CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter describes the potential beneficial and adverse environmental consequences of each alternative described in Chapter 2 of the EIS. The environmental consequences on natural, cultural and socioeconomic resources form the scientific and analytical basis for the comparison of alternatives. Specific impact topics were selected to focus the discussion of potential consequences.

This chapter is organized in sections by resource. Each resource includes discussion of the methodology used to identify and evaluate the impacts, impacts common to all alternatives, impact analysis, and assessment of cumulative impacts. The impact analysis also examines the potential for impairment to park resources and values.

Impacts are described in terms of type, area, intensity, and duration. The intensity and duration of impacts varies for each impact topic. Table 4-1 defines the intensity levels (*negligible*, *minor*, *moderate*, or *major*) and duration (*short-term* or *long-term*) for all of the impact topics considered in this discussion. Type of impact is either *beneficial* or *adverse*. The area of an impact may be *site-specific, localized,* or *regional* in nature. Impacts for a topic may be defined as a range of levels (e.g. *minor to major, or short-term to long-term*) depending upon conditions or events that may occur in the future.

The No Action alternative provides baseline conditions for evaluating changes and related environmental impacts for the remaining action alternatives. Impacts may seem similar between alternatives, but differences in impacts are identified and compared as appropriate. All impacts have been assessed assuming that mitigation measures would be implemented (see “Mitigation” Chapter 2) and may lessen the impacts on some resources (e.g. construction near an eagle nest may be postponed until after the nesting season).

METHODOLOGY OF IMPACT ASSESSMENT

Actions are first analyzed for their *direct* and *indirect* effects. Direct effects are impacts that are caused by the alternatives at the same time and in the same place as the action. Indirect effects are impacts caused by the alternatives that occur later in time or are farther in distance than the action. For example, construction grading may result in the *direct* removal of vegetation and soil from a site and result *indirect*ly in increased erosion at the site at a later time when it rains, and to water quality off-site.

Potential impacts are described in terms of type, area, duration, and intensity.

- **Type**: impacts are either ***beneficial*** or ***adverse***. An impact topic may be affected both beneficially and adversely (e.g., one wildlife species may benefit while another is harmed), however an overall impact for the topic as a whole is also designated.
- **Area**: impacts are 1) ***site-specific*** at the location of the action, 2) ***localized*** on a drainage- or district-wide level, 3) ***widespread*** throughout the Park or Forest, or 4) ***regional*** over a large area reaching into other geographical areas including the Park and Forest.

- **Duration**: impacts are ***short-term*** or ***long-term***. Sporadic impacts are short-term in nature. The definitions for these time periods depend upon the impact topic and are described in Table 4-1.
- **Intensity**: the impacts are ***negligible***, ***minor***, ***moderate***, or ***major***. Definitions of intensity vary by impact topic and are provided in Table 4-1 for each impact topic analyzed in this document.

For each resource topic, an "impact analysis area" was determined based upon