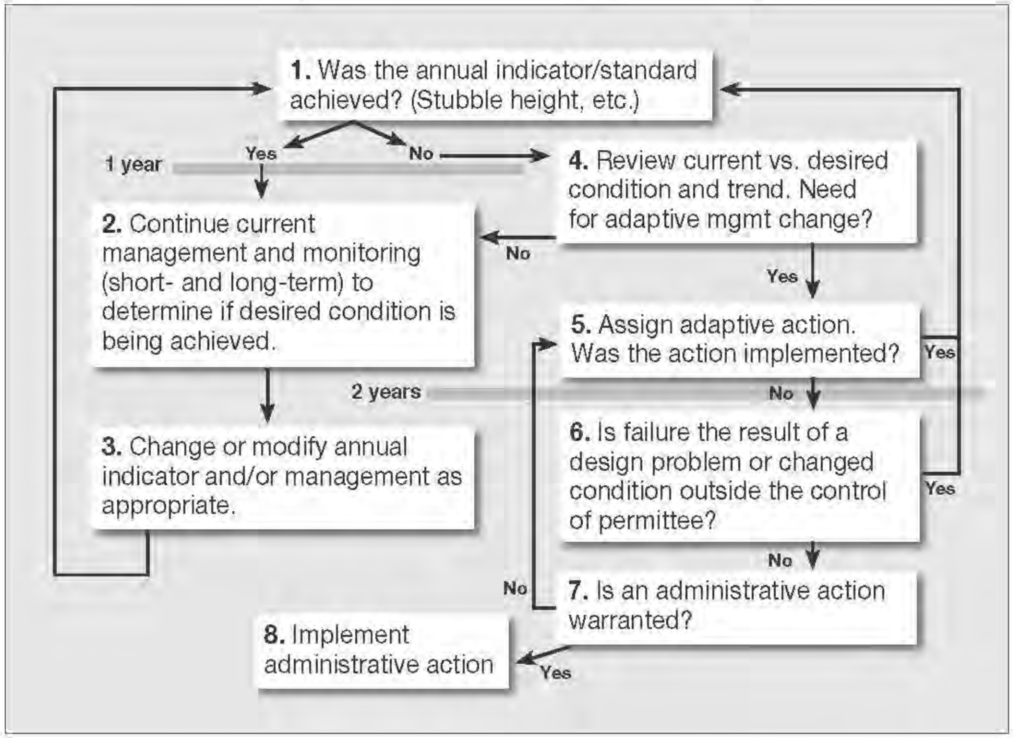
A grazing permit is used to authorize livestock grazing on NFS lands. The permit delineates the area to be grazed and defines the number, kind, and class of livestock to be grazed and the season of use. The special terms and conditions in the permit contain required management practices from the project-level NEPA decision to avoid, minimize, or mitigate effects to water quality and other resource values. The permit and AMP also include monitoring requirements to evaluate compliance with standards and determine long-term trends in range condition.

AOI issued to the grazing permittee specify those annual actions needed to implement the management direction set forth in the project-level NEPA-based decision. The AOI identify the obligations of the permittee and the Forest Service and clearly articulate annual grazing management requirements, standards, and monitoring necessary to document compliance. The permittee carries out the terms and conditions of the permit under the immediate direction and supervision of the district ranger.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Conduct implementation and effectiveness monitoring as specified in the AMP.
- Monitor water quality, habitat, or other designated beneficial uses of water as necessary (e.g., 303(d) listed streams, required terms of Biological Opinions).
- Use monitoring results as an adaptive management feedback loop to revise, if necessary, annual grazing requirements in the AOI to account for current allotment conditions and trends (figure 2).
- Use results of annual compliance monitoring and periodic trend monitoring, as well as forage utilization by wildlife and recreational livestock, to determine allowable annual amount of livestock use to meet rangeland and AMZ desired conditions.
- Adjust livestock numbers, season of use, and distribution when monitoring and periodic assessments indicate consistent noncompliance with permit provisions.
    - Use suitable range management tools to alter livestock distribution.

Figure 2. Adaptive Management Process for management of range allotments.



- Consider resting (placing an area in nonuse status for a period of time) a pasture or an allotment to allow for natural recovery of resource conditions.

- Document adaptive management actions such as allowable use, the planned sequence of grazing on the allotment, and any other operational changes in the AOI.
  - Modify the AMP and terms and conditions in the grazing permit for adaptive management actions that become consistent over a period of years or grazing rotations.
- Modify, cancel, or suspend the permit in whole or in part, as needed, to ensure proper use of the rangeland resource and protection of water quality.
  - Use permit authorities to change operations to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when special circumstances (e.g., drought) occur.

Range-3. Rangeland Improvements

Manual or Handbook Reference FSM 2240.

Objective Implement range improvements to maintain or improve soil, water quality, and riparian resources.

Explanation Rangeland improvements targeted at soil, water quality, and riparian resources are designed to protect or improve conditions of sensitive areas, streams, riparian areas, and wetlands and move these resources toward desired conditions. Improvements should emphasize protecting the beneficial uses in these areas. Improvements may supplement changes in annual use levels, seasonal use, distribution, and number, or other administrative actions.

Development and maintenance of rangeland improvements can be the responsibility of either the permittee or the Forest Service. The district ranger will ensure that the permittee is involved as a cooperator in rangeland improvements. The permittee may construct or maintain improvements under Forest Service direction, or Forest Service crews or contractors may construct or maintain improvements.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Identify and evaluate range improvement needs for soil, water quality, and riparian resources during watershed analysis, watershed condition assessment, project-level rangeland NEPA, or other assessment efforts.
- Include and schedule improvement actions and maintenance in the AMP and grazing permit.
- Design, implement, and maintain structural and nonstructural range improvements to achieve or sustain desired conditions for the rangeland, soils, water quality, and riparian resources in the allotment as determined in the project-level NEPA decision.
  - Use rangeland vegetation species and establishment techniques suitable to the project site and objectives and consistent with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
  - Use applicable Chemical Use Activities BMPs when using chemicals to treat rangeland vegetation and control invasive species.
  - Use applicable practices of BMP Veg-8 (Mechanical Site Treatment) when implementing mechanical treatments of rangeland vegetation.
  - Use applicable practices of BMP Fire-2 (Use of Prescribed Fire) when using prescribed fire to improve rangeland vegetation and conditions.
  - Use applicable practices of BMP AqEco-3 (Ponds and Wetlands) and BMP AqEco-4 (Stream Channels and Shorelines) for improvement activities that involve waterbodies.
  - Use applicable practices of BMP WatUses-3 (Administrative Water Developments) when developing water sources for livestock watering.

Resources for Rangeland Management Activities

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Riparian Area Grazing Management

Clary, W.P.; Webster, B.F. 1989. Managing grazing of riparian areas in the Intermountain Region Gen. Tech. Rep. INT-263. Ogden, UT: USDA Forest Service, Intermountain Research Station. 11 p. Available at http://www.fs.fed.us/rm/pubs_int/int_gtr263.pdf.

Wyman, S.; Bailey, D.; Borman, M.; Cote, S.; and others. 2006. Riparian area management: Grazing management processes and strategies for riparian-wetland areas. Technical Reference 1737-20. Denver, CO: U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center. 105 p. Available at http://www.blm.gov/nstc/library/techref.htm.

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Burton, T.A.; Smith, S.J.; Cowley, E.R. 2011. Riparian area management: Multiple indicator monitoring (MIM) of stream channels and aquatic vegetation. Technical Reference 1737-23. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 155 p. Available at http://www.blm.gov/nstc/library/techref.htm.

Stubble Height

University of Idaho, Stubble Height Review Team. 2004. Stubble height study report Contribution No. 986. Moscow, ID: University of Idaho, Forest, Wildlife and Range Experiment Station. Available at http://www.cnrhome.uidaho.edu/documents/Stubble_Height_Report.pdf?pid=74895&doc=1.

Recreation Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from recreation activities. An objective of the Forest Service recreation program is to provide nonurbanized outdoor recreation opportunities in natural appearing forest and rangeland settings. Recreation activities on National Forest System (NFS) lands take place at developed and undeveloped sites or are dispersed across broad areas.

Twelve National Core BMPs are in the Recreation Management Activities category. These BMPs are to be used when managing recreation use and facilities on NFS lands. BMP Rec-1 (Recreation Planning) is a planning BMP for recreation activities at the land management plan scale and project scale. BMP Rec-2 (Developed Recreation Sites) provides practices for sites that are designed and constructed to provide facilities for users. BMP Rec-3 (Dispersed Use Recreation) covers dispersed recreation, including user-created sites and frequently used areas. BMP Rec-4 (Motorized and Nonmotorized Trails) provides practices for construction, operation, and maintenance of the designated trail system. BMP Rec-5 (Motorized Vehicle Use Areas) covers areas designated for cross-country motor vehicle use. BMP Rec-6 (Pack and Riding Stock Use Areas) has practices for trailheads, corrals, and other areas where pack and riding stock use is concentrated. BMP Rec-7 (Over-Snow Vehicle Use) has direction for snowmobile trails and other over-snow vehicle uses. BMP Rec-8 (Watercraft Launches) is for boat launches on lakes and rivers. BMP Rec-9 (Recreation Special Use Authorizations) provides direction for recreation residences, outfitters and guides, and other recreation activities operated under special use authorizations. BMP Rec-10 (Ski Runs and Lifts), BMP Rec-11 (Ski Area Snowmaking), and BMP Rec-12 (Ski Area Facilities) provide practices for ski areas.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Recreation Activities BMPs	
Rec-1	Recreation Planning
Rec-2	Developed Recreation Sites
Rec-3	Dispersed Use Recreation
Rec-4	Motorized and Nonmotorized Trails
Rec-5	Motorized Vehicle Use Areas
Rec-6	Pack and Riding Stock Use Areas
Rec-7	Over-Snow Vehicle Use
Rec-8	Watercraft Launches
Rec-9	Recreation Special Use Authorizations
Rec-10	Ski Runs and Lifts
Rec-11	Ski Area Snowmaking
Rec-12	Ski Area Facilities

Rec-1. Recreation Planning

Manual or Handbook Reference Forest Service Manual (FSM) 2310; FSM 2332; FSM 2333; FSM 2341; and Forest Service Handbook (FSH) 2309.18, chapter 10.

Objective Use the applicable recreation planning process to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during recreation activities.

Explanation Recreation activities occur in a variety of settings and intensities on NFS lands, including at developed or undeveloped recreation sites or dispersed across broad areas. The objective of recreation planning is to provide for the current and future outdoor recreation demands while integrating recreation use with other resource concerns. The Recreation Opportunity Spectrum (ROS) system provides a framework for stratifying and defining classes of outdoor recreation opportunities along a continuum that combines physical, biological, social, and management conditions for providing a variety of recreational experiences across an array of settings. ROS is management tool that integrates social considerations and biophysical components of a landscape to achieve multiple social and natural resource objectives. ROS classes, and standards and guidelines, are established in the land management plan. ROS class primarily guides management of recreation use.

Recreation facilities on NFS lands are constructed and maintained by the Forest Service or others under a Forest Service authorization. These facilities include developed recreation sites, organization camps, recreation residence tracts, motorized and nonmotorized trails and facilities, dispersed recreation sites, and winter sports centers such as alpine ski areas. Some small facilities are constructed and managed by Forest Service personnel using agency design criteria and management guidelines as incorporated into project plans. Facilities developed by others on NFS lands are administered through special use authorizations issued by the Forest Service to public or private agencies, groups, or individuals. Special use authorizations must include terms and conditions to protect the environment and otherwise comply with the requirements of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1752).

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Land Management Plans

- Consider the beneficial and adverse effects of recreation use on water quality and watershed condition when developing desired conditions, ROS classes, and management direction for the plan area.
    - Identify areas where the adverse effects of recreational use to water quality and watershed condition outweigh the benefits.
- Include design criteria, standards, and guidelines for recreational use to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Project or Activity Planning

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when planning recreation projects.
- Select site locations for recreation facilities that avoid or minimize the potential for adverse effects to water quality and riparian resources.
- Design the capacity and layout of the recreation site to be consistent with land management plan desired conditions, goals, and objectives for soil, water quality, and riparian resources.

- Consider capacity and patterns of use at a site when determining measures to avoid, minimize, or mitigate adverse effects from recreational use to soil, water quality, and riparian resources.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to incorporate suitable erosion and stormwater controls in the project design.
- Use applicable practices of BMPs for access roads and water, sanitation, and solid waste systems at recreation sites (see Roads Management Activities BMPs and Facilities and Nonrecreation Special Uses Management Activities BMPs) as needed.
- Use applicable practices of BMP Road-10 (Equipment Refueling and Servicing) for recreation sites where vehicles or other equipment will be stored and maintained.
- Use applicable practices of BMP Fac-6 (Hazardous Materials) for management of hazardous materials at recreation sites.
- Determine instream flow needs to minimize damage to scenic and aesthetic values, fish and wildlife habitat, and to otherwise protect the environment where the operation of the recreation site would modify existing streamflow regimes (see BMP WatUses-1 [Water Uses Planning]).

Rec-2. Developed Recreation Sites

Manual or Handbook Reference FSM 2332, FSM 2333, and FSM 2334.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources at developed recreation sites by maintaining desired levels of ground cover, limiting soil compaction, and minimizing pollutants entering waterbodies.

Explanation Developed recreation sites provide amenities for user comfort and can be located in motorized or nonmotorized settings. Oftentimes these areas concentrate high volumes of use into relatively small areas and may be located on or near waterbodies, thereby increasing the potential for water quality degradation. Potential pollutants generated by use at developed recreation sites include, but are not limited to, human and animal waste; solid wastes (trash); petroleum products; and other hazardous substances. In addition, continuous or recurring use at one site can cause excessive soil compaction; damage to vegetation, wetlands, and riparian areas; and erosion and sediment transport from the site.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to construct and maintain appropriate erosion control and stormwater management measures to avoid or minimize adverse effects to water quality from pollutant runoff at the site.
- Use applicable practices of Roads Management Activities BMPs for construction and maintenance of access roads.
- Use applicable practices of BMP Roads-9 (Parking and Staging Areas) for trailheads and other parking areas at develop recreation sites.
- Use applicable practices of BMP Fac-3 (Potable Water Supply Systems), BMP Fac-4 (Sanitation Systems), and BMP Fac-5 (Solid Waste Management) for water, sanitation, and solid waste systems at developed recreation sites.

- Evaluate and adjust design capacity of the site when recreation use is causing adverse effects to water quality or riparian resources.
- Provide hardened campsites located sufficiently far from surface waterbodies to provide an adequate vegetative filter strip to avoid or minimize sediment delivery (see BMP Plan-3 [AMZ Planning]).
- Consider potential impacts to soils, water quality, and riparian resources when establishing recreation site use periods.
- Use suitable measures to avoid or minimize overuse on sensitive areas.
- Use suitable public relations, information, and enforcement tools to encourage the public to conduct their activities in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Provide information on the location of the nearest RV (recreational vehicle) wastewater disposal station.
- Periodically evaluate the condition of soil, water quality, and riparian resources at and near developed sites to identify signs of insufficient ground cover, detrimental soil compaction, excessive runoff, sedimentation, or chemical or pollutant release by recreationists.
    - Relocate trails, parking areas, campsites, play areas, or water distribution points that are causing offsite resource damage.
    - Redesign and reconstruct, or close and rehabilitate, areas of recreation sites that exhibit signs of overuse.
    - Use suitable measures to restrict access, when necessary, to nearby wetlands and riparian areas that show signs of excessive damage from recreation use to allow for vegetative recovery
- Rehabilitate unwanted user-created trails and sites within the developed recreation site and employ suitable measures to discourage their creation and use (see BMP Fac-10 [Facility Site Reclamation]).
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim the developed recreation site after the need for it ends.

Rec-3. Dispersed Use Recreation

Manual or Handbook Reference FSM 2330.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by managing dispersed activities and undeveloped sites to maintain ground cover, maintain soil quality, control runoff, and provide needed sanitary facilities to minimize the discharge of nonpoint source pollutants and maintain streambank and riparian area integrity.

Explanation Dispersed recreation use takes many forms, both motorized and nonmotorized, across a range of forest and grassland settings. Many dispersed uses and user-created undeveloped sites are located adjacent to or provide easy access to lakes and rivers and lack the design and amenities offered at developed sites to mitigate effects of use. As a result, the impacts of dispersed recreation use on soils, water quality, and riparian resources can be greater than impacts at developed sites. Nonpoint source pollution from dispersed recreation use includes human and animal wastes, petroleum products, other hazardous substances, streambank disturbance, stream channel alteration, and sediment eroded from the site.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use suitable public relations and information tools and enforcement measures to encourage the public to conduct dispersed recreation activities in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Designate locations and crossings for allowable motorized vehicle use within the AMZ as part of travel management (see BMP Plan-3 [AMZ Planning] and BMP Road-1 [Travel Management and Analysis]).
    - Use suitable measures to limit crossings and restrict motorized use within the AMZ to the extent practicable.
- Manage use to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Develop and designate campsites in appropriate locations.
    - Limit group size and periods of use (numbers of consecutive days, time of day, etc.).
- Consider providing primitive sanitation facilities in areas where perpetual concentrated dispersed recreation use is causing adverse effects to soil, water quality, or riparian resources (see BMP Fac-4 [Sanitation Systems]).
- Close and rehabilitate dispersed or undeveloped sites that are causing unacceptable adverse effects on soil, water quality, and riparian resources (see BMP Fac-10 [Facility Site Reclamation]).
    - Manage site to mitigate adverse effects of use when closure is not practicable.

Rec-4. Motorized and Nonmotorized Trails

Manual or Handbook Reference FSM 2353, FSH 2309.18, FSM 7715.5, FSM 7723, and EM (Engineering Management) 7720-104.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling soil erosion, erosion of trail surface materials, and water quality problems originating from construction, maintenance, and use of motorized and nonmotorized trails.

Explanation The Forest Service manages about 133,000 miles of trails that are part of the designated transportation system. Only portions of these trails are open to motorized vehicle use. Almost all NFS trails serve nonmotorized users, including hikers, bicyclists, and equestrians, alone or in some combination with motorized uses.

Trail construction, maintenance, and use by motorized vehicles and human or stock traffic can adversely affect water quality by increased sediment delivery and contamination from vehicle fluids and human and animal wastes to nearby waterbodies. Compaction of the trail surface limits water infiltration, which can lead to concentrated runoff on the trail surface. Concentrated runoff on trails lacking adequate drainage causes erosion of the trail surface and can transport sediment and other pollutants directly into waterbodies if not filtered. Heavy tread, foot, or hoof traffic can loosen some trail surface materials, making them more susceptible to erosion.

Trails open to motorized use are designated during the travel management process and depicted on the Motor Vehicle Use Map (MVUM). Motorized use is designated by allowed vehicle class and, if appropriate, time of year, with the objective of minimizing damage to soil and water resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable Road Management Activities BMPs for construction, operation, and maintenance of motorized trails.
- Locate or relocate trails to conform to the terrain, provide suitable drainage, provide adequate pollutant filtering between the trail and nearby waterbodies, and reduce potential adverse effects to soil, water quality, or riparian resources.
    - Avoid sensitive areas, such as riparian areas, wetlands, stream crossings, inner gorges, and unstable areas to the extent practicable.
    - Use suitable measures to mitigate trail impacts to the extent practicable where sensitive areas are unavoidable.
    - Use suitable measures to hydrologically disconnect trails from waterbodies to the extent practicable.
- Design, construct, and maintain trail width, grades, curves, and switchbacks suitable to the terrain and designated use.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) for control of erosion and stormwater when constructing trails.
- Install and maintain suitable drainage measures to collect and disperse runoff and avoid or minimize erosion of trail surface and adjacent areas.
- Use and maintain surfacing materials suitable to the trail site and use to withstand traffic and minimize runoff and erosion.
    - Pay particular attention to areas where high wheel slip (curves, acceleration, and braking) during motorized use generates loose soil material.
- Design stream crossings to use the most cost-efficient structure consistent with resource protection, facility needs, and types of use and safety obligations (see BMP Road-2 [Road Location and Design] and BMP Road-7 [Stream Crossings]).
- Designate season of use to avoid periods when trail surfaces are particularly prone to unacceptable erosion, rutting, or compaction.
- Designate class of vehicle and type of nonmotorized uses (e.g., hiking, bicycling, and equestrian uses) suitable for the trail width, location, waterbody crossings, and trail surfaces to avoid or minimize adverse effects to soil, water quality, or riparian resources.
- Monitor trail condition at regular intervals to identify drainage and trail surface maintenance needs to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Manage designated trails to mitigate adverse effects to soil, water quality, and riparian resources from over-use when closure and rehabilitation is not practicable or desired.
    - Change designated vehicle class and season-of-use period as necessary.
- Close and rehabilitate unauthorized trails that are causing adverse effects on soil, water quality, and riparian resources (see BMP Fac-10 [Facility Site Reclamation]).

Equestrian Trails

- Plan trails so that equestrian users will go slower in sensitive areas to protect trail tread.
- Use a trail design that constricts equestrian users to a designated tread, where practicable, to minimize the tendency of stock to create braided or multiple trail treads.
- Provide reasonable access to stock water at suitable intervals along designated equestrian trails where practicable.

Rec-5. Motorized Vehicle Use Areas

Manual or Handbook Reference FSM 2353.28, FSH 2309.18 23.22, and FSM 7716.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources at motorized vehicle use areas by managing activities to maintain ground cover, maintain soil quality, and control runoff to minimize discharge of nonpoint source pollutants and maintain streambank and riparian area integrity.

Explanation Forest Service policy recognizes that motor vehicles are a legitimate and appropriate way for people to use the national forests and grasslands—in the right places and with proper management. Unrestricted cross-country travel by motor vehicles increases soil erosion and adversely affects water quality. The first vehicle driving across a particular piece of ground may not harm the land. After many more vehicles have crossed the same path, however, the result may be a user-created route and lasting impacts to soil, water quality, and riparian resources. The proliferation of user-created roads and trails is a major challenge on many national forests and grasslands. User-created routes, in general, are not located, designed, or maintained to avoid, minimize, or mitigate adverse effects to soil, water quality, or riparian resources. The Travel Management Rule adopted in 2005 restricts motor vehicle use to designated roads, trails, and areas on NFS lands to better manage motor vehicle use and protect NFS resources.

Limited areas on NFS lands open to cross-country motorized use may be designated during the travel management process and, if designated, are depicted on the MVUM. These areas should have natural resource characteristics that are suitable for motor vehicle use, or should be so altered by past actions that motor vehicle use might be appropriate. Motorized use is designated by allowed vehicle class and, if appropriate, by time of year, with the objective of minimizing damage to soil and watershed resources. Limited cross-country use of motorized vehicles within a specified distance from designated routes may be allowed for purposes of dispersed camping and big game retrieval. After motor vehicle use areas are established on a national forest or grassland, motor vehicle use outside of these designated areas is prohibited.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use suitable public relations and information tools and enforcement measures to encourage the public to conduct motorized vehicle use activities within designated areas in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Locate and maintain designated motor vehicle use areas to avoid or minimize adverse effects on soil, water quality, and riparian resources.

- Consider suitability of slopes, access points, vegetation cover and similar features, and soil characteristics such as erodibility and texture, for motor vehicle use.
    - Favor areas that are naturally barren or have been significantly altered by past motorized vehicle use or land use (e.g., gravel pits, reservoir bathtub rings, or lake bottoms).
    - Avoid areas of sensitive soils and floodplains.
    - Manage hillclimb areas to minimize length and steepness.
    - Avoid concentration of motor vehicle use in bowl-shaped areas above draws that are susceptible to erosion.
- Designate season-of-use periods to avoid periods when soils are particularly prone to unacceptable erosion, rutting, or compaction.
- Designate class of vehicle suitable for the soil and terrain of the designated motor vehicle use area to avoid or minimize adverse effects to soil, water quality, or riparian resources.
- Clearly delineate and mark designated motor vehicle use areas in the field where practicable.
- Monitor designated motor vehicle use areas at regular intervals to identify drainage and soil cover maintenance needs to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Manage designated motor vehicle use areas, particularly hillclimb areas, to mitigate adverse effects to soil, water quality, and riparian resources from over-use when closure and rehabilitation is not practicable or desired.
    - Change designated vehicle class and season-of-use period as necessary.
    - Schedule use periods of hillclimbs to allow for rehabilitation.
    - Rotate hillclimb areas to extend the lifespan of a hillclimb.
- Close and rehabilitate designated motor vehicle use areas that are causing unacceptable adverse effects to soil, water quality, and riparian resources (see BMP Fac-10 [Facility Site Reclamation]).
- Place suitable restrictions on motor vehicle use off designated routes for dispersed camping and big game retrieval to avoid, minimize, or mitigate adverse effects on soil, water quality, and riparian resources.
    - Avoid riparian, wetland, or other identified sensitive resource areas where practicable.
    - Designate stream-crossing sites to the extent practicable.

Rec-6. Pack and Riding Stock Use Areas

Manual or Handbook Reference FSH 2309.18 22.43 and 23.12.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources at pack and riding stock use areas by managing activities to maintain ground cover, maintain soil quality, control runoff, and provide needed sanitary facilities to minimize discharge of nonpoint source pollutants and maintain streambank and riparian area integrity.

Explanation Pack and riding stock can affect soil, water quality, and riparian resources while on trails and at campsites, watering areas, and loading areas. The level of use at a site can range from single-day use by one or more riders at a remote site to large developed campsites and trails used repeatedly by outfitter and guide operations, commercial stock operators, and other recreational users. Use may take place in the general forest area or in designated wilderness areas. Access areas, in general, are used for loading and unloading, parking, and turning around vehicles and stock trailers. Potential impacts include loss of ground cover, soil compaction, rutting, or puddling, and increased erosion, streambank trampling, spread of weeds, and water contamination from animal waste.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use suitable public relations and information tools and enforcement measures to encourage the public to conduct activities on trails and at stock use areas in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Provide information on proper stock tethering, watering, and manure handling and disposal techniques.
- Use applicable practices of BMP Rec-2 (Developed Recreation Sites) when designing, constructing, and maintaining developed areas for pack and riding stock use.
- Install simple temporary holding facilities in both wilderness and nonwilderness areas.
    - Evaluate soils and vegetation for vulnerability of damage or disruption from stock use when choosing holding facility sites.
    - Locate corrals and tethering areas at a suitable distance from waterbodies to avoid or minimize adverse effects to soil, water quality, and riparian resources.
- Designate specific watering locations on streams, ponds, and lakes to avoid or minimize general use along streambanks or shorelines.
- Provide designated watering areas at developed stock use areas where practicable.
    - Surface the areas around water hydrants, troughs, and stock tanks using suitable materials to mitigate trampling effects.
    - Locate designated watering areas at a suitable distance from waterbodies to avoid or minimize adverse effects to soil, water quality, and riparian resources.
- Provide manure disposal bins at developed pack and riding stock use areas.
    - Locate manure receptacles on level ground at a suitable distance to provide adequate pollutant filtering between the accumulated manure and nearby waterbodies.
    - Provide positive drainage to prevent puddles from forming within and around the manure receptacle.
    - Provide tools (e.g., wheelbarrows, rakes, and bags) to facilitate manure cleanup.
    - Periodically remove or treat accumulated animal waste to avoid or minimize contaminating waterbodies.
- Monitor pack and riding stock use areas at regular intervals to identify drainage and ground surface maintenance needs to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Manage pack and riding stock use areas to mitigate adverse effects to soil, water quality, and riparian resources from over-use when closure and rehabilitation is not practicable or desired.
- Close and rehabilitate pack and riding stock use areas that are causing adverse effects on soil, water quality, and riparian resources (see BMP Fac-10 [Facility Site Reclamation]).

Rec-7. Over-Snow Vehicle Use

Manual or Handbook Reference FSM 7718.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from over-snow vehicle use.

Explanation An over-snow vehicle is a motor vehicle that is designed for use over snow and that runs on a track or tracks and a ski or skis, while in use over snow. Over-snow vehicles include snowmobiles, snow cats, and snow grooming machines. Snowmobiles and snow cats are used for access and for recreational activities. Snow grooming machines are used to prepare snow on trails for downhill or cross-country skiing or snowmobile use.

An over-snow vehicle traveling over snow results in different impacts to soil and water resources than do motor vehicles traveling over the ground. Unlike other motor vehicles traveling cross-country, over-snow vehicles generally do not create a permanent trail or have direct impact on soil and ground vegetation when snow depths are sufficient to protect the ground surface. Emissions from over-snow vehicles, particularly two-stroke engines on snowmobiles, release pollutants like ammonium, sulfate, benzene, polycyclic aromatic hydrocarbons, and other toxic compounds that are stored in the snowpack. During spring snowmelt runoff, these accumulated pollutants are released and may be delivered to surrounding waterbodies. In addition, over-snow vehicles that fall through thin ice can pollute waterbodies.

Use of NFS lands and trails by over-snow vehicles may be allowed, restricted, or prohibited at the discretion of the local line officer.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use suitable public relations and information tools and enforcement measures to encourage the public to conduct cross-country over-snow vehicle use on trails in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - ☐ Provide information on the hazards of running over-snow vehicles on thin ice.
    - ☐ Provide information on effects on over-snow vehicle emissions on air quality and water quality.
- Use applicable practices of BMP Rec-4 (Motorized and Nonmotorized Trails) when locating, designing, constructing, and maintaining trails for over-snow vehicle use.
- Allow over-snow vehicle use cross-country or on trails when snow depths are sufficient to protect the underlying vegetative cover and soil or trail surface.
    - ☐ Specify the minimum snow depth for each type or class of over-snow vehicle to protect underlying resources as part of any restrictions or prohibitions on over-snow use.
    - ☐ Specify season of use to be at times when the snowpack is expected to be of suitable depth.
    - ☐ Specify over-snow vehicle class suitable for the expected snowpack and terrain or trail conditions.
- Use and enforce closure orders to mitigate effects when adverse effects to soil, water quality, or riparian resources are occurring.

- Use applicable practices of BMP Rec-2 (Developed Recreation Sites) when constructing and operating over-snow vehicle trailheads, parking, and staging areas.
    - Use suitable measures to trap and treat pollutants from over-snow vehicle emissions in snowmelt runoff or locate the staging area at a sufficient distance from nearby waterbodies to provide adequate pollutant filtering.

Rec-8. Watercraft Launches

Manual or Handbook Reference FSM 2334.24 and FSM 2335.1.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from facilities at locations used to launch and retrieve watercraft.

Explanation Facilities related to the use and enjoyment of watercraft (nonpowered boats, powerboats, personal watercraft, etc.) can affect water quality. These facilities include boat ramps, roads, and parking facilities, sanitation facilities, marinas, and other infrastructure. The immediate proximity and connection of the facility to the water's edge provides a direct pathway for pollutants to enter the waterbody.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use suitable public relations and information tools and enforcement measures to encourage the public to conduct boating and related activities in a manner that will avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Provide information on measures for preventing the spread of aquatic invasive species, proper fish cleaning and disposal of fish waste, proper disposal of solid waste while boating, and preventing wake damage to shorelines.
- Locate and design watercraft launch sites to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Avoid excessive impacts to aquatic or riparian vegetation and fish spawning or rearing habitat.
    - Minimize the effect of boat wakes on adjacent shoreline and reduce the potential for sediment accumulation on the ramp.
    - Minimize the required amount of cut and fill below the waterline in the submerged or submersible zone.
- Establish suitable ramp elevation and slope to minimize ramp size while providing a ramp that is usable throughout the normal range of water elevations.
    - Use average high- and low-water elevations for each month of the intended use period over a suitable period of record to determine design high-water and design low-water elevations.
    - Extend ramp toe to a sufficient depth below the design low-water elevation to provide adequate water depth to float the average boat from its trailer while providing a hard surface for the trailer to travel on during launch and retrieval.
    - Minimize the distance of the top of the ramp above the design high-water elevation consistent with local topography.
    - Design the launch ramp slope to minimize erosion from water and vehicle tire disturbance.

- Design ramp width to provide adequate space for boaters of varying ability to maneuver the boat trailers down the ramp.
- Use surfacing material suitable for the ramp location and character of use to provide sufficient traction to discourage wheel spin and damage to the ramp or surrounding soil and water resources.
- Use suitable measures along both sides and across the lower end of the launch ramp to protect the structure from externally generated forces such as current, waves, and boat wakes.
- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) and BMP Fac-2 (Facility Construction and Stormwater Control) when constructing, reconstructing, or maintaining watercraft launch facilities.
- Use applicable practices of BMP Rec-2 (Developed Recreation Sites) when constructing and operating parking and staging areas at watercraft launch facilities.
- Use applicable practices of BMP Road-10 (Equipment Refueling and Servicing) at fuel dispensing facilities.
- Manage boating activities where necessary to decrease turbidity and physical destruction of shallow water habitats.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim watercraft launch sites when discontinuing their use.

Rec-9. Recreation Special Use Authorizations

Manual or Handbook Reference FSM 2343, FSM 2721, and FSH 2709.11.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from physical, chemical, and biological pollutants resulting from activities under recreation special use authorizations.

Explanation This BMP covers all recreation special use activities with the exceptions of ski areas. BMP Rec-10 (Ski Runs and Lifts), BMP Rec-11 (Ski Area Snowmaking), and BMP Rec-12 (Ski Area Facilities) provide direction specific to ski areas.

The Forest Service role in defining and requiring the implementation of BMPs occurs during the development of the recreation special use authorization and administration of the use. Discussions between the Forest Service and the permit holder concerning soil, water quality, and riparian resource impacts and appropriate BMP use should occur at the time of permit development and renewal. The special use authorization details the conditions that must be met, including management requirements and mitigation measures to protect water quality. The permit holder will be required to conform to all applicable Federal, State, and local regulations governing water resource protection and sanitation. State water quality law may require that the permit holder obtain a pollution discharge permit, water quality certification, or other authorization from a State, regional, or local government entity.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to provide erosion and stormwater controls when constructing facilities.

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working around waterbodies.

- Use applicable practices of Road Management Activities BMPs for access for authorized activities.
- Use applicable practices of Chemical Use Management Activities BMPs for use of chemicals in authorized activities.
- Use applicable practices of BMP Fac-3 (Potable Water Supply Systems), BMP Fac-4 (Sanitation Systems), BMP Fac-5 (Solid Waste Management), and BMP Fac-6 (Hazardous Materials) for public water supplies, sanitation systems, solid waste management, and hazardous materials for authorized activities.
- Administer the permit to appropriate standards to avoid, minimize, or mitigate adverse effects of permitted activities to soil, water quality, and riparian resources.

Rec-10. Ski Runs and Lifts

Manual or Handbook Reference FSM 2342.1 and FSH 2709.11 41.6.

Objective Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during the construction, operation, and maintenance of ski runs and lifts.

Explanation A ski area and its operation are complex and can result in a variety of adverse effects to soil, water quality, and riparian resources. These adverse effects can be particularly true for ski runs and lifts. Because good ski runs tend to be steep, extra precautions are needed to avoid or minimize accelerated erosion and resulting sedimentation. Ski run clearing, slope grading, and developing access routes, ski lift and towline facilities, and similar actions can expose and compact soils, resulting in accelerated runoff and erosion. Increased runoff can alter water yield and runoff regimes, augment peakflows, and increase instream sediment from channel erosion. Appropriate soil and water protection measures should be included in the ski area's operation and maintenance plan.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Locate ski runs and lifts on stable geology and soils to minimize risk of slope failures.
- Avoid wetlands and riparian areas when locating ski runs and lifts wherever practicable.
- Incorporate suitable measures in the design and construction of ski runs, including consideration of runoff of additional water from snowmaking, to avoid or minimize undesirable increases in runoff.
- Use applicable practices of Mechanical Vegetation Management Activities BMPs when clearing vegetation for ski runs and lift lines.
    - Use yarding equipment suitable to the steepness of the terrain to avoid or minimize adverse effects to soil and water quality (see BMP Veg-1 [Vegetation Management Planning]).
- Use applicable practices of BMP Veg-2 (Erosion Prevention and Control) to provide erosion and stormwater controls when constructing ski runs and lifts.
    - Clear and construct ski runs and lift lines in sections to limit the area of exposed disturbed soil at any one time.
    - Stabilize a completed section before beginning work on the next section.

- Avoid diverting streams and minimize disrupting swales, ephemeral channels, and wetlands.
- Minimize grading or recontouring of hill slopes to maintain intact soil horizons and infiltrative properties.
- Cut stumps flush with soil surface or grind in place instead of grubbing when clearing trees from ski runs wherever practicable.
- Use applicable practices of BMP Road-7 (Stream Crossings) to design and construct stream crossings to minimize riparian and channel disturbance and pass anticipated flood flows and associated debris, while allowing desired aquatic organism passage.
  - Maintain normal stream patterns, geometry, and habitat features to the extent practicable.
- Use low-pressure construction and maintenance equipment whenever practicable to reduce surface impact on steep slopes.
- Stockpile biologically active topsoil removed during excavation for use in reclamation.
  - Store stockpiled topsoil separately from other vegetative slash, soil, or rock and protect from wind and water erosion, unnecessary compaction, and contaminants.
- Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Maintain desired ground cover with irrigation, fertilization, or other treatments as necessary.
- Use suitable measures to direct overland flow on slopes into areas with intact soil horizons to encourage infiltration and disconnect overland flow from waterbodies.
- Treat disturbed soil to promote onsite water capture and infiltration.
- Prohibit traffic on disturbed areas during periods of excessive soil moisture, precipitation, or runoff.
- Monitor revegetation response (height, root growth, ground coverage, etc.) in terms of its capacity to avoid or minimize erosion during runoff.
  - Perform additional revegetation or erosion control as needed to protect water quality and soil integrity.

Rec-11. Ski Area Snowmaking

Manual or Handbook Reference FSM 2343.1 and FSH 2709.11 41.6.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources at all stages of the snowmaking process, including diversions, conveyance, storage, application, and return of applied waters.

Explanation All phases of snowmaking at a ski area can affect the watershed and water quality. Construction of diversion, conveyance, storage, and delivery structures can create ground disturbance leading to erosion and sedimentation. Water withdrawal from rivers and streams can create or exacerbate stream dewatering and adversely affect overwintering habitat for fish and other aquatic-dependent species. Transfer of water from one basin to another for snowmaking can lead to an annual water supply outside the natural range of variation in the receiving watershed. This additional water in spring runoff can cause changes in stream channel morphology including streambank erosion and headward extension of the channel.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Manage snowmaking and snow farming to avoid or minimize slope failures and gully erosion on the hillslopes and excessive bank erosion and sediment in receiving streams.
    - Limit snowmaking on graded terrain to the extent practicable to minimize surface runoff and subsequent erosion from reduced infiltration capacity.
- Use applicable practices of BMP WatUses-1 (Water Uses Planning) when authorizing snowmaking.
- Use applicable practices of BMP AqEco-3 (Ponds and Wetlands), BMP WatUses-4 (Water Diversions and Conveyances), and BMP WatUses-5 (Dams and Impoundments) when obtaining water and developing water storage facilities for snowmaking.
- Transport water to the slopes in the least disruptive manner.
    - Use applicable practices of BMP Fac-9 (Pipelines, Transmission Facilities, and Rights-of-Ways) when constructing, maintaining, and operating pipelines.
- Design snowmaking systems to return runoff water to the source from which it was removed.
    - Avoid interbasin transfer of waters, where practicable, to maintain original duration, magnitude, and patterns of runoff in affected watersheds.
- Avoid contaminating return water with chemicals or other pollutants.
- Monitor all aspects of the process and correct problems as they occur to avoid or minimize long-term effects.
    - Regularly inspect snowmaking lines and equipment to prevent accidental discharges and erosion due to equipment failure.

Rec-12. Ski Area Facilities

Manual or Handbook Reference FSM 2343.1 and FSH 2709.11 41.6.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources originating from design, construction, operation, and maintenance of ski area facilities.

Explanation Ski area facilities include buildings, sanitary facilities, parking lots, and other infrastructure. These facilities can be located at the base of the ski area, mid-slope, or at the top of the ski hill. During construction and operation of facility sites, land may be cleared of existing vegetation and ground cover, exposing mineral soil that may be more easily eroded by water, wind, and gravity. Changes in land use and impervious surfaces can alter temporarily or permanently stormwater runoff that, if left uncontrolled, can affect morphology, stability, and quality of nearby streams and other waterbodies. Receiving waters can be contaminated by oil, grease, anti-freeze, sewage, trash, sediment, and salt. Construction and operation of these facilities should include measures that will avoid, minimize, or mitigate effects to water quality.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Locate ski area facilities on stable geology and soils to minimize risk of slope failures.
- Avoid wetlands and riparian areas to the extent practicable when locating ski area facilities.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to provide erosion and stormwater controls when constructing and operating ski area facilities.
- Use applicable practices of BMP Road-2 (Road Location and Design), BMP Road-3 (Road Construction and Reconstruction), BMP Road-4 (Road Operations and Maintenance), BMP Road-8 (Snow Storage and Removal), and BMP Road-9 (Parking Sites and Staging Areas) for designing, constructing, maintaining, and operating roads and parking areas at ski area facilities.
- Use applicable practices of BMP Fac-9 (Pipelines, Transmission Facilities, and Rights-of-Way) for managing power and utility lines at the ski area facilities.
- Use applicable practices of BMP Fac-6 (Hazardous Materials), BMP Fac-7 (Vehicle and Equipment Wash Water), and BMP Road-10 (Equipment Refueling and Servicing) for activities related to storage and maintenance of ski area vehicles and equipment.
- Use applicable practices of BMP Fac-3 (Potable Water Supply Systems) for drinking water, BMP Fac-4 (Sanitation Systems) for managing human waste, and BMP Fac-5 (Solid Waste Management) for managing solid waste at ski area facilities.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) when discontinuing use at ski area facilities.

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Road Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and instream riparian resources that may result from road management activities. Road management activities include travel route planning, design, construction, operation, maintenance, reconstruction, storage, and decommissioning. Other transportation-system-related activities include stream and waterbody crossings, snow removal, parking areas, and equipment refueling and servicing areas.

Eleven National Core BMPs are in the Road Management Activities Category. These BMPs are to be used when managing roads on National Forest System (NFS) lands. BMP Road-1 (Travel Management Planning and Analysis) is a planning BMP for transportation systems. BMP Road-2 (Road Location and Design), BMP Road-3 (Road Construction and Reconstruction), and BMP Road-4 (Road Operations and Maintenance) provide project-level direction for road construction and operations. BMP Road-5 (Temporary Roads) provides direction for construction and use of temporary roads. BMP Road-6 (Road Storage and Decommissioning) provides direction for roads that will not be needed for 1 year or more, or that are no longer needed. BMP Road-7 (Stream Crossings) provides practices for fords, bridges, culverts, and other crossings of flowing or standing water. BMP Road-8 (Snow Removal and Storage) provides direction for snowplowing. BMP Road-9 (Parking Areas and Staging Areas) provides direction for constructing and operating permanent and temporary parking areas. BMP Road-10 (Equipment Refueling and Servicing) provides practices for vehicle refueling and servicing areas. BMP Road-11 (Road Storm-Damage Surveys) provides direction for monitoring of roads after major storms. Each BMP draws on administrative directives that guide agency management of roads on NFS land (Forest Service Manual [FSM] 7710).

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Road BMPs	
Road-1	Travel Management Planning and Analysis
Road-2	Road Location and Design
Road-3	Road Construction and Reconstruction
Road-4	Road Operations and Maintenance
Road-5	Temporary Roads
Road-6	Road Storage and Decommissioning
Road-7	Stream Crossings
Road-8	Snow Removal and Storage
Road-9	Parking and Staging Areas
Road-10	Equipment Refueling and Servicing
Road-11	Road Storm-Damage Surveys

Road-1. Travel Management Planning and Analysis

Manual or Handbook Reference Forest Service Manual (FSM) 7710; Forest Service Handbook (FSH) 7709.55; and FSH 7709.59, chapter 10.

Objective Use the travel management planning and analysis processes to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during road management activities.

Explanation Road management related planning includes travel analyses as well as consideration of road management objectives and maintenance levels to address access needs and adjustments for projects. Planning occurs at scales that range from forestwide assessments and plans, to watershed scale or project-level analyses, to individual road activities. Effects to soil, water quality, and riparian resources are evaluated during planning and balanced with the social, economic, and land management needs of the area. Appropriate protection and mitigation measures are considered when soil, water quality, and riparian resources may be adversely impacted.

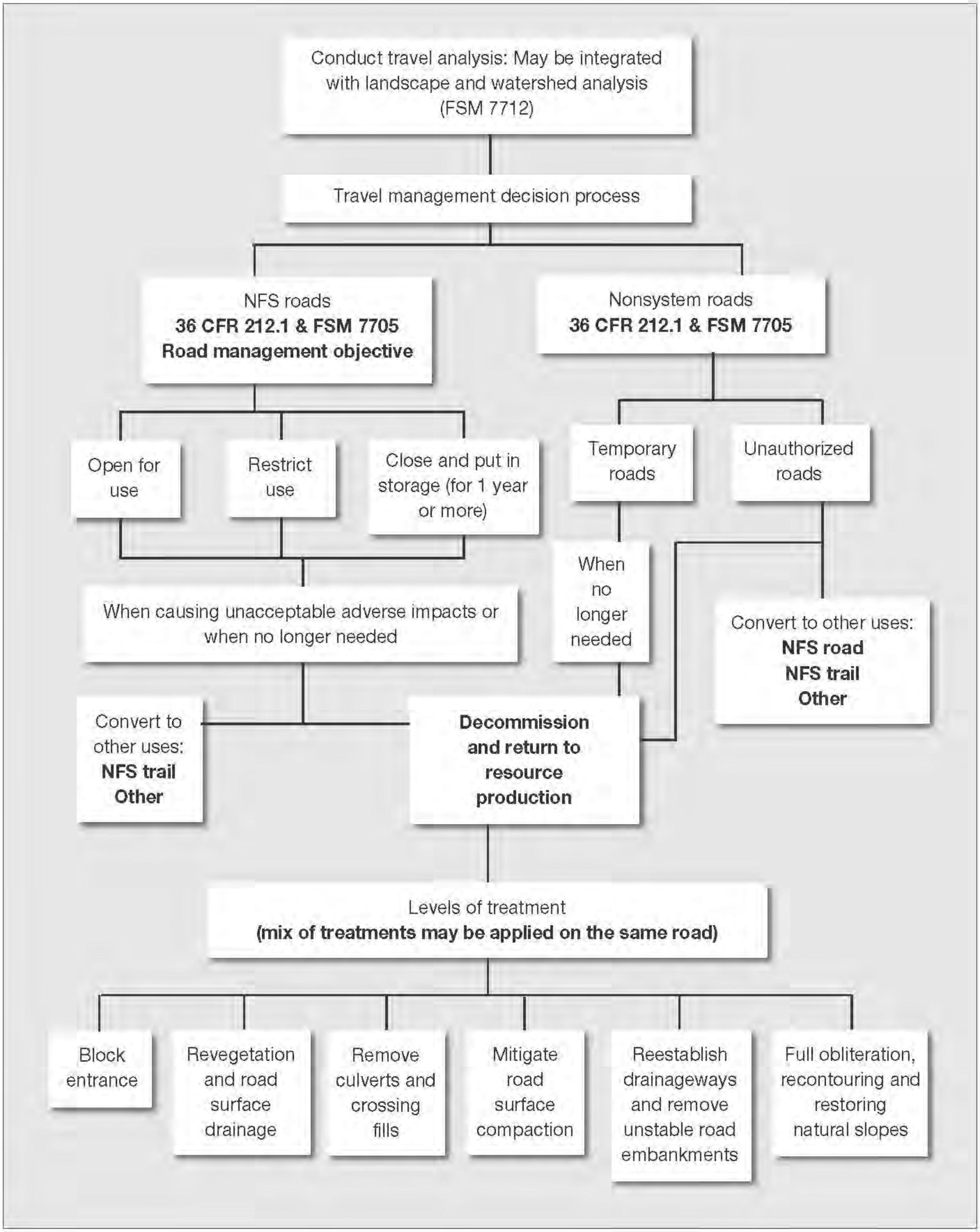
Travel analysis is conducted at a scope and scale determined by the line officer and used to inform future project decisions on the benefits and risks of, as well as the ongoing need for, the transportation system. Project-level travel analyses are conducted to inform decisions and facilitate vegetation, fire and fuels, rangeland, recreation, minerals, or other management actions. Such analyses contain detail on the condition of individual roads. Options for road management are shown in figure 3.

Road Management Objectives (RMOs) are developed and documented for each system road and include the intent and purpose in providing access to implement the land management plan. In addition to considering route needs at the site scale, RMOs also document the purpose of the road (access needs) along with operational maintenance levels and objectives.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone [AMZ] Planning) when conducting travel management planning and analysis.
- Use interdisciplinary coordination for travel planning and project-level transportation analysis, including engineers, hydrologists, soil scientists, and other resource specialists as needed, to balance protection of soil, water quality, and riparian resources with transportation and access needs.
- Design the transportation system to meet long-term land management plan desired conditions, goals, and objectives for access rather than to access individual sites.
- Limit roads to the minimum practicable number, width, and total length consistent with the purpose of specific operations, local topography, geology, and climate to achieve land management plan desired conditions, goals, and objectives for access and water quality management.
    - Use existing roads when practicable.
    - Use system roads where access is needed for long-term management of an area or where control is needed in the location, design, or construction of the road to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Figure 3. Road Options



- Use temporary roads for short-term access needs if the road can be constructed, operated, and obliterated without specific control of techniques to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources (See BMP Road-5 [Temporary Roads]).
- Decommission temporary roads and return to resource production when the access is no longer needed (See BMP Road-6 [Road Storage and Decommissioning]).
- Consider placing roads in storage (Maintenance Level 1) when the time between intermittent uses exceeds 1 year and the costs of annual maintenance (both economic and potential disturbance) or potential failures due to lack of maintenance exceed the benefits of keeping the road open in the interim (See BMP Road-6 [Road Storage and Decommissioning]).
- Consider decommissioning unneeded existing roads within a planning area when planning new system roads to reduce cumulative impacts to soil, water quality, and riparian resources (See BMP Road-6 [Road Storage and Decommissioning]).

- Plan road networks to have the minimum number of waterbody crossings as is practicable and necessary to achieve transportation system desired conditions, goals, and objectives.
- Develop or update RMOs for each system road to include design criteria, operation criteria, and maintenance criteria to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Use applicable practices of BMP Road-2 (Road Location and Design) to establish design elements and standards.
    - Use applicable practices of BMP Road-4 (Road Operations and Maintenance) to establish criteria on how the road is to be operated and maintained.
    - Revise RMOs as needed to meet changing conditions.
- Identify and evaluate road segments causing, or with the potential to cause, adverse effects to soil, water quality, and riparian resources.
    - Identify and prioritize suitable mitigation measures to avoid, minimize, or mitigate adverse effects (see BMPs Road-2 (Road Location and Design), Road-3 (Road Construction and Reconstruction), Road-4 (Road Operations and Maintenance), Road-6 (Road Storage and Decommissioning), and Road-7 (Stream Crossings) for potential mitigation measures).

Road-2. Road Location and Design

Manual or Handbook Reference FSM 7720 and FSH 7709.56.

Objective Locate and design roads to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Explanation Roads are located according to standards and specifications to meet their use objectives while protecting other resources. Well-defined project objectives are needed to locate and design roads that will best address environmental and resources issues as well as road use, safety, and traffic requirements.

New roads can be designed to avoid or minimize adverse effects to soil, water quality, and riparian resources, while existing roads may need to be redesigned or relocated to mitigate such effects. Management needs have changed considerably since most NFS roads were constructed. Influences of roads on aquatic and riparian systems are currently better understood. Designs for improvements to existing roads often revise the original design to change location, drainage, crossing type or size, or surfacing. Improvements to the road system are made on a priority basis that considers road and resource condition, values at risk, available funding, and cost.

In addition, some situations may require adherence to special conditions associated with Clean Water Act (CWA) 401 certification, CWA 402 permits, and CWA 404 permits. State and local entities may also provide guidance and regulations such as a Forest Practices Act or a Stream Alteration Act. Land management plans often contain direction on location of roads relative to streams, wetlands, and unstable landforms.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Location

- Locate roads to fit the terrain, follow natural contours, and limit the need for excavation.
  - Avoid locations that require extended steep grades, sharp curves, or switchbacks.
- Locate roads on stable geology with well-drained soils and rock formations that dip into the slope.
  - Avoid hydric soils, inner gorges, overly steep slopes, and unstable landforms to the extent practicable.
- Locate roads as far from waterbodies as is practicable to achieve access objectives, with a minimum number of crossings and connections between the road and the waterbody.
  - Avoid sensitive areas such as riparian areas, wetlands, meadows, bogs, and fens, to the extent practicable.
  - Provide an AMZ of suitable width between the road and a waterbody to maintain desired conditions, goals, and objectives for structure, function, and processes of the AMZ and associated waterbody when a road must parallel a waterbody (See BMP Plan-3 [AMZ Planning]).
- Relocate existing routes or segments that are causing, or have the potential to cause, adverse effects to soil, water quality, and riparian resources, to the extent practicable.
  - Obliterate the existing road or segment after the relocated section is completed (see BMP Road-6 [Road Storage and Decommissioning]).

Predesign

- Consider design criteria relative to soil, water quality, and riparian resources from the decision document and associated National Environmental Policy Act (NEPA) analysis document.
- Consider the road RMOs and likely future maintenance schedule in the initial design.
- Conduct suitable site investigations, data collection, and evaluations commensurate with the anticipated design and sensitivity of the area to soil, water quality, and riparian resource impacts.
  - Consider subsurface conditions and conduct suitable investigations and stability analyses for road and bridge locations where slope instability can occur due to road construction.
  - Conduct a suitable soils and geotechnical evaluation to identify susceptibility to erosion and stable angles of repose.

Design

- Design the road to fit the ground and terrain with the least practicable impacts to soil, water quality, and riparian resources considering the purpose and life of the road, safety, and cost.
    - Use road standards that minimize impacts for grade and alignment (e.g., width, turning radius, and maximum slope).
    - Use low impact development treatments that reduce long-term maintenance needs wherever practicable.
- Design the road to maintain stable road prism, cut, and fill slopes.
    - Design cut and fill slope ratios to reduce soil loss from mass failures.
    - Use structural or nonstructural measures as necessary to stabilize cut and fill slopes.
- Design the road surface drainage system to intercept, collect, and remove water from the road surface and surrounding slopes in a manner that minimizes concentrated flow in ditches, culverts, and over fill slopes and road surfaces.
    - Use structural or nonstructural measures suitable to the road materials, road gradient, and expected traffic levels.
    - Use an interval between drainage features that is suitable for the road gradient, surface material, and climate.
    - Use suitable measures to avoid or minimize erosion of ditches.
- Design the road subsurface drainage system to intercept, collect, and remove groundwater that may flow into the base course and subgrade, lower high-water tables, and drain water pockets.
    - Use suitable subsurface dispersion or collection measures to capture and disperse locally shallow groundwater flows intercepted by road cuts.
    - Use suitable measures to release groundwater into suitable areas without causing erosion or siltation.
- Design the road for minimal disruption of natural drainage patterns and to minimize the hydrologic connection of the road segment or network with nearby waterbodies.
    - Use suitable structural or nonstructural measures to avoid or minimize gully formation and erosion of fill slopes at outfalls of road surface drainage structures.
    - Use suitable measures to avoid, to the extent practicable, or minimize direct discharges from road drainage structures to nearby waterbodies.
    - Provide sufficient buffer distance at the outfalls of road surface drainage structures for water to infiltrate before reaching the waterbody.
    - Use applicable practices of BMP Road-7 (Stream Crossings) to limit the number and length of water crossing connected areas to the extent practicable.
- Design road surface treatment to support wheel loads, stabilize the roadbed, reduce dust, and control erosion consistent with anticipated traffic and use.
    - Consider whether road closures or roadway surface drainage and erosion protection can adequately mitigate adverse effects to soil, water quality, and riparian resources.
- Design roads within the AMZ (when no practicable alternative exists outside of the AMZ to achieve access objectives) to maintain desired conditions, goals, and objectives for AMZ structure, function, and processes (See BMP Plan-3 [AMZ Planning]).

- Use suitable measures to minimize or mitigate effects to waterbodies and other sensitive areas when adverse impacts cannot be practicably avoided.

- Design waterbody crossings to avoid or minimize adverse effects to soil, water quality, and riparian resources to the extent practicable consistent with road use, legal requirements, and cost considerations (See BMP Road-7 [Stream Crossings]).
- Design a post-construction site vegetation plan, including short- and long-term objectives, using suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Road-3. Road Construction and Reconstruction

Manual or Handbook Reference FSM 7720, FSH 7709.56, and FSH 7709.57.

Objective Avoid or minimize adverse effects to soil, water quality, and riparian resources from erosion, sediment, and other pollutant delivery during road construction or reconstruction.

Explanation During road construction and reconstruction activities, vegetation and ground cover is removed exposing soil to erosion. Temporary and long-term erosion control and stormwater management measures are necessary to reduce erosion and maintain overall slope stability. These erosion control measures may include vegetative and structural practices to ensure long-term stability of the area.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) for stormwater management and erosion control when constructing or reconstructing system roads
- Use suitable construction techniques to create stable fills.
    - Use full bench construction techniques or retaining walls where stable fill construction is not possible.
    - Avoid incorporating woody debris in the fill portion of the road prism.
    - Leave existing rooted trees or shrubs at the toe of the fill slope to stabilize the fill.
    - Avoid use of road fills for water impoundment dams unless specifically designed for that purpose.
- Identify and locate waste areas before the start of operations.
    - Deposit and stabilize excess and unsuitable materials only in designated sites.
    - Do not place such materials on slopes with a risk of excessive erosion, sediment delivery to waterbodies, mass failure, or within the AMZ.
    - Provide adequate surface drainage and erosion protection at disposal sites.
- Do not permit sidecasting within the AMZ.
    - Avoid or minimize excavated materials from entering waterbodies or AMZs.
- Develop and follow blasting plans when necessary.
    - Use restrictive blasting techniques in sensitive areas and in sites that have high landslide potential.

- Avoid blasting when soils are saturated.

- Remove slash and cull logs to designated sites outside the AMZ for storage or disposal.
  - Consider using cull logs in aquatic ecosystem projects to achieve aquatic resource management objectives as opportunities arise.
- Use suitable measures in compliance with local direction to prevent and control invasive species.
- Construct pioneer roads using suitable measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
  - Confine construction of pioneer roads to the planned roadway limits unless otherwise specified.
  - Locate and construct pioneering roads to avoid or minimize undercutting of the designated final cut slope.
  - Avoid deposition of materials outside the designated roadway limits.
  - Use suitable crossing structures, or temporarily dewater live streams, where pioneer roads intersect streams.
  - Use suitable erosion and stormwater control measures as needed (see BMP Fac-2 [Facility Construction and Stormwater Control]).
- Reconstruct existing roads to the degree necessary to provide adequate drainage and safety.
  - Avoid disturbing stable road surfaces.
  - Use suitable measures to avoid, to the extent practicable, or minimize direct discharges from road drainage structures to nearby waterbodies.

Road-4. Road Operations and Maintenance

Manual or Handbook Reference FSM 7732 and FSH 7709.59, chapter 60.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling road use and operations and providing adequate and appropriate maintenance to minimize sediment production and other pollutants during the useful life of the road.

Explanation Control of road use and operations and appropriate maintenance can protect road investment and soil, water quality, and riparian resources. Periodic inventory and assessment that determine road condition are used to determine operational controls and maintenance needs.

Operational objectives and activities are documented in the RMOs. In travel management decisions, roads open to motorized vehicle use are designated by allowed vehicle class and, if appropriate, by time of year. Road operations include administering permits, contracts, and agreements, controlling allowed use, maintaining roads in closed status, and revising maintenance levels and seasonal closures as needed. Road closures and restrictions are necessary because many forest roads are designed for dry season use. Many local roads are not surfaced; while others have some surfacing but little to no base. Such roads can be damaged by use during wet periods or by loads heavier than the road was designed to convey.

Properly maintained road surfaces and drainage systems can reduce adverse effects to water resources by encouraging natural hydrologic function. Roads and drainage systems normally deteriorate because of traffic, weather, and age. In addition, roads occasionally become saturated by groundwater springs and seeps after a wildfire or unusually wet periods. Many such conditions can be corrected by timely maintenance. While routine maintenance is needed to ensure the road performs as designed, however, it can also be a source of soil disturbance, concentrated flow, sediment production, and slope instability if done improperly. Lower impact maintenance techniques may be desired to minimize disturbance of stable sites.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Operations

- Designate season of use to avoid or restrict road use during periods when use would likely damage the roadway surface or road drainage features.
- Designate class of vehicle and type of uses suitable for the road width, location, waterbody crossings, and road surfaces to avoid or minimize adverse effects to soil, water quality, or riparian resources to the extent practicable.
- Use suitable measures to communicate and enforce road use restrictions.
- Use suitable measures to avoid or minimize adverse effects to soil, water quality, or riparian resources when proposed operations involve use of roads by traffic and during periods for which the road was not designed.
  - Strengthen the road surface in areas where surfaces are vulnerable to movement such as corners and steep sections.
  - Upgrade drainage structures to avoid, to the extent practicable, or minimize direct discharges into nearby waterbodies.
  - Restrict use to low-ground-pressure vehicles or frozen ground conditions.
  - Strengthen the road base if roads are tending to rut.
  - Adjust maintenance to handle the traffic while minimizing excessive erosion and damage to the road surface.
- Ensure that drainage features are fully functional on completion of seasonal operations.
  - Shape road surfaces to drain as designed.
  - Construct or reconstruct drainage control structures as needed.
  - Ensure that ditches and culverts are clean and functioning.
  - Remove berms unless specifically designed for erosion control purposes.
- Consider potential for water quality effects from road damage when granting permits for oversize or overweight loads.
- Use suitable road surface stabilization practices and dust abatement supplements on roads with high or heavy traffic use (See FSH 7709.56 and FSH 7709.59).
- Use applicable practices of Chemical Use Management Activities BMPs when chemicals are used in road operations.

Inspection

- Periodically inspect system travel routes to evaluate condition and assist in setting maintenance and improvement priorities.

- Give inspection priority to roads at high risk of failure to reduce risk of diversions and cascading failures.

- Inspect drainage structures and road surfaces after major storm events and perform any necessary maintenance (see BMP Road-11 [Road Storm-Damage Surveys]).
  - Repair and temporarily stabilize road failures actively producing and transporting sediment as soon as practicable and safe to do so.
- Inspect roads frequently during all operations.
  - Restrict use if road damage such as unacceptable surface displacement or rutting is occurring

Maintenance Planning

- Develop and implement annual maintenance plans that prioritize road maintenance work for the forest or district.
  - Increase priority for road maintenance work on road sections where road damage is causing, or potentially would cause, adverse effects to soil, water quality, and riparian resources.
  - Consider the risk and consequence of future failure at the site when prioritizing repair of road failures.
- Develop and implement annual road maintenance plans for projects where contractors or permittees are responsible for maintenance activities.
  - Define responsibilities and maintenance timing in the plan.

Maintenance Activities

- Maintain the road surface drainage system to intercept, collect, and remove water from the road surface and surrounding slopes in a manner that reduces concentrated flow in ditches, culverts, and over fill slopes and road surfaces.
  - Clean ditches and catch basins only as needed to keep them functioning.
  - Do not undercut the toe of the cut slope when cleaning ditches or catch basins.
  - Use suitable measures to avoid, to the extent practicable, or minimize direct discharges from road drainage structures to nearby waterbodies.
- Identify diversion potential on roads and prioritize for treatment.
  - Minimize diversion potential through installation and maintenance of dips, drains, or other suitable measures.
- Maintain road surface treatments to stabilize the roadbed, reduce dust, and control erosion consistent with anticipated traffic and use.
- Grade road surfaces only as necessary to meet the smoothness requirements of the assigned operational maintenance level and to provide adequate surface drainage.
  - Do not undercut the toe of the cut slope when grading roads.
  - Do not permit sidecasting of maintenance-generated debris within the AMZ to avoid or minimize excavated materials entering waterbodies or riparian areas.
  - Avoid overwidening of roads due to repeated grading over time, especially where sidecast material would encroach on waterbodies.
  - Use potential sidecast or other waste materials on the road surface where practicable.
  - Dispose of unusable waste materials in designated disposal sites.

- Remove vegetation from swales, ditches, and shoulders, and cut and fill slopes only when it impedes adequate drainage, vehicle passage, or obstructs necessary sight distance to avoid or minimize unnecessary or excessive vegetation disturbance.
- Maintain permanent stream crossings and associated fills and approaches to reduce the likelihood that water would be diverted onto the road or erode the fill if the structure becomes obstructed.
- Identify waterbody-crossing structures that lack sufficient capacity to pass expected flows, bedload, or debris, or that do not allow for desired aquatic organism passage, and prioritize for treatment.
    - Use applicable practices of BMP Road-7 (Stream Crossings) to improve crossings.
- Use applicable practices of BMP Road-6 (Road Storage and Decommissioning) for maintenance and management of Maintenance Level 1 roads.
- Ensure the necessary specifications concerning prehaul maintenance, maintenance during haul, and posthaul maintenance (putting the road back in storage) are in place when maintenance level 1 roads are opened for use on commercial resource management projects or other permitted activities.
    - Require the commercial operator or responsible party to leave roads in a satisfactory condition when project is completed.

Road-5. Temporary Roads

Manual or Handbook Reference None known.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from the construction and use of temporary roads.

Explanation Temporary roads may be used in situations where access needs are short-term and the roads can be constructed without requiring advanced engineering design or construction practices to avoid, minimize, or mitigate adverse effects to resources. Practices related to road location and stormwater and erosion control should be applied to temporary roads. Temporary roads are to be decommissioned and the area returned to resource production after the access is no longer needed.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Road-2 (Road Location and Design) to locate temporary roads.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) for stormwater management and erosion control when constructing temporary roads.
- Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
- Schedule construction activities to avoid direct soil and water-disturbance during periods of the year when heavy precipitation and runoff are likely to occur.
- Routinely inspect temporary roads to verify that erosion and stormwater controls are implemented, functioning, and appropriately maintained.

- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning.
- Use suitable measures in compliance with local direction to prevent and control invasive species.
- Use temporary crossings suitable for the expected uses and timing of use (See BMP Road-7 [Stream Crossings]).
- Use applicable practices of BMP Road-6 (Road Storage and Decommissioning) to obliterate the temporary road and return the area to resource production after the access is no longer needed.

Road-6. Road Storage and Decommissioning

Manual or Handbook Reference FSH 7709.59, chapter 60 and FSM 7734.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by storing closed roads not needed for at least 1 year (Intermittent Stored Service) and decommissioning unneeded roads in a hydrologically stable manner to eliminate hydrologic connectivity, restore natural flow patterns, and minimize soil erosion.

Explanation Roads not needed for access for long periods (greater than 1 year) may be put into storage (Intermittent Stored Service—Maintenance Level 1) to reduce maintenance costs. Level 1 roads receive basic custodial maintenance focusing on maintaining drainage facilities and runoff patterns to avoid or minimize damage to adjacent resources and to perpetuate the road for future use. The integrity of the roadway is retained to the extent practicable and measures are implemented to reduce sediment delivery from the road surface and fills and reduce the risk of crossing failure and stream diversion.

Roads no longer needed are identified during transportation planning activities at the forest, watershed, or project level. The former road may be decommissioned or converted to a trail as appropriate. Decommissioned roads are stabilized and restored to a more natural state to protect and enhance NFS lands. Temporary roads constructed for a specific short-term purpose (e.g., ski area development, minerals exploration, or timber harvesting) are decommissioned at the completion of their intended use.

Road decommissioning includes a variety of treatments to block the road, revegetate the road surface, restore surface drainage, remove crossing structures and fills, mitigate road surface compaction, re-establish drainageways, remove unstable road embankments, and recontour the surface to restore natural slopes. One or more treatments are applied to decommission the road depending on resource objectives and cost.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Activities

- Implement suitable measures to close and physically block the road entrance so that unauthorized motorized vehicles cannot access the road.
  - Remove the road from the Motor Vehicle Use Map (MVUM) to include the change in the annual forestwide order associated with the MVUM.
- Establish effective ground cover on disturbed sites to avoid or minimize accelerated erosion and soil loss.

- Use suitable species and establishment techniques to stabilize and revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Road Storage

- Evaluate all stream and waterbody crossings for potential for failure or diversion of flow if left without treatment.
  - Use suitable measures to reduce the risk of flow diversion onto the road surface.
  - Consider leaving existing crossings in low-risk situations where the culvert is not undersized, does not present an undesired passage barrier to aquatic organisms, and is relatively stable.
  - Remove culverts, fill material, and other structures that present an unacceptable risk of failure or diversion.
  - Reshape the channel and streambanks at the crossing-site to pass expected flows without scouring or ponding, minimize potential for undercutting or slumping of streambanks, and maintain continuation of channel dimensions and longitudinal profile through the crossing site.
  - Use suitable measures to avoid or minimize scour and downcutting.
- Use suitable measures to ensure that the road surface drainage system will intercept, collect, and remove water from the road surface and surrounding slopes in a manner that reduces concentrated flow in ditches, culverts, and over fill slopes and road surfaces without frequent maintenance.
- Use suitable measures to stabilize unstable road segments, seeps, slumps, or cut or fill slopes where evidence of potential failure exists.

Road Conversion to Trail

- Reclaim unneeded road width, cut, and fill slopes when converting a road for future use as a trail.
- Use suitable measures to stabilize reclaimed sections to avoid or minimize undesired access and to restore desired ecologic structures or functions.
- Use suitable measures to ensure that surface drainage will intercept, collect, and remove water from the trail surface and surrounding slopes in a manner that minimizes concentrated flow and erosion on the trail surfaces without frequent maintenance.
- Use applicable practices of BMP Road-7 (Stream Crossings) to provide waterbody crossings suitable to the expected trail uses.

Road Decommissioning

- Use existing roads identified for decommissioning as skid roads in timber sales or land stewardship projects before closing the road, where practicable, as the opportunity arises.
- Evaluate risks to soil, water quality, and riparian resources and use the most practicable, cost-effective treatments to achieve long-term desired conditions and water quality management goals and objectives.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) for stormwater management and erosion control when obliterating system roads.
- Implement suitable measures to re-establish stable slope contours and surface and subsurface hydrologic pathways where necessary to the extent practicable to avoid or minimize adverse effects to soil, water quality, and riparian resources.
  - Remove drainage structures.

- Recontour and stabilize cut slopes and fill material.
- Reshape the channel and streambanks at crossing sites to pass expected flows without scouring or ponding, minimize potential for undercutting or slumping of streambanks, and maintain continuation of channel dimensions and longitudinal profile through the crossing site.
- Restore or replace streambed materials to a particle size distribution suitable for the site.
- Restore floodplain function.

- Implement suitable measures to promote infiltration of runoff and intercepted flow and desired vegetation growth on the road prism and other compacted areas.
- Use suitable measures in compliance with local direction to prevent and control invasive species.

Road-7. Stream Crossings

Manual or Handbook Reference Manual or Handbook Reference: FSM 7722 and FSH 7709.56b.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when constructing, reconstructing, or maintaining temporary and permanent waterbody crossings.

Explanation Forest and grassland management activities often occur in areas that require surface waters to be crossed. Depending on the activity type and duration, crossings may be needed permanently or temporarily. Permanent crossings, in general, are more durable and are designed by an engineer to meet applicable standards while also protecting water quality and riparian resources.

Examples of crossings include culverts, bridges, arched pipes, low-water crossings, vented fords, and permeable fills. Crossing materials and construction will vary based on the type of access required, duration of need, and volume of use expected. Crossings should be designed and installed to provide for flow of water, bedload, and large woody debris, desired aquatic organism passage, and to minimize disturbance to the surface and shallow groundwater resources.

Construction, reconstruction, and maintenance of a crossing usually requires heavy equipment to be in and near streams, lakes, and other aquatic habitats to install or remove culverts, fords, and bridges, and their associated fills, abutments, piles, and cribbing. Such disturbance near the waterbody can increase the potential for accelerated erosion and sedimentation by altering flow paths and destabilizing streambanks or shorelines, removing vegetation and ground cover, and exposing or compacting the soil. Use of heavy equipment has a potential for contaminating the surface water from vehicle fluids or introducing aquatic nuisance species.

Some crossings may require adherence to special conditions associated with CWA 401 certification or CWA 404 permits. State and local entities may also provide guidance and regulations such as a Forest Practices Act or a Stream Alteration Act.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

All Crossings

- Plan and locate surface water crossings to limit the number and extent to those that are necessary to provide the level of access needed to meet resource management objectives as described in the RMOs.

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in or near waterbodies.
- Use crossing structures suitable for the site conditions and the RMOs.
- Design and locate crossings to minimize disturbance to the waterbody.
- Use suitable measures to locate, construct, and decommission or stabilize bypass roads to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Use suitable surface drainage and roadway stabilization measures to disconnect the road from the waterbody to avoid or minimize water and sediment from being channeled into surface waters and to dissipate concentrated flows.
- Use suitable measures to avoid, minimize, or mitigate damage to the waterbody and banks when transporting materials across the waterbody or AMZ during construction activities.

Stream Crossings

- Locate stream crossings where the channel is narrow, straight, and uniform, and has stable soils and relatively flat terrain to the extent practicable.
  - Select a site where erosion potential is low.
  - Orient the stream crossing perpendicular to the channel to the extent practicable.
  - Keep approaches to stream crossings to as gentle a slope as practicable.
  - Consider natural channel adjustments and possible channel location changes over the design life of the structure.
- Design the crossing to pass a normal range of flows for the site.
  - Design the crossing structure to have sufficient capacity to convey the design flow without appreciably altering streamflow characteristics.
  - Install stream crossings to sustain bankfull dimensions of width, depth, and slope and maintain streambed and bank resiliency and continuity through the structure.
- Bridge, culvert, or otherwise design road fill to prevent restriction of flood flows.
  - Use site conditions and local requirements to determine design flood flows.
  - Use suitable measures to protect fill from erosion and to avoid or minimize failure of the crossing at flood flows.
  - Use suitable measures to provide floodplain connectivity to the extent practicable.
- Use suitable measures to avoid or minimize scour and erosion of the channel, crossing structure, and foundation to maintain the stability of the channel and banks.
- Design and construct the stream crossing to maintain the desired migration or other movement of fish and other aquatic life inhabiting the waterbody.
  - Consider the use of bottomless arch culverts where appropriate to allow for natural channel migration and desired aquatic organism passage.
  - Install or maintain fish migration barriers only where needed to protect endangered, threatened, sensitive, or unique native aquatic populations, and only where natural barriers do not exist.
  - Use stream simulation techniques where practicable to aid in crossing design.

- Bridges
  - Use an adequately long bridge span to avoid constricting the natural active flow channel and minimize constriction of any overflow channel.
  - Place foundations onto nonscour-susceptible material (e.g., bedrock or coarse rock material) or below the expected maximum depth of scour.
  - Set bridge abutments or footings into firm natural ground (e.g., not fill material or loose soil) when placed on natural slopes.
  - Use suitable measures as needed in steep, deep drainages to retain approach fills or use a relatively long bridge span.
  - Avoid placing abutments in the active stream channel to the extent practicable.
  - Place in-channel abutments in a direction parallel to the streamflow where necessary.
  - Use suitable measures to avoid or minimize, to the extent practicable, damage to the bridge and associated road from expected flood flows, floating debris, and bedload.
  - Inspect the bridge at regular intervals and perform maintenance as needed to maintain the function of the structure.
- Culverts
  - Align the culvert with the natural stream channel.
  - Cover culvert with sufficient fill to avoid or minimize damage by traffic.
  - Construct at or near natural elevation of the streambed to avoid or minimize potential flooding upstream of the crossing and erosion below the outlet.
  - Install culverts long enough to extend beyond the toe of the fill slopes to minimize erosion.
  - Use suitable measures to avoid or minimize water from seeping around the culvert.
  - Use suitable measures to avoid or minimize culvert plugging from transported bedload and debris.
  - Regularly inspect culverts and clean as necessary.
- Low-Water Crossings
  - Consider low-water crossings on roads with low traffic volume and slow speeds, and where water depth is safe for vehicle travel.
  - Consider low-water crossings to cross ephemeral streams, streams with relatively low baseflow and shallow water depth or streams with highly variable flows or in areas prone to landslides or debris flows.
  - Locate low-water crossings where streambanks are low with gentle slopes and channels are not deeply incised.
  - Select and design low-water crossing structures to maintain the function and bedload movement of the natural stream channel.
  - Locate unimproved fords in stable reaches with a firm rock or gravel base that has sufficient load-bearing strength for the expected vehicle traffic.
  - Construct the low-water crossing to conform to the site, channel shape, and original streambed elevation and to minimize flow restriction, site disturbance, and channel blockage to the extent practicable.
  - Use suitable measures to stabilize or harden the streambed and approaches, including the entire bankfull width and sufficient freeboard, where necessary to support the design vehicle traffic.

- Use vented fords with high vent area ratio to maintain stream function and aquatic organism passage.
- Construct the roadway-driving surface with material suitable to resist expected shear stress or lateral forces of water flow at the site.
- Consider using temporary crossings on roads that provide short-term or intermittent access to avoid, minimize, or mitigate erosion, damage to streambed or channel, and flooding.
- Design and install temporary crossings suitable for the expected users, loads, and timing of use.
- Design and install temporary crossing structures to pass a design storm determined based on local site conditions and requirements.
- Install and remove temporary crossing structures in a timely manner as needed to provide access during use periods and minimize risk of washout.
- Use suitable measures to stabilize temporary crossings that must remain in place during high runoff seasons.
- Monitor temporary crossings regularly while installed to evaluate condition.
- Remove temporary crossings and restore the waterbody profile and substrate when the need for the crossing no longer exists.

Standing Water and Wetland Crossings

- Disturb the least amount of area as practicable when crossing a standing waterbody.
- Provide for sufficient cross drainage to minimize changes to, and avoid restricting, natural surface and subsurface water flow of the wetland under the road to the extent practicable.
    - Locate and design roads or road drainage to avoid dewatering or polluting wetlands.
    - Avoid or minimize actions that would significantly alter the natural drainage for flow patterns on lands immediately adjacent to wetlands.
- Use suitable measures to increase soil-bearing capacity and reduce rutting from expected vehicle traffic.
- Construct fill roads only when necessary.
    - Construct fill roads parallel to water flow and to be as low to natural ground level as practicable.
    - Construct roads with sufficient surface drainage for surface water flows.

Road-8. Snow Removal and Storage

Manual or Handbook Reference FS-7700-41 and FSH 7709.59, chapter 24.11.

Objective Avoid or minimize erosion, sedimentation, and chemical pollution that may result from snow removal and storage activities.

Explanation Snow removal from roads and parking areas may adversely affect water quality and riparian resources in several ways. Plowing may physically displace native or engineered surfaces on roads, damage drainage structures, or alter drainage patterns. Plowing may also remove protective soil cover (e.g., vegetation or mulch). These changes can result in concentrated flow, increased erosion, and greater risk of sediment delivery to waterbodies.

Snow piled in large mounds or berms, or in sensitive areas, may contribute to increased run-off, hill slope erosion, mass slope instability, and in-channel erosion from snowmelt. Snow stored in riparian areas and floodplains may compact soils, break or stunt vegetation, or channel runoff in undesirable patterns, thereby weakening the buffering capacity of these areas. Additionally, both snow removal and storage may result in additions of salts or fine aggregates used for de-icing or traction control and other vehicle pollutants directly to surface water and indirectly to both surface water and groundwater during runoff.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Develop a snow removal plan for roads plowed for recreation, administrative, or other access to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Use existing standard contract language (C5.316# or similar) for snow removal during winter logging operations to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
- Limit use of approved deicing and traction control materials to areas where safety is critical (e.g., intersections, steep segments, and corners).
  - Use site-specific characteristics such as road width and design, traffic concentration, and proximity to surface waters to determine suitable amount of de-icing material to apply.
  - Use effective plowing techniques to optimize chemical de-icer use.
  - Consider use of alternative materials to chemical de-icers, such as sand or gravel, in sensitive areas.
  - Use properly calibrated controllers to ensure material application rates are accurately regulated.
  - Limit spray distribution of chemical de-icers when near surface waters.
  - Design paved roads and parking lots to facilitate sand removal (e.g., curbs or paved ditches).
- Use suitable measures when storing de-icing materials to avoid or minimize mobility of the materials.
  - Store de-icing materials on a flat, upland, impervious area of adequate size to accommodate material stockpiles and equipment movement.
  - Stockpile de-icing materials under cover and provide runoff collection, containment, and treatment, as necessary, to avoid or minimize offsite movement.
- Move snow in a manner that will avoid or minimize disturbance of or damage to road surfaces and drainage structures.
  - Mark drainage structures to avoid damage during plowing.
  - Conduct frequent inspections to ensure road drainage is not adversely affecting soil or water resources.
- Control areas where snow removal equipment can operate to avoid or minimize damage to riparian areas, floodplains, and stream channels.
- Install snow berms where such placement will preclude concentration of snowmelt runoff and will serve to dissipate melt water.
  - Provide frequent drainage through snow berms to avoid concentration of snowmelt runoff on fillslopes and other erosive areas, to dissipate melt water, and to avoid or minimize sediment delivery to waterbodies.

- Store snow in clearly delineated pre-approved areas where snowmelt runoff will not cause erosion or deliver snow, road de-icers, or traction-enhancing materials directly into surface waters.
  - Store or dispose of snow adjacent to or on pervious surfaces in upland areas away from waterbodies to the extent practicable.
  - Do not store or dispose of snow in riparian areas, wetlands, or streams unless no other practicable alternative exists.
- Manage discharge of meltwater to avoid or minimize runoff of pollutants into surface waterbodies or groundwater.
  - Use suitable measures to filter and treat meltwater before reaching surface water or groundwater.
  - Use suitable measures to disperse meltwater to avoid creating concentrated overland flow.
  - Collect and properly dispose of onsite litter, debris, and sediment from meltwater settling areas.
- Discontinue road use and snow removal when use would likely damage the roadway surface or road drainage features.
  - Modify snow removal procedures as necessary to meet water quality concerns.
- Replace lost road surface materials with similar quality material and repair structures damaged in snow removal operations as soon as practicable.

Road-9. Parking and Staging Areas

Manual or Handbook Reference FSM 7710, FSM 7720, and FSM 7730.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when constructing and maintaining parking and staging areas.

Explanation Parking and staging areas on NFS lands may be permanent or temporary and are associated with a variety of uses including administrative buildings, developed recreation sites, trailheads, and forest management projects. These parking facilities sometimes constitute large areas with little or no infiltration capacity. Runoff from these areas can create rills or gullies and carry sediment, nutrients, and other pollutants to nearby surface waters.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Design and locate parking and staging areas of appropriate size and configuration to accommodate expected vehicles and avoid or minimize adverse effects to adjacent soil, water quality, and riparian resources.
  - Consider the number and type of vehicles to determine parking or staging area size.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) for stormwater management and erosion control when designing, constructing, reconstructing, or maintaining parking or staging areas.
- Use suitable measures to harden and avoid or minimize damage to parking area surfaces that experience heavy use or are used during wet periods.

- Use and maintain suitable measures to collect and contain oil and grease in larger parking lots with high use and where drainage discharges directly to streams.
- Connect drainage system to existing stormwater conveyance systems where available and practicable.
- Conduct maintenance activities commensurate with parking or staging area surfacing and drainage requirements as well as precipitation timing, intensity, and duration.
- Limit the size and extent of temporary parking or staging areas.
    - Take advantage of existing openings, sites away from waterbodies, and areas that are apt to be more easily restored to the extent practicable.
    - Use temporary stormwater and erosion control measures as needed.
    - Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to rehabilitate temporary parking or staging areas as soon as practicable following use.

Road-10. Equipment Refueling and Servicing

Manual or Handbook Reference FSM 2160 and FSH 7109.19, chapter 40.

Objective Avoid or minimize adverse effects to soil, water quality, and riparian resources from fuels, lubricants, cleaners, and other harmful materials discharging into nearby surface waters or infiltrating through soils to contaminate groundwater resources during equipment refueling and servicing activities.

Explanation Many activities require the use and maintenance of petroleum-powered equipment in the field. For example, mechanical vegetation management activities may employ equipment that uses or contains gasoline, diesel, oil, grease, hydraulic fluids, antifreeze, coolants, cleaning agents, and pesticides. These petroleum and chemical products may pose a risk to contaminating soils, surface water, and groundwaters during refueling and servicing the equipment. BMP Fac-6 (Hazardous Materials) provides additional guidance for handling hazardous materials.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Plan for suitable equipment refueling and servicing sites during project design.
    - Allow temporary refueling and servicing only at approved locations, located well away from the AMZ, groundwater recharge areas, and waterbodies.
- Develop or use existing fuel and chemical management plans (e.g., Spill Prevention Control and Countermeasures [SPCC], spill response plan, and emergency response plan) when developing the management prescription for refueling and servicing sites.
- Locate, design, construct, and maintain petroleum and chemical delivery and storage facilities consistent with applicable local, State, and Federal regulations.
- Use suitable measures around vehicle service, storage and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills and avoid or minimize soil contamination and seepage to groundwater.
- Provide training for all agency personnel handling fuels and chemicals in their proper use, handling, storage, and disposal.

- Ensure that contractors and permit holders provide documentation of proper training in handling hazardous materials.

- Use suitable measures to avoid spilling fuels, lubricants, cleaners, and other chemicals during handling and transporting.
- Prohibit excess chemicals or wastes from being stored or accumulated in the project area.
- Remove service residues, used oil, and other hazardous or undesirable materials from NFS land and properly dispose them as needed during and after completion of the project.
- Clean up and dispose of spilled materials according to specified requirements in the appropriate guiding document.
- Report spills and initiate suitable cleanup action in accordance with applicable State and Federal laws, rules, and regulations.
  - Remove contaminated soil and other material from NFS lands and dispose of this material in a manner consistent with controlling regulations.
- Prepare and implement a certified SPCC Plan for each facility, including mobile and portable facilities, as required by Federal regulations.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim equipment refueling and services site when the need for them ends.

Road-11. Road Storm-Damage Surveys

Manual or Handbook Reference FSM 7730 and FSM 2350.

Objective Monitor road conditions following storm events to detect road failures; assess damage or potential damage to waterbodies, riparian resources, and watershed functions; determine the causes of the failures; and identify potential remedial actions at the damaged sites and preventative actions at similar sites.

Explanation Large storms stress road systems in multiple ways: large volumes of water are transported on road surfaces and through its drainage systems; significant volumes of water and debris are transported through stream crossings; and elevated pore pressures on unstable hillslopes, road cutslopes, and fillslopes sometimes generate mass failures. All road drainage systems, stream crossings with culverts, and unstable slopes have the potential to fail during periods of high runoff. The probabilities of failure differ greatly, and the potential consequences to water quality and designated uses vary dramatically from no impacts to severe and long-term impacts to aquatic systems.

Surveying roads during or soon after storms is critical to timely detection of these problems. Observation of problems caused by storm runoff is of great value in understanding both the causes of failure and in adapting designs and prescriptions that reduce both the probability and consequences of future road failures. Over time, this kind of monitoring illustrates how and where roads can fail and points readily to practice modifications that can reduce adverse effects to water quality and watershed function.

The Emergency Relief for Federally Owned Roads (ERFO) Program is intended to help assess and fund the unusually heavy expenses associated with repairing and reconstructing Federal roads and bridges seriously damaged by a natural disaster over a wide area or catastrophic failure. To qualify for this type of funding, applications for repair must be submitted to the Federal Highways Administration through the ERFO program (FSM 7700).

Practices ***ERFO-Related Damage Surveys***

- Complete a Damage Survey Report (DSR) at damaged sites potentially eligible for ERFO funds.
- Complete the Forest Service-developed supplemental form DSR+ in the field to more thoroughly describe, in categorical terms, the cause(s) and consequences of the damage.
    - The DSR+ form and instructions may be found at http://www.stream.fs.fed.us/bmp/damagesurveys.
- Record the following information from damage sites that have been documented on the DSR and DSR+ forms in appropriate corporate database(s), including geographic information systems:
    - The geographic locations (points or road segments) where damage occurred.
    - The date of occurrence (year and month, if available).
    - The type of failure and its cause.

Special Storm Damage Surveys

- Determine the need to do more comprehensive surveys and analysis of road damage after particularly large storm events.
    - Survey all roads in the area, typically an entire watershed, ranger district, or national forest or grassland, affected by the storm or those roads that may be particularly susceptible to failure.

All Damage Surveys

- Analyze results from EFRO surveys, routine damage reconnaissance, and special surveys for patterns of damage and causes.
- Use these patterns of road damage to formulate recommendations of practice changes to reduce the incidence of future damage. Consider practice changes such as—
    - Locating or relocating roads to more stable terrain (see BMP Road-2 [Road Location and Design]);
    - Disconnecting road surface drainage from crossings and channels (see BMP Road-3 [Road Construction and Reconstruction]);
    - Using special protections in locations on unstable landforms or areas with high erosion potential (see BMP Road-3 [Road Construction and Reconstruction]);
    - Increasing the capacity of stream-crossing structures to pass water, debris, and sediment to reduce the probabilities of failure (see BMP Road-7 [Stream Crossings]);
    - Building or rebuilding stream crossings to eliminate or reduce diversion potential (see BMP Road-7 [Stream Crossings]);
    - Building or rebuilding stream crossings to improve aquatic species passage (see BMP Road-7 [Stream Crossings]); or
    - Decommissioning or storing roads in a hydrologically benign condition (see BMP Road-6 [Road Storage and Decommissioning]).
- Enter and store the results of data analysis in corporate data management systems to facilitate sharing among units that have similar terrain and road practices.

Resources for Road Management Activities

Aquatic Passage

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State Forestry BMP Documents

See Appendix B.

Mechanical Vegetation Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that may result from mechanical treatments to manage vegetation. Mechanical treatments are used to manage vegetation for a variety of purposes including timber harvest, site preparation, vegetation type conversion, fire or fuels treatment, forest health and rangeland improvement, and wildlife habitat improvement. Authorizing documents for mechanical treatments are timber sale contracts, stewardship contracts, or project plans.

Eight National Core BMPs are in the Mechanical Vegetation Management Activities category. These BMPs are to be used in all mechanical vegetation management projects on National Forest System (NFS) lands. BMP Veg-1 (Vegetation Management Planning) is a planning BMP for vegetation management projects. BMP Veg-2 (Erosion Prevention and Control) provides direction for erosion control measures for mechanical vegetation treatment projects. BMP Veg-3 (Aquatic Management Zones) provides direction for mechanical vegetation treatments in the areas adjacent to waterbodies. BMP Veg-4 (Ground-Based Skidding and Yarding Operations) and BMP Veg-5 (Cable and Aerial Yarding Operations) provide direction for yarding activities in timber management projects. BMP Veg-6 (Landings) provides direction for construction and use of landings. BMP Veg-7 (Winter Logging) provides additional direction for skidding and yarding operations in winter. BMP Veg-8 (Mechanical Site Treatment) provides practices for other mechanical vegetation treatments for site preparation, fuel treatment, and habitat improvements.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Mechanical Vegetation Management BMPs	
Veg-1	Vegetation Management Planning
Veg-2	Erosion Prevention and Control
Veg-3	Aquatic Management Zones
Veg-4	Ground-Based Skidding and Yarding Operations
Veg-5	Cable and Aerial Yarding Operations
Veg-6	Landings
Veg-7	Winter Logging
Veg-8	Mechanical Site Treatment

Veg-1. Vegetation Management Planning

Manual or Handbook Reference Forest Service Manual (FSM) 1921.12.

Objective Use the applicable vegetation management planning processes to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during mechanical vegetation treatment activities.

Explanation Vegetation on NFS lands is managed for a variety of purposes to achieve land management plan desired conditions, goals, and objectives for many resources. Planning for vegetation management generally follows a sequence of steps. The gathering and assessment of data involves evaluating the current condition of the vegetation compared to land management plan desired conditions, goals, and objectives. Potential vegetation treatment options to move the site towards desired conditions are developed and compared. Detailed treatment prescriptions are prepared to implement the preferred treatment option. The project is subjected to the National Environmental Policy Act (NEPA) analysis process where alternatives are developed and effects are analyzed. A decision is made and implemented. During the development of vegetation treatment prescriptions and alternatives, site specific measures consistent with BMP guidance to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resource are identified and included in the project as design criteria or mitigation measures. These BMP prescriptions are incorporated into the timber sale contract, stewardship contract, or project plan.

Vegetation management for scheduled timber harvest on NFS lands has additional specific requirements from the National Forest Management Act that are incorporated into the project in the planning process. Scheduled timber harvest can occur only where watershed conditions will be maintained, lands can be adequately restocked within 5 years after final regeneration harvest, and water quality will be protected.

Practices

Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone (AMZ) Planning) when planning vegetation management projects.
  - ❑ Evaluate opportunities to use proposed mechanical vegetation treatment projects to achieve AMZ desired conditions, goals, and objectives in the project area.
- Evaluate and field verify site conditions in the project area to design mechanical vegetation treatment prescriptions that avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
  - ❑ Validate land management plan timber suitability decisions for the project area.
  - ❑ Design mechanical vegetation treatment prescriptions to limit site disturbance, soil exposure, and displacement to acceptable levels as determined from the land management plan desired conditions, standards, and guidelines or other local direction or requirements.
  - ❑ Evaluate direct, indirect, and cumulative effects of vegetation alteration on streamflow regimes and consequent channel responses at suitable watershed scales.
  - ❑ Use local direction or requirements for slope, erosion potential, mass wasting potential, and other soil or site properties to determine areas suitable for ground-based, cable, and aerial yarding systems (see BMP Veg-4 [Ground-Based Skidding and Yarding Operations] and BMP Veg-5 [Cable and Aerial Yarding Operations]).
  - ❑ Use the most economically practicable yarding system that will minimize road densities.
  - ❑ Consider site preparation and fuel treatment needs and options.
  - ❑ Use applicable practices of BMP Veg-8 (Mechanical Site Treatment) to determine areas suitable for mechanical treatments for site preparation, fuels treatment, habitat improvements, or other vegetation management purposes.
  - ❑ Evaluate the capabilities of the machinery likely to operate in the landscape under consideration.
  - ❑ Use preplanning to schedule entry or timing of mechanical and other vegetation treatments (e.g., prescribed fire or chemical treatments) when needed for large projects.

- Evaluate and field verify site conditions in the project area to design a transportation plan associated with the mechanical vegetation treatments to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Use the logging system that best fits the topography, soil types, and season, while minimizing soil disturbance and road densities and that economically achieves silvicultural objectives.
    - Use applicable practices of BMP Road-2 (Road Location and Design), BMP Veg-4 (Ground-Based Skidding and Yarding Operations), BMP Veg-5 (Cable and Aerial Yarding Operations), and BMP Veg-6 (Landings) to determine proposed location and size of roads, landings, skid trails, and cable corridors.
    - Use applicable practices of BMP Road-1 (Travel Management Planning and Analysis) and BMP Road-5 (Temporary Roads) to determine the need for specified roads and temporary roads.
    - Evaluate the condition of system roads, including roads in storage, and unauthorized roads in the project area to determine their suitability for use in the project and any reconstruction or prehaul maintenance needs.
    - Evaluate the Road Management Objective of system roads to determine where log hauling should be prohibited or restricted.
- Identify sources of rock for roadwork, riprapping, and borrow materials (see BMP Min-6 [Mineral Materials Resource Sites]).
- Identify water sources available for purchasers' use (see BMP WatUses-3 [Administrative Water Developments]).
- Ensure the timber sale contract, stewardship contract, or other implementing document includes BMPs from the decision document to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Use appropriate standard B and C provisions and regional or local provisions to address measures and responsibilities consistent with the BMPs in the decision document in the timber sale or stewardship contract.
    - Delineate all protected or excluded areas, including AMZs and waterbodies, on the sale area map or project map.
    - Delineate approved water locations, staging areas, and borrow areas on the sale area map or project map.
    - Ensure that the final unit location, layout, acreage, and logging system or mechanical treatment and Knutson-Vandenberg Act plans are consistent with the decision document.
- Use contract modification procedures to the extent practicable to modify unit design, treatment methods, or other project activities where necessary to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources based on new information or changed conditions discovered during project implementation.

Veg-2. Erosion Prevention and Control

Manual or Handbook Reference Forest Service Handbook (FSH) 2409.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by implementing measures to control surface erosion, gully formation, mass slope failure, and resulting sediment movement before, during, and after mechanical vegetation treatments.

Explanation Prevention and control of erosion on areas undergoing mechanical vegetation treatments is critical to maintaining water quality. The process of erosion control has three basic phases: planning, implementation, and monitoring. During planning, areas subject to excessive erosion, detrimental soil damage and mass failure can be identified and avoided. Also during planning, treatments can be designed and units laid out to minimize or mitigate damage to soils, streambanks, shorelines, wetlands, riparian areas, and water quality. Planning for erosion control is addressed in BMP Plan-2 (Project Planning and Analysis) and BMP Veg-1 (Vegetation Management Planning). Suitable erosion control measures are implemented while the mechanical vegetation treatment is ongoing and following project completion. Inspection and maintenance of implemented measures will ensure their function and effectiveness over their expected design period.

The potential for accelerated erosion or other soil damage during or following mechanical treatments depends on climate, soil type, site conditions, and type of equipment and techniques used at the site. Erosion control measures are grouped into two general categories: structural measures to control and treat runoff and increase infiltration and nonstructural measures to increase ground cover. Many erosion control handbooks, technical guides, and commercial products are available. Both structural and nonstructural measures require onsite expertise to ensure proper design and implementation to conform to local site characteristics.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Establish designated areas for equipment staging and parking to minimize the area of ground disturbance (see BMP Road-9 [Parking Sites and Staging Areas]).
- Use provisions in the timber sale contract or land stewardship contract to implement and enforce erosion control on the project area.
    - Work with the contractor to locate landings, skid trails, and slash piles in suitable sites to avoid, minimize, or mitigate potential for erosion and sediment delivery to nearby waterbodies.
- Develop an erosion control and sediment plan that covers all disturbed areas including skid trails and roads, landings, cable corridors, temporary road fills, water source sites, borrow sites, or other areas disturbed during mechanical vegetation treatments.
- Refer to State or local forestry or silviculture BMP manuals, guidebooks, and trade publications for effective structural and nonstructural measures to—
    - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season.
    - Maintain the natural drainage pattern of the area wherever practicable.
    - Control, collect, detain, treat, and disperse stormwater runoff from disturbed areas.
    - Divert surface runoff around bare areas with appropriate energy dissipation and sediment filters.
    - Stabilize steep excavated slopes.

- Use suitable species and establishment techniques to cover or revegetate disturbed areas in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Use suitable measures in compliance with local direction to prevent and control invasive species.
- Install sediment and stormwater controls before initiating surface-disturbing activities to the extent practicable.
- Operate equipment when soil compaction, displacement, erosion, and sediment runoff would be minimized.
  - Avoid ground equipment operations on unstable, wet, or easily compacted soils and on steep slopes unless operation can be conducted without causing excessive rutting, soil puddling, or runoff of sediments directly into waterbodies.
  - Evaluate site conditions frequently to assess changing conditions.
  - Adjust equipment operations as necessary to protect the site while maintaining efficient project operations.
- Install suitable stormwater and erosion control measures to stabilize disturbed areas and waterways on incomplete projects before seasonal shutdown of operations or when severe storm or cumulative precipitation events that could result in sediment mobilization to waterbodies are expected.
- Routinely inspect disturbed areas to verify that erosion and stormwater controls are implemented and functioning as designed and are suitably maintained.
- Maintain erosion and stormwater controls as necessary to ensure proper and effective functioning.
  - Prepare for unexpected failures of erosion control measures.
- Implement mechanical treatments on the contour of sloping ground to avoid or minimize water concentration and subsequent accelerated erosion.

Veg-3. Aquatic Management Zones

Manual or Handbook Reference FSM 2526, FSM 2527.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when conducting mechanical vegetation treatment activities in the AMZ.

Explanation Designation of an AMZ around and adjacent to waterbodies is a typical BMP to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources. Mechanical vegetation treatments are a tool that can be used within the AMZ to achieve a variety of resource-desired conditions and objectives when implemented with suitable measures to maintain riparian and aquatic ecosystem structure, function, and processes. Depending on site conditions and resource-desired conditions and objectives, mechanical vegetation treatments in the AMZ could range from no activity or equipment exclusion to purposely using mechanical equipment to create desired disturbances or conditions. When treatments are to be used in the AMZ, a variety of measures can be employed to avoid, minimize, or mitigate soil disturbance, damage to the waterbody, loss of large woody debris recruitment, and shading, and impacts to floodplain function.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-3 (AMZ Planning) to determine the need for and width of the AMZ considering the proposed mechanical vegetation treatments.
    - Modify AMZ width as needed to provide assurance of leave-tree wind firmness where high windthrow risk is identified.
- Clearly delineate AMZ locations and boundaries in the project area using suitable markings and structures.
    - Maintain or reestablish these boundaries as necessary during project implementation or operation.
    - Specify AMZ layout, maintenance, and operating requirements in contracts, design plans, and other necessary project documentation.
- Use mechanical vegetation treatments in the AMZ only when suitable to achieve long-term AMZ-desired conditions and management objectives (see BMP Plan-3 [AMZ Planning]).
- Modify mechanical vegetation treatment prescriptions and operations in the AMZs as needed to maintain ecosystem structure, function, and processes.
    - Design silvicultural or other vegetation management prescriptions to maintain or improve the riparian ecosystem and adjacent waterbody.
    - Use yarding systems or mechanical treatments that avoid or minimize disturbance to the ground and vegetation consistent with project objectives.
    - Conduct equipment operations in a manner that maintains or provides sufficient ground cover to meet land management plan desired conditions, goals, and objectives to minimize erosion and trap sediment.
    - Use suitable measures to avoid or minimize soil disturbance from equipment operations to stay within acceptable disturbance levels when conducting mechanical vegetation treatment operations.
    - Prescribe mechanical site preparation techniques and fuels and residual vegetation treatments that avoid or minimize excessive erosion, sediment delivery to nearby waterbodies, or damage to desired riparian vegetation.
    - Conduct operations in a manner that avoids or minimizes introduction of excess slash or other vegetative debris into the AMZ and waterbodies; damage to streambanks, shorelines, and edges of wetlands; and adverse effects to floodplain functioning.
    - Retain trees as necessary for canopy cover and shading, bank stabilization, and as a source of large woody debris within the AMZ.
    - Avoid felling trees into streams or waterbodies, except as planned to create habitat features
- Locate transportation facilities for mechanical vegetation treatments, including roads, landings, and main skid trails, outside of the AMZ to the extent practicable.
    - Minimize the number of stream crossings to the extent practicable.
    - Evaluate options for routes that must cross waterbodies and choose the one (e.g., specified road vs. temporary road vs. skid road or trail) that avoids or minimizes adverse effects to soil, water quality, and riparian resources to the greatest extent practicable.
    - Do not use drainage bottoms as turn-around areas for equipment during mechanical vegetation treatments.
- Use suitable measures to disperse concentrated flows of water from road surface drainage features to avoid or minimize surface erosion, gully formation, and mass failure in the AMZ and sediment transport to the waterbody.

- Monitor the AMZ during mechanical operations to evaluate compliance with prescription and mitigation requirements in the authorizing document.
  - Adjust operations in the AMZ to avoid, minimize, or mitigate detrimental soil impacts where they are occurring.
  - Use suitable mitigation or restoration measures on areas in the AMZ that show signs of unacceptable erosion or those with high potential for erosion due to mechanical operations in the AMZ.
  - Remove unauthorized debris from waterbodies using techniques that will limit disturbance to bed and banks, riparian areas, aquatic-dependent species, and the waterbody unless significant damage would occur during its removal or leaving it in meets desired conditions for the waterbody.

Veg-4. Ground-Based Skidding and Yarding Operations

Manual or Handbook Reference FSH 2409.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during ground-based skidding and yarding operations by minimizing site disturbance and controlling the introduction of sediment, nutrients, and chemical pollutants to waterbodies.

Explanation Ground-based yarding systems include an array of equipment from horses, rubber-tired skidders, and bulldozers, to feller or bunchers, forwarders, and harvesters. Each method can compact soil and cause soil disturbance, though the amount of impact depends on the specific type of equipment used, the operator, unit design, and site conditions. Ground-based yarding systems can be designed and implemented to avoid, minimize, or mitigate potential adverse effects to soils, water quality, and riparian resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use ground-based yarding systems only where physical site characteristics are suitable to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
  - Use local direction or requirements for slope, erosion potential, mass wasting potential, and other soil or site properties to determine areas suitable for ground-based yarding systems.
- Use existing roads and skid trail networks to the extent practicable.
  - Create new roads and skid trail where re-use of existing ones would exacerbate soil, water quality, and riparian resource impacts.
- Design and locate skid trails and skidding operations to minimize soil disturbance to the extent practicable.
  - Designate skid trails to the extent practicable to limit site disturbance.
  - Locate skid trails outside of the AMZ to the extent practicable.
  - Locate skid trails to avoid concentrating runoff and provide breaks in grade.
  - Limit the grade of constructed skid trails on geologically unstable, saturated, highly erodible, or easily compacted soils.
  - Avoid long runs on steep slopes.

- Use suitable measures during felling and skidding operations to avoid or minimize disturbance to soils and waterbodies to the extent practicable.
  - Perform skidding or yarding operations when soil conditions are such that soil compaction, displacement, and erosion would be minimized.
  - Suspend skidding or yarding operations when soil moisture levels could result in unacceptable soil damage.
  - Avoid skidding logs in or adjacent to a stream channel or other waterbody to the extent practicable.
  - Skid across streams only at designated locations.
  - Use suitable measures at skid trail crossings to avoid or minimize damage to the stream channel and streambanks.
  - Directionally fell trees to facilitate efficient removal along predetermined yarding patterns with the least number of passes and least amount of disturbed area (e.g., felling-to-the-lead).
  - Directionally fell trees away from streambanks, shorelines, and other waterbody edges.
  - Remove logs from wet meadows or AMZs using suitable techniques to minimize equipment operations in the sensitive area and minimize dragging the logs on the ground.
  - Winch or skid logs upslope, away from waterbodies.
  - Use low ground pressure equipment when practicable, particularly on equipment traveling over large portions of units with sensitive soils or site conditions.
- Use applicable practices of BMP Veg-2 (Erosion Prevention and Control) to minimize and control erosion to the extent practicable.
- Use suitable measures to stabilize and restore skid trails after use.
  - Reshape the surface to promote dispersed drainage.
  - Install suitable drainage features.
  - Mitigate soil compaction to improve infiltration and revegetation conditions.
  - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season.
  - Use suitable measures to promote rapid revegetation.
  - Use suitable measures in compliance with local direction to prevent and control invasive species.

Veg-5. Cable and Aerial Yarding Operations

Manual or Handbook Reference FSH 2409.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during cable and aerial yarding operations by minimizing site disturbance and controlling the introduction of sediment, nutrients, and chemical pollutants to waterbodies.

Explanation Cable and aerial yarding systems partially or fully suspend logs off the ground when yarding logs to the landing. They include skyline cable, helicopter, and balloon systems that typically are used in steep, erodible, and unstable areas where ground-based systems should not operate. Soil disturbance and erosion risks from these systems are primarily confined to cable corridors and landings.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use cable or aerial yarding systems on steep slopes where ground-based equipment cannot operate without causing unacceptable ground disturbance.
  - Use local direction or requirements for slope, erosion potential, mass wasting potential, and other soil or site properties to determine areas suitable for cable or aerial yarding systems.
  - Consider slope shape, potential barriers, lift and deflection requirements, and availability of suitable landing locations when selecting cable-yarding systems.
- Identify areas requiring cable or aerial yarding during project planning and in the contract.
- Identify necessary equipment capabilities in the contract.
- Locate cable corridors to efficiently yard materials with the least soil damage.
  - Use suitable measures to minimize soil disturbance when yarding over breaks in slope.
- Fully suspend logs to the extent practicable when yarding over AMZs and streams.
- Postpone yarding operations when soil moisture levels are high if the specific type of yarding system results in unacceptable soil disturbance and erosion within cable corridors.
- Use applicable practices of BMP Veg-2 (Erosion Prevention and Control) to minimize and control erosion in cable corridors to the extent practicable.

Veg-6. Landings

Manual or Handbook Reference FSH 2409.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from the construction and use of log landings.

Explanation Log landings, in general, are the site of intense activity, serving as the endpoint of yarding operations, the setup location of large equipment (such as skyline yarders), loading areas for log trucks, and fueling and maintenance locations for heavy equipment. To accommodate all this activity, landings tend to be large, and their soils generally become compacted, rutted, and disturbed much more than the rest of the project area. Thus, landings have a high probability of being a source of concentrated overland flow containing sediment and other pollutants.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Minimize the size and number of landings as practicable to accommodate safe, economical, and efficient operations.
- Locate landings to limit the potential for pollutant delivery to waterbodies.
  - Locate landings outside the AMZ and as far from waterbodies as reasonably practicable based on travel routes and environmental considerations.
  - Avoid locating landings near any type of likely flow or sediment transport conduit during storms, such as ephemeral channels and swales, where practicable.
  - Locate landings to minimize the number of required skid roads.

- Avoid locating landings on steep slopes or highly erodible soils.
- Avoid placing landings where skidding across drainage bottoms is required.

- Design roads and trail approaches to minimize overland flow entering the landing.
- Re-use existing landings where their location is compatible with management objectives and water quality protection.
- Use applicable practices of BMP Veg-2 (Erosion Prevention and Control) to minimize and control erosion as needed during construction and use of log landings.
  - Install and maintain suitable temporary erosion control and stabilization measures when the landing will be reused within the same year.
- Use applicable practices of BMP Fac-6 (Hazardous Materials) and BMP Road-10 (Equipment Refueling and Servicing) when managing fuels, chemicals, or other hazardous materials on the landing.
- Use suitable measures as needed to restore and stabilize landings after use.
  - Remove all logging machinery refuse (e.g., tires, chains, chokers, cable, and miscellaneous discarded parts) and contaminated soil to a proper disposal site.
  - Reshape the surface to promote dispersed drainage.
  - Install suitable drainage features.
  - Mitigate soil compaction to improve infiltration and revegetation conditions.
  - Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season.
  - Use suitable measures to promote rapid revegetation.
  - Use suitable species and establishment techniques to cover or revegetate disturbed areas in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Veg-7. Winter Logging

Manual or Handbook Reference FSH 2409.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from winter logging activities.

Explanation Winter logging on frozen or snow-covered ground is a common BMP in the colder regions of the country to avoid or minimize soil, watershed, riparian, and wetland impacts. Winter logging is not without risks of watershed effects. Unknowingly operating in wetland or riparian areas when the snow cover is inadequate can cause damage to soil and vegetation. Skidding or hauling on roads when the roadbed or the soil is not sufficiently frozen can cause soil compaction and rutting. Inadequate installation and maintenance of erosion controls before snowmelt and spring runoff can cause accelerated erosion and damage to roads.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Consider using snow-roads and winter harvesting in areas with high-water tables, sensitive riparian conditions, or other potentially significant soil erosion and compaction hazards.
  - Use snow roads for single-entry harvests or temporary roads.
- Mark existing culvert locations before plowing, hauling, or yarding operations begin to avoid or minimize damage from plowing or logging machinery.
- Ensure all culverts and ditches are open and functional during and after logging operations.
- Plow any snow cover off roadways to facilitate deep-freezing of the road grade before hauling.
  - Manage hauling to avoid or minimize unacceptable damage to the road surface.
- Use suitable measures to cross streams (see BMP Road-7 [Stream Crossings]).
  - Restore crossings to near preroad conditions to avoid or minimize ice dams when use of the snow-road is no longer needed.
- Conduct winter logging operations when the ground is frozen or snow cover and depth is adequate to avoid or minimize unacceptable rutting or displacement of soil.
- Suspend winter operations if ground and snow conditions change such that unacceptable soil disturbance, compaction, displacement, or erosion becomes likely.
- Compact the snow on skid trail locations when adequate snow depths exist before felling or skidding trees.
- Avoid locating skid trails on steep areas where frozen skid trails may be subject to soil erosion the next spring.
- Mark AMZ boundaries and stream courses before the first snow in a manner that will be clearly visible in heavy snows.
- Avoid leaving slash in streams or AMZs to the extent practicable.
- Install and maintain suitable erosion control on skid trails before spring runoff (see BMP Veg-2 [Erosion Prevention and Control]).
  - Install erosion control measures during the dry season if needed.

Veg-8. Mechanical Site Treatment

Manual or Handbook Reference None known.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling the introduction of sediment, nutrients, chemical, or other pollutants to waterbodies during mechanical site treatment.

Explanation Mechanical treatments are used to remove or reduce the amount of live and dead vegetation on a site to meet management objectives, such as site preparation for reforestation, fuel treatments to reduce fire hazards, wildlife habitat improvement, recreation access, utility corridor maintenance, and other activities that require removing vegetation from specified areas on a periodic and repeated basis. Mechanical treatments include cutting and piling; chipping or mulching; roller chopping or masticating using heavy equipment; and pushing over vegetation. Disturbance from mechanical site treatments can expose and compact soils, resulting in accelerated runoff and erosion.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Evaluate multiple site factors, including soil conditions, slope, topography, and weather, to prescribe the most suitable mechanical treatment and equipment to avoid or minimize unacceptable impacts to soil while achieving treatment objectives.
  - Consider the condition of the material and the site resulting from the treatment in comparison to desired conditions, goals, and objectives for the site when analyzing treatment options (e.g., a mastication treatment will result in a very different condition than a grapple pile and burn treatment).
  - Use land management plan direction, or other local guidance, to establish residual ground cover requirements and soil disturbance limits suitable to the site to minimize erosion.
  - Consider offsite use options for the biomass material to reduce onsite treatment and disposal
- Use applicable practices of BMP Veg-3 (Aquatic Management Zones) when conducting mechanical treatments in the AMZ.
- Use applicable practices of BMP Veg-2 (Erosion Prevention and Control) to minimize and control erosion.
  - Conduct mechanical activities when soil conditions are such that unacceptable soil disturbance, compaction, displacement, and erosion would be avoided or minimized.
  - Consider using low ground-pressure equipment, booms, or similar equipment to minimize soil disturbance.
- Operate mechanical equipment so that furrows and soil indentations are aligned on the contour.
- Scarify the soil only to the extent necessary to meet reforestation objectives.
  - Use site-preparation equipment that produces irregular surfaces.
  - Avoid or minimize damage to surface soil horizons to the extent practicable.
- Conduct machine piling of slash in such a manner to leave topsoil in place and to avoid displacing soil into piles.
- Re-establish vegetation as quickly as possible.
  - Evaluate the need for active and natural revegetation of exposed and disturbed sites.
  - Use suitable species and establishment techniques to revegetate the site in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.

Resources for Mechanical Vegetation Management Activities

BMP Effectiveness

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General U.S. Environmental Protection Agency, Office of Water. 2005. National management measures to control nonpoint source pollution from forestry. EPA 841-B-05-001. Washington, DC. Available at http://www.epa.gov/owow/nps/forestrymgmt/.

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Vermont Agency of Natural Resources. 2005. Riparian buffers and corridors Technical papers. Waterbury, VT: Vermont Agency of Natural Resources. 39 p. Available at http://www.anr.state.vt.us/site/html/buff/anrbuffer2005.htm.

Selected State Forestry BMP Documents See Appendix B.

Water Uses Management Activities

The purpose of this set of Best Management Practices (BMPs) is to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from development and operation of infrastructure to collect, impound, store, transmit, and distribute water for uses on and off National Forest System (NFS) lands. Water use infrastructure includes wells for public or private water supply or groundwater monitoring; water source developments for Forest Service uses; water diversions and conveyances for uses off of NFS lands; and dams and impoundments for water supply storage, flood control, power generation, recreation, and wildlife habitat.

States govern the allocation of water for beneficial use. State laws and programs for water allocation vary widely across the country, from riparian rights systems to administrative permits to court-adjudicated water rights systems. The Forest Service responsibility when authorizing water use infrastructure projects is to avoid or minimize damage to NFS resources in compliance with environmental laws and land management plan direction.

Six National Core BMPs are in the Water Uses Management Activities category. These BMPs are to be used in all water use projects on NFS lands to the extent allowed by State laws and regulations pertaining to water allocation. Each BMP was formulated to reflect administrative directives that guide the Forest Service's development and administration of water uses on NFS lands. BMP WatUses-1 (Water Uses Planning) is a planning BMP for water uses projects. BMP WatUses-2 (Water Wells for Production and Monitoring) provides practices for drilling, operating, and abandoning water production and monitoring wells. BMP WatUses-3 (Administrative Water Developments) provides direction for development of water sources to be used for NFS land management purposes such as stock watering, potable water at campgrounds, or fire protection. BMP WatUses-4 (Water Diversions and Conveyances) provides direction for diversion and conveyance of surface water for third-party uses on or off NFS lands. BMP WatUses-5 (Dams and Impoundments) provides direction for construction and operation of dams and impoundments for flood control, hydroelectric power generation, water supplies, and recreation on NFS lands. BMP WatUses-6 (Dam Removal) provides direction for removal of dams and impoundments to restore streams and rivers.

States will be used in the rest of this resource category to signify both States and those tribes that have received approval from the U.S. Environmental Protection Agency (EPA) for treatment as a State under the Clean Water Act (CWA).

Water Uses BMPs	
WatUses-1	Water Uses Planning
WatUses-2	Water Wells for Production and Monitoring
WatUses-3	Administrative Water Developments
WatUses-4	Water Diversions and Conveyances
WatUses-5	Dams and Impoundments
WatUses-6	Dam Removal

WatUses-1. Water Uses Planning

Manual or Handbook Reference Forest Service Manual (FSM) 2540.

Objective Use the applicable authorization and administrative planning processes to develop measures to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during construction, operation, maintenance, and restoration of water use infrastructure.

Explanation Development and operation of infrastructure for water uses involve ground disturbance for construction of the facility and changes to water levels and flow regimes in source and receiving waterbodies and aquifers during operations. During planning, site conditions are evaluated and water levels and flow needs of the aquatic ecosystem are assessed to determine site-specific measures to avoid, minimize, or mitigate adverse effects to soil, water quality, groundwater, and riparian resources.

Infrastructure for water uses may be developed on NFS lands by the Forest Service for a variety of administrative and resource management purposes. As new sites are created and existing sites are expanded or rehabilitated, potential effects of the proposed development and operation on soil, water quality, groundwater, and riparian resources are considered in the project National Environmental Policy Act (NEPA) analysis and decision. Site-specific BMP prescriptions are included in the project plan, contract, or other authorizing document as appropriate.

Infrastructure developed by others on NFS lands are administered through authorizations issued by the Forest Service to a public or private agency, group, or individual. Authorization documents include terms and conditions to protect the environment and comply with the requirements of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1752) and other laws. Control of nonpoint sources of water pollution using appropriate BMPs is included in these environmental protection requirements.

Facilities on lands withdrawn under authority of the Federal Energy Regulatory Commission (FERC) are exempt from Forest Service administrative control through the NFS permit system. When a FERC permit is issued or renewed, however, the Forest Service may provide FERC with recommended requirements and mitigation measures under which the permittee should operate to protect NFS resources. Such recommendations may include any BMPs necessary to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Use applicable practices of BMP Plan-2 (Project Planning and Analysis) and BMP Plan-3 (Aquatic Management Zone (AMZ) Planning) when planning water use projects.
- Encourage reuse of water, to the extent practicable, to minimize withdrawals from surface water or groundwater sources.
- Determine the water quality, water quantity, flow regimes, and water levels necessary to maintain land management plan desired conditions, goals, and objectives, including applicable water quality standards for waterbodies and aquatic and groundwater-dependent ecosystems that are affected by the proposed project.
    - Specify a range of flows and levels to support desired uses and values.
- Obtain surface water (e.g., instream flow rights) and groundwater under appropriate Federal and State legal and regulatory authorities to avoid, minimize, or mitigate adverse effects to stream

processes, aquatic and riparian habitats and communities, groundwater-dependent ecosystems, and recreation and aesthetic values.

  - Prioritize protection of imperiled native species.

- Evaluate water levels, flows, and water quality of the affected waterbody or aquifer to ensure that the source can provide an adequate supply and quality of water for the intended purpose(s) and avoid or minimize damage to NFS resources.
  - Consider how the collection, diversion, storage, transmission, and use of the water would directly, indirectly, and cumulatively affect streamflow, water level, channel morphology and stability, groundwater, and aquatic and riparian habitats in source and receiving water-bodies at a watershed scale(s) suitable for the project area and impacts.
  - Consider the potential impacts of current and expected environmental conditions such as climate change on precipitation type, magnitude, frequency, and duration and related effects on runoff patterns and water yield.
- Develop a strategic plan for the development of a suitable number of durable long-term water sources for Forest Service administrative and resource management uses to achieve land management plan desired conditions, goals, and objectives.
  - Obtain necessary water rights, allocations, or permits and water quality permits and certifications from applicable Federal, State, and local agencies for Forest Service administrative or resource management water uses.
- Include permit conditions at the point of diversion, withdrawal, or storage to minimize damage to water-dependent resources and values consistent with land management plan desired conditions, goals, and objectives in authorizations for new or existing water use facilities.
  - Consider the water needs for physical stream processes, water quality, aquatic biota and their habitat, riparian habitat and communities, aesthetic and recreational values, and special designations such as Federal and State wild or scenic rivers.

WatUses-2. Water Wells for Production and Monitoring

Manual or Handbook Reference Forest Service Handbook (FSH) 7409.11, chapter 41.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, groundwater, and riparian resources from excessive withdrawals and contamination transmitted from or by water-well and monitoring-well developments.

Explanation Construction and operation of production wells, monitoring wells, and associated facilities have the potential to alter water levels and flow paths; contaminate surface water and groundwater; expose soil to accelerated erosion; and threaten the viability of aquatic and terrestrial species dependent on local surface water and groundwater. Properly designed wells and aboveground well-casing collars minimize the risk of aquifer contamination from the well-casing, animal and human activities, and accidental or intentional placement of materials into wells. Well uses should be within sustainable levels to avoid onsite and offsite effects to groundwater levels, streamflows, and riparian-dependent resources. States regulate water well drilling, and requirements vary.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Locate water production wells on high or well-drained ground at a sufficient distance away from potential contamination sources to avoid or minimize contamination.
- Locate monitoring wells according to a monitoring plan to minimize the number of wells needed to achieve monitoring objectives.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to control stormwater and erosion during construction of drill pads and associated facilities for well operation.
- Construct and complete wells consistent with applicable Federal and State regulations.
    - Use licensed well drilling contractors.
    - Use suitable measures to avoid or minimize well contamination, inter-aquifer exchange of water, floodwaters from contaminating the aquifer, and infiltration of surface water.
- Operate wells in such a manner as to avoid excessive withdrawals, maintain suitable groundwater levels, and minimize effects to groundwater-dependent ecosystems.
- Permanently seal abandoned wells consistent with applicable Federal, State, and local regulations and requirements.
    - Use licensed well drilling contractors.
    - Use suitable measures to avoid or minimize contaminating the aquifer or surface waters and interaquifer exchange and mixing of water.
    - Use suitable measures to preserve hydrogeologic conditions of the ground and aquifers.

WatUses-3. Administrative Water Developments

Manual or Handbook Reference FSM 2540.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when developing and operating water sources for Forest Service administrative and resource management purposes.

Explanation Water source developments are needed to supply water for a variety of Forest Service administrative and resource management purposes, including road construction and maintenance, dust control, fire control, recreation facilities, and livestock and wildlife watering. Water sources may be developed and used permanently or temporarily based on the needs of the management activity. Permanent water source development should be aimed toward the construction of a limited number of durable, long-term water sources. Piped and impounded diversions such as wells, spring developments, hydrants, supply lines, drains, ponds, cisterns, tanks, and dams are examples of permanent structures. Temporary water sources may be needed to support one-time or emergency projects such as watershed restoration and fire suppression.

Water source developments include the access road, turnaround, and drafting area. Soil, water quality, and riparian resources may be impacted by permanent or temporary water source construction and use. Potential impacts include erosion and sediment delivery to waterbodies; streambank and streambed alterations; contamination from equipment leaks or spills; changes in water temperatures; reduction in streamflows; loss of riparian vegetation; direct injury to aquatic species from pumping equipment; and transportation of eggs, larvae, and adults out of the aquatic system. Proper location and design of water sources or upgrading existing water source facilities can avoid, minimize, or mitigate adverse these impacts.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Design, construct, maintain, and monitor permanent waters sources in compliance with Federal, State, and local requirements.

Drafting From Streams or Standing Waterbodies

- Locate water source developments, including access roads, in such a manner as to avoid or minimize disturbance to the riparian area and streambanks and erosion and sedimentation to the extent practicable.
    - ▫ Draft from existing roads and bridges to the extent practicable to avoid creating new access roads.
    - ▫ Use existing hardened facilities, such as boat launches and campground access roads, for emergency or other short-term uses rather than native surface areas prone to erosion.
    - ▫ Locate facilities to minimize potential damage from streamflows.
    - ▫ Locate permanent storage tanks, dry hydrants, and standpipes outside of the AMZ to the extent practicable.
    - ▫ Locate off-channel ponds in areas where they will not be inundated with sediment at high flows.
    - ▫ Locate ponds or storage tanks as close to the major water use as practicable when water must be conveyed for use at a distance from the source.
- Design source developments, including access roads, in such a manner as to avoid or minimize disturbance to the riparian area and streambanks and to avoid or minimize erosion, sediment, and other pollutants to the extent practicable.
    - ▫ Design permanent facilities to maintain long-term stream function and processes.
    - ▫ Limit the size of the facility development footprint (area of bare soil with reduced infiltration capacity) to the minimum necessary for efficient operations to the extent practicable.
    - ▫ Design facility to minimize hydrologic connectivity with the waterbody to the extent practicable by providing a suitable vegetated filter strip, and designing access road slope and length, or using other suitable measures, to direct flow away from the waterbody (see BMP Road-2 [Road Location and Design]).
    - ▫ Modify vehicle access and turnaround areas to reduce the size of the facility within the most sensitive areas of the AMZ.
    - ▫ Install hardened facilities where an adequate streamflow exists throughout the drafting season.
- Construct water source developments, including access roads, in such a manner as to avoid or minimize disturbance to the riparian area and streambanks and erosion, sediment, and other pollutants to the extent practicable.
    - ▫ Use applicable practices of BMP Road-3 (Road Construction and Maintenance) when constructing access roads to control stormwater runoff and erosion.
    - ▫ Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in or near waterbodies.
    - ▫ Use applicable practices of BMP AqEco-3 (Ponds and Wetlands) when constructing off-channel ponds.

- Use suitable measures to minimize streambank alteration and excavation activity within the streambed to the extent practicable while providing an adequate area for water drafting.

- Conduct operations at water source developments in such a manner as to avoid, minimize, or mitigate adverse effects to aquatic species and habitats from water drafting.
  - Obtain and maintain water rights for administrative use and resource needs.
  - Avoid or minimize effects to the waterbody or aquifer by withdrawing only the minimum amount of water sufficient to achieve administrative or resource management needs.
  - Establish limits or guidelines for water withdrawals from a lake, pond, or reservoir source based on evaluation of storage capacity and recharge and potential impacts to habitat from drafting and drawdown.
  - Establish limits or guidelines for absolute pumping rates and pumping rate in relation to streamflow.
  - Limit drafting operations to daylight hours to avoid attracting fish to the drafting pool.
  - Use suitable screening devices to avoid or minimize transport of aquatic organisms out of the source waterbody.
  - Use suitable measures to avoid or minimize contamination from spills or leaks.
  - Use applicable practices of BMP Fac-6 (Hazardous Materials) to manage contamination from spills or leaks.
- Maintain sources and facilities such that diversion, drainage, and erosion control features are functional.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim water use sites when no longer needed.
  - Repair or restore temporary sources to their pre-use condition to the extent practicable before project completion.
  - Apply suitable seasonal protection measures to temporary sources if use extends past a single season.

Spring Developments

- Locate the water trough, tank, or pond at a suitable distance from the spring to avoid or minimize adverse effects to the spring and wetland vegetation from livestock trampling or vehicle access.
- Locate the spring box to allow water to flow by gravity from the spring to the spring box to eliminate disturbance from pumps and auxiliary equipment.
- Design the collection system to avoid, minimize, or mitigate adverse effects to the spring development and downstream waters from excessive water withdrawal, freezing, flooding, sedimentation, contamination, vehicular traffic, and livestock as needed.
  - Collect no more water than is sufficient to meet the intended purpose of the spring development.
  - Ensure that enough water remains in the spring to support the source groundwater-dependent ecosystem and downstream aquatic ecosystems.
  - Avoid or minimize sediment or bacteria from entering the water supply system.
  - Trap and remove sediment that does enter the system.
  - Intercept the spring flow below the ground surface upslope of where the water surfaces.

- Size the spring box sufficient to store expected volume of sediment generated between maintenance intervals and enough water for efficient operation of the system, and to provide access for maintenance and cleaning.
- Avoid or minimize backing up of spring flow by providing overflow relief sized to carry the maximum flow expected from the spring during periods of wet weather.
- Use suitable measures to avoid or minimize erosion at the overflow outlet.
- Maintain fish and wildlife access to water released below the spring development to the extent practicable.

- Construct the spring development in such a manner to avoid or minimize erosion, damage to vegetation, and contamination.
  - Use applicable practices from BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in springs.
  - Divert all surface water away from the spring to the extent practicable to avoid or minimize flooding near the spring development.
  - Use suitable species and establishment techniques for wet conditions to cover or revegetate disturbed areas near springs in compliance with local direction and requirements per FSM 2070 and FSM 2080 for vegetation ecology and prevention and control of invasive species.
- Operate and maintain the spring development and associated water storage in such a manner as to provide water of sufficient quantity and quality for the intended uses and avoid or minimize failure of infrastructure causing concentrated runoff and erosion.
  - Disinfect the spring water as needed to maintain water quality sufficient for intended uses in such a manner as to avoid or minimize adverse effects to the spring source.
  - Use suitable measures to manage uses such as livestock grazing and vehicle traffic around the spring development to avoid or minimize erosion and sedimentation affecting the spring.
  - Avoid heavy vehicle traffic over the uphill water-bearing layer to avoid or minimize compaction that may reduce water flow.
  - Use suitable measures to avoid or minimize overflow of water trough, tank, or pond.
  - Periodically monitor the spring development and promptly take corrective action for sediment buildup in the spring box, clogging of outlet and overflow pipes, diversion of surface water from the collection area and spring box, erosion from overflow pipes, and damage from animals.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim spring development sites when no longer needed.

WatUses-4. Water Diversions and Conveyances

Manual or Handbook Reference FSM 2729 and FSM 7510.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from construction, operation, and maintenance of water diversion and conveyance structures.

Explanation Water may be diverted from waterbodies on NFS lands by third parties and delivered to sites on or off of NFS lands for a variety of purposes, including agriculture, mining, domestic water supply, hydroelectric power generation, or other uses. Water delivery systems consist of a diversion structure and some type of conduit. Conduits can be ditches, open canals, flumes, tunnels, pipelines, or even natural channels. Structures to regulate flow, dispose of excess water, or trap sediment and debris may also be part of the water delivery system.

The construction, operation, and maintenance of water diversions and conveyances can have adverse direct and indirect effects on soil, water quality, and riparian resources. The construction or presence of access routes, head gates, storage tanks, reservoirs, and other facilities can alter water quality, water yield, runoff regimes, natural channel geomorphic processes, and fish and wildlife habitats. Altered flow regimes can result in elevated water temperatures, proliferating algal blooms, and invasive aquatic flora and fauna. Water yield and runoff changes can change sediment dynamics and affect channel shape and substrate composition. Regular maintenance of diversions and conveyances can result in contamination from pesticide applications, vegetation damage, and continued soil disturbance leading to increased erosion; however, lack of regular maintenance can increase the potential for even greater effects from failures of ditches and diversions.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Locate water conveyance structures in stable areas where they are not susceptible to damage from side drainage flooding.
- Design diversion and conveyance structures to efficiently capture and carry design flows in such a manner as to avoid or minimize erosion of streambanks, ditches, and adjacent areas.
    - Design intake and outflow structures to minimize streambank and streambed damage and minimize disruption of desired aquatic organism movement.
    - Design water conveyance structure to have sufficient capacity to carry the design volume of water with appropriate freeboard to avoid or minimize damage or overtopping.
    - Consider velocity of the water, horizontal and vertical alignment of the ditch or canal, amount of stormwater that may be intercepted, and change in water surface elevation at any control structures when determining appropriate freeboard needed.
    - Use suitable measures in the design to control velocity and slope to avoid or minimize erosion of the ditch.
    - Use suitable measures in the design to minimize water loss to evaporation and leakage.
    - Mitigate water imports and water disposal (including reservoir releases) so that the extent of stable banks, channel pattern, profile and dimensions are maintained in each receiving stream reach to meet applicable instream water quality standards.
- Construct diversion and conveyance structures to perform as intended in the most efficient manner and in such a way as to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources.
    - Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when constructing diversion structures in waterbodies.
    - Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to control stormwater and erosion when constructing diversion or conveyance structures.
    - Use suitable measures to stabilize the banks of the diversion channel or conveyance structure to avoid or minimize resulting erosion and instream sedimentation.

- Construct or install structures such as inlets, outlets, turnouts, checks, and crossings in such a manner as to maintain the capacity or freeboard of the ditch and the effectiveness of any lining or other channel stabilization measure.
- Use suitable measures at outlets to avoid or minimize erosion downstream of the structure when design flows are released.
- Use suitable measures on inlet structures to avoid or minimize debris entering the water conveyance structure.

- Operate diversion structures in such a manner as to leave desired or required flows and water levels in the source waterbody as determined in project planning (see BMP WatUses-1 [Water Uses Planning]).
- Operate and maintain diversion and conveyance structures in such a manner as to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from failures.
  - Limit operation of the diversion and conveyances to the established period of use.
  - Regularly inspect diversion and conveyance structures at suitable intervals to identify maintenance needs and situations that could lead to future overtopping or failures.
  - Do not flush or otherwise move sediment from behind diversion structures downstream.
  - Deposit and stabilize sediment removed from behind a diversion structure in a suitable designated upland site.
  - Maintain suitable vegetative cover near canal and ditch banks to stabilize bare soils and minimize erosion.
  - Harden or reroute breach-prone segments of ditches to minimize potential for failure and erosion of fill slopes.
  - Maintain and operate water conveyance structures to carry their design volumes of water with appropriate freeboard.
  - Keep water conveyance structures clear of vegetation, debris and other obstructions to minimize potential for failures.
  - Use applicable Chemical Use Activities BMPs when using chemicals to treat vegetation as a part of water conveyance structure maintenance.
- Use applicable measures of BMP AqEco-4 (Stream Channels and Shorelines) and BMP Fac-10 (Facility Site Reclamation) to restore the stream channel and surrounding areas after the diversion or conveyance structure is no longer needed.

WatUses-5. Dams and Impoundments

Manual or Handbook Reference FSM 7500, FSH 7509.11, FSM 2770, and FSH 2709.15.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from construction, operation, and maintenance of dams and impoundments.

Explanation The physical presence and operation of dams can result in changes in water quality, water quantity, sediment routing, channel morphology, stability, and habitat. Water quality can be impacted by changes in erosion, sedimentation, temperature, dissolved gases, and water chemistry. Resulting biologic and habitat impacts that may result include loss of habitat for existing or desirable fish, amphibian, and invertebrate species; shift from cold water to warm water species (or conversely, shift from warm-water to cold-water species); blockage of fish passage; or loss of spawning or other necessary habitat.

The operation of dams can result in diverse impacts on water quality. The area and depth of the impoundment, as well as the timing and volume of releases, determines the extent and complexity of the upstream and downstream impacts. For example, impacts of low-head dams with small impounded areas will involve sedimentation and fish passage; larger storage dams may have those issues as well as temperature, flow regulation, and water quality considerations. Impacts from dams are different above (upstream) and below (downstream) the dam. Upstream impacts occur primarily in the impoundment or reservoir created by the presence and operation of the dam. Downstream impacts result from changes in sediment load, water quantity, chemistry and the timing and magnitude of water releases.

Federal laws provide the Forest Service the authority to require or recommend BMPs to avoid, minimize, or mitigate adverse effects to soil, water quality, riparian and other resources from new or existing hydroelectric projects and associated infrastructure on or adjacent to NFS lands. The specific regulations and procedures that apply vary depending on project-specific circumstances (see FSM 2770 and FSH 2709.15).

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

- Select a design and location such that the benefits of the dam are maximized and the disturbances to the environment or hazards to downstream inhabitants are minimized.
    - Implement applicable practices of BMP AqEco-3 (Ponds and Wetlands) to locate and design dams and impoundments.
    - Complete a geotechnical review of the dam site using established protocols for stability issues.
- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when working in or near waterbodies to construct dams and impoundments.
- Use applicable practices of BMP Fac-2 (Facility Construction and Stormwater Control) to control stormwater and erosion when constructing dams and impoundments.
- Operate and maintain dams and impoundments in such a manner as to avoid, minimize, or mitigate adverse impacts to soil, water quality, and riparian resources.
    - Work with dam operators, and Federal and State regulatory agencies, to ensure that water chemistry; temperature; dissolved oxygen; nutrient levels; and hydrologic conditions, including the timing, duration and magnitude of flows, meet land management plan desired conditions, goals, and objectives (see BMP WatUses-1 [Water Uses Planning]).
- Decommission dams and impoundments that are no longer needed for mission purposes (see BMP WatUses-6 [Dam Removal]).

WatUses-6. Dam Removal

Manual or Handbook Reference FSM 7500 and FSH 7509.11.

Objective Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during and after removal of dams.

Explanation Many existing dams no longer serve their originally intended purposes or are in varying stages of disrepair and in need of significant repair and maintenance to meet modern dam safety standards. Removal of outdated dams, where the negative impacts outweigh their benefits, is a critical mechanism in achieving restoration of natural river ecology, re-establishing river continuity, and maintaining public safety.

The most important positive outcomes of dam removal are the reconnection of river reaches so that they can operate as an integrated system and the increased accessibility to upstream habitat and spawning areas for migratory and anadromous fish. Dam removal can cause short-term impacts to the river environment from released water and sediment and exposure of previously inundated land to achieve long-term desired conditions. Careful planning can limit the effects of released sediment and toxic pollutants on aquatic life, prevent extensive erosion in the restored stream channel, and limit the potential intrusion of exotic plant species in the former impoundment.

Restoring a river by removing a dam often implies that the physical and biological components will return to the same level that existed before the dam was built. Dam removal can restore some, but not all, of the characteristics of the predam river, however. The removal of a dam has the effect of reversing some undesirable changes subject to the limits imposed by many other human influences in the watershed. Productive, useful ecosystems can result from dam removal, but predictions of outcomes are sometimes difficult because of the many interrelated changes in physical and biological systems caused by placement of the dam and other physical stresses on the river. Dam removal often results in the replacement of one aquatic community with another that is partly natural and partly artificial. Reservoirs create wetland areas in some cases; the removal of a dam and draining of a reservoir may create some wetlands downstream but at the expense of some wetlands upstream. The ultimate goal for a dam removal project is to restore the channel and its biological function to the best long-term sustainable state possible to achieve desired conditions within the context of other community issues and location within the watershed.

Practices Develop site-specific BMP prescriptions for the following practices, as appropriate or when required, using State BMPs, Forest Service regional guidance, land management plan direction, BMP monitoring information, and professional judgment.

Planning

- Use applicable practices of BMP AqEco-1 (Aquatic Ecosystem Improvement and Restoration Planning) when planning dam decommissioning or removal projects.
- Evaluate system hydrology and hydraulics to assess how dam removal would affect aquatic species passage, potential flood impacts at various flows, and potential impacts to surrounding infrastructure.
- Develop a sediment management plan (e.g., natural erosion, dredging, stabilization in place, relocation on or off site, or a combination of methods) that best suits sediment quality, quantity, and physical characteristics, as well as the sensitivity of downstream reaches and the river's ability to transport sediment.

- Quantitatively determine sediment volume and physical parameters, including grain size distribution, density, shear strength, cohesion, stratification, natural armoring potential, organic content, and moisture content.
- Evaluate potential for contaminants trapped behind the dam by considering current and past upstream land uses, such as industrial activity and road density, and by adequately sampling and analyzing sediments to determine the contamination level, if any, and graduation and distribution.
- Estimate sediment transport to address fate of released sediment and potential contaminants.
- Evaluate potential disposal sites for long-term viability and stability of relocated sediments.

- Identify the various aquatic and aquatic-dependent species that live in the river or on the floodplain and their life histories to determine protection strategies, including timing of dam removal, sediment management, species relocation, and monitoring during construction.
- Evaluate floodplain and instream infrastructure to determine whether bridges, culverts, utility pipes, or other infrastructure might be affected, particularly by the drop of water level in the impoundment.
- Develop a channel and vegetation restoration plan (see BMP AqEco-4 [Stream Channels and Shorelines] and BMP Fac-10 [Facility Site Reclamation]).
    - Evaluate the need for active and natural channel and bank reconstruction.
    - Evaluate the need for active and natural revegetation of exposed and disturbed sites.
- Determine necessary Federal, State, and local permits needed for dam removal.

Construction

- Use applicable practices of BMP AqEco-2 (Operations in Aquatic Ecosystems) when removing dams.
- Remove or otherwise mitigate the sediment stored behind the impoundment before dismantling the structure.
- Drain the impoundment before removing structures to avoid downstream flooding and channel erosion.
    - Drain the impoundment slowly to minimize release of sediment downstream, allow bed of impoundment and stream to drain and stabilize, and avoid a sudden release of water that could unnecessarily damage downstream infrastructure or habitat.
    - Consider drawing down the impoundment during a time when exposed sediments would have an opportunity to stabilize and revegetate before structural removal of the dam.
- Demolish the structure in an efficient manner that avoids or minimizes adverse environmental effects to the extent practicable.
    - Remove entire vertical extent of the dam structure and as much of the lateral extent as practicable so as to not impinge on streamflow.
    - Consider phasing a project to minimize short-term impacts on the environment, beginning with out-of-channel work early in the phasing to accelerate and facilitate the removal process.
- Stabilize or relocate affected floodplain and instream infrastructure as needed to avoid, minimize, or mitigate adverse effects.

Restoration

- Use applicable practices of BMP AqEco-4 (Stream Channels and Shorelines) to restore streams when dams are removed.
- Use applicable practices of BMP Fac-10 (Facility Site Reclamation) to reclaim dam and associated infrastructure sites, such as temporary access roads, landings, and work areas, when dams are decommissioned.
- Simulate natural portions of surrounding stream or other nearby habitat to restore habitat more effectively.

Resources for Water Uses Management Activities

Dams U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). National conservation practice standards—348 dam diversion, 402 dam. Available at http://www.nrcs.usda.gov/technical/standards/nhcp.html.

Dam Removal Hoffert-Hay, D. 2008. Small dam removal in Oregon—A guide for project managers. Salem, OR: Oregon Watershed Enhancement Board. 70 p. Available at http://www.oregon.gov/OWEB/docs/pubs/SmallDamRemovalGuide.pdf?ga=t.

Massachusetts Executive Office of Energy and Environmental Affairs. 2007. Dam removal in Massachusetts, a basic guide for project proponents Boston, MA. 32 p. Available at http://www.ma.gov/envir/water/publications/eea_dam_removal_guidance.pdf.

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Hydrologic Modification U.S. Environmental Protection Agency, Office of Water. 2007. National management measures to control nonpoint source pollution from hydromodification. EPA-841-B-07-002. Washington, DC. 287 p. Available at http://www.epa.gov/owow/nps/hydromod/index.htm.

Ponds USDA NRCS. National conservation practice standards—378 pond. Available at http://www.nrcs.usda.gov/technical/standards/nhcp.html.

Spring Developments Jennings, G.D. 1996. Protecting water supply springs. Pub. No. AG 473-15. Raleigh, NC: North Carolina State University, Cooperative Extension Service. Available at http://www.ces.ncsu.edu/Publications/environment.php.

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Water Sources Napper, C. 2006. Water-source toolkit. 0625 1806. San Dimas, CA: USDA Forest Service, Technology and Development Program. 74 p. Available at http://www.fs.fed.us/eng/pubs/pdf/WaterToolkit/lo_res.shtml.

Wells USDA NRCS. National conservation practice standards—353 monitoring well, 642 water well, 351 well decommissioning. Available at http://www.nrcs.usda.gov/technical/standards/nhcp.html.

Glossary

adverse effects to soil, water quality, and riparian resources: Direct, indirect, and cumulative impacts to soil quality, surface water, and groundwater resources and riparian structure, function, and processes that prevent achievement of land management plan desired conditions, goals, and objectives for water resources; attainment of applicable Federal, State, or local water quality standards; or other water quality related requirements.

aquatic ecosystem: The stream channel, lake, or estuary bed, water, and biotic communities and the habitat features that occur therein (Forest Service Manual [FSM] 2526.05).

Aquatic Management Zone (AMZ): An administratively designated zone adjacent to stream channels and other waterbodies. The AMZ is delineated for applying special management controls aimed at maintaining and improving water quality or other water- and riparian-dependent values, including groundwater-dependent ecosystems. The width of the AMZ is determined based on site-specific factors and local requirements. AMZ delineation may encompass the floodplain and riparian areas when present. AMZ designation can have synergistic benefits to other resources, such as maintaining and improving aquatic and riparian area-dependent resources, visual and aesthetic quality, wildlife habitat, and recreation opportunities. A variety of names for the AMZ concept are used in the States and Forest Service regions: Water Influence Zone (WIZ), Rocky Mountain Region 2 (R2); Stream Environment Zones, Pacific Southwest Region (R5); Riparian Conservation Areas, R5; Riparian Reserves, R5 and Pacific Northwest Region (R6); Riparian Habitat Conservation Areas, R5 and R6; Streamside Management Unit (SMU), R6; Riparian Corridor, Southern Region (R8); Riparian Management Corridor (RMC), Eastern Region (R9); and Riparian Management Area, Alaska Region (R10). For purposes of the National Core BMPs, these areas will be referred to as AMZs.

bankfull or bankfull discharge: The bankfull stage corresponds to the discharge at which channel maintenance is the most effective; that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work results in the average morphologic characteristics of channels. Bankfull discharge is associated with a momentary maximum flow that, on the average, has a recurrence interval of 1.5 years as determined using a flood frequency analysis. (Dunne and Leopold 1978). In stable rivers, bankfull is reached when the water cannot be contained within its banks and flooding begins. In entrenched streams, bankfull width is restricted, and more difficult to determine, but the top of depositional features is typically bankfull. On aggrading streams, the bankfull discharge is no longer contained within the banks during a bankfull event, often causing excessive flooding. A stream's bankfull discharge may increase or decrease with hydrologic modifications, changes in impervious land surfaces, or vegetative cover types that alter the rates of water movement through the watershed (Rosgen 1996).

beneficial use (designated use): Use specified in water quality standards for each waterbody or segment whether or not it is being attained. Types of uses include public water supplies; protection and propagation of fish, shellfish, and wildlife; recreation; agriculture; industry; navigation; marinas; groundwater recharge; aquifer protection; and hydroelectric power (EPA 2007).

Best Management Practices (BMPs) for water quality: Methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (36 CFR 219.19).

buffer zone: (See Aquatic Management Zone.) (1) A protective, neutral area between distinct environments. (2) An area that acts to minimize the impact of pollutants on the environment or public welfare.

Burned Area Emergency Response (BAER) Program: A program initiated after a wildfire to determine the need for and to prescribe and implement emergency treatments to minimize threats to life or property or to stabilize and avoid or minimize unacceptable degradation to natural and cultural resources resulting from the effects of the wildfire. Such treatments are identified in an approved BAER report and funded under the BAER funding authority (FSM 2523).

chain of custody: A legal term that refers to the ability to guarantee the identity and integrity of the sample (or data) from collection through reporting of the test results. It is a process used to maintain and document the chronological history of the sample (or data). Chain of custody documents should include the name or initials of the person collecting the sample (or data), each person or entity subsequently having custody of it, dates the items were collected or transferred, the collection location, a brief description of the item, and a sample identification number.

Clean Water Act (CWA) 401 Certification: Certification by a State that a permit or license issued by the Federal Government meets applicable State water quality and pollution control requirements. Under section 401(a) (1) of the CWA, Federal agencies may not issue permits for activities that "may result in any discharge into navigable waters" until the State or tribe where the discharge would originate has granted or waived section 401 certification.

CWA 402 Permit: (See National Pollutant Discharge Elimination System.) Permit issued by a State or the U.S. Environmental Protection Agency that authorizes point source discharges to waters of the United States, including certain stormwater discharges from development, industrial, or construction activities (33 U.S.C. § 1342) (see Stormwater Permit). These permits often regulate the amount, timing, and composition of discharges.

CWA 404 Permit: Permit issued by the U.S. Army Corps of Engineers to regulate the discharge of dredge and fill materials to waters of the United States, including wetlands (33 U.S.C. § 1344).

cumulative watershed effects (CWE): Cumulative watershed effects (CWE) are a change in watershed condition or water quality caused by the accumulation and interaction of multiple individual impacts of land and resource management activities within a watershed over time and space. CWE may occur at locations far distances away from the sites of actual disturbance and later in time after the disturbance has occurred.

effectiveness monitoring: Monitoring to evaluate whether the specified BMPs had the desired effect (MacDonald et al. 1991).

ephemeral stream: A stream that flows only in direct response to precipitation in the immediate locality (watershed or catchment basin), and whose channel is at all times above the zone of saturation (Briggs 1996).

fen: Ancient wetland ecosystem dependent on nutrient-rich local or regional groundwater flow systems maintaining perennial soil saturation and supporting continuous organic soil (i.e., peat) accumulation (Bedford and Godwin 2003, Chimner et al. 2010, Clymo 1983, Cooper and Andrus 1994, Gorham 1953). Groundwater controls fen type, distribution, plant community composition, pH, water chemistry, and microtopography.

floodplain: The lowland and relatively flat areas adjoining inland streams and standing bodies of water and coastal waters, including debris cones and flood-prone areas of offshore islands, including at a minimum, that area subject to a 1-percent chance of flooding in any given year (FSM 2527.05).

ground cover: Material on the soil surface that impedes raindrop impact and overland flow of water. Ground cover consists of all living and dead herbaceous and woody materials in contact with the ground and all rocks greater than 0.75 inches in diameter.

groundwater-dependent ecosystem: Community of plants, animals, and other organisms whose extent and life processes depend on groundwater. Examples include many wetlands, groundwater-fed lakes and streams, cave and karst systems, aquifer systems, springs, and seeps (USDA Forest Service 2007).

implementation monitoring: Monitoring to evaluate whether BMPs were carried out as planned and specified in the environmental assessment, environmental impact statement, other planning document, permit, or contract (MacDonald et al. 1991).

inner gorge: A geomorphic feature that consists of the area of channel side slope situated immediately adjacent to the stream channel and below the first break in slope above the stream channel. Debris sliding and avalanching are the dominant mass wasting processes associated with the inner gorge (USDA Forest Service 2000).

intermittent stream: A stream or reach of stream channel that flows, in its natural condition, only during certain times of the year or in several years. Characterized by interspersed, permanent surface water areas containing aquatic flora and fauna adapted to the relatively harsh environmental conditions found in these types of environments (Briggs 1996).

lake: An inland body of standing water, perennial or intermittent, that occupies a depression in the Earth's surface and is too deep to permit vegetation to take root completely across the expanse of water.

land management plan: An individual planning document adopted under the National Forest Management Act and 36 CFR 219 that provides direction for management of a Forest Service administrative unit.

low impact development: A comprehensive stormwater management and site design technique to create a hydrologically functional site that mimics predevelopment conditions by using design techniques that infiltrate, filter, evaporate, and store runoff close to its source.

meadow: Low-level grassland near a stream, lake, or other waterbody.

municipal supply watershed: A watershed that serves a public water system as defined in the Safe Drinking Water Act of 1974, as amended (42 U.S.C. §§ 300f, et seq.), or as defined in State safe drinking water statutes or regulations (FSM 2542.05).

National Core Best Management Practices (BMPs): The nationally standardized set of general, nonprescriptive BMPs for the broad range of activities that occur on National Forest System lands as specified in the National Core BMP Technical Guide (FS-990a). The National Core BMPs require development of site-specific BMP prescriptions based on site conditions and local and regional requirements to achieve compliance with established State, tribal, and national water quality goals. (FSM 2532.05).

National Core BMPs Monitoring Protocols: The nationally standardized set of procedures for monitoring the implementation and effectiveness of the National Core BMPs as specified in the National Core BMP Monitoring Technical Guide (FS-990b) (FSM 2532.05).

National Pollutant Discharge Elimination System (NPDES): (See CWA 402 Permit.) The system for regulating the point source discharge of pollutants to waters of the United States through the issuance of permits by State water quality regulatory authorities or EPA. Section 402 of the CWA established this system.

navigable waters: Waters of the United States, including the territorial seas (CWA section 502[7]).

nonpoint source pollution: Any source of water pollution that does not meet the legal definition of "point source" in Section 502(14) of the Clean Water Act. Nonpoint sources of water pollution generally originate at indefinable or diffuse sources, and do not discharge at specific locations (FSM 2532.05).

perennial stream: A stream or reach of a channel that flows continuously or nearly so throughout the year and whose upper surface is generally lower than the top of the zone of saturation in areas adjacent to the stream (Briggs 1996).

pesticide: A general term applied to a variety of chemical pest controls, including insecticides for insects, herbicides for plants, fungicides for fungi, and rodenticides for rodents.

point source: Any discernible, confined, and discrete conveyance, such as pipes, ditches, or channels, from which pollutants are or may be discharged (CWA section 502(14); 40 CFR 122.2).

pollutant: Dredged spoil; solid waste; incinerator residue; filter backwash; sewage; garbage; sewage sludge; munitions; chemical wastes; biological materials; radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended [42 U.S.C. 2001 *et seq.*]); heat, wrecked, or discarded equipment; rock, sand, and cellar dirt; and industrial, municipal, and agricultural waste discharged into water (CWA section 502[6], 40 CFR 122.2).

pollution: The manmade or man-induced alteration of the chemical, physical, biological, or radiological integrity of water (CWA section 502[19]; 40 CFR 130.2 [c]).

pond: An inland body of standing water, perennial or intermittent, that occupies a depression in the Earth's surface and is shallow enough to permit vegetation to take root completely across the expanse of water. A pond may be natural or manmade.

practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes (40 CFR 230.3). Resource objectives should also be considered when determining practicable alternatives to meet a project's overall purposes.

practice: The recommended means for achieving the Best Management Practice (BMP) objective. Not all recommended practices will be applicable in all settings; other practices may not be listed in the BMP that would work as well, or better, to meet the BMP objective in a given situation. State or local rules or regulations may require some recommended practices in some locations. The practices are written in general, nonprescriptive terms. State BMPs, regional Forest Service guidance, land management plan standards and guidelines, monitoring results, and professional judgment are used to develop site-specific BMP prescriptions to apply the recommended practices on the ground.

reclamation: Returning disturbed land to as near to its predisturbed condition as is reasonably practical.

reference condition: The set of selected measurements and conditions used as representative of the natural potential condition of a stream or waterbody. The selected measurements and conditions describe a minimally impaired watershed or reach characteristic of a stream type in an ecoregion. Minimally impaired sites are those with the least anthropogenic influences and represent the best range of conditions that can be achieved by similar streams within an ecoregion. Reference conditions can be established using a combination of methods: a single site or multiple reference sites; historical data; simulation models; and expert opinion or professional judgment (EPA 1996).

rehabilitation: A putting back into good condition, re-establishing on a firm, sound basis.

restoration: A putting or bringing back into a former, normal, or unimpaired state or condition.

riparian area: A transition area between the aquatic ecosystem and the adjacent terrestrial ecosystem that is identified by soil characteristics or distinctive vegetation communities that require free or unbound water.

site-specific BMP prescriptions: Site-specific techniques implemented on the ground to control nonpoint source pollution. Site-specific BMP prescriptions are determined during the project planning process and described in decision documents to apply the National Core BMPs to the ground based on local site conditions. State BMPs, regional Forest Service guidance, land management plan standards and guidelines, monitoring results, and professional judgment are used to develop site-specific BMP prescriptions.

stormwater permit: A form of CWA 402 permit regulating stormwater discharges from industrial activities, including construction activities disturbing areas of 1 acre or larger (40 CFR 122.26).

stream simulation: A method of designing crossing structures (usually culverts) with the aim of creating within the structure a channel as similar as possible to the natural channel in both structure and function (USDA Forest Service 2008b).

swale: A landform feature lower in elevation than adjacent hillslopes, usually present in headwater areas of limited areal extent, generally without display of a defined watercourse or channel, which may or may not flow water in response to snowmelt or rainfall. Swales exhibit little evidence of surface runoff and may be underlain by porous soils and bedrock that readily accept infiltrating water. These areas are where soil moisture concentrates but often do not exhibit pedalogic or botanical evidence of saturated conditions (Dunne and Leopold 1978).

underground injection system: Any manmade design, structure, or activity that places fluids, mainly stormwater, but also septic effluent, treated drinking water, and other fluids, below the ground.

unstable soils: Those soils that have properties that make them susceptible to dislodgement and downslope transport of soil and rock material under direct gravitational stress. The process includes slow displacement such as creep and rapid movements, such as landslides.

waterbody: Features such as rivers, streams, reservoirs, lakes, ponds, wet meadows, fens, bogs, marshes, and wetlands. A waterbody may be perennial, intermittent, or ephemeral.

water quality: The chemical, physical, and biological integrity of surface water and groundwater.

water right: A property right granted by a State for the use of a portion of the public's surface water resource obtained under applicable legal procedures.

Waters of the United States: (1) All waters that are currently used, were used in the past, or may be susceptible to be used in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide; (2) all interstate waters, including interstate wetlands; (3) all other waters, such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds that the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce, including any such waters (a) that are or could be used by interstate or foreign travelers for recreational or other purposes, (b) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce, or (c) that are used or could be used for industrial purposes by industries in interstate commerce; and (4) all impoundments of waters otherwise defined as waters of the United States under this definition, including (a) tributaries of waters identified in paragraphs 1 through 4 of this definition, (b) the territorial sea, and (c) wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (1) through (7) of this definition (40 CFR 122.2).

wetlands: Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and that, under normal circumstances, do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 122.2).

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Appendix A. Forest Service Regional Best Management Practices Guidance Documents

Forest Service Region	Best Management Practices Document	Available at:
Northern Region (Region 1)	FSH 2509.22, Soil and Water Conservation Practices (1988)	http://www.fs.fed.us/publications/
Rocky Mountain Region (Region 2)	FSH 2509.25, Watershed Conservation Practices Handbook (2006)	http://www.fs.fed.us/publications/
Southwest Region (Region 3)	FSH 2509.22, Soil and Water Conservation Practices	http://www.fs.fed.us/publications/
Intermountain Region (Region 4)	FSH 2509.22, Soil and Water Conservation Practices (1988)	http://www.fs.fed.us/publications/
Pacific Southwest Region (Region 5)	Water Quality Management for National Forest System Lands in California (2000)	http://www.fs.fed.us/r5/publications/water_resources/waterquality/index.html
Pacific Northwest Region (Region 6)	General Water Quality Best Management Practices (1988)	—
Southern Region (Region 8)	Soil and Water Conservation Practices Guide (2002)	http://fsweb.r8.fs.fed.us/nr/bio_phy_res/water/Literature.shtml
Eastern Region (Region 9)	—	—
Alaska Region (Region 10)	FSH 2509.22 Soil and Water Conservation Practices (2006)	http://www.fs.fed.us/publications/

Appendix B. Selected State Forestry Best Management Practices Documents[a]

State	Best Management Practices Document	Available at:
Alabama	Alabama's Best Management Practices for Forestry	http://www.forestry.state.al.us/publications/BMPs/2007_BMP_Manual.pdf
Alaska	Implementing Best Management Practices for Timber Harvest Operations from the Alaska Forest Resources and Practices Regulations	http://forestry.alaska.gov/forestpractices.htm#acts
Arkansas	Best Management Practices for Water Quality Protection	http://forestry.arkansas.gov/Services/ManageYourForests/Documents/bmpbookrevise.pdf
Colorado	Forestry Best Management Practices to Protect Water Quality in Colorado	http://www.csfs.colostate.edu/pdfs/ForestryBMP-CO-2010.pdf
Florida	Silviculture Best Management Practices	http://www.fl-dof.com/forest_management/index.html
Georgia	Georgia's Best Management Practices for Forestry	http://www.gfc.state.ga.us/ForestManagement/bmp.cfm
Idaho	Compendium of Best Management Practices to Control Polluted Runoff: A Source Book	http://www.deq.State.id.us/water/data_reports/surface_water/nps/reports.cfm#bmps
Illinois	Forestry Best Management Practices	http://coas.siu.edu/docs/BMPbooklet2.pdf
Indiana	Indiana Forestry BMPs—protecting the woods while harvesting	http://www.in.gov/dnr/forestry/files/BMP.pdf Additional BMPs at http://www.in.gov/dnr/forestry
Kentucky	Kentucky Forest Practice Guidelines for Water Quality Protection	http://www.ca.uky.edu/forestryextension/publications_BMPs.pdf
Louisiana	Recommended Forestry Best Management Practices for Louisiana	http://www.ldaf.state.la.us/portal/offices/Forestry/ForestManagement/BestManagementPractices/tabid/232/Default.asp
Maine	Best Management Practices for Forestry: Protecting Maine's Water Quality	http://www.maine.gov/doc/mfs/pubs/bmp_manual.htm
Michigan	Sustainable Soil and Water Quality Practices on Forest Land	http://michigan.gov/documents/dnr/IC4011_SustainableSoilandWaterQualityPracticesonForestLand_268417_7.pdf
Minnesota	Sustaining Minnesota Forest Resources: Voluntary Site-level Forest Management Guidelines for Landowners, Loggers and Resource Managers	http://www.frc.state.mn.us/resources_documents_management.html
Mississippi	Mississippi's BMPs—Best Management Practices for Forestry in Mississippi	http://www.mfc.ms.gov/water-quality.php
Missouri	Missouri Watershed Protection Practice—2006 Management Guidelines for Managing Forested Watersheds to Protect Streams	http://mdc.gov/landwater-care/stream-and-watershed-management
Montana	Water Quality BMPs for Montana Forests	http://www.dnrc.mt.gov/forestry/Assistance/Practices/Documents/2001WaterQualityBMPGuide.pdf
Nevada	Best Management Practices Handbook	http://www.cicacenter.org/pdf/NVBMPHandbook.pdf
New Hampshire	Best Management Practices for Forestry: Protecting New Hampshire's Water Quality	http://extension.unh.edu/resources/248/Best_Management_Practices_for_Forestry_Protecting_NH's_Water_Quality
New Mexico	New Mexico Forest Practices Guidelines	http://www.emnrd.state.nm.us/FD/Publications/documents/NM_ForestPracticesGuidelines2008.pdf
New York	New York State Forestry Best Management Practices for Water Quality, BMP Field Guide, 2011 Edition.	http://www.nysbmpguidelines.com

State	Best Management Practices Document	Available at:
North Carolina	North Carolina Forestry Best Management Practices Manual to Protect Water Quality	http://www.ncforestservice.gov/water_quality/bmp_manual.htm
North Dakota	North Dakota Forestry Best Management Practices	http://www.ndsu.edu/fileadmin/ndfs/docs/r_forestry/BMP_2010_FINAL_DOC_11_12_10.pdf
Ohio	BMPs for Erosion Control for Logging Practices in Ohio	http://ohioline.osu.edu/b916/index.html
Oregon	Forest Practices Act Rulebook	http://oregon.gov/ODF/privateforests/fpaguidance.shtml
Pennsylvania	Best Management Practices for Pennsylvania's Forests—promoting forest stewardship through education, cooperation, and voluntary action	http://www.dcnr.state.pa.us/ucmprd1/groups/public/documents/document/dcnr_005564.pdf
South Carolina	South Carolina's BMPs for Forestry	http://www.state.sc.us/forest/bmpmanual.pdf
South Dakota	Forestry Best Management Practices for South Dakota	http://sdda.sd.gov/Forestry/publications.PDF/Forestry-BMP.pdf
Tennessee	Guide to Forestry Best Management Practices in Tennessee	http://www.tn.gov/agriculture/publications/forestry/BMPs.pdf
Texas	Texas Forestry Best Management Practices	http://texasforestservice.tamu.edu/main/article.aspx?id=75&terms=bmps
Utah	Utah's Forest Water Quality Guidelines—A Technical Manual for Landowners, Loggers and Resource Managers	http://forestry.usu.edu/htm/rural-forests/forest-management/best-management-practices-bmps-and-water-quality
Vermont	Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont	http://www.vtfpr.org/watershed/ampprog.cfm
Virginia	Virginia's Forestry Best Management Practices for Water Quality Technical Manual	http://www.dof.virginia.gov/wq/index-BMP-Guide
Washington	Title 222 WAC – Forest Practices Rules	http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticeRules/Pages/fs_rules.aspx
West Virginia	West Virginia Silvicultural Best Management Practices for Controlling Soil Erosion and Sedimentation from Logging Operations.	http://www.wv.forestry.com/BMP%20Book%Complete.pdf
Wisconsin	Wisconsin's forestry best management practices for water quality: Field manual for loggers, landowners and land managers	http://dnr.wi.gov/forestry/Usesof/bmp/bmpfieldmanual.htm
Wyoming	Wyoming Forestry Best Management Practices—Forestry BMPs, Water Quality Protection Guidelines	http://slf-web.state.wy.us/oldsite/forestry/bmp2.aspx

** Forestry BMP documents for States that contain NFS lands.*


The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 93

February 21, 2023

USDA United States Department of Agriculture | Forest Service | George Washington and Jefferson National Forests | 5162 Valleypointe Parkway
Roanoke, VA 24019
540-265-5100

File Code: 1900; 2700
Date: August 16, 2016

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First St., N.E., Room 1A
Washington, DC 20426

Dear Ms. Bose:

Subject: Forest Service Comments on the Hydrologic Analysis of Sedimentation
OEP/DG2E/GAS3
Mountain Valley Pipeline Project
Docket No. CP16-10-000

The Forest Service submits comments on the *Hydrologic Analysis of Sedimentation* document filed by Mountain Valley Pipeline, LLC (MVP) with the Federal Energy Regulatory Commission on June 16, 2016 (privileged filing) and on July 25, 2016 (public filing). The proposed Mountain Valley Pipeline Project would affect 3.4 miles of National Forest System lands on the Jefferson National Forest.

During a conference call held on July 5, 2016, the Forest Service discussed its comments on the *Hydrologic Analysis of Sedimentation*, provided in Attachment 1 to this letter. Though MVP addressed questions and comments from Forest Service staff during the conference call, we request that MVP revise the document with clarifications and edits to reflect the July 5 discussion. We also request that MVP revise the *Hydrologic Analysis of Sedimentation* to answer the questions listed in Attachment 2 about the model assumptions and data results.

The Forest Service appreciates the opportunity to review the *Hydrologic Analysis of Sedimentation* document and looks forward to receiving the revised document. We also appreciate MVP filing the document as public information for review by stakeholders.

For questions, please contact Jennifer Adams, Special Project Coordinator, by phone at (540) 265-5114 or by email at jenniferpadams@fs.fed.us.

Sincerely,

JOBY P. TIMM
Forest Supervisor

cc: Mountain Valley Pipeline, LLC

ATTACHMENT 1

Forest Service Comments on the *Hydrologic Analysis of Sedimentation*

- **Section 2.0** – typo of the word "subwatershed" on page 4.
- **Section 2.2** – Applicant states "soil losses after the land has been revegetated are expected to be similar to those of a shrub/scrub landscape." Justify this assumption.

Reply - Eventually, the area will likely succeed into a shrub scrub landscape as the author describes, but unless the applicant is planting shrubs, it will likely be a grass/forb landscape for a substantial period of time. A proper analysis would include a sediment yield increase for the grass/forb transitional period and then the specific elevated soil loss from a shrub/scrub cover class.

- **Section 2.35** – Applicant makes the statement "According to a review conducted by the U.S. Environmental Protection Agency (USEPA 1993), soil containment may average as high as 85 percent under proper application of soil and erosion control best management practices (BMPs); however, this estimate was in reference to coastal areas, and given the complexity of the terrain within the JNF, containment from BMPs will likely be less than 85 percent but still substantial.

No references to pipeline construction or any disturbance-specific BMPs for pipelines could be located in the document and the author and the applicant stated that the EPA publication was for "coastal areas." Please provide a justification for the relevance of this document to the proposal. It is unlikely that the EPA document is relevant in an analysis of large corridor disturbance perpendicular to the slope in steep, mountainous conditions. Requests for the specific statement that references the 85% number in the EPA publication that the author cites have yet to be answered, so a simple search of the document was conducted looking for the number 85. Five references were found that specifically indicated an 85% reduction in sedimentation as the applicant does: Table 2-1 (p. 2-15), terraced agriculture; Table 3-25 (p 3-44), applying dust oil to forest roads; Table 4-15 (p 4-77), construction sites; Case Study 3 (4-96), wetland filtration in Florida; and paragraph 1 (p 5-32), complex constructed sand filters. None of these are proposed by the applicant and are irrelevant to the current analysis. This is especially important because the BE/BA for the project applies this 85% reduction to the projected sediment estimates in the effects section of the BE/BA. An 85% reduction is not reasonable under the best circumstances. For example, the sediment analysis generally performed by Forest Service hydrologists on the George Washington and Jefferson National Forest applies mitigation measures that reduce the sediment produced from the background level as follows: standard practices (i.e. waterbars) 10%; seed 13%; fertilizer 12%; and road surfacing 25%. For these to be applied and considered in the analysis, they must be assured in the NEPA.

- **3.1 Baseline Erosion and Soil Loss** – Applicant states "Calculated using a weighted mean, baseline soil yields within the study area are projected at 82.1 tons per square mile per year."

It is unclear whether this is simply a descriptive characterization of the inherent variability of the project area soils or that the analysis used a weighted mean of the soil yields to estimate sedimentation. A weighted mean is not site-specific and would be inappropriate for a GIS-based analysis that has ready access to site soil survey data. Please clarify.

- **Table 4** (p. 11) has two identical sediment loads (down to the hundredths) for Load Above Baseline for Actions on JNF Lands in column 7. This could be a coincidence, but please examine.

- **3.2 Proposed Action Erosion and Soil Loss**

This sections has multiple fundamental problems.

In the first sentence, the applicant makes the statement that the actions proposed would "temporarily" increase sediment yields. This is an incorrect premise and unfortunately is the foundation of the effects discussion. The applicant states that pipeline construction will generate sediment loads well above background, but treats the disturbance as a single-year occurrence. The reality is that the sediment yields will continue to be elevated, decreasing over subsequent years to a new normal that is dependent on the persistence of the waterbars and other structural BMPs and the cover and type of revegetation of the pipeline corridors. The pipeline corridors will likely be maintained in a shrub/grass/forb state for the life of the pipeline. As Table 2 (p. 7) shows, this kind of land cover would have a different Management Factor that will be more than three times the current condition. **Please discuss outyear sediment production from all proposed disturbance annually until you estimate when (if ever) sediment yields return to pre-disturbance levels. <u>All</u> sediment produced during the life of the project must be estimated in order to inform the biologists and eventual decision maker of the full effects of the project. If you anticipate that a new background sediment level is likely to be the case (probably the most reasonable and logical answer based on the amount of disturbance) then please disclose the new background and estimate the time it will take for the system to reach this new equilibrium. The cumulative effect of several years of elevated sediment from the project must be discussed in the context of cumulative effects in the wider analysis watershed.** Also, the properties of the disturbed soils could also affect the erosion rate. Depending on the amount of pipeline construction disturbance in the watershed, the new sediment yield eventually becomes the new background level of the altered system and could eventually become indistinguishable at the large watershed level; however, the proposal is a permanent land cover conversion that will have long-term effects. These effects could be significant or indistinguishable at the watershed scales discussed but a disturbance of this scale will not return to background sediment levels. These short and long term effects are not disclosed in the report or factored into the effects in the BE/BA.

The continual reference to sediment effects from actions only on the Jefferson National Forest is irrelevant to the effects from the project. To make an informed decision about allowing the construction of the pipeline on the proposed route that crosses the National Forest, the decision maker needs to know the direct, indirect, and cumulative effects from all activities in the analysis watershed because allowing the construction across the Forest or denying the permit is directly connected to the consequential route the pipeline takes.

The report characterizes the model as a worst-case scenario because it does not apply mitigation measures in the analysis. First, the report does not state what conservation measures would be applied and their efficacy, so there is no context to judge the statement. Second, the model does not take extreme rainfall events, slope stability changes induced by the pipeline construction, and other factors that would have to be included in a worst case scenario. This characterization is incorrect.

No cumulative effects boundaries or justifications are present. These are crucial to any meaningful effects analysis in the BE.

Please define “headwaters” for purposes of the discussion.

ATTACHMENT 2

Forest Service Questions about the Model Assumptions and Data Results
For the *Hydrologic Analysis of Sedimentation*

1. Better describe what the proposed action consisted of in the model, as it was unclear what specific land disturbing activities were included. A general description of those would be helpful (ie: 125-ft pipeline ROW, all access roads and staging areas).
2. Since the analysis did not incorporate the recently filed route modifications FS71 and FS78, modifying the route as it crosses Craig Creek and the Appalachian National Scenic Trail near Peters Mountain, respectively, how will these changes be addressed? How do these changes affect the model results, since there are changes in the number of proposed crossings on Craig Creek, but adds an additional crossing of an unnamed perennial spring/tributary below the proposed crossing of the Appalachian National Scenic Trail on Peters Mountain?
3. Since the analysis only did a one-time construction impact assessment, what are the assumptions for the number of years or months to complete the pipeline construction? What is the total load expected to complete construction of the pipeline?
4. Better describe the long-term/cumulative impacts of the pipeline, such as the total load and yields above baseline for the pipeline as it transitions to various vegetative states over the life of the proposed project, including construction, operation, and maintenance.
5. The report references best management practices (BMP) to be up to 85% effective, but for this terrain that is an overestimate. Upon completion of our review of the Erosion and Sediment Control Plan, we will provide more specific feedback.
6. Expand the conclusion section to more accurately predict the actual containment by BMPs and consider heavy storm events effects that are likely to occur during construction and operation of the proposed project.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 94

February 21, 2023

USDA Forest Service
DECISION NOTICE AND
FINDING OF NO SIGNIFICANT IMPACT
for the
Natural Gas Pipeline Construction Project, Proposed by Columbia Gas of Virginia for service to Celanese Plant in Giles County, Virginia.

George Washington and Jefferson National Forests
Eastern Divide Ranger District
Giles County, Virginia

INTRODUCTION

An Environmental Assessment (EA) evaluating a no action alternative and an action alternative for the contruction of a buried 12-inch natural gas pipeline to serve the Celanese Acetate LLC (Celanese) Plant has been completed. The project area is located on Peters Mountain, north of the Celanese Plant near Narrows, Virginia. Please see the attached map in Appendix B. The purpose of this new line is to provide adequate natural gas service to the Celanese Plant, allowing for the conversion from coal-fired boilers to natural gas-fired boilers.

The Peters Mountain area lies primarily in Giles County, Virginia with most of the area north of the ridge line in Monroe County, West Virginia. This entire project is in Giles County, Virginia. National Forest System lands are primarily vegetated with upland hardwoods, with a few yellow pines on the southern aspects of finger ridges.

DECISION

Based on the analysis discussed in the EA, I have selected Alternative 1 (the proposed action) to allow for the construction of the gas line and to authorize the long-term special use permit for the operation and maintenance of the pipeline. This project is summarized below.

The Forest Service received a Special Use application from Columbia Gas of Virginia (CGV) to construct a buried 12-inch, coated steel natural gas distribution line across Peters Mountain to provide additional service to the Celanese Plant near Narrows, VA. This entire line is 18,488 feet with about 4,238 feet of it on National Forest lands over Peters Mountain to Celanese. The project location parallels an existing buried 6-inch natural gas line already permitted to CGV, which will remain an active line. See attached map for location.

The proposed action is to permit construction of the line and issue a long-term special use permit for its operation and maintenance. The current easement area covers the existing 6-inch line. Construction of the new 12-inch line would require a cleared corridor next to this current easement. New clearing will range from 75 feet to 125 feet in width, depending on terrain and placement along the pipeline.

The cleared area will be used for soil stockpiling, pipeline preparation, and temporary access route to the construction area. An approximately 6-foot deep and 6-foot wide trench would be excavated next to the existing 6-inch line. The excavated material will be returned to the trench upon completion of the pipeline. Some permanent grading will be required over the trench to provide necessary cover over the pipe. After the pipe is placed, a 40-foot wide easement area will be maintained long-term for inspection and maintenance. This 40-foot area will encompass the existing easement. The rest of the cleared area will eventually return to a forested condition. Any grading required outside of the easement area will be returned to as close to preconstruction contours as practical.

An approximately 20,000-square foot (or about 0.5 acre) temporary staging area just west of the existing corridor and southwest of the ridgeline of Peters Mountain will also be permitted. The location of this staging area was altered from the site shown on CGV's application to move it from the top of Peters Mountain and away from the Appalachian Trail (AT). This change allows for substantial reduced impacts on hikers and on long-term scenic quality of the area.

The existing pipeline crosses the AT at two points; the top of Peters Mountain and the bottom of Peters Mountain near Virginia State Route 641 (Clendennin Road). The construction near Clendennin Road should take 2 to 3 days. It will be easy to reroute the AT with on-site signing and temporary blazes to move hikers around the construction site. No ground disturbance is needed for this reroute as the woods are gently-sloped and open at this location.

The trail and pipeline cross at nearly right angles on top of Peters Mountain, where the AT goes over the grassy corridor on nearly flat terrain. As described above, the original proposed staging area was at this location. In addition to moving the staging area, the proposal was modified as follows to address safety and resource concerns.

- A barrier fence to restricted access will be placed around the vicinity of the AT (at the ridgeline) prior to any activity and will remain in place for the duration of the project. This fence will enclose an area about 50' uphill from traverse point #1027 on the north side of the ridge to the top of the staging area on the south side of the ridge and about 300' wide. It will be an orange plastic mesh barrier fence, about 4 feet high and will be clearly signed as a "Do not enter" area. Construction activity inside the fence will be limited to the movement of equipment and supplies a few times a day for the majority of the project. The exception to this will be when the pipeline is actually installed inside the fence (limited to an August 1 to September 30 period as described below).

- Gates will be installed in this perimeter fence where it crosses the AT. These gates will be staffed during all periods of construction activity for the length of the project, anticipated to be from April to October 2014. These gates will be closed to hikers only when equipment is inside the area. In the rare occasion when this equipment is inside the perimeter fence for more than a few minutes, hikers will only be permitted to cross the area with escort from contractor personnel.

- Installation of the pipeline inside the perimeter fence will be limited to a construction period of August 1 to September 30. This is the time of the year that has the fewest hikers while still being inside the construction season (April through November). Two interior security fences will be installed, paralleling the trail. During construction in this section, the AT will remain passable. For the short amount of time the area right at the AT needs to be trenched, a bridge will be installed over the trench with a design provided by the contractor and approved by the Forest Service. The gates in the perimeter fence at the AT crossing locations will be staffed during all construction activity and when not staffed, these gates will be left open with the area along the trail safe for public use.

- Clearing and grubbing of the corridor inside the restricted area is anticipated to occur prior to May 15th, 2014. If it is not done before May 15th, it will not be allowed until the August 1 to September 30 construction period.

- Any disposal of cleared timber and brush will occur outside of the restricted area.

- Prior to initiating clearing, CGV and the contractor will work with the Forest Service to minimize clearing within the 125-foot maximum clearing corridor where possible; particularly at the top of the small ridge most visible from US 460. This location was field-reviewed with the contractor and a Forest Service Landscape Architect.

- The staging area will be located just west of the existing corridor and southwest of the ridgeline of Peters Mountain, as flagged in the field on April 22, 2013.

- A specific erosion and sediment control plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service.

- Sediment control structures of hay bales and/or silt fences would be installed along gradient sides of all work areas and the staging area.

- A protective cover, such as mulch, will be applied on disturbed areas where needed to prevent accelerated erosion during construction or before the next growing season.

- Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely.

- Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations.

- A specific revegetation plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service, including the seed mix.

- If any cultural resources are located during project implementation, all work will stop until the resources can be evaluated by the Forest Service Archeologist, in consultation with the State Historic Preservation Office, Department of Historic Resources.

- Information concerning this project will be posted on the following web sites to alert hikers: www.appalachiantrail.org, www.nps.gov/appa, www.fs.usda.gov/gwj. Information will also be posted at the Clendennin Road (Virginia State Route 641) and Stony Creek Road (Virginia State Route 635) crossings and at Pine Swamp and Docs Knob trail shelters.

- Portable toilet facilities will be made available for use by all construction crew personnel for the duration of the project.

- Two existing access routes will be utilized as part of this project. These roads are in place but will require some maintenance. All road maintenance activities will be approved by the Forest Engineer. These roads, which are currently unclassified roads, will be part of the special use permit. Columbia Gas of Virginia will be required to install a gate to Forest Service specifications at the federal boundary on the lower access road.

Construction activities are anticipated to start in April of 2014 and finish by October of 2014, although there may be some clearing and clean-up beyond this timeframe. The actions shown in bullet form above (except the last two) deal specifically with mitigating the impacts to AT hikers. The Forest Service and Celanese recently reached an agreement on an easement for a relocation of the AT. The relocation is independent of this pipeline project and will move the AT to the east of the pipeline (see yellow line on the attached map). Every effort will be made by Columbia Gas of Virginia, Celanese, the Forest Service, and the Appalachian Trail Conservancy (ATC) to move the trail to its new location. Getting this relocation completed prior to the start of pipeline construction would eliminate the need for the measures described in the bullets above as the AT would no longer overlap with the pipeline corridor.

There is potential for the establishment of non-native invasive species due to the stirring of the soil and opening created within the cleared corridor. The application of herbicide to treat non-native invasive plants is authorized in the Decision Notice for the "George Washington and Jefferson National Forests Forest-wide Non-Native Invasive Plant Control" (12/14/2010) and therefore is not be part of the proposed action for this project. However, non-native invasive species and the use of herbicide is addressed in the Monitoring section and in the Environmental Consequences discussion in this EA for several resources.

REASONS FOR THE DECISION

I have chosen Alternative 1 because this alternative meets the purpose of the proposal and can be implemented in a safe and an environmentally sound manner. Alternative 1 adequately provides for hiker safety, and protects visual, cultural, soil, water, and other resources while implementing the project requested by the proponent.

OTHER ALTERNATIVES CONSIDERED

One other alternative was analyzed and considered in detail. **Alternative 2 - This is the No Action alternative.** This alternative was not selected because it does not satisfy the primary purpose and need for the proposed action.

SCOPING AND PUBLIC INVOLVEMENT

A variety of individuals and organizations were contacted to determine the scope of the issues and concerns related to the proposed action. On May 23, 2013, a letter describing the proposal was mailed out to interested citizens, organizations, and government agencies on the District's scoping mailing list. Comments from the May 2013 letter were received from five agencies, organizations or individuals.

FINDING OF NO SIGNIFICANT IMPACT

It is my determination that the actions associated with the construction of the new gas line under Alternative 1 of the Natural Gas Pipeline Construction Project, Proposed by Columbia Gas of Virginia for service to Celanese Plant in Giles County, Virginia Project EA are not major federal actions, individually or cumulatively, and will not significantly affect the quality of the human environment. Therefore, an Environmental Impact Statement is not needed. This finding includes consideration of the following factors concerning the context and intensity of the expected impacts of the alternative.

CONTEXT

The physical and biological effects of this action vary according to the resource area analyzed. These impacts are primarily limited to the immediate areas impacted by clearing and burying a 12-inch gas line across approximately 13 acres of Peters Mountain on the Eastern Divide Ranger District. Both beneficial and adverse impacts of this project have been considered and these activities will not cause a significant effect to the quality of the human environment. (EA, pages 9 through 48).

INTENSITY/SEVERITY

1. Both beneficial and adverse impacts of this project have been considered and these activities will not cause a significant effect on the quality of the human environment, because design criteria and mitigating measures identified in the EA (page 7 and Appendix A) will be implemented to avoid or minimize environmental effects. The physical and biological effects are limited to the immediate project area and access roads. Based on the discussions in the EA, there are no known significant irreversible resource commitments or irretrievable loss of timber production, diversity, wildlife habitat, soil production, water quality, aquatic habitat, old growth habitat, or recreational opportunities (EA, pages 9 through 48).

2. There will be no major effect on public health or safety. Mitigation measures to provide for Appalachian Trail hiker safety have been identified (Appendix A). The pipeline crossing of Clendennin Road (VA 641) is outside this project area and under the jurisdiction of the Virginia State Corporation Commission.

3. The unique characteristics of the geographic area (historic or cultural resources, wetlands, floodplains, and ecologically critical areas, etc.) will not be significantly affected. No perennial or intermittent riparian protection zones will be impacted on National Forest lands. The construction areas have been surveyed for cultural resources and all ground-disturbing activities located away from found sites (EA, pages 37 and 38).

4. The effects on the quality of the human environment are not likely to be highly controversial. Disclosure of environmental impacts is based upon widely accepted principles resulting from sound scientific research (EA, pages 9 through 48).

5. The project does not involve highly uncertain, unique, or unknown environmental risks. The construction methods and herbicides to be used have a known history; subsequent results are predictable (EA, pages 9 through 48).

6. The proposed actions will not establish a precedent influencing approval of future actions with significant effects nor does it represent a decision in principle about a future consideration. The scope of this decision is limited to the immediate construction of a 12-inch natural gas line impacting approximately 13 acres of National Forest System lands (EA, pages 1 through 4).

7. In relation to other actions with individually insignificant impacts, it will not be cumulatively significant (EA, pages 9 through 48 Cumulative Effects Analysis for each resource). Soil productivity will not be significantly affected when combined with other ongoing, past or future projects within the watershed. (EA, 22 through 29).

8. There are no effects to any cultural resources listed, eligible for listing, or potentially eligible for inclusion in the National Register of Historic Places. All areas of disturbance have been screened for the presence of historical sites (EA, page 37 and 38).

9. The proposed actions will not adversely affect an endangered or threatened species or its habitat. A Biological Evaluation has been completed for this action (EA, pages 19 through 22 and the Biological Evaluation).

   Regarding the Indiana bat, an endangered species, there is no critical habitat on the George Washington and Jefferson National Forests (GWJNF). Cumulatively, there is a forested environment where more than 60% of all forest types are maintained in an age class of 70 years old or older pursuant to the Forest's strategy and Biological Opinion (BO). Additionally, there is a forested environment where more than 40% of the white oak-northern red oak-hickory and yellow poplar-white oak-northern red oak forest (forest types 53/56) are maintained in an age class of 80 years old or older pursuant to the Forest's strategy and BO. In conjunction with these two age-class provisions of the Forest's strategy, cumulatively, potential roost trees, potential maternity sites and foraging habitat will be provided across the GWJNF to offset the trees removed by this project.

   Furthermore, the existing standards from the two Forest Plans provide for a significant number of secure summer and fall foraging areas, and a steady supply of potential roost trees and maternity sites across the two National Forests. The Forest Plans identify approximately 1,175,400 acres (66% of the Forest land base) as unsuitable for timber harvest. These lands will provide a continuous supply of potential roost trees, potential maternity sites, and foraging habitat for Indiana bats. These are also well distributed across the Forests and occur intermixed with stands in the suitable land base. The Plans provide that these areas will remain undisturbed by most human processes that could result in direct removal of trees.

   Concluding, the agency feels there is adequate overall habitat even with this action for the maintenance and promotion of Indiana bats across the GWJNF. In conjunction with the entire Forest's strategy, the Terms and Conditions of the BO, cumulatively, the potential but very unlikely loss of individual adult and young bats because of this action will not jeopardize the continued existence of overall Indiana bat populations across the GWJNF. Thus, this action will not have a significant cumulative effect on the Indiana bat when viewed in conjunction with past, present, and future activities.

10. The proposed action does not threaten a violation of any Federal, State, or local laws or requirements imposed for the protection of the environment. (EA, pages 1 through 54)

<u>FINDINGS REQUIRED BY OTHER LAWS</u>

<u>Forest Plan Consistency</u>

The Forest Plan has been reviewed to determine whether the decision being made is consistent with the present management area direction, the National Forest Management Act (NFMA), and other laws and regulations. This action is consistent with the Forest Plan Standards pertaining to Management Prescriptions 4A-Appalachian National Scenic Trail Corridor and 8A1-Mix of Successional Habitats.

PRE-DECISIONAL ADMINISTRATIVE REVIEW

This project was subject to the Project-Level Pre-decisional Administrative Review Process ("**Objection**" Process) pursuant to 36 CFR 218 Subparts A and B. The objection period closed November 12, 2013.

PROJECT IMPLEMENTATION

Since no objection was received, this Decision Notice can be signed 5 business days following the end of the of objection filing period, which is November 19, 2013 and the project can be implemented immediately after this approval.

H. Thomas Speaks

H. THOMAS SPEAKS, Jr.
Forest Supervisor

11-22-2013
Date

Map of Columbia Gas Lines,
Acquisition of Celanese Lands,
Exchange of USA Tract 1732,
and Appalachian Trail Relocation

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 95

February 21, 2023

United States
Department of
Agriculture

Forest
Service

September 2013

Environmental Assessment

Natural Gas Pipeline Construction Project, Proposed by Columbia Gas of Virginia for service to Celanese Plant in Giles County, Virginia

Eastern Divide Ranger District
George Washington & Jefferson National Forests

For Information Contact: Jesse Overcash

USDA Forest Service
Eastern Divide Ranger District
110 Southpark Drive
Blacksburg, Virginia 24060

Telephone: 540/552-4641

TABLE OF CONTENTS

INTRODUCTION

The Eastern Divide Ranger District is conducting this environmental analysis (EA) for construction of a 12-inch natural gas pipeline. The project area is located on Peters Mountain, north of the Celanese Acetate LLC (Celanese) Plant near Narrows, Virginia. Please see the map in Appendix B. The purpose of this new line is to provide adequate natural gas service to the Celanese Plant, allowing for the conversion from coal-fired boilers to natural gas-fired boilers.

GENERAL DESCRIPTION OF AREA

The Peters Mountain area lies primarily in Giles County, Virginia with most of the area north of the ridge line in Monroe County, West Virginia. This entire project is in Giles County, Virginia. National Forest System lands are primarily vegetated with upland hardwoods, with a few yellow pines on the southern aspects of finger ridges.

PROPOSED ACTION

The Forest Service received a Special Use application from Columbia Gas of Virginia (CGV) to construct a buried 12-inch, coated steel natural gas distribution line across Peters Mountain to provide additional service to the Celanese Plant near Narrows, VA. This entire line would be 18,488 feet with about 4,238 feet of it on National Forest System lands over Peters Mountain to Celanese. The project location parallels an existing buried 6-inch natural gas line permitted to CGV, which will remain an active line (Appendix B Map).

The proposed action is to permit construction of the line and issue a long-term special use permit for its operation and maintenance. The current easement area covers the existing 6-inch line. Construction of the new 12-inch line would require a cleared corridor next to this current easement. New clearing would range from 75 feet to 125 feet in width, depending on terrain and placement along the pipeline. Construction activities are anticipated to start in April of 2014 and finish in October of 2014, although there may be some clearing and clean-up beyond this timeframe.

The cleared area would be used for soil stockpiling, pipeline preparation, and a temporary access route to the construction area. An approximately 6-foot deep and 6-foot wide trench would be excavated next to the existing 6-inch line. The excavated material would be returned to the trench upon completion of the pipeline. Some permanent grading would be required over the trench to provide necessary cover over the pipe. After the pipe is placed, a 40-foot wide easement area would be maintained long-term for inspection and maintenance. This 40-foot area would encompass the existing easement. The rest of the cleared area would eventually return to a forested condition. Any grading required outside of the easement area would be returned to as close to preconstruction contours as practical.

An approximately 20,000-square foot (or about 0.5 acre) temporary staging area just west of the existing corridor and southwest of the ridgeline of Peters Mountain would also be permitted.

The location of this staging area was altered from the site shown on CGV's application to move it from the top of Peters Mountain and away from the Appalachian National Scenic Trail (AT). This change allows for substantial reduced impacts on hikers and on the long-term scenic quality of the area.

The existing pipeline crosses the AT at two points; the top of Peters Mountain and the bottom of Peters Mountain near Virginia State Route 641 (Clendennin Road). The construction near Clendennin Road should take 2 to 3 days. It will be easy to reroute the AT with on-site signing and temporary blazes to move hikers around the construction site. No ground disturbance is needed for this reroute as the woods are gently-sloped and open at this location.

On top of Peters Mountain, the trail and pipeline cross at nearly right angles. The AT goes over the grassy corridor on nearly flat terrain. As described above, the original proposed staging area was at this location. In addition to moving the staging area, the proposal was modified as follows to address concerns about impacts to hikers and visual impacts.

- A barrier fence to restrict access will be placed around the vicinity of the AT (at the ridgeline) prior to any activity and will remain in place for the duration of the project. This fence will enclose an area about 50 feet uphill from traverse point #1027 on the north side of the ridge to the top of the staging area on the south side of the ridge and will be about 300 feet wide. It will be an orange plastic mesh barrier fence, about 4 feet high and will be clearly signed as a "Do not enter" area. Construction activity inside the fence will be limited to the movement of equipment and supplies a few times a day for the majority of the project. The exception to this will be when the pipeline is actually installed inside the fence (limited to an August 1 to September 30 period as described below).

- Gates will be installed in this perimeter fence where it crosses the AT. These gates will be staffed during all periods of construction activity for the length of the project, anticipated to be from April to October 2014. These gates will be closed to hikers only when equipment is inside the area. In the rare occasion when this equipment is inside the perimeter fence for more than a few minutes, hikers will only be permitted to cross the area with escort from contractor personnel.

- Installation of the pipeline inside the perimeter fence will be limited to a construction period of August 1 to September 30. This is the time of the year that has the fewest hikers while still being inside the construction season (April through November). Two interior security fences will be installed, paralleling the trail. During construction in this section, the AT will remain passable. For the short amount of time when the area at the AT needs to be trenched, a bridge will be installed over the trench with a design provided by the contractor and approved by the Forest Service. The gates in the perimeter fence at the AT crossing locations will be staffed during all construction activity and when not staffed, these gates will be left open with the area along the trail safe for public use.

- Clearing and grubbing of the corridor inside the restricted area is anticipated to occur prior to May 15th, 2014. If it is not done before May 15th, it will not be allowed until the August 1 to September 30 construction period.

- Information concerning this project will be posted on the following web sites to alert hikers: www.appalachiantrail.org, www.nps.gov/appa, www.fs.usda.gov/gwj. Information will also be posted at the Clendennin Road (Virginia State Route 641) and Stony Creek Road (Virginia State Route 635) crossings and at Pine Swamp and Docs Knob trail shelters.

These bullets deal specifically with mitigating the impacts to AT hikers. Since the proposed action was released for public comment in May of 2013, the Forest Service and Celanese have reached agreement on an easement for a relocation of the AT that has been in the works for several years. The relocation is independent of this pipeline project and will move the AT to the east of the pipeline (see yellow line on Appendix B Map). Every effort will be made by Columbia Gas of Virginia, Celanese, the Forest Service, and the Appalachian Trail Conservancy (ATC) to move the trail to its new location. Getting this relocation completed prior to the start of pipeline construction would eliminate the need for the measures described in the bullets above as the AT would no longer overlap with the pipeline corridor.

Additional mitigation measures have been added to address concerns with visual, soil, water quality and other resources.

- The staging area will be located just west of the existing corridor and southwest of the ridgeline of Peters Mountain, as flagged in the field on April 22, 2013.
- Any disposal of cleared timber and brush will occur outside of the restricted area.
- Prior to the initiation of clearing activities, CGV and the contractor will work with the Forest Service to minimize clearing within the 125-foot maximum clearing corridor where possible; particularly at the top of the small ridge most visible from US 460. This location was field-reviewed with the contractor and a Forest Service Landscape Architect.
- A specific erosion and sediment control plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service.
- Sediment control structures of hay bales and/or silt fences would be installed along gradient sides of all work areas and the staging area.
- A protective cover, such as mulch, will be applied on disturbed areas where needed to prevent accelerated erosion during construction or before the next growing season.
- Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur.
- Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations.
- A specific revegetation plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service, including the seed mix.

- If any cultural resources are located during the implementation of construction activities, all work will stop until the resources can be evaluated by the Forest Service Archeologist, in consultation with the State Historic Preservation Office, Department of Historic Resources.
- Portable toilet facilities would be made available for use by all construction crew personnel for the duration of the project.
- Two existing access routes would be utilized as part of this project. These roads are in place but would require some maintenance. All road maintenance activities will be approved by the Forest Engineer. These roads, which are currently unclassified roads, would be part of the special use permit. Columbia Gas of Virginia will be required to install a gate to Forest Service specifications at the federal boundary on the lower access road.

There is potential for the establishment of non-native invasive species due to the stirring of the soil and opening created within the cleared corridor. The application of herbicide to treat non-native invasive plants is authorized in the Decision Notice for the "George Washington and Jefferson National Forests Forest-wide Non-Native Invasive Plant Control" (12/14/2010) and therefore is not be part of the proposed action for this project. However, non-native invasive species and the use of herbicide is addressed in the Environmental Consequences discussion in this EA for several resources.

PURPOSE AND NEED FOR ACTION

Purpose and Need:

The purpose of this proposal is to provide Celanese with an adequate, reliable source of natural gas so they are able to convert their coal-fired boilers to natural gas. Federal policies include an emphasis for the Forest Service to help meet energy resource needs to provide and sustain benefits to the American people by timely processing energy-related special use proposals. Direction in the 2004 Revised Jefferson National Forest Land and Resource Management Plan (Forest Plan) guides response to this application.

Forest-wide Goals and Objectives:

The Forest Plan recognizes that various transmission/distribution facilities on national forest lands are essential to local, regional, and national economies. These special uses of federal land serve a public benefit by providing for a reliable supply of electricity, natural gas, and water. The goal in the Forest Plan is to consolidate these uses in the same corridor where possible to minimize negative environmental, social, or visual impacts and minimize acres of land affected. Where feasible, expansion of existing corridors is preferable to designating new sites. (Forest Plan pages 2-59 to 2-61)

Management Prescription 4A - Appalachian National Scenic Trail Corridor and Management Prescription 8A1 - Mix of Successional Habitats:

The bulk of the project is in Management Prescription (Rx) 4A "Appalachian Trail" (AT) with a small portion in Rx 8A1 "Mix of Successional Habitats" in the Forest Plan. However, the AT is proposed for relocation from US 460 to the top of Peters Mountain and when that relocation is complete the AT will lay nearly one mile to the east of this new transmission line. Now that the easement across Celanese property is in place, construction of the AT relocation can begin this fall. If weather cooperates, the trail relocation can be completed prior to the pipeline construction starting; thereby eliminating all impacts to AT hikers from this project.

The AT management prescription also recognizes that utility transmission corridors, communication facilities, or signs of mineral development activity exist or may be seen within the prescription area, although the goal is to avoid these types of land uses and to blend facilities which cannot be avoided into the landscape so that they remain visually subordinate. Management practices are modified to recognize the nationally significant aesthetic and recreational values of these lands. Activities are planned and carried out in cooperation with appropriate Appalachian Trail management partners. Specific guidelines include "Locate new public utilities and rights-of-way in areas of this management prescription area where major impacts already exist. Limit linear utilities and rights-of-way to a single crossing of the prescription area, per project. Require mitigation measures including screening, feathering, and other visual management techniques to mitigate visual and other impacts of new or upgraded utility rights-of-way." (Forest Plan pages 3-19 to 3-23)

Scope of the Analysis:

The Final Environmental Impact Statement for the Forest Plan will be tiered to and will guide this analysis. Together with the Forest Plan, these documents provide the programmatic, or first, level of the two level decision process adopted by the Forest Service. These documents satisfy many requirements of the National Forest Management Act (NFMA 1976) while providing programmatic guidance.

All of these documents are available for review at the George Washington and Jefferson National Forests Supervisor's Office, 5162 Valleypointe Parkway, Roanoke VA 24019 or the Eastern Divide Ranger District Office, 110 Southpark Drive, Blacksburg VA 24060.

The Forest Service will coordinate with the Federal Energy Regulatory Commission (FERC) and the Virginia State Corporation Commission on this environmental review. FERC is conducting an environmental assessment on the section of the proposed line from Forest Hill to Peterstown, West Virginia, in Summers and Monroe Counties. This section runs from the Line KA Metering and Receipt Station to CGV's Scott Brach Point of Delivery and is being proposed by a separate entity which is Columbia Gas Transmission, LLC. The Virginia State Corporation Commission has regulator authority over the proposed line in Virginia, both on the private and national forest land sections.

DECISION FRAMEWORK

The Responsible Official for this decision is the Forest Supervisor, as he has the responsibility and authority to authorize Columbia Gas of Virginia to use and occupy the involved national forest land. Based on the stated purpose and need, the Responsible Official will review the environmental analysis for this project and decide the following:

> Should the construction of a 12-inch natural gas pipeline be permitted? If so, what are the most appropriate construction and rehabilitation standards? If so, what modifications or mitigations are needed to address potential impacts? Should a long-term special use permit be authorized for the operation and maintenance of the pipeline?

PUBLIC INVOLVEMENT

A letter describing the proposed action and requesting comments was mailed on May 23, 2013 to interested and affected agencies, organizations, and individuals. A legal announcement describing the proposed project was published in The Roanoke Times on May 24, 2013. Comments were received from five agencies, organizations, or individuals and these comments were reviewed for potential issues, alternatives and/or mitigation measures. The following summarizes the issues associated with the proposed action.

ISSUES

In general, project issues are considered for formulating and developing alternatives, identifying applicable design criteria and/or determining mitigation measures. Other issues are also analyzed by alternative to comply with laws, policies, and Forest Plan standards. All project issues are used in tracking and disclosing environmental effects.

There were two project issues identified for this proposal:

1. Short and long-term scenic quality issues as viewed from the AT and from US 460
2. Short-term impacts to hiker use of the AT and their safety during construction

1. SCENIC RESOURCES – There is concern that the wider clearing limit associated with this new line may adversely impact views from US 460 and the Appalachian Trail. The short-term concern is associated with the construction period and is particularly focused on where the proposed line crosses the AT.

INDICATORS:

a. Does the pipeline have significant impacts in the short or long-term on the scenic resources along the AT and as viewed from US 460?
b. What are the cumulative impacts to the scenic resource of this line, in conjunction with the other transmission lines and cell towers in this area?

2. HIKER EXPERIENCE AND SAFETY – There is a slight concern that the hiker experience along the AT will be negatively impacted by the construction activity but the primary concern is hiker safety. Hikers will be in the area during construction activity, including speed hikers and night hikers. If the AT is relocated before pipeline construction begins, these concerns are eliminated.

INDICATORS:

a. Are the proposed measures that are included in the proposed action adequate to address the potential hazards to hikers that are associated with the pipeline construction zone and its activities?
b. Do these measures adequate address the numbers and nature of some thru-hikers, such as speed hiking and night hiking?

ALTERNATIVES

In addition to the proposed action (under Alternative 1), the "no action" alternative (Alternative 2) will be considered for evaluation. This alternative provides a baseline for evaluating and comparing the effects of the action alternative.

Alternatives Eliminated from Detailed Study

No other alternatives were considered for study in this EA. Prior to accepting the special use application for this gas transmission line, an alternative route that avoids national forest was reviewed. This route took the line closer to populated areas and along travelways. It was also much longer. It therefore was substantially more hazardous and created more impacts so it was not considered viable.

DESIGN CRITERIA AND MITIGATION MEASURES APPLICABLE TO THE PROPOSED ACTION

Design criteria are Forest Plan standards developed to implement project activities to minimize or eliminate environmental impacts. Mitigation measures are developed based on site-specific conditions to reduce impacts. Appendix A lists the site-specific requirements for this project as well as the most applicable Forest Plan standards.

MONITORING

Monitoring of this project will occur before, during, and after construction to ensure that various aspects of the project adhere to the Forest Plan and conform to design criteria and mitigation measures set forth in this document. Monitoring will also occur to verify the accuracy of the predicted effects this assessment discloses. Specific monitoring responsibilities and activities include:

- The District Ranger or representative will ensure that the staging area is in the approved location and the safety fences, signing, and trail reroute are well established prior to project initiation. This person will also spot monitor the construction zone and the adequacy of protection measures around the AT, particularly at the top of Peters Mountain during hiker season.

- The District Trails Technician and Partnership Coordinator will coordinate trail reroute information with ATC, National Park Service, and the trail maintenance club.

These top two items will be needed if the AT relocation is not completed prior to pipeline construction.

- The District Biologist will ensure that erosion control measures are functioning, the seeding mixture is what was specified and is adequately applied, the vegetation is properly re-established and invasive species are adequately managed. This degree of monitoring will likely last at least three years.

- The Forest Soil Scientist will ensure that soil stability is maintained.

- The Forest Engineer will ensure the road work is properly accomplished and the gate is correctly installed.

ENVIRONMENTAL CONSEQUENCES

This section describes the potential effects of implementing the proposed action and the no action alternatives. It provides the scientific and analytical basis for comparing the alternatives.

Framework for Analysis

The scope of this analysis for environmental consequences can vary depending on the resource. The following activities have occurred within or near the project area and will be considered in the determination of cumulative effects, as appropriate.

The proposed gas line is to parallel an existing 6-inch gas line that serves the area. Also, a 345kV power line runs across the proposed gas line corridor. In addition, the AT is in the process of being relocated to the east of the proposed gas line construction.

Biological Environment

The biological environment is the living portion of the environment and includes trees, plants, animals, fish, mollusks, crustaceans, insects, etc. This section describes the major forest communities present in the area and the habitat found within the proposed cleared corridor. These communities are further discussed in terms of wildlife habitat including successional forests, old growth, permanent openings, interior habitats, riparian habitats, snags, dens and downed wood. Discussion of terrestrial and aquatic species is presented in four sections: demand species; migratory species; aquatic species; and threatened, endangered, sensitive and locally rare species.

Analysis of effects to the biological environment follows the framework used during forest planning (Forest Plan and FEIS) to address these elements. Use of this framework is designed to ensure comprehensive consideration of project effects to the biological environment, including effects to diversity of plant and animal communities, and to fish, plants, and wildlife. Only those relevant to the project are analyzed further in this document.

The Forest Plan identifies 13 management indicator species (MIS) to help identify effects of management on some elements of this framework. MIS populations are monitored at the Forest level (USDA Forest Service, 2004) and the effects of management actions on MIS are considered at the local scale. MIS are used to monitor and/or estimate the impacts of activities on overall ecosystems. These species are used as indicators for groups of organisms that occupy similar niches or are related within the same ecosystem (i.e. they depend upon each other or upon a common factor within the ecosystem). Effects on MIS would be discussed in the section that represents the ecosystem for which the MIS was selected.

It should be noted that six of these MIS are neotropical migrants (species that arrive in spring and depart in the fall). Declines in populations of these species may be caused by events happening on the wintering areas south of the U.S. and not necessarily in Virginia. These species were selected as MIS for the Forest Plan because they occur commonly enough to monitor trends of populations over time. MIS include the hooded warbler, scarlet tanager, pine warbler, eastern towhee, chestnut-sided warbler and Acadian flycatcher. Another MIS, listed in the Forest Plan, the Peaks of Otter Salamander, is not found in the project area.

MAJOR FOREST COMMUNITIES

MESIC DECIDUOUS AND OAK AND OAK-PINE FORESTS

Issue(s) Related to this Resource:

None

Scope of the Analysis

The spatial bounds of the analysis of effects on vegetation are limited to National Forest System lands impacted by the gas line construction. The temporal bounds include past activities that affect current vegetation condition in the project area and any foreseeable activity within the next 10 years.

Existing Condition

The forest resource within this area is primarily comprised of upland oaks such as chestnut oak, white oak, and scarlet oak.

Vegetation Effects
Alternative 1

__Direct and Indirect Effects__

The project will result in the clearing of most of the trees within a corridor paralleling the existing gas line. The trees will be cut and many of the stumps grubbed out to allow for the burying of the new gas line.

The effects of this alternative upon MIS associated with mesic deciduous and oak and oak-pine forest communities would include the following:

Scarlet Tanager – This common migrant woodland bird is typically found in upland mature deciduous (usually oak) forests for which it was selected as an MIS. It is most common in lower and middle elevations in the mountains up to 4,000 feet and is rarely found over 5,000 feet. The key habitat feature is mature deciduous forest. Nests are located 20 to 50 feet above the ground in a hardwood tree. The scarlet tanager feeds on insects that it gleans from twigs and leaves (Hamel, 1992). In the fall it often feeds on berries. It is common in the hardwood stands in this area.

This species would be displaced from the area cleared for the gas line. However, there is a large amount of forest interior habitat within the upper elevations of Peters Mountain that can provide needed habitat. Local populations are not expected to decline as a result of the proposed activities.

Hooded Warbler – Habitat of this common migrant warbler is moist deciduous and mixed forests with a dense understory, as is typically found in rich woods, ravines, and bottomlands. Key habitat requirements are forests (usually deciduous) with a thick, rich understory layer. The hooded warbler is rarely associated with these moist deciduous forests above 4,000 feet (Hamel, 1992). Nests are built 2 to 5 feet above the ground in shrubs and saplings where they are poorly concealed. These warblers forage primarily in shrubs within 15 feet of the ground by gleaning and hawking insect prey. The hooded warbler is an MIS for mid- to late-successional mesic oak and oak-pine forests. They are known to exist within the project area.

This species would benefit from the opening of the canopy since the corridor is not wide. Local populations should benefit from this project.

Pine Warbler – The pine warbler is closely associated with middle-aged to mature pine and pine-oak forests, generally occurring only where some pine component is present. While not among the common migrant warblers, it is considered the most appropriate MIS for the yellow pine habitat component. Nests are built in pines and foraging for insects occurs in the crowns of pines where they glean insects from needles and twigs (Hamel, 1992). This area contains some yellow pine, but this component will not be benefited from this project. Populations are expected to remain stable in the future.

Cumulative Effects
No future management activities are planned in the project area that would impact the forest overstory.

Vegetation Effects
Alternative 2

Direct and Indirect Effects
With no gas line constructed, there would be no impacts to the forest resource.

The effects of this alternative upon MIS associated with mesic deciduous and oak and oak-pine forest communities would include the following:

Scarlet Tanager – This species is associated with mature hardwoods so with no tree cutting, this alternative is the most favorable for this species.

Hooded Warbler – This species is associated with mid to late-successional hardwood forests. Local populations would remain stable with no action.

Pine Warbler – This species is associated with yellow pine so with no tree cutting, this alternative is the most favorable for this species.

Cumulative effects:
No future management activities are planned in the project area that would impact the forest overstory.

RARE COMMUNITIES

Rare communities and other special biological areas on the Jefferson National Forest were identified through a cooperative effort between the Forest and the Virginia Department of Conservation and Recreation, Division of Natural Heritage as part of the Forest Plan Revision process.

Issue(s) Related to this Resource:

None

Existing Conditions:

There are no rare communities or special biological areas within the project area, so by definition, there are no effects.

TERRESTRIAL SPECIES AND THEIR HABITATS

This section discusses different aspects of wildlife habitat elements. For the purpose of this discussion, the term "wildlife" refers to terrestrial wild animals, including arthropods and other invertebrates, which occur on the Forest.

SUCCESSIONAL FORESTS

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The spatial bounds of the analysis of effects on vegetation are limited to National Forest System lands that comprise the project area.

The temporal bounds include past management activities that affect the current vegetative condition in the project area and any foreseeable vegetative manipulation within the next 10 years.

Existing Conditions:

The existing gas line right-of-way is semi-open with herbaceous and woody vegetation found within the corridor. The existing corridor is approximately 30 feet wide. The rest of the project area is the adjacent woods that would be cleared to create the new wider corridor. This wood is primarily an upland oak stand.

Direct and Indirect Effects:

Alternative 1

Stump grubbing and gas line burying could result in some amphibians, reptiles, small mammals, and insects within the construction zone being crushed by heavy equipment or buried by dirt from the digging. In addition, some terrestrial or semi-aquatic species of salamanders, insects, reptiles, and small mammals within and adjacent to the gas line may be directly impacted by heavy equipment use during construction.

Through vegetation alteration, herbicide use would affect wildlife habitat. Non-native invasive species would be treated with a low volume foliar spray treatment applied to individual plants or a cut surface treatment of individual stems then sprayed with glyphosate; most wildlife species would move out of the immediate area. Smaller animals that remain are either under cover or would seek cover upon human disturbance; it is possible some herbicide could drip onto vegetation that could be ingested by herbivorous animals; a less likely exposure would occur through contact with skin/fur of an animal. Dermal exposure may be determined using the criteria of either extreme or realistic doses. The realistic dose estimate for glyphosate (Table 8-6, p.8-11 of the VMAM EIS) suggests that this herbicide is below the EPA risk criterion of 1/5 LD50 (median lethal dose) for all representative birds, reptiles, amphibians, and mammals.

Glyphosate is a chemical that presents a "low to very low" risk (VMAM, Appendix A, p.8-4). Local populations of small mammals, small birds, terrestrial amphibians, and reptiles may be adversely affected when large areas are treated; however, the reproductive capacity of these species is generally high enough to replace the lost individuals within next breeding cycle. Populations of larger mammals, birds, and any domestic animals present are not likely to be affected at all (p. 8-4, Vol. II, DEIS VMAM). Glyphosate is rapidly excreted. Based on high elimination rates and low tissue retention, there is a very low risk for bioaccumulation (DEIS VMAM, Volume II, p. 3-27).

No known documentation in the published literature exists describing the effects of this herbicide on lepidopterans and other arthropods. This herbicide was developed to impact plant physiology. The selective nature of the application would limit any impact on arthropod populations. Milkweed and other flowering plant species would not be targeted. In summary, risk is at a low ("no risk") level at typical application rates, according to EPA standards for terrestrial animals (VMAM, p. IV-75) for this herbicide.

The effects of this alternative upon MIS associated with successional forests would include the following:

<u>Chestnut-sided warbler</u> – The habitat of this common migrant warbler is typically found in second-growth hardwoods and overgrown fields in the Appalachian Mountains in Virginia, over 2,500 feet in elevation. On the Forest it is therefore found in the Blue Ridge, Ridge and Valley, and Cumberland mountains. It is most numerous in abandoned fields with scattered saplings, along woodland edges, and in open park-like deciduous woods. It nests 1 to 4 feet above the ground in saplings and shrubs and feeds on insects gleaned from leaves and twigs in deciduous vegetation (Hamel, 1992). The chestnut-sided warbler is an MIS for high-elevation early-successional habitats because of its strong association with these habitats, and because its populations should be responsive to such habitat conditions. Local populations would benefit from this alternative, as it creates early seral habitat.

<u>Eastern towhee</u> – This common short distant migrant is typically found in early-successional habitat. They nest in thickets or brushy places on the ground or in shrubs or saplings up to five feet high (Hamel 1992). Eastern towhees require shrubs, saplings, or understory trees in a wide variety of situations, usually where a thicket is present. Populations respond favorably to conditions created three years following forest regeneration in larger forest patches (Thompson and Fritzell 1990). Towhees are common within early-successional and brushy habitat found in the area. The towhee is an MIS for early-successional habitats because of its strong association with these habitats, and because its populations should be responsive to such habitat conditions. Local populations would benefit from this alternative, as it creates early seral habitat.

<u>Cumulative Effects</u>:

The cumulative effects (past, present, and reasonably foreseeable future actions considered together) of this alternative upon MIS associated with successional forests would include the following:

<u>Chestnut-sided Warbler</u> – The widening of the existing gas line corridor in combination with an existing power line corridor would likely provide an increase in usable or more suitable habitat in the immediate area for breeding pairs. This should result in an increase the potential habitat for chestnut-sided warblers and their populations into the foreseeable future.

<u>Eastern Towhee</u> – The widening of the existing gas line corridor in combination with an existing power line corridor would likely provide an increase in usable or more suitable habitat in the immediate area for breeding pairs. This should result in an increase the potential habitat for chestnut-sided warblers and their populations into the foreseeable future.

Alternative 2
There would be no impacts including cumulative effects, upon amphibians, reptiles, small mammals, and insects as no construction would occur. The existing gas line right-of-way provides some early successional habitat, and early successional species would continue to use the existing corridor.

This alternative does not create additional habitat desired by the chestnut-sided warbler or eastern towhee.

OLD GROWTH

<u>Issue(s) Related to this Resource:</u>

None

<u>Existing Conditions:</u>

In June of 1997, the Regional Forester issued new guidance on the definition and management of old growth forest communities in a report entitled "Guidance for Conserving and Restoring Old Growth Forest Communities on National Forests in the Southern Region." Areas proposed for gas line were evaluated to see if any trees met the age, disturbance, basal area, and diameter at breast height (DBH) criteria identified in the Regional Guidance. The area proposed for construction use and access had been disturbed in the past. There was old growth northern red oak observed west of the existing gas line on the north side of Peters Mountain, but this area will not be impacted by the proposed action.

<u>Direct, Indirect, and Cumulative Effects</u>:
Since the project area does not contain any old growth, there are no effects from either alternative.

INTERIOR HABITATS

Issue(s) Related to this Resource:

None

Existing Conditions:

Forest fragmentation is the breaking up of large contiguous areas of forested land into smaller units. This causes an increase in forest edge; the border between forest and non-forested areas, and reduces the amount of forest interior habitat present. It also causes an increase in temperatures at the ground level from thermal radiation.

Fragmentation and the resulting edge habitat can cause a change in the plant and animal communities within an ecotone. Forest management activities such as timber harvesting and road construction are commonly cited as causes of forest fragmentation. Construction of a gas line right-of-way will also create edge habitat. Edges are often referred to as "ecological traps" for some species of songbirds, because their structural diversity is attractive to the birds when they are seeking nesting locations. This same structural diversity, however, attracts predators and parasites, which can decrease the songbirds' nesting success. Brood parasitism from brown-headed cowbirds is often mentioned in this scenario. Brown-headed cowbirds, commonly found in southwest Virginia, are usually associated with permanent pastures and urban areas. Although cowbirds do occur on private agricultural lands in the surrounding landscape they are not considered common on National Forest System lands.

Finch (1991) reviewed existing neotropical bird population literature and identified some of the conflicting evidence. Most studies documenting the negative effects on forest interior species have been undertaken in agricultural regions where forests have been isolated and there has been a large decrease in the region's total area of forest. Even in more extensively forested areas, Rodewald and Yahner (2001) provide evidence that agricultural disturbances within forested landscapes seemed to negatively affect bird communities in adjacent forest more than silvicultural disturbances. Managing extensively forested landscapes at a variety of scales and through a variety of regeneration methods can provide suitable habitat for both species that need large unbroken forest habitats and species that need forest edges and early-successional habitat (Annand and Thompson 1997). However, Buford and Capen (1999) present evidence that challenges the argument that songbirds breeding in an extensive forest landscape are not affected by canopy disturbance. Their study suggests breeding success of some forest interior species is reduced significantly in extensive forested areas with only 10% of the area considered open. In addition, Flaspohler and others (2001) provided evidence that the creation of openings in forest landscapes reduces nesting success for ground nesting songbirds in a zone adjacent to the opening. These openings were clear cuts, not agricultural clearings.

There are over 3,000 acres of forest interior habitat along Peters Mountain to the west of the proposed gas line, and several thousand more to the east. Roads and power line right-of-ways break up forest interior habitat on this portion of Peters Mountain.

Interior Habitats Effects
Alternative 1

Direct and Indirect Effects
The construction of 4,238 feet of gas line right-of-way on the National Forest will result in a wider open area than currently exists, but no additional edge, as the line parallels an existing right-of-way.

The effects of this alternative upon MIS associated with forest interior habitat would include the following:

Ovenbird – Preferring mature, dry, deciduous hardwoods with a closed canopy, the ovenbird is an area-sensitive MIS requiring relatively large undisturbed tracts. As ground nesters, they are especially vulnerable to predators. Breeding habitat is deciduous or mixed forest (rarely pure pine woods) with moderate understory, preferably in uplands. Minimum tract size is 37 acres, (Hamel 1992). It is common within the upland hardwood stands in the area. This species would be displaced from the expanded corridor. However, there is a large amount of forest interior habitat within the area that can provide needed habitat. Local populations are not expected to decline as a result of the proposed activities. On the Forest, overall total ovenbird populations are stable or increasing (USDA Forest Service, 2004).

Cumulative Effects
No other activities are foreseeable that will add cumulative effects.

Interior Habitats Effects
Alternative 2

Direct and Indirect Effects
Existing edge conditions would not change in quantity or quality given the no action alternative. This alternative would not reduce existing interior habitat and local populations of ovenbirds would remain stable.

Cumulative Effects
No other activities are foreseeable that will add cumulative effects.

RIPARIAN HABITATS

Issue(s) Related to this Resource:

None

Existing Conditions:

There are no perennial, intermittent, or channeled ephemeral streams within the gas line right-of-way on National Forest land.

Direct, Indirect and Cumulative Effects:
Given there are no perennial or intermittent streams on National Forest land within the gas line right-of-way, there will be no impacts to riparian habitat.

INVASIVE SPECIES

Issue(s) Related to this Resource:

None

Existing Conditions:

No invasive species were observed along the existing gas line. However, tree-of-heaven, multiflora rose, and autumn olive and have been seen along Forest Service roads near the project area, and along the access roads for the project. They also occur within a nearby powerline right-of-way.

Invasive Species Effects
Alternative 1

Direct and Indirect Effects
Stirring soil and opening the forest canopy along the gas line could allow for the establishment of invasive species from existing seed sources such as existing power line right-of-ways and road corridors. Proposed use of glyphosate and fosamine to control these species would eliminate their establishment along the expanded corridor.

Cumulative Effects
The expanded gas line right-of-way would be a prime area for establishment of non-native invasive species, especially considering existing source locations of power line rights-of-way and road corridors. These other source locations are close geographically, and an increase in non-natives should be expected in all disturbed or open areas. However, there is a Forest-wide environmental assessment and associated decision notice that allows for treatment of non-native species, with appropriate documentation. This allows for treatment and control of non-native species in the corridor. This treatment is expected to control the spread of these invasive species.

Invasive Species Effects
Alternative 2

Direct and Indirect Effects
With no pipeline construction, there would be no stirring of soil. No expansion of existing non-native species populations associated with disturbance would occur.

Cumulative Effects
Existing non-natives would not have additional area to inhabit with the gas line right-of-way not being built. Therefore, no cumulative impacts are anticipated.

FISHERIES AND AQUATIC HABITAT

Issue(s) Related to this Resource:

None

Scope of the Analysis
The Celanese gas line project area is located in the Clendennin Creek-Bluestone Lake (HUC 050500020602) and the Rich Creek (HUC 020802020107) watersheds of the New River.

The gas line will cross an intermittent tributary of Stillhouse Branch, and will go under the streambed.

As stated in the Hydrological Analysis, boundary of the analysis area for aquatic biota will be the watersheds of Clendennin Creek-Bluestone Lake sub-watershed (Hydrologic Unit Code 050500020602), and the Rich Creek sub-watershed (HUC 050500020601). The time frame for the analysis will be until the sediment level returns to near pre-project levels.

Existing Situation and Effects of Past and Present Actions Related to this Resource

a. Existing Situation

There are no fish found within the project area, nor in Stillhouse Branch or its tributaries classified by the Virginia Department of Game and Inland Fish (VDGIF). The VDGIF database lists many aquatic species in the New River within the 6th level Clendennin Creek watershed. They include but are not limited to the following fish: Appalachia darter, largemouth bass, rock bass, smallmouth bass, bigmouth chub, greenside darter, Roanoke darter, candy darter, margined madtom, telescope shiner, white shiner, whitetail shiner, northern hog sucker, and redbreast sunfish; mussels: pistolgrip, pocketbook, purple wartyback, spike, and green floater; snails: crested mudalia, two-ridge rams-horn; and crayfish: Teays River, *Orconectes spinosus*, and *Cambarus sp*.

b. Past and present actions that have affected the existing situation

See the Hydrological Analysis for a description of current timber harvest activities and roads in the area. In addition, historic mining of iron ore and the associated activities of iron furnaces occurred in the area throughout the 18th and into the 19th century. The utility corridor for a high voltage electric transmission line (86 foot high) runs parallel to the road and main drainages within the project area.

Future Actions Related to this Resource

See the Hydrological Analysis for a description of future actions related to this resource.

Fisheries and Aquatic Resources Effects
Alternative 1

Direct and Indirect Effects
The main concern for aquatic biota related to the proposed action is increased sediment from the placement of the new gas line and any road reconstruction. As stated in the Hydrological Analysis, minor sedimentation can be expected from project activities. Sediment is expected to return to pre-activity levels within two years. The minor sediment increases are un-measurable and insignificant in comparison to the sediment loads of Stillhouse Branch and Rich Creek, and will have no significant effect on habitat for fish or other aquatic life.

Sedimentation and erosion potential will eventually return to a constant state, very close to the level existing before the implementation of the selected alternative.

Cumulative Effects
Alternative 1 does not have a significant cumulative effect on the aquatic biota when viewed in conjunction with past, present, and future activities.

Fisheries and Aquatic Resources Effects
Alternative 2

Direct and Indirect Effects
There would be no significant additional effects on sedimentation, water quality, or riparian areas and in turn no effect on aquatic biota.

Cumulative Effects
The No Action Alternative does not have a significant cumulative effect on the aquatic biota when viewed in conjunction with past, present, and future activities.

THREATENED, ENDANGERED, SENSITIVE AND LOCALLY RARE SPECIES

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The scope of analysis for aquatic species effects is the same as that used for the hydrology effects analysis, the Stillhouse Branch, Scott Branch, and Clendennin Creek watersheds.

The entire George Washington and Jefferson National Forests serve as the geographic scope for effects concerning the Indiana Bat, *Myotis sodalis*. The Indiana bat is not being considered as an issue in this environmental assessment because the analysis area is not situated within an Indiana bat cave protection area (Indiana bat cave protection areas are defined in the Forest Plan). This issue has already been decided and the effects disclosed by this agency through the NEPA analysis and documentation by the U.S. Fish and Wildlife Service by its Biological Opinion (BO) of January 13, 2004. The BO issued constitutes compliance with Section 7 requirements of the Endangered Species Act (ESA) regarding the Indiana Bat and therefore no further consultation with the USFWS is necessary. The BO also contains an incidental take statement which provides for "taking" (as identified in ESA) of individual bats and habitat modifications thus allowing for implementation of forest management activities within the Terms and Conditions and would not violate Sections 4 (d) and 9 of ESA.

However, to meet Endangered Species Act, (ESA) Statutory and National Forest Management Act (NFMA) requirements, Indiana bat requirements from the Forest Plan, as applicable to the proposed project and reiterated in the BE or BO, also become part of the design of the project level alternatives. Thus, these requirements for protection of the Indiana bat are included in the Design Criteria (Appendix A) section of this EA.

The scope of analysis for the sweet pinesap and the Diana fritillary is the pipeline construction zone.

Existing Situation:

The Peter's Mountain mallow, a federally endangered plant species, is known to exist within 3 air miles of the project site. This plant is only found in this one location in the world. The portion of the project area that had the highest probability of providing habitat for this species was checked three times, and no Peter's Mountain mallow were found and no appropriate habitat was considered present upon further review.

No caves that could provide wintering habitat for the federally-endangered Indiana bat are known to be found in the project area. Habitat for the bat does exist across the Eastern Divide Ranger District despite the fact that there is no critical habitat (as defined in the Endangered Species Act) for the Indiana bat on the GWJNFs or adjacent to the Forests in Virginia, West Virginia, or Kentucky. The project area is not within any primary or secondary cave protection areas surrounding hibernacula since it is not within 2 miles of any hibernaculum. The closest hibernaculum is approximately 10 miles away. The project area also does not contain any fall foraging and swarming habitat since it is not within 2 miles of any hibernaculum. The project area contains potential summer roost sites, summer foraging habitat, and potential maternity sites for the Indiana bat.

The sweet pinesap, a Forest Service Sensitive plant species, could potentially exist within the project area, but no individuals were observed during project planning surveys. The Diana fritillary, a Forest Service Sensitive butterfly species, is known to exist within the project area, but no individuals were observed during project planning surveys.

A Biological Evaluation (BE) of the proposed project has been completed, and is contained in the project files at the Eastern Divide Ranger District office in Blacksburg.

Threatened, Endangered, Sensitive and Local Rare Species Effects
Alternative 1

Direct and Indirect Effects

Individual sweet pinesap that potentially exist could be crushed or uprooted if they occurred in the clearing area or access paths. No individuals were observed within the project area, but if present, individuals of these species may be impacted as a result of proposed activities. This limited impact would not lead to Federal listing, or loss of species viability (Biological Evaluation for Sensitive Species, December 5, 2003 for the Forest Plan). Impacts to the Diana fritillary would also be limited as no existing potential nectaring areas are being eliminated. The larval stage for this butterfly feeds on violets. The expansion of the cleared area could improve nectaring sources for adult butterflies. No individuals were observed within the project area, but if present, individuals of these species may be impacted as a result of proposed activities. Again this would not lead to Federal listing, or loss of species viability due to the scope of the impacts (Biological Evaluation for Sensitive Species, December 5, 2003 for the Forest Plan). There are no significant cumulative effects anticipated.

In terms of impacts to Indiana bat habitat, the clearing of approximately 13 acres would indirectly provide feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early-successional vegetation, and along the borders of croplands, wooded strips (fence rows), and over ponds.

For the Indiana bat this project would be in compliance with the BO issued by the USFWS on January 13, 2004 and therefore constitutes compliance with ESA Section 7 requirements. Since implementation of this project would be in compliance with, and tiers to, the BO that was issued as a result of formal consultation and it provides both specific Plan and project level direction, plus no new information has been identified as of this date, a finding of the effect to the Indiana bat for this proposed project is: no effect, beyond that which is already disclosed in the Revised Land and Resource Management Plan of March 2004 and by the USFWS in the BO of January 13, 2004.

Cumulative Effects

There are no significant cumulative effects anticipated.

Threatened, Endangered, Sensitive and Local Rare Species Effects
Alternative 2

Direct and Indirect Effects

There are no management activities and therefore, there would be no potential negative direct, indirect, or cumulative impacts to the threatened, endangered, sensitive or locally rare species in this area.

Cumulative Effects
There are no significant cumulative effects anticipated.

Physical Environment

SOILS

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The scope of the analysis for the impacts to soils would be the area contained within the activity areas for this proposed project. The activity areas are the treatment areas where there is potential for soil disturbance. These areas would be expected to produce biomass in the future – areas such as, the cleared right of way and the staging area. Activity areas can be smaller in extent than the entire proposed project area and are intended to include only the areas being treated by the proposed project alternatives. The table below shows the total activity area for each project alternative, which defines the scope and the basis of the analysis for the effects to the soil from the proposed activities. Activities not expected to affect the soil resource are road maintenance to existing Forest Service access roads.

Activity Areas by Alternative

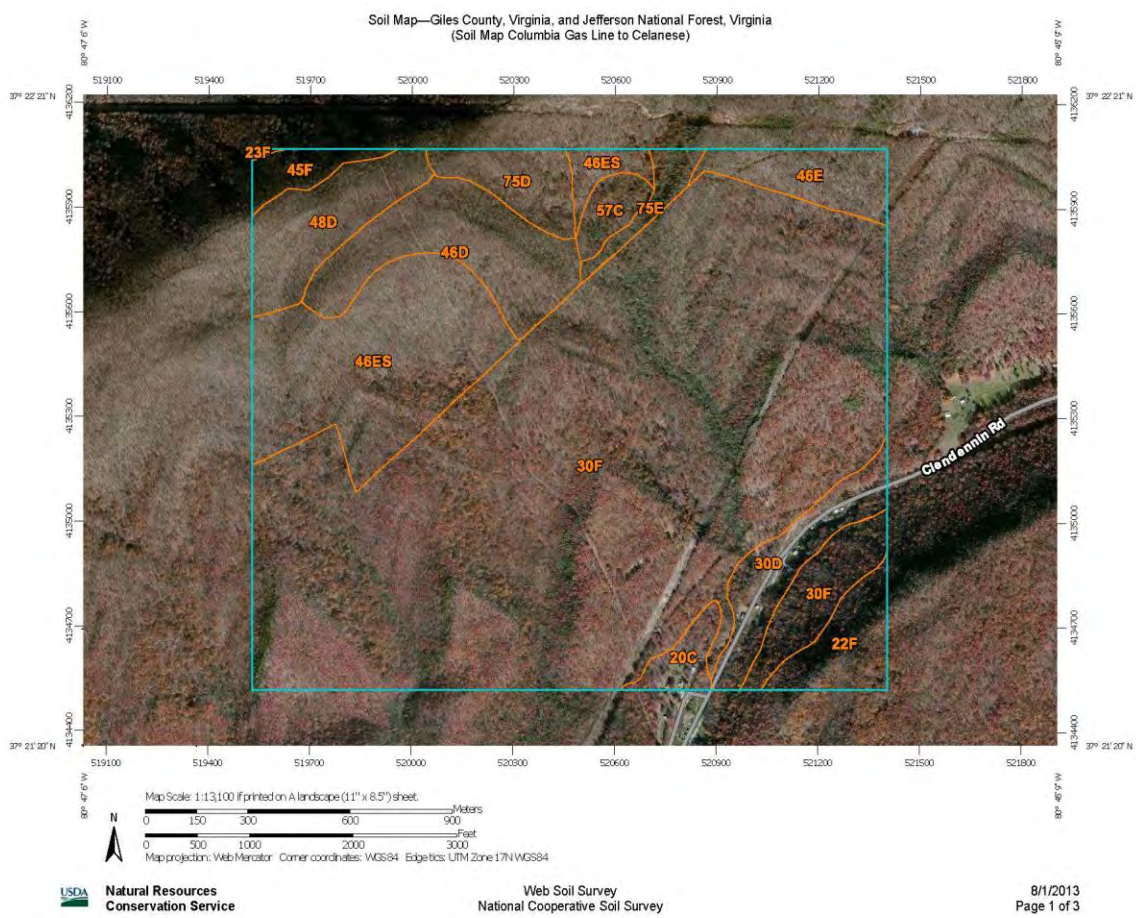
Potential soil disturbance	Alternative 1
Cleared Right of Way * Includes, stockpiled soil, temporary access, new trench.	12.2 acres
Temporary Staging area	0.5 acre
Total Activity Area	12.7 acres

*4,238 linear feet of line on Forest Service, times average of 125 linear feet width (maximum) = 12.2 acres.

Existing Condition

The existing 6-inch line corridor is within the activity area of the proposed action. This corridor is well vegetated and is not eroding. This is a good example of what to expect in the corridor after the installation of the new 12-inch line in the proposed action. Adjacent to the existing corridor on both sides is undisturbed forestland or, on the north side of Peters Mountain, rock cliffs. A detailed soil survey has been completed for the project area (see below). The information about the soils is obtained from the, Jefferson National Forest soil survey area in Virginia on the USDA Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

Field work for this soil survey was done in the mid to late 1980s and early 1990s. The soils potentially impacted by this project are derived primarily from sandstone and shale bedrock geology and material from surrounding uplands. Soils occurring in this area are identified using the maps below. The soils are well-drained and are expected to be suited for the proposed activities.



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,800 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Giles County, Virginia
Survey Area Data: Version 8, Jan 21, 2009

Soil Survey Area: Jefferson National Forest, Virginia
Survey Area Data: Version 4, Sep 17, 2012

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 11, 2010—Mar 17, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Giles County, Virginia (VA071)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
20C	Jefferson very stony loam, 0 to 15 percent slopes	8.2	1.1%
22F	Jefferson variant and Drall soils, very stony, 30 to 65 percent slopes	18.0	2.5%
23F	Lehew and Wallen soils, very stony, 35 to 65 percent slopes	0.4	0.1%
30D	Nolichucky very stony sandy loam, 15 to 30 percent slopes	24.2	3.4%
30F	Nolichucky very stony sandy loam, 30 to 65 percent slopes	453.0	62.9%
Subtotals for Soil Survey Area		**503.8**	**69.9%**
Totals for Area of Interest		**720.6**	**100.0%**

Jefferson National Forest, Virginia (VA606)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
45F	Dekalb, shallow-Rock outcrop complex, 60 to 80 percent slopes, extremely stony	8.5	1.2%
46D	Dekalb cobbly sandy loam, 15 to 35 percent slopes, very stony	43.3	6.0%
46E	Dekalb cobbly sandy loam, 35 to 60 percent slopes, very stony	19.0	2.6%
46ES	Dekalb cobbly sandy loam, 35 to 60 percent slopes, rubbly	84.9	11.8%
48D	Calvin very channery loam, 15 to 35 percent slopes, extremely stony	29.2	4.0%
57C	Clymer sandy loam, 3 to 15 percent slopes	7.9	1.1%
75D	Lily gravelly sandy loam, 15 to 35 percent slopes	16.4	2.3%
75E	Lily gravelly sandy loam, 35 to 60 percent slopes	7.6	1.0%
Subtotals for Soil Survey Area		**216.8**	**30.1%**
Totals for Area of Interest		**720.6**	**100.0%**

Hydric Soils Presence--Hydric soils (a wetland primary indicator) have not been identified in the activity area for this project.

Prime Farmland Soils Presence--No prime farmland soils have been identified in the activity areas for this project.

Direct and Indirect Effects

Alternative 1

Alternative 1 has the potential to affect the soil resource as a result of the proposed actions of constructing a gas pipeline. The effects of these actions on soils in the activity areas can be described in terms of short and long-term effects on the productivity of the soils. Short-term effects are those effects lasting three years or less, and are associated with the recovery period in which non-displaced disturbed soils become re-established with vegetative cover. Short-term effects imply that the existing soil profile is left mostly intact. Surface disturbances, such as compaction and removal of vegetation are the primary impacts. In contrast, long-term effects are associated with activities which displace the upper portions of the soil profile (topsoil). Many years are needed for the soil to recover its original productivity when the upper layers are removed. Topsoil formation is a slow process and typically occurs at a rate of one inch per 200-600 years, and depends on local climatic and ecological factors.

There is an additional indirect effect to areas which receive the displaced topsoil from excavated areas, such as fill slopes along roads. With this added mineral soil material and organic matter, productivity on these areas would be improved by increasing soil depth, soil moisture holding capacity, organic matter and nutrients. This is not to say that excavated sites, which have long-term direct effects to soil productivity, are offset by these areas where topsoil is deposited. It is mentioned here as an indirect effect of excavation activities associated with Alternative 1. Topsoil deposition areas would not be used to offset any effects shown in the following analysis. It is an effect which is not easily estimated or displayed, but one that does occur.

Important factors considered in evaluating effects to soil resources from this project are: the Columbia Gas of Virginia application for permit, the extent of the activity areas and the extent of the area where long-term soil productivity has been reduced. Effects to the soils from this project are considered not significant when at least 85 percent of the activity area retains its original soil productivity (Forest Service Handbook, R8, 2509.18.2.2, Soil Quality Standards).

General forest areas are expected to recover quickly. Research has shown that the upper few inches of soil recovers quickly from any compaction occurring, except for rutting. This is due to organic matter additions from vegetation removal, soil biota activity, freezing and thawing and plant root growth from existing and new vegetation. Recovery from compaction is slower in the 8 to 12 inch depth zone, but compaction is not expected at these depths in areas other than access routes and staging area, unless rutting occurs. Portions of the staging area are expected to have a longer recovery period since this area must recover from compaction and soil displacement. Productivity loss on the staging area is considered to be a long-term impact to soil productivity.

The extent of ground disturbance and the estimated short and long-term effects to soils for Alternative 1 is displayed below. In pipeline installation operations, the impacts of trenching are considered to be short-term impacts to soil productivity, since excavated soil is returned to the trench. Other impacts are associated with areas benched to obtain cover material for the pipe and excavated areas on the staging area and access routes. The proposed activities in Alternative 1 of road maintenance, clearing and grubbing vegetation and maintenance of a 40 feet wide easement are not expected to produce any long-term effects to soil productivity. These activities would not be displacing or deeply compacting the soils occurring in these areas. Exposure of bare soil created by proposed activities would be re-vegetated using erosion control plants and structures during a recovery period and the soil surface is not expected to erode after this recovery period.

The table below displays the estimated potential effects to soil productivity from the activities proposed in Alternative 1 and considered in this environmental analysis. Assumptions used to estimate the effects are shown below the table.

Table 1. Alternative 1 Estimated Acreage of Potential Short and Long-Term Effects to Soil Productivity.

Activity	Short-Term	Long-Term	Total
(1) Gasline trenching (10' X 4238')	1 acres	0	1 acre
(2) Permanent grading over pipe for cover (1483' X 10')	0	0.4 acre	0.4 acre
(3) Staging area (0.5 acre)	0.5 acre	0	0.5 acre
(4) Access (12' X 6000')	0.4 acre	1.3 acres	1.7 acres
Totals	**1.9 acres**	**1.7 acres**	**3.6 acres**

Assumptions used for above table:

(1) 10' used to instead of 6' stated in permit application to account for disturbed area associated with trenching operation and soil stockpiling.

(2) Anticipated permanent grading changes where there is a need to create a bench on one side of the new line to provide sufficient cover over the pipeline. This would be only within the permanent 40-foot maintained right of way. Assume 35% of trench length on Forest Service (1483 feet), 10 feet wide.

(3) Staging area, if bladed, will be returned to preconstruction contours as much as possible and to do whatever is necessary to make this a temporary impact. Soil displacement minimized.

(4) Access necessary for equipment to maneuver on the slopes along the gas line would be needed along the length of the line and also outside the 40 feet easement in the cleared area. Assume 6000' X 12', with 80% long-term impact to soil productivity.

As shown in the above table, Alternative 1 is expected to have impacts to soils in the activity areas. To put the magnitude of these impacts into perspective, the estimated acres impacted by Alternatives 1 is compared to the acres in the activity area below. This estimates the percentage of the activity area potentially impacted by the proposed activities for these alternatives.

Table 2. Estimated Percentage of the Activity Area Soils Affected by the Proposed Action.

Alternative	**Extent of Activity Area**	**Estimated Effects**		**Percent of Activity Area Affected Long-Term**
		Short-Term	**Long-Term**	
Alternative 1	12.7 acres	1.9 acres	1.7 acres	13.4 %

The table above shows that Alternative 1 will affect long-term soil productivity.

Some soil compaction would occur along the gas line construction route as a result of heavy equipment use. Areas of concentrated use, such as the staging area and access routes along the pipeline are most affected. This compaction would increase the bulk density of the soils and result in a decrease in pore space, soil air and in the water holding capacity of the soils and would increase water runoff. These effects are considered detrimental to plant growth. The degree and depth of compaction depends on the number of passes the equipment makes and the moisture content of the soil at the time the passes are made. Changes in pore space do not normally occur on well-drained soils, such as those that occur over most of the project area, until three or more passes have occurred.

Soil movement (erosion) can occur on long unimpeded slopes with grade, where mineral soil material is exposed to raindrop impact and overland water flow. Soil movement can affect soil productivity when soil is transported by water offsite. Soils on upper slopes can lose productive topsoil as it moves down slope with water. Soil erosion may occur where bare soil is exposed on a slope as a result of equipment tracking difficulties (spinning wheels), access roads and staging area. The placement of the staging area on gentle slopes prevents long unimpeded erosion surfaces. The presence of a natural organic surface layer covering the soil would also prevent long, unimpeded erosion surfaces.

Management practices for minimizing soil movement include the use of waterbars and establishment of vegetation to check the flow of water down the travel-way also interrupts the long unimpeded slopes referred to above. The potential for soil movement is also expected to be temporary and limited to a recovery period time of approximately 1 to 3 years. Prompt seeding of the disturbed areas would help prevent continued soil movement after sale closure. Mitigation measures included in the proposed action (measures 10-14 in Appendix A):

- A specific erosion and sediment control plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service.
- Sediment control structure of hay bales and/or silt fences would be installed along gradient sides of all work areas and the staging area.
- A protective cover, such as mulch, will be applied on disturbed areas where needed to prevent accelerated erosion during construction or before the next growing season.

• Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur.
• Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations.

Implementation of these management practices will minimize soil impacts due to this project. Direct and indirect effects to the soil resource are below the significance level of 15% the activity area.

Cumulative Effects

The scope of the analysis considered for cumulative effects to soils for this project is the project area. The project area is about 12.7 acres for Alternative 1 (125' X 4238'). The project area provides an area to estimate the effects to soils from past, future and proposed actions for this piece of the Forest. Past actions and future planned actions in the project area, when combined with the proposed actions described in this document, would be considered for estimating the cumulative effects to soils for this area of the Forest.

The Forest Service is charged with maintaining soil productivity on its land (Forest Service Manual 2502, Forest and Rangeland Renewable Resources Planning Act 1974, National Forest Management Act 1976). Cumulative effects to soils would consider past and future planned activities and their effects on soil productivity within this project area.

Past and Future Actions in this Project Area:

Past activities impacting soils in the project area are:

- 1973 construction of the existing gas line adjacent to the proposed line. The maintained easement appears to have recovered from the previous construction with well vegetated slopes and no evidence of access.

Future activities:

- There are no future actions planned for this area for the next 10-15 years.

The construction of the existing gas line adjacent to the proposed line has no impacts or contribution to the cumulative effects on the soil resource for this project.

Direct and Indirect Effects

Alternative 2

There are no direct or indirect impacts from the no action alternative. There would be no adverse impacts to the soil resource.

Cumulative Effects

There would be no cumulative effects associated with this alternative and the soil resource.

HYDROLOGY

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The analysis area for determining the effects on the hydrologic resources is the Stillhouse Branch, Scott Branch, and Clendennin Creek watersheds. The time frame for the analysis will be until sediment levels return to pre-project levels.

Existing Condition:

The proposed pipeline construction is in the Stillhouse Branch and Scott Branch watersheds. Forest roads accessing the work location are partially in the Clendennin Creek watershed. Stillhouse Branch and Clendennin Creek flow into the New River and are in the Clendennin Creek-Bluestone Lake sub-watershed (Hydrologic Unit Code 050500020602). Scott Branch is in the Rich Creek sub-watershed (HUC 050500020601). Rich Creek is a tributary of the New River. Annual precipitation over the project area averages 39 inches.

The Watershed Analysis conducted for the Forest Plan and documented in the Final Environmental Impact Statement determined that the Rich Creek and New River/East River watersheds have a Watershed Condition Rank (WCR) of "average".

In the Stillhouse Branch watershed (957 acres), the estimated annual sediment yield is 151 tons; in the Clendennin Creek watershed (2273 acres), 168 tons; and in the Scott Branch watershed (4379 acres), 692 tons.

The following table shows the percentage of the three watersheds in different land uses:

Land Use	Stillhouse	Clendennin	Scott
Forest	93%	96%	63%
Developed	5%	1%	9%
Pasture/Hay	2%	2%	28%

The Commonwealth of Virginia conducts an assessment of water quality every two years in accordance with Section 305(b) of the Clean Water Act. Virginia's 2012 305b assessment included a watershed load ranking for nitrogen, phosphorus, and sediment in each of three source categories – agriculture, urban, and forestry. Rankings of high, medium, and low were assigned. Watersheds were also ranked for population served by a public water supply. For stream dependent living resources, an index of biological integrity was used to indicate the degree of aquatic biotic integrity and resource importance. Watersheds were also assigned rankings of high, medium, low, or none, based on the percentage of rivers and lakes that were impaired. The results of the assessment for the Clendennin Creek/Bluestone Lake sub-watershed and the Rich Creek sub-watershed are shown in Table 3 below. (The portion of the Rich Creek sub-watershed that is in West Virginia was not included in the assessment.)

Table 3. 2012 Water Quality Assessment

PARAMETER	RANK	
	Clendennin/Bluestone	**Rich Creek**
Agriculture Nitrogen	Low	High
Agriculture Phosphorous	Low	High
Agriculture Sediment	Medium	High
Urban Nitrogen	Medium	Medium
Urban Phosphorous	Medium	Medium
Urban Sediment	Medium	Medium
Forest Nitrogen	Low	Low
Forest Phosphorous	Low	Low
Forest Sediment	Low	Low
Total Nitrogen	Low	Medium
Total Phosphorous	Low	High
Total Sediment	Low	High
Riverine Impairments	Low	High
Lacustrine Impairments	None	None
Modified Index of Biological Integrity	High	Insufficient Data
Public Water Supply	None	None

Hydrology Effects
Alternative 1

<u>Direct and Indirect Effects</u>

Some sediment occurs naturally in all stream systems and is part of the natural geologic processes. Natural watershed disturbance regimes of fire, flood, insect, and disease result in a range of natural variability of sediment to which the stream channel has adjusted. However, human caused soil disturbing activity can produce volumes and rates of sediment delivery to streams that are in excess of the stream's ability to accommodate it. Excess sediment in streams can coat the stream bottom, fill pools, and reduce the carrying capacity of the stream for fish and stream insects. Fine sediment can fill the voids between gravel particles in the streambed, reducing the movement of aquatic insects, water and oxygen. The effects of sediment delivered to a stream channel diminish as watershed size increases. Most vulnerable are small sensitive headwaters catchments where concentrated soil-disturbing activity can have profound results.

In reality, there is a great deal of variability in a watershed's sediment yield between years (interannual variability). Sediment yield is much greater during high runoff years with more stormflow to erode and transport sediment. Conversely, sediment yield is much less during drought years when high flows may be less than bankfull. Data from the USGS gage on the Clinch River at Speers Ferry provides an expression of the variability of annual sediment yield. For the 62 years with flow and sediment data, each year's percent difference from the long-term mean ranges from + 143 percent to – 100 percent. A change of annual sediment yield of plus or minus 52 percent represents one standard deviation from the long-term mean, and values less than 52 percent are interpreted as being within the range of interannual variability.

A sediment model was used to estimate the tons of sediment produced by the proposed activity, and delivered to respective stream channels. Soil erosion was calculated using (1) erosion rates derived from research data from North Carolina and West Virginia (Swift, 1984; Kochenderfer and Helvey, 1984) and (2) the Universal Soil Loss Equation, as adapted to forest land (Dissmeyer and Foster, 1984). The Universal Soil Loss Equation includes site-specific factors related to soil type and land slope. Erosion is expressed as tons per acre moved from the site. This unit rate is multiplied by the disturbed area in acres to obtain unmitigated erosion in tons. This figure is then adjusted for factors of geology, soils, and mitigation to obtain an adjusted value of total erosion. Total erosion is then delivered to the stream channels based on aggregated sediment delivery ratios from the procedural guide 'An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources' (1980). The sediment delivery ratio for each segment of soil disturbance is calculated using factors based on sideslope, soil texture, distance to the nearest channel or drainway, and also factors of surface roughness, slope position, percent ground cover, and slope shape. These combined factors are translated into a Sediment Delivery Index that represents the portion of eroded material that is actually delivered to a stream. When multiplied by the calculated erosion, it gives an estimate of tons of sediment delivered to the adjacent stream channel. This sediment increase is compared with existing annual sediment yield from each watershed as determined by data from Patric, Evans, and Helvey (1984) and displayed as a percent increase over existing.

Rates of soil erosion and sedimentation are greatest at the time of soil disturbing activity and decrease as the soil stabilizes and vegetation begins to grow. This is reflected in Table 4 below.

Sediment modeling is based on a number of assumptions that may not be accurately reflected on the ground. The results provide very rough approximations of the changes in sediment delivery that might be expected as a result of proposed activities. Nevertheless, they allow a comparison of the impacts of various alternatives and provide a measure of relative risk to the aquatic ecosystem. The model assumes that Forest Plan standards and guidelines would be implemented. It assumes "normal" runoff and sediment years. Table 4 below displays the results of the sediment model by year for Alternative 1, in tons of sediment from the activity.

Table 4. Sediment Production from Soil Disturbing Activities (tons), by Watershed and Land Ownership

	2014	2015	2016	2017
Clendennin Creek				
Forest Service	0.3	0.1	0.0	0.0
Private	0.0	0.0	0.0	0.0
Stillhouse Branch				
Forest Service	2.8	0.4	0.1	0.0
Private	3.4	0.5	0.1	0.0
Scott Branch				
Forest Service	2.4	0.3	0.0	0.0
Private	2.8	0.4	0.1	0.0

The maximum predicted sediment increase to Clendennin Creek is 0.2 percent; to Stillhouse Branch, 4.1 percent; and to Scott Branch, 0.8 percent. These are well within the expected variability of sediment from year to year (interannual variability). There would be no change in the stream bed composition or in aquatic habitat quality or complexity from sediment related to the project. The predicted sediment increases to Clendennin Creek, Stillhouse Branch, and Scott Branch would be insignificant and immeasurable, and well within the range of variability of annual sediment loads to the stream. Thus, there would be no measurable or observable direct or indirect effects.

Cumulative Effects

A portion of the Appalachian Trail is being rerouted. This entails about 0.3 mile of trail construction in the Stillhouse Branch watershed and 2.7 miles in the Clendennin Creek watershed. This will result in a negligible increase in sediment – only about 0.1 ton in the Clendennin Creek watershed. Considered cumulatively with activities related to Alternative 1, the total increase in sediment in that watershed would still be only about 0.2 percent. Thus there would be no measurable or observable cumulative effects.

In the past ten years, there have been no other activities on Forest Service land that affect water quality in the analysis area. There are no other future activities currently planned.

Virginia's 2012 list of impaired streams includes Rich Creek downstream from Scott Branch. The impairment is E. coli bacteria, and the source is municipal, wildlife, wet weather discharges, and domestic waste. The pipeline construction project will not be a source of bacterial contamination and will not contribute to this impairment.

The New River in the vicinity of the project is listed as impaired due to PCBs in fish tissue. The project will in no way add to this impairment.

Hydrology Effects
Alternative 2

Direct and Indirect Effects

Under Alternative 2, there would be no soil disturbance and no sediment increases or other direct or indirect effects on water quality.

Cumulative Effects

There would be no cumulative effects on water quality.

AIR QUALITY

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The geographic bounds for this analysis include the immediate area associated with gas line construction.

Existing Situation:

No sources of negative air impacts occur within the project area on National Forest lands.

Direct and Indirect Effects

Alternative 1
The heavy mechanized equipment used to clear the right-of-way and dig the gas line trench will emit exhaust into the air during the construction phase. This is considered a minor impact give the expected duration and few pieces of equipment being used.

Cumulative Effects

No other foreseeable planned activities are known for the area. Thus no cumulative effects are anticipated.

Alternative 2
With no construction, no additional emissions from heavy equipment will occur in the project area. Therefore by definition, there are no direct, indirect or cumulative effects.

Social and Economic Environment

Recreation

Issue(s) Related to this Resource:

2. HIKER EXPERIENCE AND SAFETY – If the Appalachian Trail (AT) has not been relocated prior to construction for this project, there is a concern that the hiker experience along the AT will be negatively impacted by the construction activity but the primary concern is hiker safety. Hikers will be in the area during construction activity, including speed hikers and night hikers. The hiker experience will be addressed here but the bulk of this issue will be addressed under the “Health and Safety” section of this EA.

INDICATORS:

a. Are the proposed measures that are included in the proposed action adequate to address the potential hazards to hikers that are associated with the pipeline construction zone and its activities?
b. Do these measures adequate address the numbers and nature of some thru-hikers, such as speed hiking and night hiking?

Scope of the Analysis:

The geographic scope of the environmental effects analysis of the alternatives on recreation resources is limited to National Forest lands within the project area. The temporal bounds include past road and trail activities affecting current recreation access and use of the area, and any reasonably foreseeable recreation projects.

Existing Situation:

The AT currently intersects the existing pipeline in two locations: once at the base of Peters Mountain, near Clendenin Road and again at the ridgeline of Peters Mountain. Since the new line parallels the existing line, it will cross the AT in these same locations. However, the AT on Peters Mountain will soon be relocated and the new location completely removes the AT from the pipeline corridor (See project map in Appendix B).

All parties involved in this project (Columbia Gas of Virginia, Celanese, the Appalachian Trail Conservancy, the National Park Service and the Forest Service) are committed to getting this relocation finished as soon as possible. If the AT relocation can be completed prior to pipeline construction activity in the vicinity of the AT, all issues with hiker experience and hiker safety will be eliminated. In case circumstances do not allow for the relocation to be completed, this analysis will address the impacts and requirements needed if the AT is not moved prior to construction. The following mitigation measures (measures 1-7 in Appendix A) were designed to reduce these impacts.

- The staging area will be located just west of the existing corridor and southwest of the ridgeline of Peters Mountain, as flagged in the field on April 22, 2013.

- A barrier fence to restricted access will be placed around the vicinity of the AT prior to any activity and will remain in place for the duration of the project. This fence will enclose an area about 50' uphill from traverse point #1027 on the north side of the ridge to the top of the staging area on the south side of the ridge and about 300’ wide. It will be an orange plastic mesh barrier fence, about 4 feet high and will be clearly signed as a “Do not enter” area. Construction activity inside the fence will be limited to the movement of equipment and supplies a few times a day for the majority of the project. The exception to this will be when the pipeline is actually installed inside the fence (limited to an August 1 to September 30 period as described below).

Gates will be installed in this perimeter fence where it crosses the AT. These gates will be staffed during all periods of construction activity for the length of the project, anticipated to be from April to October 2014. These gates will be closed to hikers only when equipment is inside the area. In the rare occasion when this equipment is inside the perimeter fence for more than a few minutes, hikers will be permitted to cross the area with escort from contractor personnel.

- Installation of the pipeline inside the perimeter fence will be limited to a construction period of August 1 to September 30. This is the time of the year that has the fewest hikers while still being inside the construction season (April through November). Two interior security fences will be installed, paralleling the trail. During construction in this section, the AT will remain passable. For the short amount of time the area right at the AT needs to be trenched (anticipated to be less than a day), a bridge will be installed over the trench with a design provided by the contractor and approved by the Forest Service. Again, the gates in the perimeter fence at the AT crossing locations will be staffed during all construction activity and when not staffed, these gates will be left open with the area along the trail safe for public use.

- Clearing and grubbing of the corridor inside the restricted area is anticipated to occur prior to May 15th, 2014. If it is not done before May 15th, it will not be allowed until the August1 to September 30 construction period.

- Information concerning this project will be posted on the following web sites to alert hikers: www.appalachiantrail.org, www.nps.gov/appa, www.fs.used.gov/gwj. Information will also be posted at the Clendennin Road (Virginia State Route 641) and Stony Creek Road (Virginia State Route 635) crossings and at Pine Swamp and Docs Knob trail shelters.

- Any disposal of cleared timber and brush will occur outside of the restricted area.

Recreation Experience Effects
Alternative 1

Direct and Indirect Effects

All of the requirements listed above are designed to deal with hiker safety during construction and some will have a negative impact on hiker experience. Walking up on the construction site will be an unexpected intrusion to many hikers as they will not have seen the information on the web sites or read the posted information along the trail. Even those that have the information ahead of time might not be expecting what will be there and the level of the project. The area will be well signed and staffed to direct/delay hikers as needed. The intent is to not delay hikers for more than a few minutes. They may need to cross the construction area at the top of the mountain with an escort.

While every effort has been made to address the safety issue, short of completely moving the AT away from the construction area, there will be a negative impact on hiker experience as they come up on the sights and noise of the project. The north bound thru-hiker will have just come through a location close to a cement plant and an active railroad track, and crossed two state roads and a US route and walked through the Celanese Plant property. So the hiker will be in an area that has considerable sights and sounds of human activity. The first AT crossing with the project is a small area near Clendennin Road that will be dealt with by a short reroute in the woods. This is another opportunity to prepare the hiker for what they will see at the top of the mountain. As mentioned above, there will be project information posted at this location. This information will include photographs of the construction site on the ridgeline to prepare the hiker. Given all of these factors, the impact to hiker experience from the project is being managed at a reasonable level.

Cumulative Effects

There are no other activities planned for this area other than the relocation of the AT, which will be away from the project site. Once the AT is moved, hiker experience should be improved as the new location moves the hiker away from the development along the US 460 corridor and the buildings on Celanese property quickly and replaces this with a river/woods walk. Once the hiker crosses Clendennin Road, they will get to the top of Peters Mountain much faster than the current location and will avoid both crossings of the gas line.

Recreation Experience Effects
Alternative 2

Direct and Indirect Effects

Since there is no project with this alternative, there is no change in hiker experience and therefor no effects.

Cumulative Effects

By definition, with no direct or indirect effects, there are no cumulative effects.

HERITAGE RESOURCES

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The geographic scope of the analysis is the area proposed for new ground disturbing activities (construction clearing limits, new corridor, and staging area). Past ground disturbing activities are not included in the analysis, as any potential damage to cultural resources that might have existed cannot be evaluated or recovered.

<u>Existing Situation</u>:

An archeological survey was performed across the project area in spring of 2013, after clearing limits were identified. No cultural or historic sites were found. The archaeological reconnaissance report concluded “no effect”. Concurrence by the Virginia Department of Historic Resources, Office of Review and Compliance was issued on June 29, 2013.

If any cultural resources are located during the implementation of construction activities, all work will stop until the resources can be evaluated by the Forest Service Archeologist, in consultation with the State Historic Preservation Office, Department of Historic Resources.

HERITAGE RESOURCES EFFECTS

Alternative 1

<u>Direct and Indirect Effects</u>
Since there are no cultural or historic sites within the proposed boundaries of the activities, there would be no impacts on heritage resources in the area.

<u>Cumulative Effects</u>
No other reasonably foreseeable future ground disturbing activities are planned for the area. Since there are no effects anticipated, there would be no cumulative effects to heritage resources by definition.

Heritage Resources Effects

Alternative 2

<u>Direct and Indirect Effects</u>
With no ground disturbing activities proposed under this alternative, there would be no impacts on heritage resources in the area.

<u>Cumulative Effects</u>
Since there is no activity, there would be no cumulative effects to heritage resources by definition.

Scenic Resource

<u>Issue(s) Related to this Resource:</u>

1. SCENIC RESOURCES – There is concern that the wider clearing limit associated with this new line may adversely impact views from US 460 and the AT. The short-term concern is associated with the construction period and is particularly focused on where the proposed line crosses the AT.

INDICATORS:

a. Does the pipeline have significant impacts in the short or long-term on the scenic resources along the AT and as viewed from US 460?
b. What are the cumulative impacts to the scenic resource of this line, in conjunction with the other transmission lines and cell towers in this area?

Definitions:

Scenic Class is a system of classification describing the importance or value of a particular landscape or portions of that landscape. The values in this classification system range from 1 (highest value) to 7 (lowest value). Scenic Class related to each prescription in the Forest Plan determines the Scenic Integrity Objectives of the area. The Forest Plan specifically provides direction as related to each prescription, the Scenic Class and its associated Scenic Integrity Objective.

Scenic Integrity Objectives (SIOs) are developed as measurable standards for the visual management of public lands. These SIOs are mapped and established as part of the Forest Plan. In managing scenery, degrees of integrity are defined as Very High to Low. Under the High SIO management activities are not visually evident. Under the Moderate SIO activities remain visually subordinate to the landscape character. Under the Low SIO management activities may visually dominate the original landscape character; however, they must be in scale with the surrounding area.

Concern Levels are a measure of people's concern for the scenic quality of the National Forests. Three concern levels are employed, each identifying a different level of user concern for the visual environment. Level 1 is the highest concern and includes all seen areas from primary travel routes and use areas. Level 2 is of moderate concern and includes secondary roads, and use areas and Level 3 is of lowest concern and includes all seen areas where less than ¼ of the Forest visitors have a major concern for scenic qualities.

Distance Zones are divisions of a particular landscape being viewed. They are used to describe the part of the landscape that is being evaluated. The three distance zones are Foreground, Middleground and Background. Foreground is within ¼ to ½ mile of the observer. Normally individual boughs of trees can be discerned at this distance. Middleground is from the Foreground zone to 3-5 miles from the observer. At this distance tree cover tends to appear very uniform and individual tree forms are only discernible in very open areas. Background extends from Middleground to infinity. Texture in stands is generally very weak or non-existent at this distance.

For additional explanation of these and other terms associated with the Visual Management System please refer to the forest plan or Agriculture Handbook Number 701, Landscape Aesthetics, A Handbook for Scenery Management.

Scope of the Analysis:

The geographic bounds for this scenic analysis would include the area visible from the identified viewing points surrounding Peters Mountain. The existing gas line location and proposed expansion of that corridor was evaluated from vantage points with high concern to eliminate obtrusive edges, shapes, patterns in conjunction with the shape and density of each unit.

The time periods for this analysis would include projects occurring up to 10 years in the past and into the future. This time period is based on the concept that the greatest impacts on visuals generally last about 10 years at which time the impacted areas are not as easily discernible to the casual observer.

Existing Situation:

Peters Mountain is managed to provide Roaded Natural recreational opportunities. Thus, the area is not remote. Visitors are expected to experience comfort and security but feelings of solitude, challenge, and risk are not to be expected. Other visitors would be frequently encountered. Recreational activities that occur within the project area are dispersed in nature.

The Concern Level 1 areas included in the analysis may be seen from US 460 west bound traffic and from the AT. Views from US 460 west are in the Middleground distance zone. These views are available for approximately 1 mile to observers traveling at 60 miles per hour and are occasionally obstructed by foreground topography and vegetation.

Views from the AT are in the Foreground distance zone at the top and bottom of Peters Mountain. At the top of Peters Mountain the AT and the existing pipeline cross at nearly right angles. The AT goes over the grassy corridor on nearly flat terrain and offers views to the valleys below on both east and west sides of Peters Mountain. At the bottom of Peters Mountain the AT crosses the existing pipeline near the AT crossing of Virginia State Route 641, known as Clendennin Road. Views from the AT at this location are in the Foreground distance zone, the woods are gently sloped and open with adjacent rural housing and rolling farm land. An existing old road bed parallels Clendennin Road at this crossing. No visual impacts of an existing pipeline are evident to the casual observer at this location. The project area is not visible at any other Concern Level 1 areas.

The Concern Level 3 route in the analysis area is Virginia State Route 641, Clendennin Road. Views from Clendennin Road are in the Foreground and Middleground distance zone. Middleground views from Clendennin Road are partially obstructed by terrain and foreground vegetation. Foreground views from Clendennin Road are of rural homes and farm land, the existing pipeline location is not evident to the casual observer.

Inventoried Scenic Integrity is a measure of the existing condition of the landscape character, vegetation and level of alteration of the land. The Inventoried Scenic Integrity for this project is Moderate. A measure of Moderate Scenic Integrity indicates that the landscape in these areas appear slightly altered.

Inventoried Scenic Class is a system of classification describing the importance or value of a particular landscape or portions of that landscape. The values in this classification system range from 1 (highest value) to 7 (lowest value). The Inventoried Scenic Class for The Appalachian Trail Corridor is Scenic Class 1. The Inventoried Scenic Class for the remainder of the project area is Scenic Class 2.

Management Prescriptions Outlined in the Forest Plan

The Scenic Class related to each prescription determines the Scenic Integrity Objectives of the area. As the prescription for each area of land varies, the Scenic Integrity Objective may also vary. The Forest Plan specifically provides direction as related to each prescription, the inventoried Scenic Class and its associated Scenic Integrity Objective.

A portion of the project area is within the Appalachian Trail Corridor. Forest Plan direction Chapter 3-23 is specific to the Appalachian Trail Corridor as it pertains to public utilities.

4A-028 direction is to locate new public utilities and rights-of-way in areas of this management prescription area where major impacts already exist. Limit linear utilities and rights of way to a single crossing of the prescription area, per project.

4A-029 direction is that mitigation measures including screening, feathering and other visual management techniques to mitigate visual and other impacts of new or upgraded utility rights of way. Mitigation measures apply to facilities as well as vegetation.

A portion of the project area is within the Rx 8A1, Mix of Successional Habitats in Forested Landscapes. The landscape character of this area retains a natural, forested appearance. A mid to late-successional forest greater than 40 years of age should dominate the landscape. The area should be interspersed with both forest communities greater than 100 years of age and herbaceous openings, providing diversity for scenic attractiveness and wildlife habitat.

Scenic Resources Effects

Alternative 1

The project as proposed meets the Forest Plan direction for Rx 4A Appalachian Trail Corridor, by co-location of the pipeline on the corridor of the existing pipeline and location of utilities where impacts already exist.

Mitigation measures to preserve the scenic resources are (these are measures 1, 7 and 8 in Appendix A):

- Any disposal of cleared timber and brush will occur outside of the restricted area.
- Prior to the initiation of clearing activities, CGV and the contractor will work with the Forest Service to minimize clearing within the 125-foot maximum clearing corridor where possible; particularly at the top of the small ridge most visible from US 460. This location was field-reviewed with the contractor and a Forest Service Landscape Architect.
- Clearing for a staging area of approximately 0.5 acres was field located with the contractor, Forest Service Landscape Architect and ATC to minimize the impacts of this area on the visual resource. The new staging area location will not impact the AT corridor and will not be readily apparent from US 460.

Lands allocated in Rx 8A1, Mix of Successional Habitats in Forested Landscapes in the Forest Plan have a Scenic Class rating of 2 and the Scenic Integrity Objective, as adopted by the Forest Plan, is Moderate. The proposed management activities would not be readily discernible to the casual observer and would easily meet the Scenic Integrity Objective of Moderate.

With fresh soil visible, short-term impacts could be visible from US 460 for approximately 60 seconds to travelers heading west. Due to the duration of the view and the viewing angle, long-term impacts to views from US 460 would not show a distinguishable difference between the existing pipeline and the proposed wider pipeline. Two other power lines and towers on Peters Mountain are more dominant than the narrow grass strip of the pipeline and tend to draw the viewer's attention.

After the initial construction has healed, AT hikers on top of Peters Mountain will cross a grassy corridor approximately 125' wide. This will afford hiker a long view of the West Virginia and Virginia valleys below. This kind of overlook often gives the hikers a sense of accomplishment to be able to see how high they have climbed. It is the same view currently visible, but will be of a slightly larger scope.

At the bottom of Peters Mountain, the trail and pipeline are not readily discernible as they both cross Clendenin Road amid rural homes and farm land and near an old roadbed. A wider pipeline location would not be evident to the casual observer at this location.

All proposed activities in Alternative 1 are in compliance with the Forest Plan.

Cumulative Effects

The consideration of potential cumulative effects of the proposed activities in each alternative when combined with past, present, and reasonable foreseeable future projects include the future relocation of the Appalachian Trail. This proposed relocation would move the Appalachian Trail away from the pipeline location. After the AT is relocated, it will no longer cross the pipeline. No other reasonably foreseeable future ground disturbing activities are planned for the area. There are no cumulative effects to scenic resources.

Scenic Resources Effects
Alternative 2

Direct and Indirect Effects

With no ground disturbing activities proposed under this alternative, there would be no impacts on scenic resources in the area.

Cumulative Effects

There are no cumulative effects to the scenic resources from the no action alternative.

ROADS MANAGEMENT

Issue(s) Related to this Resource:

None

Scope of the Analysis:

The spatial bounds of the analysis of effects are limited to national forest lands in the proposed gas transmission line corridor and the roads needed to access this corridor. The temporal bounds include past activities near the project area and any foreseeable actions within the next 10 years.

Existing Conditions:

Two existing access routes would be utilized as part of this project. They are shown in blue on the Project Map in Appendix B. These roads are in place but would require some maintenance. All road maintenance will be approved by the Forest Engineer. All construction equipment would be brought up the transmission line corridor, from the West Virginia side to the top of Peters Mountain and down the other side to the Celanese Plant. No construction equipment would be moved across Forest System Roads (FSRs).

One road, FSR11098, accesses the upper section of the transmission line. It dead ends at a power line tower and this location would be used for limited parking (5 or 6 standard trucks) for construction foremen and inspectors. FSR11098 is in fair condition and is used primarily by the power company for line and tower maintenance. This road is gated yearlong and starts off of FSR972 (Pocahontas Road). The front 1.4 miles of Pocahontas Road are open yearlong to public vehicle traffic and is maintained so that passenger cars can travel on it. The rest of Pocahontas Road is gated yearlong to general public use but is open for those who have a disabled hunter permit from Virginia Department of Game and Inland Fisheries.

The second road accesses the national forest from private land. This road has two gates on it before it enters federal land. Once it enters national forest lands it splits with one of the forks dead ending at the existing gas transmission line, right at a monitoring well. It sees very little traffic and is steep in some sections but stable. This road needs to be incorporated into Columbia Gas of Virginia's permit for this line and a gate should be installed by Columbia Gas of Virginia at the federal property line as a permit condition.

Roads Management Effects
Alternative 1

Direct and Indirect Effects
No changes in any road designation, management objective level, or use classification are needed for this project. The existing access roads would require maintenance. A gate on the lower access road would help reduce any unauthorized vehicle traffic on this road. Since no road reconstruction or construction is required, no impacts are expected.

Cumulative Effects
Since no effects are expected by the proposed action to roads management, by definition, no cumulative effects are expected.

Roads Management Effects
Alternative 2

Direct and Indirect Effects
Under the No Action Alternative, no roads would be impacted by the proposed activity.

Cumulative Effects
There are no cumulative effects to roads management from the no action alternative.

CLIMATE CHANGE

Issue(s) Related to this Resource:

None

Direct and Indirect Effects:

Alternative 1
Climate change can affect the resources in the project area and the proposed project can affect climate change through altering the carbon cycle. Climate models are continuing to be developed and refined, but the two principal models found to best simulate future climate change conditions for the various regions across the country are the Hadley Centre model and the Canadian Climate Centre model (Climate Change Impacts on the United States 2001). Both models indicate warming in the southern region of the US. However, the models differ in that one predicts little change in precipitation until 2030 followed by much drier conditions over the next 70 years. The other predicts a slight decrease in precipitation during the next 30 years followed by increased precipitation. These changes could affect forest productivity, forest pest activity, vegetation types, major weather disturbances (droughts, hurricanes), and stream flow. These effects would likely be seen across the Forest, though some sensitive species (such as high elevation communities) may be affected sooner than others. The proposed project does not have any such sensitive areas. It is not expected that the pipe line construction would substantially alter the effects of climate change in the project area given only 12. 7 acres are being impacted.

The action alternative would alter the carbon cycle in that it affects the carbon stock in any one of the pools. Alternative 1 would remove biomass as a result of timber removal. This would reduce the amount of carbon stored in the impacted area. But, all or most of carbon stored in the existing trees would continue to be stored as the trees to be cut will not be processed into products.

There would be a direct, short-term increase in carbon emissions due to an increase in dead vegetation following the clearing. However, the short-term loss of biomass resulting from clearing trees may be offset by the area's increased ability to produce herbaceous biomass.

Removal of existing trees for the gas line right-of-way in Alternative 1 would reduce existing carbon stocks at the construction site. The harvest of live trees, combined with the likely increase in down, dead wood would temporarily convert trees from a carbon sink (removes more carbon from the atmosphere than it emits) to a carbon source (emits more carbon through respiration than it absorbs). These stands would remain a source of carbon to the atmosphere until carbon uptake by new trees and other vegetation exceed the emissions from decomposing dead organic material.

The impacts of this project on global carbon sequestration and atmospheric concentrations of carbon dioxide are miniscule. However, the forests of the US significantly reduce atmospheric concentrations of carbon dioxide resulting from fossil fuel emissions. The forest and wood products of the US currently sequester approximately 200 teragrams (196,841,306 US tons) of carbon per year (Heath and Smith 2004). This rate of carbon sequestration offsets approximately 10% of carbon dioxide emissions from burning fossil fuels (Birdsey et al. 2006). US forests currently contain 66,600 teragrams of carbon. The short-term reduction in carbon stocks and sequestration rates resulting from the proposed project are imperceptibly small on global and national scales, as are the potential long-term benefits in terms of carbon storage.

The currently large carbon sink in U.S. forests is a result of past land use changes, including the re-growth of forests on large areas of the eastern US harvested in the 19th century and 20th century fire suppression in the western US (Birdsey et al. 2006). The continuation of this large carbon sink is uncertain because some of the processes promoting the current sink are likely to decline and projected increases in disturbance rates such as fire and large-scale insect mortality may release a significant fraction of existing carbon stocks (Pacala et al. 2008; Canadell et al. 2007).

Alternative 2
Under the No Action Alternative, there would be no change from the current condition. Forested stands are expected to be less resilient to possible climate change impacts such as changes in productivity or insect or disease.

<u>Cumulative Effects:</u>
There are no expected cumulative impacts expected either temporally or geographically at this site in the future.

HEALTH AND SAFETY

<u>Issue(s) Related to this Resource:</u>

2. HIKER EXPERIENCE AND SAFETY – There is a concern that the hiker experience along the AT will be negatively impacted by the construction activity but the primary concern is hiker safety. Hikers will be in the area during construction activity, including speed hikers and night hikers.

INDICATORS:

a. Are the proposed measures that are included in the proposed action adequate to address the potential hazards to hikers that are associated with the pipeline construction zone and its activities?
b. Do these measures adequate address the numbers and nature of some thru-hikers, such as speed hiking and night hiking?

Scope of the Analysis:

The geographic scope of the environmental effects analysis of the alternatives on health and safety is limited to National Forest lands within the project area. The temporal bounds include past activities affecting current use of the area, and any reasonably foreseeable recreation projects. The scope includes the following mitigation measures that will be implemented as part of this project (these are measures 1-7 and 17 in Appendix A):

- The staging area will be located just west of the existing corridor and southwest of the ridgeline of Peters Mountain, as flagged in the field on April 22, 2013.

- A barrier fence to restricted access will be placed around the vicinity of the AT prior to any activity and will remain in place for the duration of the project. This fence will enclose an area about 50' uphill from traverse point #1027 on the north side of the ridge to the top of the staging area on the south side of the ridge and about 300' wide. It will be an orange plastic mesh barrier fence, about 4 feet high and will be clearly signed as a "Do not enter" area. Construction activity inside the fence will be limited to the movement of equipment and supplies a few times a day for the majority of the project. The exception to this will be when the pipeline is actually installed inside the fence (limited to an August 1 to September 30 period as described below).

  Gates will be installed in this perimeter fence where it crosses the AT. These gates will be staffed during all periods of construction activity for the length of the project, anticipated to be from April to October 2014. These gates will be closed to hikers only when equipment is inside the area. In the rare occasion when this equipment is inside the perimeter fence for more than a few minutes, hikers will be permitted to cross the area with escort from contractor personnel.

- Installation of the pipeline inside the perimeter fence will be limited to a construction period of August 1 to September 30. This is the time of the year that has the fewest hikers while still being inside the construction season (April through November). Two interior security fences will be installed, paralleling the trail. During construction in this section, the AT will remain passable. For the short amount of time the area right at the AT needs to be trenched (anticipated to be less than a day), a bridge will be installed over the trench with a design provided by the contractor and approved by the Forest Service. Again, the gates in the perimeter fence at the AT crossing locations will be staffed during all construction activity and when not staffed, these gates will be left open with the area along the trail safe for public use.

- Clearing and grubbing of the corridor inside the restricted area is anticipated to occur prior to May 15th, 2014. If it is not done before May 15th, it will not be allowed until the August1 to September 30 construction period.

- Information concerning this project will be posted on the following web sites to alert hikers: www.appalcahiantrail.org, www.nps.gov/appa, www.fs.used.gov/gwj. Information will also be posted at the Clendennin Road (Virginia State Route 641) and Stony Creek Road (Virginia State Route 635) crossings and at Pine Swamp and Docs Knob trail shelters.

- Any disposal of cleared timber and brush will occur outside of the restricted area.

- Portable toilet facilities would be made available for use by all construction crew personnel for the duration of the project, at a ratio of no less than one per 20 persons.

Existing Situation:

As discussed under the "Recreation" section, the AT currently intersects the existing pipeline in two locations: once at the base of Peters Mountain, near Clendenin Road and again at the ridgeline of Peters Mountain. Since the new line parallels the existing line, it will cross the AT in these same locations. However, the AT on Peters Mountain will soon be relocated and the new location will completely remove the AT from the pipeline corridor (See project map in Appendix B).

All parties involved in this project (Columbia Gas of Virginia, Celanese, the Appalachian Trail Conservancy, the National Park Service and the Forest Service) are committed to getting this relocation finished as soon as possible. If the AT relocation can be completed prior to pipeline construction activity in the vicinity of the AT, all issues with hiker safety will be eliminated. In case circumstances do not allow for the relocation to be completed, this analysis will address the impacts and requirements needed if the AT is not moved prior to construction.

Health and Safety Effects
Alternative 1
All of the requirements listed above, other than the sanitation requirement with portable toilets, are designed to deal with hiker safety during construction. As discussed earlier, walking up on the construction site will be an unexpected event to many hikers. The area will be well signed and staffed to direct/delay hikers as needed. The intent is to not delay hikers for more than a few minutes. They may need to cross the construction area at the top of the mountain with an escort.

While every effort has been made to address the safety issue, short of completely moving the AT away from the construction area, there is still a potential that some hikers will not obey the signs and go through the designated area. It is possible, although unlikely, that some hikers may try to skirt around the outside edges of the perimeter fence and cross the pipeline area in an uncontrolled setting. This is unlikely since this would require them to walk several feet up and down a steep side slope and they would still be within sight of the personnel at the gates. If a hiker chose to avoid being seen while going around the construction area, it would involve even longer sidehill hiking on steep terrain and would take longer than just going through the designated areas.

Additionally, the north bound thru-hiker will have just come through a location close to a cement plant and an active railroad track, and will cross two state roads and a US route and walk through the Celanese Plant property. So the hiker will be in an area that has considerable sights and sounds of human activity and which required the hiker to be very aware of their surroundings. The first AT crossing with the project is a small area near Clendennin Road that will be dealt with by a short reroute in the woods. This is another opportunity to prepare the hiker for what they will encounter at the top of the mountain. As mentioned above, there will be project information posted at this location. This information will include photographs of the construction site on the ridgeline to prepare the hiker. Given all of these factors, the potential impact to hiker safety from the project is being managed at a reasonable level.

Cumulative Effects
There are no other activities planned for this area that will affect hiker safety.

Health and Safety Effects
Alternative 2

Direct and Indirect Effects
Since there is no project with this alternative, there is no change in health and safety and therefore no effects.

Cumulative Effects
By definition, with no direct or indirect effects, there are no cumulative effects.

LITERATURE CITED

Consultation and Coordination

The Forest Service consulted the following Federal, state, and local agencies and organizations during the development of this EA.

ID Team Members:

Tom Bailey, Soils Scientist, USDA Forest Service (USFS)
Dawn Kirk, Fisheries Biologist, USFS
Sheryl Lyles, Landscape Architect/Recreation Manager, USFS
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Forest Service Personnel, State, Local Agencies and Organizations Consulted:

Laura Belleville, Director of Conservation, Appalachian Trail Conversancy (ATC)
Andrew Downs, Regional Director, Southwest and Central Virginia, ATC
Federal Energy Regulatory Commission (FERC)
Appalachian National Scenic Trail, National Park Service
Virginia Department of Conservation & Recreation, Division of Natural Heritage
Virginia Department of Environmental Quality
Virginia Department of Game and Inland Fisheries
Virginia State Corporation Commission
Barbara Walker, Editor, USFS
Jonathan Wheeler, Dispersed Recreation/Trails/Wilderness Technician, USFS

APPENDIX A – Design Criteria and Mitigation Measures

This appendix outlines the site-specific requirements for this project as well as the most applicable Forest Plan Standards.

1. The staging area will be located just west of the existing corridor and southwest of the ridgeline of Peters Mountain, as flagged in the field on April 22, 2013.

2. Information concerning this project will be posted on the following web sites to alert hikers: www.appalachiantrail.org, www.nps.gov/appa, www.fs.usda.gov/gwj. Information will also be posted at the Clendennin Road (Virginia State Route 641) and Stony Creek Road (Virginia State Route 635) crossings and at Pine Swamp and Docs Knob trail shelters. On site posted information will include photos of the perimeter fence area.

3. A barrier fence to restricted access will be placed around the vicinity of the AT prior to any activity and will remain in place for the duration of the project. This fence will enclose an area about 50' uphill from traverse point #1027 on the north side of the ridge to the top of the staging area on the south side of the ridge and about 300' wide. It will be an orange plastic mesh barrier fence, about 4 feet high and will be clearly signed as a "Do not enter" area. Construction activity inside the fence will be limited to the movement of equipment and supplies a few times a day for the majority of the project. The exception to this will be when the pipeline is actually installed inside the fence (limited to an August 1 to September 30 period as described below).

4. Gates will be installed in this perimeter fence where it crosses the AT. These gates will be staffed during all periods of construction activity for the length of the project, anticipated to be from April to October 2014. These gates will be closed to hikers only when equipment is inside the area. In the rare occasion when this equipment is inside the perimeter fence for more than a few minutes, hikers will only be permitted to cross the area with escort from contractor personnel.

5. Installation of the pipeline inside the perimeter fence will be limited to a construction period of August 1 to September 30. This is the time of the year that has the fewest hikers while still being inside the construction season (April through November). Two interior security fences will be installed, paralleling the trail. During construction in this section, the AT will remain passable. For the short amount of time the area right at the AT needs to be trenched, a bridge will be installed over the trench with a design provided by the contractor and approved by the Forest Service. Again, the gates in the perimeter fence at the AT crossing locations will be staffed during all construction activity and when not staffed, these gates will be left open with the area along the trail safe for public use.

6. Clearing and grubbing of the corridor inside the restricted area is anticipated to occur prior to May 15th, 2014. If it is not done before May 15th, it will not be allowed until the August1 to September 30 construction period.

7. Any disposal of cleared timber and brush will occur outside of the restricted area.

8. Prior to the initiation of clearing activities, CGV and the contractor will work with the Forest Service to minimize clearing within the 125-foot maximum clearing corridor where possible; particularly at the top of the small ridge most visible from US 460. This location was field-reviewed with the contractor and a Forest Service Landscape Architect.

9. Two existing access routes would be utilized as part of this project. These roads are in place but would require some maintenance. All road maintenance will be approved by the Forest Engineer. These roads, which are currently unclassified roads, would be part of the special use permit. Columbia Gas of Virginia will be required to install a gate to Forest Service specifications at the federal boundary on the lower access road.

10. A specific erosion and sediment control plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service.

11. Sediment control structure of hay bales and/or silt fences would be installed along gradient sides of all work areas and the staging area.

12. A protective cover, such as mulch, will be applied on disturbed areas where needed to prevent accelerated erosion during construction or before the next growing season.

13. Schedule, to the extent practicable, construction activities to avoid direct soil and water disturbance during periods of the year when heavy precipitation and runoff are likely to occur.

14. Limit the amount of exposed or disturbed soil at any one time to the minimum necessary to complete construction operations.

15. A specific revegetation plan will be developed by Columbia Gas of Virginia and reviewed and approved by the Forest Service, including the seed mix.

16. If any cultural resources are located during the implementation of construction activities, all work will stop until the resources can be evaluated by the Forest Service Archeologist, in consultation with the State Historic Preservation Office, Department of Historic Resources.

17. Portable toilet facilities would be made available for use by all construction crew personnel for the duration of the project.

Additionally, all Forest Plan standards apply. Those that are most applicable to this project are listed below.

WATER QUALITY:

FW-1: Resource management activities that may affect soil and/or water quality follow Virginia, West Virginia, and Kentucky Best Management Practices, State Erosion Control Handbooks, and standards in the Forest Plan, p. 2-7.

FW-5: On all soils dedicated to growing vegetation, the organic layers, topsoil and root mat would be left in place over at least 85% of the activity area and revegetation is accomplished within 5 years, Forest Plan, p. 2-7.

FW-9: Heavy equipment is operated so that soil indentations, ruts or furrows are aligned on the contour and the slope of such indentations is 5% or less, Forest Plan, p. 2-7.

FW-10: Management activities that cause bare mineral soil on slopes greater than 5% would have erosion control planned and implemented Forest Plan, p. 2-7.

VEGETATION:

FW-86: The use of Category 1 non-native invasive plant species is prohibited, Forest Plan, p. 2-27.

FW-87: The establishment or encouragement of Category 2 non-native invasive plant species is prohibited in areas where ecological conditions would favor invasiveness and is discouraged elsewhere. Projects that use Category 2 Species should document why no other (non-invasive) species would serve the purpose and need, Forest Plan, p. 2-27.

FW-88: Favor use of native grasses and wildflowers beneficial as wildlife foods when seeding temporary roads, skid roads, log landings and other temporary openings when slopes are less than 5%. On slopes greater than 5%, favor use of vegetation that best controls erosion, Forest Plan, p. 2-27.

BACKCOUNTRY RECREATION:

FW-158: Management activities along system trails shall be implemented with sensitivity to the experience of the users. Appropriate techniques to mitigate the effects of management activities are addressed during site-specific project analysis. Measures to mitigate the effects of activities might include vegetation screening; the temporary re-routing of trail segments; temporary trail closure, avoidance and reclamation; and timing of project implementation to reduce impacts during high use periods. Forest Plan, p. 2-41.

VISUALS:

FW-184: The Forest Scenic Integrity Objectives (SIOs) Maps govern all new projects (including special uses). Assigned SIOs are consistent with Recreation Opportunity Spectrum management direction. Existing conditions may not meet the assigned SIO, Forest Plan, p. 2-48

4A-020: All management activities will meet or exceed a Scenic Integrity Objective of High, Forest Plan p.3-23

8A1-019: Management activities are designed to meet or exceed the following Scenic Integrity Objectives (SIO), which may vary by inventoried Scenic Class (SC): if SC is 1 then SIO is High; if SC is 2 then SIO is Moderate; if SC is 3 or more then SIO is Low, Forest Plan p. 3-116.

CULTURAL RESOURCES:
FW-204: Projects are designed to avoid, minimize or mitigate negative effects on potentially significant heritage resources. In-place protection of identified sites is the minimum requirement until site significance is determined, Forest Plan, p. 2-50.
FW-210: Ensure that Section 106 compliance clauses are inserted in contracts and sales documents, and that clauses are discussed in pre-work conferences, Forest Plan, p. 2-51.

LINEAR RIGHTS-OF-WAY AND COMMUNICATION SITES:
FW-247: Develop and use existing corridors and sites to their greatest potential in order to reduce the need for additional commitment of lands for these uses. When feasible, expansion of existing corridors and sites is preferable to designating new sites, Forest Plan, p. 2-60.
FW-253: Specify management requirements for permittee access roads in the designated use permit, where roads are included in the authorization, Forest Plan, p. 2-61.

LAND AND SPECIAL USES:
4A-028: Locate new public utilities and rights-of-way in areas of this management prescription area where major impacts already exist. Limit linear utilities and rights-of-way to a single crossing of the prescription area, per project, Forest Plan, p. 3-23.
FW-253: Specify management requirements for permittee access roads in the designated use permit, where roads are included in the authorization, Forest Plan, p. 2-61.

APPENDIX B – MAP

APPENDIX C – LITERATURE CITED

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 96

February 21, 2023

United States Department of Agriculture
Forest Service
George Washington and Jefferson National Forests
5162 Valleypointe Parkway
Roanoke, VA 24019
540-265-5100

File Code: 1950
Date: January 20, 2022

Dear Interested Forest Stakeholders,

The George Washington and Jefferson National Forests (GWJNF) are seeking comments regarding a programmatic Environmental Assessment (EA) and Decision Notice to issue permits to proponents to locate fiberoptic telecommunication lines across the GWJNF including the Mount Rogers National Recreation Area, Clinch Ranger District, Eastern Divide Ranger District, Glenwood and Pedlar Ranger District, James River and Warm Springs Ranger District, North River Ranger District and the Lee Ranger District across Alleghany, Amherst, Augusta, Bath, Bedford, Bland, Botetourt, Carroll, Craig, Dickensen, Frederick, Giles, Grayson, Highland, Lee, Montgomery, Nelson, Page, Pulaski, Roanoke, Rockbridge, Rockingham, Scott, Shenandoah, Smyth, Tazewell, Warren, Washington, Wise, and Wythe Counties, VA; Hampshire, Hardy, Monroe, Pendleton, and Pocahontas Counties, WV; Letcher and Pike Counties, KY.

Purpose and Need for the Project

The availability of broadband service and wireless is critical for communities to have access to health, safety, education, and employment resources. The GWJNF is receiving unprecedented requests from proponents to install linear fiberoptic telecommunication lines across and along National Forest Systems (NFS) lands to provide broadband service to rural communities. The GWJNF is long and slender and bisects the western portion of Virginia including portions of Kentucky and West Virginia. Due to the shape and arrangement of the GWJNF along western Virginia, long, linear new utilities inevitably require access across or to locate along the GWJNF.

Proposed Action

This programmatic decision would be used to meet National Environmental Policy Act (NEPA) requirements to issue special use permits to proponents requesting to locate fiberoptic telecommunication lines across NFS lands on the GWJNF. Fiberoptic telecommunication lines are long linear utilities that can largely co-locate within existing utility or road right of way corridors.

Fiberoptic telecommunication proposals would be eligible for permit issuance under this decision if the below criteria are met. This would be documented in a post decision checklist to be signed by the respective District or Area Ranger and to be issued in conjunction with a special use permit. Permit acreage would be calculated by the linear foot of the proposal by a 10’ fiberoptic telecommunication line permit width. This project does not propose a limitation of size for any permit, only that the following provisions are met:

- The project would install fiberoptic telecommunication line through micro trenching (would consist of a very narrow trench, approximately 1 foot, which would have the conduit and line installed in the bottom of the trench) and/or horizontal directional drilling (HDD) and/or lashed to existing bridges, or existing utility poles/lines,
  AND
- The fiberoptic line would have a minimal installation depth of 30”
  AND
- the fiberoptic line would mainly co-locate in existing utility or Virginia Department of Transportation (VDOT), West Virginia Department of Highways (WVDOH) or Kentucky Transportation Cabinet (KTC) road right of ways. Communication and coordination with the respective state transportation agency would be required,
  AND
- where sensitive or difficult features are to be crossed such as roads, trails, wetlands, streams etc. the fiberoptic telecommunication line would be horizontally directionally drilled. Sensitive resources would not be open trenched,
  AND
- tree clearing would be minor and limited to incidental brush or hazardous trees removal,
  AND
- as much as possible drilling pads (if needed) would be located off National Forest Systems (NFS) lands,
  AND
- no staging areas or bore pads (pits) would be located on NFS lands. The HDD machines to be used for this project should be small and sit on the ground surface within the right of way. The HDD method would not require large flat work areas or excavated pits. The drilling machine would sit on the existing ground surface and very little surface disturbance would be anticipated,
  AND
- Are not proposed on the following Forest Plan management prescriptions:

  2004 Jefferson National Forest Land and Resource Management Plan (Jefferson Forest Plan) - 2C1 Eligible Wild Rivers, 1A Designated Wilderness, 1B Recommended Wilderness,

  2014 George Washington National Forest Land and resource Management Plan (GW Forest Plan) – 2C2 Eligible Wild and Scenic Rivers, 1A Designated Wilderness, 1B Recommended Wilderness.

This project would implement and is consistent with the direction of both the Jefferson and GW Forest Plans. Specifically, GW Forest Plan Standard FW-239 and Jefferson Forest Plan Standard FW-244 both state: Evaluate new special use authorizations using the criteria outlined in 36 CFR 251.54 and according to Forest Service policy. Limit to needs that cannot be reasonably met on non-NFS lands or that enhance programs and activities. Locate uses where they minimize the need for additional designated sites and best serve their intended purpose. Require joint use on land when feasible.

During the completion of the project checklist for each permit application, the respective Forest Plan management prescriptions for the fiberoptic telecommunication line locations would be reviewed to ensure Forest Plan consistency.

Potential Resource Protection Measures

The following resource protection measures and are in addition to standards outlined in the Forest Plan. The following measures would be required for all projects. Additional measures may be developed through project development:

1. Project activities would follow pertinent State Erosion and Sediment regulations.

2. Any minor locations of ground disturbance would be revegetated with a wildlife friendly mix and in accordance with the Jefferson and GW Forest Plan standards. This mix is not to include Kentucky 31 tall fescue.

3. Would be coordinated with the appropriate state and federal partners agencies including but not limited to Federal Highways Administrative, respective state departments of transportation, Army Corp of Engineers, etc.

4. The management of traffic during installation would follow the permit requirements provided by the respective state transportation department to ensure the project does not adversely affect the safety, design, construction, operation, maintenance or stability of the state road system. This would outline such items as no disruptions to traffic would occur overnight, lane closures would be rolling, etc. The appropriate traffic control measures for each individual roadway or segment would be determined and required by each respective state's transportation department. This process would also dictate requirements for public outreach, and signage that would be required to be put into place for each segment.

5. All impacted ditch lines are to be restored to allow water flow.

6. Any impacted road shoulders are to be leveled with the road and all handholds are to be installed flat to the ground or slightly recessed to allow mowers to pass without damaging boxes.

7. An implementation checklist would be completed for each permit issuance which outlines project specific resource considerations. All pertinent Forest specialists would be consulted.

Decision to be Made and Preliminary Effects Analysis

The GWJNF Forest Supervisor is the project's responsible official. Upon the completion of this EA, each specific permit application project would be implemented with the use of a checklist tiering to this decision which would be reviewed and signed by the respective District or Area Ranger. Specific project checklists may include but would not be limited to cultural, non-native invasive species, hydrological, soil, recreation, visual, biological and Forest Plan considerations. The Forest specialists responsible for each of these resource areas would review the checklist to identify site specific design elements that may be required and verify that the impacts accounted for within the analysis of the EA captures the individual project impacts. Throughout the analysis process and development of the EA, the checklist would be drafted to capture any and all considerations that would be necessary to implement this Project in full accordance with NEPA.

No above ground infrastructure on NFS lands is proposed; therefore, no visual scenic quality impacts are expected.

Minimal hazard tree removal clearing is planned, and ground disturbance is proposed within existing disturbed corridors so impacts to threatened, endangered, sensitive and locally rare species is expected to have no effect or not likely to adversely affect. Coordination would occur with the GWJNF Forest Biologist during project development to determine the best path forward for Fish and Wildlife Service consultation.

Largely, all ground disturbing activities are proposed in previously disturbed road and trail right-of-ways; therefore, minimal impacts to heritage resources are expected. Coordination would occur with the GWJNF Forest Archeologist during project development to determine the best path forward to address cultural resources and Section 106 and Tribal Historic Preservation Office consultations.

All stream and road crossings would be horizontally directionally drilled or attached to existing bridges therefore, no impacts to streams or wetlands are expected.

Depending on additional internal and external comments received, impacts to additional forest resources would be analyzed.

Public Involvement

We welcome your involvement and encourage your comments on this proposal. For your input to be most helpful, please identify issues/concerns specific to this project which you feel need to be addressed. Comments must be postmarked or received within 30 days of the date of this scoping letter.

This Project will be subject to the pre-decisional objection process at 36 CFR 218 Subparts A and B. Only those who submit timely and specific written comments per 36 Code of Federal Regulations (CFR) §218.2 regarding the proposed Project or activity during a public comment period established by the responsible official are eligible to file an objection (36 CFR §218.24(b)(6)). In order to raise issues during the objections period, they must be based on previously submitted, specific written comments regarding the proposed Project and attributed to the objector. The publication date of the legal notice in the newspaper of record is the exclusive means for calculating the time to submit written comments on a proposal or activity. All individuals and organizations are responsible for ensuring that their comments are received in a timely manner. Comments received, including commenter names and addresses, will be considered part of the public record on this proposed action and will be available for public inspection. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not afford the agency the ability to provide the respondent with subsequent environmental documents. For objection eligibility, each individual or representative from each entity submitting timely and specific written comments regarding the proposed Project or activity must either sign the comments or verify identity upon request 36 CFR §218.24(b)(8).

Comments may be submitted electronically at:
https://cara.ecosystemmanagement.org/Public/Commentlnput?Project=61463.
Electronic comments may be submitted as Microsoft Word documents (.doc or .docx), portable document files (.pdf), or in rich text format (.rtf), text (.txt), or hypertext markup language (.html).

This web form can also be accessed from the project website:
https://www.fs.usda.gov/project/?project=61463 .

On the right side, you can select "Comment/Object on Project". Comments may also be mailed to the following address. Please state "Forestwide Fiberoptic Telecommunication Line Project" on the envelope when replying by mail.

Joby P. Timm, Forest Supervisor
5162 Valleypointe Parkway
Roanoke, VA 24019

Due to COVID-19, the Supervisor's Office is not open to the public. Customer service is being offered by phone or electronic communication. If you have any questions about this proposal, please contact Jessie Howard at (540) 492-1728 or Jessie.Howard@usda.gov. Thank you for your interest in the management of your National Forests.

Sincerely,

JOBY P. TIMM
Forest Supervisor

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 97

February 21, 2023

Ecological Applications, 27(4), 2017, pp. 1050–1056

Wild, connected, and diverse: building a more resilient system of protected areas

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Abstract. Current systems of conservation reserves may be insufficient to sustain biodiversity in the face of climate change and habitat losses. Consequently, calls have been made to protect Earth's remaining wildlands and complete the system of protected areas by establishing conservation reserves that (1) better represent ecosystems, (2) increase connectivity to facilitate biota movement in response to stressors including climate change, and (3) promote species persistence within intact landscapes. Using geospatial data, we conducted an assessment for expanding protected areas within the contiguous United States to include the least human-modified wildlands, establish a connected network, and better represent ecosystem diversity and hotspots of biodiversity. Our composite map highlights areas of high value to achieve these goals in the western United States, where existing protected areas and lands with high ecological integrity are concentrated. We also identified important areas in the East rich in species and containing ecosystems that are poorly represented in the existing protected area system. Expanding protection to these priority areas is ultimately expected to create a more resilient system for protecting the nation's biological heritage. This expectation should be subject to rigorous testing prior to implementation, and regional monitoring will ensure areas and actions are adjusted over time.

Key words: biodiversity; connectivity; conservation corridors; conservation reserves; Half Earth representation; protected areas; wildlands.

Introduction

For over 150 yr, lands within the United States have been set aside as conservation reserves to protect scenic, geological, recreational, and ecological values. These lands form the foundation of our national protected area system and provide numerous benefits to nature and society (Naughton-Treves et al. 2005). Protected areas also serve as the cornerstones of global, national, and regional efforts to sustain biological diversity (Soulé and Terbough 1999, Gaston et al. 2008). Historically, protected areas have been established in an ad hoc fashion (Pressey 1994) with little concern for representing the diversity of ecosystems (Aycrigg et al. 2013, Dietz et al. 2015) or species (Jenkins et al. 2015). Likewise, protected areas have not traditionally been intentionally connected (Belote et al. 2016), leaving many areas vulnerable to fragmentation by development (Radeloff et al. 2010, Hansen et al. 2014) and the ongoing impacts of human activities (Ordonez et al. 2014).

Many conservation scientists, therefore, recognize the need for additional protected areas that represent nature's diversity and are ecologically connected in a network, especially in the face of climate change (Secretariat of the Convention on Biological Diversity 2014). For instance, Aycrigg et al. (2016) recently called for "completing the system" of protected areas in the United States. Their recommendations include developing a national assessment of conservation priorities to identify important lands that fill gaps in the existing protected area system.

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At the same time, conservationists have documented the rapid decline in Earth's remaining wildlands and have called for their protection (Martin et al. 2016, Watson et al. 2016).

Here, we build upon previous research and respond to these recent calls by conducting a spatial assessment of conservation values in the contiguous United States. We based our assessment on a number of widely accepted principles from conservation science that provide guidance on how to construct a system of protected areas to maintain biodiversity and ecological processes in the face of habitat fragmentation and climate change (Noss and Cooperrider 1994, Soulé and Terbough 1999, Mawdsley et al. 2009, Secretariat of the Convention on Biological Diversity 2014, Schmitz et al. 2015, Aycrigg et al. 2016). We refer to the capacity of a protected area system to sustain biodiversity and natural processes across a network, even as ecosystems change within individual protected areas, as "resilience" (sensu Anderson et al. 2014). While the term "resilience" may be defined various ways (Carpenter et al. 2001, Morecroft et al. 2012), the ability of populations and species to persist among a system of protected areas under changing environmental conditions likely requires that additional lands be protected. Lands that are relatively ecologically intact, connected to existing protected areas, and representative of ecosystem and species diversity may provide the greatest degree of adaptive capacity in the face of global change (Dawson et al. 2011, Gillson et al. 2013, Schmitz et al. 2015, Martin and Watson 2016).

Methods

We used data on ecological integrity (Theobald 2013), connectivity (Belote et al. 2016), representation of ecosystems (Aycrigg et al. 2013), and a biodiversity priority index based on representation of range-limited species (Jenkins et al. 2015) to map wildland conservation values for a future protected area system in the contiguous United States. To identify intact areas of relatively high ecological integrity, we used Theobald's map of human modification (Theobald 2013). This is a composite map developed from spatial data representing land cover, human population density, roads, structures, and other stressors to ecosystems (Fig. 1a). Lands that maintain a high degree of ecological integrity or low degree of human modification have been referred to as "wildlands" (Aplet 1999, Aplet et al. 2000), and protecting the remaining wildlands is considered by many to be among the highest of conservation priorities (Watson et al. 2009, 2016, Wuerthner et al. 2015, Martin et al. 2016).

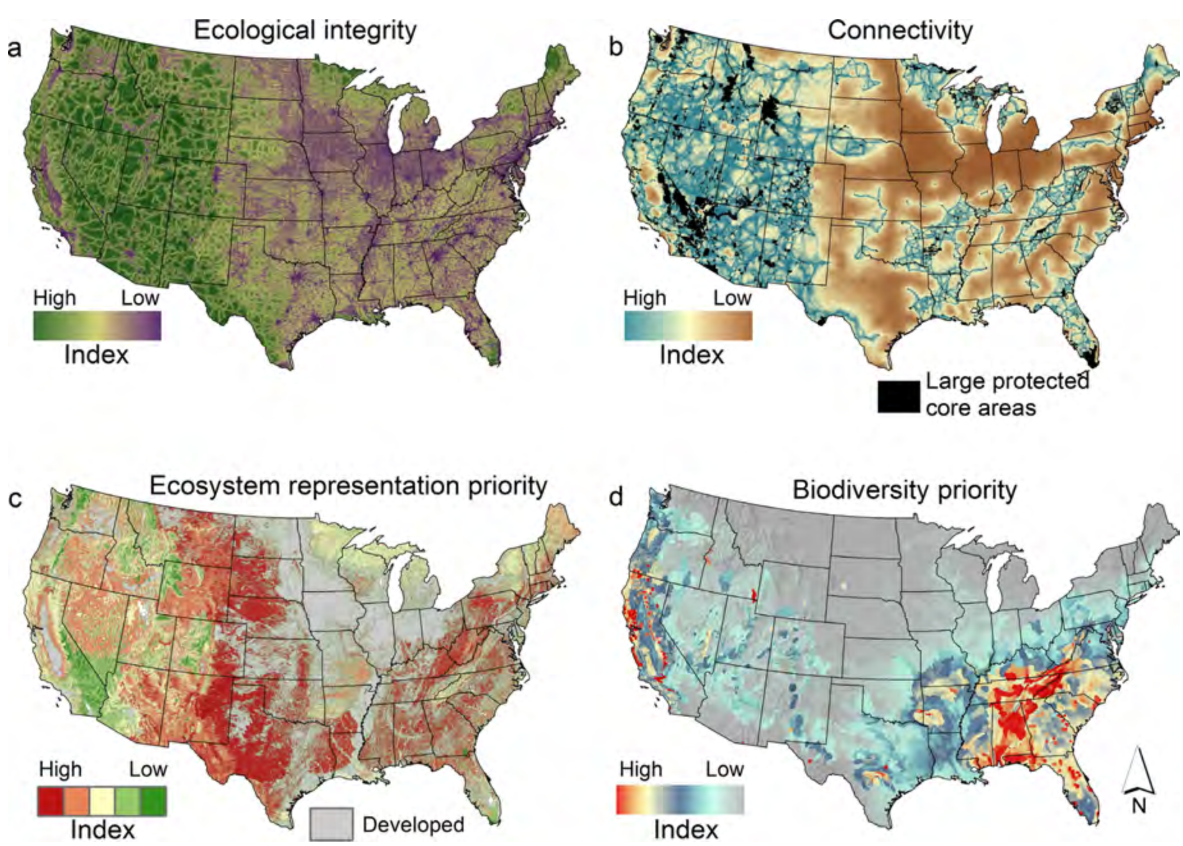

Fig. 1. Indices of conservation values used to prioritize completing the system of protected areas: (a) ecological integrity, (b) connectivity, (c) ecosystem representation priority, and (d) biodiversity priority. [Colour figure can be viewed at wileyonlinelibrary.com]

To identify lands important for maintaining or establishing connections between protected areas, we used a mapped connectivity index from Belote et al. (2016) (Fig. 1b). The index was developed to identify the least human-modified corridors between large existing protected areas, which were defined as all wilderness areas regardless of size and all other Gap Analysis Program (GAP) status 1 and 2 lands ≥4046.9 ha (10000 acres). GAP 1 and 2 areas are defined as lands for which laws, policies, or management plans mandate that biodiversity be a central conservation goal and that land conversion, commercial development, and resource extraction is prohibited or limited (USGS Gap Analysis Program 2016). Lands with a high connectivity index receive a higher wildland conservation value, as they may help to maintain ecological linkages between protected areas (Belote et al. 2016).

To identify ecosystems that are currently under-represented in the existing protected area system, we used an assessment of ecological representation in highly protected lands (Fig. 1c). Ecosystem representation has recently been calculated a number of ways, including based on the proportion of ecosystem area within different GAP status lands (Aycrigg et al. 2013), wilderness areas (Dietz et al. 2015), and roadless lands (Aycrigg et al. 2015). Our assessment of ecological representation is based on the proportion of an ecosystem's total area that occurs in lands identified in the Protected Areas Database (PAD) v 1.4 as GAP status 1 or 2 (USGS Gap Analysis Program 2016). Ecosystem classifications are based on National Vegetation Classification System in GAP land cover data (USGS 2011). We recalculated analyses of Aycrigg et al. (2013) using the latest PAD to map the percentage of total area of each ecosystem occurring in GAP status 1 or 2 areas (i.e., area of each ecosystem in GAP 1 or 2 units/total area of each ecosystem × 100). Lands composed of ecosystems that are less well represented in protected areas are assigned a higher value than lands with ecosystems that are already highly protected.

To identify regions of under-represented species, we used a biodiversity priority index of Jenkins et al. (2015) (Fig. 1d). This index was developed by overlaying maps of mammal, bird, reptile, amphibian, freshwater fish, and tree species distributions and weighting the rarity of species (calculated based on the size of each species' geographic distribution) and the proportion of its distribution that is protected based on International Union for Conservation of Nature (IUCN) categories I to VI (Jenkins et al. 2015). Lands classified in categories I to VI include similar land management goals to those of GAP 1 and 2 (USGS 2011) and most units with IUCN categories I-VI are also classified as GAP 1 or 2. Areas rich in endemic species with limited geographic distributions that are currently not well-represented in protected areas received a higher value in our index than areas with few such species.

To evaluate jointly all four conservation criteria, we normalized each mapped index using $(x_i - x_{\min})/(x_{\max} - x_{\min})$, where x_i is the value at each grid cell location, and $x_{\min}$ and $x_{\max}$ are the minimum and maximum values across the contiguous United States for each mapped criterion (Zuur et al. 2007; Appendix S1: Fig. S1). Developed lands, including urban, agricultural, or high-intensity land uses (e.g., mines) were assigned an ecosystem representation score of 0, so that they were not unintentionally prioritized for inclusion in a future protected area system even though they are not well represented in protected areas. Because of the highly right-skewed distribution of the Jenkins et al. (2015) biodiversity priority index, we log-transformed values before normalizing. The resulting distribution remained highly right-skewed, which was driven by a few species with very small geographic distributions. Because this index is ordinal, we chose to truncate the right tail of the distribution by collapsing outlying grid cells with very high values into one bin and re-normalized the index (Appendix S1: Fig. S2). Theobald's (2013) ecological integrity index was already scaled from 0 to 1 but represents a gradient of human modification where 1 is the most modified (the lowest ecological integrity). Therefore, we reversed the order so that the data ranged from 0 (lowest ecological integrity) to 1 (maximum integrity).

Following normalization, we summed the indices to produce a composite wildland conservation value map (Fig. 2). Other mapping efforts overlaying multiple values have used different calculations, such as principal components scores (Dickson et al. 2014). We chose to use the simple method of summing the normalized indices (Sanderson et al. 2002, Leu et al. 2013), because it is easy to interpret the output (e.g., mapped grid values approaching 4 are locations where the highest values of each index overlap) and qualitatively similar to output from a principle components analysis (not shown). However, recognizing limitations to overlay summation (e.g., not adequately reflecting value conflicts or complementarity; Eastman et al. 1995, Brown et al. 2015), we also produced six bivariate maps to evaluate the four values in pairwise combinations (Fig. 3). For bivariate maps, ecological integrity and ecosystem representation data were resampled from a 270- and 30-m resolution, respectively, to a 1-km resolution using bilinear interpolation prior to producing bivariate maps. This step was necessary for aligning raster grids of all data. We then classified the continuous indices into four bins using Jenks' natural breaks algorithm to minimize variance within bins and maximize variance among bins (Jenks 1967). Four bins were used for bivariate maps to ensure the occurrence of all combinations of both values.

Results

Our composite map of wildland conservation value (Fig. 2) reveals high-value areas concentrated throughout the western United States, where lands tend to be less modified by humans and where large concentrations of protected areas exist. However, several high-value regions are also distributed throughout the eastern

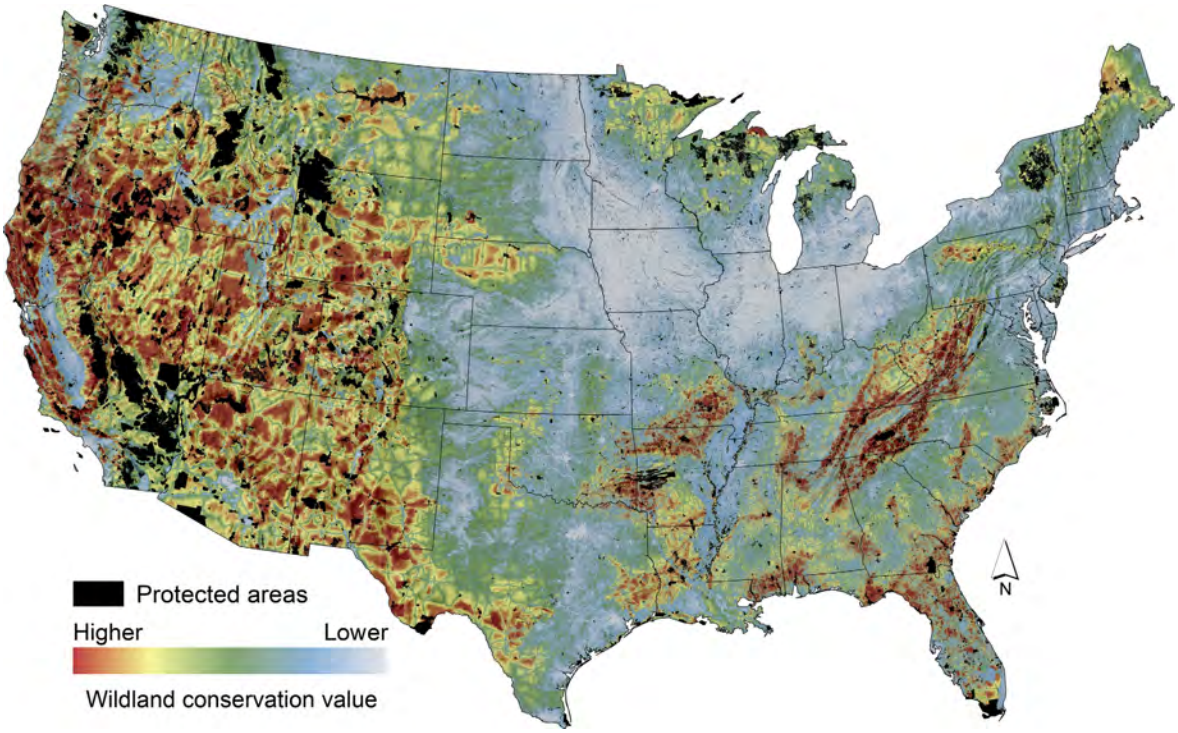

FIG. 2. Composite map of wildland conservation value based on an overlay sum of qualities in Fig. 1. Lands within existing protected areas (GAP status 1 and 2) are shown here as black (i.e., not a priority, because they are already highly protected). [Colour figure can be viewed at wileyonlinelibrary.com]

United States, including the Southern Appalachian Mountains and Cumberland Plateau, the Allegheny Plateau of Pennsylvania, the Southeastern Coastal Plain (recently recognized as a global biodiversity hotspot; Noss et al. 2015), the Sand Hills of Nebraska, the Ozark and Ouachita Mountains, east Texas and central Louisiana, Northern Minnesota and Wisconsin, and the Northern Appalachians of New England.

The bivariate maps (Fig. 3) illustrate lands where component priorities align. Areas where high ecological integrity, connectivity, and under-represented ecosystems align are common and dominate the West (Fig. 3a–c) but also occur in other areas throughout the country. Many lands located between protected areas in the West maintain a relatively high degree of ecological integrity, providing for high connectivity value (Fig. 3a). Large regions of high integrity in the West are also composed of ecosystems that are not currently well protected (Fig. 3b). These areas (Fig. 3c) may also provide important opportunities for organisms to disperse as climate changes (McGuire et al. 2016). Many of these lands of the West are managed by the federal government (Appendix S1: Fig. S3) and provide opportunities for expanding protected areas through conservation designations (e.g., wilderness or national monuments) and agency management plans. Other ecosystems with limited levels of protection that are important for connectivity occur in the mid-Atlantic, southeastern, and northeastern states (Fig. 3c). In these regions, most of the ecosystems have <5% of their distribution in protected areas. These areas may be relatively intact and important for maintaining a regional network of protected areas.

In contrast to the common co-occurrence of lands with high ecological integrity, connectivity, and ecosystem representation priorities, lands rich in range-limited species with a high degree of ecological integrity are infrequent and concentrated in California and southwestern Oregon, as well as smaller patches located in the southeastern United States (Fig. 3d). These patterns suggest that hotspots of range-limited species tend to be more impacted by human development, a pattern observed globally (Venter et al. 2016). Areas rich in range-limited species occurring in under-represented ecosystems important for connectivity are also concentrated in California, Oregon, and the Southeast (Fig. 3e–f). Appendix S1: Fig. S4 shows scatterplots between pairwise combinations of variables and describes a number of additional insights into relationships among the four metrics.

Discussion

Our assessment is designed to identify and map wildlands connecting existing protected areas that are composed of ecosystems and range-limited species not well protected in conservation reserves. Under our evaluation, these high-value areas are nationally significant

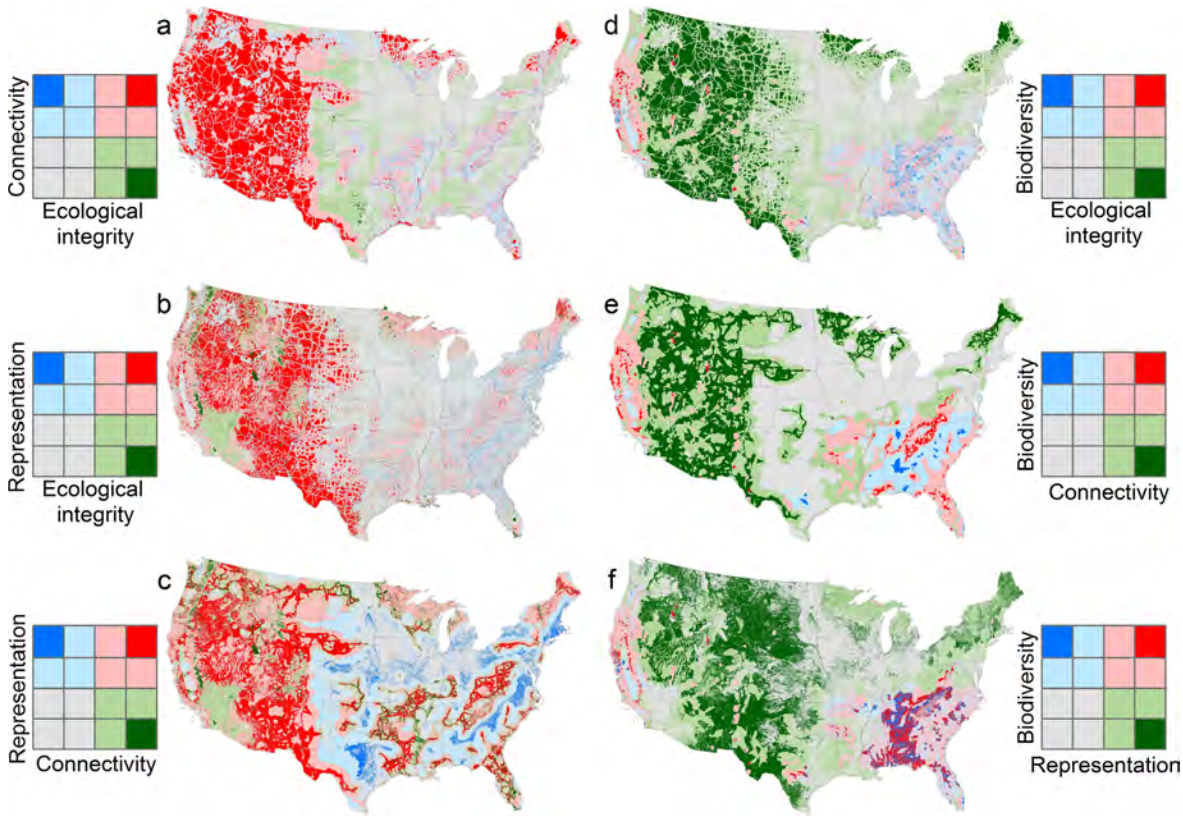

FIG. 3. Bivariate maps showing pairwise relationships between indices of (a) ecological integrity and connectivity; (b) ecological integrity and ecosystem representation priority; (c) connectivity and ecosystem representation priority; (d) ecological integrity and biodiversity priority; (e) connectivity and biodiversity; and (f) ecosystem representation priority and biodiversity. Values on each axis represent natural breaks in the index going from lower to higher from left to right along the *x*-axis and bottom to top on the *y*-axis. Therefore, in all six maps, red areas represent lands where both priorities align, blue and green areas where one priority is high and the other low. [Colour figure can be viewed at wileyonlinelibrary.com]

and reveal several regional networks that hold promise in protecting relatively intact lands important for connectivity and representative of ecosystems and species. It is important to acknowledge, however, that our proposal be treated as an initial guide for where to focus conservation efforts given the data currently available. Prior to implementation, any design should be subject to some form of initial evaluation and scrutiny to ensure that our guiding principals have empirical support. Critical to this initial evaluation is the determination of how robust any proposed conservation design is to data covering a broader set of taxa (e.g., invertebrates and herbaceous plants) and data on actual species occurrence (as opposed to the range maps used here). Even during implementation, monitoring and adaptive management will be required in the longer term to provide the evidence-based adjustments to the conservation strategies designed to maintain a resilient system of protected areas (Aycrigg et al. 2016). Regional conservation planning and monitoring coordination (e.g., through Landscape Conservation Cooperatives [Jacobson and Robertson 2012]) may be an important means to sustain these regional connected networks of protected areas.

Our work is not intended to prescribe specific actions necessary to protect individual high value lands. In practice, conservation is a complex process, involving many players using diverse tools. In some places, conservation may require the purchase of private property or easements. In other places, protection may involve the transfer of public land between agencies or the designation of a protective land class, such as wilderness. When decisions to allocate scarce resources are made by individual actors, information about costs, threats, marginal returns on investments, and other social factors are important for prioritizing conservation actions (Carwardine et al. 2008, Knight et al. 2011, Withey et al. 2012, Game et al. 2013), but determining such actions is not our intent here. Rather, we offer our assessment to guide where to take those actions, focusing on a subset of the landscape where safeguards should increase the diversity and representation of protected wildlands and facilitate movement among them.

Our analysis will serve as a resource for local conservation biologists and land managers in evaluating the national significance of local or regional lands. Of course, national gradients in values shown in Fig. 2 may not reflect some locally important areas, and regional and local assessments should complement this national evaluation. For regional and local assessments, we recommend including data not available in a national assessment such as ours (e.g., priorities for protecting herbaceous plant species or habitat used by species of conservation concern). Indeed, even when values in our composite map are rescaled to a state-wide or regional level, local areas of high value emerge (Appendix S1: Fig. S5). Many conservation decisions take place at the local or regional scales, and our assessment can place the value of local lands into a national context.

We recognize that the history of conservation science suggests that we may never be able to "complete the system," even armed with the most comprehensive assessments. A protected area system may be built that samples all known ecosystem types and even all known species, but determining the area necessary to sustain those ecosystems and species has proven difficult. The largest national park in the contiguous United States is known to depend on the surrounding lands to maintain its components (Hansen et al. 2011), and sustaining its ecosystems into the future may require connecting "Yellowstone to Yukon" (Chester et al. 2012). Building a resilient protected area system of the future is likely to be a continuing project, growing and improving as we learn more about species, ecosystems, threats, and the nature of future change through coordinated monitoring programs. It is our hope that assessments such as we provide here can offer a "guiding star" for the construction of that future system.

In a provocative new book, eminent biologist Edward O. Wilson calls for one-half of the terrestrial surface of Earth to be protected to maintain biodiversity (Wilson 2016). Wilson and others' vision (Noss et al. 2012, Locke 2015) is aspirational. The United States has been setting aside lands as conservation reserves for over 150 yr. As we look to the future it is imperative that we ask ourselves, what kind of system of protected areas should we pass down to future generations?

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Supporting Information

Additional supporting information may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/eap.1527/full

Data Availability

Data associated with this paper have been deposited in Data Basin http://adaptwest.databasin.org/pages/wildland-conservation-value

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 98

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RESEARCH ARTICLE

A general model to quantify ecological integrity for landscape assessments and US application

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Abstract Increasingly, natural resources agencies and organizations are using measures of ecological integrity to monitor and evaluate the status and condition of their landscapes, and numerous methods have been developed to map the pattern of human activities. In this paper I apply formal methods from decision theory to develop a transparent ecological indicator of landscape integrity. I developed a parsimonious set of stressors using an existing framework to minimize redundancy and overlap, mapping each variable as an individual data layer with values from 0 to 1.0, and then combined them using an "increasive" function called fuzzy sum. A novel detailed land use dataset is used to generate empirical measures of the degree of human modification to map important stressors such as land use, land cover, and presence, use, and distance from roads. I applied this general framework to the US and found that the overall average degree of human modification was 0.375. Regional variation was fairly predictable, but aggregation of these raw values into terrestrial or watershed units resulted in large differences at local to regional scales. I discuss three uses of these data by land managers to manage protected areas within a dynamic landscape context. This approach generates an internally-valid model that has a direct, empirical, and physical basis to estimate the degree of human modification.

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Keywords Landscape assessments · Ecological integrity · Land use · Degree of human modification · Fuzzy sum

Introduction

Landscape ecologists and conservation scientists have often characterized landscape and ecological systems in terms of composition, structure, and function (Noss 1990). Building on this framework, Parrish et al. (2003) defined ecological integrity of a landscape as the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region. High integrity refers to a system with natural evolutionary and ecological processes, and minimal or no influence from human activities (Angermeier and Karr 1994; Parrish et al. 2003). Species-specific approaches typically develop ecological indicators that attempt to measure attributes of a species or community, such as population size or species diversity. A complementary, and more general, approach is to develop indicators of the absence of human modification of habitat and alteration of ecological processes. An *ecological indicator* is a measurable attribute that provides insights into the state of the environment and provides information beyond its own measurement (Noon 2003). Indicators are usually surrogates for properties or system responses that are too difficult or costly to measure directly (Leibowitz et al. 1999).

Increasingly, natural resources agencies and organizations are monitoring and evaluating the status and condition of their lands and waters by measuring the ecological integrity of landscapes (e.g., Canada National Parks Act, Lindenmayer et al. 2000, IUCN 2006; Fancy et al. 2008; Borja et al. 2008; the 2012 US Forest Service Forest Planning Rule). For example, some measure of ecological integrity is typically used when assessing the current status and likely future condition of coarse-filter conservation elements that are key to the Bureau of Land Management's (BLM) Rapid Ecological Assessments (REAs) "landscape approach." Additional examples include the National Park Service's Natural Resource Condition Assessments, the Western Governor's Association (WGA) initiative on Wildlife Corridors and Crucial Habitat (www.westgov.org/initiatives/wildlife) and the US Fish & Wildlife Service's Landscape Conservation Collaboratives (LCCs; www.fws.gov/science/shc/lcc.html).

Many composite scoring systems have been used as an indicator of ecological integrity by mapping the influence of human activities on natural landscapes, including wildness (Aplet et al. 2000) and the human footprint (Hannah et al. 1995; Sanderson et al. 2002; and Leu et al. 2008; Woolmer et al. 2008). These provide general maps of human influence and have been useful, but two improvements have been offered recently (Gardner and Urban 2007; Riitters et al. 2009; Theobald 2010). First, landscape ecologists have established that proportion of cover is a fundamental metric (Gardner et al. 1987; Gardner and Urban 2007) because no other landscape metric can be interpreted independently of it (Neel et al. 2004; Wickham et al. 2008), and it provides the basis for unambiguous interpretation needed to assess landscape change (Riitters et al. 2009). Second, ad hoc scoring systems such as the human footprint are limited because the final score typically has no direct physical basis, conversion of quantitative values to ordinal categories can violate mathematical axioms, and colinearity of individual factors leads to difficulty when interpreting results (Schultz 2001). Formal methods are available from decision theory to provide transparent accountable indicators, such as multiple criteria analysis (Hajkowicz and Collins 2007).

My goal in this paper is to describe the development and applications of a quantitative, empirically-based measure of ecological integrity that is suitable for landscape-level assessments. To achieve this goal, I extend previous work (Theobald 2010; Theobald et al. 2012) and provide a formal analytical method that allows compensatory or additive effects when considering multiple stressors to: (a) describe common human modification stressors to landscapes in the US and their data sources; (b) estimate the degree of human modification that can be attributed to each stressor; (c) combine the stressors into an overall estimate of human modification; (d) incorporate spatial and landscape context into the measure; (e) validate the estimates using a national dataset of watershed condition; (f) examine the consequence of three common methods to aggregate landscape data into management-relevant decision-making units; and (g) describe general results and initial applications of this dataset. I develop a comprehensive list of common stressors and datasets used to represent them in the "Methods" section, provide basic summaries and comparison to validation data in the "Results" section, and describe some uses and ways ecological integrity maps are commonly applied by land management agencies in the "Discussion" section.

Methods

To calculate the degree of human modification I conducted three major analysis steps. First, I distinguished the magnitude (or intensity) of impact from the spatial extent (or footprint) of a given activity at a given location. Values for both the intensity and footprint range from 0.0 (low) to 1.0 (high). Second, I used an existing framework that catalogues and organizes multiple stressors into a comprehensive but parsimonious list of stressors and the spatial databases used to represent them. I generated a data layer for each stressor for which both spatial data and estimates of intensity and footprint were readily available or made. Finally, I combined the multiple stressor layers into a single, overall metric of the degree of human modification that ranges in values of 0.0 (low modification) to 1.0 (high modification).

Similar to existing approaches to map the effects of human activities on ecological integrity, for many of the stressors I relied on impacts estimated by experts documented in the literature and/or considered to be standard. However, a critical advance in this paper is that I developed empirical estimates of the degree of human modification for the key stressors on land cover, roads, and road use (based on findings of Woolmer et al. 2008) using a detailed land use dataset generated from interpretation of aerial photography. After detailing the methods used in each of the three steps to calculate the degree of human modification, I describe how I evaluated the model and some applications of the resulting data layer. The spatial datasets for each stressor were processed at 30 m resolution unless otherwise noted, and the final human modification dataset and applications of it were produced at 90 m resolution.

Estimating human modification

When measuring the degree of human modification h, I distinguished two factors of an activity at a given place: magnitude and footprint. The intensity I (or magnitude) is the degree to which an activity at a location modifies an ecological system. This helps to differentiate effects of different types of land uses—for example, using a patch of land as pasture is likely to have a lower overall effect on the ecological integrity than conversion to a parking lot. The second factor in measuring the degree of human modification is the footprint F, or the areal extent of a given human activity. In practice, the footprint is measured as the proportion of a raster cell that is occupied by a given land use. Thus, the overall effect at a location is $h = IF$, where a value of 0.0 has no human modification and a value of 1.0 has high modification. Although somewhat simplified, this equation is critical because h has a direct physical interpretation, and its value remains a ratio data type so that differences within the range are meaningful (i.e. a value of 0.8 is twice the effect of 0.4).

Estimates of I and F were made from two different sources: expert opinion or empirical datasets. Table 1 details the data sources used to represent each stressor, as well as the source of the estimates of I and F. For about half of the stressors reasonable parameters were estimated using common expert-based values, but to the extent possible, I and F were quantified using empirical estimates of modification.

For the empirically-based stressors, I estimated I as a value from 0.0 to 1.0 based on the relative amount of energy required to maintain a particular land use type (Table 2; Brown and Vivas 2005). The footprint F was calculated as the magnitude-weighted proportion of cells of land cover type c that overlap with polygons from a detailed land use dataset, which was generated interpreting land uses from recent high-resolution (<1 m) aerial photography sampled at ~6,000 random locations across mainland US. For each sample location or "chip" (roughly 600 m × 600 m), a trained photo interpreter mapped polygons of each land use type following an established protocol (Leinwand et al. 2010). To quantify F for the roughly 577 ecological system classes in the USGS Gap land cover dataset, I intersected the centers of the cells that overlap polygons found within each chip, resulting in ~400 data points in each chip. I then combined each of the natural ecological system classes into their level 3 "formation" level (Grossman et al. 1998). For human-dominated formations (Developed and Urban and Agricultural Vegetation), I maintained the detailed ecological land type. To account for bioregional variability in these broad formations and human-dominated land cover classes, the 41 formation groups were intersected with eight eco-division-groups generated based on ecodivisions that characterize both climate and biogeographic history at a sub-continental scale (Grossman et al. 1998). I then calculated the mean and standard deviation of h for each of the resulting 86 formation/ecodivision-group classes (Table 3). For formation/ecodivision group classes for which there were less than 100 data points coming from a minimum of 10 chips, I manually re-grouped these types into most similar class, first grouping across similar ecodivision groups, then formation. The final dataset had 241 unique combinations of land cover and ecodivisional classes. Note that not all formations were found in all ecodivision classes.

The detailed land use dataset was also used to derive a empirical estimates of human modification as a function of distance from interstates and highways, in 150 m increments. h was set to 0 at a distance of ≥20 km because there were fewer than 30 chips that contributed data to the calculation. Figure 1 shows a strong relationship ($r^2 = 0.98$) between the impact to the distance from major roads.

Table 1 The list of stressors incorporated in the development of the degree of human modification dataset, based on the Conservation Measures Partnership framework (Salafsky et al. 2008)

Human modification activities framework		Stressor in human modification		Parameters*		
Level 1	Level 2	Name	Data source and scale	Source	Intensity value (I)	Footprint value (F)
Residential and comm. development	Commercial and industrial areas	Urban	Fry et al.[a] (2011); Table 3, 90 m	E	Table 3	1.0
	Housing and urban areas	Residential density	Bierwagen et al. (2010); Theobald (2005) and Leinwand et al. (2010); 90 m	E	Leinwand et al. (2010)	1.0
	Tourism and recreation areas[b]	Urban	Fry et al.[a] (2011); 90 m	E	Table 3	1.0
Agriculture	Annual and perennial non-timber crops	Croplands	Fry et al. (2011); 90 m	E	Table 3	1.0
	Wood and pulp plantations	Plantations	US Geological Survey Gap Analysis Program (2011); 90 m	E	Table 3	1.0
	Livestock farming and ranching[c]					
	Marine and freshwater aqua-culture[d]					
Energy production and mining	Oil and gas drilling	Oil and gas wells	Copeland et al. (2009)	X	0.5	KD = 1.0
	Mining and quarrying	Mining	USGS Mineral Resources Data System (http://tin.er.usgs.gov/mrds/); USGS Topographic Change (http://topochange.cr.usgs.gov/)	X	0.25	KD = 0.5
	Renewable energy	Wind turbines	Federal Aviation Administration (https://oeaaa.faa.gov/oeaaa/external/portal.jsp)	X	0.17	KD = 0.5
Transportation and service corridors	Roads and railroads	Road type	TIGER (http://www.census.gov/geo/maps-data/data/tiger.html); Highways = 30 m, Secondary = 15 m, Local = 10 m 4WD/dirt = 3 m; Railways = 30 m; 30 m cell	E	1.0	Hiwy = 1.0 Sec. = 0.5 Local = 0.3 4WD = 0.1 Rlwy = 1.0
		Highway traffic	FHA (2010)—AADT (cars per day); Estimated at 50 % max for AADT = 100,000 (Theobald 2010);	X	0.5	KD = 1.0
	Utility and service lines	Utility powerlines	Electric power from Platts (http://www.platts.com/products/gis-data);	X	0.17	KD = 0.5
		Towers	FCC (2012)	X	0.25	KD = 0.25
	Shipping lanes[d]					
	Flight paths[c]					
Biological resource use	Hunting and collecting terrestrial animals[e]					
	Gathering terrestrial plants[e]					
	Logging and wood harvesting[f]					
	Fishing and harvesting aquatic resources[d]					

Table 1 continued

Human modification activities framework		Stressor in human modification		Parameters*		
Level 1	Level 2	Name	Data source and scale	Source	Intensity value (I)	Footprint value (F)
Human intrusions and disturbance	Recreational activities	Distance to major roads	FHA (2010); Theobald (2010); 90 m	E	1.0	Figure 1
	War, civil unrest and military exercises[c]					
	Work and other activities[e]					
Natural system modifications	Fire and fire suppression[c]					
	Dams and water use[d]					
Invasive species and disease	Invasive non-native species	Cover dominated by introduced species	USGS Gap Analysis Program (2011); (five classes include introduced vegetation types)	E	Table 3	1.0
	Problematic native species[c]					
	Introduced genetic material[c]					
Pollution	Household sewage and urban waste water[g]					
	Industrial and military effluents[e,g]					
	Agricultural and forestry effluents[c]					
	Garbage and solid waste[c]					
	Air-borne pollutants[e,g]					

Note that a comprehensive list of the first and second levels of classes in the framework is provided, and data gaps exist when no readily-available dataset was identified to map a stressor

* *Source of estimation E* empirical, *X* expert-opinion. *KD* kernel density with radius in kilometers. Values used to parameterize the calculation of *h*

[a] NLCD was filtered to remove the built-up land cover types that were "burned-in" on the basis of rural highways

[b] Some intense tourist and recreation uses are mapped in land cover datasets, but lower intensity tourism and recreation such as ski areas often are not included

[c] No nationally consistent, readily-available dataset is known

[d] Not applicable for terrestrial-based ecosystems

[e] Partially addressed by distance to major roads

[f] Partially addressed by plantations

[g] Partially addressed by residential and commercial development

Table 2 Estimated magnitude (*I*) values (0 → 1.0) for different land use types, from cross-walking categories to Brown and Vivas (2005)

Description	Magnitude
Undeveloped	0.0
Residential	0.7
Mixed use developed	0.9
Agriculture	0.5
Resource extraction	0.8
Industrial	1.0
Recreation	0.2
Transportation	1.0
Unknown[a]	0.3

[a] But human modified—estimated to be 0.3 because it reflects clear signs of human modification but from miscellaneous and unknown types of activities

Stressors framework and spatial datasets

The Conservation Measures Partnership (CMP) framework catalogues and organizes multiple sources of stressors or threats associated with different human activities (Salafsky et al. 2008). Organizing the multiple stressors that can influence a landscape using this existing framework helps to minimize redundancy and potential overlap. It also results in a comprehensive but parsimonious list of roughly a dozen different major threats that are further broken down into classes (or stressors) that I mapped as variables (Table 1). Each variable is represented as an individual data layer, with values that range from 0 to 1.0 (no to complete impact).

I mapped residential and commercial development stressors from the National Land Cover Dataset 2006 (NLCD; Fry et al. 2011; www.mrlc.gov) using the developed cover classes that include commercial, industrial, and residential land uses. Housing density data from Bierwagen et al. (2010) were used to map residential areas, particularly because low-density residential areas (<1 dwelling unit per acre; dua) are largely unmapped in NLCD. Agricultural stressors were mapped from NLCD classes of cropland and pastureland. I was unable to locate a consistent, reliable, and readily-available dataset on livestock farming and ranching (i.e. grazing). Energy development stressors were mapped using a kernel density (KD) function applied to oil and gas well locations (Copeland et al. 2009) with a 1 km radius and maximum impact estimated to be 0.5. State natural resource experts (WGA Landscape Integrity working group) estimated a maximum impact of 0.25 for effects associated with active mines and quarries and 0.17 for wind tower/turbine locations (https://oeaaa.faa.gov), both with a 0.5 km radius. Transportation stressors (Forman et al. 2003; Fahrig and Rytwinski 2009) were mapped using several datasets. The physical footprint of roads and railroads was mapped using TIGER 2010 data (www.census.gov/geo/www/tiger), with average widths estimated empirically from aerial photography by road type. Road use was measured by highway traffic or average annual daily traffic (AADT; number of vehicles per day) from the National Transportation Atlas Database 2012 (www.bts.gov) by applying a KD with 1 km radius and an estimated maximum impact of 0.5 for AADT ≥100,000 (Theobald 2010). Utility power lines were mapped to current power line infrastructure locations with a KD of 0.5 km and maximum impact of 0.17. I mapped communication towers and antennae from the Federal Communications Commission's Antenna Structure Registration dataset (FCC 2012) by applying a KD of 0.25 km, assuming a maximum impact of 0.25. Potential stressors associated with airplane flight paths were not mapped, due to a lack of readily-available data and limited knowledge about their impacts to biodiversity.

I was able to only partially address effects associated with biological use stressors such as hunting, fishing, plant gathering, and timber logging. These resource extraction activities tend to be quite dispersed and because they are limited by accessibility to locate a resource and to transport materials back to process, I used a measure of impact as a function of the distance from major roads (state and county highways) as a proxy (Gelbard and Belnap 2003; Coffin 2007; Fahrig and Rytwinski 2009). I did not include maps associated with fire because spatial data are limited about the degree of human modifications to these natural processes. Data on dam (and reservoir) locations are readily available, but mapping their effects is challenging, in part because much of their ecological impact manifests in an indirect way at some distance from the dam, the data required to calculate the hydraulic residency time are limited (Poff and Hart 2002) and because mapping them requires processing complex hydrologic networks. I mapped land cover that was dominated by introduced species (i.e. invasive), as mapped by the five classes in the USGS Gap land cover v2 (USGS 2011) dataset. The importance of

Table 3 Empirical estimates (average values) of human modification derived by combining detailed land use dataset with the USGS Gap land cover v2 dataset

	Pacific	IM basin	Rocky mtns.	Deserts	Great plains	Coastal	Appalachian	Northern/boreal forests	
Formation class[a]	1	2	3	4	5	6	7	8	
Polar and alpine cliff, scree and rock vegetation			0.0023	0.0023	0.0023				0.0023
Alpine scrub, forb meadow and grassland	0.0007	0.0007	0.0007					0.0007	0.0007
Temperate and boreal cliff, scree and rock vegetation			0.0185	0.0185	0.0165	0.0165	0.0165	0.0165	0.0172
Cool semi-desert cliff, scree and rock vegetation	0.4	0.0046	0.0021	0.0021	0.0021	0.0021			0.0688
Warm semi-desert cliff, scree and rock vegetation	0.0087	0.0087	0.0087	0.0061	0.0061	0.0061		0.0061	0.0072
Mediterranean cliff, scree and rock vegetation	0			0		0	0	0	0.0000
Cool temperate forest	0.0436	0.0074	0.0178	0.0119	0.1171	0.215	0.1289	0.0911	0.0791
Lowland and montane boreal forest					0.053		0.053	0.053	0.0530
Warm temperate forest	0.0328	0.1024	0.0114	0.0071	0.0683	0.2203	0.2141	0.2141	0.1088
Tropical (semi-) deciduous forest						0.1468			0.1468
Boreal grassland, meadow and shrubland								0.1427	0.1427
Temperate grassland, meadow and shrubland	0.0687	0.0232	0.0413	0.0098	0.1454	0.3129	0.1961	0.1427	0.1175
Mediterranean scrub	0.0384	0.0384		0.0384		0.0384		0.0384	0.0384
Mediterranean grassland and forb meadow	0.0962	0.0962		0.0962		0.0962		0.0962	0.0962
Cool semi-desert scrub and grassland	0.0037	0.0122	0.0103	0.0203	0.0236	0.0236			0.0156
Warm semi-desert scrub and grassland	0.0222	0.0222	0.0222	0.0236	0.0853	0.1204	0.1021	0.0613	0.0574
Temperate and boreal scrub and herb coastal vegetation	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859
Tropical wooded, scrub and herb coastal vegetation						0.1859			0.1859
Boreal flooded and swamp forest					0.0985		0.0985	0.0985	0.0985
Mangrove						0.1468			0.1468
Marine and estuarine saltwater aquatic vegetation	0.0248		0.0248			0.0364		0.0364	0.0306
Salt marsh	0.0248	0.0248	0.0248	0.0248	0.0231	0.0364	0.0364	0.0364	0.0289
Temperate and boreal bog and fen	0.1214	0.1214	0.1214		0.1214	0.1214	0.1214		0.1214
Temperate and boreal scrub and herb coastal vegetation	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859	0.1859
Temperate flooded and swamp forest	0.0862	0.0439	0.0512	0.0861	0.1643	0.1468	0.1374	0.0901	0.1008
Tropical flooded and swamp forest						0.1468			0.1468
Tropical Freshwater Marsh						0.0096			0.0096
Freshwater aquatic vegetation	0.0096					0.0096	0.0096		0.0096
Open water	0.0323	0.012	0.0013	0.0013	0.1088	0.0614	0.08	0.0341	0.0414
Barren	0.0541	0.0541	0.0541	0.0541		0.0541	0.0541	0.0541	0.0541
Current and historic mining activity	0.5887	0.3765	0.3469	0.4682	0.5328	0.4721	0.5474	0.4338	0.4708

Table 3 continued

Formation class[a]	Pacific	IM basin	Rocky mtns.	Deserts	Great plains	Coastal	Appalachian	Northern/boreal forests	
	1	2	3	4	5	6	7	8	
Introduced and semi natural vegetation	0.0847	0.0556	0.09	0.09	0.2628	0.1649	0.1649	0.1649	0.1347
Woody agricultural vegetation	0.419		0.419						0.4190
Herbaceous agricultural vegetation pasture	0.421	0.2315	0.2986	0.2806	0.3845	0.3475	0.3919	0.387	0.3428
Herbaceous agricultural vegetation cropland	0.4764	0.4201	0.351	0.4248	0.4574	0.4557	0.4335	0.3917	0.4263
Recently disturbed or modified	0.2893	0.0029	0.1297	0.069	0.2885	0.3524	0.2855	0.3466	0.2205
Developed, Open Space	0.2965	0.4064	0.2554	0.1379	0.4187	0.3953	0.397	0.3285	0.3295
Developed, low intensity	0.5887	0.3765	0.3469	0.4682	0.5328	0.4721	0.5474	0.4338	0.4708
Developed, medium intensity	0.6505	0.6505	0.6505	0.6505	0.6341	0.5329	0.6851	0.6389	0.6366
Developed, high intensity	0.6033	0.6033	0.6033	0.6033	0.7303	0.6909	0.7621	0.7621	0.6698
Average	0.20	0.16	0.15	0.15	0.22	0.19	0.23	0.19	

Note these are calculated independently for each ecodivision grouping, ensuring that there were at least 100 data points that the estimates were based on, following methods described in Leinwand et al. (2010) and Theobald et al. (2012)

[a] This is the formation level for natural cover types from the National Vegetation Classification (Grossman et al. 1998)

invasive species and problematic native species in altering the condition of ecological systems is widely recognized, but a detailed, readily-available dataset on the location or proportion of these species is not available (Bradley and Marvin 2011). Also, note that stressors related to pollution were not directly included—although effects from these are partially included in our overall model because I directly map roads, urban areas, residential housing, and croplands.

Combining stress layers to overall degree of human modification

I used a method that minimizes bias associated with non-independence among multiple stressor/threats layers. That is, I assumed that locations with multiple threats have a higher degree of human modification than locations with just a single threat (assuming the same value), but the cumulative human modification score converges to 1.0 with multiple stressors. The specific algorithm is called a "fuzzy algebraic sum" (Bonham-Carter 1994) and the result is always at least as great as the largest contributing factor, so the effect is "increasive", but never exceeds 1.0 (Theobald 2013). The overall degree of human modification H_i at each cell i, with values that range from 0.0 (no modification, natural) to 1.0 (highly modified, un-natural) and is calculated as:

$$H_i = 1.0 - \prod_{j=1}^{k} \left(1 - h_j\right)$$

and let h = human modification score for individual stressor, with values ranging from 0.0 (no human modification, natural) to 1.0 (high degree of modification, un-natural), for $j = 1 \ldots k$ data layers. For example, H_{i} for three layers of 0.6, 0.5, and 0.4, the computation would be: $H_{\mathrm{i}} = 1.0 - ((1 - 0.6) \times (1 - 0.5) \times (1 - 0.4))$, or 0.88. Note that the final human modification layer where each raster cell value equals H_{i} is denoted as H. I also identified the stressor h_j that contributed the highest level impact at a given location, which I called "dominant."

Model evaluation and application

Because measures of ecological integrity commonly are used in spatially-explicit models, such as the

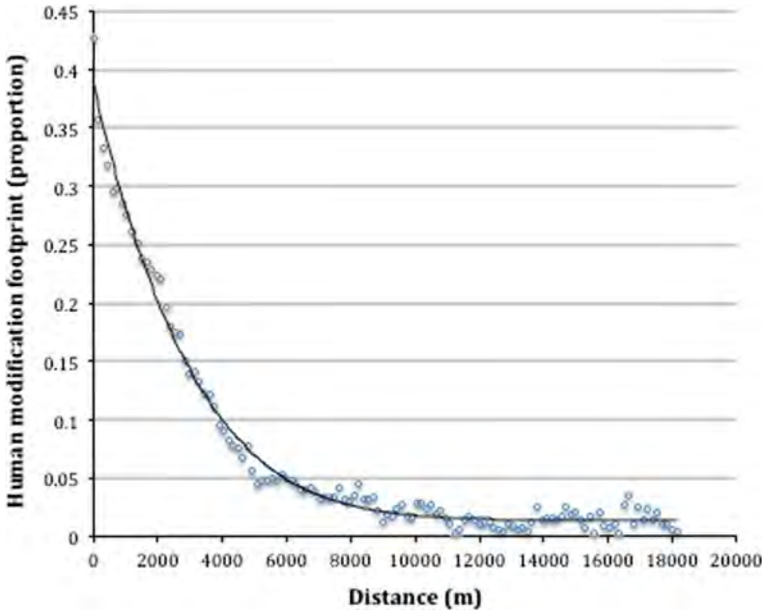

Fig. 1 The relationship of human modification to distance from major roads, fit using a 4th order polynomial trend line: $y = -5E - 22x^5 + 4E - 17x^4 - 1E - 12x^3 + 2E - 08x^2 - 0.0001x + 0.387$ ($R^2 = 0.98$)

resistance layer for connectivity mapping (e.g., Carroll et al. 2012; McRae et al. 2012; Theobald et al. 2012), it is important to understand and evaluate the degree to which spatial processes are integrated into a measure and the spatial patterns that emerge, so that reasonable interpretations can be made. That is, most landscape integrity maps account for local or very fine scale (e.g., within a cell or nearby such as 500 m), but for some purposes are aggregated to watersheds (e.g., Esselman et al. 2011). Commonly in landscape ecology two dominant ecological processes have been discussed (Wiens 2002): those dominated by terrestrial processes (animal movement, wind dispersal, etc.) and those that are dominated by freshwater processes (i.e. hydrologic and riverine).

To evaluate the role of a presumed dominant ecological process in forming spatial pattern, I calculated and compared three ways to process the raw values in the human modification dataset. To represent *local* or in situ processes, I calculated the mean value of *H* from the 90 m dataset for each 12-digit HUCs, denoted as H_l. To represent a *watershed* perspective where hydrologic connectivity dominates but is not limited to downstream-only flows (and therefore this is not freshwater in the strict sense), I calculated a hierarchical watershed average value, denoted as H_w. That is, the mean H value within each HUC found within each 12, 10, 8, 6, and 4-digit layer was calculated, and then the mean *H* value at each raster cell across the 5 layers was calculated. An important distinction here is that this approach does not assume that a given process can be adequately captured at a single scale (or even known adequately), but rather it makes use of a multi-scale averaging process that is more appropriate for general representation of landscape-level processes (Riitters et al. 2009; Theobald 2010). To represent a *terrestrial* perspective, I applied the multi-scale averaging approach and assumed that the dominant ecological processes were isotropic and therefore were represented by a moving *circular* windows, scaled in size equal to the average HUC area: 101, 545, 3981, 25426, and 42168 km^2 for HUC 12-4, denoted as H_t.

To compare the process perspectives, I calculated a *Z*-score by standardizing the H_l values in each HUC12 against the values from the local process layer. Locations with a large negative *Z*-score signify that the local scores are significantly higher and over-represent the impact compared to when areas are integrated according to either a watershed or terrestrial perspective. Locations with a large positive *Z*-score signify that the local scores (H_l) are significantly lower and under-represent the impact compared to the watershed (H_w) or terrestrial (H_t) maps.

I assessed how well the degree of human modification predicts a general indicator of field-level conditions from the EPA's Wadeable Stream Assessment (WSA) following the approach of Falcone et al.

(2010). I classified sites into two levels of disturbance: *reference* sites that were considered to be natural or least-disturbed conditions in their ecoregions (n = 1,699) and *disturbed* which were considered to be most heavily-modified by human activities (n = 440). I expected that there would be a significant difference between the human modification values within the reference sites versus the disturbed sites. I expected that the watershed characterization would have the best fit with the WSA sites, followed by terrestrial (because of spatial process), and the poorest fit with the local process (HUC12). Finally, I summarized findings by protection status level from the Protected Areas Database (http://gapanalysis.usgs.gov/padus/).

Results

For the conterminous US, I found the overall average degree of human modification H value was 0.3756 (SD = 0.243). Of course this varies regionally (Fig. 2; Table 4), and not surprisingly the intermountain west was least modified ($H = 0.2216$, SD = 0.193), while the Great Lakes region was most heavily modified by human activities ($H = 0.5349$, SD = 0.211). The general pattern of human modification also increases predictably as a function of decreasing protection level, so that H in status 1 = 0.1556 (SD = 0.141), 2 = 0.2004 (SD = 0.176), 3 = 0.2021 (SD = 0.162), and 4 = 0.4349 (SD = 0.236).

Table 4 Results of the degree of human modification within census regions (http://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf)

Region	Mean	SD
Pacific	0.2860	0.237
Intermountain West	0.2216	0.193
North Central	0.4715	0.185
South Central	0.4206	0.215
Great Lakes	0.5349	0.211
Northeast	0.4805	0.248
Southeast	0.5187	0.213

Figure 3a–c show the degree of human modification mapped to examine results from different spatial processes: local (HUC12), watershed, and terrestrial. Figures 4a–c show the same data but zoomed into the Austin, Texas area as an example of the detailed patterns. At a continental extent, all three patterns are generally similar, but Fig. 5a and b show the departure from local values for both the watershed and terrestrial maps. Zooming into a narrower region (for example, Austin Texas; Fig. 5c, d) shows the fine-grained heterogeneity of these differences, including a difference in direction

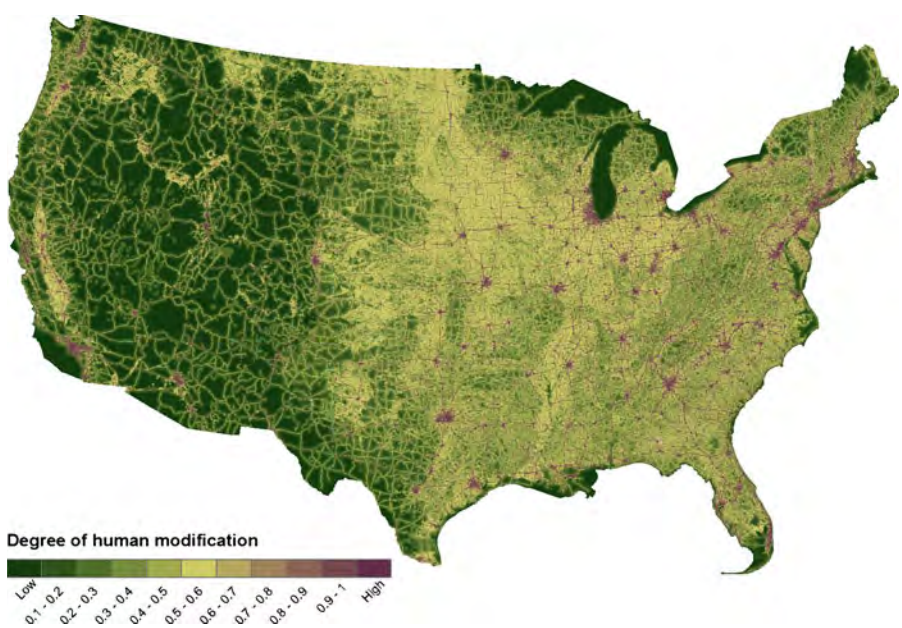

Fig. 2 The degree of human modification (H) for the conterminous US at 90 m resolution, showing low levels of human activities in *green*, moderate levels in *yellow*, and high levels of human activities in *red*. *Note* major water bodies are included for reference, but water-based stressors are not included in a primary way. (Color figure online)

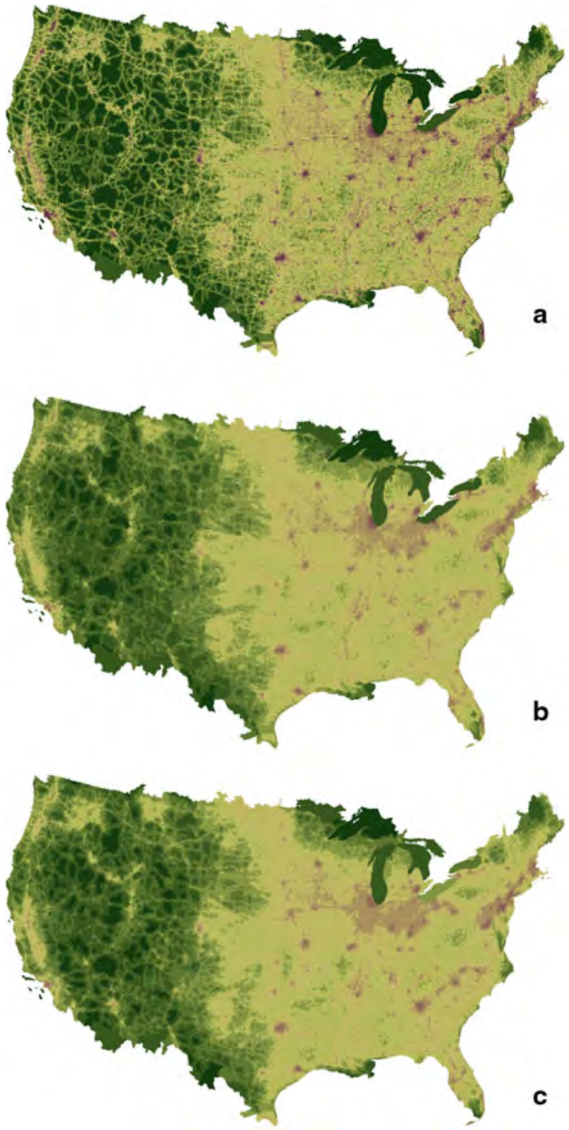

Fig. 3 Maps showing the degree of human modification (see Fig. 2 for legend), for different assumed ecological processes: **a** the "local" shown at a 12-digit hydrologic unit code; **b** "watershed" perspective by hierarchical averaging across HUC units 12, 10, 8, 6, and 4; **c** "terrestrial" using five moving windows sized equal to the average HUC units at the various scales

Fig. 4 A zoom-in map around Austin, Texas showing the degree of human modification, for different assumed ecological processes: **a** the "local"; **b** "watershed"; and **c** "terrestrial"

(under- vs. over-estimation) for some locations between watershed and terrestrial results.

Not surprisingly, I found that stressors associated with land uses that resulted in conversion to developed lands were dominant. Urban and residential density and agricultural activities were dominant for 44 % of the US, while impacts associated with distance from major roads dominated 51 %—particularly in the western US. For 2 % of the US, the road footprint was dominant, while effects associated with housing density was dominant in 0.3 %. Recall that the road footprint represents only the physical extent up to

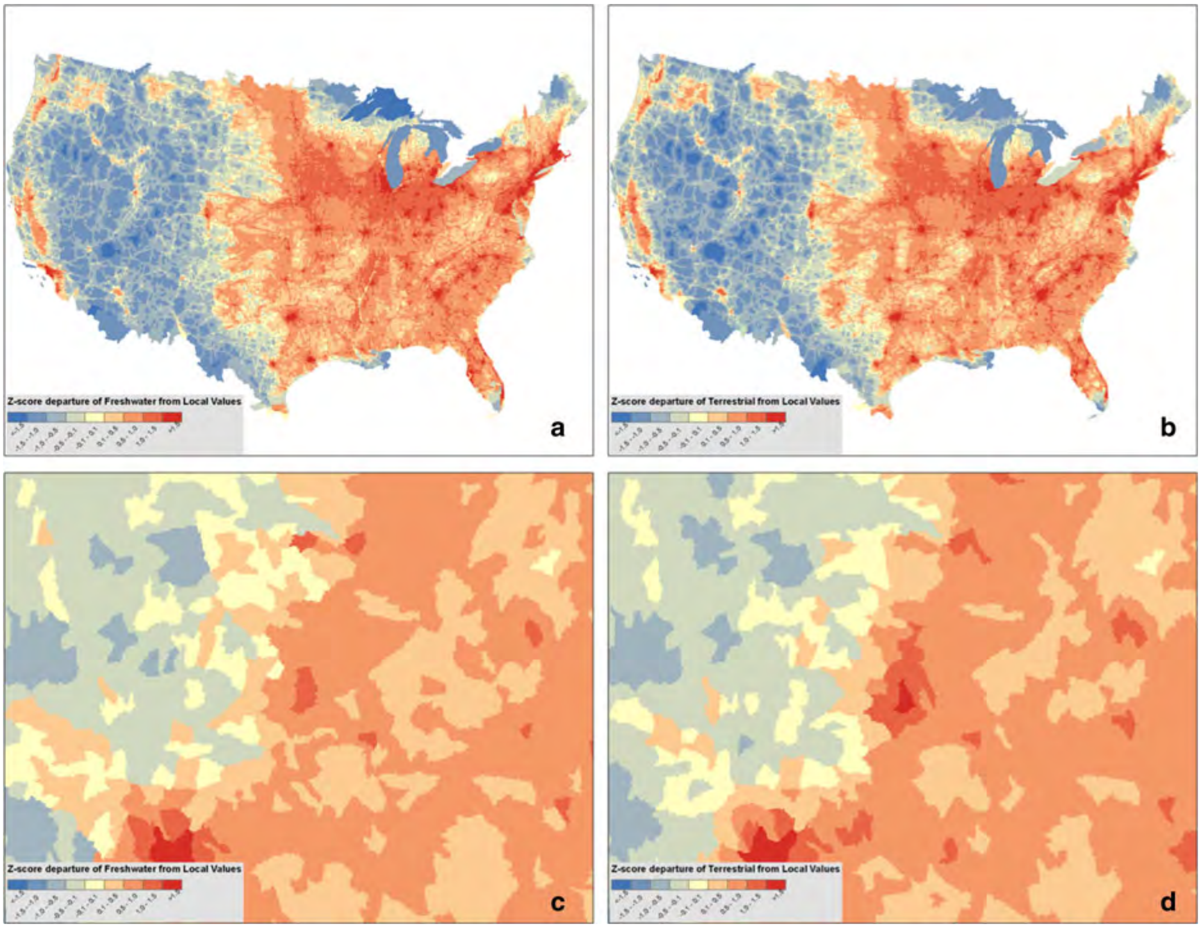

Fig. 5 A map showing the departure from local values for both **a** watershed and **b** terrestrial maps, as compared to local 12-digit HUC scores; **c** is freshwater near Austin, TX; and **d** is terrestrial near Austin, TX. That is, a *Z*-score was calculated by standardizing the *h* values in each HUC12 against the local values

30 m, and note that for most locations multiple stressors occurred together.

I compared results of *H* values (90 m resolution) from 2,139 WSA sites, and found that the mean value of *H* is less in reference sites (mean = 0.351, SD = 0.173) than disturbed sites (mean = 0.432, SD = 0.197). The distributions of reference to disturbed sites were significantly different using a Cramer–von Mises two-tailed test ($p = 0.005$) for all three forms: local ($W^2 = 6.558$), watershed ($W^2 = 3.495$), and terrestrial ($W^2 = 3.907$). Also, there is less variability in the watershed values for reference and disturbed sites (SD = 0.147, 0.161) as compared to the terrestrial (SD = 0.152, 0.164) and the local (0.173, 0.197) datasets, one indication that the watershed-process layer had the best fit with the validation dataset.

Discussion and application

The finding that about 38 % overall degree of human modification is roughly comparable with past estimates of human footprint and naturalness (34–35 %; Theobald 2010), though the variability of values in the current results has been reduced roughly in half. This is likely due to a tighter estimation of the degree of human modification.

Landscape integrity values changed substantially depending on what ecological process was assumed to be dominant. That is, for most urban and highly-modified locations (particularly in the eastern US), a map of local values tends to underestimate impacts because it does not consider any spill-over or influence from adjacent or nearby HUC12s. This assumption may be justified for some situations where local-scale processes dominate. For other situations, such as potential effects of human activities on river water quality, clearly nearby (and especially upstream) impacts can strongly influence nearby (especially downstream) conditions. Note that even a simple isotropic assumption of spatial process can result in estimated values that are quite different from local conditions. Very fine-grained differences can occur—including a difference in direction (under- vs. over-estimation) for some locations between watershed and terrestrial results (e.g., Fig. 5d). The main point from this process comparison is that strongly different results can be obtained depending on the assumed ecological process and neighborhood or scale of analysis (Wiens 1989).

These results could be applied in three main ways by land management agencies. First, many programs directly use a measure of ecological integrity as a key variable in landscape assessments. For example, the results here could be used to update the BLM's REAs to provide a more consistent basis for their results. That is, using a comprehensive and empirically-based estimate of human modification would strengthen the findings of existing REAs and would enable consistency across the roughly dozen assessments. The degree of human modification results found here could also be used directly in the ongoing ecoregional landscape assessments conducted by the 16 LCCs, or to identify the large intact landscapes that is a primary data layer in the WGA Crucial Habitat Assessment Tool.

Second, the data layer here can be summarized to provide a measure of landscape context to inform management within a specific protected area (e.g., Hansen et al. 2011). As described earlier, Table 5 provides a summary of the degree of human modification averaged across each LCC, ranging from a low of 0.1835 for Great Basin and a high of 0.5797 in the Eastern Tallgrass Prairie and Big Rivers LCC. From a continental or national perspective, analyzing these scores in this way provides a robust and consistent measure of landscape integrity that can be used to roughly compare among broad units. Similar measures can be easily developed, for example for the 17 states in the WGA CHAT, the 32 networks of the National Park Service and the 14 ecoregions of the BLM's REAs.

A third type of use is to characterize the ecological context outside of existing protected areas to provide more locally-relevant and meaningful measures that can be used to inform the selection of conservation targets and/or help to prioritize specific locations of conservation action within each administrative unit—at the local, state or federal managerial unit. For example, Fig. 6 provides a depiction of areas of potential conservation opportunity that combines a regionalized landscape integrity score with a protection status score to help distinguish potential audiences and actions. That is, the H values at each location were standardized to the LCC so that importance is expressed relative to each LCC. Locations (in this case HUC12 s) with each LCC were then ranked to identify the 90th-percentile, the 75th, and the 50th (i.e. the median) as a rough classification of importance. These are portrayed in different colors for conservation status (Gap status level) 1&2 (highest protection level for biodiversity (i.e. biodiversity reserves), 3 (protected with some extractive activities), and 4 (unprotected, mostly privately-owned). Opportunities and actions differ with each status category (Wade et al. 2011); indeed, for each land owner and management unit as well, but those are beyond the scope of this paper. For example, status 1&2 will likely be focused on management of currently protected lands, rather than targeting specific locations to change management of status 3 lands to be more compatible with biodiversity protection—particularly those with high

Table 5 Results of the degree of human modification within US Fish & Wildlife Service Landscape Conservation Collaboratives for the conterminous US

Name	Mean	SD
North Pacific	0.3143	0.230
California	0.3901	0.261
Great Northern	0.2150	0.193
Great Basin	0.1835	0.183
Southern Rockies	0.1962	0.176
Desert	0.1952	0.188
Plains and Prairie Potholes	0.4028	0.198
Great Plains	0.4269	0.184
Gulf Coast Prairie	0.4176	0.227
Upper Midwest and Great Lakes	0.3754	0.260
Eastern Tallgrass Prairie and Big Rivers	0.5797	0.173
Gulf Coastal Plains and Ozarks	0.4888	0.189
North Atlantic	0.4763	0.265
Appalachian	0.5014	0.211
South Atlantic	0.5406	0.210
Peninsular Florida	0.5150	0.259

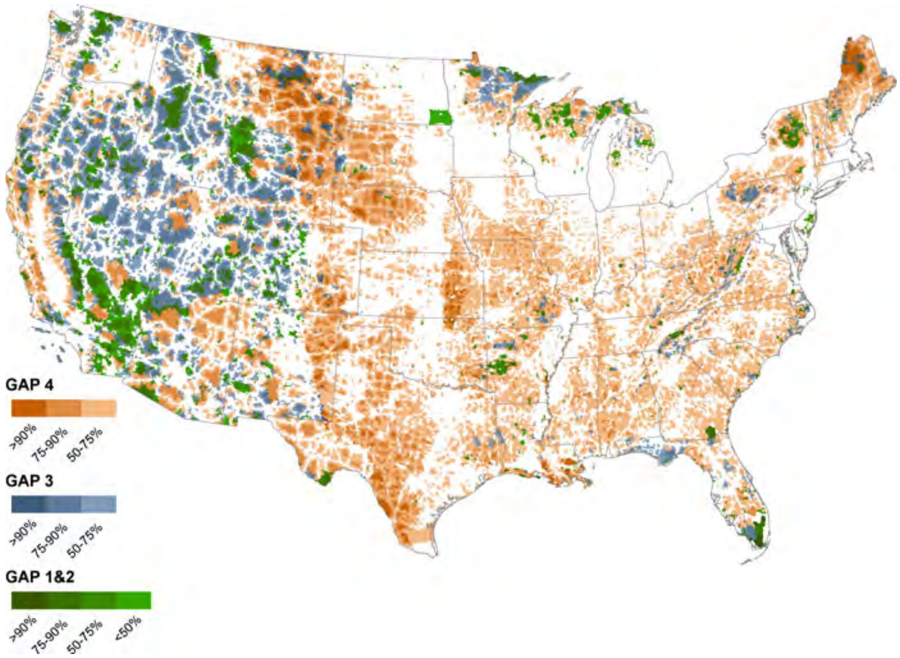

Fig. 6 Potential conservation opportunities to conserve large, intact landscapes. Results are shown for three protection level status codes: parks and wilderness areas in Gap level 1&2 (*green*), multi-use public lands in Gap 3 (*blue*), and privately-owned lands without formal conservation protection in Gap 4 (*orange*). Deeper hues signify 12-digit HUCs with a lower degree of human modification (i.e. higher levels of landscape integrity), lighter hues signify a higher degree of human modification—areas without any colors (*white*) have a relatively high degree of human modification. (Color figure online)

landscape integrity near a cluster of status 1&2, or perhaps providing corridors of higher protection to move between reserves. For status 4 lands, areas with high integrity ranks might be considered to have higher value in a prioritization for potential conservation purchase or easement programs. Although this approach is not intended to replace prioritization efforts by individual agencies and organizations, it does give an important complementary perspective by providing an integrated, synthetic, landscape view that crosses land ownership boundaries. Note that locations that are less than the mean standardized value are not portrayed in this map, but should not be interpreted as having no conservation value. Instead, these locations could be viewed through a restoration lens, by identifying those areas that contribute to overall improvements if local stressors to landscape integrity could be ameliorated (Baldwin et al. 2012).

I recognize that there was a practical and opportunistic aspect to the selection of stressors that were included in the final model, as not all stressors have reliable, publicly-available datasets available. A critical advantage of examining potential stressors within the broad framework is that insight can be gained into which threats were most important (impactful) and relevant, and the gaps are made explicit to identify future opportunities for data that would improve the overall human modification model. To that end, the most critical datasets for future improvement to this landscape integrity dataset include stressors that effect disproportionately freshwater resources such as dams, irrigation, and pumping, the proportion of invasive species, likely shifts in biomes due to climate change, the intensity of domestic grazing, and hunting and fishing pressure. Although not emphasized in this paper, this approach supports the monitoring of status and trends in landscape integrity, as the main inputs are time dependent (cover, housing, roads, etc.) so that a landscape integrity dataset could be generated at a 5–10 year interval (e.g., Theobald 2010).

In this paper I developed and provided preliminary applications of an empirically-based, robust measure of ecological integrity at the landscape level. I found that the degree of human modification averaged to be about 0.38 across the US, with reasonable regional variation. Estimates of impact for roughly half of the stressors included here relied on values established by expert judgment, but more than 97 % of the US was dominated by a stressor whose impact was estimated using empirical data. Although improvements could be made to this approach, especially in terms of filling data gaps on invasive species and grazing/hunting intensity, the framework and methodology described here provides important improvements over existing, ad hoc approaches, to provide a foundation on which sound monitoring and evaluation of ecological integrity can be based. Most importantly, landscape-level assessments of ecological integrity should be based on an internally consistent model, comply with decision theory principles, incorporate empirically-derived data to the maximum extent possible, explicitly state the incorporation of the assumed dominant ecological process, and provide validation of their results to the degree possible.

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 99

February 21, 2023

Excerpts of:

Scientific background for soil monitoring on National Forests and Rangelands: workshop proceedings; April 29-30, 2008; Denver, CO

Scientific Background for Soil Monitoring on National Forests and Rangelands

Workshop Proceedings, April 29-30, 2008, Denver, Colorado

United States Department of Agriculture / Forest Service

Rocky Mountain Research Station

Proceedings RMRS-P-59

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Abstract

This workshop was developed to determine the state-of-the-science for soil monitoring on National Forests and Rangelands. We asked international experts in the field of soil monitoring, soil monitoring indicators, and basic forest soil properties to describe the limits of our knowledge and the ongoing studies that are providing new information. This workshop and the proceedings are particularly important as National Forests wrestle with determining how (or if) to modify their existing soil quality standards and guidelines.

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Papers were edited to a uniform style; however, authors are responsible for content and accuracy of their papers.

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Scientific Background for Soil Monitoring on National Forests and Rangelands

Workshop Proceedings, April 29-30, 2008, Denver, Colorado

Preface

These proceedings are the result of interactions with Regional Soil Program Managers, Forest Soil Scientists, Regional Timber Sale Administrators, Research Soil Scientists and Silviculturists, University Professors, and the BC Ministry of Forest and Range Soil Scientists through the National Soil Quality Standards working group established by the Region 1 Regional Forester (Abigail Kimbell) in 2002. This group helped guide the development of a national Forest Soil Disturbance Monitoring Protocol, developed the idea for a picture guide to forest soil disturbance, and brought together leaders in soil quality and soil quality monitoring to establish the state-of-the-science documented in these proceedings. This documentation is meant to provide the information needed for revision of Regional Soil Quality Standards and Guidelines.

Contents

Using Soil Quality Indicators for Monitoring Sustainable Forest Management

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Abstract—Most private and public forest land owners and managers are compelled to manage their forests sustainably, which means management that is economically viable, environmentally sound, and socially acceptable. To meet this mandate, the USDA Forest Service protects the productivity of our nation's forest soils by monitoring and evaluating management activities to ensure they are both scientifically wise and socially responsive. The purpose of this paper is to review soil quality indicators and models for their possible use in soil management and evaluation programs. The Forest Service has taken a progressive stance on adapting their long-used soil quality monitoring program to take advantage of new science and technology. How forest soils function in terms of their stability, hydrology, and nutrient cycling is better understood, and indicators of these functions have been identified and tested for cause and effect relationships with tree growth and ecosystem health. Soil quality models are computer-based evaluation tools that quantify soil change and potential change in forest productivity due to management inputs or unintended detrimental disturbances. Soil quality models, when properly conceptualized, developed, and implemented, can provide a legally defensible monitoring and evaluation program based on firm scientific principles that produce unequivocal, credible results at minimum cost.

Introduction

Most private and public forest land owners are compelled to manage their forests sustainably. Sustainable forest management (SFM) is a 21st century management approach that has been branded by the forestry community in the United States and other parts of the world as a concept that provides the basis for site-specific management practices and guidelines. Sustainable forestry is economically viable, environmentally sound, and socially acceptable (Sample and others 2006).

Based on these SFM principles, groups of countries sharing similar forest resources developed criteria and indicators (C&Is) that measure and monitor sustainability (Montreal Process 1995). The C&Is serve as policy and management tools; they are neither management standards nor regulations. They provide a framework for determining the status of ecological, economic, and social conditions of forests, landowners and communities, and they provide the basis for SFM programs on private and public land (Roundtable on Sustainable Forests 2008). For example, Criterion 4, conservation and maintenance of soil and water resources, has two indicators pertaining to soil resources: (1) proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources; and (2) area and percent of forest land with significant soil degradation.

It remains the task of landowners or their representatives to develop and apply appropriate best management practices as called for by indicator #1, and to monitor the level of "significant soil degradation" referred to in indicator #2. Many private landowners have their forest operations certified by third-party entities against a set of standards (Rametsteiner and Simula 2002). Examples of certification programs include the Sustainable Forestry Initiative (SFI 2004), Forest Stewardship Council (FSC 1996), and the Canadian Standards Association (CSA 2003).

The U.S. National Forest System applies the Montreal Process C&Is through ecosystem management policies guided by federal law (the Multiple Use and Sustained Yield Act of 1960, The National Environmental Policy Act of 1969, the Forest and Rangeland Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976 [NFMA]). The NFMA requires that national forests be managed in a way that protects and maintains soil productivity (USDA Forest Service 1983). Section 2550.5 of the Forest Service Manual under soil management program (FSM 2009) defines soil productivity as "…the inherent capacity of the soil resource to support appropriate site-specific biological resource management objectives, which includes the growth of specified plants, plant communities, or a sequence of plant communities to support multiple land uses." The objective of the soil management program is to "maintain or improve soil quality on National Forest System lands to sustain ecological processes and function so that desired ecosystem services are provided in perpetuity." Soil quality management (FSM section 2551) is used to accomplish this objective by (1) using *adaptive management* (FSM 1905) to design and implement land management activities in a manner that achieves desired soil conditions to ensure that soil and water conservation practices are implemented and effective; (2) assessing the *current condition* of soil resources; and (3) *monitoring resource management activities and soil conditions* to ensure that soil and water conservation practices are implemented and effective (italics added for emphasis). Regional foresters, forest supervisors, district rangers, and soil scientists within each of the 10 Forest Service regions all play a role in achieving this objective. Soil quality monitoring programs are standardized in objectives and principles, but are region-specific to account for varying soils and ecosystems. The environmental and technical soundness of the soil quality monitoring program is important because it must withstand both scientific scrutiny and legal challenges. The Air, Water, and Soil Division and the research wing of the Forest Service periodically review the soil quality monitoring protocol to ensure that the standards and procedures are scientifically and technically up to date, and to ensure that the monitoring process is systematically achieved.

To help that review process, this paper provides an overview of soil quality principles and monitoring approaches that can be incorporated in an adaptive management process for achieving sustainable forest management.

Some Background

Adaptive Management

Various forest land management agencies and industries have developed processes for achieving SFM using logic models, reliable processes, and adaptive management. Several models are shown in figure 1. Each is conceptualized a little differently, but all contain the same basic elements: (1) an explicit or implied definition of SFM; (2) a knowledge database from which to develop management guidelines; (3) the guidelines or regulations from which best management practices are prescribed; (4) a process for monitoring compliance, effectiveness, and long-term efficacy; and (5) a research program that creates new knowledge for adaptive management.

As an example, we adapted and expanded the Heninger and others (1998) model with an SFM goal of maintaining forest and soil productivity after stand replacement harvesting (fig. 2), one of the key provisions of the "environmentally sound" component of SFM. The first step in the process after establishing or assuming a cause-and-effect relationship between harvesting disturbance and soil quality is to use existing data and knowledge (everything we know) from a "strategic database" to develop management "guidelines" that would prevent detrimental effects. All involved in applying the guidelines are trained. The guidelines, as applied in the forest, are the "best management practices" (BMPs), which are written policy guidelines that describe the manner in which specific forest operations or management activities will be conducted. They are

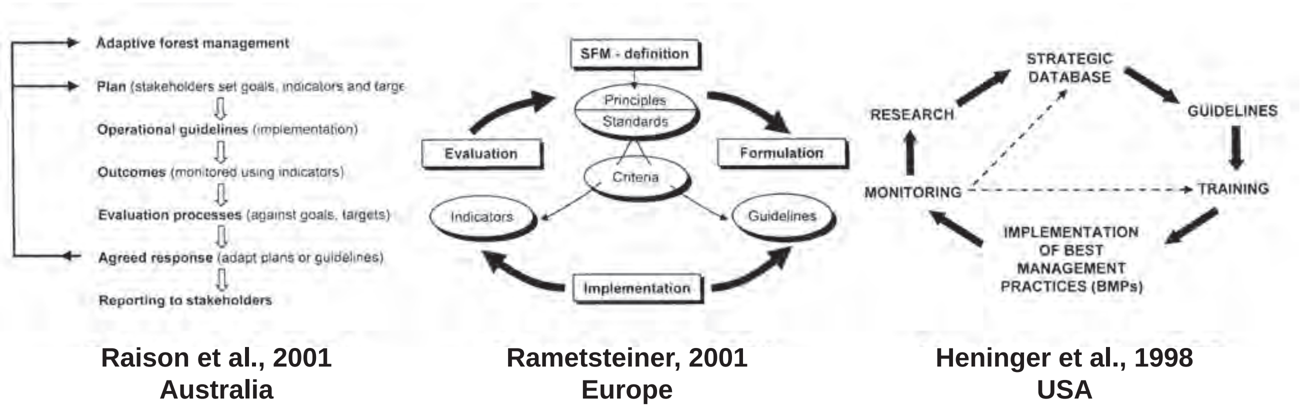

Figure 1. Examples of adaptive management models used for achieving sustainable forest management.

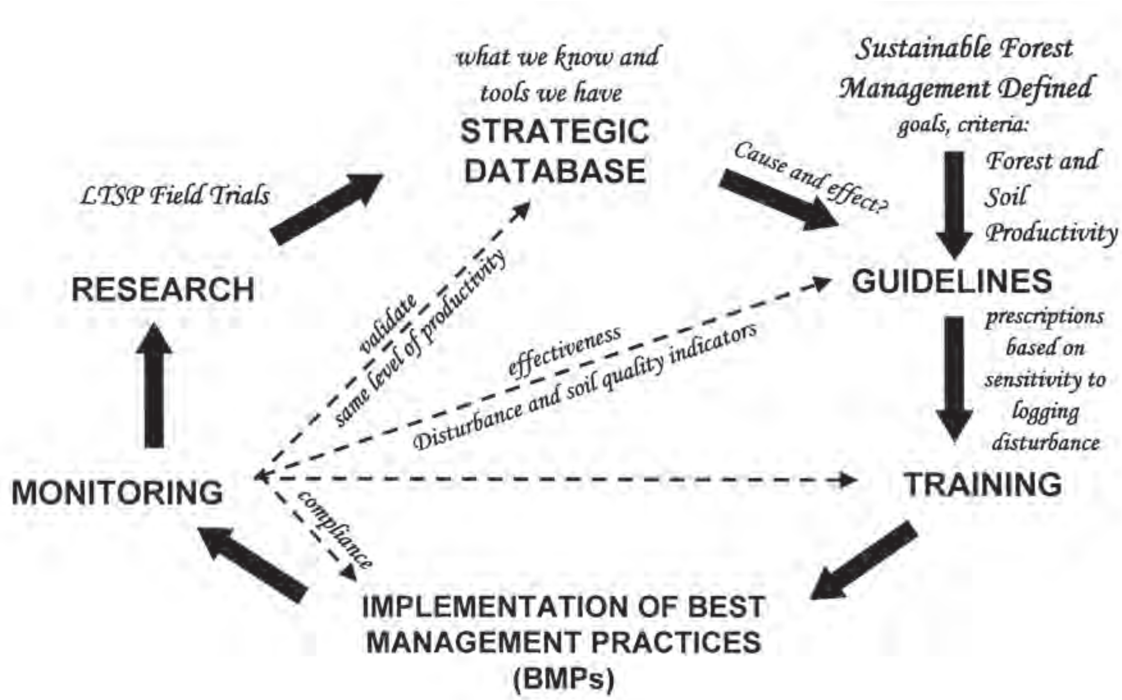

Figure 2. Components of an adaptive management model.

based on accomplishing the management objective in a cost-effective manner while maintaining or improving soil and forest productivity, and are subject to change as science and practice show ways for improvement.

Monitoring BMPs Used for Sustainable Forest Management

The next step is to determine if the BMPs are working as intended. Forest practices should be monitored for BMP compliance, a short-term indication of effectiveness of the BMPs, and long-term validation of SFM (Avers 1990) as defined by policy (*e.g.*, same growth potential and forest composition). Compliance monitoring simply ensures implementation of the BMPs. Effectiveness monitoring uses visual and measured soil disturbance indicators (DIs) and measured soil quality indicators (SQIs) to make a judgment of the efficacy of the BMPs, and whether they are likely to maintain soil and hydrologic function based on our cumulative research and knowledge. Because maintaining forest productivity and other services through time is the sustainability goal, long-term monitoring to determine if the forest is functioning the way it did before disturbance is validation that the BMPs are working as intended. When DIs and SQIs are properly chosen and calibrated, judgments on effectiveness of the BMPs can be made within weeks or months and guidelines can be modified as needed to improve forest practices. Because forests are long-lived, it may take years or decades to finally validate SFM. If monitoring shows that we need better guidelines, BMPs, or SQIs, targeted research should be conducted to expand our knowledge in the strategic database to further adapt our management to meet SFM goals. This adaptive management model, or some variant, can be applied to all managed forests, regardless of ownership, to achieve SFM required by law or compelled by forest certification processes.

For the purpose of this paper, we will assume that a primary SFM goal is maintaining soil and hydrologic function (Montreal Process Criterion #4) so that forest productivity (rate of biomass production per unit time and area) is not impaired. To accomplish this goal, BMPs are used by most public and private forest land owners, and BMP compliance (i.e., were the prescribed practices implemented?) is easily monitored. However, monitoring and demonstrating BMP effectiveness is challenging because forest managers must establish with certainty in a short period (*e.g.*, within 1 yr after completion of the operation) that forest operations in an activity area have not impaired soil and hydrologic function. The assumption is that pre- and post-disturbance soil and hydrologic function can be determined and compared. If they are the same, the BMPs were effective, and post-operation forest productivity and other forest services should be the same. This is the basis of the SFI and FSC standards and the USDA Forest Service soil management program (FSM 2009). However, the relationship between the measures of soil and hydrologic function and forest productivity must eventually be validated with long-term trials so that the standards and BMPs can be modified if needed (adaptive management process) (fig. 2).

The assumption that soil productivity, and by extension forest productivity, can be monitored, measured, and judged based on its combined attributes (properties and processes) is important because it provides a tool for land managers to meet forest sustainability standards established by law or policy (*e.g.*, U.S. National Environmental Policy Act of 1969). Because trees are long-lived, management impacts on productivity—positive or negative—may take decades to discern. Therefore, changes in soil and hydrologic properties and processes that can be measured immediately after a disturbance can serve as surrogates or proxies for change in soil and forest productivity as long as they are based on science and legally defensible. The change in soil properties and processes that results in an improved or degraded soil condition is a measure of soil quality.

Soil Quality Concepts and Principles

Soil Productivity Versus Soil Quality

Soil productivity is usually defined as a soil's ability to produce biomass or some harvestable crop. If not modified, soil has a natural or inherent productive potential based on its genesis and setting in the landscape. Some soils are naturally more productive than others, but not necessarily more valuable in terms of the role they play in their natural setting. For example, an Aridisol supporting a pinion-juniper forest in New Mexico is less productive than an Andisol supporting a mixed conifer forest in California, but each soil is providing ecosystem services commensurate with its development and setting. Within a given forest ecosystem, some soils are naturally more productive than others. This difference in soil productivity is reflected in a measure of forest site index or volume production after a given amount of time. Soil quality has been defined as its ability to provide services important to people. It is useful as a measure of the extent to which a managed soil is improved or degraded from its natural state or some other selected reference condition. Soil is complex; it has many physical, chemical, and biological properties that define its natural state and determine its productivity. Disturbances or management inputs usually change multiple properties at once. To evaluate soil change or soil quality, all or most of the important properties that were affected by the disturbance must be measured.

Agriculture scientists define soil quality as its ability to function (Larson and Pierce 1994) in a way that sustains biological productivity, environmental quality, and plant, animal, and human health and habitation (Doran and Parkin 1994; SSSA 1995). It is not a new concept. It was used by Storie (1933) 75 years ago to rate agricultural value of California soils. More recently, Warkentin and Fletcher (1977) recommended its use for monitoring the effects of intensive agriculture on soils. Karlen, and others (2003) reviewed its development and use in agriculture, and Burger and Kelting (1999) showed how one might use soil quality models to assess the impacts of intensive forest management.

Soil quality is analogous to the concepts of air and water quality where judgments are made concerning their fitness to breathe and drink based on selected, measurable standards. However, extending the air and water quality concepts to soil is less intuitive and more complex because we do not ingest soil directly. Its "fitness" is judged based on habitation and growth of plants and animals that are in turn ingested by humans; therefore, it is once removed from our personal experience. Soil also has multiple functions beyond food production: carbon sequestration, waste processing, and water regulation, among others. Furthermore, soil quality can change at different rates. Change can be slow and cumulative over time, and it can change in both negative and positive directions due to management. Finally, there is no "pure" (as in pure air or pure water) soil baseline against which to make judgments; there are many different soil types in nature each of which has its own natural condition. Nonetheless, the analogy with air and water holds in the sense that soil quality can be used to make judgments about the impacts of management, both negative and positive, against predetermined conditions or standards.

Soil Services, Functions, and Indicators

In order to use soil quality as a uniformly applied monitoring tool, there must be some agreement on its definition and use as a concept and monitoring tool. Similar to the concept of sustainable forestry, it is a work in progress. As a starting point, it is helpful to conceptualize soil in terms of "what it does for us" (services), "how it does it" (functions), "its character or attributes" (properties and processes), and "how we monitor and measure its performance or change in the level of services provided" (indicators).

Forest productivity, carbon sequestration, and a regulated hydrologic cycle are examples of soil services, sometimes called management goals (Andrews and others 2004) (table 1). Some soil services are more important than others in a given forest ecosystem. Therefore, forest managers should judge soil quality in terms of how management affects the most important services that soils provide. Soil services may not be completely complementary with respect to soil quality; one soil service may, in fact, reduce soil quality for another service. For example, longleaf pine ecosystems are managed primarily for biodiversity, not productivity. Longleaf pine as a species can be used effectively in production-based silvicultural systems, but generally speaking the interest in longleaf pine as opposed to other southern pines is the biodiversity value the entire ecosystem provides. However, the longleaf pine ecosystem thrives on disturbance, and in fact, the ecosystem loses much of its biodiversity value without disturbance. These disturbances clearly have the potential to alter soil quality, but the alterations may be positive or negative depending on the soil service. If the service managed for is biodiversity, repeated burning or other disturbances required for the main soil service increase the potential risk for surface erosion (reduction of soil quality for water quality protection), and nutrient loss (reduction of soil quality for soil productivity), but increase soil quality for a multitude of herbaceous plants that require not only the open conditions that burning provides, but also the specific soil conditions that allow them to compete with more nutrient-demanding plants. In other words, the best soils for the highest biodiversity in the longleaf pine ecosystem may not be the best soils for tree growth, and they may not be as capable of protecting water quality or sequestering carbon.

Using forest productivity as an example of a desired service, the soil functions to provide this service in several ways: (1) it remains stable and intact as a medium for root growth and habitat for soil animals; (2) it accepts, holds, and supplies water; (3) it

Table 1—Examples of soil services, functions, properties, processes, and indicators useful for monitoring sustainable forest management.

Soil services	Soil function	Soil properties and processes	Soil indicators: Disturbance	Soil indicators: Soil quality
	Soil stability: Intact medium to promote root growth and provide habitat for soil animals	Horizonation Depth Strength Water content	Mass movement Erosion Ground cover	Soil horizon depth Strength Soil loss (t/ac) Aggregate uniformity SOM
Forest productivity	**Soil hydrology:** (accept, hold, and supply water, and drain properly for optimum gas exchange)	Texture Structure Porosity Infiltration Conductivity Water storage Gas exchange	Soil compaction Rutting Puddling Impeded drainage Surface runoff	θ vol. between 1/3 bar and 15 bar Soil structure Soil consistence Macroporosity Redox potential O_2 level
Regulated hydrologic cycle Regulated carbon balance Waste bioremediation	**Nutrient cycling:** (sequester, hold, and cycle organic matter and nutrients and promote biological activity)	SOM content Nutrient content pH CEC Decomposition Mineralization N fixation Acidification Leaching	CWD amount and distribution Litter displacement Severe burn Organic matter loss Acid deposition Accelerated nutrient leaching	C content Active organic matter Effective CEC Extractable nutrients N mineralization Microbial biomass Biopores Fecal deposits Soil respiration

promotes optimum gas exchange; (4) it sequesters, holds, and cycles organic matter and nutrients; and (5) it promotes biological activity (Doran and Parkin 1994; Burger and Kelting 1999; Andrews and others 2004). In the context of forest soils and forestry operations, these functions might be consolidated to soil stability, soil hydrology, and nutrient cycling (table 1). If a soil is protected from erosion, mass wasting, and displacement, it is stable and can provide a medium for plant growth. If it is protected from compaction, rutting, and puddling, it can function hydrologically, that is, water can infiltrate the soil, be stored, and be released for uptake by plants, and the soil will have the right proportion of macro- and micropore space so that it can drain properly. In forest soils, nutrient supply and biological activity are intimately tied to organic matter and nutrient cycling processes, including rates of input, decomposition and mineralization, storage, and release or uptake. Protection of these processes from soil surface disturbances, displacement of soil organic matter layers, and severe burns should maintain function in a given soil of a certain ecosystem. Of course, soil function is ecosystem-specific and must be assessed in the context of desired ecological condition. For example, soils in tupelo-cypress, longleaf pine, pinion-juniper, and black spruce ecosystems have the same functional elements, but each ecosystem will have different levels of soil properties and processes considered “normal.”

Examples of the soil properties and processes, sometimes called soil attributes (Nortcliff 2002), associated with the first function (soil stability) are horizonation, strength, depth, and water content (table 1). Some soil properties and processes cannot be measured directly or efficiently; therefore, DIs, SQIs, measurable surrogates, or proxies of soil function must be used. Indicators may be a soil condition, property, or process such as soil compaction, soil strength, or water infiltration, or a combination of several soil properties such as soil tilth (soil tilth combines a measure of bulk density, strength, aggregate uniformity, soil organic matter, and plasticity index [Singh and others 1990]). Soil DIs or SQIs may be determined visually, or via measurement by laboratory or field testing (table 1).

Regardless of their simplicity or complexity, ideal indicators should (1) have a baseline against which to compare change; (2) provide a sensitive and timely measure of a soil’s ability to function within a given ecosystem; (3) be applicable over large areas; (4) be capable of providing a continuous assessment; (5) be inexpensive and easy to use, collect, and calculate; (6) discriminate between natural changes and those induced by management; (7) have a cause-and-effect connection with forest productivity; and (8) be responsive to corrective measures (Burger and Kelting 1999).

These indicator characteristics are mostly obvious and intuitive, but two common monitoring pitfalls are using indicators too broadly, and not having a cause-and-effect relationship with the soil service or management goal. The ideal indicator would be applicable over large areas, but in reality indicators and their relative importance are quite soil- and site-specific.

Perhaps the most serious monitoring pitfall is using indicators with no cause-and-effect relationship with the soil service (*e.g.*, soil productivity) (Powers and others 1998; Miller and others, in preparation). Many forest disturbances, both natural and human-induced, are totally benign. In fact, the health and productivity of some forest ecosystems require disturbance (*e.g.*, ground fire, litter layer disturbance by animals). A detrimental disturbance in one forest ecosystem may be a beneficial process in another. Furthermore, disturbances are often soil- and species-specific (Page-Dumroese and others 2000; Powers and others 2005; Kranabetter and others 2006). Indicators of detrimental disturbance must be applied carefully, and they should have known correlations with forest productivity or some other service or management goal. All indicators will not have all eight features listed above, which is why several may be needed to adequately measure BMP effectiveness.

Different Indicators Needed for Different Soils

Soil services (what soils do for us) and soil functions (how they do it) are fairly universal. However, soil types and their properties and processes (attributes) vary greatly, which requires site-specific selection of indicators for monitoring the most important soil functions for a given soil type and disturbance activity. Furthermore, some soils are more resistant to impact than others; a given impact may be detrimental to one soil and have no effect on another. This is illustrated in the example in figure 3: Soil quality is shown as a function of a soil's ability to hold, supply, and cycle organic matter and nutrients (nutrient cycling) on the y axis, and the ability to accept, hold, and supply water, air and heat (air/water balance) on the x axis (Burger 1997); both are important forest soil functions identified by several researchers (Powers and others 1998; Burger and Kelting 1998). Soil quality generally increases as organic matter and nutrients are conserved, and soil quality increases as the air/water ratio is balanced. Soil specificity is shown in several general ways:

- Alfisols (*e.g.*, Soil A) are more likely to be detrimentally impacted by changes in air/water balance than changes in fertility, while the opposite is true for Entisols (*e.g.*, Soil B). Alfisols are usually better buffered than Entisols against nutrient removals, while Entisols usually have a coarser texture and resist compaction and loss of macropore space. Ultisols and Inceptisols are likely to be more equally impacted by changes in both soil functions, but are better buffered against extreme changes in air/water balance and nutrient cycling, respectively, for the Alfisols and Entisols.
- The risk of a detrimental impact varies within a soil order. For example, a low-quality Entisol (well-drained marine sand, Soil C) is more likely to be detrimentally impacted by organic matter and nutrient removal (Brendemuehl 1967) than a high-quality Entisol (alluvial flood plain soil, Soil B) (Aust and others 1997), which is illustrated in figure 3 by convergence of a possible response surface toward higher soil quality.
- Soil compaction and organic matter removal may be good indicators for air/water balance and nutrient cycling, respectively, for most soils, but their relative importance (weight) would be different for different soils. Soil compaction would be more detrimental to most Alfisols than organic matter removal, and organic matter removal would be more detrimental to most Entisols than compaction. Therefore, a uniform, one-size-fits-all soil quality monitoring program would not be applicable across all soils and forest sites. This was illustrated in a study by Page-Dumroese and others (2000) who evaluated the effectiveness of applying uniform soil quality standards

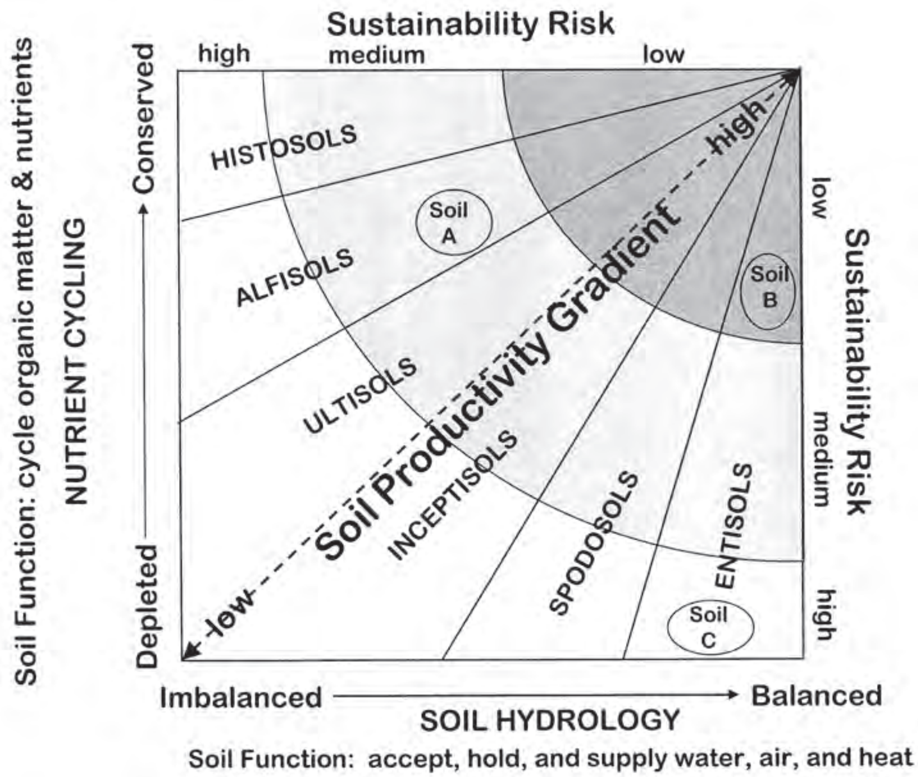

Figure 3. Soil quality response surface defined by soil nutrient cycling and hydrology (after Burger 1997).

to disturbances caused by forest operations over diverse forest landscapes in the Pacific Northwest. They concluded that application of selected USDA Forest Service standards (USDA Forest Service 1991) did not provide a comparative accounting of detrimental change in soil quality for the sites measured, and that some level of soil and site specificity needs to be incorporated in monitoring protocols.

USDA Forest Service Soil Monitoring and Research Programs

Soil Quality Monitoring

The USDA Forest Service has a well-established soil quality monitoring program that has been in place for several decades (USDA Forest Service 1991; Powers and others 1998). The program is a process by which data are collected to determine if soil management objectives have been achieved. It is meant to assist land managers in making better decisions on how to maintain or improve long-term soil productivity. The program and its evolution were described by Powers and others (1998) and by Page-Dumroese and others (2000). A fundamental assumption is that forest operations cause soil disturbances at some critical level that interfere with soil function (soil stability, soil hydrology, and nutrient cycling), which in turn have a detrimental effect on soil and forest productivity. A second assumption is that measures of one or more soil disturbances can be used to judge whether an operation had a detrimental impact on productivity, provided the disturbance, or a combination of disturbances, exceeded a predetermined threshold (usually 15 percent of the pre-disturbance condition) on more than 15 percent of the activity area. Disturbance and SQIs used by Forest Service Regions as reported in supplements to FSH 2509.18 are shown in table 2. Regions 1, 2, 4, 6, 8, and 9 use DIs for monitoring sustainable management, while Regions 3 and 5 use SQIs representing soil functions (table 2). The use of different sets of indicators and different approaches suggest a degree of region-specific application of the soil quality monitoring process; however, standardization of approach to the extent feasible would be advantageous for withstanding public and legal scrutiny.

Table 2—Detrimental soil disturbances or soil functions monitored by Forest Service Region (R1 through R10) and those listed in the Soil Management Handbook (USDA Forest Service 1991).

	Region and effective date									
	R1 1999	R2 1992	R3 1999	R4 2003	R5 1995	R6 1998	R8 2003	R9 2005	R10 1992	HB 1991
Disturbance:										
Compaction	X	X		X		X	X	X	X	X
Rutting	X					X	X	X	X	
Displacement									X	X
Severely burned	X	X		X		X		X	X	X
Surface erosion	X					X	X	X	X	X
Organic matter loss	X			X		X	X	X		
Mass movement	X					X		X	X	
Puddling		X		X				X	X	X
Ground cover				X				X	X	
Altered wetness									X	
Functions:										
Stability			X							
Hydrology			X		X					
Nutrient cycling			X							
Soil productivity					X					
Buffering capacity					X					

According to Powers and others (1998), the soil quality standards are meant as early warning thresholds of impaired soil conditions. When threshold standards for detrimental disturbance are exceeded, a 15 percent decline in productivity is assumed. Threshold standards are based on scientific findings or best professional judgment, but there is little or no documented evidence of any connection between disturbance thresholds and productivity. When critical data are lacking, it is prudent to err on the conservative side to ensure that productivity is not impaired; on the other hand, unreasonably strict standards having no basis in fact can limit forest use opportunities and tie up human resources in unnecessary litigation.

Following an assessment of soil disturbance in forests of the Interior Columbia Basin, Miller and others (in preparation) suggest that current soil quality methodology is inadequate, and they make a case for a more rigorous approach underpinned by research findings and sound scientific interpretations. Their finding was based on 15 soil monitoring projects after logging in which they visually classified disturbance and took bulk density samples along transects. They concluded that (1) different applications of a visual assessment protocol by different people led to different conclusions as to whether a logging operation is judged detrimental; (2) visual versus measured estimates of bulk density showed that visual estimates are unreliable; (3) the effect of equipment tracks and surface soil displacement is often over estimated, which overstates detrimental impacts of logging operations; (4) because current interpretations of detrimental disturbance are seldom justified by scientific investigations (*e.g.*, the assumption that a 15 percent increase in bulk density reduces tree growth on all soils is not supported by research), classification of soil disturbance should be for descriptive purposes only; (5) given broad variation in soils and climate among national forests, using the same standards for defining detrimental disturbance as it affects tree growth is not reasonable; and (6) current soil disturbance interpretations are based on experience and opinions of local specialists that are seldom documented or peer-reviewed. To overcome these limitations, they recommend a formal process for selecting activity areas for monitoring, and a revised set of descriptive disturbance and SQIs that account for both severity and extent of disturbance. For making judgments on impaired productivity, they recommend using risk-rating models based on research findings and collective expert opinion that account for specific site factors, potential vegetation, and forestry activity. Risk rating can then be used for site-specific prescriptions allocated to high-risk sites.

Synthesis of LTSP Research Findings

If the critique of the Forest Service's soil quality monitoring program by Miller and his co-workers has merit, the adaptive management model (fig. 2) suggests that the way to improve effectiveness monitoring is to adjust DIs and SQIs using current research findings. The North American long-term soil productivity study (LTSP) (Powers and others 1990) was installed, in part, to validate or improve SQIs used for short-term judgments of sustainable forest management. The study addressed organic matter removal and compaction DIs each at three levels: stem-only harvest, whole-tree harvest, and whole-tree harvest plus litter layer removal; and none, moderate, and high levels of compaction, respectively. Although still a relatively young project after only 15 years, preliminary results have been reported that suggest several ways in which the selection and interpretation of USFS DIs and SQIs might be reconsidered or adjusted.

Powers and others (2005) reported findings from the first 10 years of study for a range of LTSP study sites in CA, ID, LA, MI, MS, and NC. Several other key papers reported site-specific responses to the LTSP treatments at different locations. Key findings include the following:

- Soil organic matter across all sites was generally unaffected by complete removal of surface organic matter (stem-only versus whole-tree plus litter removal). Based on composite results, it appears that carbon inputs to mineral soil horizons are due primarily to root decomposition, while carbon mineralized in the surface Oi and Oe layers efflux as CO_2.
- For four contrasting CA sites, whole-tree plus litter removal caused substantial declines in soil C and N concentrations and mineralizable N. In a later report for the NC and LA loblolly pine LTSP plots (age 10 data), Sanchez and others (2006) reported no organic matter removal effects on tree growth. Heavy compaction resulted in a slight increase in stand volume on LA plots and a slight decrease in growth on NC plots. Organic matter removal had little effect on soil N but significantly reduced extractable P. This effect on P was also reported by Scott and others (2004) for LA plots at age 5.
- Composite data for all sites indicated no general decline in productivity with organic matter removal, which is consistent with the observation by Blake and Ruark (1992) that effects of organic matter removal is confounded by an array of influences both positive and negative. One exception was that aspen biomass on the MI plots was significantly less on plots where trees and litter were removed due to vigorous sprouting and dieback of root suckers. Another was on some inherently P-deficient soils in LA and MS, which showed substantial declines due to whole-tree harvesting at age 10 (Scott and Dean 2006).
- Severe soil compaction increased D_b an average of 18 percent in the 10- to 20-cm soil layer, but little compaction occurred if initial D_b was >1.4 Mg m^{-3}. Composite data for all sites showed that severe compaction had little or no effect on standing biomass; however, biomass on sandy sites increased by 40 percent while that on clayey sites decreased by half. This textural influence was clearly demonstrated across three CA LTSP sites (Gomez and others 2002). The authors reported growth responses to compaction by mixed conifers that decreased, remained the same, and increased for a clay, loam, and sandy loam, respectively. The soil series, in the same order, were Challenge (Typic Palexerults), Cohasset (Ultic Haploxeralfs), and Chaix (Typic Dystroxerepts). The different impacts of compaction among soils (negative, benign, positive) were attributed to changes in strength, pore space distribution (which changed available water holding capacity), and an interaction between these factors.

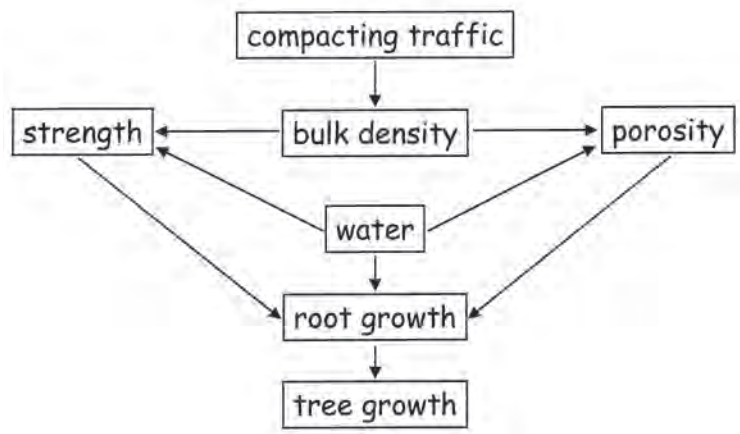

Figure 4. Root and tree growth as a function of soil compaction effects on bulk density, soil strength, porosity, and water content (after Greacen and Sands 1980).

This finding corroborates the Greacen and Sands (1980) model showing that strength and porosity are the static physical properties most directly affecting the tree (fig. 4). The clay soil suffered the greatest increase in soil strength and the greatest loss in porosity with no increase in available water holding capacity (AWHC) resulting in decreased tree growth on compacted plots. Although the loam soil had a strength exceeding 3 MPa below 10 cm, its AWHC increased significantly, which resulted in a negative/positive tradeoff and a net result of no change in tree response. Compaction increased strength of the sandy loam soil, but AWHC increased at all depths of the measured profile, resulting in a net positive change in growth.

Implications of LTSP Research Findings for Soil Quality Monitoring

Collectively, the LTSP research results have the following implications for the Forest Service's soil quality monitoring protocol:

- The age-10 LTSP data clearly demonstrate site- and soil-specific responses to disturbance, which further explains the inconsistent conclusions provided by soil disturbance monitoring when applied across different sites (Page-Dumroese and others 2000) or when applied by different people (Miller and others, in preparation). Currently used detrimental DIs are all good in principle, but they need to be selectively applied and weighted by importance in different regions and within regions.
- The effect of organic matter removal (*e.g.*, whole-tree plus litter) from the surface of a forest site is clearly site-specific (sucker sprouting in aspen; P depletion in Gulf Coast loblolly pine; N depletion in CA mixed conifers). The LTSP data show that much higher levels of removal are needed to affect a detrimental response than are currently set as regional standards on most sites, yet some highly sensitive sites may be impaired by removals currently allowed. Organic matter is a master variable in the sense that it plays multiple roles in forest ecosystems. In addition to N and P cycling and natural regeneration demonstrated in the LTSP trials, it is habitat for myriad animals, protects mineral soil from erosion, buffers temperature and water extremes in the surface mineral soil, and is an energy source for plants and animals. Some of these functions are more important than others on a given site, but, in any case, those that play a clear role in productivity should be monitored. In addition to the DI (area and degree of organic matter displacement), one or more soil/site quality indicators (N mineralization, sucker sprouting, etc.) should be used to make judgments about SFM.
- Soil compaction is an important and useful DI, but it is clear from the LTSP data that it is not always detrimental; in fact, it clearly enhances soil productivity in some cases. In other cases, forest productivity may be improved while soil productivity is unchanged. Stagg and Scott (2006) found that planted loblolly pine growth was increased by compaction through reducing understory competition. Planted tree growth on plots with herbicide applications to control competition showed little response to

compaction. This finding reinforces the principle that many types of disturbance in ecosystems are beneficial and sometimes necessary for normal ecosystem function (for example, fire, windthrow, and deposition of sediment by natural processes); human influences often enforce these positive processes. Therefore, simple visual indicators of compaction are inadequate for judging detrimental disturbance (Aust and others 1998; Steber and others 2007). A measure of bulk density, the one commonly measured SQI in Forest Service monitoring protocols, will often lead to erroneous conclusions because detrimental effects of compaction can occur in clayey soils with less than a 15 percent change, and beneficial effects can occur in sandy soils with an even greater change. Better indicators of compaction are soil strength and the ratio between macro- and micro-porosity as shown by the conceptual model by Greacen and Sands (1980) (fig. 4). Compaction increases D_b, but the impact of the D_b change on strength and pore space distribution are the real drivers of root growth and productivity (fig. 4), and D_b change is not always a reliable surrogate for these soil properties. Attempts have been made to determine root-growth limiting D_b for forests (Daddow and Warrington 1983), but rules of thumb from these attempts have not been successfully applied to forests.

More Known About Soil Response to Disturbance Than Reflected in Current Monitoring Protocols

The old cliché “more research is needed” certainly applies to our quest for a better understanding of site-specific forest response to disturbances for achieving SFM. However, we maintain that more is known about soil disturbance processes and effects than is currently reflected in Forest Service SQM protocols. For example, a 15 percent increase in D_b is used by most Forest Service regions as an indication of detrimental disturbance. The empirical findings by Gomez and others (2002) clearly show that this indicator will lead to erroneous conclusions on many sites and strongly suggests that we need to move beyond a blanket approach of using visually estimated or measured D_b. Gomez and others (2002) showed that soil strength and pore space distribution were better SQIs than D_b, as conceptualized by Greacan and Sands (1980) decades ago. Furthermore, we understand the basis for this model given decades of research on the interactions among factors in the model. Recent work by Siegel-Issem and others (2005) contrasting data from California and Missouri LTSP sites demonstrates our understanding of compaction effects that can be extrapolated to many soils across regions. A brief summary of selected bits of their results are presented to make the point that a synthesis of knowledge can be used to improve SQM.

The California soil was a Cohasset coarse sandy loam (Haploxeralf) (fig. 5A) from the Tahoe National Forest similar to the one Gomez and others (2002) studied, but with a sandy loam texture. Its parent material is an andesitic mudflow and the dominant vegetation is mixed conifers. The Missouri soil was a Clarksville silt loam (Paleudult) (fig. 5B) from the Carr Creek State Forest. Its parent material is a sandstone residuum and the dominant vegetation is oak-hickory with a component of shortleaf pine. Given the contrasting particle size distributions and different levels of organic matter, the soils reacted very differently to compaction. The MO soil reached proctor level D_b (maximum possible under controlled conditions) at 1.53 Mg kg^{-3} compared to 1.25 Mg kg^{-3} for the CA soil. As D_b increased and volumetric water content (θ) decreased, soil strength increased. For the CA coarse sandy loam, above D_b 1.00 Mg kg^{-1} and below 35 percent θ, soil strength approached or exceeded 2MPa, the strength that becomes root-limiting. Below 1.00 Mg kg^{-1}, D_b had virtually no effect on soil strength at any θ (fig. 5C). By contrast, soil strength of the MO silt loam did not reach the 2MPa threshold until D_b exceeded 1.5 Mg kg^{-1}, which was nearly the proctor limit (fig. 5D).

The total and available water holding capacity (AWHC) of the CA soil increased significantly with increasing D_b (fig. 6A), but there was little change in the AWHC of the MO soil (fig. 6B). Increasing D_b dramatically reduces the non-capillary or macropore space in most soils. When macropore space drops below 10 percent, roots of upland species become hypoxic due to inadequate gas exchange rates (Grable and Siemer 1968).

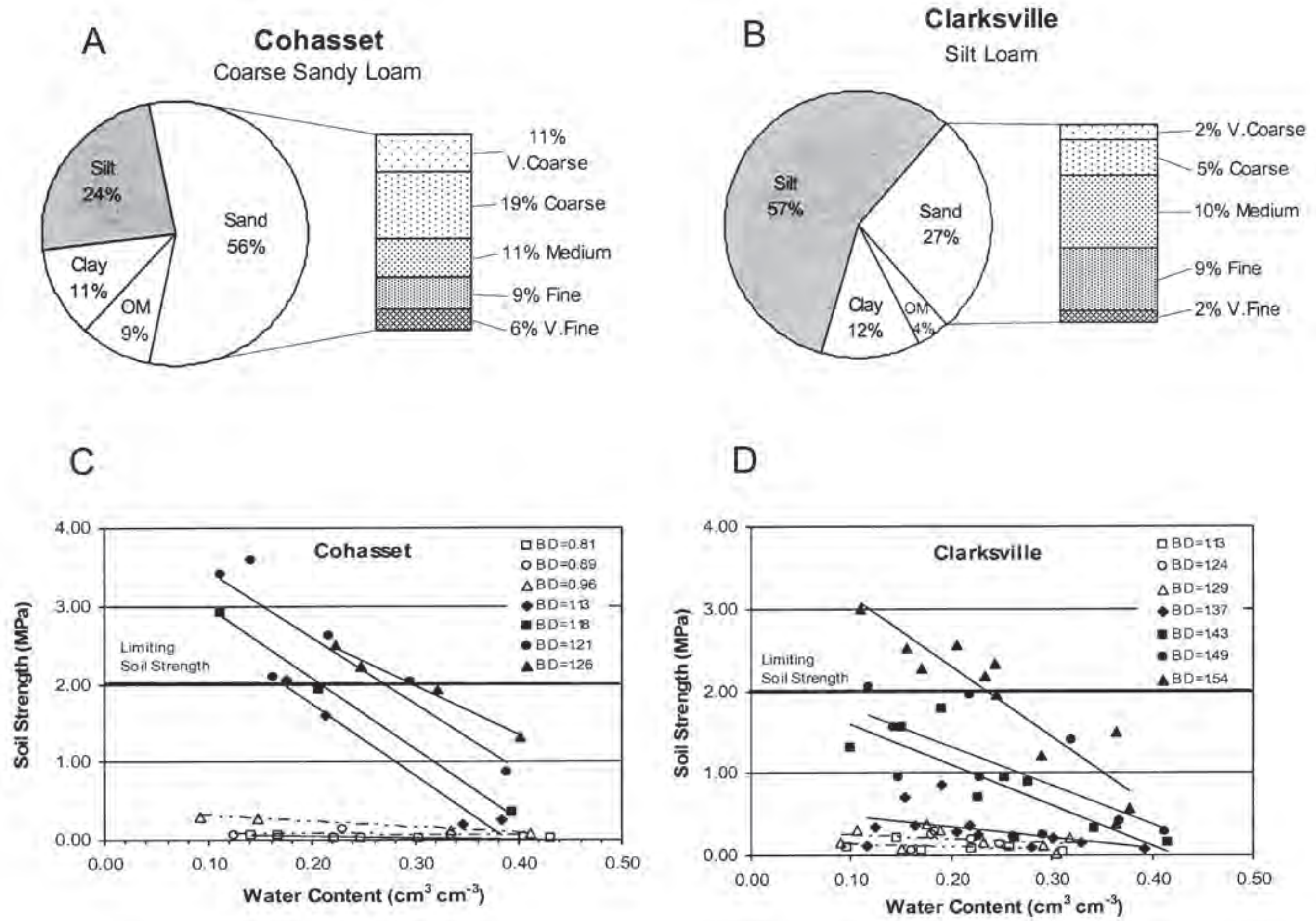

Figure 5. Particle size distribution of a Clarksville and Cohasset soil series from MO and CA LTSP study sites, respectively (from Siegel-Issem and others 2005).

This is illustrated in figure 6D for shortleaf pine in the MO soil. Root length density followed a classic bell-shaped response for upland species in loam soils, decreasing from optimum water content as the soil became both drier and wetter due to inadequate available water on the dry end and inadequate aeration on the wet end of the soil water gradient (da Silva and others 1994). As D_b increases, the range in soil water content within which roots can grow narrows, which in turn causes a decrease in root length density. The trees growing in the CA soil suffered from increased strength on the dry end of the θ gradient, but not at all on the wet end of the θ gradient, despite reduced aeration porosity (fig. 6C).

These soil and tree responses to compaction under controlled lab conditions corroborate the field results reported by Gomez and others (2002). Soil texture and organic matter content influence the extent to which a soil can be compacted and the relative influence of strength versus pore size distribution. The degree and influence of compaction are predictable based on texture and organic matter content and thus could be used to adjust the importance of D_b change relative to other DIs. Furthermore, soil strength and pore space distribution could be used as soil texture-specific SQIs in lieu of estimated or measured D_b. Clearly, we know enough about soil physical processes to create a combined basic/empirical mathematical model to estimate and make definitive judgments of detrimental compaction, rutting, and puddling impacts on productivity. The same could probably be said for organic matter displacement and loss, and good models already exist for soil erosion prediction and risk assessment (Laflen and others 1997). A similar argument was made by Miller and others (in preparation) based on their firsthand experience with the limitations of current SQM protocols. Modeled soil disturbance processes that address the stability, hydrology, and nutrient cycling functions

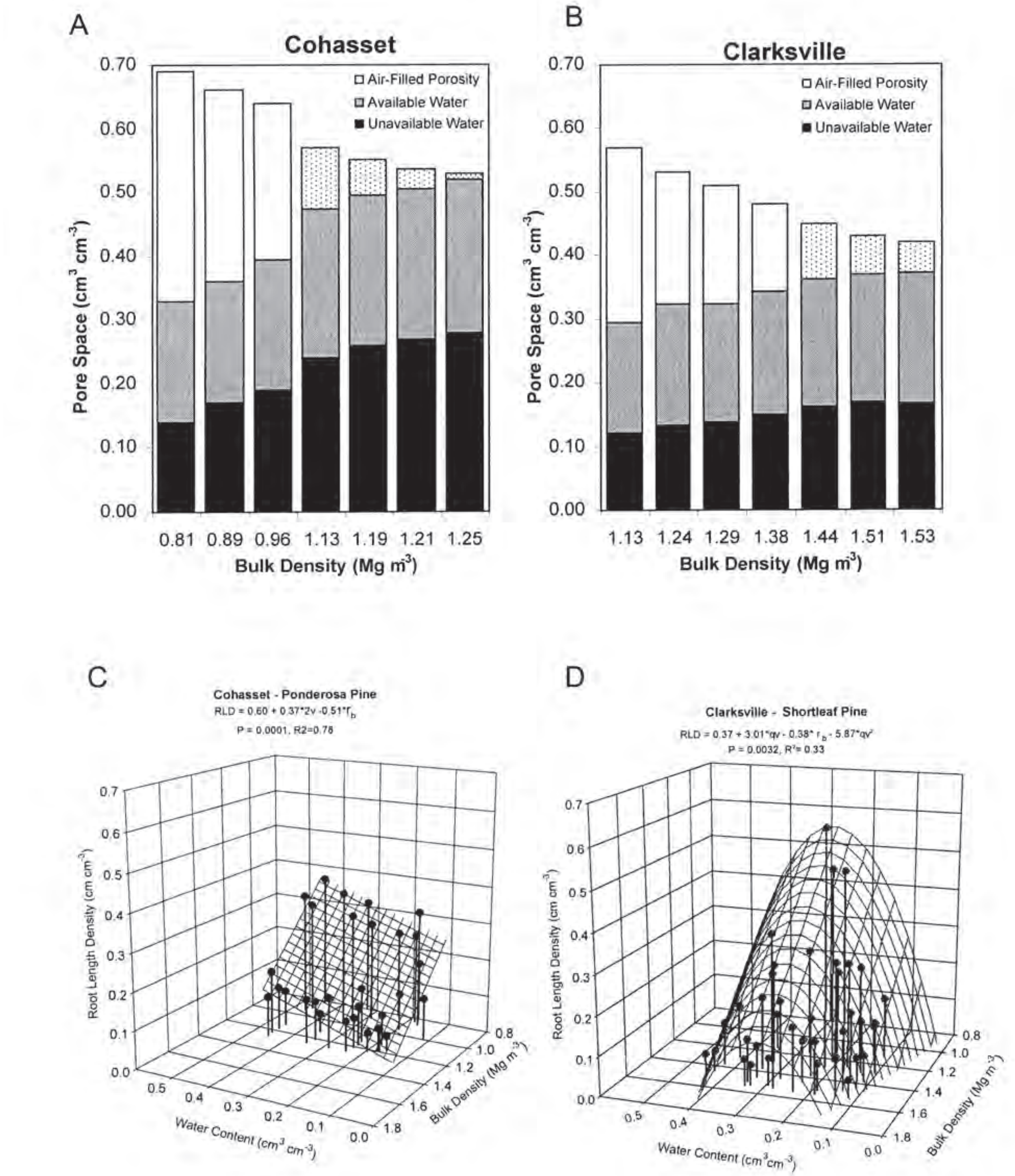

Figure 6. Pore space distribution and root length density of shortleaf pine seedlings and ponderosa pine seedlings grown on Clarksville and Cohasset soils, respectively, as a function of soil bulk density and volumetric water content (Siegel-Issem and others 2005).

of soils need to be combined in a single, workable, cost-effective protocol that can be continuously updated as new findings warrant.

Modeling Soil Quality

An Approach for Modeling Soil Quality

A number of efforts have been made to model soil quality (Doran and Parkin 1994; Carter and others 1997), quantitatively score soil quality for use as a performance standard (Larson and Pierce 1994; Andrews and others 2004), and extrapolate soil quality classes or risk assessments to an activity area (Halvorson and others 1996; Wendroth and others 1997; Kelting and others 1999). Most of these efforts have been made on agricultural landscapes, and extensive reviews of these topics are covered in several publications (Doran and Parkin 1994; Doran and Jones 1996; Gregorich and Carter 1997; Lal 1999). Several compilations have also been made for forest landscapes (Ramakrishna and Davidson 1998; Raison and others 2001).

This approach is conceptualized in figure 7. Forest practices can degrade or improve soil quality compared to a pre-disturbance or reference condition (solid circle in diagram). Often, positive and negative effects occur simultaneously. Degrading processes include soil displacement or erosion, water logging, compaction, organic matter loss, nutrient depletion, and acidification, among others. Soil improvement can include enhanced fertility, better tilth, increased available water holding capacity, better drainage of excess water, organic matter addition, and liming. Intensive industrial forest operations may impose a combination of these effects with a net result of better, same, or worse soil quality. Extensive forest operations that only include harvesting during wet weather could have a net negative effect on soil quality due to soil compaction and water logging. Soil quality is the ability of the soil to function by storing and releasing water to plants, cycling nutrient elements, buffering organisms from temperature extremes, decomposing organic debris, etc. As mentioned above, they can be categorized as soil stability, hydrology, and nutrient cycling functions (table 1). These soil functions can be monitored and measured using soil properties or processes (depicted by letters A through G in fig. 7), or by using DIs or SQIs that serve as surrogates for properties and processes (table 1). Forest operations may improve some properties (arc of wedges exceeding the pre-disturbance or reference condition), and they may degrade others (arc of wedges less than the reference condition) (fig. 7). The net effect of the disturbance on soil quality may be the same (sum of the area of the wedges equal to the area of the reference condition), or the net effect may be better or worse than the reference condition. Some soil properties may be more important to forest productivity than others (greater angle, thus area, of some wedges compared to others), but seldom is one "all" important or even dominantly important. However, if Liebig's principle of "most limiting" factor applied, one could select and monitor the function most affected (*e.g.*, function A) as it is degraded most from the reference condition and is below the standard or allowable limit (dashed circle). In most cases, all properties (A through G) contribute to soil quality in interactive ways, and those interactions are often complex and unknown. A better judgment of soil quality change would entail a composite, weighted score of all soil functions (sum of the area of the wedges compared to the area of the allowable condition).

Forest Service Regions 3 and 5 use this general approach as reported in supplements to 2509.18 (USDA Forest Service 1991). Region 3 (R3) defines soil function in terms of stability, hydrology, and nutrient cycling and uses a combination of DIs and SQIs as indicators of those functions to classify soil condition as satisfactory, impaired, or unsatisfactory. Given our previous discussion of the limitations of arbitrarily (meaning no evidence of cause and effect) applying visual DIs, we suggest that the R3 approach is the most comprehensive and sophisticated. Lacking are justifications for indicator selection, site-specific weighting, and relationships with vegetative productivity, and a scoring mechanism to show that combined indicators will result in a specified amount of productivity decline over a specified areal extent. Nonetheless, the approach is conceptually based with logical linkages among soil function, properties, and indicators, and it includes a risk assessment within three categories.

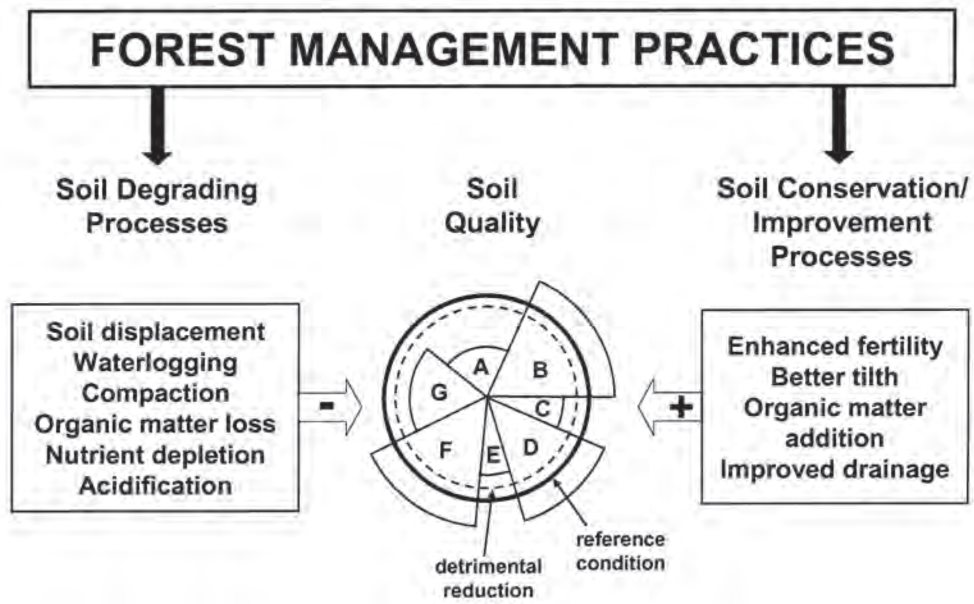

Figure 7. Conceptualization of the effects of forest management practices on soil quality.

Steps for Building a Soil Quality Model

A common approach to soil quality monitoring is to (1) select key disturbance or soil quality indicators representing soil function, (2) develop sufficiency relationships between soil services and the indicators, and (3) weight and combine sufficiency levels for all indicators in additive or multiplicative models based on their importance and vertical and spatial extent in an activity area.

Step 1: Select Key Soil Quality Indicators—Two good review papers on indicator selection for forest soils are by Schoenholtz and others (2000) and Moffat (2003). Both reviews provide lists of physical, chemical, and biological indicators with a rationale for their potential use. Ultimately, selection of indicators for a given forest type and land region must be done by scientists and practitioners with expert knowledge of specific forest ecosystems, forestry operations, and forest response to disturbances. However, in addition to local expertise, there is a large body of research literature on soil/site effects on growth and yield for forest ecosystems for every region of the country. This research has been ongoing for nearly a century as foresters have striven to understand fundamental relationships underpinning productivity.

Carmean (1975) did an early review of this literature, and Pritchett and Fisher (1987) did a follow-up review listing the number of reports in which a given soil property was found to be a determinant of growth and yield. For example, for western conifers the key soil properties and the number of times reported were effective soil depth (20), available water (8), surface soil texture (8), soil fertility (4), subsoil texture (3), and stone content (4). For southern pines the key soil properties and number of times reported were subsoil depth and consistency (23), surface soil depth (21), surface and internal drainage (19), depth to least permeable horizon (14), depth to mottling (13), subsoil imbibitional water value (8), N, P, or K content, and surface organic content (3). Moffat (2003) also has a short literature synthesis on soil/site growth and yield relationships in his review. These reviews demonstrate that there is a huge knowledge base on which to draw for first approximation soil quality models.

Step 2: Developing Soil Quality Sufficiency Curves—Central to soil quality models are sufficiency curves, which are cause-and-effect relationships between a soil service such as forest productivity and a soil indicator. For forest productivity, sufficiency of a given soil indicator is often based on its ability to support root growth. The assumption is that if a soil indicator is sufficient for root growth, it will be sufficient for tree growth. Sufficiency for each soil indicator is scaled from 0 to 1, where a value of 0 is totally root-growth limiting and a value of 1 has no limitations for root growth. Sufficiency relationships can be developed based on the literature, designed

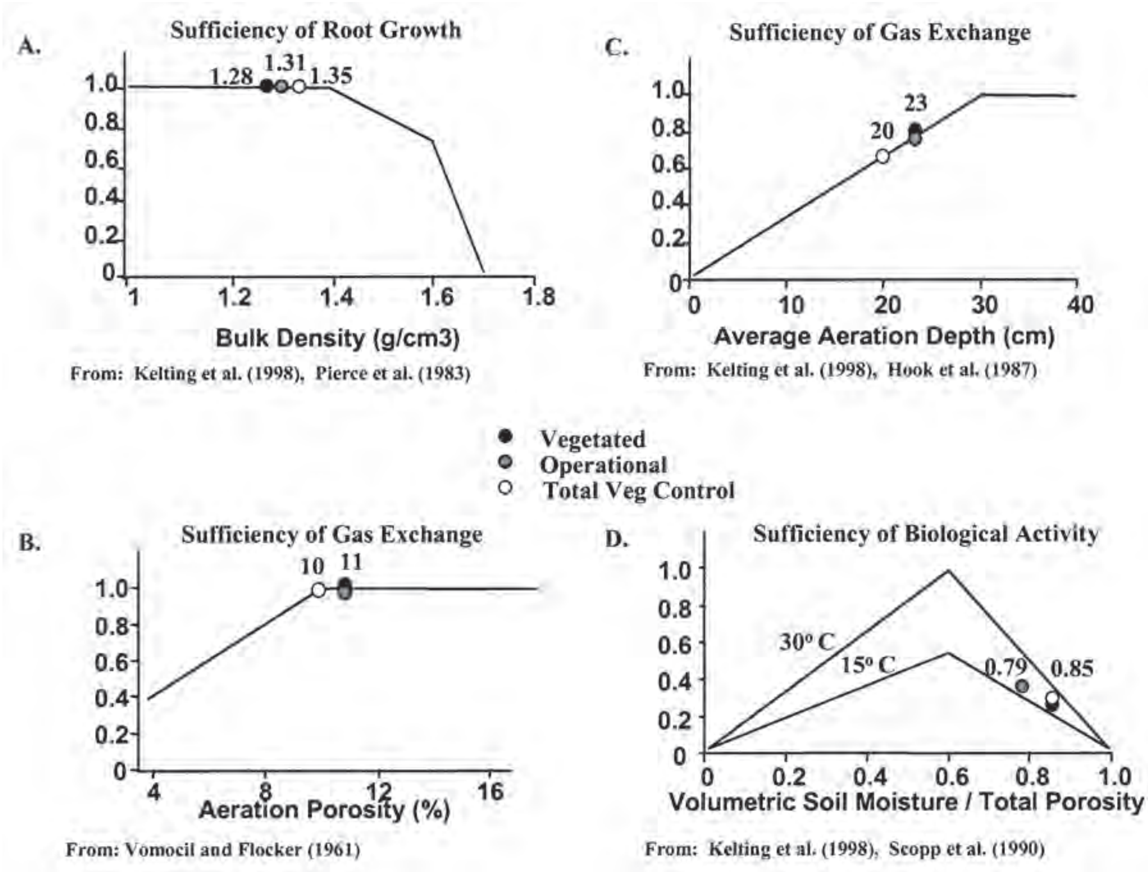

Figure 8. Sufficiency curves for vegetation treatment effect on (A) the soil rooting environment, (B and C) aeration, and (D) soil biological activity.

experiments, or professional experience and judgment. For example, Kelting and others (1999) developed sufficiency relationships for loblolly pine response to soil conditions on poorly drained soils. The curves were based on a combination of compiled literature and research. Lister and others (2004) used these relationships to judge the effect of different levels of ground cover vegetation on soil quality recovery after wet-weather logging (fig. 8).

Furthermore, most of this work was regression-based, so sufficiency curves are often reported or can be constructed from reported data. Lacking past research of this type, soil scientists can develop their own soil/site growth and yield relationships for specific forests or land types. The results accumulating from LTSP studies that have been targeted for this purpose are even better.

Step 3: Combining and Weighting Indicators in a Soil Quality Model—After indicators are selected and their sufficiency curves established, they can be incorporated in a model for an overall index of soil quality (Gale and others 1991). Eq. (1) is a soil-quality model developed by Kelting and others (1999) and Lister and others (2004) for loblolly pine on an affiliate LTSP site on Mead-Westvaco property in the lower coastal plain of SC. The soils were predominantly poorly drained Argent loam (Ochraqualf) and Santee loam (Argiaquoll) subject to compaction, rutting, and puddling when tree stands are harvested under wet conditions. The model provides an index of the net effect of harvesting disturbance using key soil quality indicators that are disturbed by wet-weather logging and influence tree growth predictably:

$$SQ = \sum_{i=1}^{area} \left[(D_b \times wt) + (P_a \times wt) + (AD \times wt) + (\Theta / P_t \times wt)\right] \times WF_{area} \quad (1)$$

where SQ is the overall soil quality index (0 to 1), D_b the sufficiency for bulk density, P_a the sufficiency for aeration porosity, AD the sufficiency for aeration depth, Θ/P_t the

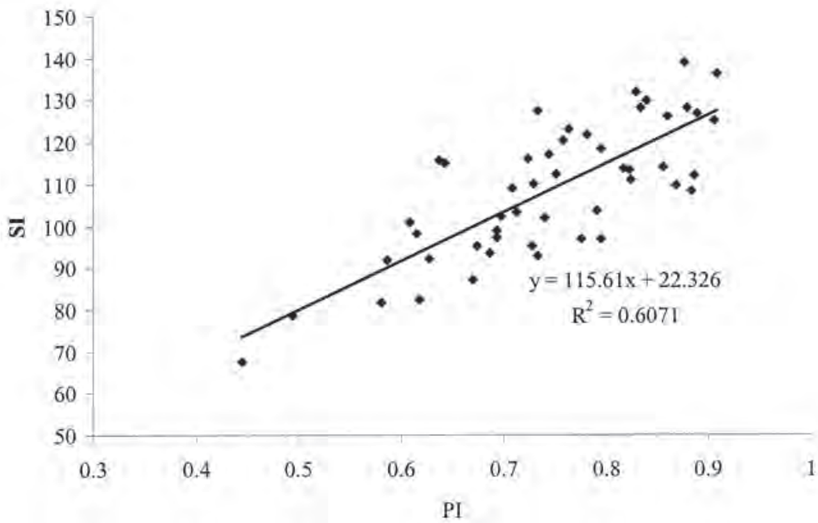

Figure 9. Relationship between site index (tree height at age 50) of white pine and a productivity index (soil quality) calculated from literature-based sufficiency curves for pH, soluble salts, soil density, slope, coarse fragment content, and aspect. Site index and soil measurements were for 52 reclaimed mined sites in the Appalachian region of Virginia and West Virginia.

sufficiency for biological activity, wt the relative weight or standardized coefficient for each indicator, WF_{area} the weighting factor for the extent of the overall activity area impacted, and area is each subsection of the overall activity area surveyed.

Jones and others (2005) developed a soil quality model to judge suitability of land reclaimed to forest after mining disturbance. Their work demonstrates all steps in the development of a soil quality modeling approach and might be used as a template for similar efforts. Previous soil/site regression studies suggested that the major mine soil growth limiting factors were soil density, P deficiency, toxic levels of soluble salts, extremes in pH, soil texture, coarse fragment content (Torbert and others 1988a, b; Torbert and others 1990; Andrews and others 1998; Rodrigue and Burger 2004). Using these reported relationships between tree growth and mine soil properties, Jones and co-workers developed sufficiency curves for mine soil properties that were consistently related to growth in these regression studies, and then used the following general soil quality model as a first approximation:

$$SQI = (pH \times texture \times density \times CF)^{1/4} \times depth \qquad (2)$$

where SQI = site quality index; pH = sufficiency of pH; texture = sufficiency of texture; density = sufficiency of soil density; CF = sufficiency of coarse fragments; and depth = sufficiency of rooting depth (equivalent to WF in Eq. 1). To test the performance of the model, a SQI was calculated for each of 52 reclaimed sites planted with white pine. Tree height and age were used to determine site index (SI), and soils were sampled for pH, texture, density, CF, and depth. SQI values were calculated using Equation 2 and regressed with white pine SI. SI was significantly linearly related to SQI (calculated from Eq. 2) with an R^2 value of 0.63 (fig. 9), showing that this general SQI model could be used with acceptable accuracy to predict forest productivity based on mine soil properties; that is, it could be used as a performance standard to determine if post-mining productivity equaled pre-mining productivity as required by law.

The SQI model (Eq. 2) assumes that all soil variables are equally important, which is unlikely. Jones and co-workers refined the model to make it locally specific. They regressed measured SI with measured soil properties from the 52 study sites. Standardized coefficients were calculated and used to develop relative importance factors for weighting the soil variables in the final site-specific model:

$$SQI_{ss} = (pH \times IF) + (texture \times IF) + (density \times IF) + (depth \times IF) \qquad (3)$$

where SQIss = site-specific SQI; pH = sufficiency of pH; texture = sufficiency of texture; density = sufficiency of soil density; depth = sufficiency of rooting depth; and IF = importance factor for each soil property (table 3). This weighted, additive, site-specific model improved the fit with measured SI somewhat with an R^2 of 0.68 (fig. 10). This model can and should be further validated with additional field testing. It, along

Table 3—Standardized coefficients, importance factors, and significance values for the independent variables used in the final model (Equation 4).

Variable	Standardized coefficient	Importance factor	*p*-value
Density	–0.54789	0.44	<0.0001
Rooting depth	0.34989	0.28	0.0004
Texture	–0.25135	0.20	0.0039
pH	–0.10393	0.08	0.2167

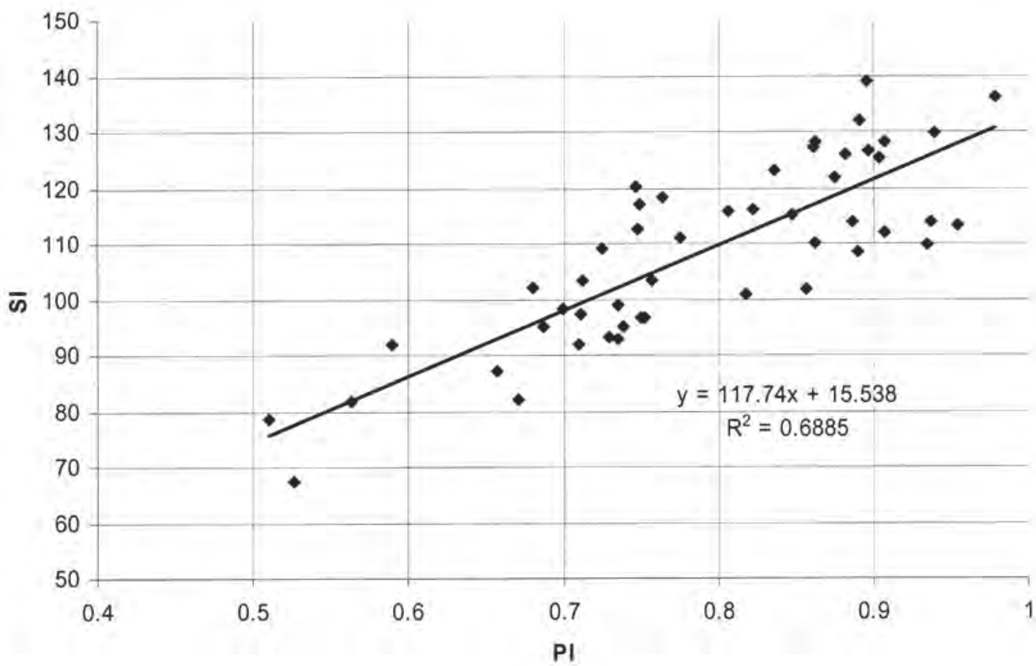

Figure 10. Relationship between site index (tree height at age 50) of white pine and a productivity index (soil quality) calculated from literature-based sufficiency curves for pH, soil density, soil depth, and soil texture. Sufficiency values for the four soil properties were weighted based on their relative contribution to white pine site index. Soil measurements were for 52 reclaimed mined sites in the Appalachian region of Virginia and West Virginia.

with similar earlier work (Torbert and others 1994; Burger and others 1994, 2002), is currently being advocated for use as a mechanism to judge post-mining forest productivity in the Appalachian region.

Site quality models as outlined above can easily be applied to different sections of an activity area by calculating SQIs by section (*e.g.*, percent of area compacted) and weighting indices by areal extent. The model, sufficiency calculations, weighting by importance, and weighting by areal extent can all be part of a SQI algorithm programmed in field computers. Immediately after field and laboratory sampling data are entered, an area based SQI can be generated.

This work by Jones and others (2005) shows that a first approximation general SQ model can be developed based on a compilation and synthesis of research results for a given area, and that further refinement can improve its specificity. Using this model within current operational and regulatory frameworks is entirely feasible. General models that incorporate the known productivity determinants could be made for general forest types across Forest Service regions and made more region- and site-specific with local data on sufficiency curves for specific forest types and plant species.

Classifying and Mapping Risk of Soil Impairment Across Landscapes

Once armed with a good soil quality monitoring protocol, another consideration is applying monitoring effort proportional to risk of soil impairment due to natural or human-caused disturbances. Some soils and sites are relatively more resistant than others to the same disturbance impacts, and some soils and sites rebound to pre-disturbance conditions faster than others. GIS-based risk assessments at a landscape, watershed, or national forest scale would be helpful for allocated monitoring resources and prescribing appropriate management practices.

Elias and Burger (in preparation) recently developed acid deposition (AD) resistance maps for the Monongahela National Forest in West Virginia to help target monitoring efforts cost effectively. Increasing soil acidification, base leaching, and soil Al toxicity may adversely impact forest productivity. Stand volume in about one-third of 91 Forest Inventory and Analysis (FIA) plots recently (10-yr period between 1989-2000) declined periodic annual increment (PAI) of by up to 9.5 $m^3ha^{-1}yr^{-1}$, while another one-third was less than 3 $m^3ha^{-1}yr^{-1}$ growth (Elias and others 2009), which is less than expected growth. Incremental growth was not correlated with site index, but was strongly correlated with Ca/Al molar ratio, effective base saturation, and other indicators of acidification. Given the broad range in periodic annual increment (PAI) and the diverse terrain and soil parent materials that range from acid sandstones to limestone, a GIS-based acid deposition resistance index was modeled to help direct monitoring efforts.

Elias and Burger (in preparation) created AD resistance relationships for parent material, slope, aspect, elevation, soil mineralogy, depth, texture, and rock fragments based on published relationships and expert knowledge to encompass the range of each factor found on the Monongahela National Forest (MNF) (table 4). All soil and site factors were tied to existing MNF GIS layers. At each FIA plot location, values for each site factor were determined using 30 by 30 m U.S. Geologic Survey Digital Elevation Models (USGS DEM), SSURGO, and MNF maps (table 4). A resistance index ($RI_{general}$) was then calculated for each FIA plot using the following model:

$$RI_{general} = [.2\text{ (parent material score)} + .2\text{(aspect score)} + .2\text{(elevation score)} + .2\text{(soil depth score)} + .2\text{(texture score)}]^2 \quad (4)$$

PAI was significantly correlated with $RI_{general}$ indicating that the combined soil/site factors were associated with forest productivity and that the modeling approach had merit. A site-specific AD resistance model (RI_{MNF}) was then developed by weighting

Table 4—Range of site factors used to create a Resistance Index for the Monongahela National Forest in West Virginia.

Factor	Range of characteristics and resistance: 0				1
Parent material‡	Acidic				Calcareous
Slope	Resistance = $-0.00005x^2 + 0.0055x*2.7$				
Aspect	235 – 286	197 – 234/ 285 – 325	145 – 196/ 326 – 15	107 – 144/ 16 – 55	56 – 106
Elevation	Resistance = $-0.0005* e^{0.005x} + 1$				
Mineralogy	Siliceous				Mixed
Depth	Resistance = $1.3* e^{-55/(x + 0.0001)}$				
Rock fragments	Resistance = $-0.0175* e^{0.045x} + 1.015$				
Texture	Resistance = $-0.001x^2 + 0.06x$				

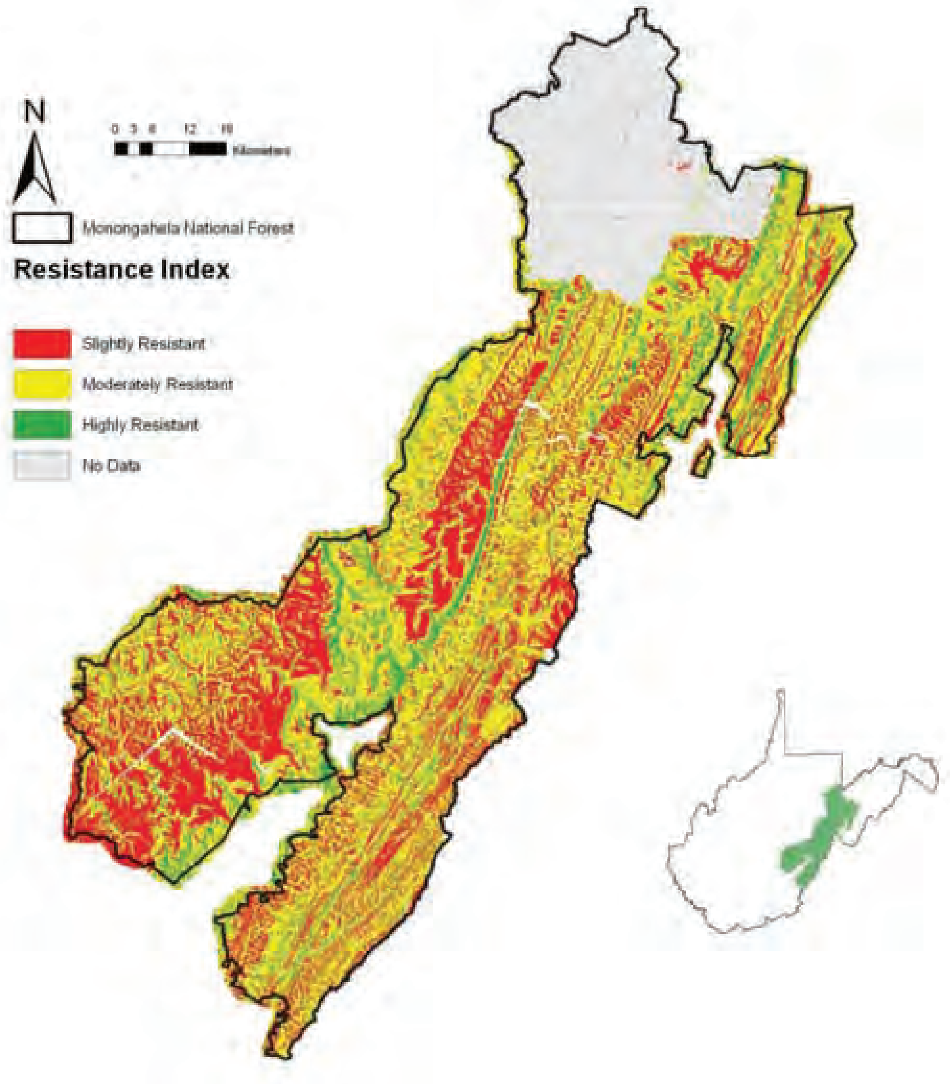

Figure 11. Map of resistance to acidification on the Monongahela National Forest.

the influence of each site factor to reflect current forest conditions as measured on MNF FIA plots.

The relationship between RI_{MNF} and significant indicators (pH, EBS, Ca/Al ratio, Al content) were used to create RI classes (slightly, moderately, and highly resistant). Class breaks were made at indicator levels associated with forest response in similar ecosystems (Cronan and Grigal 1995; Fenn and others 1998). A resistance index based on the classes of weighted site and soil factors (RI_{MNF}) was mapped across the Monongahela National Forest (fig. 11). Across the MNF, 14 percent of the land area was mapped as highly resistance to acidification ($RI_{MNF} \geq 0.7$), 57 percent was mapped as moderately resistant ($0.7 > RI_{MNF} > 0.45$), and 29 percent was mapped as slightly resistant ($RI_{MNF} \leq 0.45$).

This work by Elias (2008) demonstrates the use of soil quality monitoring principles for assessing risk of soil quality change across a forest. Correlation between forest growth and disturbance (PAI and AD) was established; criteria and indicators were selected based on a synthesis of previous research; the indicators were tested and those correlated with growth were selected; and a gradient of sensitivity (RI) to AD was developed and mapped based on available GIS layers. A systematic monitoring protocol using these soil quality indicators can now be directed to the least resistant sites, but soil-specific soil quality standards still need to be established for triggering mitigative and preventive management practices.

Incorporating Adaptive Management and Soil Quality Models Into the Forest Service Soil Management Program

Stewards of the public's forests are compelled to manage in a way that is economically viable, environmentally sound, and socially acceptable; this is called sustainable forest management (SFM). The Montreal Process is a multi-national initiative providing policy and management tools for achieving SFM. The United States is a Montreal Process signatory and the U.S. Forest Service represents the United States on its various committees. The organization establishes criteria and indicators for monitoring the status and health of temperate forests (Montreal Process 1995). Criterion #4 calls for monitoring the level of significant soil degradation. Various monitoring methods have been proposed and tried throughout the world with varying degrees of success, but the general approach of using indicators to measure change in soil function due to forest management disturbances is central to all.

The USDA Forest Service has a long-established soil quality monitoring program (USDA Forest Service 1991) with a goal of "developing a legally defensible monitoring and evaluation program based on firm scientific principles that produces unequivocal, credible results at minimum cost." Attaining this goal is a work in progress, as it is for all land management agencies, private landowners, and third-party certification entities. Due to recent legal challenges associated with management activities within the National Forest System, the Forest Service is especially compelled to review and update its soil management program.

The current objectives of the Forest Service Soil Management program as recently amended in the Forest Service Manual (FSM 2500-2009-1) are good and should meet the spirit and letter of the authorities that govern Forest Service management, but the policies and program approach for achieving the objectives fall short of getting the job done. The current approach is essentially one of inventorying the soil resource, classifying and describing its current condition, and monitoring its condition after management activities using disturbance indicators with threshold levels that, if exceeded, indicate that the soil has been impaired. This approach has limitations: (1) it is a passive and reactive approach; (2) it requires the use of disturbance indicators that have little or no science-based cause-and-effect relationship with ecological processes and function; (3) it uses the same disturbance indicators (one size fits all) across a gradient of highly variable soils and forest ecosystem, which is not workable; and (4) experience shows that different people applying current methods on the same site produce different results and assessments. Increasingly, elements of the public are challenging this approach as being inadequate for protecting soil quality and forest productivity.

We believe a broader, proactive, adaptive management approach that would (1) explicitly define best management practices for use on NFS lands, (2) monitor their implementation and effectiveness using science-based soil quality models, and (3) continually incorporate research results into the adaptive management process via established mechanisms would better serve the soil management program and achieve the overall goal of SFM. The use of adaptive management is now policy according to the recently revised Forest Service Manual (Section 2551.02). The overall approach, objective, policy, and even the general ecological processes and functions being sustained could be common across the NFS. However, the soil and ecosystem services, the indicators of change, and soil quality models, and the interpretations of the models regarding risk and judgments of impairment and mitigation need to be region-, forest-, and soil-specific as needed, although much overlap is possible and desirable.

Using similar adaptive management approaches across Forest Service Regions, to the extent possible, would provide better credibility with the public, and it would be more efficient to share techniques, models, and protocols. Choices for the hierarchical components of adaptive management would best follow biological, not jurisdictional boundaries. In order to develop guidelines for BMPs and evaluate soil quality, the soil services in question must first be selected. These would most likely be selected at large biological and jurisdictional scales. For example, the NFS would likely choose soil productivity, protection of water quality, biodiversity, and ability to sequester or buffer C and pollutants as major soil services that differ in relative importance at smaller scales. Within each soil service, soil functions can generally be set at broad biological spatial scales, because the fundamental functions that allow soils to provide services are not specific to biological systems. To protect soil and ecosystem function, management guidelines applied as BMPs could be developed inter-regionally in many cases. Some management practices are site- and forest-specific, while others can be broadly applied across Forest Service regions.

The attributes and indicators that provide the details of soil quality modeling, however, cannot cross biological boundaries as well as they can cross jurisdictional boundaries. Sufficiency curves for a given indicator are generally forest-type specific. For example, sufficiency curves for soil productivity of upland oak-dominated forests are likely to be similar in Tennessee or Wisconsin, even though these forests are located in two separate Forest Service regions. Similarly, ponderosa pine likely has more in common with loblolly pine than with redwood. In some cases, different forest types might have more in common with respect to soil indicator sufficiency responses than site types within a forest type. Coastal Douglas-fir may respond to soil indicators more similarly to redwood than to Douglas-fir in the Rocky Mountains. The best first approximation would likely be to adapt Bailey's (1995) ecoregions for development of SQMs.

In many cases, SQMs might be developed at the province or section level, while in other cases land type association might be more appropriate. While this would require increased regional cooperation, and in some cases more local involvement, it would reduce duplicative efforts where provinces or land type associations crossed regional boundaries, and it could increase the reliability and appropriateness of an SQM. The relative importance of specific land type associations or the relative management intensity within land types would help to prioritize the scale at which SQMs would need to be developed. SQMs might be able to be developed at the province level for provinces that have few management activities or for which certain services are of less importance, while heavily managed or critical areas might require SQMs at land type association levels to ensure their effectiveness.

Compared to current use of disturbance indicators with ill-defined "impairment" thresholds, soil quality models have the potential to improve monitoring and evaluation protocols when based on the following: (1) a clear management goal is defined (*e.g.*, maintain soil and function for long-term forest productivity); (2) soil function (stability, hydrology, nutrient cycling) is monitored and evaluated using site-specific indicators based on a synthesis of research and expert opinion; (3) indicators, both disturbance and soil quality, are correlated with productivity; (4) disturbance and soil quality indicators can be uniformly used and applied by trained technicians; (5) measures of disturbance and soil quality can be weighted based on importance and areal extent and combined into a single index that is correlated with tree growth or some other measure of productivity; (6) performance standards (some score or level of the combined indicators) can be established based on pre-disturbance conditions.

Powers and others (1998) stress that SQM protocols must be operationally feasible and cost effective, and they and others (Fox 2000) have criticized soil quality models as too complicated and too costly for routine monitoring. We believe this criticism is based on a misunderstanding of effort and cost of developing the models and protocol versus applying them. The models and protocols are developed by soil scientists as relatively simple and straightforward decision-support computer programs. Soil technicians apply the field protocols and enter data for computation. We believe the extent and quality of our current research database and our ability to select good, cost-effective indicators has been underestimated. The general literature, combined with up-to-date results from LTSP trials, could serve as a source for a refined soil quality monitoring protocol. For example, several soil properties recently shown to be correlated with both disturbance and tree growth are pore size distribution, strength, extractable P, and mineralizable N. Sampling for all these properties, except strength, is no more complicated than taking a soil core sample for bulk density, and strength is measured directly in the field using a penetrometer. Testing for density, pore size distribution, N, and P are routine tests that can be done locally or via contract.

In any case, implementation protocols for Soil Quality Management policy (FSM Section 2551.03) need to be reviewed and revised to be legally defensible. For years, soil quality managers have used disturbance and soil productivity indicators in the same way that air and water quality indicators are used, yet soil quality indicators do not perform properly alone or apart from a more comprehensive soil quality assessment. Similarly, reporting monitoring results without putting them in proper context within an adaptive management program (FSM 2009: 2551.03) will likely be inefficient or counterproductive.

Soil quality cannot be defined by individual indicator threshold values the way indicators for air and water quality can be. Water quality, for example, can be defined based on whether values for temperature, oxygenation, sediment load, and various chemicals are within some defined tolerance level. Tolerance levels are easily set because the effects have been directly observed in either humans or other animals. In soils, indicators work indirectly in concert with other indicators. Soil quality indicators show the sufficiency of a combination of soil properties and processes to function toward providing a service. Sufficiency is based on a reference level (*e.g.*, pre-harvest soil condition) specific for a given soil in a given forest ecosystem.

Critics of the soil quality modeling approach for assessing soils worry about a lack of threshold values for soil quality indicators beyond which a soil is "impaired"; however, currently used threshold values for individual indicators are usually not appropriate for judging impairment because they do not have actual cause-effect relationships with soil functions. There is little or no science for establishing threshold levels for soils. By contrast, the basic science needed to create and develop first-approximation sufficiency curves for most soil functions is widely available. Sufficiency curves can be improved with additional research and monitoring over time, but the basic structure of each curve can be developed today with our current understanding of soil functions.

Soil quality models created with a set of well-selected indicators and associated sufficiency curves do not provide threshold levels. SQMs provide a scaled "score" that indicates the direction and magnitude of change in the ability of a soil to function to provide a particular service. For example, Kelting and others (1999) developed a soil quality model that used bulk density, aeration porosity, and nitrogen mineralization (indicators) to evaluate sufficiency for root growth and biological activity (soil functions). They used the SQM to evaluate the impact of wet-weather harvesting (management action) on intensively managed loblolly pine growth (soil service) in the lower coastal plain of South Carolina. The SQM was scaled to actual loblolly pine growth on these sites. The SQM could be generally adapted to most southern pine forests with imperfect drainage, but the score would need to be scaled to be site- and species-specific (*e.g.*, naturally managed longleaf pine on the flatwoods of central Louisiana).

Soil quality models also have the ability to provide much more information about soil services other than soil productivity. Because of forest management's agronomic-based background and focus on producing timber, soil scientists and forest managers have focused on soil productivity (measured as wood production: $m^3\ ha^{-1}\ yr^{-1}$). However, across the National Forest System, other soil services such as water quality protection, wildlife habitat, and carbon, nutrient and pollutant sequestration and processing are vitally important. These services are even more difficult to measure directly, and threshold values for individual indicators are probably even less useful. However, sufficiency curves and SQMs can be created for the soil functions that provide these services (Scott and others 2006), and they can be continually improved through targeted research and monitoring.

The final key to developing soil quality models is to recognize their proper place within an adaptive management program. As mentioned above, soil quality models do not provide threshold standards for individual indicators that can be applied across sites, forests and regions; they provide relative values for overall sufficiency or ability to provide a soil service that changes in response to management. Threshold values can be set for the overall change in soil quality, but not individual indicators. Because of this, soil quality models (and their indicators) do not function well as broad spatial scale monitoring tools. Rather, they work best as tools to help evaluate management impacts at the site level. They provide the ability to evaluate BMP effectiveness within adaptive management frameworks.

In summary, we believe there is ample opportunity given our current knowledge and technical skills to improve soil management in the context of adaptive management programs. Action and change are needed in order to meet the goal of legally defensible, science-based soil management that produces “unequivocal and credible results.” Required is a commitment by regional foresters and soil specialists to accept the challenge of developing sophisticated, computer-based soil quality models as part of the monitoring process. Also required is a commitment by Forest Service soil scientists to be part of the adaptive management process by providing input for the selection of soil quality indicators, development of sufficiency curves, and construction of the actual SQMs. The process of discovering “how the forest works” (creating knowledge) may be more enticing to soil scientists than applying knowledge for protecting it; but we would argue that the outcome of applying existing knowledge for a good adaptive management for the NFS is equally important and rewarding.

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 100

February 21, 2023

Excerpts of:
U.S. Forest Serv., Nantahala and Pisgah National Forests, *Final Environmental Impact Statement for the Land Management Plan* (Jan. 2022)

USDA Forest Service U.S. DEPARTMENT OF AGRICULTURE

Southern Region | National Forests in North Carolina | R8 MB-161 | January 2022

Nantahala and Pisgah National Forests

Final Environmental Impact Statement

for the Land Management Plan

Front cover courtesy photo by Travis Bordley

Final Environmental Impact Statement
for the Land Management Plan
Nantahala and Pisgah National Forests
National Forests in North Carolina

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Abstract: This environmental impact statement (EIS) documents the analysis of five alternatives (A through E) developed by the Forest Service to revise the land and resource management plan, as amended, for the Nantahala and Pisgah National Forests. The revised forest plan would provide for the programmatic management of approximately one million acres administered by the U.S. Forest Service in Western North Carolina (WNC). Alternative A is the no-action alternative and would keep in place the management direction from the current forest plan, as amended. Alternative B responds to those who desire more flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. Alternative C is intended to be responsive to those who desire more certainty defined in the forest plan and less project level flexibility for managing vegetation patterns, wildlife habitats, recreation, and access. Alternative D is an intermediate approach between Alternatives B and C in terms of plan restrictions versus project flexibility for vegetation management, recreation, and access. Alternative E was added between the draft and final EIS to be responsive to public comments. The EIS analyzes the anticipated progress toward desired conditions as well as potential environmental and social consequences of implementing each alternative. The notice of intent (NOI) to prepare an EIS was published in the Federal Register on March 12, 2014. The notice of availability (NOA) for the DEIS was published in the Federal Register on February 14, 2020, and extended an additional 45 days to close on June 29, 2020. Public input was also used to update the Revised Forest Plan and its associated Final Environmental Impact Statement. The response to those comments can be seen in FEIS Appendix A. The final forest plan accompanies this analysis. The Bureau of Land Management (BLM) is a cooperating agency in the Nantahala and Pisgah NF plan revision, because the BLM has legal jurisdiction over the federal mineral estate underlying the Nantahala and Pisgah National Forests.

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producing bedrock or in areas with ultramafic rock with asbestos, although additional screening standards in the action alternatives should reduce that risk.

Ground disturbance generally is more prevalent on lands outside NFS lands than on NFS lands. Residential, commercial and industrial development, and highways and high density roads networks are found on lands outside NFS lands. As WNC continues to grow, these types of ground disturbances necessary for economic development can be expected to continue on lands outside NFS lands. The ground disturbance on the NFS lands contributes to the overall ground disturbance in WNC, but it is less intense than ground disturbance on lands outside NFS lands. As a result, the cumulative impacts from ground disturbance on geologic resources is expected to be less on NFS lands than on lands outside NFS lands.

3.2.4 Soils

Affected Environment

Background

Soil morphology

The Nantahala and Pisgah National Forests are within the mountain belt of the Blue Ridge physiographic province. This belt consists mostly of igneous and metamorphic rocks and small areas of sedimentary rock on the western margins (Trapp and Horn 1997). Soils form from parent material prone to weathering, influenced by high rainfall and moderate air temperatures.

General soil descriptions can be broken down into the Broad Basins, River Terraces, and Floodplain System, the Low and Intermediate Mountain System and the High Mountain System. The Broad Basins, River Terraces, and Floodplain System is characterized by wide valleys and low, rounded hills with few steep slopes. These soil profiles have higher nutrient supply and water-holding capacity due to a high rate of organic material decomposition. Low and Intermediate Mountain System soils are found at elevations between 1,400–4,600 feet above sea level. Soil formation is influenced by elevation, slope aspect, exposure, and vegetation present, and have well developed profiles. They are acidic and highly weathered, and their principal topography includes steep slopes and ridges, as well as steep, narrow, and wet valleys. The High Mountain System soils are generally found above 4,600 feet and have unique ecological systems and soils that are directly related to the severity of the environment. Their formation is limited by frigid temperatures, resulting in less developed soil profiles with minimal microbial activity. Vegetative cover includes Red spruce and Fraser fir stands as well as heath and grassy balds.

Soil productivity

Soils vary widely in productivity, behavior, and response to management. While natural fertility and mineralogy are influenced by the type of materials from which the soils developed, site quality often is more closely related to landscape position and elevation. However, the soils derived from granites and gneisses generally are more productive than soils from metasedimentary rocks on similar landscape positions. Within a given area, the most productive soils generally are those in the coves and at the toe of slopes. Such sites are characterized by very deep, colluvial soils, which can support high quality cove hardwoods.

Residual soils on side slopes and ridgetops, which constitute the majority of any given area, vary widely in productivity. Below an elevation of approximately 4,800 feet, productivity is greatly influenced by soil depth (rooting depth) and moisture supply. Soils commonly range from shallow to deep, with moderately deep soils predominating. Within a local area, slopes that face north or east or that are sheltered by higher mountains are cooler, moister, and more productive than south- and west-facing slopes. Cool slopes generally sustain high-quality cove and upland hardwoods, except on some very steep slopes where shallow or outcropping bedrock limits rooting depth and/or growing space. Warm slopes vary widely, ranging from sites with moderately deep to deep soils capable of sustaining good growth of upland hardwoods and pines to droughty sites with shallow soils and very low productivity. Generally, within a local area, broad ridgetops have deeper soils with more available water for vegetation, and thus are more productive than narrow ridgetops.

Above 4,800 feet, productivity is limited by the short growing season and severe climate. Soil formation is limited by cold temperatures, resulting in less developed soil profiles with minimal microbial activity. *Frigid soils* occur in these areas, occupying 55,270 acres of the planning area. They are characterized by organic, rich soils and cool, moist microclimates. Sheltered positions can support good growth of northern hardwoods and, at the higher elevations, spruce-fir as well as heath and grassy balds. Tree growth on positions that are exposed to the strong prevailing wind is limited by ice and wind damage.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (59 Federal Register 35680, 7/13/94). These soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation. Hydric soils occur across the landscape in areas along stream channels, on floodplains, and in isolated springs and seeps. Based on data from NRCS, hydric soils occupy 594 acres in the planning area, and there are an additional 74,205 acres of partially hydric soils. Hydric soils are a primary indicator of wetlands and are used in the assessment of Forest Service compliance with Executive Orders 11988 and 11990, directives relative to the management and disposition of floodplains and wetlands.

There are 3,498 acres of *prime farmland soils* in the planning area. Farmland of local and statewide importance and potential prime farmland also occur. These soils have been identified by Congress, in the Farmland Protection Policy Act, Section 2 [7 USC 4201], and management is "to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, will be compatible with State, unit of local government, and private programs and policies to protect farmland." Therefore, the Forest Service is to avoid activities that would contribute to unnecessary and irreversible conversion of these farmland areas to nonagricultural uses. Such development could include roads, buildings, and campgrounds.

Forest management and soil quality

Historically, with the increasing influence of human activity, the occurrence of wildfire increased as Native Americans used fire to create meadow conditions for wild game management. These activities likely caused the consumption of more forest litter and the surface soil organic layer, possibly leading to increases in soil erosion following rainstorm events on steep slopes. Across the forest however, these impacts were likely small and soil development was not adversely impacted. With the colonization of the area by European settlers, small subsistence farms, ranches, and small towns appeared and a slight shift in land use occurred from forested to more open areas.

The importance of timber to the growing American economy in the early 1900s led to the harvest of vast timber resources in the mountains. Some of the largest impacts to soil stability are likely to have occurred during this period due to the extensive transportation network needed to remove timber for processing. With heavy rains, these disturbed mountainous areas likely suffered extensive soil movement in mass as landslides and debris flows occurred on steep and shallow soil areas. Certainly, some areas appear to have been more active than others, such as the Bent Creek drainage (USFS 2005), but evidence of landslides from a century ago appear across the landscape. As regrowth of the forest occurred and tracts of land were consolidated under federal ownership, land management practices improved and soils began to recover.

The operation of coal burning energy plants to the west and southwest brought a more silent threat to soil quality as prevailing winds delivered elevated levels of sulfur and nitrogen that fell in the rain, clouds, or dry deposition on the naturally acidic soils. Once in the soil, sulfur and nitrogen molecules attached to calcium, magnesium, and potassium (cations), and reduced these important nutrients from vegetation uptake. Where soils had abundant amounts of cations, they are considered to have a high “buffering capacity” to the adverse effects of the sulfur and nitrogen deposition, and were impacted the least. However, over time, the loss of cations was extensive and the soil’s ability to effectively buffer incoming levels of acid was diminished. Consequently, soils became more acidic and within these watersheds surface water in streams and reservoirs likely became more acidic.

Regulations on coal energy plant emissions began in the 1970s and steady reductions in sulfur and nitrogen emissions were established. In many watersheds damage to soils had already been done and soils will not likely recover for centuries. What this means to soil productivity is difficult to determine since reference soil nutrient conditions do not exist. Plant composition may have shifted to favor species like rhododendron, but this was more likely a result of historic clearcut harvesting. Plant health does not seem to indicate notable degradation of soil productivity.

Timber harvest impacts on soil quality

Extensive logging in the early 1900s, resulted in an extensive network of skid and haul roads on the landscape. Overtime many of these roads were abandoned; some were closed while others left to stabilize on their own. The stabilization of these “old woods” roads has been an ongoing effort of the Forest Service since the land was acquired to reduce erosion and improve soil productivity. Areas of soil compaction, such as on these old woods roads, continue to improve as compaction is reduced by natural processes, such as frost heave and disturbance by roots and ground dwelling animals, thus slowly improving soil productivity.

Soil disturbance can occur as a result of heavy equipment use during logging. Areas of concentrated use, such as log landings and skid roads are most affected. Compaction of these areas would increase the bulk density of the soils and result in a decrease in pore space, soil air, infiltration rate, and the water holding capacity of the soils and would increase water runoff. These effects are considered detrimental to plant growth. The degree and depth of compaction depends on several factors, such as on the number of passes the equipment makes and the moisture content of the soil at the time the passes are made. Changes in pore space do not normally occur on well-drained soils, such as those that occur over most of the Nantahala and Pisgah Forests, until three or more passes have occurred.

A review of the soil data and interpretations from the NRCS Web Soil Survey Site shows that a majority of the planning area has soils sensitive to erosion if a majority of the surface organic layer was removed. Because timber harvest has the greatest potential for disturbing the largest area of soil, the current Plan (Alternative A) Management Areas that promote active harvest of timber were assessed (these include MA 1b, 2a, 3b, 4a, and 4d). Table 10 and Figure 19 summarizes the NRCS Erosion Hazard Rating for soils on general forested lands, excluding excavated roads or trails, which will be addressed below. A “very severe” and “severe” hazard rating exists for 35.5 percent and 38 percent, respectively, (a total of 74 percent) of the area in these management areas if activities, such as timber harvest and prescribed fire, expose bare soil.

Table 10. Summary of Acres of Erosion Hazard Off Roads and Trails by Current Plan "Timber Production" Management Areas

Sum of Acres of Erosion Hazard Off Roads and Trails by "Timber Production" Management Areas						
	Erosion Hazard Rating - Off Roads & Trails					
Management Area (Current Plan)	Slight	Moderate	Severe	V. Severe	Not Rated	Grand Total
1b	1,528.54	8,094.75	14,325.78	12,374.80	319.62	36,643.49
2a	2,799.78	8,351.83	13,013.33	12,220.98	341.00	36,726.91
3b	10,575.96	52,943.29	90,098.75	83,465.44	922.68	238,006.12
4a	2,551.14	13,290.18	22,213.34	17,900.11	346.49	56,301.26
4d	5,202.27	30,230.96	59,985.49	59,972.76	738.38	156,129.86
Grand Total	**22,657.69**	**112,911.01**	**199,636.69**	**185,934.08**	**2,668.17**	**523,807.64**
Percent	**4.33**	**21.56**	**38.11**	**35.50**	**0.51**	

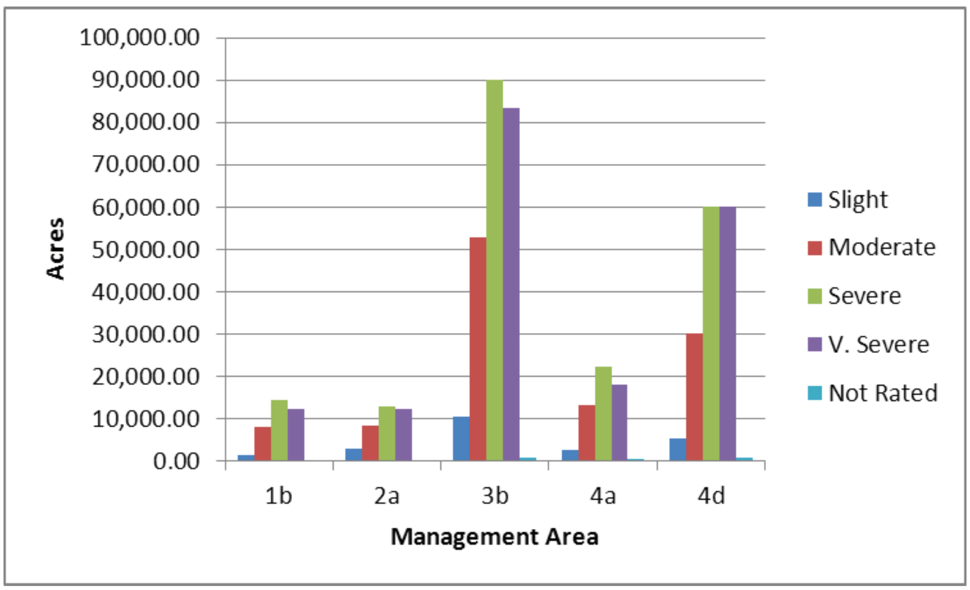


Figure 19. Summary of acres of erosion hazard off roads and trails by management areas that are suitable for timber production

Forest practices monitoring

Monitoring indicates very little long-term soil disturbance from activities other than roads and trails over the past planning period. Forest Practices Best Management Practices (BMP) monitoring from 1992 to 2000 compared to recent years (2009 to 2013) shows a notable improvement in the implementation and effectiveness of management practices (Table 11). This improvement means less soil disturbance including compaction and erosion. Harvest activities are improving in the type of BMP applied, such as the increased use of slash on skid roads and trails, choosing a temporary bridge over installing a culvert at stream crossings, and planning unit boundaries to exclude sensitive soils and streamside zones.

Table 11. Best Management Practices (BMP) Monitoring Summary Data Comparing Forestry BMP Implementation and Effectiveness Monitoring on the NFs in NC, Between 1992-2000 and 2009-2013

BMP Monitoring Period	Implementation				Effectiveness					Visible Sediment		
	Meets or Exceeds	Minor Departure	Major Departure	Gross Departure	Improvement Over Past	Adequate Protection	Minor/Temp. Impact	Major Short-Term Impact	Major Long-Term Impact	No Visible Sediment	Non-Critical Visible	Critical Visible
1992-2000 Total	785	310	56	2	5	833	219	83	3	435	84	20
Percent in Class	68.1%	26.9%	4.9%	0.2%	0.4%	72.9%	19.2%	7.3%	0.3%	80.7%	15.6%	3.7%
2009-2013 Total	1861	63	35	5	9	1862	53	28	12	1146	35	5
Percent in Class	94.8%	3.2%	1.8%	0.3%	0.5%	94.8%	2.7%	1.4%	0.6%	96.6%	3.0%	0.4%

An important factor considered in evaluating effects to soil resources is the extent of the area where long-term soil productivity might be impacted. Effects to the soils from projects are considered not significant on the Forest when 85 percent of the activity area is unaffected and retains its potential long-term soil productivity. In other words, no more than 15 percent of the activity area and each individual harvest unit are affected and lose potential long-term soil productivity.

Soil Quality Monitoring (SQM) was conducted on the Nantahala and Pisgah NFs using the Forest Soil Disturbance Monitoring Protocol (Page-Dumroese et al. 2009). The monitoring was done to determine if there was significant change in land productivity due to timber harvest activities. “Significant change” is defined as detrimental soil disturbance exceeding 15 percent of each individual harvest unit.

A summary of the 2009 - 2012 SQM is presented in Table 12. All timber sale units surveyed had predominantly ground-based harvested and had some degree of detrimental soil disturbance. Only two of the 30 post-harvest units were found to have disturbance above the significant level. The detrimental soil disturbance found in Farmers Branch Timber Sale in harvest Unit 4 in 2010 (15.7 percent detrimental disturbance) was mitigated in 2011 by subsoiling detrimentally compacted soils on skid roads and landings (Figure 20). Detrimental soil disturbance in this unit is now well below the 15 percent standard and soil productivity has been restored too much of the area. Likewise, Eagle Fork Timber Sale Unit 2, determined to have a detrimental soil disturbance of 16.3 percent in 2009, was also mitigated in 2012 (Figure 20), bringing the detrimental soil disturbance in this unit well below the 15 percent threshold. Several units, surveyed pre-harvest in 2009 and 2010, were resurveyed in 2011 following logging. Although an increase in disturbed area occurred from pre-harvest, the units surveyed maintained appropriate soil productivity.

Table 12. NFs in NC 2009 - 2012 Soil Quality Monitoring Results with Detrimental Soil Disturbance

Forest	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
Pisgah	Baldwin Gap	2	Post	11	9.4	0	9.4
		3	Post	27	3.2	0	3.2
		8	Post	23	9.1	0	9.1
Pisgah	Case Camp	3	Post	13	9.2	1.6	10.8
		6	Post	8	2.5	0.1	6.2
		8	Post	12	1.7	3.3	5
Pisgah	Shope Creek	23-12A	Pre/Post	12	4.7/9.3	0/2.2	4.7/10.9
		23-13	Pre/Post	9	1.2/2.5	0/0	1.2/2.5
		23-12B	Pre/Post	6	0/5.0	0/0	0/5.0
Pisgah	Mulberry Globe	2	Post	37	0.3	0	0.3
		3	Post	22	12.3	0	12.3
Pisgah	Pressley Fields	1	Post	17	1	0	1
		2	Post	11	3.5	0	3.5
		3	Post	2	10	0	10
		7	Post	16	8.2	0	8.2
Pisgah	Stateline	1	Post	30	7	0	7
		2	Post	19	11	0	11
Nantahala	Eagle Fork	1	Post	25	2.4	0	2.4
		2	Post	16	16.3	0	16.3
		3	Post	25	9.6	1.4	10.8
Nantahala	Locust Cove	1	Post	10	0.7	0	0.7
		2	Post	18	1.1	3.2	4.4
		3	Post	17	0.5	0	0.5
Nantahala	Slipoff	8	Post	8	4.4	3.1	7.5
		10	Pre/Post	24	0.3/3.6	0/3.3	0.3/7.0
		11	Pre/Post	19	0/6.3	0/0	0/6.3
Nantahala	Farmer Branch	1	Pre	25	0.6	0	0.6

Forest	Timber Sale	Unit #	Pre-harvest (Pre) or Post-harvest (Post)	Unit Area (acres)	Percent Detrimental Soil Disturbance		
					Skid Roads & Landings	Other within Unit	Total
		2	Post	20	3.2	0	3.2
		3	Post	10	6.5	0	6.5
		4	Post	14	15.7	0	15.7
		5	Post	18	9.8	0	9.8

Soil quality monitoring shows that the level of soil disturbance is minimized during operations and is often well below the 15% guidance. As a result, the majority of the harvested area maintains an organic layer that protects the soil from erosion. Therefore, the high hazard ratings within these management areas have been mitigated through proper application of effective best management practices.

Figure 20. Farmers Branch Timber Sale in harvest unit 4 (left) and Eagle Fork Timber Sale unit 2 (right) subsoiling to reduce soil compaction and detrimental soil disturbance from skid roads and landings

Recreation impacts on soil quality

Recreation activities that can expose large areas of bare soil, such as camping, do not typically occur on NRCS designated sensitive soils since the severe and very severe erosion hazards occur on steep side slopes that are often too steep to accommodate such activities. Concentrated use from the public often occurs on flatter areas often located near streams and can have detrimental impacts to soil productivity from compaction and rutting from vehicles. Exposed soils in these locations can pose often small but chronic erosion and sedimentation.

Road and trail impacts on soil quality

Roads and trails are often a long-term alteration of soil properties converting productive forest soils to a dedicated non-productive state. Assuming a 25 feet wide corridor of road disturbance, there is approximately 11 square miles of Forest land dedicated to roads, and assuming 7 feet wide corridor for trails, another two square miles of Forest land dedicated to trails. Where these features are on erosion-sensitive soils they can be of particular concern for erosion since they often cut into hill slopes exposing soil to weathering and interrupt flow of both surface and ground water. Roads and trails constructed in soils sensitive to erosion are important to identify and manage to address potential soil erosion concerns and sedimentation to nearby waters.

Table 13 shows miles of road and trail, and where they intersect with NRCS Erosion Hazard Ratings for such features. This information is useful in determining the need for erosion control mitigation measures, such as gravel surfacing and increased frequency of water diversion structures. Existing roads and trails on the transportation system predominantly occur within soils rated as having a "Severe" erosion hazard (81% and 86% respectively) (Table 13). Therefore, the application and maintenance of erosion control mitigation measures are essential to reducing erosion and maintaining soil quality. On the NFs in NC, very few roads are in a native surfaced condition due to erosion concerns. Roads predominantly have gravel surfacing applied and/or are planted in a ground cover type vegetation. Trails on the other hand depend largely on appropriate drainage that removes surface runoff from the trail before erosion begins.

Table 13. Miles and Percent of Road and Trail by Road and Trail Erosion Hazard Ratings

	Erosion Hazard Rating - On Roads & Trails				
	Slight	***Moderate***	***Severe***	***Not Rated***	***Total***
Total Road Miles	50.2	282.2	1907.8	108.9	2349.0
Percent	*2.1*	*12.0*	*81.2*	*4.6*	-
Total Trail Miles	41.8	156.8	1391.3	25.9	1615.9
Percent	*2.6*	*9.7*	*86.1*	*1.6*	-
Total Road/Trail Miles	92.0	439.0	3299.1	134.8	3964.9
Percent	*2.3*	*11.1*	*83.2*	*3.4*	-

Note: Erosion Hazard Rating calculated for road and trail miles on Nantahala and Pisgah Forests managed lands only, therefore will be less than presented in the Transportation and Recreation analysis, which consider different geographical analysis scales.

Across the Forest most roads and trails are properly designed, constructed and maintained to mitigate the hazard of erosion by effectively draining storm runoff with frequent rolling-dips and ditch relief culverts, and the application of gravel surfacing. In some situations, however, roads and trails were constructed with unsustainable practices decades ago and are in need of frequent maintenance or relocation or obliteration.

Environmental Consequences

Common to all alternatives

Fire effects on soil properties and processes is quite varied. Effects to the organic layers and soil organisms depend greatly on heat penetration into the soil. Heat penetration depends upon the duration of the fire and soil moisture (Swift et al. 1993). Fire generally affects soil erodibility if mineral soil is exposed, however, reports show little to no erosion after the typical light to moderate intensity fires in the southeastern United States (Swift et al. 1993; USFS 2010c). Overall, published scientific studies have concluded that prescribed fire, implemented under managed or controlled conditions, have negligible to beneficial effects on the physical, chemical, and biological properties of soils and soil

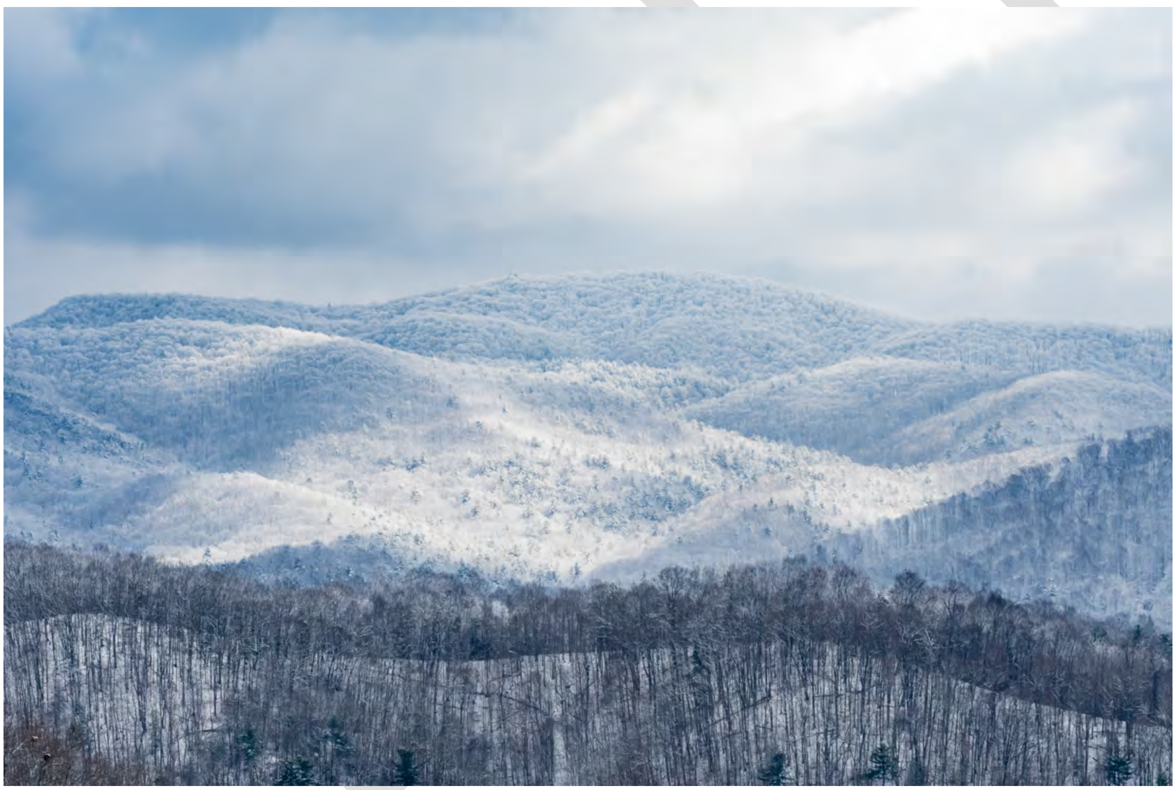
The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 101

February 21, 2023

United States Department of Agriculture

FY2015 – FY2019 Monitoring Evaluation Report for the George Washington and Jefferson National Forests



Iron Mountain looking southeast from State Route 91 in Washington County on the Mount Rogers National Recreation Area.

Forest Service George Washington and Jefferson National Forests September 2020

For More Information Contact:

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About our Plan Monitoring Program

Purpose

The purpose of the biennial monitoring evaluation report is to help the responsible official determine whether a change is needed in forest plan direction, such as plan components or other plan content that guide management of resources in the plan area. The biennial monitoring evaluation report represents one part of the Forest Service's overall monitoring program for this national forest unit. The biennial monitoring evaluation report is not a decision document—it evaluates monitoring questions and indicators presented in the Plan Monitoring Program chapter of the forest plan, in relation to management actions carried out in the plan area.

Our monitoring plan covers these eight topics required under FSH 1909.12, in addition to social, economic and cultural sustainability. You'll find each of these topics addressed in this report numbered 1 -9.

1. The status of select watershed conditions.
2. The status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.
3. The status of focal species to assess the ecological conditions required under § 219.9.
4. The status of a select set of the ecological conditions required under § 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.
5. The status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.
6. Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.
7. Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.
8. The effects of each management system to determine that they do not substantially and permanently impair the productivity of the land (16 U.S.C. 1604(g)(3)(C)). (36 CFR 219.12(a))
9. Social, Economic and Cultural Sustainability

How Our Plan Monitoring Program Works

Monitoring and evaluation requirements have been established through the National Forest Management Act (NFMA) at 36 CFR 219. Additional direction is provided by the Forest Service in Chapter 30 – Monitoring – of the Land Management Handbook (FSH 1909.12).

The Jefferson and the George Washington National Forests (GWJNF) are administratively combined therefore this monitoring report will address both the 2014 Revised George Washington Land and Resource Management Plan (hereinafter referred to as the George Washington Plan) and the 2004 Revised Jefferson Land and Resource Management Plan (hereinafter referred to as the Jefferson Plan).

Both the Jefferson (signed administrative change - https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd519607.pdf) and the George Washington National

Forests (signed administrative change https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd519607.pdf) monitoring programs were updated on September 28, 2016 for consistency with the 2012 planning regulations [36 CFR 219.12 (c)(1)]. The monitoring program components for each of the Forest Plans are located here:

Jefferson Forest Plan – Implementation, Monitoring and Evaluation Chapter 5
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd519609.pdf

Jefferson Forest Plan Appendix E Monitoring Tasks -
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd519611.pdf

George Washington Forest Plan Implementation and Monitoring Chapter 5-
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3822829.pdf

George Washington Forest Plan Appendix G Monitoring Tasks -
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd519599.pdf

Monitoring questions and indicators were selected to inform the management of resources on the plan area and not every plan component was determined necessary to track [36 CFR 219.12(a)(2)]. See administrative change for the Jefferson Forest Plan and George Washington Forest Plan - for discussion on how the monitoring questions were selected to be consistent with the 2012 planning regulations 36 CFR 219.12.

This will be the first monitoring report for the 2014 Revised George Washington Land and Resource Management Plan. Additionally, this will be the first report of this evaluation since the 2016 administrative change for both the Jefferson and George Washington Forest Plans to comply with the 2012 planning Rule (36 CFR 219.12(a)(5)) as referenced above.

As a result of the 2016 administrative change there are four new monitoring questions related to climate change (Jefferson Forest Plan monitoring questions 20 - 23 and George Washington Forest Plan monitoring questions 27- 29), that are addressed and evaluated through the Region 8 Broader-Scale Monitoring Strategy. Indicators and procedures that are used at the broader scale for these monitoring questions can be found at Region 8’s Broader-Scale Monitoring Strategy (www.fs.usda.gov/main/r8/landmanagement/planning).

Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program. This monitoring evaluation report is the vehicle for disseminating this information.

There are monitoring questions and tasks located in each the Jefferson and George Washington Forest Plan’s monitoring programs that will not be included in this monitoring report. For a list of those tasks please see Appendix A – Deferred Monitoring Tasks.

Additional appendices include:

Appendix B – MIS and Threatened and Endangered Species (T&E) Population Trends

Appendix C – Evaluations by Fiscal Year for BMP Targets

Appendix D – George Washington and Jefferson National Forests 2019 Soils Disturbance Monitoring Report

Monitoring Objectives

The objectives of our plan monitoring plan include:

- Assess the current condition and trend of selected forest resources.
- Document implementation of the Plan monitoring Program
- Evaluate relevant assumptions, changed conditions, management effectiveness, and progress towards achieving the selected desired conditions, objectives, and goals described in the Forest Plan.
- Assess the status of previous recommended options for change based on previous monitoring & evaluation reports.
- Document scheduled monitoring actions that have not been completed and the reasons and rationale why.
- Present any new information not outlined in the current plan monitoring program that is relevant to the evaluation of the selected monitoring questions.
- Incorporate broader scale monitoring information from the Regional Broader Scale Monitoring Strategy that is relevant to the understanding of the newly identified 2016 administrative change monitoring questions.
- Present recommended change opportunities to the responsible official.

Monitoring Results Summary

Monitoring from 2015-2019 revealed that largely the Forest is moving towards meeting the desired conditions of both Forest Plans. Many resources area findings recommend no change in the management of that program area. Some areas recommend continued monitoring or data collection while others recommend Forest Plan changes. This monitoring report does not include all resource areas such as wildernesses and air as outlined in full in appendix A. These program areas will be fully explored in the FY 20 – FY21 monitoring report.

Table 1 below summarizes current recommendations for line officer consideration.

Table 1. Summary of Recommendations

Monitoring Topic	Jeff Monitoring Question	GW Monitoring Questions	Jeff Task	GW Task	Resource Area	Recommendation
1	14	13, 14	61	41	Grazing	No changes – continued monitoring.
1	5, 14, 15	13, 14	51, 52, 57, 58	35, 38, 39	Water Quality	No changes – continued monitoring.
2	3	4, 5, 25	8, 9	6	Specific Habitat Conditions	No changes.
2	2, 4, 7	6, 7	6, 13, 37	5, 25	Management Indicator Species	Continue to monitor management effects to Cow Knob Salamanders.
2	3, 19	3	11	7	Old Growth	Conduct a functional review to determine efficacy and efficiency of the GWJNF old growth survey protocol. Explore options and methodologies to analyze direct, indirect and cumulative impacts to existing old growth if proposed for mechanical treatment.
2	4, 6, 19	4, 5, 7, 8, 11, 12	14, 23,	9, 15	Forest Health	The southern front of the Gypsy Moth Spread has breached past the Jefferson

			24			and now includes other Forests in the Southern Region. The GWJNF could seek opportunities to work collaboratively across Forest boundaries with the Regional office to develop a programmatic approach to providing NEPA coverage for annual Slow the Spread Gypsy Moth treatments.
2	5, 15, 19	13, 14, 25	17, 59	10	Aquatics	Continue to explore road decommission and aquatic organism passage restoration efforts in conjunction with project development.
2	7, 19	4 5	34, 35	55, 54	Birds	Incorporate Cerulean and Golden Winged Warbler habitat needs into vegetation projects.
3	5, 19	13, 14, 25	18	11	Focal Species	No changes.
4	7, 19	4, 5	25, 26, 27, 28, 29, 30, 31, 32, 33, 36	16, 17, 18, 19, 20, 21, 22, 23, 24	Threatened and Endangered Species	1.Spirea related Forest Plan management prescription changes. 2.Development of Round leaf birch strategy. 3.Continue monitoring sneezeweed and work towards developing post delisting plan.
5	9, 20	16, 17, 24, 26	38, 41	26	Recreation, Visitor Use and Satisfaction	No changes.
6	19, 21, 22, 23	25, 27, 28, 29	NA	NA	Climate Change	Incorporate adaptive management strategies for climate induced stressors during project development and selection. Refer to table 14 for more details.

7	1	NA	2	NA	Rare Communities and Caves	No changes.
7	2, 6, 10	1, 2, 3, 9, 10	5, 21, 44	4, 14, 31	Fire	No changes – continued support of monitoring program.
7	12, 20	16, 17, 26	48	33	Visuals	No changes.
7	13, 20	17, 26	50	34	Heritage	No changes.
7	14, 19	14, 23	54, 55	36, 37	Soils	No changes – continued support of monitoring program.
7	14, 16, 20	NA	56, 62	NA	Minerals / Geology	Process requested oil and gas leases.
7	16, 20	14, 23	63	42	Transportation	As capacity allows, complete a review of Road Management Objectives across the Forest.
7	2, 3,, 4, 19	1	7, 3, 15, 16	2	Major Forest Types and Successional Habitats	Continue to increase the pace and scale of restoration to meet the Jefferson and George Washington Forest Plans desired conditions for greater early successional and late open successional representation.
7	18	NA	72, 73, 74	51, 52, 53	Plan Implementation	Consider several Forest plan changes for completed congressional designations, mapping errors and land acquisitions.
8	17	3, 15	67, 69	46, 48	Land Productivity	Provide opportunities for micro after action reviews between timber sale administration staff and resource specialist to convey lessons upon closure of timber sales. Reinitiate annual quality assurance reviews of NEPA

						document and associated implementation of projects.
9	16	18, 19, 20	60	40	Timber	Coordinate efforts to align timber program offerings with market conditions.
9	16, 20	19, 20, 26	64	43	Special Uses	No changes.

Forest Supervisor's Certification

This report documents the results of monitoring activities that occurred through Fiscal Years 2015 – 2019 on the George Washington and Jefferson National Forests. Monitoring on some topics is long-term and evaluation of those data will occur later in time.

I have evaluated the monitoring and evaluation results presented in this report. I have examined the recommended changes to the 2004 Jefferson and 2014 George Washington Land Management Plans, as amended at this time. I therefore consider these Forest Plans sufficient to continue to guide land and resource management of the George Washington and Jefferson National Forests for the near future and plan a deeper examination of the recommended changes through engagement with resource specialists and the public. Information about public engagement sessions will be posted at: https://www.fs.usda.gov/main/gwj.

This document has been reviewed and preliminarily approved by the Forest Supervisor. The document is still in draft form necessitating a few additional data inputs. Once finalized the Forest Supervisor will sign it.

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JOBY P. TIMM

1.Status of Select Watershed Conditions

Summary

The following results reflect updates from data collected from 2015 -2019. New information collected or compiled from the last evaluation report 2014 has been incorporated. The 2008-2014 Monitoring and Evaluation Report was formatted differently. This section contains the water quality and grazing section of that report. This section aims to summarize changes to select watershed conditions due to Forest management activities.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

5. What is the status and trend in aquatic habitat conditions in relationship to aquatic communities?

14. Are watersheds maintained (and where necessary restored) to provide resilient and stable conditions to support the quality and quantity of water necessary to protect ecological functions and support intended beneficial uses?

15. What are the conditions and trends of riparian area, wetland and floodplain functions and values?

Jefferson Forest Plan Tasks Pertinent to this Section

51. Stream stability in reference watersheds compared to stability of streams in watersheds where projects are occurring. Conduct pebble count sampling on a subset sample of projects once per year (September – October or following a major storm event) using procedure described by Kappesser (2002). Utilize Riffle Stability Index, Relative Bed Stability (Kauffman, 1999) and percent finer than 4 millimeters to determine acceptable levels of variability or thresholds of concern. Evaluate project watersheds before, during, and after projects and compare with reference.

52. Stream water temperatures in reference watersheds compared to watersheds where projects are occurring (maximums and minimums) Install data loggers in all reference watershed streams and use data from them to compare with data from managed watersheds. Once a year, conduct statistical analysis to evaluate occurrence and significance of differences.

57. Are State BMPs and Forest Standards being implemented to protect and maintain soil and water resources? [36 CFR 219.27(a)(4), 36 CFR 219.12(k)(2)]. Field inspection of project sites following established monitoring protocol. Review of sample of project documents and related EAs/EISs for compliance with

58. Are Standards (BMPs) Effective minimizing non-point source pollution? Sample project activities related to BMPs to for effectiveness of BMPs and standards. 1) Visual inspection of implemented standards, 2) Measured effects of standards, and/or 3) Aquatic biota inventories.

61. Are livestock management systems and improvements adequately protecting riparian areas and aquatic habitats? Pastures monitored annually for livestock damage

George Washington Forest Plan Questions Pertinent to this Section

13. What is the ecological condition and trend of watershed health, including the aquatic ecosystem potential, for watersheds identified in the desired condition and/ or objectives of the plan area?

14. How effective are management actions in moving the National Forest/Grassland toward improving watershed health?

George Washington Forest Plan Tasks Pertinent to this Section

35. Condition and trend of chemical resilience of watersheds across the Forest as indicated by chemical parameters via water quality sampling protocol.

38. Are State BMPs and Forest Standards being implemented to protect and maintain soil and water resources? [36 CFR 219.27(a)(4), 36 CFR 219.12(k)(2)] - Field inspection of project sites following established monitoring protocol. Review of sample of project documents and related EAs/EISs for compliance with BMPs and standards.

39. Are Standards (BMPs) Effective minimizing non-point source pollution? Sample project activities related to BMPs for effectiveness of BMPs and standards. 1) Visual inspection of implemented standards, 2) Measured effects of standards, and/or 3) Aquatic biota inventories.

41. Are livestock management systems and improvements adequately protecting riparian areas and aquatic habitats? Pastures monitored annually for livestock damage.

Key Results

Water Quality

From 2015 to 2019, 13 projects were monitored for implementation of Forest Plan standards and Best Management Practices (BMPs), following the Forest Service National BMP protocols. Projects included timber sales, vegetation treatments, recreation, range, roads, minerals, and aquatic ecosystem improvements among others. Of 714 monitoring elements, an average 70% showed that implementation met or exceeded BMP requirements. On average, 30% showed minor departures from the intent of the BMP. These departures resulted from BMPs not installed, operating in wet periods, and erosion controls improperly installed. Lessons from these monitoring experiences resulted in expanded soil disturbance monitoring efforts in 2019 (further explored in the Soils section of this report), a forestwide soils and BMP training in 2019 and more focused hydrological surveys during project development to inform BMP’s layout and implementation.

Standards and BMP Effectiveness

Visual monitoring of the effectiveness of Forest Plan standards and Best Management Practices was conducted on numerous projects. Of 714 monitoring elements, 49% indicated that BMPs provided adequate or improved protection of soil and water, while 51% indicated minor or temporary impacts on the resources. The most common issues were no BMPs installed, poor revegetation of disturbed soils, ineffective drainage structures, and ineffective erosion control. Follow-up corrective measures included improvements to drainage structures, additional revegetation measures, improved road closures, and proper installation of erosion controls. Yearly monitoring results are shown below.

Table 2. Forest Plan standards and BMP effectiveness, 2015 – 2019

Year	Adequate or improved protection	Minor or temporary impact	Sample Size
2015	80%	20%	5
2016	33%	66%	3
2017	33%	66%	3
2018	50%	50%	2
2019	no data	no data	0

Grazing

Most of the grazing occurs on the Mt. Rogers National Recreation Area. Each active allotments are inspected several times a year for compliance with National and Forest Plan standards for grazing. Results are reported yearly in the INFRA Range database. See the FY2008-2014 Monitoring and Evaluation report for a summary of aquatic conditions related to grazing, and the Aquatics and Water Quality Report for current Forest trends.

Between 2015 and 2019, the number of acres grazed in active allotments decreased slightly (Table 3). The 2018 Lee Grazing decision on the Lee Ranger District removed the Zepp and Moody grazing allotments, as well as the Whitting allotments that were in the 100 year floodplain. Reduced grazing in these critical riparian areas greatly reduces potential impact of livestock to Cedar Creek, the South Fork Shenandoah River and associated floodplain wetlands. In addition, the continued improvements to riparian fencing and off stream watering on grazing allotments on the Mount Rogers NRA provide additional protection from livestock impacts.

Table 3. Annual grazing acreage on the JNF and GWNF

Year	Acres
2015	8,558
2016	8,558
2017	8,558
2018	8,454
2019	8,454

Recommended Changes

Grazing

Continued required maintenance and monitoring of grazing allotments should continue to ensure grazing infrastructure is maintained to manage the allotments and protect water features.

Water Quality

No changes recommended at this time to water quality management aside from continued support of monitoring efforts.

2. Status of Select Ecological Conditions (Including Terrestrial and Aquatic Ecosystems)

Summary

The following results reflect updates from data collected from 2015-2019. New information collected or compiled from the last evaluation report 2008-2014 has been incorporated. Acknowledge any results that have not been updated since the last monitoring report here and when this update will occur. This section includes the, specific habitat conditions, management indicator species (including demand species), old growth, forest health, aquatics, and birds sections of the previous report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

2. Are landscape and stand level composition, structure, and function of major forest communities within desirable ranges of variability?

4. The status of a select set of the ecological conditions required under § 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

5. What is the status and trend in aquatic habitat conditions in relationship to aquatic communities?

7. What are the status and trends of federally listed species and species with viability concerns on the forest?

19. What is the impact of climate change on the planning area?

Jefferson Forest Plan Tasks Pertinent to this Section

6. Trends in MIS populations in relationship to the to major forest community/condition MIS was selected to indicate. (See Tables 5-1 in Chapter 5). Annual Breeding Bird Survey occurrence trends for selected MIS compared to status and trends in forest cover acreage in Task #3.

8. How many acres of high-elevation early successional habitats exist and what are the trends in their abundance and condition. Map and update changes through periodic routine inventories. Monitor acres and trends.

9. Trends in MIS populations in relationship to the successional stage habitat condition MIS was selected to indicate. (See Tables 5-2 in Chapter 5). Annual Breeding Bird Survey occurrence trends for selected MIS compared to successional stage habitat trends in Task #8.

11. Acreage of existing and potential old growth by forest community class based on FSVeg data.

13. Trends in MIS populations in relationship to the terrestrial habitat attributes MIS was selected to indicate. (See Tables 5-3 in Chapter 5). Annual Breeding Bird Survey occurrence trends for Pileated woodpeckers compared to snag abundance as indicated by trends in late-successional forest communities. See Task #14.

14. Map and update changes in forest successional conditions and area impacted by insect and disease through routine annual inventories. Infer snag and downed wood by the acres of late- successional stage forests and mortality due to insects and disease.

17. Conditions and trends in the overall health of streams including trends in water quality parameters and physical habitat conditions in relationship to aquatic communities. Water quality sampling, emphasis on nitrogen, sulfur, and mercury compounds. Aquatic macroinvertebrate sampling (EPA's Rapid Bioassessment Protocol II (EPA 1989) with modifications by Smith & Voshell (1997)). Systematic stream fish community inventories, stream stability, streambed structure and large woody debris as appropriate. Sample selected streams on a periodic basis and use fixed sampling points – coordinate location with other aquatic monitoring.

34. Presence/absence of cerulean warblers in suitable habitats. Using standardized survey methods (CEWAP) determine presence/absence of cerulean warbler in optimal habitats. If present, determine habitat relationships.

35. Presence/absence of golden-winged warblers in suitable habitats. Standardized surveys for Golden-winged warblers using transects and playback in high-elevation early-successional habitats. Habitat characterized at occupied sites.

37. Trends in harvest data for demand MIS in relationship to habitat improvement activities for those animals? [MIS – 36 CFR 219.19(a)(6)]. (See Table 5-6 in Chapter 5). Collect harvest data from Cooperating State Agency related to annual accomplishments for habitat improvement tracked with standard tracking systems.

George Washington Forest Plan Questions Pertinent to this Section

1. How are ecological conditions maintaining or making progress towards the LMP desired conditions and objectives.

3. How are management actions maintaining or making progress toward DC for the key characteristics of vegetation in the plan area?

4. How are ecological conditions for selected T&E species, sensitive, or locally rare maintaining or making progress toward the LMP desired conditions and objectives?

5. How are management actions for the recovery of T&E species, conservation of sensitive, and management of locally rare achieving LMP objectives?

6. How are changes in Management Indicator Species and the relationship to their habitats reflecting the effectiveness of management activities in achieving desired conditions and objectives?

7. What are the status and trends of areas infested by aquatic and terrestrial invasive species on the unit’s plan area relative to the desired condition?

13. What is the ecological condition and trend of watershed health, including the aquatic ecosystem potential, for watersheds identified in the desired condition and/ or objectives of the plan area?

14. How effective are management actions in moving the National Forest/Grassland toward improving watershed health?

25. What is the impact of climate change on the planning area?

George Washington Forest Plan Tasks Pertinent to this Section

5. Trends in MIS populations in relationship to the ecological system/condition MIS was selected to indicate. Annual Breeding Bird Survey occurrence trends for selected MIS compared to status and trends in forest cover acreage in Task #3.

10. Conditions and trends in the overall health of streams including trends in water quality parameters and physical habitat conditions in relationship to aquatic communities. Water quality sampling, emphasis on nitrogen, sulfur, and mercury compounds. Aquatic macroinvertebrate sampling (EPA's Rapid Bioassessment Protocol II (EPA 1989) with modifications by Smith & Voshell (1997)). Systematic stream fish community inventories, stream stability, streambed structure and large woody debris as appropriate. Sample selected streams on a periodic basis and use fixed sampling points - coordinate locations with other aquatic monitoring.

25. Trends in harvest data for demand MIS in relationship to habitat improvement activities for those animals? [MIS - 36 CFR 219.19(a)(6)]. (See Table 5-6 in Chapter 5). Collect harvest data from Cooperating State Agency related to annual accomplishments for habitat improvement tracked with standard tracking systems

54. Presence/absence of golden-winged warblers in suitable habitats. Using standardized survey methods, determine presence/absence of cerulean warbler in optimum habitats. If present, determine habitat relationships.

55. Presence/absence of cerulean warblers in suitable habitats. Collect harvest data from Cooperating State Agency related to annual accomplishments for habitat improvement tracked with standard tracking systems.

Key Results

Specific Habitat Conditions

JNF Plan objectives to maintain high elevation habitat has been met and in terms of early successional habitat exceeded, though a combination of grazing, prescribed fire, timber, and permanent grassland/shrubland management (Tables 4, 6 and 7). The only key habitat whose objectives have not been met is spruce restoration. A decision was signed to release spruce at Laurel Fork on the James River Warm Springs Ranger District which will assist in this maintenance of this ecological system on the George Washington National Forest. With key partnerships now established with organizations such as the Southern Appalachian Spruce Restoration Initiative, our goal is to increase the pace of spruce restoration in the next 5 years.

Table 4. JNF high-elevation early successional habitat affected by management activities

Year	Acres of Timber Regeneration	Acres of Prescribed Fire	Acres of Permanent Grassland / shrubland maintained	Acres Actively Grazed	Total Acres
2004	0	4,367	4,051	5,414	**13,832**
2005	163	2,812	4,051	5,414	**12,440**
2006	35	501	4,051	5,414	**10,001**
2007	25	5,907	4,051	5,414	**15,397**
2008	185	6,571	4,051	5,414	**16,221**
2009	49	5,717	4,051	5,414	**15,231**
2010	271	2,710	4,051	5,414	**12,446**
2011	210	0	4,051	5,414	**9,675**
2012	62	1,236	4,051	5,414	**10,763**
2013	96	6,753	4,051	5,414	**16,314**
2014	63	1,704	4,051	5,414	**11,232**
2015	0	0	4,051	5,414	**9,465**
2016	142	0	4,051	5,414	**9,607**
2017	91	4,496	4,051	5,414	**14,052**
2018	12	3,962	4,051	5,414	**13,439**
2019	304	3,511	4,051	5,414	**13,280**
Objective					**2,500**
Yearly Average	107	3,140	4,051	5,414	**12,712**

Management Indicator Species

Listed below are the specific Management indicator species (MIS) that serve as ecological, biological community, or special habitat indicators for the Jefferson and George Washington National Forests. The full summaries and findings for MIS are included in the supplemental Appendix B – MIS and T&E Population Trends document.

Table 5. Management Indicator Species

Forest Plan	Species
Jefferson	Peaks of Otter salamander
George Washington	Cow knob salamander
Jefferson and George Washington	Pileated woodpecker
Jefferson and George Washington	Ovenbird
Jefferson and George Washington	Chestnut sided warbler
Jefferson and George Washington	Acadian flycatcher
Jefferson and George Washington	Hooded warbler
Jefferson and George Washington	Scarlet tanager
Jefferson and George Washington	Pine warbler
Jefferson and George Washington	Eastern Towhee
Jefferson and George Washington	Eastern wild turkey
Jefferson and George Washington	Black bear
Jefferson and George Washington	White tailed deer

Old Growth

On the JNF, the acres of existing old growth exceed JNF Plan Objective 13.01 acreages in all community types except the Montane Spruce Fir type (Table 6). The total percentage of the Forest that exceeds the age criteria for old growth determination has doubled from 7% to 15%. On the GWNF, the acres of old growth has either been maintained or increased in all community types except the Hardwood Wetland Forest (Table 6). The reduction seen in this community type is a result of a forest type change in the database rather than a harvest in the Hardwood Wetland community type. One Old Growth Forest Type (OGFT) group still has no acreage that meets the minimum age criteria. That type, Type 37, is the rocky, thin-soiled, excessively drained conifer woodland that is found over limestone bedrock and dominated by eastern red cedar. Very few acres of that type exist on the GWNF and no management activity is occurring in those acres that would affect stand age.

The total percentage of the GWNF that exceeds the age criteria for old growth determination has increased from 20% in 2004 to 26% in 2014.

Old growth surveys are completed in plots proposed for regeneration treatments and when it cannot be clearly discerned if old growth exists in commercial thinning units. The Forest is working to update this data in FSVeg. The old growth survey process was adapted during the 2014 George Washington Forest Plan revision. The Forest is seeking opportunities to complete a functional review of that process in FY21 to determine if it is effective and yielding quality data.

As the GWJNF continues to age, greater proportions of the land base will approach old growth classification eligibility. Both Forest Plans permit the management of old growth as long as the prescription meets Forest Plan desired conditions and an old growth analysis is completed thorough enough to document the direct, indirect and cumulative effects to the old growth forest community types proposed for management. The Forest should continue to explore options for the analysis of old growth management.

Table 6. Existing old growth on the JNF, by old growth community type

			2002				2014					2019					
Type No.	**Forest Community Type**	**Old Growth Age**	**Acres of Existing Old Growth**	**Total Acres of Community Type**	**Percent of Total Community Type**	**Percent of Total JNF Forested Acres**	**Acres of Existing Old Growth**	**Total Acres of Community Type**	**Percent of Total Community Type**	**Percent of Total JNF Forested Acres**	**Old Growth + Late Successional**	**Acres of Existing Old Growth**	**Total Acres of Community Type**	**Percent of Total Community Type**	**Percent of Total JNF Forested Acres**	**Old Growth + Late Successional**	**Objective**
1	Northern Hardwoods	100	2,000	16,850	12%	0.30%	3,289	18,398	18%	0%	14,167	4,085	18,395	22%	1%	14,671	8,400
2	Conifer-Northern Hardwood	140	900	21,350	4%	0.10%	729	14,372	5%	0%	7,398	1,266	21,611	6%	0%	9,176	2,200
5	Mixed Mesophytic	140	4,700	83,990	6%	0.70%	1,453	83,591	2%	0%	54,817	1,112	83,166	1%	0%	60,052	8,500
13, 28	River Floodplain/ Eastern Riverfront	100	13	320	4%	0.00%	47	479	10%	0%	235	49	317	15%	0%	64	150
21	Dry- Mesic Oak	130	21,800	269,140	8%	3.10%	25,246	268,525	9%	4%	208,927	33,243	265,607	13%	5%	221,421	27,000
22	Dry and Xeric Oak	110	10,300	120,330	9%	1.50%	46,741	120,292	39%	7%	107,275	52,514	121,273	43%	7%	112,044	12,000
24	Xeric Pine and Pine Oak	100	1,300	41,510	3%	0.20%	14,520	38,472	38%	2%	39,781	21,225	41,725	51%	3%	38,338	3,400
25	Dry and Dry Mesic Oak-	120	8,800	146,670	6%	1.20%	16,291	156,669	10%	2%	135,182	20,152	144,854	14%	3%	133,904	14,700

	Pine																
31	Montane Spruce-Fir	120	120	4130	3%	0.00%	129	2703	5%	0%	526	534	4,473	12%	0%	4,188	2,100
-	Brush Species	-	-	-	-	-	-	-	-	-	-		-				-
Totals			**49,993**	**704,290**		**7.10%**	**108,445**	**703,501**		**15%**		**134,180**	**701,421**		**19%**		

Table 7. Potential and uture acres of old growth on the GWNF by old growth community type

Old Growth Forest Type Groups *	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
01 - Northern Hardwood Forests	369	369	1,047	1,141	1,141	1,255	1,356	1,412	1,482	1,546	1,619	1,832	1,984	2,270	2,498	4,027
02 - Conifer & North. Hardwood Forests																
2a-Hemlock-North. Hardwd Subgroup	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,412	1,593	1,633	1,633	3,076	3,116	3,131	3,172	3,254
2b-Wh. Pine-North. Hardwd Subgroup	9	9	9	9	28	28	28	28	28	28	28	855	865	918	944	1,119
2c-Spruce-North. Hardwood Subgroup	71	71	71	71	71	71	71	71	71	71	71	118	118	118	118	118

05 - Mixed Mesophytic Forests	1,542	1,619	3,866	4,009	4,009	4,312	4,906	5,322	5,675	5,822	5,925	6,299	6,429	6,512	6,653	7,001
10 - Hardwood Wetland Forests	78	78	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21 - Dry-mesic Oak Forests	111,879	118,974	122,484	126,367	129,659	134,127	151,360	155,505	161,113	164,884	170,532	173,833	179,174	182,905	187,210	191,661
22 - Dry and Xeric Oak Woodlands	80	80	85	85	85	85	271	271	271	312	331	402	402	402	428	428
24 - Xeric pine & Pine-oak Forests	106,076	110,011	111,821	112,589	113,602	114,672	115,297	116,042	116,456	116,846	117,239	87,559	90,784	93,254	97,097	99,300
25 - Dry & Dry-mesic Oak-pine Forests	7,375	7,819	8,198	8,465	9,246	9,684	10,943	11,276	11,873	12,192	13,085	23,653	25,538	26,724	28,186	30,651
28 - Eastern Riverfront Forests	25	25	25	25	25	25	25	25	25	25	25	6	6	6	6	6
37 – Rocky, Thin-soil Conifer Wood.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total acres	**238,342**	**249,372**	**249,018**	**254,173**	**259,278**	**265,671**	**285,669**	**291,364**	**298,587**	**303,359**	**310,488**	**297,633**	**308,416**	**316,234**	**326,306**	**337,565**

* Names and associated identification numbers are from Forestry Report R8-FR 62.

Forest Health

American Chestnut

Several American chestnut (*Castanea dentata*) research and test planting sites have been established in cooperation with the USDA Forest Service Southern Research Station, American Chestnut Foundation, and American Chestnut Cooperators Research Foundation on both the JNF and GWNF.

Gypsy Moth

Gypsy moth populations have been at low levels throughout the Forest for the past 7 years. Aside from the relatively small number of acres defoliated in 2009 on both Forests, no defoliation has been detected since 2008 up to 2014 (table below). The susceptibility and or vulnerability to gypsy moth has been reduced on approximately 10,000 acres on both forests as a result of silvicultural activities.

Table 8. Acres of gypsy moth defoliation by year, by Forest

	Gypsy Moth Defoliation		
	GWNF	JNF	Total
2004	0	0	0
2005	0	3,030	3,030
2006	0	2,950	2,950
2007	26,548	18,897	45,445
2008	0	0	0
2009	3,864	8,424	12,288
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	8,569	0	8,569
2016	191	54,929	55,120
2017	0	33,978	33,978
2018	13,088	12,226	25,314
2019	23	9,015	9,038

Table 9 below displays acres treated for gypsy moth under both the gypsy moth suppression and Slow the Spread Projects. Suppression treatments focused on values at risk such as recreation areas, active timber sales (product value), and preservation of stump sprouting capability and hard mast production. These efforts have helped maintain the species composition in the threatened forested stands.

Table 9. Acres of gypsy moth treatments by year, by Forest

Fiscal Year	Pheromone Flake			BtK			Annual Total		
	GWNF	JNF	Total	GWNF	JNF	Total	GWNF	JNF	Total
2004	0	5,510	5,510	0	0	0	0	5,510	5,510
2005	0	10,573	10,573	0	239	239	0	10,812	10,812
2006	0	6,905	6,905	0	158	158	0	7,063	7,063
2007	0	28,423	28,423	0	5,540	5,540	0	33,963	33,963
2008	0	67,225	67,225	0	8,505	8,505	0	75,730	75,730
2009	0	9,895	9,895	0	15,356	15,356	0	25,251	25,251
2010	0	3,378	3,378	0	0	0	0	3,378	3,378
2011	0	5,256	5,256	0	0	0	0	5,256	5,256
2012	0	549	549	0	0	0	0	549	549
2013	0	9,361	9,361	0	0	0		9,361	9,361
2014	0	4,467	4,467	0	0	0	0	4,467	4,467
2015	0	21,746	21,746	0	0	0	0	21,746	21,746
2016	0	8,362	8,362	0	0	0	0	8,362	8,362
2017	0	5,146	5,146	0	0	0	0	5,146	5,146
2018	0	4,588	4,588	0	0	0	0	4,588	4,588
2019	0	23,164	23,164	0	349	349	0	23,513	23,513

Hemlock Wooly Adelgid

Hemlock Wooly Adelgid (HWA) infestations have progressed through both Forests and are now active on the Clinch Ranger District in far southwest Virginia. Severe mortality of hemlock is very evident as far south as Blacksburg, VA. Hemlock stands are in various stages of decline from Blacksburg south. Approximately 50 to 75 acres in designated hemlock conservation areas per year on the Clinch Ranger District are treated with a soil injection of imidacloprid to preserve intact hemlock populations.

Emerald Ash Borer

Emerald Ash Borer (EAB), a relatively new insect pest, had not been detected on the Forest as of 2014. Active trapping has been occurring at selected sites for the past few years. However, this insect pest has been documented on privately held lands near the National Forests and it is only a matter of time before we begin to see infestation of ash on NFS lands.

Aquatics

Water Quality

Water quality has been systematically monitored on Forest streams since 1987. As expected, the general water quality of any given stream is strongly tied to the underlying geology coupled with prevailing air quality. The collected data has been used to determine trends and changes in stream water composition related to natural and anthropogenic conditions. See the FY2008-2014 M&E report for a summary of water chemistry related to improvements in air quality (Webb, 2014), trends in stream water ANC and pH on the Forests (Smith and Voshell 2013), stream chemistry response to wildfire (Downey & Haraldstadt 2013).

Between 2015 and 2020, our partner, the Chemistry Department of James Madison University, has analyzed over 375 water samples collected by the Forest Service from National Forest streams to monitor conditions across the Forest. These samples monitor current conditions, and also specific projects on the Forest (Downey 2016; Downey 2019a; Downey 2019b; Downey 2020; Teears and Downey 2017).

There are 42 sites on National Forest within the Virginia Trout Stream Sensitivity Study run through a water chemistry lab at University of Virginia (http://swas.evsc.virginia.edu/). The Forest is a partner and collects water samples at these sites every quarter; thus, an additional 292 water samples have been collected and analyzed since 2015. A recent analysis of long-term trends in water chemistry for all the quarterly sites through 2019 evaluated changes in chronic and episodic acidification in response to the Clean Air Act and Amendments (Scanlon et al. 2020). Over the 1987-2019 timeframe, a majority of the most acid-sensitive streams (those with watersheds underlain by siliciclastic bedrock) have experienced reductions in acid neutralizing capacity. Meanwhile, stream water pH has increased for all watershed bedrock types. Overall, the steep reductions in sulfur deposition over the three decades since the 1990 Amendments have led to a “flushing” of sulfate from shallow soils, which has contributed to improved acid/base statue during episodes of high flow. The findings suggest that continued low acidic deposition rates will lead to further improvement in stream water quality, with the timescales of recovery dependent upon bedrock geology of the watersheds.

Macroinvertebrates

Aquatic macroinvertebrate monitoring is also being used as an indicator of the effectiveness of BMPs and Forest Standards in protecting water quality and the aquatic biological community. Nine ecological metrics of the aquatic macroinvertebrate community are derived from macroinvertebrate samples, and a Macroinvertebrate Aggregated Index for Streams (MAIS) (range of scores 0-18) is computed using the nine metrics. Approximately 140 macroinvertebrate samples have been collected from Forst streams since 2015, with 117 analyzed to date. Sample sites were selected downstream of management activity areas to monitor the impacts on stream health of projects including but not limited to timber sales and prescribed burns. Other samples were collected to create a baseline of stream conditions within the forest.

See the FY2008-2014 M&E report for a summary of over 1,850 macroinvertebrate samples and a report that compared pre-activity macroinvertebrate metrics with post-activity metrics for streams located below timber harvests and prescribed burns at various locations across the Forest (Smith and Voshell, 2013). It concluded that "management practices are successful at reducing effects on aquatic organisms" from these activities. The results showed no decline in macroinvertebrates following timber sales or prescribed burns, while a comparison of pre and post stream liming macroinvertebrate metrics showed a significant increase in macroinvertebrate health following that management activity.

Large Woody Debris and Stream Habitat

Almost 1,000 miles of streams have been surveyed since 1995 using a modified Basinwide Visual Estimation Technique (BVET [Dolloff et. al. 1993]) to estimate woody debris loading, percentage of pool and riffle area, and the width of the riparian area of streams. The distribution of woody debris was also mapped. These are ecologically important physical stream characteristics as described in the desired future condition for GWNF and JNF Forest Plans. See the FY2008-2014 M&E report for a summary through 2014.

These stream inventories were initiated on the GWJNF over 20 years ago to establish a baseline from which to monitor for future changes in stream habitat. Over half of the streams in the initial round of inventories fell below the desired condition for pool area and nearly three-quarters were below the desired condition for large wood. These habitat characteristics are a typical legacy of wholesale logging that was completed over much of the forest in the late 19th and early 20th centuries. Where large scale stream habitat improvement projects are impractical, remediation tactics focus on reducing sediment and increasing large wood delivery to streams through improved watershed and riparian management.

Without direct manipulation habitats will continue to be shaped by a combination of land management actions and natural disturbances. In the short-term the most obvious changes in stream habitat will be related to the continued addition of large wood from adelgid infested riparian hemlock stands. To assess these changes, the Forest had the Center for Aquatic Technology Transfer (CATT), Southern Research Station, inventory stream habitat in selected sections of 15 streams within the Pedlar Ranger District in 1989, 1995, 2005, and 2015 (Krause et al. 2017).

Following large floods in 2005, only one stream met the minimum for pool area and another met the minimum for large wood. By 2015, one stream met the desired conditions for pool area (though not the same stream as in 2005), and a handful of streams met the desired condition for large wood, though all streams had increases in large wood likely related to the dead and dying hemlocks along most streams. The increased quantities of large wood seen during our 2015 inventories, versus 2005, should promote pool habitat creation and complexity. We expect this trend of increased large wood to continue due to increased recruitment of hemlock trees being killed by the hemlock wooly adelgid, as well as green ash trees being killed by the Emerald ash borer. As habitat complexity increases, the likelihood that large wood will remain in place rather than being flushed out during high flow events also increases, leading to development of a self-sustaining system. It is possible that pool formation has yet to catch up to the large wood inputs or that total amount or sizes of large wood are not sufficient to promote pool formation. Once the hemlocks are gone, future recruitment of large wood will depend on other woody species to replace eastern hemlock in near stream riparian areas. Efforts to reverse or mitigate habitat degradation effects have been ongoing for decades and will continue into the foreseeable future. In the long run, it will prove cost-effective to manage riparian areas to provide a source of large wood for natural recruitment.

Aquatic Organism Passage and Road Decommissioning

Recent National and Regional attention has focused on the issue of aquatic organism passage. Land managers recognized that instream barriers can prevent migration, dispersal, and colonization, leading to genetic isolation and possible extirpation. Specifically, culverts at road crossings can be barriers to fish or other aquatic organisms, in addition to impeding debris and water during high flow events, causing ecological and infrastructure problems (Gibson et al. 2005, Gillespie et al. 2014, Verry 2000). Aquatic organism passage and natural flow regimes were specified in both Forest Plans through standards (GW Plan page 4-121, JNF Plan page3-187). See the FY2008-2014 M&E report for a summary through 2014. Since 2015, approximately 12 road crossings have been either replaced or are planned for replacement.

Dams are also an impediment to aquatic organism passage. In 2017, the Forest partnered with Virginia Dept. of Wildlife Resources and Trout Unlimited (TU) and removed a small dam in Passage Creek, and reintroduced wild brook trout to the stream reach (Reeser 2017). Also, in partnership with TU, two small dams were removed from Bob Downey Branch, and the stream channel restored (Cooper 2020).

In addition to aquatic organism passage, sedimentation from illegal, poorly designed or poorly maintained roads is recognized as a problem (Gillespie et al. 2014, McCaffery et al. 2007, Robinson et al. 2010). Both Forest Plans address this through their road standards (GW Plan pages 4-125 through 4-126, JNF Plan pages 3-186 through 3-187). Since 2015, approximately 5 miles of roads have been decommissioned, and more are planned for decommissioning in recent NEPA decisions.

Birds

Cerulean Warblers

The cerulean warbler (*Setophaga cerulea)* is a small songbird of the New World warbler family. Adult males have pale cerulean blue and white upperparts with a black necklace across the breast and black streaks on the back and flanks. They are found in deciduous forests of eastern North America during the breeding season and then migrate to forested mountain areas in South America. The cerulean warbler has experienced steep declines in the last 30 years and is considered a locally rare species on the George Washington and Jefferson National Forests. Using playback call protocols developed by Cornell Laboratory of Ornithology (USFWS 2007), monitoring has been conducted on the GWJNF since 2000 to present. Scattered but stable populations have been documented on the Clinch, Eastern Divide, Glenwood/Pedlar, James River and Warm Springs Ranger Districts. This species is closely associated with mixed mesophytic forests dominated by mature tulip poplars and white oaks exhibiting small canopy gaps associated with roads, trails, and disturbances such as ice-storm induced treefall and other weather-related blowdowns (Woods et al. 2013).

Golden Winged Warblers

The golden-winged warbler *(Vermivora chrysoptera*) has experienced one of the steepest declines of any North American songbird. The eastern portion of the breeding populations, primarily in the Appalachian Mountains, has declined precipitously and is now largely disjunct from the Midwestern populations (Roth et al. 2012). It is considered a locally rare species for the George Washington and Jefferson National Forests. Using play-back technology developed by the Cornell Laboratory of Ornithology (Cornell 2000), monitoring has been conducted since 2003 on the GWJNFs. Small but stable populations have been documented on the Clinch, Mt. Rogers, Eastern Divide, Warm Springs, and North River ranger districts. This species is closely associated with grassland/shrubland habitats, with tall grass imbedded with woody vegetation such as blackberry bushes and scattered trees nested in a larger landscape of mature wooded habitat. This species uses both grassland/shrubland and mature forested habitat during the breeding and post-breeding seasons (Roth et al. 2012).

Recommended Changes

Specific Habitat Conditions

No changes recommended at this time.

Management Indicator Species (including demand species),

The only recommendation for management indicator species is in regards to Cow Knob Salamander - Continue conducting field surveys, and coordinating with cooperators to conduct field surveys, to better refine the range, elevation limits, and habitat needs of the Cow Knob salamander. Continue monitoring the effects of management activities.

Old Growth

Complete a functional review to determine the efficacy and consistency of the old growth survey process. This process should include public stakeholders. As part of this effort develop a framework for the analysis of proposed management to old growth.

Explore options and methodologies to analyze direct, indirect and cumulative impacts to existing old growth if proposed for mechanical treatments.

Forest Health

The southern front of the Gypsy Moth Spread has breached past the Jefferson and now includes other Forests in the Southern Region. The GWJNF could seek opportunities to work collaboratively across Forest boundaries with the Regional office to develop a programmatic approach to providing NEPA coverage for annual Slow the Spread Gypsy Moth treatments. Trap counts spurring the need to treat with aerial hormone applications on the Jefferson are likely to continue to annually occur and this approach to the NEPA process would allow for flexibility and efficiencies in documenting those treatments. It is recommended that this occur with Regional Office, National Forests in North Carolina, the Cherokee National Forest and the Forest Health Program involvement.

Aquatics

Continue to explore road decommission and aquatic organism passage opportunities during project development. The Forest should continue to support water quality monitoring that is critical to understanding the Forest land base impact to reference and impaired watersheds.

Birds

Focus vegetation management activities to continue to provide critical habitat to cerulean and golden-winged warblers. Specifically small canopy gaps in tulip poplar and oak systems for cerulean warblers and the management of existing and the further development of grassland/shrubland habitats, with tall grass imbedded with woody vegetation such as blackberry bushes and scattered trees nested in a larger landscape of mature wooded habitat for golden winged warblers.

3. Status of Focal Species to Assess Ecological Conditions

Summary

Brook trout was identified as a focal species for the George Washington and Jefferson Forest Plans after the last monitoring report as a result of an administrative change in 2016 to make the plans compliant with the 2012 Planning Rule, therefore this is a new section not present in the previous 2008-2014 Monitoring and Evaluation Report. Previous brook trout had been identified as a Management Indicator Species.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

5. What is the status and trend in aquatic habitat conditions in relationship to aquatic communities?

19. What is the impact of climate change on the planning area?

Jefferson Forest Plan Tasks Pertinent to this Section

18. Trends in presence and abundance of wild trout in relation to acidification of stream systems and the application of mitigating measures. Sample selected streams on a periodic basis for wild trout and pH in high elevation streams using systematic stream fish community inventories.

George Washington Forest Plan Questions Pertinent to this Section

13. What is the ecological condition and trend of watershed health, including the aquatic ecosystem potential, for watersheds identified in the desired condition and/ or objectives of the plan area?

14. How effective are management actions in moving the National Forest/Grassland toward improving watershed health?

25. What is the impact of climate change on the planning area?

George Washington Forest Plan Tasks Pertinent to this Section

11. Trends in presence and abundance of wild trout in relation to acidification of stream systems and the application of mitigating measures. Sample selected streams on a periodic basis for wild trout and pH in high elevation streams using systematic stream fish community inventories.

Key Results

The result are included in the supplemental Appendix B – MIS and T&E Population Trends document.

Recommended Changes

No changes are recommended at this time.

4. Status of Ecological Conditions that Contribute to the Recovery of Federally Listed Threatened and Endangered (T&E) Species

Summary

The results for this section are located in Appendix B – MIS and T&E Population Trends document which includes updates from data collected from 2015 – 2019. This section includes the threatened and endangered species sections of the previous Monitoring and Evaluation report from 2014.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

7. What are the status and trends of federally listed species and species with viability concerns on the forest?

19. What is the impact of climate change on the planning area?

George Washington Forest Plan Questions Pertinent to this Section

4. How are ecological conditions for selected T&E species, sensitive, or locally rare maintaining or making progress toward the LMP desired conditions and objectives?

5. How are management actions for the recovery of T&E species, conservation of sensitive, and management of locally rare achieving LMP objectives?

Jefferson Forest Plan Tasks Pertinent to this Section

36. Trends in recovery of T&E species, and status and distribution of some viability concern species that are not specifically identified under other elements. Species targeted under this element will be determined through periodic review of each species' status and conservation priority. [36 CFR 219.19 (a)(7)]. Various methods will be used as appropriate to the species or species group to monitor status, trends and distribution (refer to the PETS Inventory and Monitoring Handbook).

Table 10. Jefferson Forest Plan and George Washington Forest Plan Threatened and Endangered Species Tasks

Jefferson National Forest Monitoring Task	George Washington National Forest Monitoring Task	Species (Population status of below species and progress towards recovery).
25	N/A	Blackside dace
26	17	James spiny mussel

27	24	Northern flying squirrel
28	19	Indiana bat
29	20	Northeastern bulrush
30	N/A	Virginia spirea
31	N/A	Small-whorled pogonia
32	N/A	Round leaf birch
N/A	16	Shale barren rock cress
N/A	18	Virginia big-eared bat
N/A	21	Virginia sneezeweed
N/A	22	Swamp pink
N/A	23	Smooth coneflower

Additional T&E species that are considered in Appendix B that are not specifically identified through a monitoring tasks or Forest Plan objectives include water shrew Allegheny woodrat (*Neotoma magister*), Southern water shrew (*Sorex palustris*), Southern rock vole (*Microtus chrotorrhinus*).

Key Results

Key results for the above federally–listed threatened and endangered species are included in the supplemental Appendix B – MIS and T&E Population Trends document.

Recommended Changes

For all T&E it is recommended to establish and maintain periodic monitoring schedules to allow for reliable detection of population trends.

Spirea - The 2004 JNF Plan provides contradictory direction for Spirea. On the one hand it states that all known locations of Virginia spiraea will be allocated as management prescription 4D, Special Biological Area (SBA) designation. However, only part of the Guest River population is in the SBA, with the rest being in 2C3 Eligible Recreational River designation. The North Fork Pound River population is not addressed in the Revised LRMP and is in a management prescription 11 Riparian Corridors designation. It is recommended that consideration be given to including these two populations in SBAs.

The Chimney Cliffs/Russell Fork population is on land allocated to management prescription 9F Rare Communities. To make it consistent with the other populations and with Plan direction, it is recommended that the Chimney Cliffs/Russell Fork Rare Community Rare Community designation be changed to Special Biological Area. The Pound River population was found to not occur on the national forest, in fact it was previously owned by the Forest Service but exchanged to the U.S. Army Corps of Engineers (Corps).

Round leaf birch - It is recommended that the Forest work cooperatively with U.S. Fish and Wildlife Service to develop a meaningful strategy to encourage natural regeneration of Betula uber (Round leaf birch) in progeny plots. Progeny plots were established between 1984 and 1987, meaning that the existing mature B. uber trees are 33-36 years old as of calendar year 2020. The average life expectancy of B. uber is only 50 years, so there is an urgent need to establish a new cohort while existing mature individuals remain alive and reproductive.

Sneezeweed - Continue monitoring *H. virginicum* element occurrences, and work with U.S. Fish and Wildlife Service to develop draft post-delisting monitoring plan in case the species is ultimately delisted. Continue to protect *H. virginicum* habitat to ensure viability of the species (thus reducing the likelihood of the species needing to ever be re-listed) as well as other sensitive or unique biological resources in the vicinity.

5. Status of Visitor Use and Satisfaction

Summary

In this section visitor use and satisfaction on the Forest was measured through a survey. These results help the Forest to prioritize areas in need of management attention for recreation opportunities. The following results reflect updates from data collected from 2016. This includes the recreation section of the previous 2014 report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

9. Are high quality, nature-based recreation experiences being provided and what are the trends?

20. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

Jefferson Forest Plan Tasks Pertinent to this Section

38. Results and trends in user satisfaction ratings [36 CFR 219.21(a)]. Analysis of NVUM customer satisfaction data for Day Use, Overnight General Forest Area, and Wilderness programs and local Customer Satisfaction survey tools.

41. Are the following recreation opportunities being increased: wildlife/ bird viewing, photography, interpretive opportunities, nature trails, day use and group facilities, water-based facilities, nonmotorized trails, OHV routes, ATV systems, Special Interest Areas? Review of construction, reconstruction, and maintenance of facilities plans and accomplishments. Check of INFRA inventory.

George Washington Forest Plan Questions Pertinent to this Section

16. What is the status and trend of settings and opportunities provided by the NFS unit compared to Desired Conditions stated in the LMP?

17. How are management actions maintaining or improving Desired Conditions for settings and opportunities provided by the NFS unit, including contributions to sustaining social systems within the unit’s LMP analysis area?

24. Is the road and trail system serving its intended purposes and addressing recreational demands?

26. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

George Washington Forest Plan Tasks Pertinent to this Section

26. Results and trends in user satisfaction ratings [36 CFR 219.21(a)]. Analysis of NVUM customer satisfaction data for Day Use, Overnight General Forest Area, and Wilderness programs and local Customer Satisfaction survey tools.

Key Results

User Satisfaction

The National Visitor Use Monitoring program (NVUM) is conducted on the George Washington and Jefferson National Forests every 5 years. Surveys of exiting recreationists are conducted at developed recreation overnight sites, developed recreation day use sites, general forest areas (including trails and FS roads), designated Wildernesses, and viewing corridors. NVUM methodology and analysis is explained in detail in the research paper entitled: Forest Service National Visitor Use Monitoring Process: Research Method Documentation; English, Kocis, Zarnoch, and Arnold; Southern Research Station; May 2002 available at http://www.fs.fed.us/recreation/programs/nvum. Final NVUM reports for the George Washington and Jefferson National Forests are also available at that website.

The last NVUM surveys occurred in Fiscal Years 2011 and 2016 and includes visitor satisfaction ratings for national forest visits. The data from these reports is used to assess trends in user satisfaction. The two national forests are combined as one in this research.

The percent of survey respondents that indicated they were very satisfied with their national forest recreation visit declined from FY2011 and FY2016, shifting to the somewhat satisfied rating. The percent of very dissatisfied trended slightly upward toward somewhat dissatisfied in that same time period.

Table 11. User Satisfaction Ratings

Visitor Satisfaction Rating	FY 2011 – Percent of National Forest Visits	FY 2016 – Percent of National Forest Visits
Very Satisfied	81.2%	77.4%
Somewhat Satisfied	12.0%	16.6%
Neither Satisfied nor Dissatisfied	3.5%	3.6%
Somewhat Dissatisfied	1.3%	2.2%
Very Dissatisfied	1.9%	0.1%
		100.0%

Recreation Opportunities

Recreation opportunities for trails and dispersed recreation such as wildlife/bird viewing, wildlife and nature photography, trails, hunting, fishing, water access for kayaking and canoeing, and special interest areas remained relatively flat over the last five years. On the Clinch Ranger District, portions of trails in the vicinity of Cave Springs Recreation Area on the Clinch Ranger District were closed in 2018 and 2019 for public safety; a portion of the Little Stony National Recreation Trail was also closed during this time due to storm damage. Designation of the Raccoon Branch Wilderness displaced mountain-bikers that used a trail within that area. The 4.9 mile Valley Divide Trail was constructed outside of the Wilderness so that this mountain biking use may continue in this area.

Developed recreation experienced a slight decline in opportunities between 2015 and 2019. The operating season for some developed recreation areas were shortened, particularly Beartree and Grindstone recreation areas operated by a private company under a special use permit. Angler access at Beartree Lake was not impacted. Bark Camp family campground on the Clinch Ranger District remained closed for two summers due to water system problems, and Cave Springs Recreation Area was closed for one year due to reduced Forest Service capacity. The swimming opportunity at High Knob Lake was ceased in 2019, however the day use area did not close. Two other swim sites on the Clinch RD, Cave Springs and Phillips Creek beaches, experienced temporary closures throughout 2019 due to repairs needed and concerns of potentially unsafe water quality for swimming. Wolf Creek Day Use Area picnic sites were removed and the vault toilet building closed; the site still has a group picnic shelter and serves as a trailhead. Campgrounds throughout the Jefferson National Forest experienced short-term temporary reduced services and closures due to sporadic water system repair needs which grew more frequent during this monitoring period as infrastructure grew older.

Sites that include interpretive opportunities remained open, however interpretive programs grew less frequent at locations like Glen Alton, Pandapas Pond, Grindstone, and Green Cove Station. The condition of interpretive signs declined across the national forest, making it more challenging for visitors to experience and enjoy self-guided interpretive opportunities. The exception is the addition of new interpretive signs at Birch Knob Observation Tower on the Clinch Ranger District, and addition of a QR code to scan at the Cascades Trail information kiosk to view an interpretive video about geology of that site.

Recommended Changes

No changes are recommended at this time.

6. Measurable Changes Related to Climate Change and Other Stressors

Summary

The following results reflect updates from data collected from 2015 - 2019. New information collected or compiled from the last evaluation report in 2014 has been incorporated. The 2016 administrative change completed to both the George Washington and Jefferson Forest Plans brought them into compliance with the 2012 planning rule. This resulted in new climate change focused questions that were not covered in the previous 2014 Monitoring and Evaluation report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

19. What is the impact of climate change on the planning area?

21. How has climate variability changed and how is it projected to change across the region?

22. How is climate variability and chance influencing the ecological, social, and economic conditions and contributions provided by plan areas in the region?

23. What effects do national forests in the region have on a changing climate?

George Washington Forest Plan Questions Pertinent to this Section

25. What is the impact of climate change on the planning area?

27. How has climate variability changed and how is it projected to change across the region?

28. How is climate variability and chance influencing the ecological, social, and economic conditions and contributions provided by plan areas in the region?

29. What effects do national forests in the region have on a changing climate?

Key Results

Climate Variability and Projected Changes

This climate summary is from the Southern Region Broad-Scale Monitoring strategy and is based on climate models originally developed for the United Nations Intergovernmental Panel on Climate Change, downscaled by Pierce et al.1 and available from the USDA Southeast Climate Hub's Climate by Forest tool which is an adaptation of the National Oceanic and Atmospheric Administration's Climate Explorer.2 The Climate by Forest tool produces graphs and tables showing historic and future projected conditions for two possible greenhouse gas emissions scenarios. 3 MQ22 will be addressed and evaluated through the Region 8 Broader-Scale Monitoring Strategy, which the Forest will incorporate into the Sumter Monitoring Reports.

About the data—the climate data considered in this report are based on both historical observations and future projections:

> *Historic climate*— for all observed data, the gray bars are plotted with respect to the 1961-1990 mean.4 The black line shows gridded historical observations.
>
> *Future climate:* The modeled future climate projections are Localize Constructed Analogs (LOCA) downscaled from the Coupled Model Intercomparison Project Phase 5 (CMIP5) model realizations. This includes the hindcast (historical) and the projected (future) climate for the RCP4.5 (low) and RCP8.5 (high) emission scenarios. Each year, the range is defined by the highest and lowest model values for that year across all 32 models and the central line represents the weighted mean across all models.[5,6]

How the results are produced—the results summarized in this section represent an analysis area defined by a bounding box surrounding the Ridge and Valley ecological subsection (RV – M221Aa[7]). Data are retrieved dynamically from a NOAA-funded site at Cornell University (DeGaetano et al.[8]).

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[1] Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology, volume 15, page 2558-2585. http://loca.ucsd.edu/~pierce/IEPR_Clim_proj_using_LOCA_and_VIC_2016-06-13b.pdf

[2] U.S. Federal Government. 2018. U.S. Climate Resilience Toolkit Climate Explorer. [Online] https://climate-explorer2.nemac.org Accessed August 8, 2018.

[3] U.S. Forest Service. 2018. U.S. Climate By Forest (adaptation of Climate Resilience Toolkit Climate Explorer). [Online] http://climate-by-forest.nemac.org Accessed August 8, 2018.

[4] https://www.esrl.noaa.gov/psd/data/gridded/data.livneh.metvars.html

[5] Taylor K. E., Stouffer R. J., Meehl G. A. (2012): An overview of CMIP5 and the experiment design. Bulletin of the American Meteorological Society, 93, 485-498, doi:10.1175/bams-d-11-00094.1.

[6] Sanderson,B.M. and M.F.Wehner (2017):Weighting strategy for the Fourth National Climate Assessment.In: Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Change Research Program [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 644-653.

[7] Keys, J.E.; Cleland, D.T.; McNab, W.H. 2007. Delineation, peer review, and refinement of subregions of the conterminous United States. Gen. Tech. Report WO-76A. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p.

[8] DeGaetano, A.T., W. Noon, and K.L. Eggleston (2014): Efficient Access to Climate Products in Support of Climate Services using the Applied Climate Information System (ACIS) Web Services, Bulletin of the American Meteorological Society, 96, 173–180

Best Available Science—these results represent the best available scientific information for evaluating climate, but limitations must be understood to make meaningful interpretations:

Accuracy and precision— One may assess model performance by comparing model reconstructions of the historical period with historical observations. For this evaluation, the envelope of model realizations used to reconstruct historical conditions aligned very well with the gridded historical observations themselves (Figure 1 and 2). The same models that produced accurate historical reconstructions were used to develop climate projections based on specific emissions pathways. By using results from multiple models (i.e., model agreement/uncertainty), this analysis incorporates a diversity of scientific approaches to modeling the climate system. This analysis is agnostic about how best to represent the physics of the coupled ocean and atmosphere, its sensitivity to greenhouse gases, and resultant climate changes that emerge at a regional level or at the scale of analysis used here. The methods used here are not concerned with examining precise conditions in a specific year in the future. Instead, we analyze a weighted average of model results to provide general guidance about trends and trajectories that are well-supported by modeling studies.

The accuracy of model results relates most closely to future emissions, which themselves will be determined by future human decisions. Human decisions about greenhouse gas emissions cannot be accurately modeled, so the Climate by Forest tools adopts two emissions pathways that are frequently used in climate science.

Each interpretation section in this report addresses these characteristics of accuracy and precision. There are other limitations of these data that are inherent to the systems, models, and assumptions used to develop them that are not readily assessed, but should be considered contextually as these are considered alongside other sources of information, including findings from peer-reviewed literature and local expertise.

Reliability—the results presented in this report are based on peer-reviewed science being widely applied within the National Climate Assessment. [9]

Relevance—Relevance is assessable through geographic and attribute-level considerations. The Climate by Forest tool summarizes results at the ecological subsection scale, which is not perfectly coincident with the boundaries of our area of interest (i.e., George Washington and Jefferson National Forests), but given the coarseness of the climate data and other sources of uncertainty, the selected subsection (RV – M221Aa) provides a representative sample that can be reasonably applied to the area of interest as a whole and represents areas that, at least historically, have similar climates. While there are additional climate variables that are relevant

[9] https://science2017.globalchange.gov/downloads/

to the mission and operations of the George Washington and Jefferson National Forests, the selected attributes cover the major physical variables of temperature and precipitation and give sufficient insight into potential influences on resources and management activities.

Figure 1. Ridge and Valley ecological subsection (Keys et al. 2007)

Temperature

Both greenhouse gas concentration pathways (i.e., RCP4.5 and RCP8.5) indicate that by mid-century (2036-2065 compared with 1961-1990 baseline) RV – M221Aa would see statistically significant increases in the average daily maximum and minimum temperatures, increases in the average number of days per year above 90F, and a decrease in the average number of days with lows below freezing (32F) per year across all levels of model uncertainty (Table 12; Figure 2):

- The projected change in average daily maximum temperature is a mean increase of 2.6F to 2.9F across RCP4.5 to RCP8.5, respectively, while average daily minimum temperature are expected to increase by a mean of 4.2F to 5.2F across the same scenarios.
- The number of days per year with maximum temperature above 90F show a mean increase of about 30 to 39 days across RCP4.5 to RCP8.5, respectively. The number of days per year with minimum temperature below 32F show a mean decrease of about 24 to 29 days for RCP4.5 and RCP8.5, respectively.

Table 12. Projected range of change in temperature variables by the period 2036-2065, using RCP 4.5 and RCP 8.5 over the 1961-1990 baseline period for the George Washington and Jefferson National Forest.

		Ridge and Valley Ecoregion		
Variable		**Min**	**Mean**	**Max**
Average Daily Maximum Temperature (F)	**RCP 4.5 Change**	**1.1**	**2.6**	**5.0**
	95% Confidence Interval	0.8	0.7	1.3
	Statistical Significance	S	S	S
	RCP 8.5 Change	**1.5**	**2.9**	**5.1**
	95% Confidence Interval	0.7	0.5	1.3
	Statistical Significance	S	S	S
Average Daily Minimum Temperature (F)	**RCP 4.5 Change**	**3.7**	**4.2**	**4.9**
	95% Confidence Interval	0.4	0.2	0.4
	Statistical Significance	S	S	S
	RCP 8.5 Change	**4.7**	**5.2**	**5.7**
	95% Confidence Interval	0.4	0.4	0.5
	Statistical Significance	S	S	S
Average Days per Year Maximum Temperature above 90F	**RCP 4.5 Change**	**6.5**	**29.8**	**53.1**
	95% Confidence Interval	0.8	1.6	4.0
	Statistical Significance	S	S	S
	RCP 8.5 Change	**12.0**	**39.3**	**62.4**
	95% Confidence Interval	2.1	3.2	4.5
	Statistical Significance	S	S	S
Average Days per Year Minimum Temperature below 32F	**RCP 4.5 Change**	**-28.4**	**-23.5**	**-21.8**
	95% Confidence Interval	3.6	1.6	2.7
	Statistical Significance	S	S	S
	RCP 8.5 Change	**-31.3**	**-28.5**	**-25.8**
	95% Confidence Interval	4.0	2.1	3.1
	Statistical Significance	S	S	S

S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval is plus or minus (+/-).

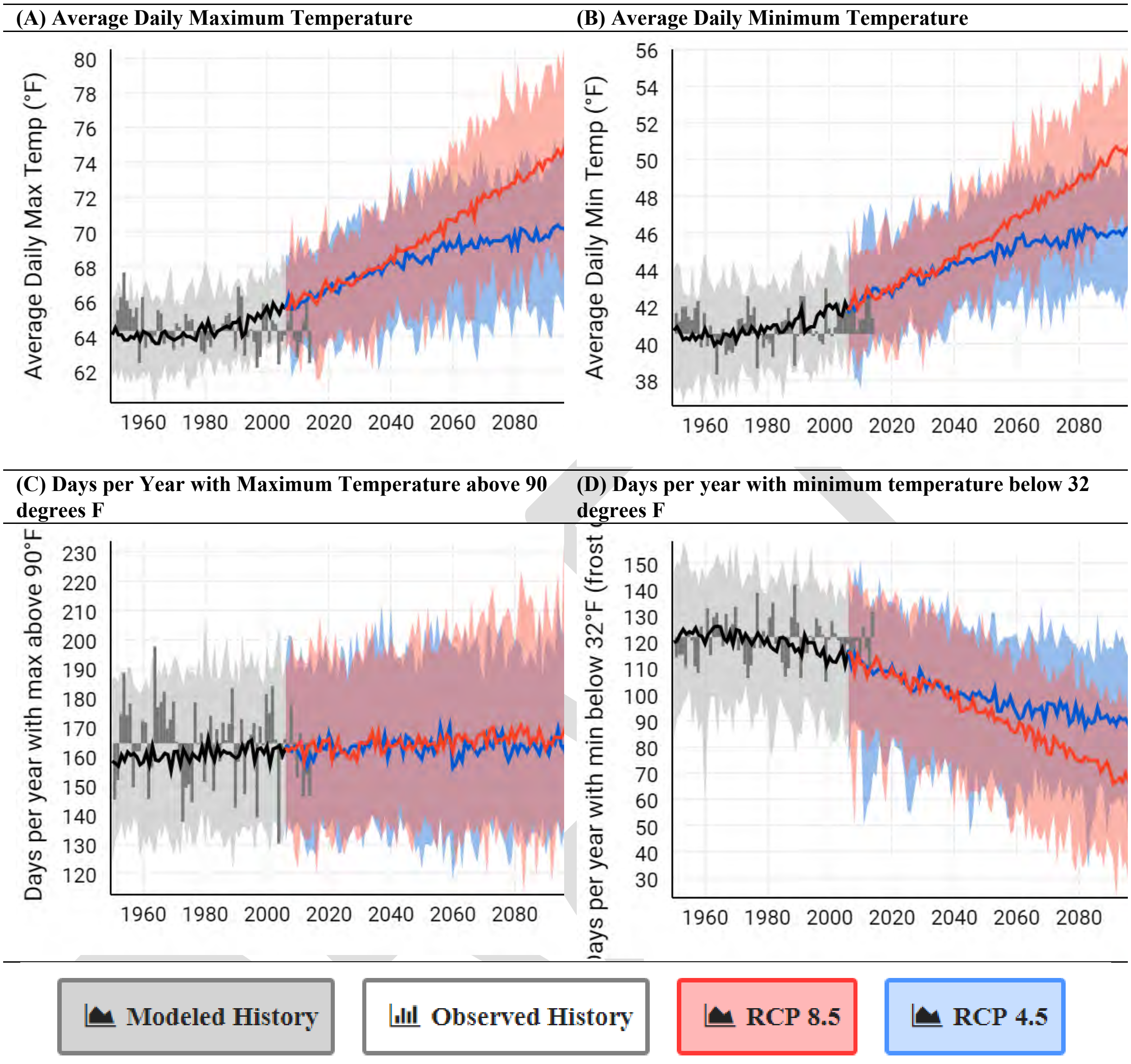

Figure 2. Projected temperature variables for the RV – M221Aa under RCP 4.5 and RCP 8.5 for (A) average daily maximum temperature, (B) average daily minimum temperature, (C) days per year with maximum temperature above 90 degrees F, and (D) days per year with minimum temperature blow 32 degrees F.

Precipitation

Changes in total precipitation and number of dry days per year for the RV – M221Aa are less clear than temperature. While both scenarios show a statistically significant increase in precipitation, and the number of dry days are expected to increase, results are not significant for the minimum change in dry days (table 13; figure 3):

- Increases in mean total precipitation of 2.6 to 2.9 inches are projected for RCP4.5 and RCP8.5, respectively.
- The number of dry days per year show a mean increase of about 3 to 4 days across RCP4.5 to RCP8.5, respectively, but results are not significant for the minimum for either scenario.
- Storm events associated with heavy rainfall are becoming more regularly occurring results in recurring, annual forestwide road damage that. Federal Highways provides funding assistance to address these damages in some situations.

Table 13. Projected range of change in precipitation variables by the period 2036-2065, using RCP 4.5 and RCP 8.5 over the 1961-1990 baseline period for the George Washington and Jefferson National Forest.

		Ridge and Valley Ecoregion		
Variable		**Min**	**Mean**	**Max**
Average Number of Dry Days per Year	**RCP 4.5 Change**	**-0.9**	**2.9**	**7.9**
	95% Confidence Interval	2.6	1.5	2.9
	Statistical Significance	NS	S	S
	RCP 8.5 Change	**1.7**	**4.1**	**9.1**
	95% Confidence Interval	2.4	1.1	2.7
	Statistical Significance	NS	S	S
Average Total Annual Precipitation (in)	**RCP 4.5 Change**	**1.1**	**2.6**	**5.0**
	95% Confidence Interval	0.8	0.7	1.3
	Statistical Significance	S	S	S
	RCP 8.5 Change	**1.5**	**2.9**	**5.1**
	95% Confidence Interval	0.7	0.5	1.3
	Statistical Significance	S	S	S

S = Statistically significant at the 95% (or higher) confidence level. NS = Not statistically significant at the 95% confidence level. The 95% confidence interval is plus or minus (+/-).

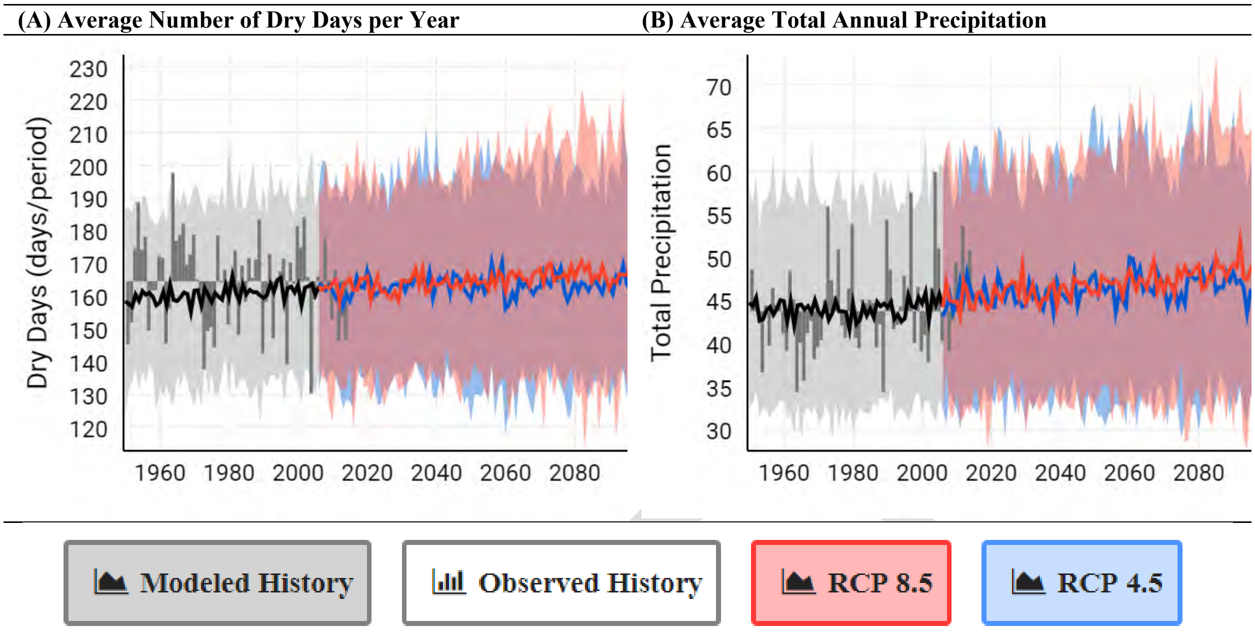

Figure 3. Projected precipitation variables for the RV – M221Aa under RCP 4.5 and RCP 8.5 for (A) average total precipitation and (B) average dry days.

Discussion and Findings

- Temperature— Projections suggest that future warming is expected, resulting in 30-39 more days above 950 and 24-29 fewer freezing days per year.
- Precipitation—Precipitation was historically variable and will likely continue to be variable from one year to the next. There does appear to be a trend toward a modest increase in total precipitation, with a small reduction in the number of dry days per year, suggesting that precipitation events may be less frequent but more intense.

Recommended Changes

Adaptive Management Considerations

Forestlands across the Southern region are experiencing increased threats from fire, insect and plant invasions, disease, extreme weather, and drought. Scientists project increases in temperature and changes in rainfall patterns that can make these threats occur more often, with more intensity, and/or for longer durations. Although many of the effects of future changes could be negative, natural resource management can help mitigate these impacts. Responses informed by the best current science enable natural resource professionals within the Forest Service to better protect the land and resources and conserve the region's forestlands into the future.

The table below provides a summary of climate related findings and potential responses. Several resource areas from other sections of this report are included in this table. The table outlines considerations for those resources areas to create adaptive management resiliency strategies in regards to climate induced changed. This table was developed using the USDA Forest Service's TACCIMO tool fact sheets for the George Washington and Jefferson National Forests. These considerations are holistic in nature and can be utilized to develop and in the development of projects.

Table 14. Summary of findings and adaptive management considerations.

Resource Area	Findings	Adaptive Management Considerations
Forest Health	Invasive and aggressive plant and insect species may increasingly outcompete or negatively affect native species in the future. Winter freezes currently limit many forest pests, but higher temperatures will likely allow these species to increase. Destructive insects, such as southern pine beetles, will be better able to take advantage of forests due to factors such as increased drought. Certain invasive plant species found in these forests, including kudzu, Japanese honeysuckle, and Amur honeysuckle are expected to increase dramatically as they are able to tolerate a wide range of harsh conditions, allowing them to rapidly move into new areas.	Manage tree densities through practices such as thinning and prescribed fire to maximize carbon sequestration and reduce the vulnerability of forest stands to water stress, insect and disease outbreaks, and fire. Continually monitor for new invasive species moving into areas where they were not traditionally found, especially following events such as hurricanes and fire.
Plant Communities	Heat stress may limit the growth of some southern pines and hardwood species. Stresses from drought and wide-scale pest outbreaks have the potential to cause large areas of forest dieback.	Include a range of ages and species in forests to lessen potential loss from drought or infestation.

Resource Area	Findings	Adaptive Management Considerations
	Intensified extreme weather events, such as hurricanes, ice storms, and fire, are also expected to lead to changes in plant community composition. Populations of some rare or endemic plants may be disproportionately impacted. Species more resistant to these disturbances, such as longleaf pine, will be more resilient to a changing climate.	
Animal Communities	Wildlife species will be affected in different ways. Amphibians may be most at risk, due to dependencies on moisture and cool temperatures that could be altered. Increasing water temperatures will also likely decrease populations of brook trout and greater ambient temperatures may also be harmful to the endangered Indiana bat. Alternatively, mammals such as deer and black bears may increase due to higher survival rates during warmer winters.	Maintain piles of natural woody debris in areas of high amphibian diversity to supplement habitats that retain cool, moist conditions. Create habitat corridors; assist in species movement; increase National Forest management unit sizes and identify high-value conservation lands adjacent to National Forests.
Extreme Weather	The potential for severe storms is expected to increase in the future, including more intense hurricanes making landfall in the southern US. Extended periods of extreme high temperature and drought may lead to drier forest fuels which will burn more easily and contribute to larger and more	Identify areas that provide particularly valuable ecosystem services, like timber harvest or carbon sequestration, and are also vulnerable to extreme weather, like hurricanes or fires. Then plan conservation strategies accordingly to mitigate for extreme weather

Resource Area	Findings	Adaptive Management Considerations
	frequent wildfires. More cloud-to-ground lightning due to warming may also increase wildfire ignitions.	impacts and payment for ecosystem service programs. Prescribed burning can also be a management option for reducing the impacts of any future increases in wildfire potential emanating from climate change.
Water Resources	Shifts in rainfall patterns will lead to periods of flooding and drought that can significantly impact water resources. Increases in heavy downpours and more intense hurricanes can lead to greater erosion and more sedimentation in waterways. Increased periods of drought may lead to poor water quality.	Focus attention on and near smaller, isolated water systems that are more vulnerable and may not be able to absorb and benefit from wildfires and heavy rains that cause large floods or debris flow. Restore and reinforce vegetation in headwater and marsh areas to help alleviate runoff of sediment during heavy rain; reduce climate-induced warming of water; and decrease water sensitivity to changes in air temperature.
Recreation	Environmental changes may negatively impact recreational experiences due to changes in the plant and animal communities that make those experiences unique. More days above freezing could increase tick and mosquito populations throughout the year, leading to an increase in vector-borne illness. With more days of extreme heat, recreation areas	Examine the goals for a water system or area of land when considering changing dynamics. For example, a stream managed mostly for recreation must balance the demand for rainbow trout from anglers with other aquatic and terrestrial impacts.

Resource Area	Findings	Adaptive Management Considerations
	could see decreased use in the summer if temperatures impact visitor comfort.	

7. Progress Toward Meeting the Desired Conditions in the Plan

Summary

This includes the rare communities and caves, fire, visuals, heritage, soils, minerals / geology, transportation, timber (portions of the timber section), successional habitats, major forest types and plan implementation efficiency and effectiveness sections from the previous 2014 Monitoring and Evaluation report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

1. Are rare ecological communities being protected, maintained, and restored?

2. Are landscape and stand level composition, structure, and function of major forest communities within desirable ranges of variability?

6. What are status and trends of forest health threats on the forest?

10. What is the status and trend of wilderness character?

12. Are the scenic and aesthetic values being protected and enhanced?

13. Are heritage sites being protected?

14. Are watersheds maintained (and where necessary restored) to provide resilient and stable conditions to support the quality and quantity of water necessary to protect ecological functions and support intended beneficial uses?

16. How do actual outputs and services compare with projected?

18. Are Forest Plan objectives and standards being applied and accomplishing their intended purpose?

19. What is the impact of climate change on the planning area?

20. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

Jefferson Forest Plan Tasks Pertinent to this Section

3. Status and trend in forest cover acreage by major forest and woodland community type and successional

stage. Map and update changes through annual routine inventories. Monitor acres by major forest and woodland community type and trends?

2. Acres and/or number of occurrences of rare communities treated to maintain or restore desired conditions. Annually schedule site visits to map and track locations, composition and condition of selected sample of rare communities utilizing standard GIS coverage and NRIS Terra, FSVeg and Fauna databases. Utilize standard reports for Annual M&E reporting. Use the assigned values to determine cave classification and to determine cave significance under the implementation regulations of the Federal Cave Resources Protection Act of 1988.

4. Acres and/or number of occurrences of rare communities treated to maintain or restore desired conditions. Summarize acres of (silvicultural) treatments by major community type utilizing established activity tracking systems.

5. Acres burned (wildland and prescribed) by major forest community type. Maps of prescribed burn units are incorporated into the GIS data base annually, by the end of the burning season. Total acres are determined from a GIS query.

15. Trend in riparian area acreage by forest type and successional stage. Map and update changes in riparian areas, forest community type and successional conditions through.

16. Acres of vegetation management implemented in riparian areas by activity. Track annual accomplishments with standard tracking system.

21. Fuel monitoring following Regional protocol. Acres of hazardous fuels treated through wildland fire use, prescribed fire, and mechanical treatment mapped into the GIS data base reports generated through GIS / NRIS FSVeg queries.

44. Annual summary report of number of Wildland Fire Use Fires and acres and number of management ignited fires and season of burn.

48. Treatment and location data entered in activity tracking system at time treatment completed. Summary report of project acres that meet or exceed the assigned Scenic Integrity Objective (SIO).

50. Heritage inventories and surveys pursuant to 106 for all ground disturbing projects are reviewed by SHPO/THPO per Regional PA and Forest MOUs. Sample field condition assessment of sites eligible or listed in National Register. Review of preservation/maintenance plans completed.

54. Effect of management activities on soil quality and productivity [36 CFR 219.12 (k)(2), 36 CFR 219.27(a)(1)]Sample projects for soil loss.

55. Are temporary roads being revegetated within 10 years of contract or permit termination? [36 CFR 219.27(a)(11)]. Sample projects during program reviews to determine and document that standard (temporary roads are revegetated within 10 years of contract or permit termination) is being met.

56. Field inspection of project sites following established monitoring protocol. Review of sample of project documents and related NEPA documents for compliance with laws, BMPs and standards. Follow-up field inspections annually after reclamation operations for five years. Summarize findings and recommend.

62. Review of requests received and process time elapsed to decision for energy and non-energy minerals as well as requests from private mineral holders.

63. Are roads being maintained, constructed or reconstructed to reduce sediment delivery to water bodies and to provide a transportation system that supplies safe and efficient access for forest users while protecting forest resources. [36 CFR 219.27(a)(10)].

72. 5 year review (to determine when changes in GPRA, policies, or other direction would have significant effects on Forest Plans).

73. 5 year review (to determine if planning information or physical conditions have changed).

74. Document research needs in annual Monitoring and Evaluation Report if appropriate.

George Washington Forest Plan Questions Pertinent to this Section

1. How are ecological conditions maintaining or making progress toward the LMP desired conditions and objectives?

2. What are the current condition and trend of key characteristics for vegetation identified in the desired conditions (DC) for the plan area?

3. How are management actions maintaining or making progress toward DC for the key characteristics of vegetation in the plan area?

9. What is the distribution and trend in Fire Regime Condition Class on the National Forest/Grassland?

10. How effective are management actions in moving the National Forest/Grassland toward FRCC 1?

14. How effective are management actions in moving the National Forest/Grassland toward improving watershed health?

17. How are management actions maintaining or improving Desired Conditions for settings and opportunities provided by the NFS unit, including contributions to sustaining social systems within the unit's LMP analysis area?

23. Are the impacts from the road and trail system on soils, water quality, wildlife, and other natural and cultural resources sustainable and within acceptable tolerance?

26. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

George Washington Forest Plan Tasks Pertinent to this Section

2. Status and trend in the extent and condition of ecological systems. Map and update changes through annual routine inventories. Monitor acres by major forest and woodland community type and trends.

3. Acres of silvicultural treatments implemented by activity type and forest type. Summarize acres of treatments by major community type utilizing established activity tracking systems.

4. Acres burned (wildland and prescribed) by major forest community type. Maps of prescribed burn units are incorporated into the GIS data base annually, by the end of the burning season. Total acres are determined from a GIS query.

14. Fuel monitoring following Regional protocol. Acres of fuels treated through the use of wildland fire and mechanical treatment mapped into the GIS data base reports generated through GIS/NRIS FSVeg queries.

31. Annual summary report of number of Wildland Fire Use Fires and acres and number of management ignited fires and season of burn.

33. Treatment and location data entered in activity tracking system at time treatment completed. Summary report of project acres that meet or exceed the assigned Scenic Integrity Objective (SIO).

34. Heritage inventories and surveys pursuant to 106 for all ground disturbing projects are reviewed by SHPO/THPO per Regional PA and Forest MOUs. Sample field condition assessment of sites eligible or listed in National Register. Review of preservation/maintenance plans completed.

36. Effect of management activities on soil quality and productivity [36 CFR 219.12(k)(2), 36 CFR 219.27(a)(1)]. Assess projects for long term effects to soil productivity. Compare assessments to NEPA estimates.

37. Are temporary roads being revegetated within 10 years of contract or permit termination? [36 CFR 219.27(a)(11)]. Sample projects during program reviews to determine and document that standard (temporary roads are revegetated within 10 years of contract or permit termination) is being met.

42. Are roads being maintained, constructed or reconstructed to reduce sediment delivery to water bodies and to provide a transportation system that supplies safe and efficient access for forest users while protecting forest resources. [36 CFR 219.27(a)(10)].

51. 5 year review (to determine when changes in GPRA, policies, or other direction would have significant effects on Forest Plans).

52. 5 year review (to determine if planning information or physical conditions have changed).

53. Document research needs in annual Monitoring and Evaluation Report if appropriate.

Key Results

Rare Communities and Caves

Various gates have been installed in caves across the Forest to protect the biological integrity of the caves.

Herbicide treatments to manage non-native invasive plant species has been the main management activity implanted on special biological areas and rare communities.

Table 15. Herbicide Treatments Conducted in Special Biological Areas (SBAs) on the George Washington and Jefferson National Forests, 2015-2019.

Forest	District	Fiscal Year	SBA Name	Acres
GWNF	Lee	2019	Buck Mountain	22.8
GWNF	Lee	2019	Buck Mountain	11.1
GWNF	Lee	2019	Church Mountain	21.6
GWNF	North River	2017	Dunkle Knob	48.3
GWNF	North River	2017	Whetmiller Knob	71.0
GWNF	Pedlar	2015	Big Levels	156.6
GWNF	Pedlar	2017	Big Levels	462.8
GWNF	Pedlar	2018	Big Levels	65.0
GWNF	Pedlar	2018	Little Irish Creek	18.8
GWNF	Pedlar	2018	Little Irish Creek	12.5
GWNF	Pedlar	2018	Upper Crabtree Creek	6.6
GWNF	Warm Springs	2018	South Fork Pads Creek Barrens, Copeland Barrens	26.8
JNF	Clinch	2017	Keokee Lake	23.6
JNF	Clinch	2017	Keokee Lake	31.5
JNF	Clinch	2017	Keokee Lake	11.5
JNF	Clinch	2019	Keokee Lake	142.4
JNF	Eastern Divide	2015	Bald Mountain	13.4
JNF	Eastern Divide	2015	Interior Seep	88.3
JNF	Glenwood	2015	James River Gorge	17.5
JNF	Glenwood	2016	James River Gorge	191.1
JNF	Glenwood	2017	James River Gorge	185.2
JNF	Glenwood	2018	James River Gorge	1.1

Fire

The Fire budget is being allocated with guidance from the National Interagency Fire budgeting program FPA (Fire Planning Analysis). This has been deemed effective to achieve the desired level of protection; it should be noted that during the evaluation period (FY2015 – FY2019), there were no losses of life or homes on private land from wildfires originating on the Forest. No changes are recommended, the Forest should continue to implement preparedness and protection as analyzed and funded.

Table 16. Acres of wildfire

	Wildfires		GW		Jeff	
Year	**Number**	**Total Acres**	**Number**	**Acres**	**Number**	**Acres**
2015	22	414	17	318	5	96
2016	30	1492	27	1487	3	4
2017	26	14009	11	11303	15	2706
2018	22	3223	15	3096	7	127
2019	10	9	10	9	0	0
Total	**110**	**19149**	**80**	**16215**	**30**	**2934**

Natural ignitions that have occurred in wildernesses were not suppressed. This resulted in various wildlife events that were controlled in various wildernesses on both the George Washington and Jefferson National Forests.

Table 17. Acres of wildfire in wildernesses

Acres Burn in Wilderness	Wilderness	Acres Burned
Jefferson NF	Brush Mtn East	27
	Total on the Jefferson	**27**
George Washington NF	James River Face	8
	Saint Mary's	1346
	Thunder Ridge	1
	Total on the George Washington	**1355**
	Total on both Forests	**1382**

The George Washington and Jefferson National Forests have and plan to continue to engage in a multi-party monitoring program which began in 2009 as part of the Central Appalachians Fire Learning Network. The Monongahela National Forest started a similar program in 2019 using the same protocol to allow for collected data to be combined with the Central Appalachians Fire Learning Network's dataset. Photopoints have been established in all prescribed burn areas since 2017. Monitoring has been focused on the impacts of prescribed burning but could be expanded to include the impacts of silviculture and climate change and quantify watershed restoration goals.

All monitoring described below has been designed to provide data related to goals set out in the George Washington and Jefferson Forest Plans. Both Forest Plans describe the desired conditions for landscapes and ecological communities across the forests. They share a goal to successfully regenerate oak (Quercus spp.) and yellow pine in Virginia (Pinus spp.), as well as to create greater amounts of early-successional and open-woodland conditions.

The monitoring team established a network of over 400 permanent plots across Fire Learning Network ownership, which includes lands managed by the forests, The Nature Conservancy and several state agencies. This network has provided information about forest structure and composition after prescribed burning to help answer specific questions about oak regeneration success and the creation of desired forest structure. The results have been used by District Rangers and the Forest Supervisor to shape future projects and have been in the National Environmental Policy Act (NEPA) process. Staff from the forests and The Nature Conservancy co-lead a Monitoring Working Group to organize trainings, coordinate field work and oversee data entry. All Fire Learning Network partners provide staff for field work. Staff from The Nature Conservancy and the forests analyze and write monitoring reports.

A canopy gap analysis was completed by The Nature Conservancy and forest staff using GIS data to assess dozens of burn units on the George Washington and Jefferson National Forests. The Monongahela National Forest conducted a canopy gap analysis to determine the effectiveness of prescribed fire. Songbird populations have also been monitored by The Nature Conservancy on some plots, with analysis focused on the George Washington Forest Plan's Management Indicator Species. These data have been used by the forest to track Plan implementation and to directly address high-level, quantifiable Plan goals such as the amount of woodlands created. The work has been published (USFS Research Paper NRS-31) and plans to replicate the methodology for newer burns are underway. A second publication, designed to help managers predict fire severity, could be completed if funding were available. All reports are available at Conservationgateway.org.

A large-scale analysis of existing data, bolstered by new data and conducted with stakeholder input, is fostering increased collaboration and support for projects. This effort continues using data collected and analyzed by staff from the forest and The Nature Conservancy and discussed with existing stakeholder groups (e.g. George Washington National Forest Conveners). The table below demonstrates the acres by forest ecological vegetation of prescribed burn that occurred every year from 2015 – 2019.

Table 18. Acres of prescribed burn by forest ecological vegetation type

Forest Ecological Vegetation (Simon EV code)	2015	2016	2017	2018	2019
Blank (not catgegorized)	269	24	206	357	581
Bear oak-southern scrub oak-yellow pine	0	0	0	0	0.57
Black locust	65	0	0	0	46
Brush species	68	0	7	1	54
Chestnut oak	423	0.28	268	1152	1559
Chestnut oak-scarlet oak	166	10	955	1271	1349
Chestnut oak-scarlet oak-yellow pine	793	49	346	1671	1328
Cove hardwood - white pine - hemlock	34	0	101	90	0.94
Eastern redcedar	0	0	0	0	11

Fraser fir	0.86	0	0	44	0
Hemlock	0	0	0	29	0.6
Hemlock-hardwood	14	0	0	124	151
Loblolly pine	0	0	0	0	34
Non Forest	0	0	224	224	65
Northern red oak	340	0	0	137	22
Northern red oak-hickory-yellow pine	41	0	0	441	233
Pitch pine	11	0	9	208	281
Pitch pine-oak	149	0.11	402	488	357
River birch-sycamore	0	0	0	0	50
Scarlet oak	474	72	45	588	595
Scrub oak	0.25	0	0	0	0
Shortleaf pine	26	0.01	0	11	75
Shortleaf pine-oak	0	0	0	3	0
Sugar maple-beech-yellow birch	85	0	20	38	20
Sycamore-pecan-American elm	0	0	0	0	50
Table Mountain pine	370	0	0	486	38
Table Mountain-pine-hardwood	554	0	0	292	187
Upland hardwoods-white pine	89	29	231	178	239
Virginia pine	52	0	34	37	175
Virginia pine-oak	34	0	0	117	18
White oak	34	125	35	18	231
White oak-black oak-yellow pine	0	0	32	98	6
White oak-northern red oak-hickory	4376	203	2464	6169	6024
White pine	101	17	86	189	175
White pine-hemlock	0	0	0	92	2
White pine-upland hardwood	6	12	24	335	180
Yellow poplar	0	0	0	0	20
Yellow poplar-white oak-northern red oak	224	0	207	194	433
Total	**8811**	**544**	**5713**	**15097**	**14607**

As demonstrated in the table above the prescribed burn program is focused on fire adapted forest types consisting primarily of oak and pine species.

Prescribe fire effects monitoring results show that burning has begun to shift the forest towards the Desired Conditions of the Forest Plan. A single burn created moderate levels of early and open conditions, but repeated burning did not always result in ever-increasing amounts of these conditions. Taken as a whole, the results of burning were close to the Plan's goal for early forest creation but have not yet achieved the goal for open forest creation.

Visuals

Forest Service management activities such as forest restoration, timber harvesting, wildlife habitat improvements, prescribed fires, and issuances of special use permits include design criteria to reduce potential impacts to scenery. Some impacts occurred, but not sufficiently to keep projects from meeting the Scenic Quality Objectives.

The one exception is the Mountain Valley Pipeline which impacted scenic quality along the construction right-of-way on the Eastern Divide Ranger District.

Gypsy moth damage on the Eastern Divide Ranger District impacted scenic quality, including defoliation of trees. Planning began in 2018 and continues into 2010 for a project to improve resiliency in affected stands in seven working areas encompassing over 1,366 acres.

Wildfires temporarily caused degradation of scenic quality. Most were short-term impacts because natural revegetation of herbaceous species within a year which reduces the visibility of blackened ground and tree trunks. Several larger fires resulted in impacted scenery, specifically the Brushy Fire on the Eastern Divide Ranger District in 2018 and the Raven Rock fire on the Clinch Ranger District in 2016.

Forest Service management activities such as restoration, timber harvesting, wildlife habitat improvements, prescribed fires, and issuances of special use permits include design criteria to eliminate or reduce impacts to scenery. Some impacts occurred with these projects, but not sufficiently to keep projects from meeting the Scenic Quality Objectives. An exception is the Atlantic Coast Pipeline, portions of which were cleared before the project was abandoned by the permit holder. The scenery assessment concluded that Scenic Integrity Objectives would be met within five years due to required mitigation of replanting all of the right-of-way except ten feet over the pipeline. Until the revegetation is completed and has time to grow, the scenic quality is impacted and may not meet current Scenic Integrity Objectives in some areas.

Wildfires temporarily caused degradation of scenic quality. Most were short-term impacts with natural revegetation of herbaceous species within a year. This greening up with new vegetation reduced the visible contrast of color, and to a lesser degree reduced the visible deviation in texture from the unburned landscape scenery. Several larger fires impacted scenery during this monitoring period, particularly on the Glenwood-Pedlar Ranger District. The Mount Pleasant and Cellar Mountain fires in 2016 and the Tye River fire in 2018 burned a total of 11,644 acres of Forest Service land that impacted scenery by blackening the ground, tree trunks, and some tree mortality.

Heritage

Both archaeological and structural (standing structures), all cultural resources under the management plans of both the George Washington and Jefferson National Forests are protected from potential disturbance by adherence to the guidelines established under our Programmatic Agreement (PA) with the Virginia State Historic Preservation Officer (SHPO) the Eastern Band of Cherokee Indians (EBCI) and, the Cherokee Nation of Oklahoma. We are able to protect cultural resources potentially eligible for the National Register of Historic Places (NRHP) through strict adherence to avoidance measures. Furthermore, we require Phase I testing for all potentially ground disturbing activities for the early identification and protection of cultural resources from disturbance, removal or destruction.

Currently, no cultural resources within the George Washington and Jefferson National Forests have been elevated to listing on the NRHP. Several resources have been identified for potential NRHP listing (6 historic iron furnaces), and we are formulating a submission under a joint undertaking with the Virginia SHPO. As part of Heritage Program Managed to Standard protocols, all priority heritage assets (PHAs), as well as those sites qualifying for national register nomination and those deemed potentially eligible, have been protected from potential adverse effects from site disturbing activities through a combination of avoidance, gating (cave resources), monitoring by heritage personnel (PHA's as well as non-PHA sites), and increased patrolling and awareness exhibited by Forest Law Enforcement and Investigation (LE&I) staff. In order to meet the directives of our PA with the Virginia SHPO and EBCI following established guidelines in site survey, preservation and securing of sensitive cultural resources has been imperative in maintaining strong working relationships and integrity with these entities as evidenced by their concurrence on forest projects.

Soils

The GWJNF includes erosion control in the design criteria of every earth disturbing management activity that we propose and we have many Forest Plan standards and guidelines, Virginia Dept. of Forestry Best Management Practices (BMPs), timber sale administration inspections, and National BMP monitoring, all of which help us to control and monitor soil erosion and its effect on the soil resource. Our BMP monitoring shows these techniques can be effective in controlling erosion and sediment, when BMPs are installed and maintained properly. The results of our National BMP Monitoring is shown below in Table 19 (Also see Appendix C – Evaluations by Fiscal Year for BMP Targets).

Table 19. National BMP monitoring evaluations on the GWJ NF by activity type, 2015-2020.

Monitoring activity	Site	Evaluation Type	Date	Implementation	Effectiveness	Composite
Min_B Active Non-Placer Mineral Operations	Equitable Resources well WS-0288	Both implementation and effectiveness	09/28/2015	Mostly	Effective	Excellent
Range_A Grazing Management	Burton Chapel Pasture	Both implementation and effectiveness	09/02/2015	Marginal	Not	Poor
	Smith Tract Pasture, 001	Both implementation and effectiveness	09/29/2016	Marginal	Missing Q47	Missing data
Rec_A Developed Recreation Sites	Elkhorn Lake Day Use Area	Both implementation and effectiveness	08/31/2018	Fully	Not	Poor
Rec_B Developed Recreation Sites	Clear Creek	Both implementation and effectiveness	10/05/2016	No BMPs	Not	No Plan
Veg_A Ground-Based Skidding and Harvesting	White Rocks Vegetation Management	Both implementation and effectiveness	03/17/2015	Marginal	Effective	Good
	Little Mountain Timber Sale, Unit 2	Both implementation and effectiveness	03/25/2015	Marginal	Effective	Good

Monitoring activity	Site	Evaluation Type	Date	Implementation	Effectiveness	Composite
Veg_C Mechanical Site Treatments	Boley Field Brush Cutting	Both implementation and effectiveness	10/17/2016	No BMPs	Effective	No Plan
Road_C Road Operation and Maintenance	FDR 35	Both implementation and effectiveness	09/29/2016	Fully	Not	Poor
Road_H Completed Construction, Reconstruction or Operation and Maintenance of Parking Areas	Longdale Day Use Area	Both implementation and effectiveness	09/16/2015	No BMPs	Effective	No Plan
	Dragons Tooth Trail Head Parking Area	Both implementation and effectiveness	10/04/2016	No BMPs	Not	No Plan
Monitoring activity	**Site**	**Evaluation Type**	**Date**	**Implementation**	**Effectiveness**	**Composite**
AqEco_B Completed Aquatic Ecosystem Improvements	North River Restoration	Both implementation and effectiveness	09/22/2016	Mostly	Effective	Excellent
	North River Restoration - 2017 phase	Both implementation and effectiveness	08/31/2018	Marginal	Effective	Good

In addition to National BMP monitoring, the GWJ initiated a new soil monitoring program beginning in 2019 to specifically address soil related impacts associated with timber harvesting activities. Monitoring was conducted using the National Soil Disturbance Monitoring Protocol, which is in two volumes (Page-Dumroese et al 2009a and 2009b). One year following timber sale closure, staff collected data and assessed the extent of detrimental soil disturbance resulting from timber harvest activities; assessed whether plan standards were met and if they provided necessary protections. The full report (Appendix D – George Washington and Jefferson National Forests 2019 Soils Disturbance Monitoring Report) provides results of the soil disturbance data that was collected and other field observations.

National Soil Disturbance Monitoring Summary

Seven timber harvest units that closed in 2018 were surveyed in May and June 2019 for post-implementation soil disturbance monitoring. Data for 24 parameters was collected from at least 30 pits in each unit. Forest floor depth, amount of live vegetation, fine and coarse woody material cover, bare soil, surface erosion, rutting, and compaction were measured at each soil pit.

Total estimated detrimental soil disturbance (DSD) ranged from 3-16% for the units, and disturbance of 10% or more was determined for 4 of the 7 units. Average forest floor depth did not exceed 3cm for any unit and bare soil was exposed approximately 10-40% of the unit areas. Topsoil displacement ranged from approximately 0-20% of the unit areas. Unit soils are considerably rocky and while these soils are less prone to disturbance from compaction, they are vulnerable to impacts from loss of the forest floor and the organic matter component. Tables 20 and 21 below shows unit data results.

Table 20. Summary of Forest Soil Disturbance Monitoring Protocol results from May and June 2019 on the George Washington- Jefferson National Forest.

Unit	% DSD	% Forest Floor Impacted	Forest Floor Depth (cm)	% Live Plants	% Fine Woody	% Coarse Woody	% Bare Soil	% Rock	% Topsoil Displacement
White Pine #1	7	10	2.7	73	93	13	10	0	3
Round Mountain #2	10	20	1.7	63	87	10	13	43	3
Gilmore Hollow #1	9	13	2.6	63	97	16	16	13	0
Porters Mill #7	16	32	1.6	39	94	10	39	45	19
Sugar Run #3	13	20	2	77	93	23	20	20	13
Little Mountain #3	10	17	2.3	83	87	17	17	33	10
Beards Mountain #3	3	10	2.6	67	90	17	13	3	3

Table 11. Summary of Forest Soil Disturbance Monitoring Protocol results from May and June 2019 on the George Washington-Jefferson National Forest (continued).

Unit	% Erosion	% Rutting <5 cm	% Rutting 5-10 cm	% Rutting > 10 cm	% Compaction 0-10 cm	% Compaction 10-30 cm	% Compaction > 30 cm
White Pine #1	0	7	3	0	27	10	7
Round Mountain #2	10	3	3	0	20	0	0
Gilmore Hollow #1	3	6	0	0	19	6	0
Porters Mill #7	16	3	3	0	19	13	0
Sugar Run #3	0	3	0	0	13	0	0
Little Mountain #3	0	3	0	0	10	3	0
Beards Mountain #3	0	3	3	0	20	0	0

Soil & Water Improvement Projects

During the period pertaining to this monitoring report (Fiscal years 2015-2019) the GWJNF has implemented projects that have improved approximately 916 acres according to our annual Soil & Water improvement target reporting. Data is recorded in the Watershed Improvement Tracking (WIT) online database. This means that the goal of 600 acres of watershed improvement per decade has been attained. Priority is given to watersheds listed in Tables 20 and 21 and improvement needs in riparian areas, the Chesapeake Bay watershed, aquatic Threatened, Endangered and Sensitive (TES) species watersheds and where public safety is a concern. Typical soil improvement projects include restoring areas from OHV or dispersed recreation impacts along riparian areas, reinforcing road closures, and decommissioning roads.

Minerals / Geology

During the monitoring period mineral operations remained active, and thus, did not reach the stage where reclamation is appropriate.

Mineral material authorizations were processed in a timely manner. A FY 2019 Bureau of Land Reclamation) BLM request for reinstatement of an oil and gas lease was processed in a timely manner by the Forest Service in FY 2019; but changes in BLM process will result in additional processing time by Forest Service and BLM extending into FY21. A FY2019 BLM request for renewal of a hardrock lease for underground limestone mine is requiring more time and will extend into FY2021.

Transportation

National direction has been to only complete road condition surveys on a random sampling of roads that is generated through the INFRA database. The forest has been completing condition surveys according to this national direction.

The Travel Analysis Report for the GWJNF was signed on September 24, 2015 (https://www.fs.usda.gov/detail/gwj/landmanagement/?cid=fseprd537432). The report identifies potential candidates for decommissioning. Once candidates have been identified, the appropriate NEPA analysis will be performed in order to determine the greatest potential for mitigating resource damage and reducing road densities. The forest is considering on-going opportunities to decommission roads as part of larger landscape-scale restoration projects being proposed.

Carter Road was constructed on the Eastern Divide Ranger district as part of a timber sale between Fiscal Years 2015 – 2017 and included 1.5 miles of new road construction (operational maintenance level 2 - high clearance vehicles). Ethan Road included 1.75 miles of new road construction (ML 2 road) and was constructed on the North River Ranger District as part of a timber sale between FY 2015 – 2016.

Storm damage is an increasing impact on the forest throughout the years. The FHWA emergency response program for dealing with disaster impacts to federal lands is the Emergency Relief Federally Owned (ERFO) program. The forest has seen increasing frequencies of storm events that damage the transportation network, especially at road stream crossings. Where possible, the forest is pursuing repairs at these damage sites to both increase storm resilience (lower risk of overtopping) and improve aquatic habitat at these road-stream crossings. These efforts are offering opportunities to reduce sedimentation from roads (due to storm damage).

When more analysis has been accomplished, the forest will provide data showing road maintenance, reconstruction, and aquatic organism passage accomplishments from FY2015 – FY2021.

Major Forest Types, Timber Management and Successional Habitats

Table 22 displays the changes in succession stage by major forest community type on the JNF. The objective for total acres of Montane Spruce-Fir and Northern Hardwood Forest communities has been met and increased slightly since 2004. The amount of mid-late successional habitat has remained nearly constant slightly above the objective and the amount of late successional habitat has increased from about 2,500 acres to about 12,400 acres, now above the objective.

Table 22. Acres of successional state by Community Type

	2004					2014					2019				
Community Type	**Early successional**	**Sapling/ Pole**	**Mid-Successional**	**Late-Successional**	**Old**	**Early successional**	**Sapling/ Pole**	**Mid-Successional**	**Late-Successional**	**Old**	**Early Successional**	**Sapling/Pole**	**Mid-Successional**	**Late-Successional**	**Old**
Conifer-Northern Hardwood Forest(4)	1,252	8,777	5,791	5,182	343	321	5,963	6,913	7,553	706	353	41	12,041	8,519	657
Northern Hardwood Forest(1)	0	1,125	11,651	1,841	2,230	-	95	3,152	10,878	2,892	1,379	0	2,345	13,663	1,008
Mixed Mesophytic Forest(3)	2,446	12,894	37,323	27,810	3,516	592	7,356	20,839	53,337	1,446	552	493	22,069	58,143	1,909
Eastern Riverfront and River Floodplain Hardwood Forests(9)	0	12	242	37	27	-	-	199	92	27	0	0	253	64	0
Dry-Mesic Oak Forest(5)	2,962	23,155	115,260	120,494	7,270	1,636	14,725	45,441	183,681	22,780	1,514	1,150	43,036	206,524	14,897

Dry and Dry-Mesic Oak-Pine Forest(6)	1,036	6,699	53,653	77,377	7,898	145	4,943	10,448	114,447	14,584	154	131	10,665	130,904	3,000
Dry and Xeric Oak Forest, Woodland, and Savanna(7)	645	4,397	40,733	37,700	36,852	263	3,715	9,906	60,555	45,873	328	305	8,596	99,247	12,797
Xeric Pine and Pine-Oak Forest and Woodland(8)	31	205	3,040	33,415	4,823	-	30	1,698	27,823	12,200	3	0	3,384	37,233	1,105
Montane Spruce-Fir Forest(2)	0	9	3,214	638	273	-	9	2,408	1,522	534	0	0	285	4,074	114

Timber harvest has not affected the objectives for the Xeric Pine and Pine-Oak Forest and Woodland community. The Mixed Mesophytic Forest communities have decreased very slightly but remain near the objective level. The mid to late successional acres have increased and exceed the objective. The late successional component has increased from 28,000 acres to 53,000 acres and now also exceeds the objective.

Three American chestnut research plantings have been established on the JNF in cooperation with researchers from the Forest Service Southern Research Station (SRS) and The American Chestnut Foundation. This activity exceeds JNF Plan Objective 12.04 to establish one planting. It is hoped that these research plantings will further eventual restoration efforts on the JNF.

The acres of the Xeric Pine and Pine-Oak Forest and Woodlands has only increased slightly and meets JNF Plan Objective 12.02 to maintain 41,500 acres in this type. Approximately 2,000 acres of open woodland-grassland complexes have been restored, including 200 acres of table mountain pine forests.

We are maintaining composition of forest ecosystems within desired ranges of variability as reflected by changes, or the lack thereof, the abundance and distribution of major forest communities across the landscape.

The acres of Dry-Mesic Oak, Dry and Dry-Mesic Oak-Pine, Dry and Xeric Oak Forest communities on the JNF managed by timber harvest has increased from 250 to over 900 acres (Table 23). A total of over 6,000 acres have been managed through commercial harvest on the JNF in these community types. The amount managed by prescribed burning, and wildland fire has been slightly less than 60,000 acres. Therefore, a total of 66,000 acres in the Dry-Mesic Oak, Dry and Dry-Mesic Oak-Pine, Dry and Xeric Oak Forest communities has been maintained through a combination of timber harvest and prescribed fire, exceeding the 28,000 acre goal described in JNF Plan Objective. 12.05.

Table 23. Timber Sold by Method of Cut by Forest Community Type

Community Type	2004							2014							2019						
	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total
Northern Hardwood Forest(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montane Spruce-Fir Forest(2)	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Mesophytic Forest(3)	0	24	0	34	0	0	58	0	15	0	0	0	0	15	0	25	0	0	0	0	25
Conifer-Northern Hardwood Forest(4)	0	34	0	0	0	0	34	72	0	0	69	0	0	141	60	25	0	70	0	0	155
Dry-Mesic Oak Forest(5)	0	28	0	166	58	0	252	0	346	0	80	0	0	426	398	492	20	115	0	0	1,025

Community Type	2004							2014							2019						
	Clearcut	**Shelterwood**	**Selection**	**Thinning**	**Salvage**	**Other**	**Total**	**Clearcut**	**Shelterwood**	**Selection**	**Thinning**	**Salvage**	**Other**	**Total**	**Clearcut**	**Shelterwood**	**Selection**	**Thinning**	**Salvage**	**Other**	**Total**
Dry and Dry-Mesic Oak-Pine Forest(6)	0	0	0	0	0	0	0	0	16	0	9	0	0	25	127	0	0	4	0	0	131
Dry and Xeric Oak Forest, Woodland, and Savanna(7)	0	0	0	0	0	0	0	0	263	0	197	0	0	460	568	44	0	32	0	0	644
Xeric Pine and Pine-Oak Forest and Woodland(8)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	4
Eastern Riverfront and River Floodplain Hardwood Forests(9)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 24 displays the annual acres of timber cut by method of cut by forest.

Table 24. Annual Cut Acres by Method of Cut by Forest

	Fiscal Year	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total
GWNF	2004	0	625	0	111	44	0	780
	2005	0	862	29	104	81	100	1,176
	2006	25	459	36	247	50	7	824
	2007	22	364	6	340	0	0	732
	2008	9	556	0	46	0	0	611
	2009	70	314	0	345	74	0	803
	2010	97	389	0	49	71	0	606
	2011	10	542	0	143	0	0	695
	2012	16	251	0	0	69	0	336
	2013	0	335	0	267	0	0	602
	2014	0	368	0	0	0	0	368
	2015	0	785	0	120	0	0	905
	2016	25	348	0	12	0	0	385
	2017	47	592	0	207	0	0	846
	2018	85	436	0	207	0	0	728
	2019	63	301	0	474	0	0	838
JNF	2004	0	127	0	111	6	0	244
	2005	40	153	0	214	0	0	407
	2006	11	41	3	61	42	14	172

	Fiscal Year	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total
	2007	36	145	2	264	33	0	480
	2008	152	121	60	212	10	0	555
	2009	90	107	33	115	16	0	361
	2010	28	128	0	202	93	0	451
	2011	124	131	0	142	114	0	511
	2012	70	96	0	62	5	0	233
	2013	79	128	0	0	1	0	208
	2014	30	25	13	119	12	0	199
	2015	0	101	9	95	3	0	208
	2016	0	150	92	120	0	0	362
	2017	0	193	74	71	0	0	338
	2018	0	114	0	57	0	25	196
	2019	43	38	0	0	0	0	81
Combined GWJNFs	2004	0	752	0	222	50	0	1,024
	2005	40	1015	29	318	81	100	1,583
	2006	36	500	39	308	92	21	996
	2007	58	509	8	604	33	0	1,212
	2008	161	677	60	258	10	0	1,166
	2009	160	421	33	460	90	0	1,164
	2010	125	517	0	251	164	0	1,057

	Fiscal Year	Clearcut	Shelterwood	Selection	Thinning	Salvage	Other	Total
	2011	134	673	0	285	114	0	1,206
	2012	86	347	0	62	74	0	569
	2013	79	463	0	267	1	0	810
	2014	30	393	13	119	12	0	567
	2015	0	886	9	215	3	0	1,113
	2016	25	498	92	132	0	0	747
	2017	47	785	74	278	0	0	1,184
	2018	85	550	0	264	0	25	924
	2019	106	339	0	474	0	0	919

Trends in age class distribution (Table 25, below) are similar on both Forests. Young stands (0-10 years old) have decreased from around 4% in 1989 to less than 1% in 2019. Meanwhile, the percentage of the forest older than 70 years old has increased from about 60% to 80%. Age class distribution on the forest's continues to be skewed to older age classes and the pace of regenerating forested stands has not kept up with the aging forest.

Table 25. Age Class Distribution for All Forested Land 1989, 2007, 2014, and 2019

	Age	1989	%	2007	%	2014	%	2019	%
JNF	0-10	26,269	3.9%	2,146	0.3%	2,932	0.4%	294	0.0%
	11-20	25,682	3.8%	12,322	1.7%	3,659	0.5%	1,661	0.2%
	21-30	13,122	1.9%	17,253	2.4%	17,650	2.5%	10,257	1.2%
	31-40	6,967	1%	26,349	3.7%	16,227	2.3%	19,577	2.4%
	41-50	29,840	4.4%	10,622	1.5%	23,561	3.4%	22,277	2.7%

	Age	1989	%	2007	%	2014	%	2019	%
	51-60	121,277	17.9%	8,352	1.2%	9,632	1.4%	15,901	1.9%
	61-70	173,584	25.6%	39,544	5.5%	12,305	1.8%	8,087	1.0%
	71-80	115,851	17.1%	148,865	20.8%	57,753	8.2%	26,482	3.2%
	81-90	55,392	8.3%	176,672	24.7%	157,205	22.4%	114,584	13.8%
	91-100	29,911	4.4%	115,216	16.1%	163,525	23.3%	276,981	33.4%
	101-110	43,927	6.5%	51,595	7.2%	92,416	13.2%	155,146	18.7%
	111-120	17,835	2.6%	26,551	3.7%	45,069	6.4%	61,886	7.5%
	121-130	9,499	1.4%	48,507	6.8%	33,418	4.8%	27,912	3.4%
	131-140	4,860	0.7%	17,983	2.5%	38,421	5.5%	47,667	5.7%
	141-150+	3,149	0.5%	14,726	2.1%	27,069	3.9%	40,606	4.9%
	Total	**677,165**	**100%**	**716,703**	**100%**	**700,842**	**100.0%**	**830,093**	**100.0%**
GWNF	0-10	44,367	4.3%	7,576	0.7%	7,793	0.7%	969	0.1%
	11-20	32,524	3.1%	27,124	2.6%	14,323	1.4%	7,678	0.8%
	21-30	22,987	2.2%	26,705	2.6%	29,142	2.8%	22,132	2.2%
	31-40	3,309	0.3%	40,328	3.9%	26,641	2.6%	28,915	2.9%
	41-50	5,490	0.5%	11,503	1.1%	40,304	3.9%	30,704	3.1%
	51-60	31,822	3.1%	3,681	0.4%	6,255	0.6%	20,270	2.0%
	61-70	101,660	9.8%	8,332	0.8%	3,989	0.4%	3,120	0.3%
	71-80	214,257	20.7%	44,620	4.3%	13,000	1.2%	5,398	0.5%
	81-90	218,002	21.1%	133,311	12.8%	55,084	5.3%	27,350	2.8%
	91-100	115,456	11.2%	228,543	21.9%	156,022	15.0%	93,172	9.4%

	Age	1989	%	2007	%	2014	%	2019	%
	101-110	79,291	7.7%	203,317	19.5%	226,638	21.8%	203,013	20.5%
	111-120	63,294	6.1%	90,055	8.6%	181,114	17.4%	217,924	22.0%
	121-130	33,702	3.3%	75,189	7.2%	78,875	7.6%	107,290	10.8%
	131-140	26,012	2.5%	55,786	5.3%	72,018	6.9%	71,786	7.2%
	141-150+	42,546	4.1%	88,445	8.5%	129,095	12.4%	152,552	15.4%
	Total	**1,034,719**	**100%**	**1,044,515**	**100%**	**1,040,293**	**100.0%**	**992,281**	**100.0%**
Combined GWJNFs	0-10	70,636	4.1%	9,722	0.6%	10,725	0.6%	1,263	0.1%
	11-20	58,206	3.4%	39,446	2.2%	17,982	1.0%	9,339	0.5%
	21-30	36,109	2.1%	43,958	2.5%	46,792	2.7%	32,389	1.8%
	31-40	10,276	0.6%	66,677	3.8%	42,868	2.5%	48,492	2.7%
	41-50	35,330	2.1%	22,125	1.3%	63,865	3.7%	52,981	2.9%
	51-60	153,099	8.9%	12,033	0.7%	15,887	0.9%	36,171	2.0%
	61-70	275,244	16.1%	47,876	2.7%	16,294	0.9%	11,207	0.6%
	71-80	330,108	19.3%	193,485	11%	70,753	4.1%	31,880	1.7%
	81-90	273,394	16%	309,983	17.6%	212,289	12.2%	141,934	7.8%
	91-100	145,367	8.5%	343,759	19.5%	319,547	18.4%	370,153	20.3%
	101-110	123,218	7.2%	254,912	14.5%	319,054	18.3%	358,159	19.7%
	111-120	81,129	4.7%	116,606	6.6%	226,183	13.0%	279,810	15.4%
	121-130	43,201	2.5%	123,696	7%	112,293	6.4%	135,202	7.4%
	131-140	30,872	1.8%	73,769	4.2%	110,439	6.3%	119,453	6.6%
	141-150+	45,695	2.7%	103,171	5.9%	156,164	9.0%	193,158	10.6%

	Age	1989	%	2007	%	2014	%	2019	%
	Total	**1,711,884**	**100%**	**1,761,218**	**100%**	**1,741,135**	**100.0%**	**1,822,374**	**100.0%**

Successional Habitats

On the JNF, only 70 acres (<1%) are in early successional habitat in Management Area 7E2 (MA 7E2), down from 2014 and well short of the objective of 4%. Over 66,177 acres are in late successional habitat in MA 7E2, exceeding the objective of 60% by 33%.

Only 401 acres on the JNF, less than one percent, are in early successional habitat in Management Area 8A1 (MA 8A1), well short of the objective of 4%. Over 68,317 acres are in late successional habitat in 8A1 exceeding the objective of 20% by 21%.

The acres of early successional habitat in Management Area 8B have declined from 4 to well below 1 percent. The late successional component is well above the objective of 5% by approximately 66%

Early successional habitat in Management Area 8C is below the objective and has maintained at 2 percent. Late successional habitat has decreased from 67% to 51% percent, failing to meet the objective for that habitat and management prescription by 11%.

Early successional habitat in Management Area 8E1 is well below the objective with 19 acres in this habitat condition. Late successional habitat has increased from 56% to 84% percent, exceeding the objective for that habitat and management prescription by 74%.

On the GWNF an annual average of 508 acres of early successional habitat was created as a result of regeneration harvests, a far departure from Forest Plan objective ESD-1 that outlines the need to create approximately 18,000 – 30,000 acres of forest age class 0-10 by the end of the first decade of the plan implementation (2024).

It is apparent from comparing the current habitat to the objectives in the Forest Plan that we are not providing early successional habitat in the desired amounts. Meanwhile, late successional habitat is more than plentiful when compared to the Forest Plan objectives. Key successional stages may not be provided.

Table 26. JNF Succession by Management Area - acres

Management Rx Description		Total Acres	Early successional			Sapling/ Pole			Mid-Successional			Late-Successional			Old		
			2004	2014	2019	2004	2014	2019	2004	2014	2019	2004	2014	2019	2004	2014	2019
7E17E2	Dispersed Recreation Areas	71,400	542	263	70	6,742	4,411	80	22,327	11,425	15,509	35,050	44,583	66,177	6,739	8,467	1,586
8A1	Mix of Successional Habitats	112,704		674	401		9,672	542		20,152	14,356		71,424	68,317		8,731	1,902
8B	Early Successional Habitats	19,600	874	227	64	3,847	3,011	508	6,057	1,965	4,803	8,567	13,960	13,956	255	423	409
8C	Remote Habitats for Wildlife	57,300	196	1,145	754	5,805	3,719	176	19,356	8,066	6,605	28,824	38,481	29,359	3,119	5,573	1,957
8E1	Ruffed Grouse Habitats	16,000	150	165	19	2,832	1,814	139	6,491	3,869	4,269	5,798	9,035	13,427	729	990	1,145
8E6	Old Field Habitats	13,000	0	0	0	131	29	0	459	175	102	689	524	115	21	57	23

Table 27. JNF Succession objectives, by Management Area

Management Rx Description		Total Acres	Early successional				Mid-Successional				Late-Successional			
			2004	2014	2019	Objective	2004	2014	2019	Objective	2004	2014	2019	Objective
7E1, 7E2	Dispersed Recreation Areas	71,400	1%	0%	**0%**	**4%**	31%	16%	**22%**	**60%**	49%	62%	**93%**	**60%**
8A1	Mix of Successional Habitats	112,704	0%	1%	**1%**	**4%**	0%	18%	**13%**	**60%**	0%	63%	**61%**	**20%**
8B	Early Successional Habitats	19,600	4%	1%	**3%**	**10%**	31%	10%	**25%**		44%	71%	**71%**	**5%**
8C	Remote Habitats for Wildlife	57,300	0%	2%	**2%**	**4%**	34%	14%	**12%**	**60%**	50%	67%	**51%**	**60%**
8E1	Ruffed Grouse Habitats	16,000	1%	1%	**1%**	**10%**	41%	24%	**27%**		36%	56%	**84%**	**10%**
8E6	Old Field Habitats	13,000	0%	0%	**0%**	**10%**	4%	1%	**1%**		5%	4%	**1%**	

Table 28. Timber management on the George Washington National Forest

Fiscal Yr.	Clearcut	Shelterwood	Thinning	Salvage	TOTAL	Timber Stand Improvement
	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)
2014	0	368	0	0	**368**	**1,627**
2015	0	785	120	0	**905**	**1,052**
2016	25	348	12	0	**385**	
2017	47	592	207	0	**846**	
2018	85	436	207	0	**728**	
2019	63	301	474	0	**838**	

Table 29. JNF Acres of Timber Sold Within Plan Management Prescriptions

Management Rx Description		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
7B	Scenic Corridors				17								0	0	66	0	0
7E2	Dispersed Recreation Areas - Suitable					143	33	67	43	15	45	151	0	0	102	0	0
8A1	Mix of Successional Habitats	172	68	90	50	41	47	106	69	49	33	0	0	0	16	110	754
8B	Early Successional Habitat Emphasis	53	109		93			30		17		36	0	0	0	0	0
8C	Black Bear Habitat Management					172	104	93	218	70	103	0	0	0	187	0	65
8E1	Ruffed Grouse/Woodcock Habitat Emphasis		230	40	60	95	19	125	0	0	0	0	0	0	0	313	91
8E2b	Peaks of Otter Salamander Secondary Habitat Conservation Area			24	33		53				26	0	0	0	0	0	0
8E4b	Indiana Bat Hibernacula Protection Areas - Secondary			18	0	0	0	0	0	0	0	0	0	0	0	0	0
9A1	Source Water Protection Area	19			136	94	105	30	33	0	0	0	0	0	70	0	0
9A2	Reference Watershed				53				71	0	0	0	0	0	0	0	0
9A3	Watershed Restoration Area				38	0	0	0	0	0	0	0	0	0	0	0	0

9H	Management, Maintenance and Restoration of Forest Communities									59	0	0	0	0	0	0	0
10B	High Quality Forest Products					10			77	23	1	12	0	194	0	0	0
	Totals	**244**	**407**	**172**	**480**	**555**	**361**	**451**	**511**	**233**	**208**	**199**	**0**	**194**	**441**	**423**	**910**

Plan Implementation Efficiency and Effectiveness and Research

See the sections on Water Quality and Soils for information on monitoring the implementation of site-specific projects.

Changes are needed for the Jefferson Forest Plan to consider The Omnibus Public Land Management Act of 2009 congressional designations, mapping errors, and allocations of new land acquisitions to management prescriptions. Additionally as outlined in the TES section above, changes to the Forest plan should occur to accommodate the land allocation changes needed for spirea.

Two of the most important aspects of implementing the Forest Plans are monitoring and evaluation because they provide information to determine whether programs and projects are meeting forest plan direction and whether plans should be revised. Monitoring of project actions (i.e. implementation monitoring) also occurs to ensure that various aspects of the project adhere to the standards of the Forest Plans, the applicable State Best Management Practices and project-specific mitigation measures.

Due to attrition and hiring freezes that have occurred between 2015 and 2019 Forest capacity across all resource areas suffered. Largely vacancies have been filled and it is recommended that annual quality assurance checks of NEPA project implementation be completed by the Supervisor's Office resource staff areas as a consolidated team (this is specifically in regards to the Jefferson Forest Plan task 71 and the George Washington Forest Plan task 50 that was deferred from this report at this time).

Recommended Changes

Rare Communities and Caves

No changes recommended at this time.

Fire

Fire effects monitoring has proven invaluable in providing a feedback loop to improve the prescribe burn program while also informing how prescribed fire is meeting the desired conditions of the Forest Plan. The monitoring program has been a tremendous partnership success. It is recommended that this monitoring program continue to be supported.

Visuals

No changes recommended at this time.

Heritage

No changes recommended at this time.

Soils

Soils disturbance monitoring has proven helpful in informing project layout and the understanding of vegetation management activities to the soil resource. It is recommended that this monitoring continue.

Minerals / Geology

Forest should seek ways to work collaboratively and efficiently to process pending oils and gas leases as requested by the BLM.

Transportation

Project specific roads analysis should continue and road decommission opportunities should be sought. Additionally, capacity dependent, the Forest may facilitate a process for Districts to review and update Road Management Objectives in the data of record in fiscal year 2021.

Major Forest Types / Successional Habitats

The implementation of regeneration harvests and thinning of late open successional stage classes is not meeting the desired conditions of both the Jefferson and George Washington Forest Plans. Early successional habitat conditions across both Forests are even more departed from the desired conditions that were documented in the 2014 Monitoring and Evolution Report. Late open conditions as a result of thinning and prescribe fire are not meeting Forest Plan goals.

Plan Implementation

Consider the needed Forest Plan changes in regards to the Omnibus Public Land Management Act of 2009 congressional designations, mapping errors, and allocations of new land acquisitions to management prescriptions.

Reinitiate annual quality assurance reviews of NEPA document and associated implementation of projects.

Continue implementation monitoring.

8.Effects of Each Management System to Determine That They do not Impair Land Productivity

Summary

This includes portions of the timber section from the previous 2014 Monitoring and Evaluation report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

17. Are silvicultural requirements of the Forest Plan being met?

Jefferson Forest Plan Tasks Pertinent to this Section

67. Are lands being adequately restocked within 5 years of regeneration treatments? [36 CFR 219.27(c)(3)]. Routine regeneration examinations following standard protocols.

69. Are harvest unit sizes within the allowable limits? [36 CFR 219.12(k)5 (iii)] Should maximum harvest unit size limits be continued? [36 CFR 219.27(d)] Annual field inspection of selected site- specific projects. Document needs for change in annual Monitoring and Evaluation Report if appropriate.

George Washington Forest Plan Questions Pertinent to this Section

3. How are management actions maintaining or making progress toward DC for the key characteristics of vegetation in the plan area?

15. Are management systems implemented in a manner to assure they do not substantially and permanently impair the productivity of the land?

George Washington Forest Plan Tasks Pertinent to this Section

46. Are lands being adequately restocked within 5 years of regeneration treatments? [36 CFR 219.27(c)(3)]. Routine regeneration examinations following standard protocols.

48. Are harvest unit sizes within the allowable limits? [36 CFR 219.12(k)5 (iii)] Should maximum harvest unit size limits be continued? [36 CFR 219.27(d)] Annual field inspection of selected site- specific projects. Document needs for change in annual Monitoring and Evaluation Report if appropriate.

Key Results

The vast majority of Forest lands are adequately regenerated within 5 years. The few areas where regeneration is found to be lacking during the third year certifications are evaluated for remedial treatments and those treatments are implemented where feasible. Modified shelterwood harvest (a.k.a. shelterwood with reserves) do continue to retain a significant oak component primarily through coppice regeneration. However it appears that in most situations the overall percentage of oak as compared to the original stand has decreased slightly. More so on the extremely productive sites. Very few pine dominated forest types were regenerated by commercial timber harvest. Regular commercial harvests continue to occur only on lands suitable for timber production. In rare cases (e.g. salvage or sanitation) commercial harvesting has been used on unsuitable lands in and around recreation sites to remove dead or hazard trees.

No changes in lands suitable for timber production have occurred on the GWNF. Lands suitable for timber production were reduced on the JNF by approximately 5,000 acres due to Congressional designation of Wilderness. The total acres of lands suitable on the JNF is now approximately 254,000 acres. The average size of regeneration openings is 20 acres, indicating that size of openings are driven by wildlife habitat needs. Only 7% of the regenerated openings approached 40 acres in size.

Recommended Changes

It was recommended that opportunities be sought for after action review with timber sale administration staff and resources specialists upon the closure of timber sales to convey lessons learned for future NEPA documents analysis and project development.

9.Social, Economic, and Cultural Sustainability

Summary

This includes portions of the timber sections and special uses and from the previous 2014 Monitoring and Evaluation report.

Monitoring Questions and Indicators

Jefferson Forest Plan Questions Pertinent to this Section

16. How do actual outputs and services compare with projected?

20. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

Jefferson Forest Plan Tasks Pertinent to this Section

60. Are forest products being produced within predicted ranges? [36 CFR 219.27 (c)(2)]. Sales Tracking and Reporting System

66. How do estimated and actual costs of plan implementation compare? [36 CFR 219.12(k)3] . Review of projected forest plan costs compared to actual costs and annual budgets.

George Washington Forest Plan Questions Pertinent to this Section

18. How do people involved in the adaptive planning process interpret settings and opportunities provided by the NFS unit compared with Desired Conditions? Do they think there is a need for change?

19. What are the status and trends of goods and services provided from the unit with regards to progress towards desired conditions?

20. How do these goods and services contribute to key opportunities for sustaining economic systems relevant to the plan area?

26. What changes are occurring in the social, cultural, and economic conditions in the areas influenced by national forests in the region?

George Washington Forest Plan Tasks Pertinent to this Section

40. Are forest products being produced within predicted ranges? [36 CFR 219.27 (c)(2)]. Sales Tracking and Reporting System

Key Results

Timber

Table 30 below displays the trend of timber volume offered, sold, and cut over the past decade. On the GWNF, the volume offered trended downward in the middle of the decade but has rebounded to be slightly more than the offer in 2004. The total 10-year volume sold is 124 MMBF (thousand thousand board feet = million board feet) for the decade, approximately 38% of the Allowable Sale Quantity (ASQ) computed under the GWNF Plan.

On the GWJNF (numbers combined) have steadily increased in the amount of timber volume offered and timber volume sold. Fuelwood sales has stayed relatively constant around 3 MMBF sold each year. Market conditions in recent years have impacted the ability to receive offerings on sale bids for timber sales. In fiscal year 2017 there were 2 no bids, in fiscal year 2018 there were 3 and in fiscal year 2019 there were 3 and this increased to 5 in fiscal year 2020.

Table 30. Timber Volume Offered, Sold, and Harvested, in MMBF (million board feet)

Fiscal Year	Volume Offered			Volume Sold			Volume Harvested			Volume fuelwood Sold		
	GWNF	JNF	Total	GWNF	JNF	Total	GWNF	JNF	Total	GWNF	JNF	Total
2004	14.7	8.2	22.9	12.4	6.1	18.5	17.4	4.1	21.5	2.3	1	3.3
2005	11.2	6.5	17.7	10.4	6.5	16.9	15.6	5.8	21.4	2.3	1	3.3
2006	12.8	13.3	26.1	11.6	12	23.6	11.7	4	15.7	3.2	1	4.2
2007	12.2	10.5	22.7	8.2	7.3	15.5	10.8	9	19.8	2.1	1.2	3.3
2008	11.2	4.9	16.1	11.2	6.2	17.4	*	*	21.3	2.3	1	3.3
2009	7.7	7.6	15.3	7.7	7.3	15	11.2	6	17.2	2.8	1.8	4.6
2010	11.8	3.3	15.1	12.1	6.1	18.2	9.2	10	19.2	2.9	1.9	4.8
2011	11.8	3.4	15.2	11.8	3.7	15.5	10.5	8.5	19	2.7	2.2	4.9
2012	13.2	7.8	21	13.2	4.5	17.7	7.6	4.2	11.8	2.6	1.4	4
2013	12.5	7.3	19.8	11.5	6	17.5	8.7	4.5	13.2	1.5	1.4	2.9
2014	13.7	4.8	18.5	13.7	6	19.7	9.1	3.75	12.85	2.6	1.3	3.9
2015			13.3			4.8						4.2
2016			23.6			18.2						3.3
2017			25.4			18.2						2.8

Fiscal Year	Volume Offered			Volume Sold			Volume Harvested			Volume fuelwood Sold		
	GWNF	JNF	Total	GWNF	JNF	Total	GWNF	JNF	Total	GWNF	JNF	Total
2018			22.8			15.7						2.7
2019			28.1			22.2						3.1

* Reporting method changed and reported only by administrative forest, not proclaimed forest.

Special Uses

The Special Uses Data system (SUDS) is the system of record for recording special use applications and authorizations. The metric used to query the database was "applications accepted" on or after 10/1/2014 and "authorizations issued" on or prior to 9/30/2019. The output is the number of applications processed with a subsequent authorization issued within the timeframe specified for the Jefferson National Forest (Eastern Divide, Clinch, Glenwood and Pedlar Ranger Districts and the Mount Rogers National Recreation Area) and the George Washington National Forest (James River and Warm Springs, North River and Lee Ranger Districts). _. From this data, it can be averaged how much output occurred annually and how long, on average, the output took to accomplish. 164 applications on the Jefferson and 148 applications were processed on the George Washington over a period of 5 years, which equates to approximately 33 and 30 (respectively) applications annually. The Forest can then extrapolate the average number of work days associated with each application which equates to roughly 11-12 work days per application.

Currently, the only bar to measure timeliness is found at 36 CFR 251.58(c)(7), which states "The Forest Service shall endeavor to make a decision on an application that falls into minor processing category 1, 2, 3, or 4, and that is subject to a categorical exclusion pursuant to the National Environmental Policy Act, within 60 calendar days from the date of receipt of the processing fee. If the application cannot be processed within the 60-day period, then prior to the 30th calendar day of the 60-day period, the authorized officer shall notify the applicant in writing of the reason why the application cannot be processed within the 60-day period and shall provide the applicant with a projected date when the agency plans to complete processing the application. For all other applications, including all applications that require an environmental assessment or an environmental impact statement, the authorized officer shall, within 60 calendar days of acceptance of the application, notify the applicant in writing of the anticipated steps that will be needed to process the application. These customer service standards do not apply to applications that are subject to a waiver of or exempt from cost recovery fees under §§251.58(f) or (g)." There is insufficient SUDS data to measure how many calendar days for each of the 164 and 148 applications were processed as CE's within a 60 day period, nor can we asses the timeliness of major CE's, EA's, or EIS's as that is not subject to a regulatory bar and is often applicant driven. Anecdotally, general observation on this question demonstrate that the Forest is processing applications in a timely manner when there is adequate special uses staff and NEPA support. When leadership prioritizes special uses work as a high priority within the NEPA program of work and there is adequate special uses personnel to assist with processing, then meeting regulatory or other proponent driven timelines generally is not problematic, barring any unforeseen circumstances with the project design or anticipated resource impacts. When there is insufficient special uses staff or NEPA prioritization, then the Forest generally does not meet regulatory or proponent driven timelines. Between 2014-2019, there was inadequate special uses staffing and NEPA prioritization to meet most regulatory or proponent driven timelines due to hiring freezes and reduction to special use staffing levels due to attrition. The Forest has, however, invested resources during this time period in Enterprise Team support and programmatic CE decisions to expedite high priority and simple administrative application processing tasks (such as reissuing expired permits, permit transfers, and other purely administrative changes to authorizations).

Recommended Changes

Timber

Coordinate efforts to align timber offerings with market conditions.

Special Uses

No recommended changes to the special use program.

Public Engagement Opportunities

The Forest looks forward to continued collaboration with interested and affected stakeholders. In 2016 the first successful, collaborative, large landscape project (Lower Cowpasture) under the new 2014 George Washington Forest Plan was signed and implementation began in 2017. In 2020 the large landscape North Shenandoah Mountain Restoration and Management Project planning was completed and implementation is underway. This project was selected for a Joint Chiefs funding opportunity which was funded based on the public and partnership support of the project. During it's development, the project provided robust public collaboration efforts with multiple public meeting and various working groups that helped to create the project.

The Nettle Patch Vegetation Project objection resolution project resulted in a vigorous collaborative effort that has resulted in a developed framework for public engagement through the project implementation phase.

It is standard practice to provide our stakeholders multiple opportunities to engage throughout project development including public meetings, scoping and the ability to read and provide comments on Environmental Assessments prior to draft Decisions.

Moving into 2020 and 2021 the Forest intends to hold various virtual workshops to engage public stakeholders are developing projects. Scoping and public involvement is critical to successful project and program development. The Forest intends to scope all projects including smaller categorical exclusions to ensure analysis is issue focused and decisions are made after project issues have been addressed.

Additional information is available at the following links:

Monitoring plan: https://www.fs.usda.gov/detail/gwj/landmanagement/?cid=stelprd3834544

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 102

February 21, 2023

George Washington-Jefferson National Forest

2019 Soil Disturbance Monitoring Report

Prepared by:
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for:

Supervisors Office
George Washington-Jefferson National Forest
June, 2020

Introduction

The George Washington-Jefferson National Forest in Virginia and West Virginia contracted with the Forest Service Enterprise Program to conduct soil disturbance monitoring in a suite of timber sales that were closed in 2018. Monitoring was conducted using the Forest Soil Disturbance Monitoring Protocol, which is in two volumes (Page-Dumroese et al 2009a and 2009b). The report herein summarizes results of soil disturbance data that was collected and other field observations.

Methodology

In May and June 2019 seven timber sale units on the George Washington-Jefferson National Forest were monitored for detrimental soil disturbance post-harvest. The sampling protocol used was the Soil Disturbance Field Guide (Page-Dumroese et al 2009). This soil-effects protocol is designed to conform to Regional standards which, in turn, are designed to comply with the National Forest Management Act and Soil Quality Standards (SQS) in the Forest Plan for the George Washington-Jefferson National Forest. The methodology allows for measuring data consistently and efficiently, and provides estimates of overall soil disturbance within timber harvest units. Soil disturbance classes were determined from a gridded sample distributed throughout the harvest units. Disturbance in classes 2 or 3 were considered detrimental in the analysis except where evidence suggested only short-term disturbance with robust recovery. Shallow soil pits were excavated and examined for structure, texture, rupture resistance, rooting depth, rooting abundance and horizon thickness at gridded sample locations throughout the units. Observations were also made on the presence of non-native species.

The George Washington-Jefferson National Forest provided timber sale area maps and GIS shapefiles of the sale units. Each of the seven surveyed units had data collected from at least 30 pits (Page-Dumroese et al 2009a) distributed evenly throughout the unit. Gridded sample points were developed in ArcMap and maps of unit boundaries and gridded sample points were viewed in the Avenza Maps smartphone application (https://www.avenza.com/avenza-maps/) while traversing units and collecting data (Figure 1).

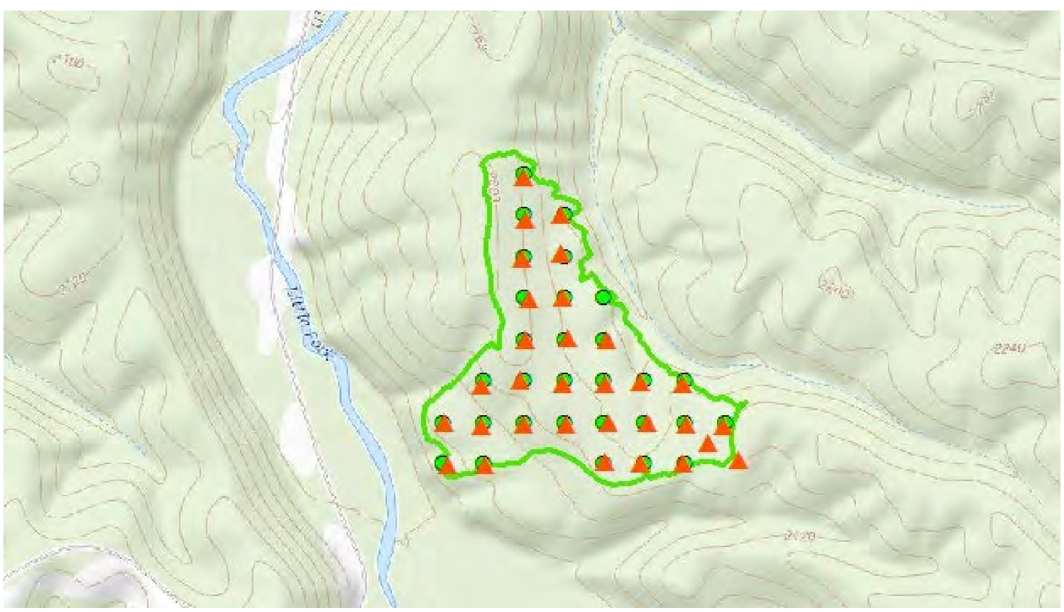

Figure 1 Map of Sugar Run Unit #3 showing GIS gridded sample points (dots) and field sample locations (triangles). Map scale approximately 1:10,000.

Data for the following attributes were collected at each sample pit:

- Forest floor depth (cm)
- Forest floor impacted (yes or no)
- Live plants (yes or no)
- Presence of fine woody debris (<7cm) (yes or no)
- Presence of coarse wood debris (> 7cm) (yes or no)
- Presence of bare soil (yes or no)
- Presence of rock (yes or no)
- Presence of topsoil displacement (yes or no)
- Presence of erosion (yes or no and comments)
- Presence of bare rock or soil (yes or no)
- Rutting (<5cm, 5 – 10 cm, or > 10 cm) (yes or no)
- Burning light, moderate or severe (yes or no)
- Compaction (0 – 10 cm, 10 – 30 cm, or > 30 cm) (yes or no)
- Platy/Massive/Puddled structure (0 – 10 cm, 10 – 30 cm, or > 30cm) (yes or no)

Forest soil disturbance class is defined as level 0, 1, 2, or 3 as follows:

- Class 0: No evidence of compaction, depressions, tracks or ruts. Forest layers intact and present. Displacement not evident and no management generated erosion. Litter and duff not burned.
- Class 1: Any depressions < 5 cm deep, forest layers present and intact, no soil displacement and minimal mixing, burning light, compaction just greater than natural conditions and at depths of 0 – 10 cm. May see massive or platy structure at 0 – 10 cm, rooting still present and erosion is slight.
- Class 2: Wheel tracks or depressions 5 – 10 cm deep, increased compaction from 10 – 30 cm is present, platy structure generally continuous, erosion moderate.
- Class 3: Wheel tracks and depressions greater than 10 cm in depth, compaction present at depths greater than 30 cm, massive or platy structure present at depths greater than 30 cm and continuous, erosion is severe and gullies or rills present.

At each pit the 24 total attributes were rated and entered in to a field data form. Photographs were taken while traversing the units. Following field evaluation, data were entered in an excel spreadsheet for each unit. Data sheets, field notes and photographs can be found in the project file.

Unit Summaries

The following is a narrative summary of the soil pit data from surveyed timber harvest units. Tables 1 and 2 following the narrative summaries section display the data in tabular form.

White Pine Unit #1, Clinch Ranger District

Surveyed 5/30 and 5/31/19

Figure 2 View across a portion of White Pine Unit #1 to a system road and log landing.

Soils in White Pine Unit #1 are derived from residuum weathered from sandstone and/or quartzite and generally have high coarse fragments throughout the soil profile with a loamy-skeletal soil texture. The northern half of the unit is classified as Dekalb cobbly sandy loam with 15 – 35% slopes (soil map unit: 46D) and the southern portion of the unit is classified as Lily gravelly sandy loam with 3 – 15% slopes (soil map unit: 75C).

Overall Detrimental Soil Disturbance

Sample results indicated that some localized disturbance to soil properties occurred within the unit typically associated with skid trails, roads, and landings. However, only 7% of the sample points rated in disturbance class 3 having undergone detrimental soil disturbance. This is partly due to the high coarse fragments and shallow soils present in this unit. Soils with greater than 35% coarse fragments are resistant to compaction. The forest floor depth averaged 2.7 cm and the forest floor was disturbed in approximately

10% of the unit. The unit has 10% bare soil exposed leaving 90% of the unit with good cover. *Rosa multiflora* and *Microstegium vimineum* were present at 2 of 30 soil pits.

Round Mountain Unit #2, Eastern Divide Ranger District

Surveyed 5/31 and 6/1/19

Figure 3 View of a segment of skid road (bladed) with slash cover in Round Mountain Unit #2.

Soils in Round Mountain Unit #2 are derived from residuum weathered from sandstone (50%) and residuum weathered from chert and/or cherty limestone (50%). These soils have high coarse fragments throughout the soil profile with a loamy-skeletal soil texture. The western portion of the unit is classified as Lily gravelly sandy loam with 15 – 35% slopes (soil map unit: 75D) and the eastern legs of the unit are classified as Brushy extremely gravelly loam with 15 – 35% slopes (soil map unit: 64D).

Overall Detrimental Soil Disturbance

Approximately 10% of the unit has been detrimentally disturbed. The disturbance was generally localized to skid trails, roads, and landings with some areas of compaction at the surface and areas of soil loss and erosion. Approximately 13% of the unit had bare soil exposed. The soils in this unit are shallow and rocky limiting the potential for compaction from heavy equipment. But shallow soils are more vulnerable to disturbance from displacement and loss of the forest floor and organic matter components. The forest floor was disturbed on 20% of the unit and the depth of the forest floor averaged 1.7 cm, shallower than expected in this forest type/soil type. *Microstegium vimineum* was present at 1 of 30 soil pits.

Gilmore Hollow Unit #1, Glenwood – Pedlar Ranger District

Surveyed 6/2/19

Figure 4 View of a seeded temporary road segment in Gilmore Hollow Unit #1.

Soils in Gilmore Hollow Unit #1 are derived from sandstone and shale colluvium. These soils are coarse textured, and although the soil map unit does not classify them as skeletal, upon field review, the soils were shallow to rock with higher coarse fragments. The majority of the unit is classified as Tumbling fine sandy loam with 15 – 35% slopes (soil map unit: 25D).

Overall Detrimental Soil Disturbance

Nine percent of the unit was estimated to have detrimental soil disturbance. The disturbance is localized to skid trails, roads, and landings, but there is some evidence of erosion in other portions of the unit as well. The soils are shallow and rocky limiting the potential for compaction from heavy equipment, but shallow soils are more vulnerable to disturbance from displacement and loss of the forest floor, so the organic matter component is very important. The forest floor depth averaged 2.6 cm with 13% of the forest floor disturbed and approximately 16% bare soil exposed in the unit. *Ailanthus altissima* was common in the unit and present at 2 of 32 soil pits. *Microstegium vimineum* was also present at 2 of 32 soil pits.

Porter's Mill Unit #7, James River – Warm Springs Ranger District

Surveyed 6/3/19

Figure 5 View of skid trail (bladed) with surface erosion in Porter's Mill Unit #7.

Soils in Porters Mill Unit #7 were derived from sandstone with interbeds of limestone. Most of the unit is classified as McClung-Watahala-Dekalb complex with 8 – 15% slopes (soil map unit: 38C). Some areas are characterized by 35 – 55% slope. These soils are loamy skeletal in texture, meaning coarse fragments are present throughout the profile and comprise greater than 35% of the soil.

Overall Detrimental Soil Disturbance

Overall this unit has fairly high detrimental soil disturbance at 16% of the total area. This disturbance is mainly from displacement and erosion. Almost a third of the forest floor has been disturbed and 20% of the unit has displacement present with 16% showing soil loss through erosion. The forest floor depth is low, estimated at 1.6 cm. Most of the detrimental disturbance is associated with skid trails and landings, but skid trails are prevalent throughout the unit. Some compaction at the surface was also noted throughout the unit. Invasive species were not noted at any of the 31 soil pits.

Sugar Run Unit #3, North River Ranger District

Surveyed 6/4/19

Figure 6 Overview of vegetation conditions in Sugar Run Unit #3.

Soils in Sugar Run Unit #3 are derived from residuum weathered from shale and siltstone and/or fine-grained sandstone. These soils are coarse textured, have a high volume of coarse fragments and are shallow in many places. Approximately half of the unit is classified as Berks channery silt loam with 8 – 15% slopes (Soil map unit: Bkc), and the other half is classified as the same unit with slopes ranging from 15 – 25% (Soil map unit: BnD).

Overall Detrimental Soil Disturbance

Approximately 13% of the unit is detrimentally disturbed with compaction, displacement, and erosion occurring on skid trails and landings throughout the unit. The soils in the unit are shallow and rocky, limiting the potential for compaction from heavy equipment. However, shallow soils are more vulnerable to disturbance from displacement and loss of the forest floor and organic matter component, and these factors are important to determining total disturbance on the site. Approximately 20% of the forest floor was disturbed with 20% bare soil exposed and an average forest floor depth of 2 cm, less than expected on the site. Invasive species were not noted at any of the 30 soil pits.

Little Mountain Unit #3, Lee Ranger District

Surveyed 6/4/19

Figure 7 View of waterbar on skid road (bladed) in the Little Mountain Unit #3.

Soils in Little Mountain Unit #3 are derived mainly from shale, sandstone, and siltstone. About 60% of the unit is classified as Gilpin channery silt loam with 35 – 55% slopes and very stony. The other approximately 40% of the unit is classified as Chilhowie silty clay loam with 35 – 55% slopes and very rocky. Channery soils are not shallow to bedrock but are very stony and are an accumulative of flat, coarse fragments. The coarse fragments make up more than 35% of the soil by volume.

Overall Detrimental Soil Disturbance

Field surveys determined that 10% of the unit was detrimentally disturbed mostly due to topsoil displacement and loss of forest floor and organic matter in the surface horizons. This disturbance is generally localized to skid trails and landings. Approximately 17% of the forest floor is disturbed with 17% of the unit having bare soil exposed. The forest floor depth averaged 2.3 cm. Due to the coarse nature of the soil compaction is fairly limited to the surface. *Ailanthus altissima* was common in the unit and present at 4 of 30 soil pits. *Microstegium vimineum* was present at 1 of 30 soil pits.

Beards Mountain Unit #3, James River – Warm Springs Ranger District

Surveyed 6/5/19

Figure 3 View of landing area in Beard's Mountain Unit #3.

Soils in Beards Mountain Unit #3 are derived from shale and siltstone and have a loamy skeletal texture with greater than 35% coarse fragments. The main soil map unit is Berks-Weikert channery silt loams with 8 – 15% slopes (soil map units: 6C and 50D). Channery soils are not shallow to bedrock but are very stony and are an accumulative of flat, coarse fragments. The coarse fragments make up more than 35% of the soil by volume.

Overall Detrimental Soil Disturbance

Total detrimental soil disturbance was estimated at just 3% in Beard's Mountain Unit #3, mainly due to compaction associated with one of the skid trails. It's is likely this skid trail was located on soils with a lower percentage of coarse fragments. Other disturbance was noted but was mainly slight compaction at the surface or minor rutting as. About 10% of the forest floor was impacted with 13% bare soil exposed in the unit. The forest floor depth averaged 2.6 cm.

Summary

Seven timber harvest units that closed in 2018 were surveyed in May and June 2019 for post-implementation soil disturbance monitoring. Data for 24 parameters was collected from at least 30 pits in each unit. Forest floor depth, amount of live vegetation, fine and coarse woody material cover, bare soil, surface erosion, rutting, and compaction were measured at each soil pit.

Total estimated detrimental soil disturbance ranged from 3 – 16% for the units, and disturbance of 10% or more was determined for 4 of the 7 units. Average forest floor depth did not exceed 3 cm for any unit and bare soil was exposed in 10 to approximately 40% of the unit areas. Topsoil displacement ranged from 0 to approximately 20% of the unit. Unit soils are considerably rocky and while these soils are less prone to disturbance from compaction, they are vulnerable to impacts from loss of the forest floor and the organic matter component.

Table 1 Summary of Forest Soil Disturbance Monitoring Protocol results from May and June 2019 on the George Washington- Jefferson National Forest.

Unit	% DSD	% Forest Floor Impacted	Forest Floor Depth (cm)	% Live Plants	% Fine Woody	% Coarse Woody	% Bare Soil	% Rock	% Topsoil Displacement
White Pine #1	7	10	2.7	73	93	13	10	0	3
Round Mountain #2	10	20	1.7	63	87	10	13	43	3
Gilmore Hollow #1	9	13	2.6	63	97	16	16	13	0
Porters Mill #7	16	32	1.6	39	94	10	39	45	19
Sugar Run #3	13	20	2	77	93	23	20	20	13
Little Mountain #3	10	17	2.3	83	87	17	17	33	10
Beards Mountain #3	3	10	2.6	67	90	17	13	3	3

Table 2 Summary of Forest Soil Disturbance Monitoring Protocol results from May and June 2019 on the George Washington-Jefferson National Forest (continued).

Unit	% Erosion	% Rutting <5 cm	% Rutting 5-10 cm	% Rutting > 10 cm	% Compaction 0-10 cm	% Compaction 10-30 cm	% Compaction > 30 cm
White Pine #1	0	7	3	0	27	10	7
Round Mountain #2	10	3	3	0	20	0	0
Gilmore Hollow #1	3	6	0	0	19	6	0
Porters Mill #7	16	3	3	0	19	13	0
Sugar Run #3	0	3	0	0	13	0	0
Little Mountain #3	0	3	0	0	10	3	0
Beards Mountain #3	0	3	3	0	20	0	0

References Cited

Natural Resource Conservation Service Web Soil Survey online tool. https://websoilsurvey.nrcs.usda.gov/app/.

Page-Dumroese, Deborah S. and Ann M. Abbott and Thomas M. Rice. 2009a. Forest Soil Disturbance Monitoring Protocol, Volume 1: Rapid Assessment, United States Department of Agriculture, U.S. Forest Service, General Technical Report WO-82a, September 2009.

Page-Dumroese, Deborah S. and Ann M. Abbott and Thomas M. Rice. 2009b. Forest Soil Disturbance Monitoring Protocol, Volume 2: Supplementary Methods, Statistics and Data Collection, United States Department of Agriculture, U.S. Forest Service, General Technical Report WO-82b, September 2009.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 103

February 21, 2023

Since enactment of various state and Federal regulations (e.g., Federal Clean Water Act of 1977 (33 U.S.C. 1251 *et seq*.), Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1234–1328), West Virginia Water Pollution Control Act (WVSC § 22–11)) and the increased implementation of forestry and construction “best management practices” (BMPs) designed to reduce erosion and sedimentation, levels of stream sedimentation have generally improved over historical conditions. However, based on the most recent state water quality reports, sedimentation remains a problem in many streams within the range of the candy darter. In the Ridge and Valley physiographic province of West Virginia, which includes the Greenbrier River watershed, an estimated 21.5 percent of the total stream miles were rated as “poor” with respect to sedimentation, 43.2 percent were rated “fair,” and 35.3 percent were rated as “good.” In the Appalachian Plateaus province, which includes the Gauley and Lower New watersheds, 41.5 percent of the stream miles were rated as “poor,” 36.3 percent “fair,” and 22.2 percent “good” (WVDEP 2012, pp. 25–26). A similar regional breakdown of stream sedimentation is not available for Virginia, but statewide estimates indicate that 39.0 percent of the stream miles were “suboptimal” with respect to sedimentation, 23.7 percent were “fair,” and 37.3 percent were “optimal” VADEQ 2014, p. 182).

Although not listed as “impaired” by the WVDEP (2012, entire), the U.S. Forest Service (USFS) identified excess sedimentation as a continuing problem in portions of the upper Greenbrier River system (USFS 2011a, entire; USFS 2011b, entire). Therefore, the USFS is implementing a variety of stream restoration projects in the Monongahela National Forest specifically to reduce sedimentation in the Greenbrier watershed (USFS 2011a, entire; USFS 2011b, entire).

Future projects, such as a proposed large (107 cm (42 in) diameter) interstate natural gas pipeline, are expected to increase sediment loading in streams within the range of the candy darter (Federal Energy Regulatory Commission (FERC) 2016, pp. 4-108–4-115, 4-176–4-179). This proposed pipeline project will involve the clearing of a 23 to 38 m (75 to 125 ft) wide permanent right-of-way, trenching for the pipe, and will cross five current or historical candy darter streams (the upper Gauley River, lower Greenbrier River, Indian Creek, Stony Creek, and Sinking Creek) (FERC 2016, pp. 4-26–4-27). While project construction is not anticipated to cause direct “adverse impacts” to candy darters in Stony Creek (FERC 2016, pp. 4-187), the stream crossings and forest clearing associated with the permanent right-of-way are likely to increase sediment loading in the relevant watersheds, possibly degrading the habitat in streams potentially suitable for future candy darter reintroductions (if this is determined to be a feasible conservation tool).

Excessive sedimentation was likely a primary cause of the historical decline of the candy darter, and several species experts indicated that it continues to act as a stressor in some watersheds. However, they also expressed the view that variegate darter hybridization (discussed above) is exerting a stronger influence on candy darter distribution and population status (Service 2016).

Water Temperature—An analysis of historical water temperature data indicates a general increase in river and stream temperatures throughout the United States over about the last 90 years. These temperature increases are attributed primarily to changes in land use (e.g., urbanization and deforestation), thermal inputs (e.g., power plant discharges), and changes in climatic conditions (Kaushal *et al*. 2010, entire). Other studies demonstrate that changes in

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 104

February 21, 2023

Virginia Scientist-Community Interface
February 20, 2023

Deficiencies in 2022 Draft Supplemental Environmental Impact Statement

Executive Summary

We strongly urge the US Forest Service to not allow MVP to cross the Jefferson National Forest (the No Action Alternative) based on our scientific analysis of the Draft Supplemental Environmental Impact Statement. In this comment, we:

- Illustrate several flaws in the Forest Service's 2022 DSEIS analysis of USGS paired gage turbidity measurements. Further, we present an independent analysis that demonstrates pipeline construction activities do in fact elevate downstream turbidity.
- Outline concerns regarding the misuse of RUSLE models, high levels of uncertainty in model results, and sole reliance on these results to inform erosion control planning.
- Criticize the DSEIS conclusion that it is "not likely" MVP will adversely impact the endangered candy darter in JNF.
- Discuss the potential impacts of MVP's proposed use of insecticides in JNF and stress the importance of USFS providing a more detailed description and assessment of this proposed project for cumulative effects analysis.
- Criticize the DSEIS conclusion that it is "not expected" MVP will threaten freshwater mussels when there has been no analysis of potential impacts to mussel host fish.

About this report: This independent analysis was completed by the Virginia Scientist-Community Interface (V-SCI). V-SCI is a volunteer organization dedicated to reviewing and synthesizing science related to environmental issues across the southeastern United States. We are happy to discuss our findings in more detail if we can be of greater service.

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Contents

1. Rationale and background

In December 2022, the US Forest Service (USFS) released The Mountain Valley Pipeline (MVP) and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (DSEIS) #50036. The DSEIS concerns MVP's proposal seeking approval for a natural gas pipeline across approximately 3.5 miles of Jefferson National Forest (JNF). Specifically, the DSEIS responds to the January 25, 2022 US Court of Appeals Fourth Circuit decision that vacated and remanded the Forest Service and Bureau of Land Management (BLM)'s decision to grant access to the MVP pipeline.

In this document, we review scientific evidence related to the Forest Service's response and assessment described in the DSEIS. Our group, called Virginia Scientist-Community Interface (V-SCI), is a volunteer-led group of early-career scientists who offer scientific support for environmental issues. Our group includes graduate students and postdoctoral scholars with expertise across hydrology, biology, climate change, resource management, and other science and engineering fields. Together, we have reviewed scientific evidence related to MVP for over two years and produced numerous public comments (found at our website: https://virginiasci.org/past-work).

2. Turbidity analysis

The Forest Service states that:

> "[t]he Fourth Circuit remanded the Forest Service "to consider USGS data and other relevant information indicating that the modeling used in the EIS may not be consistent with data about the actual impacts of the Pipeline and its construction."

The Fourth Circuit's directions to the Forest Service were based on findings that downstream turbidity was greater than upstream turbidity at the Roanoke River paired stream gages at Lafayette, Virginia (see V-SCI 2020; upstream = USGS 0205450393 ROANOKE RIVER ALONG ROUTE 626 AT LAFAYETTE, VA, downstream = USGS 0205450495 ROANOKE RIVER ABOVE ROUTE 11 AT LAFAYETTE, VA). In an attempt to address this requirement from the Fourth Circuit, the Forest Service conducted an independent review that "considers modeling and monitoring activities as they relate to erosion and sediment effects on surface water."

Here, we 1) discuss how the Forest Service's 2022 DSEIS analysis of USGS paired stream gage turbidity measurements is flawed and 2) present an independent analysis of USGS turbidity data using similar methods as those in the 2022 DSEIS that demonstrate construction activities do in fact elevate downstream turbidity.

2.1 The Forest Service's analysis of USGS turbidity in the 2022 DSEIS is deficient

2.1.1 Construction periods are not defined

In Table 4 of the DSEIS, the Forest Service presents USGS stream gages used in their analysis. They indicate the beginning of the monitoring period at these gages and the "construction start" date at these gages. However, construction occurred at these gages, and particularly at the Roanoke River gages, before 2019. **In fact, 2018 saw the majority of construction and land clearing activities (Wild Virginia, 2022), and it was this period (2018/05/01 - 2019/08/19) that was previously analyzed by V-SCI in 2020 and cited by the Fourth Circuit. However, the Forest Service did not analyze this period, and instead states that construction only began in 2019.** Further, the dates of construction use in that previous analysis (2018/05/01 -2019/08/19) were taken from MVP's response to a previous comment about concerns related to sedimentation in the Roanoke River (see MVP Response to the Cristopulos Report, Geosyntec Consultants, Inc 2019). In addition, the current Forest Service 2022 DSEIS does not document when construction ended, which is important when performing a statistical analysis of the effects of construction on turbidity at these gages.

2.1.2 Turbidity events >50 FNU used in analysis are not defined

In Table 5, the Forest Service indicates pre- and post-construction turbidity events greater than 50 FNU, but these events are not defined. This, coupled with the lack of information regarding construction periods means that a thorough review of the Forest Service's analysis is unable to occur. Additionally, **for this analysis, the Forest Service used peak turbidity for these events, which likely does not fully capture the continuous effects of elevated turbidity in-stream.**

2.1.3 Peak turbidity for events >50 FNU is not in line with the Fish and Wildlife Service's application of the Newcombe and Jensen (1996) "severity of effect" (SEV) model and the Bull Trout Guidance in the 2022 Supplement to the Biological Assessment (MVP 2022)

The US Fish and Wildlife Service has stated that communication with Newcombe and Jensen confirms that their model, which calculates the "severity of effect" to salmonids based on the duration and concentration of suspended sediment is applicable to the MVP project's "aquatic Action Area". In the 2022 SBA, the Fish and Wildlife Service stated that "adverse effects to Roanoke logperch and candy darters in the following continuous exposure circumstances:

- Any time sediment concentrations exceed 148 mg/L over background.

- When sediment concentrations exceed 99 mg/L over background for more than 1 hour continuously.
- When sediment concentrations exceed 40 mg/L over background for more than 3 hours continuously.
- When sediment concentrations exceeded 20 mg/L over background for over 7 hours continuously.

These thresholds are chosen because continuous exposure to suspended sediment, even at relatively low concentrations, can have a negative impact on Candy Darters. However, the Forest Service aggregated turbidity data from USGS paired stream gages "into individual events that exceeded 50 Formazin Nephelometric Units (FNU)." This threshold was chosen "because it is the basis for State water quality standards for turbidity in neighboring West Virginia and North Carolina (Virginia does not have a water quality standard for turbidity)". **This is not in line with the Forest Service's application of the above continuous exposure methodology that is stated to be "both consistent with the best available science and appropriate for this Project." (MVP 2022)**

2.1.4 Statistical methods not clear

The Forest Service states it used a "regression approach", but they do not define their model, making their analysis unclear. The citation used for their statistical analysis, Grabow et al. (1998), is not currently available for review and is not a widely cited article for a "regression approach". A different article by Garry L. Grabow published in a 1999 edition of the NCSU Water Quality Group Newsletter indicates that an analysis of covariance (ANCOVA) is the "regression approach" likely used by the Forest Service, but this is not at all clear in their description of their analysis.

2.1.5 MVP analysis of USGS monitoring data not available for analysis

The Forest Service states that "Mountain Valley provided its own analysis of the USGS monitoring data (MVP 2022e), concluding that the USGS data could not corroborate the RUSLE2 modeling." This indicates that MVP's own analysis shows that turbidity following or during (it is not clear) construction is greater than RUSLE2 estimates. However, this analysis, which "does not corroborate the RUSLE2 modeling" and is appendix L of the 2022 SBA, is fully redacted. In a FERC filing, MVP argues that appendix L, which contains MVP's own analysis of USGS turbidity data that does not agree with RUSLE2 modeling, was redacted because "its extensive focus on sensitive species location and related confidential information" (see supplemental attachment 1). **MVP should provide the methods and results of this analysis, and can easily do so without divulging the location of sensitive species.**

2.1.6 The Forest Service does not compare real-world USGS monitoring data to RUSLE2 modeling estimates, as directed to by the 4th Circuit Court

The Forest Service argues that RUSLE2 modeling is "not meant to be validated by USGS or other monitoring data". The Forest Service also cites the RUSLE2 documentation (USDA 2008) and states that "[t]he most important part of RUSLE2's validation is whether RUSLE2 leads to the desired erosion control decision, not how well RUSLE2 estimates compare to measured data." However, the full quote from the RUSLE2 documentation states:

> "The most important part of RUSLE2 validation is whether RUSLE2 leads to the desired erosion control decision, not how well RUSLE2 estimates compare to measured data. **Validation certainly involves evaluating RUSLE2's accuracy, but many other considerations are also important in judging how well RUSLE2 serves its stated purpose** (emphasis added).

For example, a model could perfectly compute erosion, but if the resources required to use a particular model exceed available resources, the model is invalid, (i.e., it does not serve its intended purpose)." Thus the Forest Service misrepresented the RUSLE2 documentation, incorrectly asserting that RUSLE2 modeling cannot be compared to real-world data, despite the 4th Circuit Court direction.

The RUSLE2 model documentation also suggests that model estimates are useful for analyzing individual storm events, stating "[a]lthough RUSLE2 is not intended to estimate erosion from individual storms, its accuracy for individual storm event erosion estimates may be comparable to estimates from complex, process-based models. **RUSLE2 is better for estimating individual event erosion than is commonly assumed."**(emphasis added).

The Forest Service also states that:

> "[b]ecause RUSLE2 is not designed to be validated with in-stream water quality monitoring data, it is not possible to conclusively determine if the USGS data and other relevant information are consistent with the modeling."

But the RUSLE2 documentation state "If users understand how RULSE2 works regarding individual storms and representing historical events and they have the expertise and other resources to apply RUSLE2, then RUSLE2 is valid in these applications if these RUSLE2 users consider RUSLE2 estimates to be useful." This indicates that properly trained individuals with the appropriate expertise can apply RUSLE2 in this way if they choose to.

Lastly, while the Forest Service argues that "RUSLE2 is not designed to be validated with in-stream water quality monitoring data", the Forest Service states that MVP did exactly that when "[b]aseline field embeddedness surveys were completed on multiple streams in March and April 2020 to ground truth the RUSLE2 sedimentation model predictions" (Fisheries and Aquatic Resources Specialist Report) at the "request of the agencies" (MVP 2022). If the Forest Service believes that embeddedness surveys performed by MVP to "ground truth the RUSLE2 sedimentation model predictions" are applicable, then the Forest Service should also consider and compare USGS data to RUSLE2 estimates.

2.2 Independent analysis of USGS paired turbidity data finds that downstream turbidity greater than upstream turbidity during construction on the Roanoke River at Lafayette, VA

We analyzed 5-minute turbidity (FNU) data from two paired stream gauges on the Roanoke River (Table 1). Data was downloaded from the USGS' National Water Information System (NWIS) using the R package dataRetrieval (De Cicco et al., 2022) . All available data was downloaded for each site. Because USGS data undergoes extensive QA/QC, erroneous and incorrect data, often caused by debris or sensor malfunction, is removed. From this raw, 5-minute dataset, a new dataset was created where each time-step had a value for both sites (n = 495581 for both sites). In an effort to recreate the Forest Service analysis in the 2022 DSEIS as closely as possible, this dataset with no missing values was filtered to only contain values >50 FNU (see Table 1; supplemental data).

To understand the effects of construction activities, we relied on a timeline for spread G which contains the Roanoke River at Lafayette, VA USGS gages, that was assembled by Wild Virginia (2022) based on inspection reports from Virginia Department of Environmental Quality (DEQ), McDonough Bolyard Peck, Inc., and Mountain Valley Pipeline, LLC. (see Figure 3 in Wild Virginia 2022 for timeline). Because this timeline provides specific construction activities, we included the construction activities "clearing" and "backfilling" as factors in our analysis.

We used an analysis of variance (ANOVA) to analyze the difference between upstream and downstream turbidity during documented construction in the vicinity of the Roanoke River at Lafayette, VA. This gage was chosen for analysis because 1) it was cited in the 4th Circuit Court of Appeals, and 2) it was analyzed by the Forest Service in the 2022 DSEIS. We used R Statistical Software (R Core Team 2021) to perform the ANOVA, and then we computed estimated marginal means using the emmeans R package to examine the differences between upstream and downstream gages during different periods of construction. The dataset and R script used in this analysis are provided as supplemental data.The ANOVA model formula was as follows:

turbidity   site * clearing * backfilled

We found that downstream turbidity was significantly greater than upstream turbidity (15.8 ±3.22 FNU) when both clearing and backfilling was occurring in the vicinity ($p > 0.0001$). There were no significant differences between upstream and downstream turbidity during any other combination of construction periods (Figure 1). These results show that construction activities elevate downstream turbidity. Further, this analysis did not examine the differences in duration of various elevated turbidity events such as those indicated as leading to "adverse effects to Roanoke logperch and candy darter" (MVP 2022).

3. RUSLE2 modelling deficiencies

Both RUSLE and RUSLE2 soil erosion models can inform erosion control planning and best management practices (BMPs), but only when the models are applied carefully, and the results are cautiously interpreted alongside other tools. The current DSEIS states MVP exclusively relied on RUSLE models to plan its BMPs and erosion control devices in the JNF. However, **MVP misused these models in multiple ways that generate high uncertainty in their results** as presented in the DSEIS and Hydrologic Analysis of Sedimentation for the Jefferson National Forest Report of Findings (Hydrologic Report, Geosyntec Consultants, Inc 2020). **MVP failed to incorporate other tools to offset this uncertainty or make any significant updates in its 2022 DSEIS to improve their erosion control planning**. Additionally, although the DSEIS repeatedly claims the RUSLE model's results are only a "conservative planning and analytical tool to identify areas with increased potential for sedimentation" (pg 38) and "are not meant to be validated by USGS or other monitoring data" (pg 42), our analysis of USGS turbidity data in section 1 of this document illustrates **RUSLE modeling alone did not lead MVP to implement adequate BMPs and erosion control measures.**

Based on our review of MVP's modeling procedures, we strongly urge the USFS to reconsider their acceptance of the modeling results described in the Hydrologic Report and DSEIS. Also, because JNF is a unique and challenging area to model with RUSLE methods, we also recommend that the **modeling should be reviewed by a third-party expert who is familiar with leading-edge RUSLE modeling research and implementation.**

Below, we summarize our concerns with MVP's use of the RUSLE models described in the DSEIS and the Hydrologic Report. Readers can find more technical details about our concerns with the Hydrologic Report's RUSLE modeling methods in our previous comment for the 2020 DSEIS ("MVP sedimentation analysis fails to sufficiently mitigate water quality impacts within the Jefferson National Forest") and academic journal articles that are attached to this comment.

3.1 Models are unfit for the complex terrain of JNF and fail to incorporate additional tools

The RUSLE models are calibrated using thousands of real-world measurements from many locations. This means the model is most accurate in places where there has been data collected to inform the mathematical relationships between climate, soils, topography, and soil erosion. Model developers have warned about the limitations of the model and encouraged users to interpret results with great caution, especially in areas where the model was not calibrated (USDA, 2008). As acknowledged in the Hydrologic Report, the RUSLE models are not calibrated in the MVP disturbance area in JNF, or in

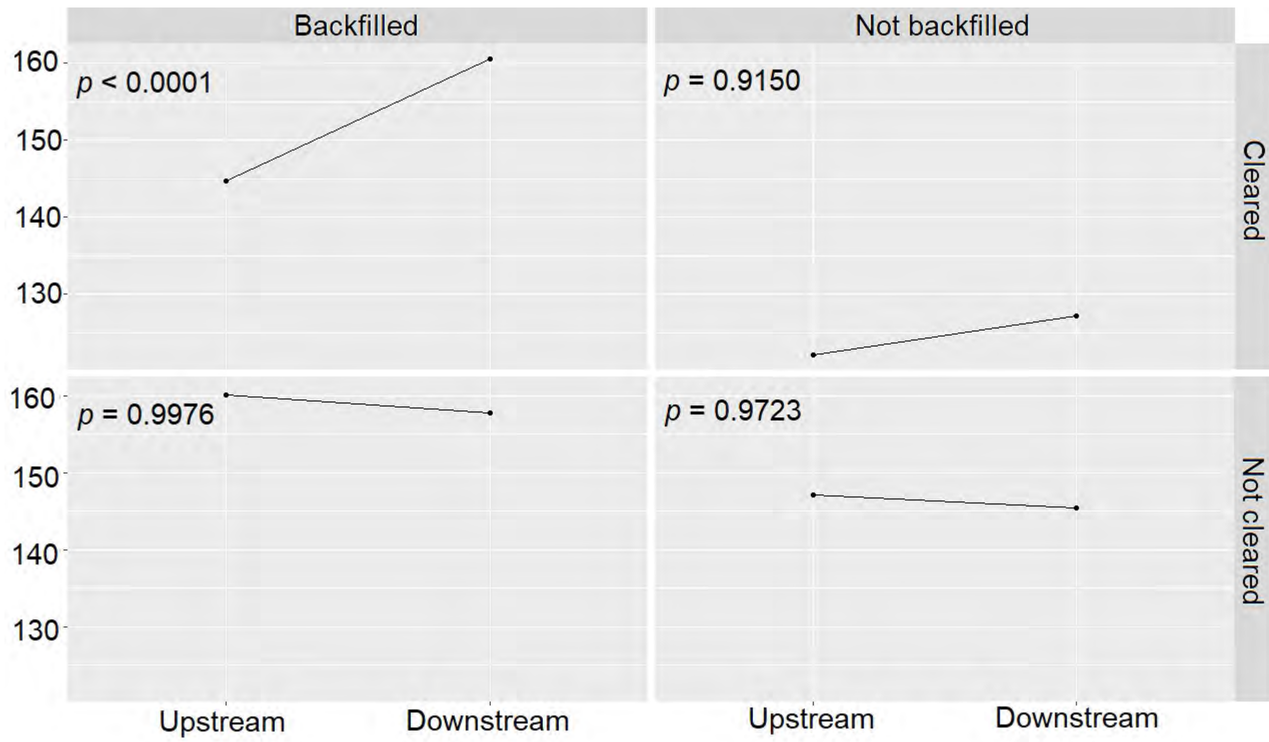

Figure 1. Interaction plot for estimated marginal means at upstream (Roanoke River along Route 626 at Lafayette, VA) and downstream (Roanoke River above Route 11 at Lafayette, VA) gages during clearing and backfilling construction activities.

Site	USGS station number	Location	Beginning of Record	End of record used for analysis	n of period of record	n of analyis
Roanoke River along Route 626 at Lafayette, VA	205450393	Upstream	2017-08-23	2023-01-10	544,858	16,559
Roanoke River above Route 11 at Lafayette, VA	205450495	Downstream	2017-08-23	2023-01-10	559,238	18,087

Table 1. Station name, USGS station number, beginning of data record at each station, end date of the record used for statistical analysis, number of 5-minute data points in the period of record, number of 5-minute data points were FNU was greater than 50 used in analysis.

any area with similar environmental features. Therefore, **the modeling results reported in the DSEIS cannot reliably inform MVP's erosion control decisions.**

Due to the limitations of the method, the RUSLE models should not be used as a sole factor in decision making, even for areas where the model was calibrated, as stated here:

> "Erosion-control planners should consider information generated by RUSLE2 to be only one set of information used to make an erosion control decision" (USDA, 2008).

MVP ignored this advice from model developers and solely relied on RUSLE in their erosion control planning in the JNF. **Additional methods to improve BMPs applied in JNF are pivotal to preventing catastrophic damage to the disturbance areas.**

3.2 Modeling is not applied at the correct scale

The Hydrologic Report defines the watershed based on the Hydrologic Unit Code- (HUC-) 12, which is not proper engineering practice or a reasonable definition to examine stream impacts that occur at a much smaller scale, rather than site-specific topography-based delineations. The HUC system is a nationally defined stream and river referencing system, in which specific watersheds are referenced by numerical codes. HUCs are simply stream "addresses," and are not intended to be units for hydrologic analysis. HUC-12 refers to the smallest-scale watersheds in the referencing system, 25,000 acres on average, compared with about 20 acres for a first-order stream watershed. **Averaging across the HUC-12 scale, rather than focusing on the smaller watersheds and individual streams, results in misleadingly low average sedimentation increases.** There is no justification for presenting any overall results at the larger HUC-12 scale and doing so obscures the greatest sedimentation impacts in smaller topographically defined watersheds.

3.3 Sedimentation estimates by RUSLE2 are too high to be accurately modeled in 39% of the project area

The Hydrologic Report acknowledges that RUSLE2 results are erroneous when estimated sedimentation is greater than 20 tons/acre/year, and that 39% of the study area had sediment yields of greater than this threshold (pg 19). The sedimentation rate calculated in RUSLE2 means 1) that there is excessive sedimentation expected in at least 39% of the study area that needs to be reduced to levels that are safe for water quality and 2) **the Hydrologic Report did not accurately model how excessive these sedimentation rates will be because RUSLE2 does not work well in areas with high sedimentation.** No justification is given for accepting these erroneous estimates except to say that they are "reasonable." According to the USDA (2008), "reasonable" just means not physically impossible.

3.4 Model calculations were oversimplified and do not account for steep terrain of JNF

The Hydrologic Report did not calculate all RUSLE and RUSLE2 parameters according to best practices. For mountainous terrain like JNF, MVP's calculation of the Slope Length (LS) factor in its models is of particular concern because it represents the impact of slope steepness on erosion and has a large impact on sedimentation predictions (USDA, 1997). The Hydrologic Report states that it uses the RUSLE methodology provided in Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE) (USDA, 1997). However, on page 104 of that document, using a formulaic approach in LS factor calculations is recommended (USDA, 1997). A formulaic approach means adjusting calculations based on topographical features, as opposed to a static approach of assigning values that do not change. A wide breadth of scientific literature has examined best practices to calculate the LS factor for different terrains, but MVP instead used static values that do not adjust for the slope of the terrain or account for increased erosion in steep terrain. **Since the formulaic calculation adjusts for slope, it is better adapted for steep-slope areas such as JNF.** In our 2020 comment, we provide more detail about how MVP's miscalculation of the LS factor systematically underestimates sedimentation in areas with slopes greater than 9%; MVP construction will routinely work along slopes well above 15% (see Tables 4.1-1, 4.1-2, and 4.1-3 in Dodds, 2017).

4. Candy Darter

On February 3rd, 2022, the Fourth Circuit vacated the 2020 U.S. Fish and Wildlife (FWS) Biological Opinion, stating that FWS "did not adequately analyze the environmental context for the Roanoke logperch and candy darter". The candy darter (*Etheostoma obsurnii*) is a freshwater fish found only in Virginia and West Virginia. Candy darters are critical for the local ecology, but they are listed as federally endangered. Habitat degradation, caused by sedimentation, stream acidification, or deforestation, is a major threat to this species survival. FWS was directed to evaluate the environmental baseline condition of the candy darter and its critical habitat, as well as the cumulative effects of future activities likely to occur within the area. We find no such comprehensive evaluation in the 2022 DSEIS. Here, we outline that (1) The DSEIS incorrectly concludes MVP waterbody crossings will not harm JNF candy darter habitat, (2) MVP sediment monitoring cannot accurately assess the impact of MVP on candy darters in JNF, and (3) MVP's impact on candy darters will extend beyond the issues discussed in the DSEIS, in particular when climate change and repatriation efforts are considered.

4.1 DSEIS incorrectly concludes MVP will have minimal impact on JNF candy darters.

Since the Forest Service 2020 Final Supplemental Environmental Impact Statement (2020 FSEIS), a critical habitat for the candy darter was established and became effective on May 7th, 2021. The critical habitat is a geographic region designated as essential for the species survival. The candy darter critical habitat includes areas in the Jefferson National Forest (JNF) and overlaps considerably with the proposed pipeline and construction. It is thus vital that the Forest Service thoroughly evaluate the impact of MVP's pipeline and construction on the candy darter in the current DSEIS.

4.1.1 The MVP Stony Creek crossing can impact JNF candy darter populations and critical habitat

In the 2022 DSEIS, the Forest Service references the 2022 Supplemental to the Biological Assessment (SBA; MVP 2022) recommended determination for candy darter impact is "not likely to destroy or adversely modify" when considering the critical habitat within JNF boundaries. This determination is based on the technicality that "no candy darter critical habitat occurs in the JNF waterbodies crossed by the MVP". However, MVP's proposed pipeline does cross a critical habitat waterbody – Stony Creek – but the crossing lies just outside of the JNF boundary (roughly $>$0.5 miles, according to Figure 1 of the 2022 DSEIS). Candy darter habitat is reliant on connectivity and not restricted to national forest boundaries. Any portion of the candy darter range impacted by MVP could fragment important parts of their network. Critically, emerging scientific evidence is showing a larger existing and potential range for candy darters than previously thought. Research by McBaine et al., 2022 show a much larger natural range for candy darters and provide strong evidence that "families may use an entire stream network to complete their life history, with spatiotemporal variation in occupancy among life stages." This constitutes a major increase in the range previously considered and underscores the importance of habitat connectivity for species wellbeing. Thus it cannot be assumed that because the MVP Stony Creek crossing lies just outside of JNF boundaries it will have no impact on JNF candy darter populations. It is crucial that the Forest Service perform a thorough assessment of the impact of the Stony Creek crossing on candy darter populations. It is worth noting that when considering the entire 303.5 mile-long project, the 2022 SBA recommended determination of candy darter impact was "may affect, likely to adversely affect".

4.1.2 The MVP Kimballton Branch crossing within JNF will adversely affect candy darter critical habitat and potential local candy darter populations

Second, there is another waterbody crossed by MVP that does lie within JNF, Kimballton Branch. In the DSEIS the Forest Service argues that there is no concern because Kimballton Branch is not part of the critical habitat. However, Kimballton Branch directly feeds into Stony Creek, a designated critical habitat. Thus increased sediment or pollutants in Kimballton Branch will likely impact Stony Creek and the protected candy darter populations there. Additionally, just because the Kimballton Branch is not part of the federally designated critical habitat, it cannot be assumed that Kimballton Branch does not support candy darter fish at all. It would be prudent to assess whether there are candy darters in this area. Further, as the McBaine et al., 2022 study discussed above demonstrated, the candy darter range may be much larger than previously thought.

4.2 MVP sediment monitoring as presented in the DSEIS cannot be relied upon to accurately assess the impact on candy darters in JNF.

Starting in 2020, MVP began their own sediment monitoring in response to the 2020 FWS BO requirement. Several monitoring stations were brought online and have continually collected data. In the 2022 DSEIS, the Forest Service argues that these monitoring data show that sources of suspended sediment concentrations (SSC) in the tributaries that include pipeline are similar or lower than those that do not include the pipeline. Further, they state that when data from these monitoring stations during specific storms were examined, the maximum SSC difference calculated was below the FWS 3-hour 40mg/L threshold for adverse effects to candy darters. Together, the Forest Service thus concludes that the impact of MVP will be minimal in JNF. We find several issues with the Forest Service's conclusion given the provided data:

- The candy darter sediment monitoring watersheds are in areas where construction did not resume following the vacatur. As such, it is impossible to use this data to evaluate how pipeline construction will impact stream water quality, which is ultimately what is necessary to know in order to confidently conclude candy darters will not be adversely affected.
- The monitoring results are not provided. The detailed description of MVP's monitoring methodology, data, and analysis are in Appendix L of the 2022 SBA, which is fully redacted. It is necessary that MVP provide this information in order for it to be critically evaluated (see 2.1.5 for further discussion).
- The data used by the Forest Service to make their conclusion is based entirely on data collected during individual storms. Storms result in atypical, and often unpredictable, conditions that cannot easily be extrapolated and cannot be used as a proxy for construction. At best, storms may only reflect acute and extreme exposures. However, continual low-level exposures can be just as harmful (Jimenez-Tenorio et al., 2007), and this cannot be assessed from the data available. Further, the methodology used by the Forest Service may not be in alignment with accepted continuous exposure analysis, if it is the same as that used for USGS stream gage data (see 2.1 for full discussion), but this cannot be determined because the analysis details were not provided.

In conclusion, the Forest Service relies on MVP's sediment monitoring to conclude the impact of MVP on JNF candy darters will be minimal. However, we find it is not possible to draw this conclusion with the data available. Further, the efforts described in the DSEIS cannot be critically evaluated due to a lack of transparency regarding MVP's methodology, data, and analysis.

4.3 MVP's impact on candy darters within JNF will extend beyond construction and stream crossings.

The Endangered Species Act prohibits any federal action that will jeopardize the future of an endangered species. Critical habitats for candy darter survival are found within JNF. With regards to MVP, there are many considerations beyond the specifics outlined in this comment and the DSEIS. We outline two here:

4.3.1 Candy darter habitat is highly vulnerable to impacts from climate change, including from sedimentation.

Climate change is widely expected to create substantial changes in hydrology, which in turn creates changes in sediment regimes. One of the major ways in which climate change impacts sediment delivery is through vegetation disturbance (Goode et al., 2012). Loss of vegetation, combined with increased precipitation and extreme events, means that climate change is likely to cause serious sedimentation events within the candy darter range. The Central Appalachian forests have many vulnerabilities related to climate change that are likely to result in increased sedimentation as well as nutrient export. A 2015 report on climate sensitivity prepared by the U.S. Department of Agriculture and the **U.S. Forest Service found that small riparian stream forests were "the most vulnerable ecosystems" to climate change**, with serious implications for forest-dependent wildlife. We include the following quotation from that report:

> "Projected increases in total precipitation in spring, intense precipitation events, and storm frequency are expected to lead to more runoff at that time of year, and a subsequent reduction in water quality arising from increased erosion and sedimentation (Liu et al. 2008, U.S. Environmental Protection Agency [EPA] 1998). Increased runoff also promotes flushing of nutrients (e.g., nitrogen and phosphorus) that build up in natural and disturbed ecosystems, thereby increasing the potential for downstream eutrophication and hypoxia (Peterjohn et al. 1996, Vitousek et al. 2010). Additional factors such as fire and insect defoliation exacerbated by climate change are also expected to increase runoff, erosion, and sedimentation." (page 178)

The report goes on to describe how climate change is also likely to decrease "the capacity of a stream system to dilute larger loads of nutrients." Based on the report, **we emphasize three points related to candy darter wellbeing under climate change:**

- Forests that provide bank stabilization, and temperature control for candy darters are highly vulnerable to climate change.
- Increased precipitation is expected at multiple times of year, including in spring, when the candy darter reproductive cycle is occurring.
- Climate change is driving temperature-sensitive aquatic species to migrate to higher elevation streams to access cold water refugia (e.g., Daigle et al., 2015). Darter species show high sensitivity to temperature change, and the potential for range expansion – into or within JNF land – as candy darters seek refuge in colder streams should be carefully examined.

The combined forest disturbance and precipitation changes make it highly likely that candy darter habitat will have increased baseline and storm-related sedimentation. The expected increase in sedimentation from extreme events cannot be evaluated independently of the vulnerabilities of riparian forests. Fragmentation of forests, such as by MVP, also contributes to decreased forest health and resilience to climate change stressors.

MVP's analysis of candy darter habitat should not only consider extreme events, but the combined stresses of vegetation disturbance and increased precipitation frequency. The assessment should also describe how these events, and MVP's impact, intersects with the candy darter life cycle.

4.3.2 The Forest Service should reconsider areas that are suitable for candy darter repatriation.

In new research by McBaine et al., 2022 there is new insight about areas suitable for repatriation, indicating that new surveys should be designed that incorporate the best available information about repatriation. Careful evaluation of repatriation potential is especially critical given the recent success in breeding candy darters at the USFWS White Sulphur Springs National Fish Hatchery (McCoy, 2022). On November 15th, 2022, the hatchery reported that the first captive-bred candy darters were released into the wild in West Virginia. Given this remarkable progress, suitable but unoccupied habitat should be carefully preserved to contribute to the ongoing species recovery. The experts at USFWS leading the repatriation should be included in determining whether and where MVP could negatively impact their efforts.

5. Pesticides

The 2022 DSEIS lists several "past, present, and reasonably foreseeable projects" in the HUC-10 watersheds that overlap the MVP route on NFS lands. These projects are included in the cumulative effects analysis to assess cumulative, measurable effects to several aspects of the environment, including soil, water quality, threatened and endangered species, and vegetation. These are listed in Table 10 in the 2022 DSEIS. Here, we comment on one specific item in Table 10: the use of insecticides to control the spread of the gypsy moth in the Sarton Ridge Vegetation Management Project. We outline concerns surrounding the use of insecticides and urge the Forest Service to require more details around the type, specific use, and necessity of insecticides.

5.1 Different insecticides have drastically different effects on environment

Insecticide products vary widely in relation to the types of "active ingredient", with broad categories including organophosphates, pyrethroids, and carbamates (U.S. EPA CADDIS Vol. 2 Insecticides). Each active ingredient can have drastically different effects on the surrounding environment, wildlife, or human health. Each insecticide will also have different chemical properties, such as solubility, which will differently affect how far it will travel through rivers, streams, runoff, etc., as well as differently affect levels of bioaccumulation in wildlife that may consume sprayed vegetation. Each insecticide will also exhibit varying neurotoxic effects on wildlife and human health. It is thus impossible to assess the cumulative effects of MVP's use of insecticides without knowledge of the types of insecticides that MVP would use to treat gypsy moth outbreaks. Additionally, the application method of use, such as aerial spraying, will dramatically influence the harmful effects of the insecticide, but the DSEIS does not provide any such details. **Given the variety of insecticide types and potential environmental harms, it is vital that MVP specify the insecticide type, brand, active ingredient, and application method so that the potential harmful effects can be fully assessed.**

5.2 Alternative non-chemical management methods must be evaluated

Many alternative methods to chemical pest management are available, effective, and often essential. These include weeding, mulching, or setting traps. Indeed with respect to gypsy moths, many best management practices, including research from the USFS (Kauffman et al., 2017), recommend pheromone-baited traps or mating disruptions with synthetically-made female moth scents. In Kauffman et al., 2017 they explain that, "because pheromone traps are highly effective at locating and delimiting newly established populations, every one of these projects has been successful at eliminating gypsy moth from previously uninfested regions." While some of these non-chemical approaches may be best used preventatively, **it is critical the Forest Service fully evaluates alternative pest control strategies and their effectiveness in the face of potential environmental harm from insecticides.**

6. Mussels

The 2022 DSEIS states that the threatened freshwater mussel Atlantic Pigtoe (Fusconaia masoni) is not expected to be affected by pipeline development. This determination appears to be based on the lack of occurrence of adult mussels "at or downstream of the MVP pipeline crossing of Craig Creek or any other MVP pipeline stream crossings, or in the Action Area (which includes upland sedimentation effects)" (MVP 2022; DSEIS pg 53). This determination was based on the 2021 Species Status Assessment (US Fish and Wildlife Service 2021) for the Atlantic Pigtoe and does not include any more recent species updates. We are not confident that MVP has addressed all potential threats to the Atlantic Pigtoe mussel, particularly in regards to the complex life cycle of this species.

6.1 Impacts on Atlantic Pigtoe host fish has not been addressed

Freshwater mussels have a complex life cycle that often involves their larvae attaching to the gills or fins of a host fish in order to successfully transform into a juvenile mussel. This is both a vulnerable part of the freshwater mussel life cycle and an important one. Freshwater mussels are thought to have evolved their reproductive timing to match that of the migration and movement of their host fish, which is usually associated with host fish spawning (Kat 1984). As sedentary animals, freshwater mussels rely on the movement of their larvae-infested fish host within the stream system in order to maintain populations within the stream. Members of the Cyprinidae family likely serve as the primary hosts for this mussel species including Bluehead Chub (*Nocomis leptocephalus*), Creek Chub (*Semotilus atromaculatus*), Mountain Redbelly Dace (*Chrosomus oreas*), Pinewoods Shiner (*Lythrurus matutinus*), Rosyside Dace (*Clinostomus funduloides*), Satinfin Shiner (*Cyprinella analostana*), Swallowtail Shiner (*Notropis procne*), and White Shiner (*Luxilus albeolus*; Eads and Levine 2011). With the exception of the Pinewoods Shiner and White Shiner, the native ranges of all these fish species span the proposed project area (USGS; https://nas.er.usgs.gov/). Freshwater fish such as these species are susceptible to elevated sedimentation rates, with the potential for their feeding and reproduction to be affected (Burkhead et al. 1995). Further, noise pollution from anthropogenic sources can interfere with the movement and health of fish (Popper and Hastings 2009). Given the elevated sedimentation rates and the noise pollution and human activity associated with pipeline construction, it is possible that Atlantic Pigtoe host fish health and movement will be affected. This could hinder the yearly reproduction of the Atlantic Pigtoe mussels and result in lower juvenile recruitment for this species. **In the 2022 DSEIS, MVP does not address these potential impacts on non-endangered native fish species that may serve as a host fish for the threatened Atlantic Pigtoe, and thus are missing a critical portion of their No Effect assessment.**

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 105

February 21, 2023

PETERS MOUNTAIN REVISITED

Posted on **October 11, 2015** by **Rick Webb**

Pipeline construction over steep Appalachian mountains creates significant runoff and slope-failure problems. Dominion Transmission, Inc., for example, was fined in 2014 for serial slope failures at one of its pipeline projects in West Virginia. In that case, as in others, the difficulties associated with construction in extreme landscape have been compounded by noncompliance, relaxed standards, and ineffective regulatory oversight. Our ongoing study of a relatively small (12-inch diameter) pipeline project over Peters Mountain in the Jefferson National Forest in Giles County, Virginia, provides another case in point.

The Peters Mountain pipeline project was the focus of the DPMC's Case Study Number One. Our Pipeline Air Force flew over the now "restored" construction corridor on October 8th. The following letter, requesting investigation of slope failures and access to documents, has been submitted to the Virginia Department of Environmental Quality. Additional information will be posted as responses are provided and documents are obtained.

October 9, 2015

James Golden
Deputy Director of Operations
Virginia Department of Environmental Quality

Robert Weld
Director, Blue Ridge Regional Offices
Virginia Department of Environmental Quality

RE: Slope failure at Columbia Gas – Celanese pipeline corridor

Gentlemen,

As you may know, the Dominion Pipeline Monitoring Coalition is conducting case studies of pipeline construction projects that are subject to regulatory oversight by the Virginia DEQ.

One ongoing study concerns the Columbia Gas of Virginia Celanese pipeline project in Giles County, Virginia. Earlier information about this project was published on our website:

Case Study #1, Part 1 – Columbia Gas, Giles County, VA

We obtained new aerial photography of this project yesterday, October 8, 2015.

The attached photos, obtained for the western slope of Peters Mountain, in the Jefferson National Forest, reveal significant and ongoing slope failure on a steep (slope > 40%) section of the corridor. Based on the photos it appears that this is a known restoration problem and that efforts to stabilize the slope with some sort of landscape fabric have not been successful. It also appears that a significant amount of surficial material has either slipped or washed downslope.

In addition to the photos, a map is attached that shows the location of the slope failure in relation to corridor steepness. The coordinates for the slope failure location shown in the photos are: 37°22'18.47″N; 80°46'32.88″W

This observed slope failure cannot be in compliance with Virginia Erosion and Sediment Control or Stormwater Management requirements. We also point out that water interceptor diversions were not properly installed during the construction phase of this project. Also, the DEQ granted a variance to the open trench limitations specified in the state ESC regulations. Moreover, the DEQ made no on-site inspections of this project during construction. This apparent noncompliance, relaxation of standards, and lack of regulatory oversight may have contributed to the present restoration failure and slope instability.

Thus we ask you to investigate the slope failure problem at the Columbia Gas – Celanese pipeline corridor, and we would appreciate obtaining copies of all information, documents, reports, photos, notices of violation, etc. related to the problem.

Finally, as a follow-up to previous information requests, we would like copies of all documents in the possession of the DEQ related to the project in question, including inspection reports, enforcement actions, permit applications, variance requests, and related correspondence. This is a Freedom of Information Act request. This request applies to the period of February 1, 2015 to the present date. Digital copies are preferred. Please advise if the cost for providing the requested information will exceed $150.

Thank you,

Rick Webb, Coordinator
Dominion Pipeline Monitoring Coalition
rwebb.dpmc@gmail.org

cc:
Thomas Speaks, Supervisor
Jefferson National Forest

This entry was posted in **Environmental Review**, **Erosion and Sediment Control**, **Regulatory Compliance** by **Rick Webb**. Bookmark the **permalink [http://pipelineupdate.org/2015/10/11/peters-mountain-revisited/]** .

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 106

February 21, 2023

SOIL PRODUCTIVITY ASSESSMENT OF THE MOUNTAIN VALLEY PIPELINE CORRIDOR ON THE JEFFERSON NATIONAL FOREST
BY NAN GRAY, LICENCED PROFESSIONAL SOIL SCIENTIST
February 16, 2023

I have reviewed the December 2022 Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement and the Plan of Development. I provide my opinion as a Licensed Professional Soil Scientist on whether the Forest Service has a reasonable expectation that the post-construction condition of the land disturbance for the Mountain Valley Pipeline will support the vegetation upon which the agency relies to constitute restoration of the construction activities. Based on my 35 years of experience, personal and professional knowledge of the geology and soils of the Craig, Giles, and Montgomery Counties, and the Jefferson National Forest, and the flora and fauna supported in the local ecosystems, as well as what is known about the agency's faulty use of RUSLE predictive soil-loss modeling, my assessment is that the Forest Service lacks sufficient information about the post-construction productivity of the soils to assume that vegetation will grow, the proposed restoration appears aimed at slope stabilization rather than ecosystem restoration, and it is more likely than not that the proposed restoration activities will not be successful.

The Forest Service has not acknowledged the complex chemical and biological structure and functions of native forest soils and the effects of their disturbance by industrial gas pipeline construction.

There are five soil forming factors: climate, parent material, topography, organisms, and time. Forest soils have a thick layer of leaves and sticks and various stages of decomposition of litter material covering the underlying soil. The leaf litter layer is habitat to rotifers, millipedes, nematodes, insects, and newts and other amphibians, and larger forest animals. Native healthy soils have an organic matter litter-layer cover to moderate microclimates, further increasing biodiversity of flora and fauna, and the soils have structure that roots wrap around or penetrate, air and water in balance for soil animals and microorganisms, bacteria and fungi, protozoans and nematodes, roots, and mineral particles of sand, silt, and clay size, sometimes rocks, all held together by the dynamics of soil biology.

Nematodes and Fungi breakdown minerals and release nutrients for the next level biota to ingest for energy, excreting bionutrients for other soil life forms while extending hyphae to continue the trade route of sugars, water, air, animals, decaying organic matter and detritivores (Handbook of Soil Science, p.C-5, C.1.2 Ecology of Soil Microorganisms). Symbiosis of the soil community allows tree roots to exchange sugars for nutrients and air and water and space and safety, secure "footing", "groundedness", stability, for all the living creatures plus forest animals who require a forest canopy and soil for food and shelter, and who distribute tree seeds improving reproduction success (Properties and Management of Forest Soils, p. 3). Leaves on forest floors reduce raindrop impact on soils and allows water to slowly infiltrate forest soils. The humic acid released in decaying forest leaf litter can distinctly lighten the color of soils in one horizon and distinctly darken soils in another horizon. Soil water will move through each of those horizons differently, with water passing through the more porous horizon faster than the other. Water retention is important on south-facing mountain slopes.

The Forest Service does not describe or acknowledge the complex physical nature of native forest soils that existed on the pipeline corridor prior to construction activity on Brush and Sinking Creek Mountains, and the native soil that is still present on Peters Mountain where only tree clearing has occurred.

Nor does the Forest Service acknowledge that the organization of layered functions, the microorganisms and soil structure strength and framework, are destroyed when soil is disturbed by construction equipment digging and scraping and shoving native soil. The air and water get squeezed out, microorganisms exposed to air quickly decompose easily decomposable organic matter and the plants and animals that died by excavation. Then the microorganisms die themselves and the cycle of life in the soil comes to an end. The heavily disturbed soil would be lifeless.

Soil productivity is affected by soil loss factors that are not accounted for in the DSEIS.

According to the DSEIS, the construction of the MVP will disturb 54 acres of the Jefferson National Forest, including the soils. The soils have stories that are not told by the number of acres, they are told by the rocks, the soil types, the weather, and the water. The MVP would change the soil story from one of complex chemical and biological organization to that of excavation, water diversion, rock blasting, materials mixing, compaction, and erosion, each and all of which change soil structure and therefore post-construction productivity.

Soil loss from wind and water erosion will affect the post-construction productivity of the soil. The Forest Service failed to account for erosion losses in post-construction soil productivity. Dr. Johh Czuba has assessed the agency's faulty reliance on RUSLE/RUSLE2 soil-loss modeling to project instream water quality impacts (Czuba, Jonathon A., P.E.). I have reviewed Dr. Czuba's report in which he concluded that the modeling relied upon by the Forest Service likely underestimated soil loss. In his analysis, Czuba concluded that the model is most applicable only for 43% of the MVP study area in the JNF because some slopes in the pipeline corridor exceed the slopes on which predictive capacity of the model is based. Czuba also criticized the post-construction land cover factor that the Forest Service used in the model. I, too, submitted comments to the Forest Service in November 2020 in which I faulted the use of the RUSLE/RUSLE2 modeling based on the slope, cover-type, and soil erodibility and erosivity factors. I attach my November 2020 letter here.

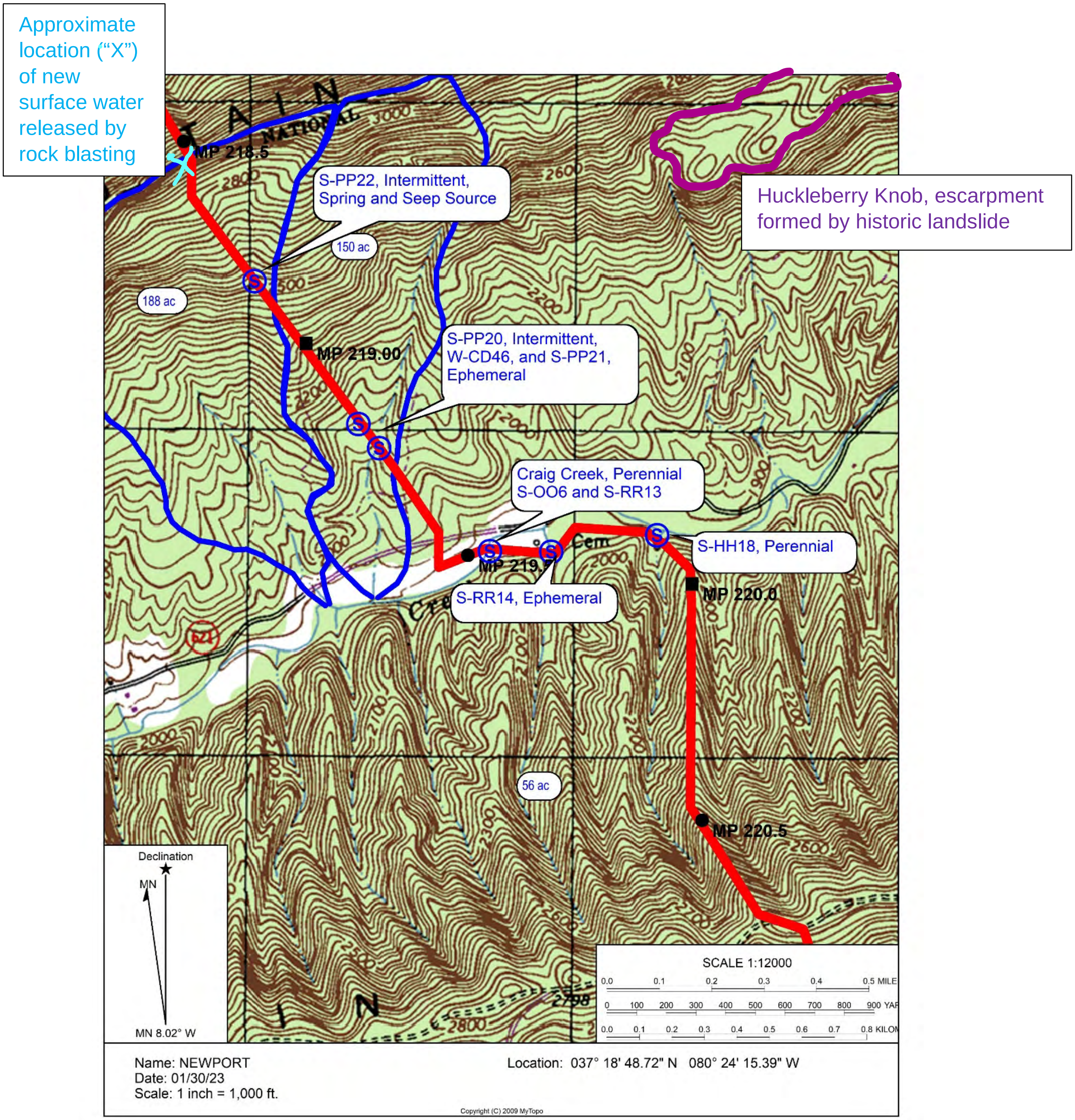
RUSLE and RUSLE2 are soil loss calculations and according to Dr. Czuba, the Geosyntech assessment underestimates the tonnage of soil that will erode from the MVP activity area. The Forest Service has failed to account for any soil loss in its assumption that vegetation will grow on the corridor and the predicted soil loss is underestimated according to Dr. Czuba.

There is some unaccounted-for water that is already having an erosive impact on the corridor. I investigated the conditions on the crest of Sinking Creek Mountain many times before construction and at distance after the rock crest was blasted with explosives. The blasting released a seep of groundwater that had been confined in rock. Now surface water, the seep has been flowing down the corridor on the rock face and under erosion control devices, as a small trickling spread-out perennial stream and contributing to the surface water burden of the temporary erosion and sediment control devices. The Forest Service has not identified the presence of this previously undetected water source or accounted for its impact on soil loss on the slopes of Sinking Creek Mountain.

Dr. Pamela C. Dodds plotted the water resources on the corridor in the JNF as those features were identified by Mountain Valley Pipeline in information provided to FERC in the certificate-application process (Dodds, Pamela C., Ph.D., LPG). In the figure on the following page, I used a copy of Figure 2.0-3 from Dr. Dodd's report and marked where I observed a seep that was released with blasting at the crest of Sinking Creek Mountain. This water source is not among those plotted using pre-construction field data because it was not released to the surface until the rock was blasted.

The current condition of the corridor is providing a laboratory for how soils impacted by construction will perform. The water bars that were made by compacting disturbed soil material with heavy equipment gain weight with an increase of water content, and freeze-and-thaw with temperature fluctuations, particularly on the south and east facing slopes. Since the soil material is no longer in its complex, native state the soil tends to crumble with the freeze/thaw cycles, contributing to the erosion processes.

Even in an undisturbed state, the southeast facing slope of Sinking Creek Mountain, through which the pipeline corridor is routed, is historically unstable. The Forest Service documented the landslide-prone mountain in a pamphlet titled, "The mountain that moved: geologic wonders of the George Washington and Jefferson National Forests." https://pubs.usgs.gov/gip/mountain/mountain.pdf. Also annotated to the figure on the following page is the location of Huckleberry Knob, which has an escarpment above and below the historic landslide resting place.



Copy of Figure 2.0-3 from Dr. Pamela C. Dodd's 2023 Hydrologic Assessment with the following added features: the location of Huckleberry Knob, which is an escarpment on the front of a historic landslide (drawn in purple) and the location of a "new" seep on the top of Sinking Creek Mountain that was released with rock blasting (aqua-colored "X").

In addition to erosion from water, the disturbed soils on the pipeline corridor are, and will continue to be eroded by wind. A concentrated wind tunnel effect was created by MVP with linear tree clearing. The construction at the crest of Sinking Creek Mountain has exacerbated the tunnel effect. At the crest, the rock was blasted through the hard Tuscarora sandstone to a depth of approximately 30 feet, creating a shelf of approximately 60 feet in length where the pinnacle of the armored crest had been. The tunneling phenomenon makes wind an erosion factor that has not been considered in soil loss estimates and soil productivity.

The trees and mountain ridge had buffered the effects of high winds for millennia before being cleared and dynamited by Mountain Valley Pipeline. Now the wind blows up the path of least resistance (bare, disturbed soil in the pipeline corridor) straight up the mountain to the blasted rock conduit at the ridge. Both sides dramatically channel wind up to the top or down the other very steep side of the mountain. Wind concentrated by the blasted area of the Sinking Creek Mountain will dictate erosion to both sides of the mountain.

Wind has the effect of drying out water in soil and vegetation. Wind pushes things down. And Wind pushes things downhill much faster if funneled with confining boundaries, such as rock or tree or soils.

Wind carries soil when soil is exposed due to disturbance. Depending upon the strength of the wind, clays can be carried thousands of miles into the Earth’s atmosphere. The red sunsets we see in the USA are Africa’s subsoil, in the air. Their topsoils were dispersed and transported long ago by wind, water, and poor management. Soils transported by wind are aeolian soils, loess, dust.

Wind has the effect of focusing attention on fragile environments, and fragile and slow life cycles in soils and its attendant vegetation and animals and water. The drying affect reduces habitat for at least 20 feet from a cut bank of soil, but the drying defines dying and that is likely to further destabilize the symbiotic associations that survive among fungi and plant roots.

The wind-tunneling forces up and down the extreme slopes further limit which vegetation can grow now versus which trees and vegetation grew before disturbance. Vegetation is measurable, and no data has been made available to show that it was ever properly measured or inventoried by qualified specialists on the ground. A once unique ecosystem with a riparian area that extends from the crest of the mountain to the banks of Craigs Creek will now be shaped by wind where there had been tree-and-rock-buffers from its forces. Wind twists trees, reducing their life cycles, shearing roots, which in turn reduces marketability, recreation safety, sources of animal food while leaving weakened trees to absorb nutrients from the soil.

Wind erodes soil by transporting exposed soil from one place to another, and possibly depositing soil in water, as sediment, the effects of which are described by Dodds and Czuba. All the soils crossed by the proposed pipeline on the JNF have wind erodibility susceptibility, that is, it does not take much to disaggregate the soils so that they fall apart, because that is their behavior when trenched or disturbed, and these properties are known by Forest Service staff and published in NRCS Official Soil Descriptions of those Soil Series.

Wind exacerbates soil erosion and further limits productivity on a pipeline corridor constructed through mature forests, up-and-down steep slopes, and over blasted mountain crests, which effects have not been considered.

The Forest Service cannot assume that post-construction soil conditions will support revegetation or restoration as defined by the Forest Service.

The disturbed soils in the pipeline corridor will never be as productive as pre-tree cutting. The corridor is not likely to ever support much more than moss and lichens without high inputs of expensive amendments to meet nutrient demands of transplanted seedlings. A good starting point is to know the productivity of the native soils, although no Order 1 Soil Survey was performed (as described in my November 2020 letter) and so no site-specific data is known for Forest Soil Nutrient Management.

Specifically, on Sinking Creek Mountain the MVP is routed through very hard, resistant acid sandstone, which creates acidic soils of low water holding capacity, low organic matter, low available nutrients for plants, is very confining to roots, and moves in the ground which shears roots.

The trees that grew in the pipeline corridor at the ridge of Sinking Creek Mountain, and have been cut down, were white oak and chestnut oak and red oaks and a few hickories and pine trees. The trees grew to approximately 50 feet tall and at least 100 years old. The Site Index, pre-construction, was probably Site Index of 50 to 60 (Service Forester's Handbook). The pre-construction conditions already limited the production capacity on many parts of the MVP corridor. The denuded, disaggregated, disturbed, redistributed, and eroded soils which would have no soil structure and no water holding capacity, would yield an even lower Site Index, meaning natural recovery of the forest in a degraded site may limit trees to thirty feet tall after 100 years.

Local Native Soils are primarily residual from rotten parent material rock or transported soils. The pipeline corridor spans several ranges of what was previously undisturbed parent material up on the slopes, with accumulations of transported soils on ledges and at the bottoms of the slopes.

Residual Native Soils in the Jefferson National Forest have a thick layer of leaves to walk through with cush underfoot of more decayed leaf matter and mineral soil with rocks. The mineral soils may have three to five distinct horizons of different colors, structure, texture or rocks over bedrock. These soils weathered according to climate, topography, organisms, parent rock material and time into the existent soils.

Native undisturbed soils have a spectrum of diverse organisms and microorganisms sharing space in a symbiotic environment of physical structure and multiple sets of processes of nutrient cycling.

Transported soils have either moved downhill by gravity or water. Where soils are thin, smaller roots form. Where soils have become thicker in zones of accumulation of transported soils, larger roots can grow, bigger trees. Variations in soil thickness change water holding capacity and stability and soil function. Undisturbed, living soils can perform functions that abiotic, post-construction soil-mix cannot perform.

The litter layer of leaves on a forest floor is important to the overall stability of the forest because of all the creatures living in that layer, supporting forest health and offering shelter for microclimates and animals living in the leaf litter. The leaf layer allows water to penetrate soil slowly, without erosion of particles. The decomposition of the leaf layer provides acids to the soils and recycles nutrients and carbon and stores carbon in the soil.

Native Hardwood forests can produce 2-45 tons/Acre/year of leaf litter that covers the forest floor (Properties and Management of Forest Soils). The pipeline right of way, and likely the entire corridor will produce zero (0) tons/Acre/yr of leaf little. The detritovores will not have organic matter to decay, and the whole microorganism food chain is collapsed which in turn affects nutrient cycling and availability for plants. Any trees that may grow in the corridor will never be as large or productive as those that have been removed, thereby further reducing the future nutrition that would come from decayed leaves.

MVP lists the soil types by the one-tenth mile increments. A linear mile is 5280 feet long. This implies that MVP relied on Order 2 published soil survey descriptions for information on soils by assuming every 528 feet the general map agreed with a spot check. This methodology fails to identify many physical properties of the soils that might inform efforts to replant vegetation. A more useful on-site sampling protocol would verify soils every 100 feet for a proper construction scale of 1:30 planning and construction.

Sampling and describing soils every 100 feet along and in the MVP construction corridor is appropriate to know what soil nutrients may be available. The Restoration Plan appended to the Plan of Development shows that plants intended for restoration prefer a soil pH that is higher than that of the native soils (Appendix H to the POD, p 9). One-time applications of fertilizer and agricultural lime as described in the Plan of Development will not have much effect, particularly the lime in changing the pH of forest soils in the JNF unless regular applications are made forevermore- or more than 25 years (Properties and Management of Forest Soils). That is to say, the damage to forest soils and the forest floor will last for more than 25 years and likely much longer than the MVP intends to operate, particularly if the pipe once constructed is later required to be removed.

The rock at the crest of Sinking Creek Mountain has already been blasted. The Forest Service would have to agree that growing trees on bare rock is tough, so the Sinking Creek Mountain crest that has irreparable damage and is now blast-fractured acid sandstone rock with numerous scattered water seeps and would now have zero productivity relative to before the construction started, and a challenge to establishing at least 80% vegetative cover.

The extraordinary soil disturbance required for pipeline construction disables the ecosystem functions and services of the native undisturbed soils. Hydric soil boundaries will change where dewatering redirects water and refocuses it elsewhere. There are no ecosystem services that can be attributed to pipeline construction that will help restore the native soils on the National Forest back to Forest Soils. Additions of lime and fertilizer will not restore the post-construction soil to its preconstruction condition. Supplements do not repair the structure.

The Forest Service defines restoration as “The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions” (36 C.F.R. § 219.19). The plan to add soil amendments and plant saplings and grass seed mixes will not achieve soil restoration under the Forest Service’s definition of restoration. Soil restoration is the foundation of ecosystem restoration (The Nature and Properties of Soils). The practices described in the Plan of Development may contribute to post-construction stabilization of the slope, as intended, but the practices will not restore the soil.

Furthermore, the proposed rate of fertilizer application is extraordinary, even if it were for the purpose of agricultural crop production on flat land. (Plan of Development, Appendix H, p H-7). The soil amendment rates stated in Appendix H to the POD far exceed the need of any agricultural production soil tested by me locally and regionally in my 35 years of experience. Compared to Forest Soils, agricultural soils have far greater nutrient replenishment requirements annually because each crop harvest removes nutrients. Functioning forest ecosystems hold their nutrients and symbiotically recycle and repurpose exudates.

The pipeline corridor is narrow and steep and easily eroded. No fertilizer is appropriate at the rates listed in Appendix H for the Forest Soils, especially in a narrow steep wet corridor with highly disturbed construction-soil. The disturbed soil has little or no binding sites to which the nutrients can bond. Most of the soil amendments applied at the rates in Appendix H would run off the corridor and accumulate at the bottom of the slopes and/or runoff into water courses, the consequences of which have not been considered.

Fertilizers should not be applied until laboratory soil tests results recommend fertilizers. Further, there are few slopes in JNF suitable for disking the soils to incorporate the fertilizer. Fertilizer not incorporated into the soil misses its target vegetation, is mineralized, or is unavailable to plant roots unless placed next to the roots.

Suitable fertilizer additions can create temporary improvement in site quality which may spur short term growth. However, some plants may take up some nutrients, others will not, which creates an imbalance between species. Excess nutrients can make trees more susceptible to insects, more palatable to deer browse, and decrease soil mycorrhizae depending on soil conditions which impacts the availability of nutrients. (Properties and Management of Forest Soils, see Chapter 20, Effects of Antropogenic [sic] Chemicals on Forest Ecosystems, pp 376-377).

The pH of Forest Soil may not be affected by lime (Properties and Management of Forest Soils, p 269). Although the Forest Service includes lists of recommended species of tree and shrub saplings for revegetation with associated soil pH needs and instructions for placement when planting, there are no guidelines for soil testing to assure suitable pH and rate of supplemental nutrition at the time of transplanting (POD, Appendix H, Attachment H-4). In Appendix H, page H-8, MVP states, "Soil chemistry tests will be conducted in areas where revegetation potential is low or revegetation is unsuccessful. The fertilizer and liming rates described above will be adjusted accordingly based on the results of site-specific soil tests. Soil chemistry data will be submitted to the FS following testing, and any modifications to the fertilizer or lime application rates described above will be provided to the FS for approval prior to use."

Rather than waiting until after revegetation has failed as proposed by MVP, the standard practice is to test the soils before the soils are disturbed and with the extreme disturbance proposed for the MVP, also prior to attempted revegetation. If the Forest Service were honest about the post-construction soil conditions, it would admit that the revegetation potential is low and revegetation will be a challenge across the JNF, thereby requiring soil testing before any attempt at revegetation across the entire corridor.

In standard practices, soil supplementation should be applied with as much precision as possible to avoid over-application which will result in nutrient runoff, particularly on the slopes of the JNF, and unnecessary financial expenditure.

The Forest Service notes the need for transplants to be watered but there is no plan for watering the transplants across the corridor on the JNF. The Forest Service did not consider revegetating with nitrogen-fixing plants and soil-conserving plants to reduce fertilizer use (Properties and Management of Forest Soils p 299, see nutrient-depleted sites), and plants with a lower water demand which may be more suited to the post-construction dewatered slopes.

The Soil Surveys for Giles and Montgomery Counties (cited by MVP in "Mountain Valley Pipeline Soil Profile Descriptions Report for Jefferson National Forest" April 2016) include both general and cautionary guidance for specific land uses, and particularly where water management is a construction goal, which guidance has not been considered in the proposed pipeline construction activity on the JNF. (Soil Survey of Montgomery County, p 9, 55, and Table 7 "Woodland Management and Productivity"). The productivity, stability, and limitations of these soils are predictable. Nevertheless, there is no scientific basis for the stated plans for post-construction soil supplementation.

I have casually observed from a distance the appearance of the Columbia gas pipeline on the east and west slopes of Peter's Mountain in Giles County, Virginia and

Monroe County, West Virginia, which pipeline also was constructed on the JNF. I have also reviewed aerial photography of the corridor (Dominion Pipeline Monitoring Coalition). Some grasses that were planted post-construction grew for a season, however, in subsequent years and until the last time I saw it in the fall of 2022, the corridor has appeared barren and denuded. The current condition of the Columbia gas pipeline does not appear to be restored as defined by the Forest Service and it is the best representation of the potential for the restoration of soil structure and productivity on the proposed route of the MVP.

Whatever tools used to predict what would happen to the disturbed Forest Soils, were either not properly used or not properly interpreted or fully ignored. Given the complexity and importance of the forest floor to the stability of Forest Soils, the Forest Service cannot assume or reasonably predict that the once-forested corridor will be restored to anything comparable to the surrounding undisturbed area.

I wish to support and integrate my observations and knowledge with my colleagues, Dodds' and Czuba's good work.

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Professional Field Excursions which covered Mt. Lake, Canoed the New River to study river deposits, explored Damplands, Intermittently Wet Lands, and Wetlands around Sinking Creek Mountain including Huckleberry Knob and Newport, Virginia", in part of two Field Excursions: Virginia Association of Professional Soil Scientists in June 2002 and South East Friends of the Pleistocene April 2015, 13 years later.

Professional Profile

Nan Gray, LPSS
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- RELEVANT EXPERIENCE

1988-Present

General Practitioner of Soil Science since 1988, when I started Soil Works, Inc., consulting in field mapping soils and landscapes for land uses such as conservation easements, road layout, fracture trace analysis, water well siting, shrink-swell clay problem solving, soil and geomorphic interpretations, agronomic practices, karst, wetland delineations, septic drainfield suitability and design, pond and dam material suitability, farming, erosion and sediment control, GPS and GIS mapping, nutrient and pollution movement in soils.

Soil Works, Inc. was a Small, Woman and Minority (SWaM) owned business and a Disadvantaged Business Enterprise (DBE) with Virginia Department of Transportation until recently. I provided professional soil science services for a variety of land uses to the Private Sector and to Government Agencies.

1986-1988 Chemist/Laboratory Manager, Coal Laboratory and Forest Soils Laboratory, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
1983-1986 Graduate Student in Agronomy and Chemistry Tutor, U of Illinois, Champaign, Illinois
1982-1983 Technician, Soil Characterization Laboratory, University of Illinois, Champaign, Illinois

- EDUCATION

MS, Agronomy, University of Illinois
BS, Chemistry, Wilmington College, Ohio

Continuing Education through Virginia Polytechnic Institute and State University (Virginia Tech), North
Carolina State University, Virginia Association of Professional Soil Scientists (VAPSS), Virginia
Department of Health, Virginia Geological Field Conferences, Southeast Friends of the Pleistocene Field
Excursions, National Society of Consulting Soil Scientists, Soil Science Society of America, Geological Society of America, Family and Friends

- PROFESSIONAL LICENSES

Licensed Professional Soil Scientist (LPSS) in Virginia and North Carolina

Master Alternative Onsite Soil Evaluator License (MAOSE) in Virginia

- PROFESSIONAL MEMBERSHIPS

Soil Science Society of America

Virginia Association of Professional Soil Scientists (past-President, Board Member)

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 107

February 21, 2023

Report-- Thos. Campbell

In the annals of the Appalachian Trail Conference the triennium 1964-67 will be known as the era of negotiations, or else the beginning of that era. Within the territory in which I am particularly interested there have been repeated interviews with land owners, with state and federal legislators, and with local, county, state and federal officials -- all with the intent of forestalling or warding off threatened or actual encroachments on the Appalachian Trail. Success has attended these efforts --- in part.

There are those of us who have an active part in the construction of new segments of the Appalachian Trail. The feeling is that they are our own creation; in consequence we feel a peculiar attachment to these particular segments. It is with some foreboding, then, that we contemplate the inevitable: if the Trail is to survive, these segments along with the rest of the Trail must become part of a Federal system. No parent is quite at ease when the care of his child is turned over to strangers.

Possibly at some future date the manufacture of automobiles and road construction will reach a saturation point, and the tide of spreading suburbia will reach a peak and recede toward the central cities. Perhaps at that time the wilderness will be reborn, and the Trail returned to those who have cared for it these many years. Its a thought, anyway.

During the triennium we have accepted with regret the retirement of the Rev. A. J. Shumate AND his boys of Grace Lutheran Church, Rural Retreat, Va. as Trail maintainers. The Rev. Shumate volunteered and gave much assistance during the construction of the lengthy Southwestern Virginia relocation.

Welcomed to the Conference in the same area were the Piedmont Appalachian Trail Hikers of Greensboro, N. C.

It had been hoped that the completion of a seventeen mile relocation could be reported at this meeting. Relocation will move an extensive section of Trail in Giles County, Va. from valley roads to the crest of Peters Mountain. The section, although difficult of access, contains at Symms Gap one of the most beautiful views east of the Mississippi. Relocation has been beset with more delays, difficulties and frustrations than any other in Conference history. To avoid any road walking whatsoever it had bean planned to locate the southernmost mile and a half across a minor elevation known asx Hemlock Ridge. Some six weeks ago I received from the company owning this land a form of agreement for Trail access. Contained therein was an indemnity provision which made it impossible for me to sign.

On Wednesday, May 17, I received a second form of agreement from the company. We may now proceed. The indemnity provision had been deleted.

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 108

February 21, 2023

United States Department of the Interior

NATIONAL PARK SERVICE
Appalachian National Scenic Trail
P.O. Box 50 (Deliveries: 252 McDowell St.)
Harpers Ferry, WV 25425

November 2, 2020

To: Regional Environmental Officer, Philadelphia, PA
Office of Environmental Policy Compliance (OEPC)

From: Wendy K. Janssen, Superintendent, Appalachian National Scenic Trail
DOI – Region 1, National Park Service

Re: Comments on the USDA Forest Service - Jefferson National Forest (JNF) Draft Supplemental Environmental Impact Statement (DSEIS) for the Mountain Valley Pipeline (MVP) Project

The National Park Service (NPS) has reviewed the Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (DSEIS). Mountain Valley, LLC, seeks approval from the USDA Forest Service and the Bureau of Land Management (BLM) to construct and operate a 42-inch natural gas pipeline across approximately 3.5 miles of the Jefferson National Forest (JNF). Approval of the project requires a project specific Land and Resource Management Plan (Forest Plan) amendment and a right-of-way (ROW) grant from the BLM to cross the JNF.

The Forest Service's proposed action is to amend the JNF Forest Plan as necessary to allow for the MVP to cross the JNF. The BLM proposed action is to issue a temporary use permit and ROW grant for the pipeline across Forest Service and the Weston and Gauley Turnpike on U.S. Army Corps of Engineer lands. Generally, the proposal entails use of a 50-foot-wide permanent ROW and a 125-foot-wide temporary construction ROW. The Forest Service would provide construction, operation, and maintenance terms and conditions, or stipulations to be included in BLM's temporary use permit and ROW grant to protect the environment and the public.

The DSEIS supplements the June 2017 Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement and focuses only on key issues that are relevant to the decisions to be made by the Forest Service and the BLM that have not already been analyzed in the 2017 FERC FEIS. The three key issues analyzed in the DSEIS analysis are: (1) The purpose and effect of the Forest Plan amendment on the utility corridor management area and resources including soil; riparian; water; threatened and endangered species; old growth; the Appalachian National Scenic Trail (ANST); and scenic integrity; (2) The feasibility and practicality of utilizing ROWs in common on federal land; and (3) The potential for erosion, sedimentation, and adverse water quality effects in relation to the anticipated effectiveness of mitigation measures, and a disclosure on how previous Forest Service comments submitted to the FERC on erosion and sedimentation have been addressed and remedied.

The NPS offers the following comments on the DSEIS related to key issue item number 1 regarding the effect of the Forest Plan amendment on the utility corridor management area and the ANST.

Overall, eleven Forest Plan standards on the JNF are proposed to be amended to make the project compliant. Two of these amendments, Standards 4A-028 (Appalachian National Scenic Trail [ANST] and utility corridors), and FW-184 (Scenic Integrity Objectives) address the ANST. Standard 4A-028, which specifically addresses the ANST, requires that new public utilities and rights-of-way be located in areas where major impacts already exist and that linear utilities and rights-of-way be limited to a single crossing of the prescription area, per project. The Forest Service proposes to revise this standard in the Forest Plan to allow an exemption to this requirement for the MVP project. Similarly, the Forest Service proposes to amend Standard FW-184 to allow an exemption specifically for the MVP project of the Forest Scenic Integrity Objectives (SIOs) that govern all new projects for five years following construction.

The NPS provided comments on the Draft Environmental Impact Statement for the Mountain Valley Pipeline Project in December 2016. While many of our comments expressed at that time have been addressed, we continue to have concerns regarding the proposed Forest Plan amendments listed above. The NPS as administrator of the ANST, encourages consistency in planning for the protection of the ANST in all the national forests it crosses. Revising the Jefferson National Forest Plan to lower protections in place for the ANST in order to accommodate a proposed project diminishes the standard of Trail protection in the JNF and could set a precedent for future similar actions in other national forests.

The NPS commends the Forest Service and MVP for outlining in great detail in the Plan of Development (POD) scenery mitigation measures designed to re-attain High Scenery Integrity Objectives (SIO) on forest lands within five years of construction of the pipeline. The NPS continues to support finalization of plans to apply similar scenery mitigation measures on certain private lands the MVP ROW crosses to further reduce the impacts on the recreation experience of ANST users. These limited areas of restoration within the cleared ROW visible from the ANST were being identified and discussed during consultation under the MVP Programmatic Agreement. We are very appreciative of this effort and look forward to confirming agreed upon restoration measures.

Thank you for the opportunity to provide comments. If you have any questions or need additional information, please contact Mary Krueger, Energy Specialist for the Northeast Region at mary_c_krueger@nps.gov or 617-223-5066. When submitting material regarding MVP for our information and/or review, please submit copies to Mary Krueger and Denise Nelson (denise_nelson@nps.gov).

Sincerely,

Wendy K. Janssen
Superintendent

The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 109

February 21, 2023

Appalachian National Scenic Trail

A Special Report | *March* 2010

National Parks Conservation Association®
Protecting Our National Parks for Future Generations

STATE
◆ OF THE ◆
PARKS®

Center for State of the Parks®

More than a century ago, Congress established Yellowstone as the world's first national park. That single act was the beginning of a remarkable and ongoing effort to protect this nation's natural, historical, and cultural heritage.

Today, Americans are learning that national park designation alone cannot provide full resource protection. Many parks are compromised by development of adjacent lands, air and water pollution, invasive plants and animals, and rapid increases in motorized recreation. Park officials often lack adequate information on the condition of critical resources.

The National Parks Conservation Association initiated the State of the Parks program in 2000 to assess the condition of natural and cultural resources in the national parks. The goal is to provide information that will help policymakers, the public, and the National Park Service improve conditions in national parks, celebrate successes as models for other parks, and ensure a lasting legacy for future generations.

To learn more about the Center for State of the Parks, visit www.npca.org/stateoftheparks or contact: NPCA, Center for State of the Parks, P.O. Box 737, Fort Collins, CO 80522; phone: 970.493.2545; email: stateoftheparks@npca.org.

Since 1919, the National Parks Conservation Association has been the leading voice of the American people in protecting and enhancing our National Park System. NPCA, its members, and partners work together to protect the park system and preserve our nation's natural, historical, and cultural heritage for generations to come.

- More than 325,000 members
- Twenty-four regional and field offices
- More than 120,000 activists

Contents

MIKE ELLERY

On the cover: A.T. shelter in Vermont near Bourne Pond ©iStockphoto.com/Dan Barnard; yellow lady slipper by Philip Jordan; hiker at Baker Peak, Vermont by Laurie Potteiger. Above: Trail Days in Damascus, Virginia.

A special note of appreciation goes to those whose generous grants and donations made this report possible: John Ben Snow Memorial Trust, MARPAT Foundation, Inc., MSST Foundation, Seraph Foundation, Ben and Ruth Hammett, Alec Rhodes, Lee and Marty Talbot, and anonymous donors.

Introduction

BENJAMIN TUPPER

Meandering some 2,178 miles between Springer Mountain in Georgia and Mount Katahdin in Maine, the Appalachian National Scenic Trail (A.T.) is the United States' most beloved recreational footpath. The trail follows the spine of the Appalachian Mountains, passing through 14 states and six national parks, eight national forests (which contain 1,015 miles, or 47 percent of the trail), two national wildlife refuges, 67 state-owned land areas (e.g., game lands, forests, or parks), and more than a dozen local municipal watershed properties. The Appalachian Trail's protected corridor (a swath of land averaging about 1,000 feet in width) encompasses more than 250,000 acres, making it one of the largest units of the National Park System in the eastern United States. The trail passes through some of the most significant and rare ecosystems remaining along the East Coast.

The Appalachian Trail provides solitude, quiet, and a wilderness-like experience that is accessible to millions of residents on the Eastern Seaboard. Those living in cities such as Boston, New York, Philadelphia, Baltimore, Washington, D.C., and Atlanta are within a few hours' drive of trailheads. Each year, approximately two million hikers walk some portion of the trail, whether it be a mile, the entire length, or something in between. They are drawn to the trail for myriad reasons: recreation and exercise, wildflower and wildlife viewing, and spiritual and psychological renewal. The A.T. serves as a gathering place for old friends and provides ample opportunities for hikers to make new ones. The trail offers opportunities, challenges, obstacles, goals

America needs her forests and her wild spaces quite as much as her cities and her settled places.

—Benton MacKaye
Appalachian Trail visionary

©ISTOCKPHOTO.COM/JOEL CARILLET

Wooden signs, along with more than 165,000 painted blazes on trees, help hikers stay on the trail.

NATIONAL PARK SERVICE

Key Findings

- **Incompatible development threatens trail resources and integrity.** The narrow, linear nature of the trail corridor, coupled with its prime location along the crest of the Appalachian Mountains, leaves it susceptible to an array of development threats, such as pipelines, power lines, racetracks, quarries, residences, and energy-producing wind turbines. Increasing motorized off-road vehicle and mountain bike use along the narrow boundaries of the A.T. also represents a perennial challenge that threatens both natural and cultural resources, as well as the visitor experience.

- **Trail protection efforts must be ongoing and will evolve.** The state and federal land protection efforts for the Appalachian Trail sparked by the 1968 National Trails System Act have been remarkably successful in securing a continuous protected corridor around the trail between Maine and Georgia, but this slender thread of protected land will not be enough to protect the A.T. in perpetuity. While there will be some opportunity in the years ahead to protect additional high-value conservation lands, the next era of trail protection must involve raising awareness of the trail and its value in neighboring communities and influencing local land uses. The Commonwealth of Pennsylvania took an important step in 2008 when it passed a law requiring municipalities and counties through which the A.T. passes to enact ordinances to protect trail values. Appalachian Trail managers recognize the significance of this legislation and will support efforts to enact similar legislation in other states.

- **Increased recognition of the Appalachian Trail as a valued part of our national heritage would enhance protection.** The Appalachian Trail is eligible for listing in the National Register of Historic Places or even designation as a national historic landmark. Such listing or designation would help to increase the trail's visibility, and it also would contribute to resource protection by allowing A.T. managers to apply for funding that is designated for listed properties. In addition, the listing would help to ensure that an appropriate level of review and adequate mitigation is achieved for projects with the potential to harm the trail. Managers are pursuing National Register designation. Perhaps more significantly, the Appalachian Trail Conservancy and the National Park Service are advancing programs such as *A Trail to Every Classroom* and the *Community Partners Program*. These programs raise awareness of and appreciation for the A.T. as a resource that is a part of community history and contributes to the quality of life of the people and communities through which it passes.

- **Appalachian Trail resource managers need more and better information.** While the Appalachian Trail is well known as a continuous footpath spanning the Appalachian Mountains between Georgia and Maine, it is less well known for the wealth of natural and cultural resources harbored within its protected corridor. These resources would benefit from further study. Recent recognition of the A.T. as an important "mega-transect" for environmental monitoring purposes—because of the unique piece of geography that it occupies and its icon status—gave birth to the A.T. MEGA-Transect project, a citizen science-based program sponsored by NPS and ATC that uses the A.T. to engage citizens and others in monitoring a variety of critical indicators of environmental health, important not only to good management of the A.T., but to the overall ecological health of the region. The A.T. and its protected corridor also provide a laboratory well suited to study the effects of climate change.

to be reached, and something to measure oneself against. In addition to providing recreational opportunities and enjoyment of the outdoors, the trail offers visitors a wealth of cultural resources. America's heritage, in the form of historic structures, cultural landscapes, and archaeological sites, is located along the Appalachian Trail.

This report by the National Parks Conservation Association's Center for State of the Parks provides a brief overview of the history of the Appalachian National Scenic Trail, an explanation of how the trail is managed, descriptions of the trail's natural, cultural, and recreational resources and the challenges they face, and recommendations for how to bolster current efforts to protect and preserve this American icon.

A Unique Concept Takes Shape

The Appalachian Trail began as the vision of one man, a landscape architect named Benton MacKaye, who outlined his plan for a trail along the Appalachian Mountains in 1921. MacKaye was concerned about loss of habitat and wildlife, diminishing recreational opportunities, and deteriorating environmental health for the eastern United States, as well as the effects of these changes on area residents. He envisioned more than a mere footpath, but rather a system of protected land dotted with mountaintop lodges where easterners could reacquaint themselves with nature in their own backyards. MacKaye organized and convened the first conference of Appalachian Trail enthusiasts in Washington, D.C., in 1925. The assembled gathering of hikers, foresters, and public officials embraced his vision of creating a primitive trail experience in proximity to the urban centers of the eastern United States. They began by creating the organization that later became the Appalachian Trail Conservancy (ATC).

The first section of the trail was constructed in Harriman and Bear Mountain State Parks, New York, in 1923. Under the guidance of ATC chairman Myron Avery, thousands of volunteers constructed the Appalachian Trail throughout the 1920s and 1930s. By 1937 a continuous footpath from Maine to Georgia was completed. During the 1930s and 1940s, the Civilian Conservation Corps (CCC) built much of the original infrastructure along the trail, including rock walls and steps, cabins and shelters, and fire towers.

The protected corridor surrounding the Appalachian Trail today is a direct result of a 30-plus-year land-acquisition program pursued by the National Park Service, U.S. Forest Service, and a number of states, supported primarily by federal Land and Water Conservation Fund (LWCF) appropriations. While some lands along the trail—primarily inholdings within the national forest system—were acquired following the initial National Trails System Act of 1968, most have been acquired since amendments to the act were adopted in 1978.

Specifically, the National Park Service has acquired 111,485 acres, the U.S. Forest Service has acquired 56,457 acres, and various states have acquired 19,493 acres for a total of 187,435 acres. Thousands of additional publicly owned acres bring the total protected area of the Appalachian Trail to more than 250,000 acres. This total includes lands specifically acquired for the Appalachian Trail and lands that are managed primarily for trail purposes on other federal- and state-administered lands. The Appalachian Trail's land-acquisition program has been both consistently funded and successful in acquiring land for the trail.

The Appalachian National Scenic Trail is unique from other park units in several ways: It was established, constructed, and continues to be maintained, rebuilt, relocated, supported, and protected by dedicated volunteers; it is managed by a consortium of private organizations and public agencies; and it has an unusual shape—a long, thin swath of land that traverses along the ridges of the Eastern Seaboard.

COURTESY OF THE APPALACHIAN TRAIL CONSERVANCY

Benton MacKaye (left) and Myron Avery in 1931. Avery helped bring MacKaye's vision of the trail to fruition.

Volunteers are the lifeblood of the Appalachian Trail. In addition to those who built the trail and those who maintain it, a host of economists, scientists, and planners lend their expertise to A.T. managers in efforts to protect the trail. In 2008 approximately 6,000 volunteers devoted more than 200,000 hours to maintain and manage the Appalachian Trail, participating in projects that included trail maintenance and building, data collection, invasive non-native species removal, rare plant and natural community monitoring, boundary maintenance, and a variety of other natural resource monitoring and management activities. The work of these volunteers is guided and supported by the Appalachian Trail Conservancy and its 30 affiliated trail-maintaining clubs.

Trail Management via Public-Private Partnership: A Model of Cooperation

Managing the Appalachian National Scenic Trail has required a herculean effort since the trail's inception. Responsibility for trail management has varied over time but has always depended upon partnerships between public and private entities. Today, two entities work together to oversee the entire length of the Appalachian National Scenic Trail: the Appalachian Trail Conservancy (ATC), a private nonprofit established in 1925, and the National Park Service (NPS). (With about one-half of Appalachian Trail lands within its borders, the U.S. Forest Service is also a major manager of the Appalachian Trail.)

The roles and responsibilities of the ATC and the NPS's Appalachian Trail Park Office (ATPO) have been outlined within a memorandum of understanding that dates back to 1984 and that has been renewed periodically. The ATC is responsible for day-to-day management of the Appalachian Trail, coordination of 30 independent trail-maintaining clubs, financial management and fundraising for the trail, maintenance of the trail and its associated structures, and stewardship of the lands through which it passes. The ATPO retains primary responsibility for federal land acquisition, boundary surveys, issuance of special use permits (i.e., permission required for uses ranging from hang gliding to conducting natural resource research on federal land), law enforcement, environmental compliance, and overall administration of more than 85,000 acres of federally acquired Appalachian Trail lands.

This partnership between the ATC and the NPS represents the definition of synergy: Together the two organizations can accomplish much more than either could do alone. Being a part of the National Park System provides the Appalachian Trail with federal protection and funding. Yet, the Park Service could not maintain the trail without the tireless contributions of the ATC, its trail-maintaining clubs, and numerous volunteers, as well as the private funds poured into these efforts. The arrangement is considered a model for public-private collaboration in conservation and stewardship of nationally significant public lands.

Although the ATC and ATPO oversee the management of the trail along its entire length,

NY-NJ TRAIL CONFERENCE

A young volunteer helps with trail improvement at Bear Mountain State Park in New York.

Recommendations

- **Increase funding:** Additional federal funding is needed to support necessary natural and cultural resource inventories and associated resource interpretation, as well as to pursue National Register designation.
- **Fully protect trail:** Today the goal of a permanently protected Appalachian Trail footpath owned entirely by the public is within reach. Just over 10 miles of the trail are not publicly owned—only about 150 properties remain to be protected on the trail in order to reach this goal.
- **Continue adding high-priority lands to protected trail corridor:** Some privately owned lands bordering the Appalachian Trail have special natural or cultural resource significance, or are otherwise important to the trail experience. Including these lands within the Appalachian National Scenic Trail is important so that their resources can be protected by A.T. managers and enjoyed by trail visitors. A primary way that A.T. managers protect additional lands is through support from the Land and Water Conservation Fund (LWCF), a federal program that provides funds for land acquisition and easements, among other resource projects. The A.T. has significantly benefitted from LWCF-supported appropriations, and funding should be accessed in the future for selected properties possessing important natural or cultural resources. Continued congressional support for the LWCF with funds directed toward protecting the Appalachian Trail corridor will allow managers to improve protection of the A.T.'s resources.
- **Continue to vigorously defend the A.T. from impacts of external projects and identify appropriate mitigation to offset unavoidable impacts:** Decisions affecting the placement and design of roads, electric-transmission corridors, wind-energy projects, wireless-communications facilities, and other development should reflect recognition of the special and fragile character of the A.T., its resources, and adjacent landscapes. Potentially acceptable crossing locations for road and energy projects should be identified, and so should treasured trail landscapes where such proposals will not be entertained. As society strives to create a sustainable energy future and balance competing needs, substantial and meaningful mitigation must be identified to compensate for unavoidable impacts.
- **Celebrate the Appalachian Trail's remarkable private support:** Federal funds support less than half of the annual cost of managing the Appalachian Trail. The balance comes from the Appalachian Trail Conservancy, its members and supporters, and from its affiliated clubs and their volunteers. Decades ago, the ATC formally accepted delegated management responsibility for the NPS-acquired public trail corridor lands, and must raise funds to carry out those responsibilities. The ATC needs ongoing support to continue to provide longstanding, large-scale programs such as its seasonal trail crew and Ridge Runner programs, as well as to expand its community-outreach programs.

TED MARTELLO

D L ENNIS

DESTRY JARVIS

Top: Volunteers help paint blazes to mark the trail.

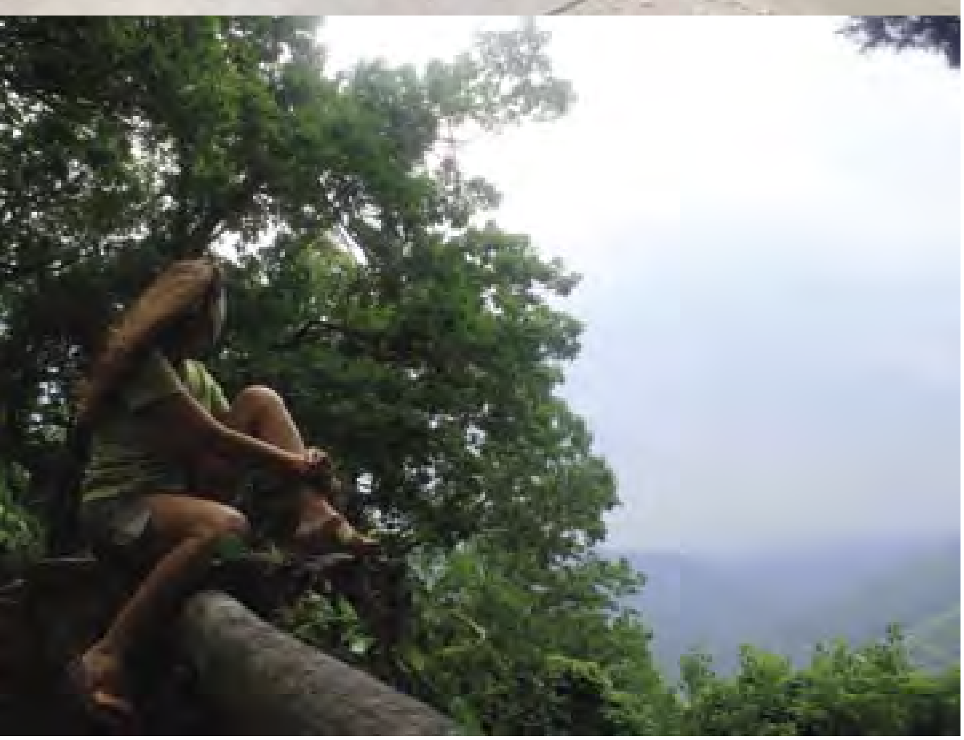
Middle: A hiker enjoys the scenery along the trail.

Bottom: The ATC Mid-Atlantic Regional Office in Boiling Springs, Pennsylvania.

myriad other public agencies—including national parks, national forests, the Tennessee Valley Authority, state parks, state game commissions, state forests, state highway departments, county parks, town parks, and water reservoir authorities—administer portions of the trail corridor. Understandably, the sheer number of organizations and differences in mandates and administrative policies can make decision-making and planning complicated. The ATC and ATPO strive to encourage some consistency in management along the trail, primarily through a series of memorandums of understanding and special management-area designations in forest plans. In addition, the ATC has produced a local management planning guide, which is a compendium of trail-management policies.

The most significant factor affecting a park's ability to protect its resources is the annual funding it receives from Congress. Through the unique management partnership between the National Park Service and the Appalachian Trail Conservancy, these organizations can share resources, but difficult decisions must be made on how this limited funding is spent. Furthermore, because the trail passes through lands administered by a host of different federal, state, and local agencies, a reduction in one of these agency's budgets shifts the burden onto the other partners, making it difficult for them to achieve their goals for resource management programs and trail protection. Private funding sources are integral to managing and protecting the trail, but acquiring private funding is sometimes difficult because of the misperception that the trail is adequately protected due to its status within the National Park System. The ATC and its affiliated clubs provide about $3 million annually in contributed volunteer services to the trail.

BUNNY MEDEIROS



LB BRYANT

Above: A hiker takes a break from the trail to visit the Damascus, Virginia, branch library, dubbed "the friendliest little library on the trail."

Below: A hiker looks out over a spectacular view of the Blue Ridge Mountains.

A Reason for Continued Protection

CARL HAGELIN

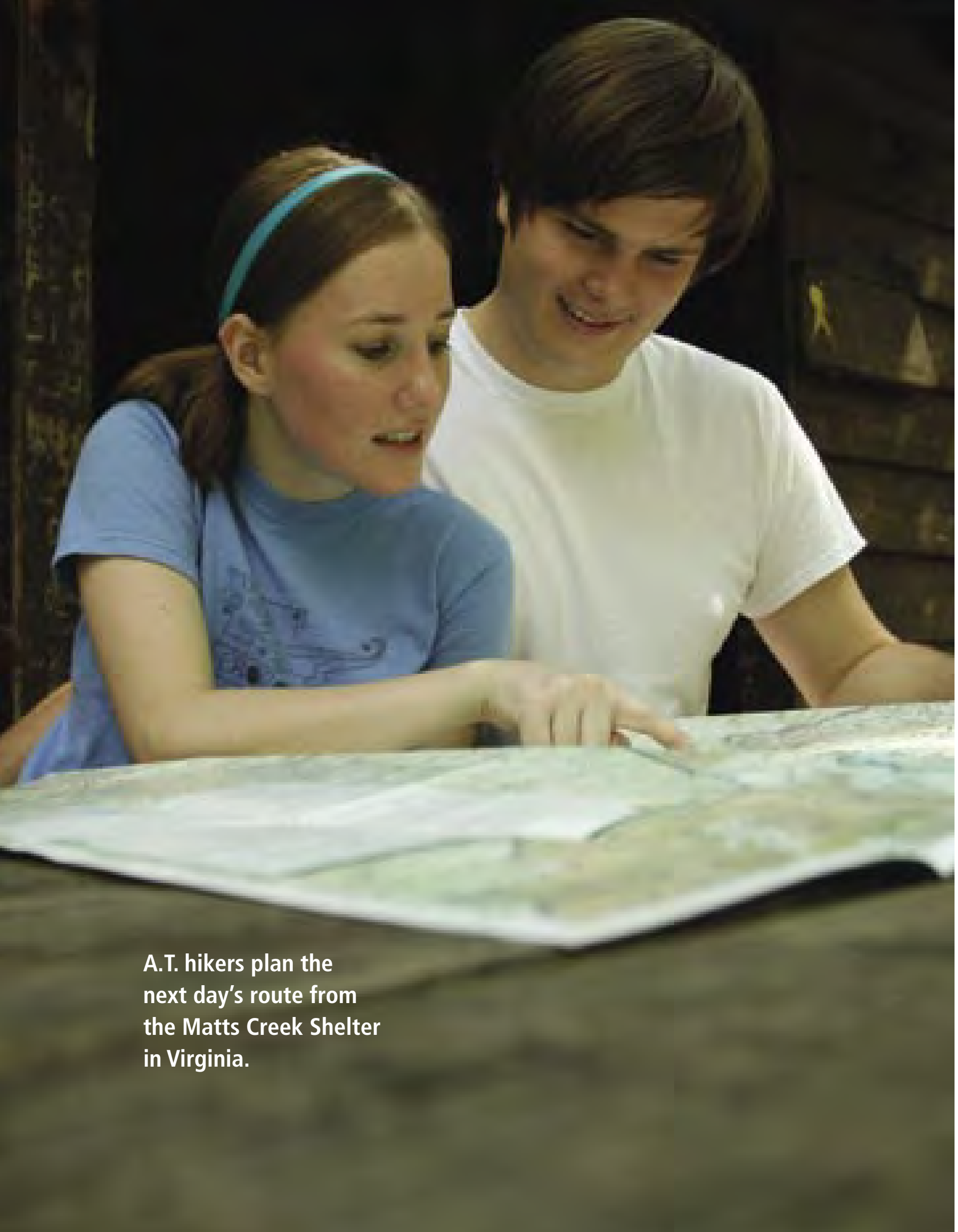
Hikers walk along a wooden boardwalk in New Jersey, built to protect sensitive natural resources and help hikers navigate flood-prone areas.

Natural and Cultural Resources Abound Along the Trail

Traversing the ridges of the Appalachian Mountains and passing through countless valleys, ravines, gaps, forests, and meadows, and crossing numerous streams, creeks, seasonal rivulets, ecosystems, habitats, and microclimates, the Appalachian Trail has the capacity to serve as an indicator of the health of the natural resources of the entire Eastern Seaboard. You can assess this vast area by examining the scenic landscapes, fragile and rare habitats, flora and fauna, soils, watersheds, waterways, mountains, meadows, and alpine habitats. The Appalachian Trail serves as a protected corridor along which plants and animals can move—a feature that could prove to be critical in the future if climate change projections are realized and plants and animals must migrate to survive.

At this time, not enough is known about the current condition of the trail's diverse natural resources—plants, wildlife, and ecosystems. Formal natural resource data collection is costly and requires coordination among many agencies along the trail's 2,178 miles and associated protected lands. Time, funding, and staffing limitations constrain the amount of natural resource data that can be collected. Resource managers are addressing these limitations through an initiative called the MEGA-Transect program (see "Appalachian Trail MEGA-Transect Program" on page 12).

Even less is known about the trail's diverse cultural resources, such as historic structures, archaeological and historic sites, and paleontological resources. This overall lack of knowledge, as well as conflicting trail uses and



A.T. hikers plan the next day's route from the Matts Creek Shelter in Virginia.

KATIE ROBINSON

encroaching developments adjacent to the A.T. corridor, puts the trail's significant resources at risk. Conducting trail-wide cultural resource inventories would be a first step toward identifying resources and protecting them. Some site-specific inventories of cultural and archaeological resources have been completed prior to activities such as shelter construction, but what's stopping trail-wide inventories is primarily a lack of funds. Similar funding shortages face many other national parks, also preventing them from conducting comprehensive inventories. Faced with the realities of limited funds and multiple threats, protecting the trail's known cultural resources takes top priority for A.T. resource managers, while expanding the search to identify additional resources remains secondary.

Regardless of the condition of the trail's unmeasured natural resources and those cultural resources that have yet to be discovered, land managers do know that a number of issues threaten the Appalachian Trail and the hiking experience. The trail's shape and length leave it vulnerable to incompatible adjacent development and inappropriate use (e.g., off-road vehicle use), and the proliferation and entrenchment of invasive non-native plant species is facilitated. Maintaining trail land corridor boundaries, monitoring natural resource threats, and coordinating goals and tasks are also significant challenges due to the multitude of management partners that oversee the Appalachian National Scenic Trail.

Goal Within Reach

Since the passage of the 1968 legislation establishing the Appalachian National Scenic Trail and the subsequent 1978 amendments expanding the land acquisition authority for protection of the A. T. corridor, it has been the goal of the National Park Service and trail advocates to have a permanently protected footpath that is entirely in public ownership. Today that goal is within reach. Of the more than 2,100 miles of the A.T., just over 10 miles are not owned by NPS, the Forest Service, or one of the states or municipalities through which the trail passes. Only about 150 properties remain to be acquired on the trail in order to reach the goal. The NPS and the Appalachian Trail Conservancy will also continue to take advantage of opportunities to expand the zone of protection along the A.T. where particular conservation values or significant scenic viewsheds are at stake.

GARY SZELC

The A.T. appeals to people of all ages, and it provides opportunities for families to spend time together.

JEFF ZIMMERMAN PHOTOGRAPHY

Sunrise breaks over the splendid natural resources of the Grayson Highlands in Virginia.

NATURAL RESOURCES—
Trail Corridor Includes Many Habitats and Myriad Species

An incredible array of natural resources—plants, animals, habitats, soils, scenic vistas, rivers, and streams—is located within the swath of land encompassed by the Appalachian Trail corridor. These resources not only comprise the hiking experience, but also provide valuable ecosystem services. For example, forests along the Appalachian Trail corridor give hikers a sense of isolation while anchoring the watersheds that provide drinking water to more than 10 percent of the nation's population. The Appalachian Trail passes through eight distinct ecoregions (i.e., areas defined by environmental conditions and natural features) and at least 14 major forest types, including some of the largest and least fragmented tracts of forest remaining in the eastern United States.

The Appalachian Trail Conservancy and Appalachian Trail Park Office arranged and funded, using a combination of public and private funds, natural heritage inventories for the entire trail between 1989 and 2001. These inventories were conducted by state natural heritage offices and identified more than 2,200 occurrences of rare plant and animal species and communities. Populations of six threatened or endangered and 360 individual state-listed rare species of plants were among those documented. More than 80 globally rare plant community types have been identified to date on the trail, including red spruce/Fraser fir forest and Southern Appalachian mountain bogs—two of the most endangered ecosystems in the United States. The red spruce and Fraser fir populations throughout the Southern Appalachians have been decimated by pollution, aphid infestation, acid rain deposition, spruce budworm, and balsam woolly adelgid. Southern Appalachian mountain bogs have been damaged by logging, mining, grazing, feral hogs, agriculture, residential development, and road building. Any activity that causes a change in the surrounding water flow patterns can destroy these unique systems. Also present along the trail are other rare habitats and unique plant communities, such as alpine tundra (a treeless ecosystem resulting from elevation rather than latitude), subalpine krummholz (stunted trees that occur near tree line on a mountain), grassy balds (open summits densely covered with native grasses), and heath balds (habitats found along narrow ridges and mountain crests that consist of dense evergreen shrubs, especially rhododendron), among others.

Regularly monitoring natural resources is critical to detect trends that could be occurring over time, such as changes in species distributions or even disappearance of some species. However, establishing a comprehensive natural resources monitoring program is difficult, largely due to the trail's exceptional length. Currently there are more than 50 volunteer-based natural-heritage

WAYNE COLLINS

White-tailed deer are common along the Appalachian Trail.

monitoring sites located within all 14 A.T. states. Along the Appalachian Trail, the Northeast Temperate Network of the National Park Service's Inventory and Monitoring Program coordinates some natural resources monitoring, such as air quality, water quality, forest health, migratory breeding birds, atmospheric deposition, invasive species, visitor usage, alpine and high elevation vegetation, and ozone. A.T. managers also rely on citizen scientists and hikers to gather data to complement the information collected by formal resource monitoring programs. Because data collection standards may vary among individuals, using these data to make management decisions can be problematic. In an effort to standardize data collection, there are efforts under way to develop data-collection protocols for use by citizen scientists.

In addition to presenting challenges for resource monitoring, the trail's narrow configuration and great length leave it vulnerable to threats that originate both within and outside its boundaries. The natural resources along the Appalachian Trail are at risk from natural as well as human-induced changes, including air and water quality degradation from pollution; species loss and natural community impacts from climate change; soil compaction; trampling of sensitive plant species and damage from trail overuse; invasions of non-native plant species; and illicit collection of rare plants and animals. Over the past five years the entire trail was assessed by ATPO, the ATC, and trail-maintaining clubs to identify trail problems (e.g., erosion and trampling of vegetation) and potential solutions such as short relocations to protect rare plant species or communities. To address the problem of non-native species, A.T. managers could inventory plant and animal species to acquire baseline conditions, periodically survey and collect data to determine trends, and set long-term objectives to guide management. Some of this work is being done at certain high-risk sites, and the ATC is working to expand its site-monitoring capacity. Currently, two full-time law enforcement rangers employed by the Appalachian Trail Park Office coordinate the law enforcement efforts to protect animal and plant species along the trail.

Children assist with invasive non-native plant removal as a part of the Trail to Every Classroom program.

JULIE JUDKINS

Non-Native Plant Species—Native Species Face Encroaching Invaders

Invasive non-native plants are a critical concern along the entire length of the Appalachian Trail and are a considerable threat to the trail's ecosystems. Oftentimes invasive non-native plant species lack natural predators and can withstand diseases that plague native species. The result is that invasive non-native plants can outcompete native species, quickly becoming entrenched while threatening the survival of both common and rare native species. Native herbivorous wildlife, especially those that only eat certain native plants, are particularly vulnerable to any decrease in the availability of native plants.

Appalachian Trail managers engage volunteers to help collect invasive non-native plant species data. In 2005, a hiker surveyed the entire trail (to 30 feet on either side) for the presence of invasive non-native plant species. This survey documented invasive non-native plants at 250 locations between North Carolina and Maine, covering more than 1,300 acres or 9 percent of the area surveyed. The survey found that Virginia, West Virginia, Maryland, and Pennsylvania had the highest percentages of land plagued by invasive non-native plant species. According to the hiker's data the most common invasive non-native species trail-wide are multiflora rose (*Rosa multiflora*) and garlic mustard (*Alliaria petiolata*), followed by Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), tree of heaven (*Ailanthus altissima*), and crown vetch (*Securigera varia*).

Controlling the spread of invasive non-native plants along the Appalachian Trail is difficult because adjacent lands can be sources of non-

JAMIE DONALDSON

In 2008, a volunteer-based non-native plant removal project using Angora goats was initiated on Roan Bald, on the North Carolina-Tennessee border. To learn more about this project or to "adopt" a goat visit http://baatanygoatproject.blogspot.com/.

natives, and foot traffic along the Appalachian Trail creates bare soil that may be colonized by non-native plant species. Additionally, hikers moving along the trail may unintentionally spread non-native plant seeds to other locations via their boots and other gear. Although managing invasive non-native species along the trail is a daunting challenge, A.T. managers still make serious efforts to do so. The Appalachian Trail Park Office receives assistance from three National Park Service Exotic Plant Management Teams (EPMTs)—Northeast EPMT, Mid-Atlantic EPMT, and the National Capital Region EPMT. The Park Service EPMTs and private contractors have targeted a number of the worst invasive plants, such as multiflora rose, Japanese stilt grass, garlic mustard, Japanese honeysuckle, Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), glossy buckthorn (*Frangula alnus*), wavyleaf basketgrass (*Oplismenus hirtellus* ssp. *undulatifolius*), purple loosestrife (*Lythrum salicaria*), and common reed (*Phragmites australis*). Trail-maintaining clubs have also added invasive non-native plant control into their work plans in an effort to inventory and eradicate these species.

In 2008 several invasive non-native plant control projects started along the Appalachian Trail, increasing the number of control sites on the trail from five to 14. The Appalachian Trail Park Office, Appalachian Trail Conservancy, the Connecticut chapter of the Appalachian Mountain Club, and The Nature Conservancy joined in fall 2008 to participate in The Nature Conservancy's Weed-it-Now program to remove invasive non-native plants in the Berkshire Taconic Forest near the Connecticut-Massachusetts border in western Massachusetts. Since 2002, the Weed-it-Now program has removed invasive non-native plants such as Japanese barberry and garlic mustard from more than 9,000 acres, including portions of the Appalachian National Scenic Trail. Another project involved the Mid-Atlantic EPMT and some 180 volunteers, who removed invasive plants along the Appalachian Trail in northern Virginia. In Georgia, North Carolina, and Tennessee, partners from nonprofit organizations and government agencies have joined together to develop a cooperative weed-management partnership. The partnership's goal is to inventory approximately 14 of the most threatening

Hiking the Trail

"A Trail to Every Classroom" Initiative Inspires Educators and Students Alike

In 2006, the Appalachian Trail Conservancy and the National Park Service developed A Trail to Every Classroom (TTEC) as a three-season professional development program for K-12 teachers that promotes conservation, civic participation, and healthy lifestyles by using the Appalachian Trail as an educational resource. By inviting teams of teachers and community partners from the 14 trail states to a week-long summer institute and subsequent regional workshops, TTEC invests in a trail-wide network of educators and students.

The core strategy of TTEC is sustainable service-learning, which combines the best practices of place-based education, sustainable development, and service-learning. The program builds sustainability by promoting partnerships between teachers, trail volunteers, and agency partners. The Trail to Every Classroom program engages teams of teachers from the same school to promote multi-disciplinary/whole school approaches to curriculum development, and adds skills to their tool kits by offering sessions in curriculum planning, reflection, grant writing, program evaluation, student assessment through experiential education, and hike leadership.

This program has been supported through a variety of funding sources within the National Park Service, as well as through foundation and corporate support secured by ATC.

Teachers participate in a Trail to Every Classroom training session.

KAREN LUTZ


KATHRYN CASE


SARAH FREY

Left: Volunteers monitor water quality at Laurel Fork Creek in Tennessee.

Right: Bicknell's thrush is one of the rare species monitored along the Appalachian Trail.

species in and around significant natural heritage areas and wilderness areas. The partnership has also initiated control efforts in high-priority areas of North Carolina, where volunteers use manual methods and chemical agents on non-native invasive plant species. Workshops presented by ATC and Park Service EPMT staff provide information on non-native species identification and what participants can do on the trail and at home to prevent the spread of invasive plants. A field day on the trail following these workshops allows volunteers, students, hikers, and agency partners to inventory or control non-natives, or to restore areas that have already been treated.

Appalachian Trail MEGA-Transect Program—An Exciting Opportunity to Learn More About the Trail's Resources

The Appalachian National Scenic Trail corridor is an ideal swath of land for long-term ecological research. The trail is long, permanently protected, covers an elevation gradient that ranges from near sea level to some of the highest points on the Eastern Seaboard, receives a wide range of moisture, and experiences large temperature fluctuations. As a result, the Appalachian Trail corridor may encompass one of the richest assemblages of temperate zone species in the world. Because of the factors previously mentioned (e.g., length, budget, logistics), extensive research, inventorying, and monitoring of species and habitats along the Appalachian Trail require the help of volunteers to collect and compile data and coordinate research. The trail is located in close proximity to a number of universities and colleges, which may be sources of volunteers interested in engaging in high-quality long-term research.

To better understand the health of the trail's natural resources, the Appalachian Trail Conservancy and the Appalachian Trail Park Office have initiated the Appalachian Trail MEGA-Transect program. The MEGA-Transect is designed to unite existing research efforts while identifying new opportunities to monitor, understand, and communicate the long-term ecological health of the Appalachian region. Federal, state, and local agencies; private organizations; nonprofits; research universities; schools and youth groups; and individuals, including hikers, are encouraged to supply data on air and water quality; invasive non-native plant locations and dispersion rates; rare, threatened, and endangered species; visitor impacts (e.g., effects on soil, water, and vegetation); seasonal life cycles (i.e., the timing of plant flowering and other seasonal biological events); and the effects of global climate change on natural resources, among many other topics. ATC and Appalachian Trail Park Office staff are working to develop standardized data-collection protocols that should be used by these groups. The ATC and ATPO hope that the MEGA-Transect program will help bring residents closer to the A.T., get them out on the trail, and help them learn more about the resources and conditions of the ecosystems in their backyards.

Rare plant monitoring and vegetation mapping, collaborative efforts among the National Park Service, Appalachian Trail Conservancy, U.S. Geological Survey, and NatureServe (a nonprofit conservation organization), are currently under way and there are plans to compile and analyze data in the near future. Citizen scientists collect data on birds along the A.T. via 38 North American Breeding Bird Survey routes. The Cornell Lab of Ornithology and the National Audubon Society developed this project to allow citizen scientists to easily collect and share data on bird species. The Vermont Institute of Natural Science has established 32 Mountain BirdWatch routes along the Appalachian Trail's northern section to track certain alpine/subalpine bird species such as Bicknell's thrush (*Catharus bicknelli*) and other montane forest bird species. Data collected from this project are entered into an electronic database maintained by the Vermont Institute of Natural Science, which is widely used by bird-watchers, scientists, and conservationists.

Air Quality—Pollution Makes Hiking More Difficult and Threatens Human Health

Air quality has a profound effect on hiker health and enjoyment of the Appalachian Trail, as well as the health of people residing near the A.T. corridor, and the natural resources along the trail. Obscured views, breathing difficulties, tree deaths resulting in degraded landscapes, and damage to plants are just a few possible consequences of poor air quality. While neither the Appalachian Trail Conservancy nor the Appalachian Trail Park Office operates any air-quality monitoring stations along the A.T., data are collected near the trail by numerous stations operated by federal and state air-quality monitoring programs. The Appalachian Trail MEGA-Transect program aims to collect new data and compile existing data in an effort to expand air-quality monitoring efforts.

Air quality threats along the Appalachian Trail fall into three main categories: wet and dry acid deposition, ground-level ozone, and visibility reductions due to haze and particulates. While data show that trends for sulfur (SO_4) deposition, nitrogen (NO_3) deposition, haze, and ozone within the A.T.'s airshed are either stable or improving, current levels are high and are cause for concern. Heavy metals emitted from smelters and other industrial sources are also a concern and can affect air and water quality within the trail corridor. The heavy metals enter rivers, lakes, streams, and creeks in runoff during and after rainfall. Human ingestion of heavy metals can result in reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death.

Situated downwind of coal-fired power plants, the Appalachian Mountains receive some of the highest acid deposition rates in North America. When sulfur dioxide (SO_2) and nitrogen oxides (NO and NO_2) react with water, oxygen, and other chemicals in the atmosphere, various acidic compounds are formed that fall to the Earth with precipitation. Sulfur dioxide and nitrogen oxides are commonly emitted from fossil fuel-burning power plants and other combustion sources and can be carried by wind across hundreds of miles.

The results of acidic precipitation on plants and trees include slower growth, leaf injury, and potentially the death of sections of forests, which can lead to losses of food and habitat for a number of animal species. Such losses can increase mortality or result in migration to more hospitable areas. Since serious acidification and associated adverse effects (e.g., damage to fine roots that reduces a plant's ability to absorb nutrients) have been observed at Great Smoky Mountains National Park, Shenandoah National Park, and a number of national forests within the Appalachian Mountains, there is a high probability that current levels of acid deposition are contributing to soil and surface water acidification, soil nutrient

NATIONAL PARK SERVICE

The view of Shaver Hollow (located just west of the A.T.) on a clear day and a hazy day (in Shenandoah National Park).

The renovated Crawford Notch Train Depot now serves as an Appalachian Mountain Club visitor center. Adaptively reusing historic structures aids their preservation.

APPALACHIAN MOUNTAIN CLUB

Hiking the Trail

Historic Structures Serve Today's Hikers

Perhaps the best way to provide for the continued preservation of a historic building is to adaptively re-use the structure in some other capacity than that for which it was originally intended. Two examples of adaptive re-use can be seen along the Appalachian Trail at Crawford Notch in White Mountain National Forest. Members of the Appalachian Mountain Club restored two structures—the Crawford Notch train depot and the Crawford House artist's studio. The train depot was built in 1891 to serve visitors staying at the Crawford House, which was built in 1828 by the Crawford family to house visitors to the White Mountains. The restored Crawford Notch train depot is now used as a visitor center with exhibits on the area's rich natural resources and human history. Renowned landscape painter Frank Shapleigh was the artist-in-residence at the Crawford House artist's studio during the summers from 1877 to 1893. The Crawford House artist's studio is now used to accommodate hikers for overnight stays.

imbalance, and plant and animal species loss along the trail.

Increased concentrations of ground-level ozone are a concern along the Appalachian Trail. Ground-level ozone is formed by chemical reactions that occur when nitrogen oxides and volatile organic compounds combine in the presence of sunlight. The risks of elevated levels of ozone to humans include lung tissue damage, reduced lung function, and increased lung sensitivity to other irritants. High concentrations of ozone also affect a plant's ability to produce and store food, which compromises growth, reproduction, and overall plant health. These weakened plants are then more susceptible to disease, pests, and environmental stresses. Air pollution, including ground-level ozone and acidic precipitation, is substantial across much of the Appalachian Trail corridor and is increasingly contributing to the death of sensitive vegetation, including red spruce (*Picea rubens*) and sugar maple (*Acer saccharum*).

In addition to directly harming resources, diminished air quality reduces visibility along the trail, affecting one of the A.T.'s most enjoyed features: expansive views from mountain ridges and viewpoints. Without the effects of air pollution, visibility in the eastern United States is approximately 90 miles at very high elevations. Because of poor air quality, summer visibility along the A.T. within Shenandoah National Park is sometimes as little as 10 to 12 miles or less, while hikers in Great Smoky Mountains National Park may only be able to see 12 to 16 miles. These ranges are among the lowest along the entire trail, despite being located within national parks.

Water Quality—Degraded Water Quality an Issue for Hikers and Wildlife

The Appalachian Trail corridor contains nearly 1,800 streams, rivers, and lakes. Many of them serve as vital water sources for hikers and crucial habitat for plants and animals. Downstream of the trail this water supplies drinking water to communities, provides additional habitat, and is used to produce electricity at hydroelectric power stations.

In the trail's 2008 resource management plan, the Appalachian Trail Park Office identified four main threats to the trail's water quality: climate change; wet and dry deposition of nitrate, sulfate, and heavy metals; excess nutrients; and erosion. Risks from climate change include the possibility of more frequent and/or severe weather that can result in flooding, increased water temperature, changes in types of precipitation, and lakes remaining open during the winter, among other effects. Each of these changes will bring unknown consequences for native plant and animal species and water quality along the Appalachian Trail.

PHILLIP JORDAN

Streams, rivers, and lakes along the A.T. provide drinking water for people and wildlife. Left: Long Creek Falls, Georgia.

Deposition of nitrate, sulfate, and heavy metals are concerns as discussed in the “Air Quality” section (page 13). Excess nutrients in bodies of water come from either atmospheric sources (e.g., ammonium deposited with rainfall) or from human or animal waste. Privies that are located too close to bodies of water, and nutrient loading from agricultural and grazing practices could result in pollutants leaching into waterways, leading to changes in species composition (toward species that can survive in altered systems) as well as human health risks from elevated levels of fecal coliform bacteria in drinking water. Appalachian Trail managers are actively seeking to minimize contamination from human waste by replacing traditional pit privies with composting toilets and by choosing better sites for privies.

Rainfall and adjacent land uses (e.g., commercial and residential development, farming, and logging) erode soils, which are deposited in streams, rivers, and lakes. This erosion increases sedimentation and cloudiness, ultimately resulting in altered habitats. For example, increased sedimentation can suffocate trout eggs and freshwater mussels, leading to reduced survival and reproductive success rates.

TIMOTHY CUMMINGS

Fitzgerald Falls in New York.

Global Climate Change—A.T. Offers Opportunity to Study Its Effects

Climate is a key driver of natural systems and affects ecosystem structure, composition, and function. Global climate change has the potential to alter every ecosystem on Earth and is truly a global pandemic of leviathan proportion. Climate change could result in alterations in seasonal maximum and minimum temperatures, changes in mean annual precipitation, and shifts in the seasonality of precipitation. The effects on natural habitats include, but are not limited to, increasing severity and frequency of damaging storms, wildfires, and droughts, as well as increased pest insect populations and opportunities for invasive non-native plants to proliferate. Climate change could also cause species to shift their

Hiking the Trail

Ridge Runners and Other Caretakers Educate Hikers and Protect High-Use Areas

The Appalachian National Scenic Trail is comprised of more than 250,000 acres of parkland and 4,000 miles of park boundary. It is the longest of the Park Service units. Protection of this resource is neither practical nor possible through traditional means. It is accomplished through the collaboration and cooperation of a multitude of agencies and management partners. The Appalachian Trail Park Office's two full-time law enforcement rangers work with local law enforcement officials along the trail to ensure hiker safety, to establish emergency response, and to maintain trail corridor boundaries. To bolster the protection of resources and to encourage appropriate hiking habits (e.g., Leave No Trace hiking and camping practices, staying on the trail to protect sensitive plant communities, and camping in designated areas), the Appalachian Trail Conservancy established the Ridge Runner program more than a decade ago. Program participants provide a friendly, consistent, and reliable presence on the trail during the heavy-use seasons. The Ridge Runners are seasonal ATC employees whose main role is to deter potential harm to the trail sites and facilities, including natural and cultural resources, along high-use sections of the trail and at heavily used overnight sites. Although they do not have law-enforcement capability, the Ridge Runners serve as resources for trail users and their presence reduces the likelihood of vandalism, poaching, or inadvertent damage to resources.

Endangered Gray's lilies are a target for poaching.

ROBERT G. SHAW

ranges northward and upward, result in a loss of biodiversity and changes in species composition along the trail, and alter phenological (seasonal) life cycles. Temperature changes also can affect the feeding and breeding cycles of bird species by changing the timing of insect hatches. Alpine plants and wildlife are particularly susceptible to these changes as they cannot migrate upslope as temperatures increase, and they are adapted to a narrow set of conditions.

The A.T. MEGA-Transect program offers scientists and researchers the opportunity to study the effects of climate change on eastern plants and animals, especially range shifts (both up-latitude and up-slope) and changes in tree species composition. The trail provides a protected swath of land that includes a multitude of habitats, microclimates, and elevational and latitudinal variations. Scientists are particularly concerned about the "mountain island" effect where species become stranded at the highest elevation in an area.

Plant and Animal Poaching—Illegal Harvesting of Plants and Animals a Trail-Wide Concern

Appalachian Trail managers have documented wildlife poaching and illicit plant collection, especially of rare, threatened, and endangered species, along the Appalachian Trail. Poachers have particularly focused on wild ginseng (*Panax quinquefolius*), which can be used for medicinal uses. Ornamental plant species that are also targeted by poachers include lady slipper orchids (subfamily *Cypripedioideae*), kidney-leaved twayblade (*Listera smallii*), dwarf violet iris (*Iris verna*), and trillium (*Trillium* spp.). Gray's lily (*Lilium grayi*), a species that is listed as endangered in Tennessee and threatened in North Carolina, is also poached. Animals that are known to be illegally harvested along the trail include timber rattlesnakes (*Crotalus horridus*), white-tailed deer (*Odocoileus viginianus*), and black bears (*Ursus americanus*).

Protecting these species over the trail's 2,178 miles is accomplished through the cooperative efforts of local, state, and federal agencies, depending on law enforcement jurisdiction. Two full-time law enforcement rangers employed by the Appalachian Trail Park Office coordinate law enforcement efforts by providing investigative and technical support and through the tracking and documenting of incidents.

Learn about some ways that A.T. managers are boosting resource protection in "Ridge Runners and Caretakers Educate Hikers and Protect High-Use Areas" (left).

Hand-built rock and timber bridges are among the myriad cultural resources located along the trail. Pictured here is the Laurel Fork Creek bridge in Tennessee.

CULTURAL RESOURCES—
Numerous Resources, Limited Data

The Appalachian National Scenic Trail is not solely a recreational footpath surrounded by natural resources; the trail corridor encompasses a wealth of nationally significant cultural resources. The history of the lands along the Appalachian Trail and the history of the trail itself are rich and include the stories of American Indians, pioneers, settlers, and farmers; wars; resource industries; and outdoor recreation that preceded the establishment of the Appalachian Trail. For example, Pilger Ruh (Pilgrim's Rest) Spring in Pennsylvania was used extensively by American Indians, missionaries, government officials, and settlers dating back before the 18th century. Later, Civil War soldiers journeyed up and down the Appalachian Mountains during the bloodiest four years the nation has ever known. The Civil War Battle of South Mountain in Maryland took place on land that is now protected within the Appalachian Trail corridor. The Confederate capture of Union troops at Harpers Ferry as well as the Confederate defeat and retreat after Antietam also took place on lands now within the trail corridor.

Despite the historical importance of many lands within the Appalachian Trail corridor—as well as the cultural importance of the trail itself, its historic structures, and its ties to the thousands of people who have had a hand in building and maintaining it—acknowledgment, preservation, and interpretation of the cultural resources along the trail are generally lacking. Like many national parks that were established mainly for natural resource protection or recreational opportunities, cultural resource protection along the Appalachian Trail is limited. While hundreds of archaeological sites have been documented within the Appalachian Trail corridor, many as part of a 2003 survey of the Fox Gap section of the South Mountain Battlefield in Maryland, perhaps thousands still lie buried waiting to be discovered and explored. A.T. managers have made a conscious decision to limit the number

Volunteers with the New York-New Jersey Trail Conference help to build a safer and more ecologically sensitive trail in Bear Mountain State Park, New York.

APPALACHIAN TRAIL CONSERVANCY

APPALACHIAN TRAIL CONSERVANCY

This newly finished section of trail is safer for hikers and will reduce erosion.

Hiking the Trail

Trail Restored in Bear Mountain State Park

The Appalachian National Scenic Trail is at risk of being "loved to death." Each year an estimated two million hikers walk at least a portion of the Appalachian Trail. Wear and tear from hikers' footsteps can significantly damage the trail (e.g., compact soil, exacerbate erosion, trample vegetation, widen or deepen the trail), making hiking more difficult and even dangerous in some areas. Located just an hour's drive from New York City, Bear Mountain State Park attracts hundreds of thousands of visitors every year. Bear Mountain has become one of the most heavily used sections of the Appalachian Trail, frequented by both Appalachian Trail through and section hikers, as well as day hikers looking to stretch their legs along some of the oldest sections of the Appalachian Trail.

The Bear Mountain Trails Project was launched in 2006 in an effort to improve the condition of this section of the Appalachian Trail and the hiking experience along it. Echoing the overall cooperative management style of the trail, the Bear Mountain Trails Project is a partnership between the Appalachian Trail Conservancy, the New York-New Jersey Trail Conference, the Palisades Interstate Park Commission, the New York State Office of Parks, Recreation and Historic Preservation, and the National Park Service Appalachian Trail Park Office. Volunteers and skilled trail builders have joined forces to design and construct an entirely new route for the Appalachian Trail over Bear Mountain that can withstand this heavy use, with design elements and standards atypical of the Appalachian Trail in most other locations, but well suited to this unique location. Wide enough to accommodate larger numbers of hikers, the grade of the new route is low enough to encourage hikers to remain on it and to allow water to flow over it instead of down it, reducing or eliminating erosion. In construction techniques reminiscent of the Works Progress Administration work done there nearly eight decades ago, native stone from the site is cut and shaped to size and used to build crib wall—essentially a retaining wall constructed to support trail tread as it traverses a slope—and to install steps where the grade is too steep to allow tread on the crib wall. As the first section of new trail nears completion, Bear Mountain Trails Project partners will now work toward closing and restoring the old portions of the trail and the miles of social trails that have developed over the years. When the Bear Mountain Trails Project is fully completed, hopefully in 2012 or 2013, Bear Mountain will have three miles of new, state-of-the-art trail for all Appalachian Trail hikers to enjoy.

of historical markers and interpretive waysides near cultural resources along the trail in order to avoid signage clutter, to respect wilderness-area designation, and for fear that such attention would lead to vandalism and artifact hunting, which are already issues along certain sections of the trail. While these concerns are valid, limiting the acknowledgement and interpretation of historic sites and cultural resources prevents them from gaining the recognition they deserve and limits the public's understanding of, and perhaps willingness to protect and preserve, these resources.

The Appalachian Trail corridor—the footpath and associated infrastructure (e.g., bridges, shelters, backcountry huts, viewpoints, and rock steps)—constitutes one of the nation's most significant cultural landscapes. The trail's cultural landscape also includes thousands of individual prehistoric and historic archaeological sites that lie along the Appalachian Trail corridor. The Civilian Conservation Corps-built infrastructure along the trail (e.g., rock walls and steps, cabins and shelters, and fire towers) might not be here today without the trail clubs that maintain, repair, and restore them when necessary.

Historic Structures— Historically Significant Buildings and Structures Line the Trail

The Appalachian National Scenic Trail corridor contains a host of historic structures (the exact number is unknown), such as shelters built by the Civilian Conservation Corps, early industrial buildings, monuments, fire lookouts, and rock walls, that help to tell the story of the United States. Some fire towers are now used as observation platforms that provide stunning views for hikers. Adaptively reusing historic structures is a great way to ensure their protection. Other historic structures offer hikers the opportunity to pause and learn something about important people and events in the nation's history. For example, the first monument to General George Washington—a stone tower built by the people of Boonsboro, Maryland, in 1827—is located along the Appalachian Trail in Washington Monument State Park in Maryland. Washington surveyed the Appalachian Mountains as a young man and led his army through them during the Revolutionary War.

The Appalachian Trail traverses land that supported the growth and development of the United States. Hikers pass by many quarries, kilns, furnace sites, and mines that demonstrate how natural resources were used to fuel industrial growth during the 18th and 19th centuries. Pine Grove Furnace in Cumberland County, Pennsylvania, is one example of an early industrial historic structure located along the trail. Now located within a state park, the Pine Grove Furnace is a stone structure

DESTRY JARVIS

In Washington Monument State Park, Maryland, the Appalachian Trail passes near the first monument built to commemorate George Washington.

that produced iron products, including cast-iron pots and kettles and wrought-iron goods, for more than 130 years. The history of the furnace is interpreted for hikers via wayside exhibits. Many of the known historic sites and structures along the trail are described in books produced by the Appalachian Trail Conservancy. These guides allow hikers to learn about the historic resources that they see while traveling the trail.

The various trail-maintaining clubs associated with the Appalachian Trail Conservancy care for the historic structures in their respective regions, restoring and rehabilitating historic trail shelters when necessary. Recently, members of the Green Mountain Club rehabilitated two historic structures on the Appalachian Trail in Vermont—the Glastenbury Fire Tower and the Prosper Ski Tow Warming Hut—which now provide hikers wonderful views and shelter from the elements.

National Designation for Appalachian Trail's Cultural Resources

The Appalachian National Scenic Trail corridor and the cultural resources located within this swath of land are likely to be eligible for listing in the National Register of Historic Places, and the trail itself is probably qualified to be listed as a national historic landmark. The National Register of Historic Places is the official list of historic properties determined to be worthy of protection. A resource that is determined to be exceptionally significant is listed as a national historic landmark, which is recognition of a resource's value to preserving and interpreting the heritage of the United States. The Landmarks Committee of the National Park System Advisory Board and the secretary of the Interior are responsible for making the decision on whether to designate the trail as a national historic landmark. Robert Grumet, a National Park Service historian, completed a cultural resources survey in 2002 that identified more than 1,200 components that contribute to the trail's national significance, such as shelters, Civilian Conservation Corps camps, viewpoints, improved roads, bridges, impoundments, buildings, monuments, towers, railroad grades, and the ruins of a moonshine still.

The Appalachian Trail's numerous historic structures have historical significance for a number of reasons, but A.T. managers are not currently using their limited staff and funding to nominate structures to the National Register

Hikers stop for a rest at the Thomas Knob Shelter in Virginia.

APPALACHIAN TRAIL CONSERVANCY

of Historic Places. However, they do consider all these structures to be eligible, which provides a level of protection in itself because the National Historic Preservation Act mandates that federal agencies must consider the effects of their actions on properties listed in or eligible to be listed in the National Register of Historic Places. Without a determination of eligibility confirmed by the state historic preservation officer, however, properties are not protected from the actions of other federal agencies.

A consultant was hired in 2009 to complete additional groundwork and analysis, which helped the ATC and ATPO decide to pursue National Register designation for the trail. This work began in 2009. There are two options that A.T. managers can use to list the Appalachian Trail corridor in the National Register—14 separate state-by-state designations or one overall multistate designation that includes the whole trail corridor. Once listed in the National Register, a resource is eligible to receive public and private support to increase awareness and protection. Listing the Appalachian Trail in the National Register of Historic Places would bring increased recognition, management, and protection of the trail's cultural resources.

Adjacent Development—Incompatible Land Use Threatens the Integrity of Trail Experience

The biggest threat to the Appalachian National Scenic Trail's cultural and natural resources is the encroachment of residential and commercial development. Adjacent development threatens the trail in several ways: It interrupts natural viewsheds, diminishing the hiking experience, and it facilitates illegal motorized vehicle use, which can damage the trail, lead to looting and vandalism of cultural resources (and poaching of natural resources), and further diminish the hiking experience, among others.

In general, the protective corridor that has been acquired along the A.T. averages 1,000 feet in width. Where the trail crosses existing public lands such as parks, forests, and game-management units, the trail is generally more protected. Most adjacent lands have been designated as special management zones and the lands and resources within those zones are managed primarily for trail purposes by avoiding paralleling or intersecting roads and limiting timber harvesting and other incompatible activities. Still, the narrow protective corridor or "greenway" that has been acquired or designated along the A.T. is vulnerable to adjacent residential and commercial development as well as energy, communications, and transportation projects.

For more than 30 years, Appalachian Trail managers have pursued an ambitious land-

ERICH RAINVILLE

Hiking the Trail

Rocky Run Shelter Renovated

A shelter with a solid roof and a dry floor can be a most welcome sight for weary hikers on the Appalachian Trail, especially after a long day slogging through the rain, sleet, or even snow. Unadorned shelters were a part of Benton MacKaye's original vision for the trail, and today there are more than 250 scattered along the A.T. Many shelters were built by Civilian Conservation Corps (CCC) crews in the 1930s and 1940s. After years of weathering and routine wear and tear, just 15 of these CCC-built structures remain today. Some of the remaining CCC-era shelters, as well as more recently built enclosures, are in ill repair and in need of renovation despite the best efforts of the volunteer groups that help to maintain them. Regardless of their condition, these trail shelters—some of them listed in the National Register of Historic Places—are integral parts of the Appalachian Trail's cultural landscape.

The Rocky Run shelter, built in 1940 by the Civilian Conservation Corps near Boonsboro, Maryland, was slated to be torn down due to its deteriorated condition. The structure was saved from demolition when Preservation Maryland, the state's oldest historic preservation organization, stepped in to provide funding for the renovation. Volunteers with the Potomac Appalachian Trail Club replaced rotted timber, wood shakes on the roof, and the wood floor. The renovated Rocky Run shelter reopened to hikers in fall 2008. The renovation of this shelter is a model for successful collaboration to preserve resources. In a typical year, trail-maintaining clubs renovate or replace anywhere from one to four shelters.

acquisition program to establish a permanent right-of-way and greenway for the A.T. as the primary means to mitigate the impacts of adjacent development bordering the trail. At the time of the 1978 amendments to the National Trails System Act, approximately 800 miles of the trail were situated along road shoulders or on private lands subject to development. By the late 1970s more than 26 miles of the A.T. in northern Virginia followed the shoulder of Route 601. Today, the full length of the footpath there has been relocated to a wooded corridor acquired by the National Park Service that includes a number of sweeping vistas of the Shenandoah Valley.

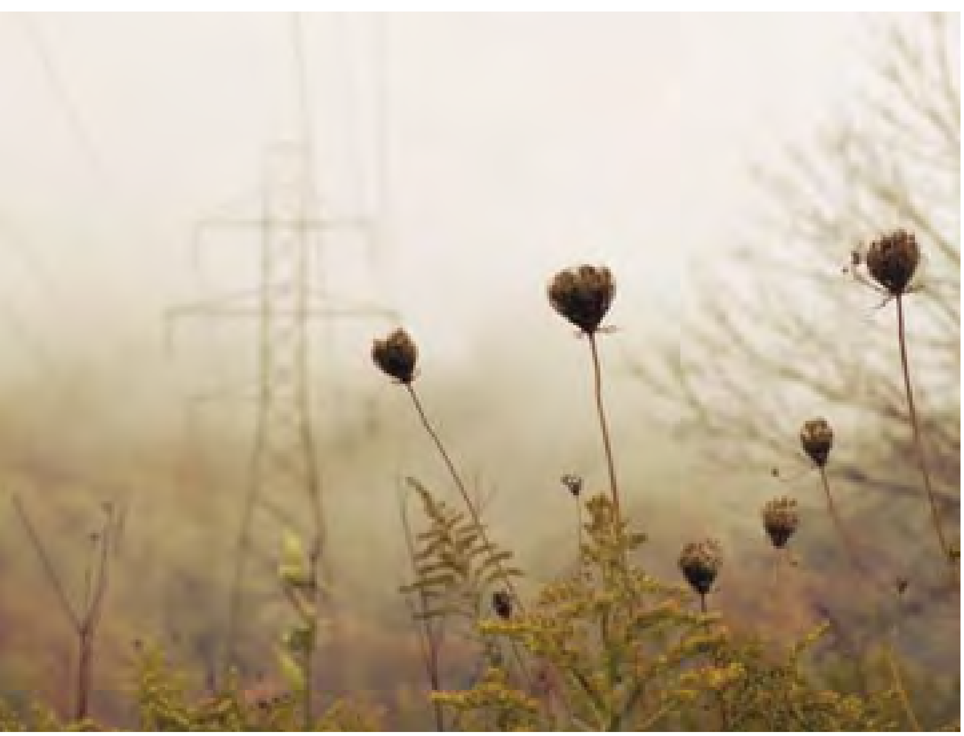
Today, just over 10 miles of the A.T. remain in private ownership, a testament to the success of the Appalachian Trail land-acquisition program. Many examples where development impacts were avoided through timely land acquisition by federal and state agencies as well as through the ATC land-trust program can be cited. For example, in the Cumberland Valley of Pennsylvania south of Harrisburg—the longest valley crossing along the A.T.—rapid residential and commercial development threatened to sever the A.T. and to consume adjacent prime agricultural lands. As a result of the National Park Service land-acquisition program there, a pleasant route for the A.T. now follows along a low ridgeline through the valley in an open-space corridor that also includes portions of working agricultural lands that are managed through a special-use permit program.

Development along Appalachian Mountain ridges, including energy-producing wind turbines and telecommunications towers, can diminish one of the joys of hiking the Appalachian Trail—the experience of mountaintop vistas and expansive views of adjacent forested and agricultural landscapes. It is a major priority of the ATC and the ATPO to protect the trail's miles of uninterrupted views by opposing projects that would mar adjacent scenic and historic landscapes. Trail advocates want to see these developments placed outside of the trail's viewshed when possible, so hikers can fully experience historic cultural landscapes and the sense of isolation of remote areas.

One example of how to help achieve this goal is the voluntary agreement that was reached some years ago between the Appalachian Trail Conservancy (assisted by the American Hiking Society) and the telecommunications industry that calls for early notification of wireless communications facilities proposed within one mile of any national scenic trail, including the Appalachian Trail. While compliance has not been 100 percent, there have been numerous instances in which early notification allowed A.T. managers to proactively work with wireless communications developers to design or site the proposed facilities in a way that protected the trail experience. Less intrusive strategies include strategic placement of the facilities, height limitations, utilizing existing structures, and designing and painting structures to minimize visual disruptions.

The impacts of wind-energy developments are not limited solely to aesthetic considerations such as undeveloped scenic vistas. These developments often include high-grade access roads in fragile, high-elevation terrain, outbuildings, and transmission lines. They adversely affect soils (e.g., increase erosion or compaction), vegetation (e.g., facilitate the spread of invasive non-native plants), and wildlife (e.g., harm migratory birds and bats that collide with blades). A.T. managers opposed Maine Mountain Power's proposal to build 30 400-foot wind turbines adjacent to the A.T. corridor on the ridges of Redington and Black Nubble Mountains, some within one mile of especially remote and scenic sections of the Appalachian Trail. The Maine Appalachian Trail Club, the Appalachian Trail Conservancy, and the National Park Service also opposed this development and were instrumental in blocking the project. Eventually the Maine Land Use Regulation Commission rejected the project in 2007 and has upheld this decision several times. The Appalachian Trail Conservancy and Park Service would like to see improved siting criteria in states where wind energy appears to be viable as well as on federal lands, such as national forests, where landscapes bordering the A.T. or other

Power lines are one example of adjacent development that mars the scenic viewshed along the trail. This photo was taken on Peters Mountain in Giles County, Virginia.


JESSICA ANDERSON

NICHOLAS A. TONELLI

Stunning vistas, such as this view of Mount Tammany in Warren County, New Jersey, must be protected from air pollution and incompatible development.

sensitive resources might be excluded.

Roads also threaten the resources and experience of the Appalachian National Scenic Trail. They detract from the wilderness experience, they are noisy, they are venues for illegal trespass by motorized vehicles, they increase the incidence of vandalism and litter, and they pose a safety threat to hikers who must cross them when hiking the trail. Portions of the Appalachian Trail run parallel to major roads and relocating the trail off of and away from roads has long been a top priority of A.T. managers.

Pennsylvania has enacted legislation to manage threats to the trail posed by adjacent development. The 2008 amendment to Pennsylvania's Appalachian Trail Act of 1978 requires the affected counties and 58 local townships along the Appalachian Trail to enact zoning ordinances aimed at protecting the trail from incompatible adjacent land uses. The Appalachian Trail Conservancy is working to provide guidance on specific zoning ordinances, including setback distances, sightlines, building heights, night lighting, and other design elements, to protect the trail's viewshed and hiker experience. Working with so many counties and local municipalities is an extremely labor-intensive undertaking for the ATC, so while it is possible that a legislative approach could be applied in other states bordering the A.T., it is more likely the ATC will attempt to influence local land-use controls through other means as an outgrowth of their emerging community-partner program.

While Appalachian Trail managers hope to defend the trail and adjacent landscapes from the impacts of adjacent development through a variety of means, it is likely that some land-acquisition capability will continue to be essential to conserve adjacent lands—especially those possessing high-value natural and/or cultural resources.

KAREN LUTZ

APPALACHIAN TRAIL CONSERVANCY

What You Can Do to Help

Perhaps the Appalachian Trail's best asset is the legion of volunteers who have helped over the years to make the A.T. what it is today—America's most beloved and preeminent footpath. Despite all that has been accomplished over the past 80 years there is still much to be done. You can help improve the Appalachian Trail in several ways:

- Join the ranks of the 36,000-member Appalachian Trail Conservancy (www.appalachiantrail.org).
- Learn more about how you can help protect and preserve the Appalachian National Scenic Trail at the Appalachian National Scenic Trail website, www.nps.gov/appa.
- Become a citizen scientist and collect data on the natural and cultural resources along the trail.
- Join a local trail-maintaining club for an afternoon of trail maintenance or spend a week on an A.T. trail crew.
- Purchase an A.T. license plate from your state's department of motor vehicles or help get one for your state.
- Know and practice Leave No Trace (www.lnt.org) principles while on the trail.
- Get involved in community planning decisions if you live near the A.T. corridor, and advocate that local development be compatible with the park and its values.
- Join the National Parks Conservation Association, America's leading voice for the national parks, and help support its mission to preserve the parks for the enjoyment of future generations.

Above: Children and adults celebrated the 2006 National Trails Day at the ATC's Mid-Atlantic Regional Office in Boiling Springs, Pennsylvania.

Below: Volunteers set a stone step on the trail in Bear Mountain State Park, New York.

Acknowledgments

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Back cover: High Point Monument in High Point State Park, New Jersey (photo by Timothy Cummings); the terminus of the Appalachian Trail on Mount Katahdin, Maine (©iStockphoto.com/ Brittany Courville).

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The Wilderness Society et al. Comments on the U.S. Forest Service Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement (#50036)

EXHIBIT 110

February 21, 2023

NATIONAL PARK SERVICE • U.S. DEPARTMENT OF THE INTERIOR

Foundation Document

Appalachian National Scenic Trail

ME, NH, VT, MA, CT, NY, NJ, PA, MD, WV, VA, TN, NC, GA

March 2015

Appalachian National Scenic Trail
National Park Service
U.S. Department of the Interior
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Maine
Vermont
White Mtn
National Forest
Green Mtn
National Forest
Toronto
Michigan
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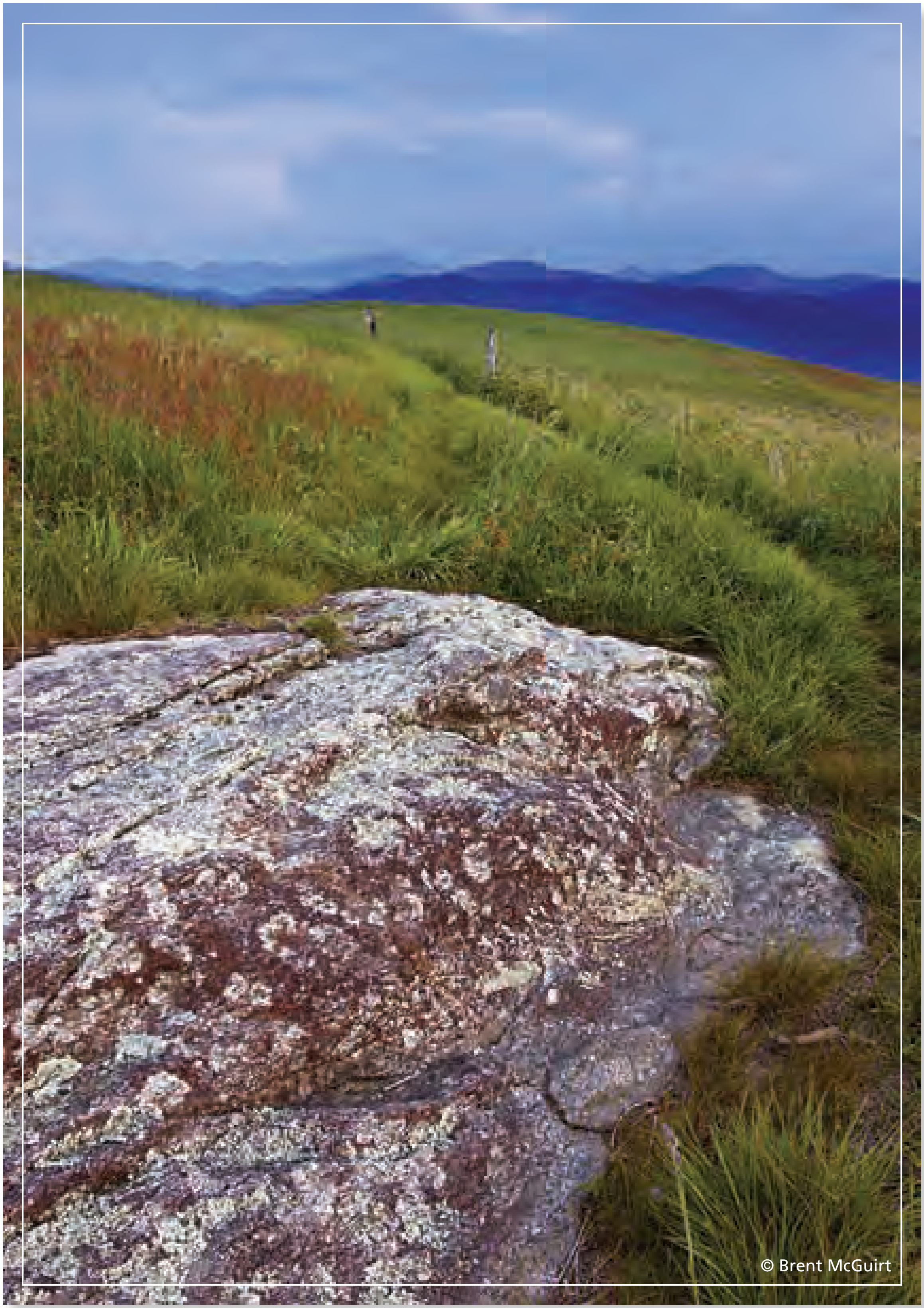
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Mission of the National Park Service

The National Park Service (NPS) preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The National Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.

The NPS core values are a framework in which the National Park Service accomplishes its mission. They express the manner in which, both individually and collectively, the National Park Service pursues its mission. The NPS core values are:

- **Shared stewardship:** We share a commitment to resource stewardship with the global preservation community.
- **Excellence:** We strive continually to learn and improve so that we may achieve the highest ideals of public service.
- **Integrity:** We deal honestly and fairly with the public and one another.
- **Tradition:** We are proud of it; we learn from it; we are not bound by it.
- **Respect:** We embrace each other's differences so that we may enrich the well-being of everyone.

The National Park Service is a bureau within the Department of the Interior. While numerous national park system units were created prior to 1916, it was not until August 25, 1916, that President Woodrow Wilson signed the National Park Service Organic Act formally establishing the National Park Service.

The national park system continues to grow and comprises more than 400 park units covering more than 84 million acres in every state, the District of Columbia, American Samoa, Guam, Puerto Rico, and the Virgin Islands. These units include, but are not limited to, national parks, monuments, battlefields, military parks, historical parks, historic sites, lakeshores, seashores, recreation areas, wild and scenic rivers, scenic trails, historic trails, recreation trails, and the White House. The variety and diversity of park units throughout the nation require a strong commitment to resource stewardship and management to ensure both the protection and enjoyment of these resources for future generations.

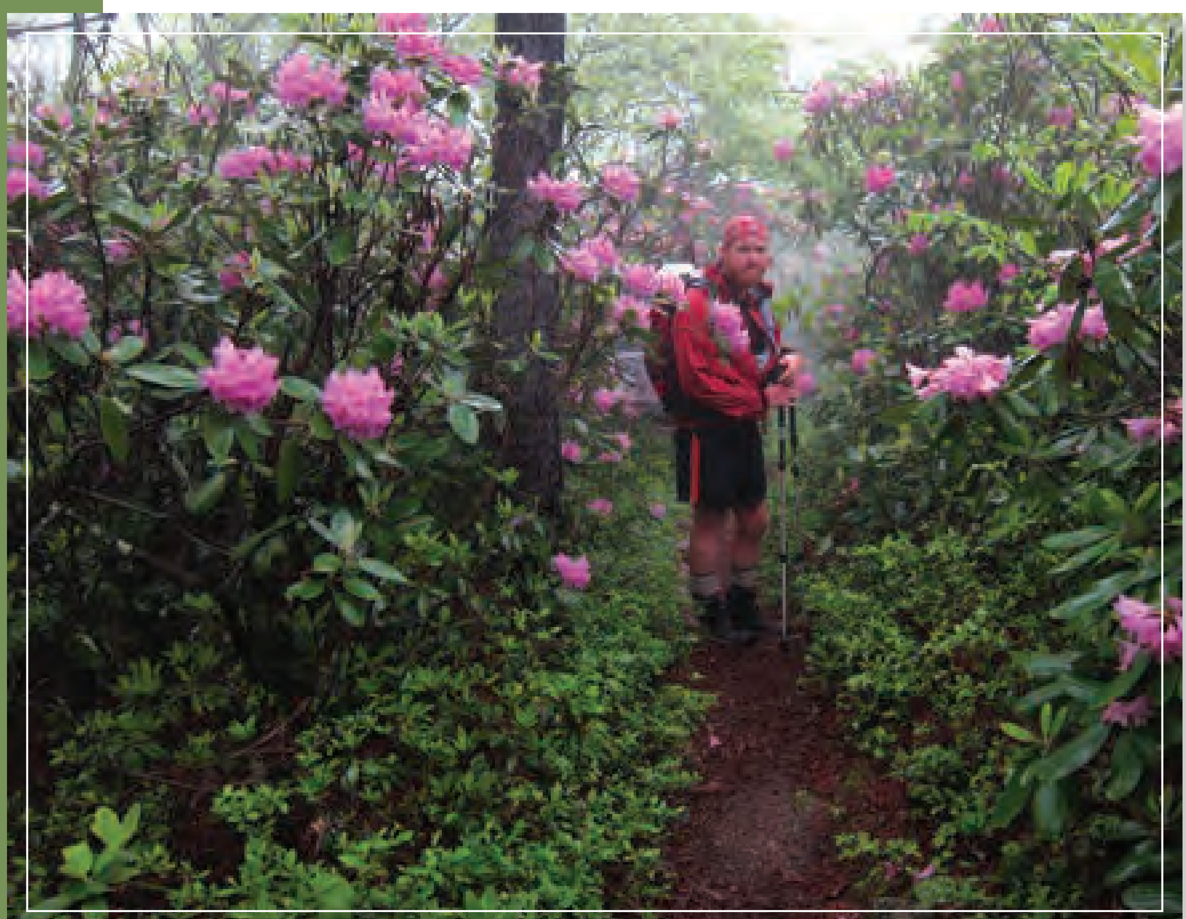
The arrowhead was authorized as the official National Park Service emblem by the Secretary of the Interior on July 20, 1951. The sequoia tree and bison represent vegetation and wildlife, the mountains and water represent scenic and recreational values, and the arrowhead represents historical and archeological values.

Introduction

Every unit of the national park system will have a foundational document to provide basic guidance for planning and management decisions—a foundation for planning and management. The core components of a foundation document include a brief description of the park as well as the park's purpose, significance, fundamental resources and values, and interpretive themes. The foundation document also includes special mandates and administrative commitments, an assessment of planning and data needs that identifies planning issues, planning products to be developed, and the associated studies and data required for park planning. Along with the core components, the assessment provides a focus for park planning activities and establishes a baseline from which planning documents are developed.

A primary benefit of developing a foundation document is the opportunity to integrate and coordinate all kinds and levels of planning from a single, shared understanding of what is most important about the park. The process of developing a foundation document begins with gathering and integrating information about the park. Next, this information is refined and focused to determine the most important attributes of the park. The process of preparing a foundation document aids park managers, staff, and the public in identifying and clearly stating in one document the essential information that is necessary for park management to consider when determining future planning efforts, outlining key planning issues, and protecting resources and values that are integral to park purpose and identity.

While not included in this document, a park atlas is also part of a foundation project. The atlas is a series of maps compiled from available geographic information system (GIS) data. It serves as a GIS-based support tool for planning and park operations. The atlas is published for use in a web mapping environment. The park atlas for Appalachian National Scenic Trail can be accessed online at: http://imgis.nps.gov/DSC/Viewer.



Part 1: Core Components

The core components of this foundation document include a brief description of the Appalachian National Scenic Trail, the nature and purposes of the Appalachian National Scenic Trail, significance statements, fundamental resources and values, and interpretive themes. These components are core because they typically do not change over time. Core components are expected to be used in future planning and management efforts.

Brief Description of the Trail

The Appalachian National Scenic Trail—commonly referred to as the A.T. and referenced throughout this document as simply the Trail—is a public footpath that traverses more than 2,100 miles of the Appalachian Mountains and valleys between Katahdin, Maine (northern terminus), and Springer Mountain, Georgia (southern terminus). The Trail winds through scenic, wooded, pastoral, wild, and culturally resonant lands along this ancient mountain range. More than 99% of the Trail's corridor is protected by publicly owned lands.

The Trail has a celebrated grassroots origin. The A.T. idea gained momentum in 1921 with the proposals of Benton MacKaye, a regional planner from Massachusetts. He envisioned a trail as a means to preserve the Appalachian crests and to provide a retreat from increasingly industrialized modern life. The Trail was designed, constructed, and maintained in the 1920s and 1930s by volunteer hiking clubs, brought together by a volunteer-based nonprofit—the Appalachian Trail Conference, now known as the Appalachian Trail Conservancy. Formed in 1925 and based in Harpers Ferry, West Virginia, the Appalachian Trail Conservancy continues to work in partnership with the National Park Service, U.S. Forest Service (USFS), states, local communities, and a federation of 31 volunteer-led hiking clubs. This partnership, along with the Depression-era Civilian Conservation Corps, combined forces to open a continuous trail by August 1937.

The national significance of the Trail was formally recognized in 1968, when the National Trails System Act established the Appalachian National Scenic Trail as one of the first national scenic trails in the United States. Specifically, this legislation directed the National Park Service, in consultation with the U.S. Forest Service, to administer the Appalachian National Scenic Trail. The National Trails System Act was amended in 1978 to also authorize funds for the two agencies and the states to protect the entire route with public lands. Today, federal and state agencies remain important in the stewardship of the Trail, and volunteers maintain their long-standing and central role as the heart and soul of the Trail.

Nature and Purposes

The nature and purposes statement identifies the specific reason(s) for establishment of a particular national scenic trail and its predominant characteristics. The nature and purposes statement for the Trail was drafted through a careful analysis of its enabling legislation and the legislative history that influenced its development. The Trail was established when the enabling legislation adopted by Congress was signed into law on October 2, 1968 (see appendix A for enabling legislation). The nature and purpose statement lays the foundation for understanding what is most important about the Trail.

The Appalachian National Scenic Trail is a way, continuous from Katahdin in Maine to Springer Mountain in Georgia, for travel on foot through the wild, scenic, wooded, pastoral, and culturally significant landscapes of the Appalachian Mountains. It is a means of sojourning among these lands, such that the visitors may experience them by their own unaided efforts. The Trail is preserved for the conservation, public use, enjoyment, and appreciation of the nationally significant scenic, historic, natural and cultural quality of the areas through which the trail passes. Purposeful in direction and concept, favoring the heights of land, and located for minimum reliance on construction for protecting the resource, the body of the Trail is provided by the lands it traverses, and its soul is the living stewardship of the volunteers and workers of the Appalachian Trail community.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Trail Significance

Significance statements express why a trail's resources and values are important enough to merit designation as a unit of the national park system. These statements are linked to the nature and purposes of the Appalachian National Scenic Trail, and are supported by data, research, and consensus. Statements of significance describe the distinctive nature of the Trail and why an area is important within a global, national, regional, and systemwide context. They focus on the most important resources and values that will assist in Trail planning and management.

The following significance statements have been identified for Appalachian National Scenic Trail. (Please note that the sequence of the statements does not reflect the level of significance.)

- Conceived, designed, and constructed by volunteers, the Appalachian National Scenic Trail is unprecedented in scale and collaboration. It is one of the longest continuously marked, maintained, and publicly protected trails in the United States and was also one of the nation's first national scenic trails.
- The Trail is one of the greatest testaments to volunteerism in the nation. Volunteers are the soul of the Trail and, since 1921, have contributed millions of hours to the creation, conservation, promotion, and management of America's premier long-distance footpath.
- The Trail is an internationally recognized example of a public-private partnership. Hundreds of agencies and organizations, diverse in size and membership, collaborate in the Trail's management. Their initiative and dedication are fundamental to the preservation, traditions, and integrity of the Trail.
- Traversing 14 states through wildlands and communities, the more than 2,100-mile world-renowned hiking trail and its extensive protected landscape protects the most readily accessible, long-distance footpath in the United States. The Appalachian National Scenic Trail offers healthy outdoor opportunities for self-reliant foot travel through wild, scenic, natural, and culturally and historically significant lands. It provides a range of experiences for people of all ages and abilities to seek enjoyment, inspiration, learning, challenge, adventure, volunteer stewardship, and self-fulfillment, either in solitude or with others.
- The Trail's varied topography, ecosystem diversity, and numerous view points offer a visual showcase including wild, natural, wooded, pastoral, and historic environments. The Trail offers opportunities for scenic enjoyment, ranging from the subtle beauty of a trillium to tranquil ponds and streams to the grand view of mighty Katahdin.
- The north-south corridor of the Trail, traversing the highest and lowest elevations and myriad microclimates of the ancient Appalachian Mountains, helps protect one of the richest assemblages of temperate zone species in the world and anchors the headwaters of critical watersheds that sustain more than 10% of the population of the United States.
- The Trail corridor is one of the nation's most significant cultural landscapes, revealing the history of human use and settlement along the Appalachian Mountain range and the resulting distinct regional traditions. Visitors to the Trail have the unique opportunity to interact with the communities and resources representing these diverse eras in U.S. history and prehistory.

Fundamental Resources and Values

Fundamental resources and values (FRVs) are those features, systems, processes, experiences, stories, scenes, sounds, smells, or other attributes determined to warrant primary consideration during planning and management processes because they are essential to achieving the nature and purposes of the Trail and maintaining its significance. Fundamental resources and values are closely related to a trail's legislative purpose and are more specific than significance statements.

Fundamental resources and values help focus planning and management efforts on what is truly significant about the Trail. One of the most important responsibilities of NPS managers is to ensure the conservation and public enjoyment of those qualities that are essential (fundamental) to achieving the nature and purposes of the Trail and maintaining its significance. If fundamental resources and values are allowed to deteriorate, the Trail nature and purposes and/or significance could be jeopardized.

The following fundamental resources and values have been identified for Appalachian National Scenic Trail:

- **The Trail Itself.** The Trail treadway and many of its supporting structures are significant cultural resources that have continuously evolved in response to broad national trends in recreation, conservation, society, and political history.
- **The Empowered Volunteer.** For a century, volunteers under the leadership and guidance of the Appalachian Trail Conservancy have led nearly every aspect of the Trail's development, management, maintenance, and protection. In 2013, approximately 6,000 volunteers contributed nearly 250,000 volunteer hours, valued at more than $5 million. The Trail community is a clearinghouse for conservation skills development and is regarded as one of the most capable and professional conservation volunteer forces in the United States.
- **Enduring Collaborative Spirit.** The Trail's cooperative management system is recognized as the model for national trails and unrivaled in its scale. Local partnerships are the basic building blocks of this intricate system spanning 14 states, 8 national forests, 6 national park units, 2 national wildlife refuges, 24 wilderness areas, 8 national natural landmarks, 3 national historic landmarks, approximately 60 state protected areas, 88 counties, 164 townships and municipalities, and many other areas. The collaborative spirit among these diverse organizations allows for the protection and perpetuation of a national and international treasure.

- **Experience.** Within reach of millions, the Trail attracts visitors each year for hikes as short as an afternoon's walk and as long as an extended thru-hike from Georgia to Maine. The Trail offers visitors the opportunity to connect with nature and others, relax, and reflect. The Trail also allows people to challenge themselves, physically and mentally, through self-reliant backcountry recreation and long-distance hiking that are among the best in the world.
- **Education.** The Trail and its protected landscape provide opportunities for learning for a broad spectrum of visitors and audiences. Through partnerships with schools, teachers, and educational organizations, the Trail offers access to a variety of educational experiences that enable people to learn about, appreciate, understand, and study the Trail's natural and cultural heritage and help foster the next generation of stewards.
- **Scenery Along the Treadway.** The Trail offers opportunities to view stunning scenery in proximity to the most populated areas of the United States. Within the boundaries of the protected trail corridor, visitors may see native wildlife and flowers, rustic cultural features, seasonal variations, and dynamic weather patterns in environments such as southern balds, pastoral lands, diverse forests, wetlands, rugged outcrops, and mountainous alpine areas.
- **Views Beyond the Corridor.** Traversing the height of land, Trail visitors are afforded sweeping views of vast landscapes extending beyond the Trail corridor and are exposed to the splendid range of landforms and history along the Appalachian Mountains. Enjoyment of far-reaching views and deep starry nights are dependent on clean air and clear skies.
- **Natural Resource Quality and Ecological Connectivity.** The Trail corridor passes through eight separate ecoregions, linking extensive forest landscapes and an extraordinary variety of aquatic and terrestrial habitats over a distance of more than 2,100 miles. The Trail unifies understanding, management, and protection of representative natural resources at a scale that no other single entity can provide, while offering visitors the chance to see, hear, and feel nature all around them.
- **A Journey through American Heritage.** The lands along the Appalachian National Scenic Trail are rich in history and include the stories of people—American Indians, pioneers, settlers, farmers, as well as early trailblazers and trail advocates such as Grandma Gatewood—and places, wars, industry, and agriculture. The Trail provides a direct physical link between nationally significant areas such as Great Smoky Mountains National Park, Harpers Ferry National Historical Park, and Green Mountain National Forest.

Interpretive Themes

Interpretive themes are often described as the key stories or concepts that visitors should understand after visiting a park unit—they define the most important ideas or concepts communicated to visitors about the park unit. Themes are derived from, and should reflect, Trail nature and purposes, significance, resources, and values. The set of interpretive themes is complete when it provides the structure necessary for Trail staff and partners to facilitate opportunities for visitors to explore and relate to all Trail significance statements and fundamental resources and values.

Interpretive themes are an organizational tool that reveal and clarify meaning, concepts, contexts, and values represented by Trail resources. Sound themes are accurate and reflect current scholarship and science. They encourage exploration of the context in which events or natural processes occurred and the effects of those events and processes. Interpretive themes go beyond a mere description of the event or process to foster multiple opportunities to experience and consider the Trail and its resources. These themes help explain why a Trail story is relevant to people who may otherwise be unaware of connections they have to an event, time, or place associated with the Trail.

The following interpretive themes have been identified for Appalachian National Scenic Trail:

- **The Trail Itself.** The white-blazed Appalachian National Scenic Trail, which as a whole is greater than the sum of its parts, reflects the vision of its creators, ongoing dedication of its passionate volunteer force, and epitomizes American spirit, ingenuity, and idealism. It now stands as the longest continuously marked and protected trail in the world.
- **Volunteers.** Volunteers are the heart and soul of the Appalachian National Scenic Trail. They pioneered and continue a grassroots tradition of service for the Trail and engage in every aspect of its stewardship. Individuals from all walks of life take great pride in their specific trail duties, yet collectively work together toward a shared vision.

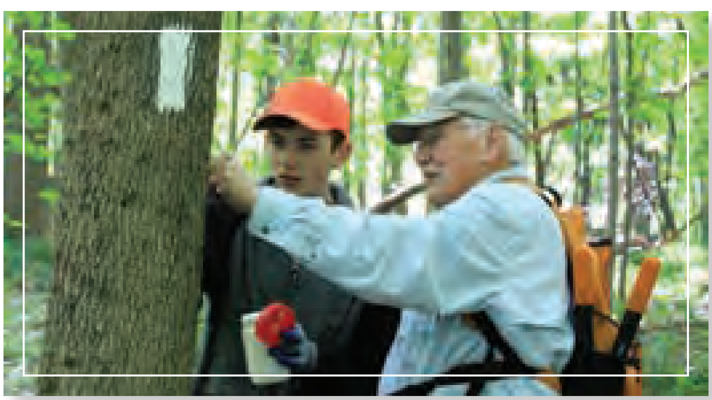
- **Partnerships.** The Appalachian National Scenic Trail's model management system is the embodiment of the cooperative spirit. The cooperative management system allows for diverse perspectives and skills from numerous partners to achieve common goals in service to the Trail and visitors.

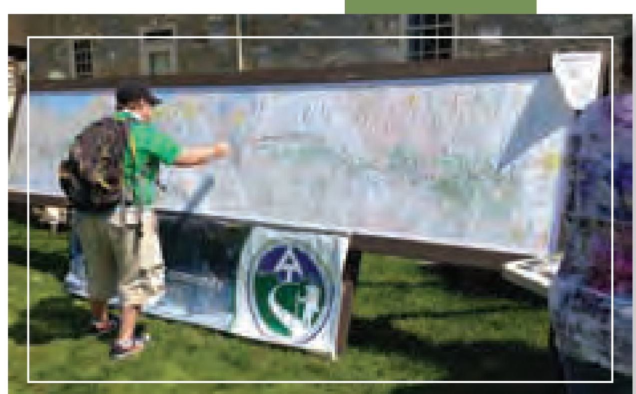
- **Visitor Experience.** The Appalachian National Scenic Trail offers the opportunity to experience simplicity, self-reliance, adventure, discovery, and connection with nature as a means of slowing down in a fast-paced society. Through the intimate setting of a fern-filled woodland or the sweeping expanse of an alpine ridge, a personal experience on the Appalachian National Scenic Trail has the power to transform and uplift the human spirit, whether traveling solo or as part of a group of fellow hikers.

- **Natural Resources.** The Appalachian National Scenic Trail threads a diverse array of habitats, such as subalpine forests, open balds, rocky outcrops, meadows, and wetlands, providing a haven for abundant flora and fauna, including rare, threatened, and endangered species. The Trail's uninterrupted north-south aspect, long length, and varied habitats provide a living laboratory that serves as an important barometer of climate change and ecological health as well as an avenue for adaptation.

- **American Heritage.** Traversing a mosaic of landscapes inhabited by peoples over thousands of years, the Appalachian National Scenic Trail is home to countless irreplaceable cultural and historic resources. The combination of the Trail, its travelers, and the resources through which it meanders offers an exceptional opportunity to understand American heritage and values through time.

- **Community.** The Appalachian National Scenic Trail inspires rich connections between people and local communities through the common currency of shared experiences and passions about outdoor recreation, open space, and preservation of Trail values for future generations.





Part 2: Dynamic Components

The dynamic components of a foundation document include special mandates and administrative commitments and an assessment of planning and data needs. These components are dynamic because they will change over time. New special mandates can be established and new administrative commitments made. As conditions and trends of fundamental resources and values change over time, the analysis of planning and data needs will need to be revisited and revised, along with key issues. Therefore, this part of the foundation document will be updated accordingly.

Special Mandates and Administrative Commitments

Many management decisions for an NPS unit are directed or influenced by special mandates and administrative commitments with other federal agencies, state and local governments, utility companies, partnering organizations, and other entities. Special mandates are requirements specific to a trail that must be fulfilled. Mandates can be expressed in enabling legislation, in separate legislation following the establishment of the trail, or through a judicial process. They may expand on trail nature and purposes or introduce elements unrelated to the nature and purposes of the trail. Administrative commitments are, in general, agreements that have been reached through formal, documented processes, often through memorandums of agreement. Examples include easements, rights-of-way, arrangements for emergency service responses, etc. Special mandates and administrative commitments can support, in many cases, a network of partnerships that help fulfill the objectives of the trail and facilitate working relationships with other organizations. They are an essential component of managing and planning for Appalachian National Scenic Trail.

For more information about the existing special mandates and administrative commitments for Appalachian National Scenic Trail, please see appendix B.

Assessment of Planning and Data Needs

Once the core components of part 1 of the foundation document have been identified, it is important to gather and evaluate existing information about the Trail's resources and values, and develop a full assessment of the Trail's planning and data needs. The assessment of planning and data needs section presents planning issues, the planning projects that will address these issues, and the associated information requirements for planning, such as resource inventories and data collection, including GIS data.

There are three sections in the assessment of planning and data needs:

1. identification of key issues and associated planning and data needs
2. analysis of fundamental resources and values
3. identification of planning and data needs (including spatial mapping activities or GIS maps)

The analysis of fundamental resources and values and identification of key issues leads up to and supports the identification of planning and data collection needs.

Identification of Key Issues and Associated Planning and Data Needs

This section considers key issues to be addressed in planning and management and therefore takes a broader view over the primary focus of part 1. A key issue focuses on a question that is important for an NPS unit. Key issues often raise questions regarding Trail nature and purposes and significance and fundamental resources and values. For example, a key issue may pertain to the potential for a fundamental resource or value in a trail to be detrimentally affected by discretionary management decisions. A key issue may also address crucial questions not directly related to nature and purposes and significance, but which still indirectly affect them. Usually, a key issue is one that a future planning effort or data collection needs to address and requires a decision by trail managers.

The following are key issues for the Appalachian National Scenic Trail and the associated planning and data needs to address them:

Broadening and diversifying the Trail support network. The volunteer force is the lifeblood of the Trail. But many of the Trail's stalwart supporters and long-time volunteers are aging. In addition, some Trail clubs face challenges such as capacity building and leadership succession and have requested assistance with organizational development. Major demographic changes in the country also necessitate broadening and diversifying the network of Trail supporters.

- Related planning and data needs: Visitor use surveys; community outreach plan / volunteer engagement strategy

Responding to the challenges and seizing the opportunities created by increased visitation. Some Trail segments near populated areas have experienced substantial increases in visitation in recent years, leading to greater impacts on Trail resources. Overnight use of Trail shelters and campsites is generally increasing, as are the number and size of large groups using the Trail. There is also an increase in the number of applications for special use permits and in the number of proposals for snowmobile and all-terrain vehicle (ATV) crossings.

- Related planning and data needs: Visitor use management plan, identify management zones, baseline data on visitor use levels and patterns

Reacting proactively to external threats associated with development, power infrastructure, and industrial operations. The Trail is within a day's drive of two-thirds of the population of the United States. The eastern seaboard continues to grow, as does development and the desire for power and connectivity, resulting in more infrastructure—wind turbines, powerlines, pipelines, and wider roads. These trends create major impacts on Trail viewsheds, soundscapes, ecological systems, and cultural resources. The geographic position and length and width of the Trail make it especially vulnerable to fragmentation and degradation from development. For example, in many areas, the Trail's protected corridor is less than 1,000 feet.

- Related planning and data needs: Scenic and landscape-level protection and response strategy

Providing consistency and promoting excellence in Trail maintenance. The Trail traverses more than 2,100 miles of diverse landscapes, with hundreds of organizations and agencies involved in its management. This creates inherent challenges for Trail managers. Local initiative and creativity must be fostered, but some level of consistency is necessary for an iconic national scenic trail. Clear and consistent standards are needed for signage, trailhead facilities, treadway maintenance, and structures such as shelters, camping areas, and trail bridges. These trailwide standards are necessary to protect resources and to continue providing for high-quality visitor experiences. Any future standards should be simple, practical, adaptable to on-the-ground conditions, and reflect local practices.

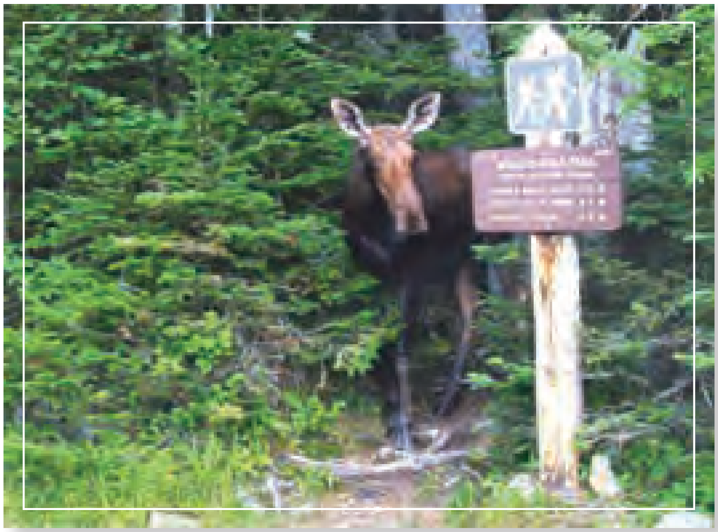
- Related planning and data needs: Sustainable trail design and campsite standards (including an optimal location review to determine the ideal location for the Trail in a particular area.); wayfinding plan

Promoting sustainability. Many sections of the Trail treadway and associated facilities require frequent maintenance and periodic reconstruction such as shelters, campsites, bridges, latrines, waterbars, checkdams, stone steps and retaining walls, boardwalks, ladders, and puncheons. This infrastructure is constantly worn down by continual use and natural elements. In addition, increasing visitor use results in accelerated wear and tear on the treadway and associated facilities. In order for the Trail and its facilities to provide for high-quality visitor experiences into perpetuity, sustainable design is important.

- Related planning and data needs: Sustainable trail design and campsite standards

Analysis of Fundamental Resources and Values

The fundamental resource or value analysis table includes current conditions, potential threats and opportunities, and planning and data needs related to management of the identified resource or value. In the tables that follow, the identified opportunities and potential planning and data collection efforts would be carried out collaboratively with Trail partners and stakeholders. Furthermore, the identified planning and data needs are limited to efforts where the National Park Service may need to become directly involved through project management or technical assistance. The list is not intended to capture all the planning and data needs that could be carried out by local communities, trail clubs, or other agencies.



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Fundamental Resource or Value	The Trail Itself
Related Significance Statements	All
Current Conditions and Trends	**Conditions** • Trail rerouting projects are being conducted to improve visitor experience and trail sustainability • The Trail receives heavy use in some segments, particularly near towns and cities • At least 99% of the footpath is protected through acquisitions, easements, public lands, and other means • Aging infrastructure is in need of rehabilitation, replacement, or removal (bridges, shelters, etc) **Trends** • The tread and trail facilities require frequent maintenance, especially along the oldest portions of the Trail found in the New England region and in high-use segments • There is a need to make structures accessible for people with disabilities • There is a growing need for group-use overnight sites in many specific locations • Severe weather events are becoming more frequent along the Trail; these events often impact the Trail treadway and associated structures

Fundamental Resource or Value	The Trail Itself
Threats and Opportunities	**Threats** • Vandalism threatens resources and structures along the Trail • Increased visitation and use places additional stress on natural and cultural resources as well as Trail facilities • Encroachment from neighboring lands on Trail boundary and corridor lands resulting in resource damage • Potential impacts from climate change including extensive droughts (impacting water availability for hikers) and severe storms (impacting trail conditions due to erosion/flooding) • Illegal use of the Trail threatens resources and the treadway • Transmission easements and rights-of-way across the Trail surface add management complexities and degrade the Trail experience • In some areas, lack of volunteers could negatively impact trail maintenance **Opportunities** • Acquire additional tracts of land for protection, or purchase underlying fee of existing easement lands • Expand efforts to engage and educate visitors in high-use areas • Use sustainable trail design to improve Trail conditions for visitor experience and safety as well as resource protection
Existing Data and Plans Related to the FRV	• Trail assessment capital plans • USFS Infrastructure Database (INFRA) provides inventory and condition assessments of trail infrastructure • Specific NPS facility and condition assessment data in the Facility Management Software System (FMSS)
Data and/or GIS Needs	• Boundary survey data • Maintained landscape inventory • Trail assessment studies to evaluate trail conditions to document maintenance deficiencies and include a database management component • Boundary monitoring and maintenance tracking system • Climate change vulnerability assessment for the Trail and structures along the Trail
Planning Needs	• Update comprehensive management plan • Sustainable trail design study and guide • Administrative history of the Trail • Cultural landscape reports • Complete National Register of Historic Places nomination for "The Trail Itself " • Archeological overview and assessment • Climate change scenario planning • Maintained landscape management plan • Sustainable trail and campsite planning • Visitor use management plan • Identify management zones • Wayfinding plan

Fundamental Resource or Value	The Empowered Volunteer
Related Significance Statements	Significance statement 2
Current Conditions and Trends	**Conditions** • There are 31 maintaining clubs for the Trail • Some volunteer clubs are not near the actual Trail, which creates problems for organizing projects and building relationships with communities This also creates logistical problems and a greater environmental impact when organizing "shovel work " • In recent years, the number of volunteers has been approximately 6,000 annually • Leadership attrition has been an issue • A significant amount of volunteer hours are unknown or unreported This has been an issue for many years • During the last few years, new initiatives have been launched to increase diversity among Trail volunteers; specifically, these efforts have sought to bring in younger volunteers and more female volunteers • Many volunteers are not connected to the larger A T community and may not understand their role in the cooperative management system • Many of the strongest clubs (largest and most active) are near large population centers **Trends** • For the last five years, there has been a 2% average increase in reported hours and total volunteers • Overall, the volunteer force is aging • Many of the trail clubs are carried by a small core of stalwart members This is great for institutional knowledge and efficiency, but creates problems for succession planning For example if a club president retires, all their institutional knowledge and relationships leave with them • More people are looking for short-term or one-time volunteer opportunities • Popularity of people seeking group volunteer opportunities (i e , families and college "alternative spring break") has increased

Fundamental Resource or Value	The Empowered Volunteer
Threats and Opportunities	**Threats** • High travel cost for participating in volunteer projects This issue is compounded by growing environmental awareness about the impacts of personal automobile use • Loss of institutional knowledge and long-time leaders in trail clubs • Loss of trail maintenance knowledge These skills are not widely held in our society • Lyme and other tick-borne diseases are health and safety concerns for volunteers • Training funds have been diminishing for important trainings such as saw safety • Increasing regulation from agencies is a turnoff to volunteers, often discouraging willing volunteers Volunteers just want to get their hands dirty without bureaucratic red tape • Inability to enhance opportunities for underserved audiences without expanding paid internships and other employment opportunities such as youth conservation corps **Opportunities** • Connections could be improved with local land trusts, youth organizations, and educational institutions • Proactively engage the thru-hiker community and passionate hikers to increase youth representation in the volunteer corps and to fill leadership positions and crew leader positions This could be accomplished through creating more paid internships for youth • Engage more educators and youth volunteers from the "Trail to Every Classroom" program • Effectively use social media to reach and recruit a larger group of supporters • Increase efficiency in turning people in Trail communities into Trail volunteers, supporters, and advocates • Update memorandums of understanding • Plan actively for leadership succession in Trail clubs • Evaluate the geographic placement of trail ridge runners and caretakers in order to determine whether their total number and placement are adequate
Existing Data and Plans Related to the FRV	• "Local Management Planning Guide" (LMPG) • Local management plans of individual clubs • Volunteer Leadership Handbook (Appalachian Trail Conservancy) • Appalachian Trail Conservancy Strategic Plan (2014) • Volunteer database maintained by Appalachian Trail Conservancy and larger clubs (CIVICORE)
Data and/or GIS Needs	• Boundary survey data • Trail assessment studies • Compiling a database/list of project identification and logistics for episodic volunteers (shovel-ready projects) • Volunteer survey focused on volunteer motivations to inform strategies for recruiting new volunteers • Capture undocumented volunteer hours—to identify the difference between reported and actual hours and identify how to close the gap
Planning Needs	• Update comprehensive management plan • Analysis of how to efficiently update local management plans, or perhaps, how to efficiently develop amendments • Identify management zones

Fundamental Resource or Value	Enduring Collaborative Spirit
Related Significance Statements	Significance statement 3
Current Conditions and Trends	**Conditions** • Most interorganizational relationships among the major players are healthy • Federal agencies have had increased difficulty participating in planning and management activities due to sequester and budget cuts • Some state agencies are frequently and closely involved, while others participate infrequently (once a year or once a decade) **Trends** • There has been decreased involvement from state agencies due to budget and travel constraints • There has been a decrease in funding availability from federal partners • There has been more involvement from local governments—cities and towns are increasingly at the table • There has been an increase in requests for special use permits, mainly from recreation guides and outfitters

Fundamental Resource or Value	Enduring Collaborative Spirit
Threats and Opportunities	**Threats** • Turnover of agency and organization personnel leads to loss of institutional knowledge • Decreased funding opportunities from federal agencies make it difficult to maintain meaningful programs • Increasing agency requirements lead to a decrease in ability and willingness of partners to collaborate **Opportunities** • Conduct more active outreach to state and local agencies, especially along the northern segments of the Trail where there is more municipal and state land In addition, memorandums of understanding with these organizations should be updated in a timely manner—those processes can also be used to strengthen relationships • Fold new designated "Trail communities" into the cooperative management system For example, have them represented in regional partnership meetings • Increase the number of venues for engagement with Trail communities and to provide training • Design volunteer projects that are mutually beneficial for communities and Trail organizations • Have a better process to engage people and communities with limited interaction with the Trail and partners, but who may have an interest in becoming involved • Share best practices for succession planning to offset the loss of institutional knowledge • Leverage lessons learned and best management practices (through workshops and conferences already in place) from others in the national trail system • Establish a better relationship with the Partnership for the National Trails System • Update state memorandums of understanding and hold periodic meetings with signatories
Existing Data and Plans Related to the FRV	• The "Local Management Planning Guide" includes a list of major organizations / agencies involved with the Trail • Appalachian Trail comprehensive plan
Data and/or GIS Needs	• Boundary survey data • Better system for maintaining the cooperative partner list • Economic impact study • Study of the best practices / best methods for conducting an evaluation of ecosystem services • The community cost of converting land from one use (open space) to another (suburban, urban, paved) • Database of existing special use activities permitted on or near the Appalachian National Scenic Trail
Planning Needs	• Update comprehensive management plan • Identify management zones

Fundamental Resource or Value	Experience
Related Significance Statements	All
Current Conditions and Trends	**Conditions** • The Trail is more than 2,100 miles long and provides a wide array of opportunities to experience nature at a local, regional, or national level • The Trail and related Trail facilities are maintained primarily by Trail volunteers • The Trail connects to a variety of places to learn about history and nature • A variety of partners help to facilitate visitor experiences • Because the Trail traverses many different properties, the primary visitor experience is that of a primitive trail, but the Trail also passes through some areas that provide interpretation and hiker services • There is an occasional diminished quality of the visitor experience as a result of high visitor use, particularly at scenic overlooks and overnight sites • The narrowness of the Trail limits the number of people engaged in any one activity in the same area • The continuous nature of the Trail requires that the Trail is maintained to a high standard • The Trail is open year-round and mostly free • The Trail provides opportunities to experience both solitude and/or camaraderie with fellow users • Trail communities provide services to visitors and partner with various Trail entities while visitors provide economic benefits to those communities • The shelters and campsites are part of the overall experience • Shelters and campsites are open and available continuously along the Trail • There is a diversity of visitor services and educational materials offered by a variety of partners available along the Trail • There is information about a variety of hiking opportunities available on blogs and websites from various organizations and individuals, as well as frequent mention in print media, such as magazines and newspaper articles, though their accuracy and quality vary greatly **Trends** • There is increasing visitation on the Trail • The Trail has seen a higher number of successful thru-hikers in recent years • Day hikers are the most prevalent users of the Trail • There is an increasing desire for adventure sport opportunities among some user groups • Increasing requests for commercial activities and special park uses such as fund–raising events, long-distances races, organized group uses such as college orientations and summer camps, and filming • Increasing demand for connectivity and electronic media (cell phones, smartphones, GPS, etc), among some users • Some visitors' cultural and recreational values and interests are shifting from traditional hiking and backpacking • Demographics of Trail users and potential Trail users are shifting, as are the way people recreate and what they consider recreation • Backcountry preparedness and self-reliance are values that are increasingly being lost • Visitors are increasingly bringing inappropriate frontcountry habits into the backcountry • Progressively difficult to coordinate with the wide range of partners with decreased funding • The number of applications for special use permits has grown considerably in recent years

Fundamental Resource or Value	Experience
Threats and Opportunities	**Threats** • Continued lack of preparedness of visitors • Lyme disease and other tick-borne diseases result in health and safety threats to visitors • Crime and illegal off-road vehicle use • Decreased ability to respond to incidents and coordinate partners due to decreased funding and increased incidents • Potentially dwindling volunteer force in the future, making it difficult to continue to maintain Trail and Trail facilities • Loss of relevancy of the Trail • Trail users do not reflect the diversity of the United States • Relationships between partners take work and dedication to maintain Less engagement could negatively impact the Trail • External threats, such as boundary encroachment and transmission lines, threaten visitor experience • Areas of concentrated, extremely high use threaten the visitor experience • Climate change could negatively impact visitor experience; for example, the projected increased warming trend, along with an increase in extreme precipitation and temperature events, could increase invasive species and pests (e g , ticks, chiggers), flooding/erosion impacts to the Trail and structures, and declines in water availability along the Trail • Resource degradation from activities such as encroachment, clear-cutting, and graffiti • Overcrowding at campsites diminishes the quality of the visitor experience **Opportunities** • Increase information, orientation, and education services to provide important information to visitors For example, trailhead kiosks could be used to provide information to visitors on "Leave No Trace" principles • Work with federal agencies for enhancement of the visitor experience—the Appalachian National Scenic Trail can lead by example with participation on the Federal Interagency Council on Trails and the new Federal Interagency Council on Outdoor Recreation • Increase or develop messaging regarding sustainability and safety For example, hikesafe com was developed in the White Mountain National Forest to increase visitor safety and awareness This type of informational program could be used in other areas • Identify hotspots and areas where the Trail doesn't have high-quality wayfinding • Use sustainable trail and campsite construction techniques to improve the visitor experience • Take advantage of opportunities to engage diverse audiences, particularly youth, young adults and families, active-duty military, and veterans through outdoor learning experiences • Provide opportunities for increased availability of non-English messaging • Leverage funding and personnel from 21st Century Conservation Service Corps to assist clubs with maintaining their sections of the Trail • Continue to use new technologies to engage and communicate with monument partners and users • Partner with new service organizations and communities • Develop high-quality personal and nonpersonal interpretive services program Interpretive staff could be placed at key locations along the Trail, such as popular trailheads, to better connect with visitors • Interpretation/education about climate change influences along the Trail

Fundamental Resource or Value	Experience
Existing Data and Plans Related to the FRV	• *Appalachian National Scenic Trail Pilot Survey* (2011) • *Use and Users of the Appalachian Trail: A Source Book* (2000) • *Camping Impact Management on the Appalachian National Scenic Trail* (2003)
Data and/or GIS Needs	• Boundary survey data • Baseline data on visitor use levels and patterns • Establishing indicators and thresholds and ongoing monitoring protocols as part of a future visitor use management plan • Budget and operational analysis to support bringing on the 21st Century Conservation Service Corps • Economic impact study • Trail-related weather statistics • Analysis of which clubs are most successful at incorporating community outreach into their mission and what is leading to those successes, as well as how (or if) those communities are contributing to the visitor experience • Analysis of changes to parcels of land near the trail that could have a negative impact on visitor experience (related to development) • Curation of all data and plans relevant to the Trail • Collection of data related to rules and regulations for partners • Land use / ownership analysis
Planning Needs	• Update comprehensive management plan • Wayfinding plan • Community outreach plan / volunteer engagement strategy • Development concept plans for specific high-use areas such as McAfee's Knob, Nuclear Lake, and Bulls Bridge, to name a few • Analysis of how to efficiently update local management plans, or perhaps, how to efficiently develop amendments • Communication or technology plan • Visitor use management plan • Identify management zones

Fundamental Resource or Value	Education
Related Significance Statements	All
Current Conditions and Trends	**Conditions** • There are a wide variety of educational opportunities available along the Trail • There is a lack of capacity across all partner organizations—especially those far afield—to provide educational opportunities • The Trail to Every Classroom program is a professional development program that provides K–12 educators with the tools and training for place-based education and service-learning on the Appalachian National Scenic Trail This program offers educators resources needed to engage their students in their local community, while growing academically and professionally The program has trained more than 300 teachers; their capacity may be under-utilized • There is a range of commitment to education and community outreach as part of club missions **Trends** • Trail staff are slowly engaging other organizations and partners to help achieve educational goals • Use of technology has increased in education • There is a lack of diversity in NPS visitors as a whole, and the Trail sees a similar lack of diversity

Fundamental Resource or Value	Education
Threats and Opportunities	**Threats** • Educational opportunities are fragmented in part by underfunding • There is a lack of relevancy of the Trail • People are choosing not to use leisure time to participate in educational programs as much as in the past • Need to diversify educational offerings in order to remain sustainable **Opportunities** • Establish interpretive standards and training programs with partners • Develop a suite of educational offerings in addition to the Trail to Every Classroom program • Connect with diverse audiences and make them feel welcome and engaged • Engage with other national trails, parks, and forests to share educational and outreach resources and best practices • Recruit more volunteers to present education programs • Begin using the NPS "Teaching with Historic Places" program • Interpretation/education of the influences from climate change along the Trail
Existing Data and Plans Related to the FRV	• "A Trail to Every Classroom Participant Manual" (2012) Program Evaluations can be found at http://www peerassociates net/products Curriculum can be found at http://appalachiantrail org/what-we-do/youth-education/trail-to-every-classroom-resources
Data and/or GIS Needs	• Boundary survey data • Develop database of all formal and informal educational opportunities, institutions, schools, etc , that teach about the Trail • Document and catalog all units and lesson plans developed by teachers related to the Appalachian National Scenic Trail and make it available online • Evaluation of impacts of Trail educational programs on student learning and youth stewardship opportunities and career development • Demographic studies for students who participate in Appalachian National Scenic Trail educational opportunities • Develop database of all research that pertains to the Appalachian National Scenic Trail • Document success stories from education programs • Gap analysis of educational and learning opportunities • Measure effectiveness of initiatives and programs related to all educational efforts
Planning Needs	• Update comprehensive management plan • Long-range interpretive and education plan • Financial strategy for educational programs • Community outreach plan / volunteer engagement strategy • Appalachian National Scenic Trail community program planning and branding • Finalize and implement Appalachian National Scenic Trail Leave No Trace Program • Identify management zones

Fundamental Resource or Value	Scenery Along the Treadway
Related Significance Statements	Significance statements 4, 5, 6, and 7
Current Conditions and Trends	**Conditions** • The location of the Trail is designed to incorporate scenic features within its protected corridor, as well as maximize scenic views outside the corridor • The Trail is surrounded by a largely undeveloped land base, but does pass near and through some highly developed areas • There is a rich, outstanding variation of natural resources along the Trail • There are a variety of rustic trail structures (e g , shelters, rock staircases, bridges) • Visitor-related impacts detract from scenic value (e g , litter, graffiti, unauthorized trails branching out from the main treadway [social trails]) **Trends** • Visitor use is increasing, with subsequent impacts • Evolving science of sustainable trail alignments may not always afford the best scenery • Rapidly evolving threats have the potential to diminish natural environments • There is improved documentation of scenic resources and threats
Threats and Opportunities	**Threats** • Encroachment threatens the aesthetic quality of the Trail corridor • Over-use throughout the Trail affects the viewscape and visitor experience • Infrastructure development within the corridor (e g , pipelines, powerlines, roads) • Increase in invasive species due to climate change (e g , increased average annual temperature) will change forest composition and the visual landscape For example, the invasive species kudzu is projected to increase in the Mid-Atlantic region of the Trail • Lack of management of maintained landscapes reduces scenic opportunities and values • Decreasing biodiversity (e g , encroachment of nonnative plants) • Climate change alters ecosystem composition and distribution, which alters scenic resource conditions • Decreased air quality diminishes extent of scenic vistas • Increased development near the Trail results in nighttime light pollution impacting the night sky **Opportunities** • Several Mid-Atlantic states would benefit from land exchanges or trades between those states and the NPS Trail Office to consolidate state and federal holdings Right now, the "patchwork quilt" may actually detract from resource protection and public recreation in portions of New Jersey, Pennsylvania, and Maryland • Ongoing removal of incidentally acquired structures and land restoration • Provide better documentation of scenic resources • Take advantage of, and coordinate with, Leave No Trace education efforts • Work with adjacent communities to improve local planning and zoning to supplement protection of the Trail viewshed

Fundamental Resource or Value	Scenery Along the Treadway
Existing Data and Plans Related to the FRV	• Appalachian Trail comprehensive plan • Natural resource management plan (2008) • Other cooperative agency scenery management plans • Fire management plan (2013) • Baseline viewshed analysis • Established plans and management zones to protect the scenic values (e g , U S Forest Service forest management plans and park plans) • Trail assessment and capital plans • Rare plant inventories for 14 states • Vital Signs Report (2005) • State of the Parks Report (National Parks Conservation Association) • Local management plans • U S Forest Service Scenery Management System • "Locating and Designing A T Shelters and Formal Campsites" (Appalachian Trail Conservancy) • Appalachian Trail Conservancy land protection in high priority areas • Inventory and monitoring protocols for rare plants, invasive species, and phenology
Data and/or GIS Needs	• Boundary survey data • Complete visitor use count • Update viewshed analysis • Baseline data on visitor use levels and patterns • Survey unsurveyed tracts • Develop encroachment database system • Improved comprehensive invasive species inventory • Climate change vulnerability assessment for select resources that comprise the surrounding landscapes along the Trail
Planning Needs	• Establish indicators and thresholds and ongoing monitoring protocols as part of a future visitor use management plan • Invasive species management plan • Update comprehensive management plan • Update local management plans • Maintained landscape management plan • Identify management zones

Fundamental Resource or Value	Views Beyond the Corridor
Related Significance Statements	Significance statements 3, 4, and 5
Current Conditions and Trends	**Conditions** • Considerable regional variation of landscapes and viewsheds along the length of the Trail • There are both undeveloped and developed views overlaid with a variety of land uses • There are variable air quality conditions along the length of the Trail • Variable levels of light pollution along the length of the Trail **Trends** • Cumulative scenic degradation results in significant impacts • Growing external threats (please see "Threats" below) • Increasing interest in renewable energy development
Threats and Opportunities	**Threats** • External developments (e g , telecommunication infrastructure, energy development and distribution, industrial developments, housing developments, etc) and energy transmission lines can negatively impact viewsheds and visitor experience • Air quality degradation impacts viewsheds along the Trail (e g , hazy visibility) • Climate change could impact natural resources (e g , changes in forest composition) and infrastructure (e g , flooding/storm damage) within the surrounding landscapes • Landscape fragmentation (e g , parcelization) changes the visual landscape • Invasive species are changing the natural composition of ecosystems **Opportunities** • Work with local municipalities and communities on residential and commercial development plans • Continue ongoing cooperative partnerships to address incompatible external developments and large landscape protection • Advocate for appropriate siting of renewable energy infrastructure • Demonstrate air quality impacts through visual depictions and other interpretive mechanisms to educate public • Educate public about changing land uses and climate and the associated influences on the scenery • Complete National Register of Historic Places nomination for the Trail to help protect viewsheds
Existing Data and Plans Related to the FRV	• Complete viewshed analysis • USFS Scenery Management System • Vital signs report (2005) • State of the Parks Report (National Parks Conservation Association) • Land Protection Plan (National Park Service)
Data and/or GIS Needs	• Analysis of cumulative scenic impacts • Ongoing scenic threats analysis • Increased focus on large landscape analysis • Improved photo documentation of visual resources and current conditions (baseline) • Improved visual simulation capabilities • Further GIS analysis of land use trends
Planning Needs	• Boundary survey data • Update comprehensive management plan • Scenic and landscape-level proactive protection and response strategy (This planning effort could include participation in "A Call to Action" initiatives "Enjoy the View" and "Scaling Up ") • Identify management zones

<table>
<tr><th>Fundamental Resource or Value</th><th>Natural Resource Quality and Ecological Connectivity</th></tr>
<tr><td>Related Significance Statements</td><td>Significance statement 6</td></tr>
<tr><td>Current Conditions and Trends</td><td>Conditions

In places, Trail alignment and construction are not sustainable and are adversely affecting resources and fragmenting habitats
During peak hiking season, some overnight sites are not large enough to accommodate the number of users In some cases, this issue has led to the establishment of undesignated campsites, social trails, and loss of ground cover
Invasive nonnative species are a problem at numerous locations along the Trail
Rare plant and exemplary natural communities are at risk from a variety of threats including air pollution, invasive species, and visitor use
There are fourteen national natural landmarks located within five miles of the Trail
Encroachment on the land base has occurred due to incompatible development adjacent to the Trail
Greenhouse gas emissions from vehicles, power plants, deforestation, and other human activities have increased temperatures around the world and changed other aspects of climate
Published field research shows that climate change is also altering ecosystems by shifting biomes, contributing to species extinctions, and causing numerous other changes
According to the NPS Hydrographic and Impairment Statistics database, there are approximately 640 4 miles of perennial and intermittent rivers, streams, and canals within or adjacent to the Trail management area
Of the approximately 640 4 miles of perennial and intermittent rivers, streams, and canals within or adjacent to the Trail management area, approximately 66 5 miles (10 4%) are considered impaired, meaning they fail to attain one or more of a state's designated beneficial uses
Water quality impairments occur throughout the Trail management area but are most numerous in the middle portion, which experiences greater development pressure

Trends

Forest health is declining due to forest pests, pathogens, invasive species, acid deposition, etc
Poor air quality is affecting ecological health of habitats
Biodiversity is declining, due in part to invasive species
High-intensity weather events, changes in phenology, and other possible manifestations of climate change are affecting plant and animal life cycles
Open areas are being lost to early successional forest Balds are declining in scope and health
Some agricultural activities along pastoral portions of the Trail are causing soil loss and adverse impacts on water quality
Alpine and other high-elevation vegetation is being affected by climate change and visitor impacts
Increased encroachments are occurring along the Trail corridor near heavily populated areas
Loss of large predator species has contributed to increases in deer populations and, in turn, the tick population
There is increasing pressure for incompatible energy development along the Trail corridor
In New England, 11 of 21 U S Historical Climatology Network Stations showed statistically significant decreases in snow as a fraction of all precipitation
Upslope shifts in northern hardwood forests and northward shifts in bird winter ranges are attributed to climate change
</td></tr>
</table>

Fundamental Resource or Value	Natural Resource Quality and Ecological Connectivity
Threats and Opportunities	**Threats** • In places, the Trail alignment contributes to soil loss, hydrological alterations, and vegetation/habitat impacts • Historic fire regimes have changed, affecting the make-up of biological communities • Climate change is affecting biological communities and may be causing a decline in water resource availability • Incompatible development along the Trail is resulting in encroachment on natural communities • Forest fragmentation is affecting species movement • Degraded air quality is adversely affecting vegetation and overall forest health The high-elevation ecosystems protected by the Trail are also sensitive to acid deposition • Loss of biodiversity is occurring from various causes, including invasive nonnatives, pollutants, etc • Increased visitor use is resulting in concentrated impacts in certain areas • Analyses of climate projections and modeling of ecosystem and infrastructure changes indicate potential vulnerabilities of species, ecosystems, and other resources from climate change • Climate change could shift the ranges of numerous tree species in the Appalachian Mountains northward • Because cold winter temperatures reduce the survival and limit the range of the hemlock wooly adelgid (a pest that has killed extensive areas of forest) future warmer temperatures may favor substantial northward and upslope expansion of the pest across eastern North America • Modeling of the range of the invasive species kudzu (*Pueraria lobata*) indicates a potential increase in the Mid-Atlantic • Experimental increases of atmospheric carbon dioxide in a North Carolina forest indicate that climate change could increase the growth and toxicity of poison ivy (*Toxicodendron radicans*) • Among mammal species, moose and bats are vulnerable to increased mortality with warmer winters • For New England, modeling of plant phenology projects an average two-week advance of leafing and blooming under emissions scenario A2 **Opportunities** • Reintroduce prescribed fire as a management technique • Support cooperative weed management areas • Where possible, acquire additional interests in land for ecological connectivity and to enable improvements to Trail alignment • Interpret the Trail as an indicator of ecological health, especially with respect to effects of climate change and other impacts caused by air pollution • Be visionary about large landscape planning There are opportunities to participate in a number of regional and national (e g , NPS "A Call to Action," "Scaling Up" and "Enjoy the View") initiatives regarding topics such as protection of habitats, air quality, and water quality • Continue to reach out to adjacent landowners to build positive relationships Strong landowner relationships will assist with management of the boundary and help prevent and reverse encroachment • Better management of overnight campsites to handle impacts from overnight use • Carry out an optimal alignment review, incorporating trail sustainability standards for heavily eroded sections of the Trail • Partnerships could be established with local botanical, horticultural, and gardening clubs to bolster monitoring and removal of invasive plant species • Establish citizen science stewardship engagement program to facilitate education and outreach

Fundamental Resource or Value	Natural Resource Quality and Ecological Connectivity
Existing Data and Plans Related to the FRV	• Resource management plan • Acidic Deposition Along the Appalachian Trail Corridor and its Effects on Acid-Sensitive Terrestrial and Aquatic Resources: Results of the Appalachian Trail MegaTransect Study (in review) • Inventory and Monitoring Program monitoring plan • Vital signs resource assessments • Vital signs monitoring report • National Aeronautics and Space Administration decision support system • Water chemistry report • Boundary location data • Trail assessment studies
Data and/or GIS Needs	• Boundary survey data • Maintained landscape inventory • Overnight site inventory and condition assessment • Rare plant inventories for Pennsylvania and Maine • Continuous weather and forest health data to deal with localized resource situations • Obtain climate change resiliency models from The Nature Conservancy and stitch data together • Obtain updated rare, threatened, and endangered plant species data from state heritage offices • Water quality and quantity assessment • Geologic map for Trail • Additional data on invasive species • Climate change vulnerability assessment
Planning Needs	• Update comprehensive management plan • Vegetation management plan • Integrated pest management plan • Visitor use management plan • Communication and outreach plan for environmental monitoring • Resource stewardship strategy • Corridor study • Identify management zones • Climate change scenario planning



Fundamental Resource or Value	A Journey Through American Heritage
Related Significance Statements	Significance statement 7
Current Conditions and Trends	**Conditions** • Along the Trail, there are 26 specific features on the National Register of Historic Places, 8 historic districts, numerous archeological sites, and 3 national historic landmarks • There are thirteen national historic landmarks located within five miles of the Trail • Numerous and varied cultural landscapes representing Appalachian mountain range history and traditions • Extent of archives unknown • Trail does not have museum collection items in one location Trail staff learned in September 2013 of items at other NPS units, but not catalogued for the Trail The Trail will work with the NPS Northeast Regional Office to consolidate and catalogue collection • The Trail passes near many towns and communities, each with its own cultural identity, which enriches the experience for hikers who may pass through or visit **Trends** • None identified
Threats and Opportunities	**Threats** • Development along the Trail corridor affects cultural resources • Loss of viewsheds and cultural landscapes • Lack of understanding of cultural connection to the recreational Trail • Lack of management of maintained landscapes reduces ability to conserve cultural landscapes • Without archival survey, critical resources management data will not be identified and will thereby be unavailable for Trail management, research, and education **Opportunities** • Continued cooperation with federal, state, regional, and local heritage groups • Increase number of partnerships • Increase relationship with federally recognized tribes and tribal groups • Foster youth involvement to increase understanding, communicate relevancy, and promote stewardship of the Trail • Engage new stakeholders in Trail preservation
Existing Data and Plans Related to the FRV	• Draft National Register of Historic Places nominations • Shenandoah National Park cultural landscape inventory • "Methodology for Inventorying Cultural Landscapes of the Appalachian National Scenic Trail" (draft), by Margie Coffin Brown and Maciej Konieczny, NPS, Boston, MA 2006 • "Historic Context for the Appalachian National Scenic Trail," by Dr Robert Grumet
Data and/or GIS Needs	• Boundary survey data • Archeological data • National register data • Oral histories • Maintained landscape inventory • Cultural landscape inventory • Archeological overview and assessment

Fundamental Resource or Value	A Journey Through American Heritage
Planning Needs	• Update comprehensive management plan • Complete national register nominations • Scope of collections statement • Historic structure reports • Cultural affiliation study • Historic resources study • Maintained landscape management plan • Cultural landscape report • Archival survey • Identify management zones • Resource stewardship strategy

Planning and Data Needs

To maintain connection to the core elements of the foundation, the planning and data needs listed here are directly related to protecting the Trail's fundamental resources and values, significance, and nature and purposes, as well as addressing key issues. To successfully undertake a planning effort, information from sources such as inventories, studies, research activities, and analyses may be required to provide adequate knowledge of Trail resources and visitor information. Such information sources have been identified as data needs. Geospatial mapping tasks and products are included in data needs.

This section identifies high-priority planning and data needs for the entire Appalachian National Scenic Trail, as well as for each of the four geographic regions of the Trail—New England, Mid-Atlantic, Virginia, and Deep South (please see appendix D for maps that delineate the regional boundaries). Regional priorities vary along the Trail due to differences in land ownership, natural and cultural resources, visitor use patterns, and trail conditions. These high-priority needs are considered to be of the utmost importance. Other planning and data needs were identified as either medium- or low-priority needs, and appear in the FRV analysis tables. These lower priority needs are not included; however, they will be reevaluated once the high-priority needs are accomplished.

The identified planning and data needs that follow are limited to plans and data collection efforts where the National Park Service may need to become directly involved through project management or technical assistance. Each plan or study will be carried out as a collaborative effort with other parties, such as local stakeholders and subject matter experts. As funding becomes available for each project, scoping will take place to better define goals, objectives, and methods. Note that this list is not intended to capture all the planning and data needs that could be carried out by local communities, Trail clubs, or other agencies.

Planning Needs – Where A Decision-making Process Is Needed			
Related to an FRV?	**Planning Needs**	**Priority (H, M, L)**	**Notes**
Trailwide Planning Needs			
All	Update comprehensive management plan	H	This overarching plan for the Trail was completed in 1981 and needs to be updated This strategic document focuses primarily on operation of the cooperative management system for development and management of the Trail and its immediate environs
Scenery along Treadway; Experience; Volunteers	Update local management plans	H	Local management plans need to be updated with partnering organizations to ensure consistency in management along the entire length of the Trail
Trail; Experience; Natural	Visitor use management plan	H	The plan would include management of high-use sites and popular areas to better accommodate group use and address visitor use impacts It would also address capacity for various areas
Views Beyond the Corridor	Scenic and landscape-level protection and response strategy	H	A strategy is needed for protecting land that lies within important viewsheds and focus areas along the Trail, such as view points from mountaintops, balds, and prominent rock outcropings This planning effort could include participation in the "A Call to Action" initiatives "Enjoy the View" and "Scaling Up "
Trail	Sustainable trail and campsite plan	H	The plan would focus on Trail structures and facilities to better accommodate increased use along the Trail and at overnight sites in order to minimize impacts within high-use areas
Trail; Scenery Along Treadway; American Heritage	Maintained landscape management plan	H	The plan would identify and prioritize maintained landscapes (e g , pastoral landscapes) and describe specific management goals and the means to achieve them

Planning Needs – Where A Decision-making Process Is Needed			
Related to an FRV?	**Planning Needs**	**Priority (H, M, L)**	**Notes**
Trailwide Planning Needs			
Experience; Trail	Development concept plans for specific high-use areas such as McAfee's Knob, Nuclear Lake, and Bulls Bridge	H	These plans would tier off the updated comprehensive management plan to provide more site-specific management direction of high-use areas along the Trail
Experience; Education	Community outreach plan / volunteer engagement strategy	H	The strategy would focus on community outreach and volunteer employment, service, and learning opportunities It would include strategies for attracting new volunteers from various age and demographic groups such as young adults and families, recently retired individuals, active-duty military, and veterans
Education	Long-range interpretive and education plan	H	This plan would focus on education and stewardship programs to maintain relevancy with a diverse public and include a financial strategy for expanded educational opportunities
All	Identify management zones	H	This plan would explore the establishment of desired resource conditions and visitor experiences for different sections of the Trail through the use of management zones The plan would consider integration of other agencies' approaches to developing desired conditions
Trail; Experience	Wayfinding plan	H	Wayfinding refers to a system of signs, maps, and other graphic and audible materials used to convey locational and directional information to travelers This plan would establish strategies for improving trailhead, route marking, and interpretive signage It would also address the issue of consistency regarding signage along the entire trail
New England Regional Planning Needs			
Natural	Vegetation management plan	H	The plan would establish management strategies for rare plant communities (e g , high-elevation balds) as well as invasive plants
American Heritage	Cultural landscape report	H	This report would include cultural landscape inventories and establish management treatment recommendations
Natural; American Heritage	Resource stewardship strategy	H	The strategy would focus on achieving and maintaining desired natural and cultural resource conditions along the Trail
Mid-Atlantic Regional Planning Needs			
Natural	Corridor study	H	The study would identify deficiencies in the existing Trail boundary and opportunities to protect resources with targeted boundary adjustments
Virginia Regional Planning Needs			
No specific regional planning needs were identified All trailwide planning priorities were ranked high by the Virginia Region			
Deep South Regional Planning Needs			
Education	Finalize and implement the Leave No Trace planning program	H	This program would educate visitors about Leave No Trace principles to minimize visitor impacts along the Trail It would focus on thru-hikers at the start of their hike

Data Needs – Where Information Is Needed Before Decisions Can Be Made			
Related to an FRV?	**Data and GIS Needs**	**Priority (H, M, L)**	**Notes**
Trailwide Data Needs			
Trailwide	Visitor use survey	H	The survey would gather information about visitor demographics and their perceptions at both high-use locations along the Trail (i e , Bear Mountain State Park) and low-use sections to gain a better understanding of their motivations and interests in visiting the Trail The information would inform a future visitor use management plan Also identify why people are not using the Trail
Experience; Scenery Along Treadway; Trailwide	Baseline data on visitor use levels and patterns	H	The baseline visitor use data would be used to inform the development of indicators, thresholds, and ongoing monitoring protocols as part of a future visitor use management plan
Collaborative Spirit	Database of existing special use activities permitted on or near the Trail	H	The database would be used to develop a more consistent and unified approach across agencies for special use permits, including group, commercial, and special events
Views Beyond the Corridor	Large landscape analysis	H	The analysis would be used to determine high-priority areas along the Trail for conserving natural landscape-level connectivity
Experience; Collaborative Spirit	Economic impact study	H	The analysis would determine the economic impact of the Trail from tourism and visitation to encourage greater community engagement and promote the significance of the Trail at a local level with the ultimate goal of increasing protection of the Trail
Trail; Volunteer	Trail assessment studies	H	These ongoing assessments would evaluate Trail conditions to document maintenance deficiencies and include a database management component
Trail; Natural; American Heritage	Maintained landscape inventory	H	The inventory would identify the location of maintained landscapes along the Trail to better understand the extent and distribution of these rare habitats (e g , grassy balds and meadows) and scenic areas over time
Experience	Land use / ownership analysis	H	The analysis would study changes to parcels over time that are in proximity to the Trail Information would be used to identify potential external threats and guide the land acquisition program
Views Beyond the Corridor	Scenic threats analysis	H	The analysis would focus on ongoing threats to scenic viewsheds along the Trail, as well as analyze cumulative impacts on viewsheds over time
Education	Effectiveness of educational programs and initiatives	H	The study would measure the effectiveness of initiatives and programs related to all educational efforts, including youth stewardship and career development opportunities The effort would include documentation and dissemination of effective school curricula used to educate students about the Trail
American Heritage	Archeological assessment	H	The study would include an inventory and condition assessment of archeological sites along the Trail
Volunteer	Volunteer survey	H	The survey would focus on volunteer motivations to inform strategies for recruiting new volunteers
Volunteer	Database of shovel-ready trail maintenance projects	H	The database would be used to maintain a list of shovel-ready projects for episodic volunteer groups

Data Needs – Where Information Is Needed Before Decisions Can Be Made			
Related to an FRV?	**Data and GIS Needs**	**Priority (H, M, L)**	**Notes**
New England Regional Data Needs			
American Heritage	National register data	H	The data collection effort would inventory national register sites along the Trail
Natural	Climate change resiliency model	H	The effort would include obtaining regional resiliency model data from The Nature Conservancy and consolidating the information for areas along the Trail
American Heritage	Archeological assessment	H	The study would include an inventory and condition assessment of archeological sites along the Trail
Trail; Scenery Along Treadway; Natural	Climate change vulnerability assessment	H	The study would assess the vulnerability of resources to climate change
Mid-Atlantic Regional Data Needs			
Natural	Climate change resiliency model	H	The effort would include obtaining regional resiliency model data from The Nature Conservancy and consolidating the information for areas along the Trail
Natural	Update rare, threat-ened, and endangered plant species data	H	Special status species information would be routinely updated based on the most current information from state heritage offices
Natural	Water quality and quantity assessment	H	The effort would assess water quality and quantity to identify trends resulting from climate change
All	Boundary survey	H	Survey tracts, research deeds, and collect boundary information for priority areas along the Trail
Virginia Regional Data Needs			
Natural	Update rare, threat-ened, and endangered plant species data	H	Special status species information would be routinely updated based on the most current information from state heritage offices
Natural	Overnight site inventory and condition assessment	H	The condition assessment would document changes to overnight sites over time (i e , rate of expansion into surrounding environs)
Volunteer	Volunteer survey	H	The survey would focus on volunteer motivations to inform strategies for recruiting new volunteers
Deep South Regional Data Needs			
Natural	Update rare, threatened, and endangered plant species data	H	Special status species information would be routinely updated based on the most current information from state heritage offices
Natural	Overnight site inventory and condition assessment	H	The condition assessment would document changes to overnight sites over time (i e , rate of expansion into surrounding environs)
Volunteer	Volunteer survey	H	The survey would focus on volunteer motivations to inform strategies for recruiting new volunteers
Volunteer	Database of shovel-ready trail maintenance projects	H	The database would be used to maintain a list of shovel-ready projects for episodic volunteer groups

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Appendixes

Appendix A: Enabling Legislation and Legislative Acts for the Appalachian National Scenic Trail

National Trail System Act of 1968; Enabling Legislation for Appalachian National Scenic Trail (Public Law 90-543, 82 Stat 919)

82 STAT.] PUBLIC LAW 90-543-OCT. 2, 1968 919

Public Law 90-543

AN ACT

To establish a national trails system, and for other purposes.

October 2, 1968 [S. 827]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

National Trails System Act.

SHORT TITLE

SECTION 1. This Act may be cited as the "National Trails System Act".

STATEMENT OF POLICY

SEC. 2. (a) In order to provide for the ever-increasing outdoor recreation needs of an expanding population and in order to promote public access to, travel within, and enjoyment and appreciation of the open-air, outdoor areas of the Nation, trails should be established (i) primarily, near the urban areas of the Nation, and (ii) secondarily, within established scenic areas more remotely located.

(b) The purpose of this Act is to provide the means for attaining these objectives by instituting a national system of recreation and scenic trails, by designating the Appalachian Trail and the Pacific Crest Trail as the initial components of that system, and by prescribing the methods by which, and standards according to which, additional components may be added to the system.

NATIONAL TRAILS SYSTEM

SEC. 3. The national system of trails shall be composed of—

(a) National recreation trails, established as provided in section 4 of this Act, which will provide a variety of outdoor recreation uses in or reasonably accessible to urban areas.

(b) National scenic trails, established as provided in section 5 of this Act, which will be extended trails so located as to provide for maximum outdoor recreation potential and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass.

(c) Connecting or side trails, established as provided in section 6 of this Act, which will provide additional points of public access to national recreation or national scenic trails or which will provide connections between such trails.

The Secretary of the Interior and the Secretary of Agriculture, in consultation with appropriate governmental agencies and public and private organizations, shall establish a uniform marker for the national trails system.

NATIONAL RECREATION TRAILS

SEC. 4. (a) The Secretary of the Interior, or the Secretary of Agriculture where lands administered by him are involved, may establish and designate national recreation trails, with the consent of the Federal agency, State, or political subdivision having jurisdiction over the lands involved, upon finding that—

(i) such trails are reasonably accessible to urban areas, and, or

(ii) such trails meet the criteria established in this Act and such supplementary criteria as he may prescribe.

(b) As provided in this section, trails within park, forest, and other recreation areas administered by the Secretary of the Interior or the Secretary of Agriculture or in other federally administered areas may be established and designated as "National Recreation Trails" by the appropriate Secretary and, when no Federal land acquisition is involved—

(i) trails in or reasonably accessible to urban areas may be designated as "National Recreation Trails" by the Secretary of the Interior with the consent of the States, their political subdivisions, or other appropriate administering agencies, and

(ii) trails within park, forest, and other recreation areas owned or administered by States may be designated as "National Recreation Trails" by the Secretary of the Interior with the consent of the State.

NATIONAL SCENIC TRAILS

SEC. 5. (a) National scenic trails shall be authorized and designated only by Act of Congress. There are hereby established as the initial National Scenic Trails:

(1) The Appalachian Trail, a trail of approximately two thousand miles extending generally along the Appalachian Mountains from Mount Katahdin, Maine, to Springer Mountain, Georgia. Insofar as practicable, the right-of-way for such trail shall comprise the trail depicted on the maps identified as "Nationwide System of Trails, Proposed Appalachian Trail, NST–AT–101–May 1967", which shall be on file and available for public inspection in the office of the Director of the National Park Service. Where practicable, such rights-of-way shall include lands protected for it under agreements in effect as of the date of enactment of this Act, to which Federal agencies and States were parties. The Appalachian Trail shall be administered primarily as a footpath by the Secretary of the Interior, in consultation with the Secretary of Agriculture.

Rights-of-way.

(2) The Pacific Crest Trail, a trail of approximately two thousand three hundred fifty miles, extending from the Mexican-California border northward generally along the mountain ranges of the west coast States to the Canadian-Washington border near Lake Ross, following the route as generally depicted on the map, identified as "Nationwide System of Trails, Proposed Pacific Crest Trail, NST–PC–103–May 1967" which shall be on file and available for public inspection in the office of the Chief of the Forest Service. The Pacific Crest Trail shall be administered by the Secretary of Agriculture, in consultation with the Secretary of the Interior.

Administration.

Advisory councils.

(3) The Secretary of the Interior shall establish an advisory council for the Appalachian National Scenic Trail, and the Secretary of Agriculture shall establish an advisory council for the Pacific Crest National Scenic Trail. The appropriate Secretary shall consult with such council from time to time with respect to matters relating to the trail, including the selection of rights-of-way, standards of the erection and maintenance of markers along the trail, and the administration of the trail. The members of each advisory council, which shall not exceed thirty-five in number, shall serve without compensation or expense to the Federal Government for a term of five years and shall be appointed by the appropriate Secretary as follows:

Membership; term of office.

(i) A member appointed to represent each Federal department or independent agency administering lands through which the trail route passes and each appointee shall be the person designated by the head of such department or agency;

(ii) A member appointed to represent each State through which the trail passes and such appointments shall be made from recommendations of the Governors of such States;

(iii) One or more members appointed to represent private organizations, including landowners and land users, that, in the opinion of the Secretary, have an established and recognized interest in the trail and such appointments shall be made from recommendations of the heads of such organizations: *Provided*, That the Appalachian Trail Conference shall be represented by a sufficient number of persons to represent the various sections of the country through which the Appalachian Trail passes; and

(iv) The Secretary shall designate one member to be chairman and shall fill vacancies in the same manner as the original appointment.

Additional studies.

(b) The Secretary of the Interior, and the Secretary of Agriculture where lands administered by him are involved, shall make such additional studies as are herein or may hereafter be authorized by the Congress for the purpose of determining the feasibility and desirability of designating other trails as national scenic trails. Such studies shall be made in consultation with the heads of other Federal agencies administering lands through which such additional proposed trails would pass and in cooperation with interested interstate, State, and local governmental agencies, public and private organizations, and landowners and land users concerned. When completed, such studies shall be the basis of appropriate proposals for additional national scenic trails which shall be submitted from time to time to the President and to the Congress. Such proposals shall be accompanied by a report, which shall be printed as a House or Senate document, showing among other things—

Report to President and Congress.

(1) the proposed route of such trail (including maps and illustrations);

(2) the areas adjacent to such trails, to be utilized for scenic, historic, natural, cultural, or developmental, purposes;

(3) the characteristics which, in the judgment of the appropriate Secretary, make the proposed trail worthy of designation as a national scenic trail;

(4) the current status of land ownership and current and potential use along the designated route;

(5) the estimated cost of acquisition of lands or interest in lands, if any;

(6) the plans for developing and maintaining the trail and the cost thereof;

(7) the proposed Federal administering agency (which, in the case of a national scenic trail wholly or substantially within a national forest, shall be the Department of Agriculture);

(8) the extent to which a State or its political subdivisions and public and private organizations might reasonably be expected to participate in acquiring the necessary lands and in the administration thereof; and

(9) the relative uses of the lands involved, including: the number of anticipated visitor-days for the entire length of, as well as for segments of, such trail; the number of months which such trail, or segments thereof, will be open for recreation purposes; the economic and social benefits which might accrue from alternate land uses; and the estimated man-years of civilian employment and expenditures expected for the purposes of maintenance, supervision, and regulation of such trail.

(c) The following routes shall be studied in accordance with the objectives outlined in subsection (b) of this section:

(1) Continental Divide Trail, a three-thousand-one-hundred-mile trail extending from near the Mexican border in southwestern New Mexico northward generally along the Continental Divide to the Canadian border in Glacier National Park.

(2) Potomac Heritage Trail, an eight-hundred-and-twenty-five-mile trail extending generally from the mouth of the Potomac River to its sources in Pennsylvania and West Virginia, including the one-hundred-and-seventy-mile Chesapeake and Ohio Canal towpath.

(3) Old Cattle Trails of the Southwest from the vicinity of San Antonio, Texas, approximately eight hundred miles through Oklahoma via Baxter Springs and Chetopa, Kansas, to Fort Scott, Kansas, including the Chisholm Trail, from the vicinity of San Antonio or Cuero, Texas, approximately eight hundred miles north through Oklahoma to Abilene, Kansas.

(4) Lewis and Clark Trail, from Wood River, Illinois, to the Pacific Ocean in Oregon, following both the outbound and inbound routes of the Lewis and Clark Expedition.

(5) Natchez Trace, from Nashville, Tennessee, approximately six hundred miles to Natchez, Mississippi.

(6) North Country Trail, from the Appalachian Trail in Vermont, approximately three thousand two hundred miles through the States of New York, Pennsylvania, Ohio, Michigan, Wisconsin, and Minnesota, to the Lewis and Clark Trail in North Dakota.

(7) Kittanning Trail from Shirleysburg in Huntingdon County to Kittanning, Armstrong County, Pennsylvania.

(8) Oregon Trail, from Independence, Missouri, approximately two thousand miles to near Fort Vancouver, Washington.

(9) Santa Fe Trail, from Independence, Missouri, approximately eight hundred miles to Santa Fe, New Mexico.

(10) Long Trail, extending two hundred and fifty-five miles from the Massachusetts border northward through Vermont to the Canadian border.

(11) Mormon Trail, extending from Nauvoo, Illinois, to Salt Lake City, Utah, through the States of Iowa, Nebraska, and Wyoming.

(12) Gold Rush Trails in Alaska.

(13) Mormon Battalion Trail, extending two thousand miles from Mount Pisgah, Iowa, through Kansas, Colorado, New Mexico, and Arizona to Los Angeles, California.

(14) El Camino Real from St. Augustine to San Mateo, Florida, approximately 20 miles along the southern boundary of the St. Johns River from Fort Caroline National Memorial to the St. Augustine National Park Monument.

CONNECTING AND SIDE TRAILS

SEC. 6. Connecting or side trails within park, forest, and other recreation areas administered by the Secretary of the Interior or Secretary of Agriculture may be established, designated, and marked as components of a national recreation or national scenic trail. When no Federal land acquisition is involved, connecting or side trails may be located across lands administered by interstate, State, or local governmental agencies with their consent: *Provided*, That such trails provide additional points of public access to national recreation or scenic trails.

ADMINISTRATION AND DEVELOPMENT

Publication in Federal Register.

SEC. 7. (a) Pursuant to section 5(a), the appropriate Secretary shall select the rights-of-way for National Scenic Trails and shall publish notice thereof in the Federal Register, together with appropriate maps and descriptions: *Provided*, That in selecting the rights-of-way full consideration shall be given to minimizing the adverse effects upon the adjacent landowner or user and his operation. Development and management of each segment of the National Trails System shall be designed to harmonize with and complement any established multiple-use plans for that specific area in order to insure continued maximum benefits from the land. The location and width of such rights-of-way across Federal lands under the jurisdiction of another Federal agency shall be by agreement between the head of that agency and the appropriate Secretary. In selecting rights-of-way for trail purposes, the Secretary shall obtain the advice and assistance of the States, local governments, private organizations, and landowners and land users concerned.

(b) After publication of notice in the Federal Register, together with appropriate maps and descriptions, the Secretary charged with the administration of a national scenic trail may relocate segments of a national scenic trail right-of-way, with the concurrence of the head of the Federal agency having jurisdiction over the lands involved, upon a determination that: (i) such a relocation is necessary to preserve the purposes for which the trail was established, or (ii) the relocation is necessary to promote a sound land management program in accordance with established multiple-use principles: *Provided*, That a substantial relocation of the rights-of-way for such trail shall be by Act of Congress. Relocation of right-of-way, determination.

(c) National scenic trails may contain campsites, shelters, and related-public-use facilities. Other uses along the trail, which will not substantially interfere with the nature and purposes of the trail, may be permitted by the Secretary charged with the administration of the trail. Reasonable efforts shall be made to provide sufficient access opportunities to such trails and, to the extent practicable, efforts shall be made to avoid activities incompatible with the purposes for which such trails were established. The use of motorized vehicles by the general public along any national scenic trail shall be prohibited and nothing in this Act shall be construed as authorizing the use of motorized vehicles within the natural and historical areas of the national park system, the national wildlife refuge system, the national wilderness preservation system where they are presently prohibited or on other Federal lands where trails are designated as being closed to such use by the appropriate Secretary: *Provided*, That the Secretary charged with the administration of such trail shall establish regulations which shall authorize the use of motorized vehicles when, in his judgment, such vehicles are necessary to meet emergencies or to enable adjacent landowners or land users to have reasonable access to their lands or timber rights: *Provided further*, That private lands included in the national recreation or scenic trails by cooperative agreement of a landowner shall not preclude such owner from using motorized vehicles on or across such trails or adjacent lands from time to time in accordance with regulations to be established by the appropriate Secretary. The Secretary of the Interior and the Secretary of Agriculture, in consultation with appropriate governmental agencies and public and private organizations, shall establish a uniform marker, including thereon an appropriate and distinctive symbol for each national recreation and scenic trail. Where the trails cross lands administered by Federal agencies such markers shall be erected at appropriate points along the trails and maintained by the Federal agency administering the trail in accordance with standards established by the appropriate Secretary and where the trails cross non-Federal lands, in accordance with written cooperative agreements, the appropriate Secretary shall provide such uniform markers to cooperating agencies and shall require such agencies to erect and maintain them in accordance with the standards established. Facilities on trails. Motorized vehicles, prohibition, exception. Uniform markers.

(d) Within the exterior boundaries of areas under their administration that are included in the right-of-way selected for a national recreation or scenic trail, the heads of Federal agencies may use lands for trail purposes and may acquire lands or interests in lands by written cooperative agreement, donation, purchase with donated or appropriated funds or exchange: *Provided*, That not more than twenty-five acres in any one mile may be acquired without the consent of the owner. Acquisition of lands, use. Acreage limitation.

Right-of-way lands outside exterior boundaries.

(e) Where the lands included in a national scenic trail right-of-way are outside of the exterior boundaries of federally administered areas, the Secretary charged with the administration of such trail shall encourage the States or local governments involved (1) to enter into written cooperative agreements with landowners, private organizations, and individuals to provide the necessary trail right-of-way, or (2) to acquire such lands or interests therein to be utilized as segments of the national scenic trail: *Provided*, That if the State or local governments fail to enter into such written cooperative agreements or to acquire such lands or interests therein within two years after notice of the selection of the right-of-way is published, the appropriate Secretary may (i) enter into such agreements with landowners, States, local governments, private organizations, and individuals for the use of lands for trail purposes, or (ii) acquire private lands or interests therein by donation, purchase with donated or appropriated funds or exchange in accordance with the provisions of subsection (g) of this section. The lands involved in such rights-of-way should be acquired in fee, if other methods of public control are not sufficient to assure their use for the purpose for which they are acquired: *Provided*, That if the Secretary charged with the administration of such trail permanently relocates the right-of-way and disposes of all title or interest in the land, the original owner, or his heirs or assigns, shall be offered, by notice given at the former owner's last known address, the right of first refusal at the fair market price.

Property suitable for exchange.

(f) The Secretary of the Interior, in the exercise of his exchange authority, may accept title to any non-Federal property within the right-of-way and in exchange therefor he may convey to the grantor of such property any federally owned property under his jurisdiction which is located in the State wherein such property is located and which he classifies as suitable for exchange or other disposal. The values of the properties so exchanged either shall be approximately equal, or if they are not approximately equal the values shall be equalized by the payment of cash to the grantor or to the Secretary as the circumstances require. The Secretary of Agriculture, in the exercise of his exchange authority, may utilize authorities and procedures available to him in connection with exchanges of national forest lands.

Use of condemnation proceedings to acquire private lands.

(g) The appropriate Secretary may utilize condemnation proceedings without the consent of the owner to acquire private lands or interests therein pursuant to this section only in cases where, in his judgment, all reasonable efforts to acquire such lands or interests therein by negotiation have failed, and in such cases he shall acquire only such title as, in his judgment, is reasonably necessary to provide passage across such lands: *Provided*, That condemnation proceedings may not be utilized to acquire fee title or lesser interests to more than twenty-five acres in any one mile and when used such authority shall be limited to the most direct or practicable connecting trail right-of-way: *Provided further*, That condemnation is prohibited with respect to all acquisition of lands or interest in lands for the purposes of the Pacific Crest Trail. Money appropriated for Federal purposes from the land and water conservation fund shall, without prejudice to appropriations from other sources, be available to Federal departments for the acquisition of lands or interests in lands for the purposes of this Act.

Limitation.

Pacific Crest Trail.

Lands within federally administered areas.

(h) The Secretary charged with the administration of a national recreation or scenic trail shall provide for the development and maintenance of such trails within federally administered areas and shall cooperate with and encourage the States to operate, develop, and maintain portions of such trails which are located outside the boundaries of federally administered areas. When deemed to be in the public interest, such Secretary may enter written cooperative agreements with the States or their political subdivisions, landowners, private organizations, or individuals to operate, develop, and maintain any portion of a national scenic trail either within or outside a federally administered area.

Whenever the Secretary of the Interior makes any conveyance of land under any of the public land laws, he may reserve a right-of-way for trails to the extent he deems necessary to carry out the purposes of this Act. *Right-of-way reservation.*

(i) The appropriate Secretary, with the concurrence of the heads of any other Federal agencies administering lands through which a national recreation or scenic trail passes, and after consultation with the States, local governments, and organizations concerned, may issue regulations, which may be revised from time to time, governing the use, protection, management, development, and administration of trails of the national trails system. In order to maintain good conduct on and along the trails located within federally administered areas and to provide for the proper government and protection of such trails, the Secretary of the Interior and the Secretary of Agriculture shall prescribe and publish such uniform regulations as they deem necessary and any person who violates such regulations shall be guilty of a misdemeanor, and may be punished by a fine of not more than $500, or by imprisonment not exceeding six months, or by both such fine and imprisonment. *Regulations.* *Enforcement.* *Penalty.*

STATE AND METROPOLITAN AREA TRAILS

SEC. 8. (a) The Secretary of the Interior is directed to encourage States to consider, in their comprehensive statewide outdoor recreation plans and proposals for financial assistance for State and local projects submitted pursuant to the Land and Water Conservation Fund Act, needs and opportunities for establishing park, forest, and other recreation trails on lands owned or administered by States, and recreation trails on lands in or near urban areas. He is further directed, in accordance with the authority contained in the Act of May 28, 1963 (77 Stat. 49), to encourage States, political subdivisions, and private interests, including nonprofit organizations, to establish such trails. *78 Stat. 897. 16 USC 460l-4 note.* *16 USC 460l-460l-3.*

(b) The Secretary of Housing and Urban Development is directed, in administering the program of comprehensive urban planning and assistance under section 701 of the Housing Act of 1954, to encourage the planning of recreation trails in connection with the recreation and transportation planning for metropolitan and other urban areas. He is further directed, in administering the urban open-space program under title VII of the Housing Act of 1961, to encourage such recreation trails. *72 Stat. 678; 78 Stat. 783; 81 Stat. 262. 40 USC 461.* *75 Stat. 183. 42 USC 1500 et seq.*

(c) The Secretary of Agriculture is directed, in accordance with authority vested in him, to encourage States and local agencies and private interests to establish such trails.

(d) Such trails may be designated and suitably marked as parts of the nationwide system of trails by the States, their political subdivisions, or other appropriate administering agencies with the approval of the Secretary of the Interior. *Nationwide system.*

RIGHTS-OF-WAY AND OTHER PROPERTIES

SEC. 9. (a) The Secretary of the Interior or the Secretary of Agriculture as the case may be, may grant easements and rights-of-way upon, over, under, across, or along any component of the national trails system in accordance with the laws applicable to the national park system and the national forest system, respectively: *Provided*, That any conditions contained in such easements and rights-of-way shall be related to the policy and purposes of this Act. *Easements and rights-of-way.*

(b) The Department of Defense, the Department of Transportation, the Interstate Commerce Commission, the Federal Communications Commission, the Federal Power Commission, and other Federal agencies having jurisdiction or control over or information concerning the use, abandonment, or disposition of roadways, utility rights-of-way, or other properties which may be suitable for the purpose of improving or expanding the national trails system shall cooperate with the Secretary of the Interior and the Secretary of Agriculture in order to assure, to the extent practicable, that any such properties having values suitable for trail purposes may be made available for such use.

AUTHORIZATION OF APPROPRIATIONS

SEC. 10. There are hereby authorized to be appropriated for the acquisition of lands or interests in lands not more than $5,000,000 for the Appalachian National Scenic Trail and not more than $500,000 for the Pacific Crest National Scenic Trail.

Approved October 2, 1968.

1978 APPA PL95-248 92Stat159 HR8803

Public Law 95-248
95th Congress

An Act

To amend the National Trails System Act, and for other purposes.

Mar. 21, 1978
[H.R. 8803]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Trails System Act (82 Stat. 919; 16 U.S.C. 1241), as amended (90 Stat. 2481; 16 U.S.C. 1244), is further amended as follows:

National Trails System Act, amendment.

(1) Amend section 5(a)(3) to read as follows:

"(3) The Secretary of the Interior shall establish within sixty days of the enactment of this subsection an Advisory Council for the Appalachian National Scenic Trail which shall terminate one hundred and twenty months from the date of enactment of this subsection. The Secretary of the Interior shall consult with such Council from time to time with respect to matters relating to the Trail, including the selection of rights-of-way, standards for the erection and maintenance of markers along the Trail, and the administration of the Trail. The members of the Advisory Council, which shall not exceed thirty-five in number, shall serve for a term of two years without compensation as such, but the Secretary may pay, upon vouchers signed by the Chairman of the Council, the expenses reasonably incurred by the Council and its members in carrying out their responsibilities under this section. Members of the Council shall be appointed by the Secretary of the Interior as follows:

Advisory Council for the Appalachian National Scenic Trail. Establishment; termination.

Membership.

"(i) a member appointed to represent each Federal department or independent agency administering lands through which the Trail route passes and each appointee shall be the person designated by the head of such department or agency;

"(ii) a member appointed to represent each State through which the Trail passes and such appointments shall be made from the recommendations of the Governors of such States;

"(iii) one or more members appointed to represent private organizations, including corporate and individual landowners and land users, that, in the opinion of the Secretary, have an established and recognized interest in the Trail and such appointments shall be made from recommendations of the heads of such organizations: *Provided*, That the Appalachian Trail Conference shall be represented by a sufficient number of persons to represent the various sections of the country through which the Appalachian Trail passes; and

"(iv) the Secretary shall designate one member to be chairman and shall fill vacancies in the same manner as the original appointment.".

(2) Amend section 5 by adding the following new subsection (d):

"(d) Within two years of the date of enactment of this subsection, the Secretary of the Interior shall, after full consultation with the Governors of the affected States, the Advisory Council, and the Appalachian Trail Conference, submit to the Committee on Energy and Natural Resources of the Senate and the Committee on Interior and Insular Affairs of the House of Representatives, a comprehensive

Appalachian Trail, plans for; submittal to congressional committees.

92 STAT. 160 PUBLIC LAW 95-248—MAR. 21, 1978

plan for the management, acquisition, development, and use of the Appalachian Trail, including but not limited to, the following items:

"(1) specific objectives and practices to be observed in the management of the Trail, including the identification of all significant natural, historical, and cultural resources to be preserved; details of anticipated cooperative agreements to be consummated with other entities; and identification of carrying capacity and use patterns of the Trail;

"(2) an acquisition or protection plan, by fiscal year, for all lands to be acquired by fee title or lesser interest, along with detailed explanation of anticipated necessary cooperative agreements for any lands not to be acquired; and

"(3) general and site-specific development plans, including anticipated costs.".

16 USC 1246.

(3) Amend section 7(d) by changing the colon to a period and by deleting the proviso.

Condemnation proceedings.

(4) Amend section 7(g) by deleting the first proviso and inserting in lieu thereof "*Provided*, That condemnation proceedings may not be utilized to acquire fee title or lesser interests to more than an average of one hundred and twenty-five acres per mile.".

16 USC 1249.

(5) Amend section 10, by adding at the end thereof the following: "From the appropriations authorized for fiscal year 1979 and succeeding fiscal years pursuant to the Land and Water Conservation Fund Act (78 Stat. 897), as amended, not more than the following amounts may be expended for the acquisition of lands and interests in lands authorized to be acquired pursuant to the provisions of this Act:

16 USC 460l-4 note.

"(a)(1) The Appalachian National Scenic Trail, not to exceed $30,000,000 for fiscal year 1979, $30,000,000 for fiscal year 1980, and $30,000,000 for fiscal year 1981, except that the difference between the foregoing amounts and the actual appropriations in any one fiscal year shall be available for appropriation in the subsequent fiscal year.

Land acquisition program, completion time.

Information to congressional committees.

It is the express intent of the Congress that the Secretary should substantially complete the land acquisition program necessary to insure the protection of the Trail within three complete fiscal years following the date of enactment of this sentence. Until the entire acquisition program is completed, he shall transmit in writing at the close of each fiscal year the following information to the Committee on Energy and Natural Resources of the Senate and to the Committee on Interior and Insular Affairs of the House of Representatives:

"(A) the amount of land acquired during the fiscal year and the amount expended therefor;

"(B) the estimated amount of land remaining to be acquired; and

"(C) the amount of land planned for acquisition in the ensuing fiscal year and the estimated cost thereof.

"(2) Until the entire acquisition program is completed, the Appalachian Trail Conference shall transmit a report at the close of each fiscal year to the Committee on Energy and Natural Resources of the Senate and to the Committee on Interior and Insular Affairs of the House of Representatives which shall include but not be limited to comments on— Report to congressional committees.

"(A) the manner in which negotiations for the acquisition program are being conducted for every section of the Trail;

"(B) the attitudes of the landowners with whom negotiations have been undertaken; and

"(C) whether in any case larger interests in land are being acquired than are necessary to carry out the purposes of this Act.

"(b) For the purposes of Public Law 95-42 (91 Stat. 211), the lands and interests therein acquired pursuant to this section shall be deemed to qualify for funding under the provisions of section 1, clause 2, of said Act.". 16 USC 460l-7.

Approved March 21, 1978.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 95-734 (Comm. on Interior and Insular Affairs).
SENATE REPORT No. 95-636 (Comm. on Energy and Natural Resources).
CONGRESSIONAL RECORD:
Vol. 123 (1977): Oct. 25, considered and passed House.
Vol. 124 (1978): Feb. 22, considered and passed Senate, amended.
Mar. 7, House concurred in Senate amendment.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS:
Vol. 14, No. 12 (1978): Mar. 22, Presidential statement.

1978 PL 95-625 92Stat3467 S 791

PUBLIC LAW 95-625—NOV. 10, 1978 92 STAT. 3511

Subtitle B—Trails

SEC. 551. The National Trails System Act (82 Stat. 919; 16 U.S.C. 1241), as amended, is further amended as follows:

(1) In section 2(a) after "promote" insert "the preservation of,"; and after "outdoor areas" insert "and historic resources". 16 USC 1241.

(2) In section 2(a) delete "(ii)" and the remainder of the sentence and insert "(ii) secondarily, within scenic areas and along historic travel routes of the Nation, which are often more remotely located.".

(3) In section 2(b) delete "and scenic" and insert ", scenic and historic".

(4) In section 3 redesignate subsection "(c)" as "(d)", and insert a new subsection (c) as follows: National historic trails. 16 USC 1242. 16 USC 1244.

"(c) National historic trails, established as provided in section 5 of this Act, which will be extended trails which follow as closely as possible and practicable the original trails or routes of travel of national historical significance. Designation of such trails or routes shall be continuous, but the established or developed trail, and the acquisition thereof, need not be continuous onsite. National historic trails shall have as their purpose the identification and protection of the historic route and its historic remnants and artifacts for public use and enjoyment. Only those selected land and water based components of an historic trail which are on federally owned lands and which meet the national historic trail criteria established in this Act, are established as initial Federal protection components of a national historic trail. The appropriate Secretary may subsequently certify other lands as protected segments of an historic trail upon application from State or local governmental agencies or private interests involved Protected segments, certification.

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Nationally significant, qualifications.

trade and commerce, migration and settlement, or military campaigns. To qualify as nationally significant, historic use of the trail must have had a far-reaching effect on broad patterns of American culture. Trails significant in the history of native Americans may be included.

"(C) It must have significant potential for public recreational use or historical interest based on historic interpretation and appreciation. The potential for such use is generally greater along roadless segments developed as historic trails, and at historic sites associated with the trail. The presence of recreation potential not related to historic appreciation is not sufficient justification for designation under this category.".

16 USC 1244.

(13) In section 5(c), add the following at the end thereof:

"(20) Overmountain Victory Trail, extending from the vicinity of Elizabethton, Tennessee, to Kings Mountain National Military Park, South Carolina.".

Trail advisory councils, establishments.

(14) In section 5 delete subsection (d), and insert a new section 5(d) to read as follows:

"(d) The Secretary charged with the administration of each respective trail shall, within one year of the date of the addition of any national scenic or national historic trail to the System, and within sixty days of the enactment of this sentence for the Appalachian and Pacific Crest National Scenic Trails, establish an advisory council for each such trail, each of which councils shall expire ten years from the date of its establishment. The appropriate Secretary shall consult with such council from time to time with respect to matters relating to the trail, including the selection of rights-of-way, standards for the erection and maintenance of markers along the trail, and the administration of the trail. The members of each advisory council, which shall not exceed thirty-five in number, shall serve for a term of two years and without compensation as such, but the Secretary may pay, upon vouchers signed by the chairman of the council, the expenses reasonably incurred by the council and its members in carrying out their responsibilities under this section. Members of each council shall be appointed by the appropriate Secretary as follows:

Term and compensation.

Membership.

"(i) a member appointed to represent each Federal department or independent agency administering lands through which the trail route passes, and each appointee shall be the person designated by the head of such department or agency;

"(ii) a member appointed to represent each State through which the trail passes, and such appointments shall be made from recommendations of the Governors of such States;

"(iii) one or more members appointed to represent private organizations, including corporate and individual landowners and land users, which in the opinion of the Secretary, have an established and recognized interest in the trail, and such appointments shall be made from recommendations of the heads of such organizations: *Provided*, That the Appalachian Trail Conference shall be represented by a sufficient number of persons to represent the various sections of the country through which the Appalachian Trail passes; and

Chairman.

"(iv) the Secretary shall designate one member to be chairman and shall fill vacancies in the same manner as the original appointment.".

(15) In section 5 add two new subsections (e) and (f) as follows: 16 USC 1244.

"(e) Within two complete fiscal years of the date of enactment of legislation designating a national scenic trail, except for the Continental Divide National Scenic Trail, as part of the system, and within two complete fiscal years of the date of enactment of this subsection for the Pacific Crest and Appalachian Trails, the responsible Secretary shall, after full consultation with affected Federal land managing agencies, the Governors of the affected States, the relevant advisory council established pursuant to section 5(d), and the Appalachian Trail Conference in the case of the Appalachian Trail, submit to the Committee on Interior and Insular Affairs of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a comprehensive plan for the acquisition, management, development, and use of the trail, including but not limited to, the following items:

Comprehensive plan, consultation and submittal to congressional committees.

Ante, p. 3514.

"(1) specific objectives and practices to be observed in the management of the trail, including the identification of all significant natural, historical, and cultural resources to be preserved (along with high potential historic sites and high potential route segments in the case of national historic trails), details of anticipated cooperative agreements to be consummated with other entities, and an identified carrying capacity of the trail and a plan for its implementation;

"(2) an acquisition or protection plan, by fiscal year, for all lands to be acquired by fee title or lesser interest, along with detailed explanation of anticipated necessary cooperative agreements for any lands not to be acquired; and

"(3) general and site-specific development plans including anticipated costs.

"(f) Within two complete fiscal years of the date of enactment of legislation designating a national historic trail or the Continental Divide National Scenic Trail as part of the system, the responsible Secretary shall, after full consultation with affected Federal land managing agencies, the Governors of the affected States, and the relevant Advisory Council established pursuant to section 5(d) of this Act, submit to the Committee on Interior and Insular Affairs of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a comprehensive plan for the management, and use of the trail, including but not limited to, the following items:

Comprehensive plan, consultation and submittal to congressional committees.

"(1) specific objectives and practices to be observed in the management of the trail, including the identification of all significant natural, historical, and cultural resources to be preserved, details of any anticipated cooperative agreements to be consummated with State and local government agencies or private interests, and for national scenic or national recreational trails an identified carrying capacity of the trail and a plan for its implementation; and

"(2) the process to be followed by the appropriate Secretary to implement the marking requirements established in section 7(c) of this Act.".

16 USC 1246.

(16) In section 6 in the first sentence delete "or national scenic," and insert ", national scenic or national historic", and in the second sentence delete "or scenic" and insert ", national scenic, or national historic". 16 USC 1245.

(17) In section 7(a) in the first sentence delete "National Scenic Trails" and insert "national scenic and national historic trails"; in two instances in subsection (b), and in the first sentence of subsection

Appendix B: Inventory of Special Mandates and Administrative Commitments

Special Mandates

The Appalachian National Scenic Trail is managed through a model "cooperative management system" involving the National Park Service, U.S. Forest Service, numerous other federal and state agencies, the nonprofit Appalachian Trail Conservancy, and 31 volunteer-based trail-maintaining clubs. All of these partners work together to protect and manage the Appalachian National Scenic Trail and each contributes to the Trail's success. The Appalachian National Scenic Trail follows the policies and regulations of various federal and state entities, such as those pertaining to designated wilderness, state parks, state forests, and state game-lands (among others). In addition, various aspects of trail management are guided by policies developed by the Appalachian Trail Conservancy.

- "The Appalachian Trail shall be administered primarily as a footpath by the Secretary of the Interior, in consultation with the Secretary of Agriculture" (Public Law 90-543 [October 2, 1968]).
- Clean Air Act – Class I Airshed Designation. The Trail passes through five mandatory class I areas: Great Smoky Mountains and Shenandoah National Parks (which are managed by the National Park Service), and the James River Face, Lye Brook, Great Gulf wilderness areas (which are managed by the U.S. Forest Service), and is immediately adjacent to the Presidential Range-Dry River Wilderness in New Hampshire. In the Clean Air Act Congress set a national goal "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic or historic value" (42 U.S.C. §7470(2)). The Clean Air Act bestows an "affirmative responsibility" on federal land managers to protect Class I areas from the adverse effects of air pollution.
- The Wilderness Act of 1964. The Trail passes through 24 wilderness areas, wherein motorized equipment and mechanized transport are prohibited.

Administrative Commitments

These are the core agreements addressing the cooperative management system of the Trail. Numerous other agreements are in place for specific projects and programs pertaining to such things as trail crews, chainsaw certification, volunteers, etc.

ATC Agreements	Partners to Agreement	Start Date	Expiration	Status	Purpose
Cooperative Agreement	NPS, ATC	07/17/2014	07/17/2024	New cooperative agreement signed on 07/17/2014	Identifies a broad spectrum of management roles and transfer of funding
MOU	NPS, ATC	11/20/2004	11/20/2014	Expired	Addresses the more philosophical aspects of cooperative management and "delegation" of authority All items addressed in new cooperative agreement
MOU	NPS, USFS, ATC	08/10/2014	08/10/2019	New MOU signed on 08/10/2014	Provides framework for the training and safety certification of chainsaw and crosscut saw operators

USFS Agreement	Partners to Agreement	Start Date	Expiration	Status	Purpose
MOU	NPS, USFS	01/26/1993	No Expiration	Amended in 2002 for a specific tract in VT	Administrative transfer of specific lands in NH, VT, and VA, as authorized by the National Trails System Act

TVA Agreement	Partners to Agreement	Start Date	Expiration	Status	Purpose
License Agreement	NPS, TVA	02/28/2013	No Expiration	May need additional licenses	Allows the Appalachian National Scenic Trail to be constructed and maintained on a portion of TVA lands

Statewide MOUs	Partners to Agreement	Start Date	Expiration	Status	Purpose
Appalachian National Scenic Trail Advisory Committee (ANSTAC)	Representatives from 14 states, NPS, USFS, Smithsonian, TVA, ATC	12/04/1987	12/04/1992	Sunsetted	Affirming the role of state and federal agencies in the cooperative management of the trail after ANSTAC sunsetted Recommends state agreements be developed
Maine statewide MOU	NPS, MATC, ATC, state bureaus (DEC, DOT, Baxter SP, DIFW, LURC)	08/28/1972		In effect, but outdated	Cooperative management of A T on state and ATPO-acquired lands
New Hampshire statewide MOU	NPS, WMNF, AMC, DOC, ATC, DRED-Forestry, Parks, Safety (State Police), DOT, DF&G	04/01/2009	04/1/2019	Current	Cooperative management of A T on state and ATPO-acquired lands
Vermont statewide MOU	NPS, GMC, DOC, GMC, state agencies (ANR, DOT)	11/30/1982	11/30/1987	Expired	Cooperative management of A T on state and ATPO-acquired lands
Massachusetts statewide MOU	NPS, ATC, AMC, state agencies (DCR, EOEA, MHD, DFWELE, MTA, MSP)	06/16/2003	06/15/2013	Update in Progress	Cooperative management of A T on state and ATPO acquired lands; includes department of highways, turnpike authority and all law enforcement agencies
Connecticut statewide MOU	NPS, ATC, AMC, state agencies (DEEP, DOT, SP)	06/01/2012	06/01/2022	Current	Cooperative management of A T on state and ATPO-acquired lands
New York statewide MOU	NPS, ATC, NYNJTC, PIPC, DEC, OPRHP, SBA, SP	06/17/2014	06/17/2024	New agreement signed on 06/17/14	Cooperative management of A T on state and ATPO-acquired lands Multiple state and bi-state (NY and NJ) agencies
New Jersey statewide MOU	NPS, ATC, NYNJTC, USF&WS, NJ-DEP, divisions of Forestry, Parks	04/29/1999	04/29/2009	Expired	Cooperative management of A T on state and ATPO-acquired lands

Statewide MOUs	Partners to Agreement	Start Date	Expiration	Status	Purpose
Pennsylvania statewide MOU	NPS, ATC, KTA, 11 Trail clubs (WTC, BHC, AMC-DV, PTC, BMECC, AHC, SATC, YHC, CVATC, MCM, PATC), state agencies (DCNR, BSP, BOF, PGC, SMRC, PSP, PEMA, DOT, PTC)	06/2/2006	06/1/2016	Current	Cooperative management of A T on state and ATPO-acquired lands Includes all land-owning, state highway, and emergency management, agency partners
Maryland statewide MOU	NPS, ATC, PATC, state agencies (DNR, DOT, SP), Washington County	08/13/2002	08/13/2012	Expired	Cooperative management of A T on state, county, and ATPO-acquired lands
West Virginia statewide MOU	NPS, ATC, PATC, State agencies	10/30/1975		In effect, but outdated	Cooperative management of A T on state and ATPO-acquired lands
Virginia statewide MOU	NPS, ATC, 9 Trail clubs, state agencies (DCR, DOT, DSP, DGIF, DOF)	01/14/2010	01/14/2020	Current	Cooperative management of A T on state and ATPO-acquired lands
Tennessee statewide MOU	NPS, ATC, Trail clubs	07/5/1972		In effect, but outdated	Cooperative management of A T
North Carolina statewide MOU	NPS, ATC, Trail clubs	05/26/1971		In effect, but outdated	Cooperative management of A T
Georgia statewide MOU	NPS, ATC, Trail clubs	05/4/1972		In effect, but outdated	Cooperative management of A T

NPS Park Unit MOUs	Partners to Agreement	Start Date	Expiration	Status	Purpose
NPS-Delaware Water Gap NRA MOU	NPS-ATPO, NPS DEWA, ATC, BATONA, WTC	3/31/1997	3/31/2007	Expired	Cooperative management of the A T in Delaware Water Gap NRA and on adjoining ATPO lands
NPS-C&O Canal NHP MOU	NPS ATPO, NPS CHOH, ATC, PATC	11/16/2001	11/15/2006	Expired	Cooperative management of the A T on the C&O Canal
NPS-Harpers Ferry NHP MOU	NPS ATPO, NPS HAFE, ATC, PATC	9/21/1998	9/21/2008	Expired	Cooperative management of the A T in Harpers Ferry NHP and on adjoining lands
NPS-Shenandoah NP MOU	NPS ATPO, NPS SHEN, ATC, PATC	7/29/2009	7/29/2019	Current	Cooperative management of the A T in Shenandoah NP
NPS-Blue Ridge Parkway MOU	NPS ATPO, NPS BLRI, ATC, Trail clubs	4/19/2012	4/19/2022	Current	Cooperative management of the A T in Blue Ridge Parkway
NPS-Great Smoky Mountains NP MOU	NPS ATPO, NPS GRSM, ATC, SMHC	4/8/1996	4/8/2006	Expired	Cooperative management of the A T in Great Smoky Mountains NP

Existing Trail Partnerships

The Appalachian National Scenic Trail is managed and maintained by 31 trail clubs and multiple federal and state agencies, working in partnership with the National Park Service / Appalachian National Scenic Trail and Appalachian Trail Conservancy. These partnerships are at the core of managing the trail.

State	Volunteer Partners	Federal Agency Partners	State Agency Partners
ME	• Appalachian Mountain Club • Maine Appalachian Trail Club • Appalachian Trail Conservancy	• Appalachian National Scenic Trail	• ME Dept of Conservation • ME Dept of Inland Fisheries and Wildlife • ME Warden Service • ME Office of State Planning • ME Dept of Public Safety • ME Bureau of Parks and Lands • Baxter State Park • The Hermitage Nature Preserve • Bald Mountain Pond • Bigelow Preserve • Grafton Notch State Park • ME Historic Preservation Commission
NH	• Appalachian Mountain Club • Dartmouth Outing Club • Randolph Mountain Club • Appalachian Trail Conservancy	• White Mountain National Forest • Appalachian National Scenic Trail	• NH Dept of Fish and Game • NH Dept of Resources and Economic Development • NH Office of State Planning • NH Dept of Transportation • NH State Police • Benton State Forest • Lead Mine State Forest • Mount Washington State Park • Crawford Notch State Park • Franconia Notch State Park • NH Division of Historical Resources
VT	• Green Mountain Club • Appalachian Trail Conservancy	• Green Mountain National Forest • Appalachian National Scenic Trail • Marsh-Billings-Rockefeller National Historical Park	• VT Agency of Natural Resources • VT Environmental and Water Resources Board • VT Dept of Public Safety • VT State Police • VT Agency if Natural Resources • VT Dept of Forests, Parks, and Recreation • Gifford Woods State Park • Kent Pond (State Fish and Wildlife) • Calvin Coolidge State Forest • Clarendon Gorge (State Fish and Wildlife) • VT Division for Historic Preservation

State	Volunteer Partners	Federal Agency Partners	State Agency Partners
MA	• AMC, Berkshire Chapter • Appalachian Mountain Club • Appalachian Trail Conservancy	• Appalachian National Scenic Trail	• MA Executive Office of Environmental Affairs • MA Dept of Conservation and Recreation • MA Division of Fisheries • MA Wildlife and Environmental Law Enforcement • MA Dept of Public Safety • Clarksburg State Forest • Mount Greylock State Reservation • October Mountain State Forest • Beartown State Forest • East Mountain State Forest • Mt Everett State Reservation • MA Historical Commission
CT	• AMC, Connecticut Chapter • Appalachian Mountain Club • Appalachian Trail Conservancy	• Appalachian National Scenic Trail	• CT Dept of Energy and Environmental Protection • CT Dept of Transportation • CT State Police • Housatonic State Forest • Housatonic Meadows State Park • CT Historic Preservation and Museum Division
NY	• New York-New Jersey Trail Conference • Appalachian Trail Conservancy	• Appalachian National Scenic Trail • Roosevelt-Vanderbilt National Historical Park	• NY Dept of Environmental Conservation • NY Division of Fish and Wildlife • NY Dept of Transportation • NY Bridge Authority • NY Office of Parks, Recreation, and Historic Preservation • NY Palisades Interstate Park Commission • NY State Police • Depot Hill State Forest • Clarence Fahnestock Memorial State Park • Hudson Highlands State Park • Bear Mountain State Park • Harriman State Park • Sterling Forest State Park • NY State Historic Preservation Office
NJ	• New York-New Jersey Trail Conference • Appalachian Trail Conservancy	• Wallkill River National Wildlife Refuge • Delaware Water Gap National Recreation Area • Appalachian National Scenic Trail	• NJ Dept of Environmental Protection • NJ State Police • NJ Dept of Transportation • Abram S Hewitt State Forest • Wawayanda State Park • High Point State Park • Stokes State Forest • Worthington State Forest • NJ State Historic Preservation Office

State	Volunteer Partners	Federal Agency Partners	State Agency Partners
PA	• Wilmington Trail Club • Batona Hiking Club • AMC, Delaware Valley Chapter • Philadelphia Trail Club • Blue Mountain Eagle Climbing Club • Allentown Hiking Club • Susquehanna Appalachian Trail Club • York Hiking Club • Cumberland Valley Appalachian Trail Club • Mountain Club of Maryland • Potomac Appalachian Trail Club • Appalachian Trail Conservancy	• Cherry Valley National Wildlife Refuge • Delaware Water Gap National Recreation Area • Appalachian National Scenic Trail	• PA Dept of Conservation and Natural Resources • PA State Parks • Caledonia State Park • Pine Grove Furnace State Park • Swatara State Park • PA Bureau of Forestry • Michaux State Forest • Weiser State Forest • William Penn State Forest • PA Game Commission • PA Fish and Boat Commission • PA Dept of Transportation • PA Natural Diversity Inventory Office • PA State Police • Pennsylvania State Game Lands • PA Historical & Museum Commission
MD	• Potomac Appalachian Trail Club • Mountain Club of Maryland • Appalachian Trail Conservancy	• Harpers Ferry National Historical Park • Chesapeake & Ohio Canal National Historical Park • Potomac Heritage National Scenic Trail • Appalachian National Scenic Trail	• MD Dept of Natural Resources • MD Dept of Transportation • MD State Police • South Mountain State Park • Greenbrier State Park • Washington Monument State Park • Gathland State Park • MD Historical Trust
WV	• Potomac Appalachian Trail Club • Appalachian Trail Conservancy	• Harpers Ferry National Historical Park • Potomac Heritage National Scenic Trail • Appalachian National Scenic Trail	• WV Dept of Natural Resources • WV Dept of Transportation • WV State Police • WV Division of Culture and History

State	Volunteer Partners	Federal Agency Partners	State Agency Partners
VA	• Potomac Appalachian Trail Club • Old Dominion Appalachian Trail Club • Tidewater Appalachian Trail Club • Natural Bridge Appalachian Trail Club • Outdoor Club of Virginia Tech • Roanoke Appalachian Trail Club • Piedmont Appalachian Trail Hikers • Mount Rogers Appalachian Trail Club • Appalachian Trail Conservancy	• George Washington National Forest • Jefferson National Forest • Harpers Ferry National Historical Park • Potomac Heritage National Scenic Trail • Shenandoah National Park • Blue Ridge Parkway • Smithsonian Institution • Appalachian National Scenic Trail	• VA Dept of Conservation and Recreation • VA Dept of Game and Inland Fisheries • VA Dept of Transportation • VA Dept of State Police • VA Dept of Forestry • VA Dept of Historic Resources • Sky Meadows State Park • G R Thompson State Wildlife Management Area • Grayson Highlands State Park
TN	• Smoky Mountains Hiking Club • Carolina Mountain Club • Tennessee Eastman Hiking and • Canoeing Club • Appalachian Trail Conservancy	• Cherokee National Forest • Great Smoky Mountains National Park • Tennessee Valley Authority • Appalachian National Scenic Trail	• TN Dept of Environment and Conservation • TN Historical Commission
NC	• Nantahala Hiking Club • Smoky Mountains Hiking Club • Carolina Mountain Club • Appalachian Trail Conservancy	• Pisgah National Forest • Nantahala National Forest • Blue Ridge Parkway • Great Smoky Mountains National Park • Appalachian National Scenic Trail • Tennessee Valley Authority	• NC Dept of Environment, Health and Natural Resources • NC State Historic Preservation Office
GA	• Georgia Appalachian Trail Club • Appalachian Trail Conservancy	• Chattahoochee National Forest • Appalachian National Scenic Trail	• GA Dept of Natural Resources • Vogel State Park • Amicalola Falls State Park • GA Historic Preservation Division

Appendix C: Related Federal Legislation, Regulations, and Executive Orders

While regulatory responsibility for the Appalachian National Scenic Trail is shared among the National Park Service, U.S. Forest Service, and states, what follows below are the federal legislation, regulations, and executive orders that apply to the National Park Service, and in some cases—as with executive orders—other federal agencies. The U.S. Forest Service and states each have their own suite of related regulations that apply to the Appalachian National Scenic Trail. While not listed within this document, these non-NPS regulations are an important component of Trail management and regulatory structure.

Legislation and Acts

Americans with Disabilities Act – 1990, as amended

Archeological and Historical Preservation Act – 1974

Archaeological Resources Protection Act – 1979

Clean Air Act – 1977

Clean Water Act – 1972

Comprehensive Environmental Response and Compensation and Liability Act (CERCLA) – 1984, as amended

Department of Transportation Act – 1966

Endangered Species Act – 1973

Historic Sites Act – 1935

National Environmental Policy Act – 1969

National Historic Preservation Act – 1966, as amended

National Parks Omnibus Management Act – 1998

National Park Service Organic Act – 1916

National Trail System Act – 1968

Redwood Act, Amending the NPS Organic Act – 1978

The Resource Conservation and Recovery Act (RCRA) – 1976, as amended

Code of Federal Regulations

- Title 36, Chapter 1, Part 1, General Provisions
- Title 36, Chapter 1, Part 2, Resource Protection, Public Use and Recreation
- Title 36, Chapter 1, Part 4, Vehicles and Traffic Safety
- Title 36, Chapter 1, Part 5, Commercial and Private Operations

Executive Orders

Executive Order 11514, "Protection and Enhancement of Environmental Quality"

Executive Order 11593, "Protection and Enhancement of the Cultural Environment"

Executive Order 11988, "Floodplain Management"

Executive Order 11990, "Protection of Wetlands"

Executive Order 12003, "Energy Policy and Conservation"

Executive Order 12088, "Federal Compliance with Pollution Control Standards"

Executive Order 12372, "Intergovernmental Review of Federal Programs"

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"

Executive Order 13112, "Invasive Species"

Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds"

Executive Order 13195, "Trails for America in the 21st Century"

Executive Order 13327 "Federal Real Property Asset Management"

Executive Order 13352, "Facilitation of Cooperative Conservation"

Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management"

NPS *Management Policies 2006*

NPS Director's Orders

Order 2-1: *Resource Stewardship Planning*

Order 6: *Interpretation and Education*

Order 7: *Volunteers in Parks*

Order 9: *Law Enforcement Program*

Order 12: *Conservation Planning, Environmental Impact Analysis, and Decision-making and Handbook*

Order 18: *Wildland Fire Management*

Order 24: *NPS Museum Collections Management*

Order 28: *Cultural Resource Management*

Order 28A: *Archeology*

Order 28B: *Ethnography*

Order 41: *Wilderness Stewardship*

Order 42: *Accessibility for Visitors with Disabilities in National Park Service Programs and Services*

Order 45: *National Trails System*

Order 47: *Soundscape Preservation and Noise Management*

Order 64: *Commemorative Works and Plaques*

Order 75: *Civic Engagement and Public Involvement*

Order 77: *Natural Resource Protection*

Order 77-1: *Wetland Protection*

Order 77-2: *Floodplain Management*

Order 77-7: *Integrated Pest Management*

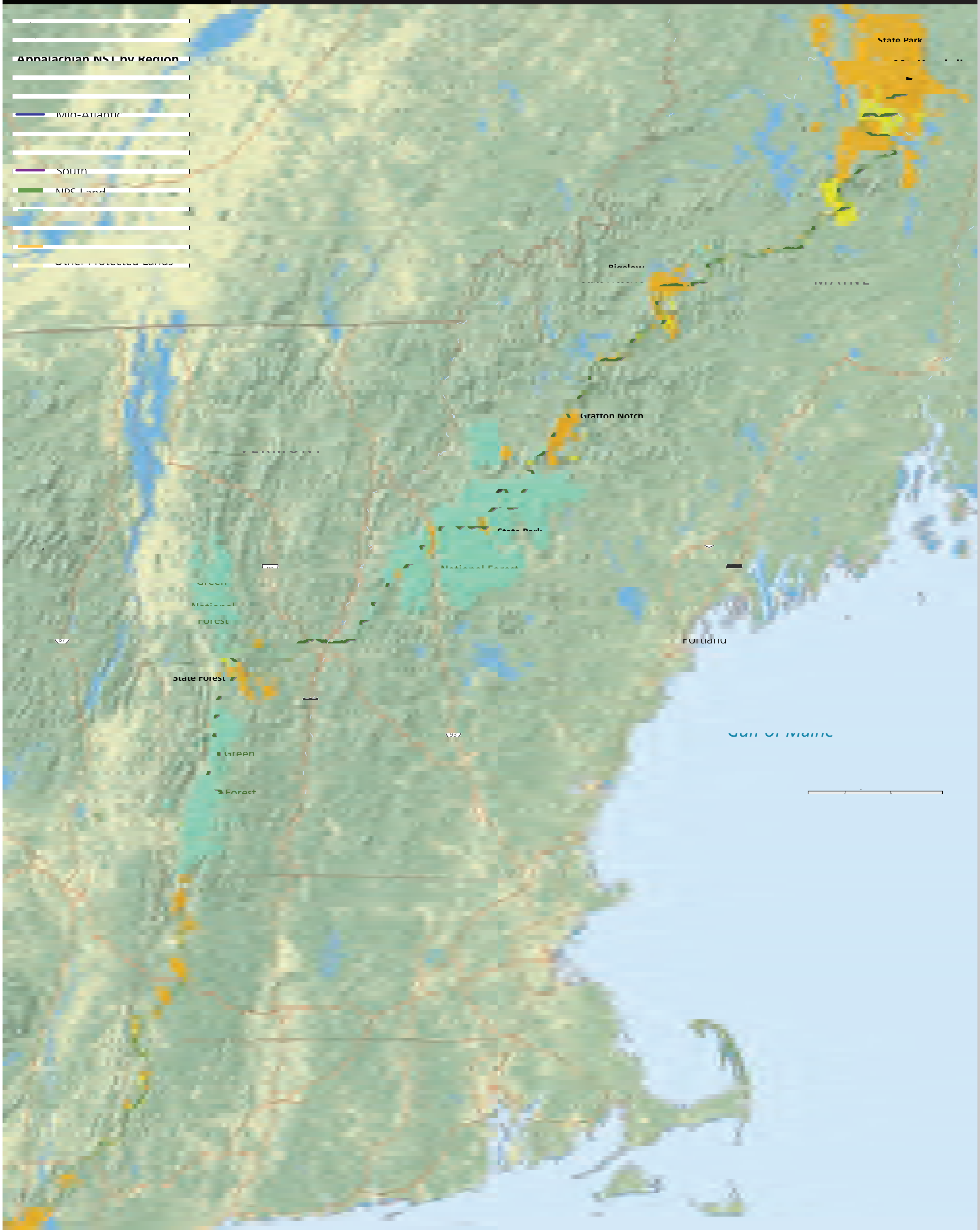
Order 77-8: *Endangered Species*

Order 80: *Real Property Asset Management*

Appendix D: Regional Maps of the Appalachian National Scenic Trail

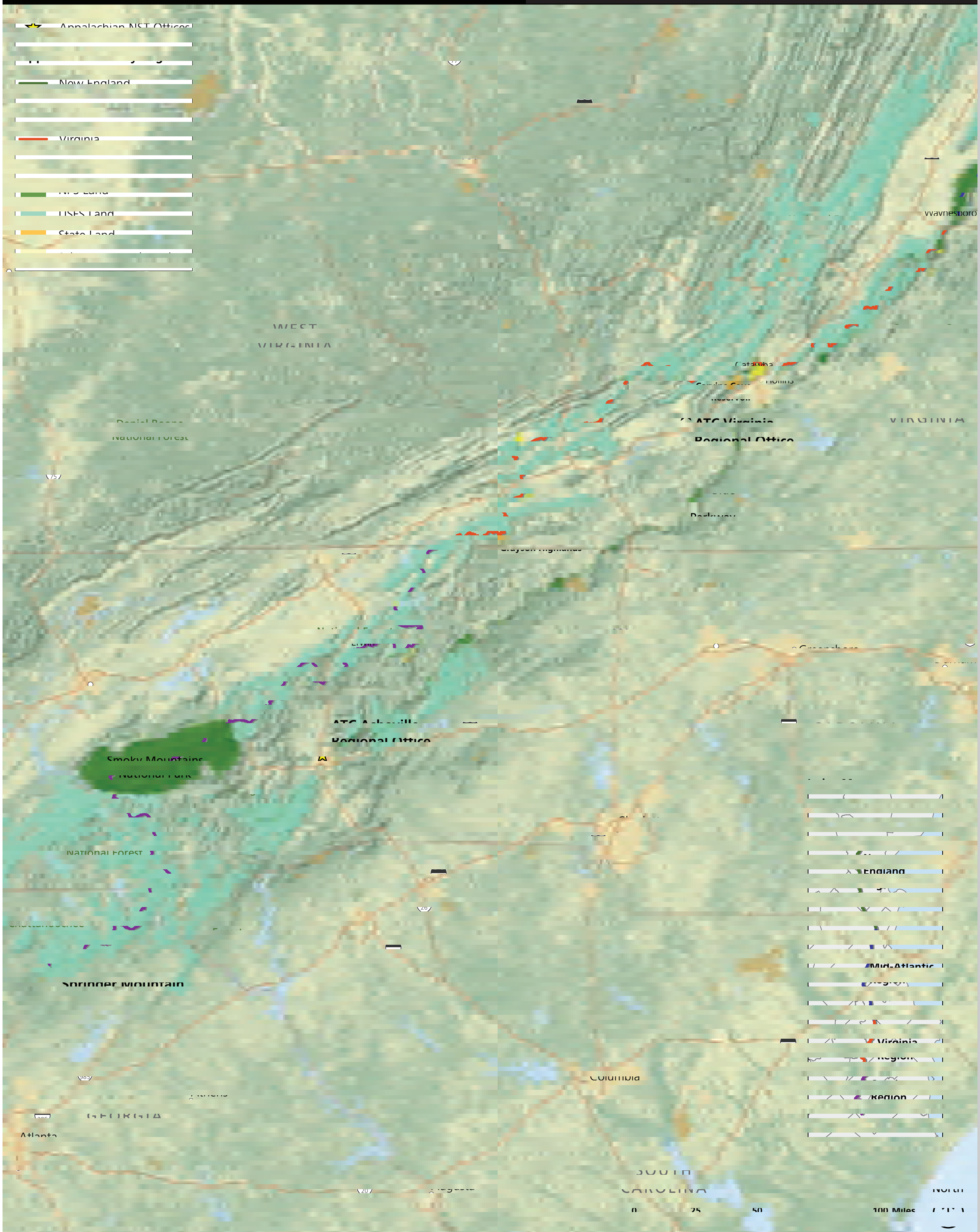
The Appalachian National Scenic Trail is divided into four distinct geographic regions—New England, Mid-Atlantic, Virginia, and Deep South. These regions provide a framework for collaboration between partners, volunteers, and clubs to aid in management of the Trail.

New England Region



Mid Atlantic Region

Central and Southwest Virginia and Southern Region



Northeast Region, National Capital Region, Southeast Region
Foundation Document Recommendation
Appalachian National Scenic Trail

February 2015

This Foundation Document has been prepared as a collaborative effort between park and regional staff and is recommended for approval by the Northeast Regional Director, National Capital Regional Director, and Southeast Regional Director

2/11/15

RECOMMENDED
Wendy K Janssen, Superintendent, Appalachian National Scenic Trail — **Date**

2/23/15

CONCURRED
Robert Vogel, Regional Director, National Capital Region — **Date**

3/4/15

CONCURRED
Stan Austin, Regional Director, Southeast Region — **Date**

3/23/15

APPROVED
Michael Caldwell, Regional Director, Northeast Region — **Date**

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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Foundation Document • Appalachian National Scenic Trail

NATIONAL PARK SERVICE • U.S. DEPARTMENT OF THE INTERIOR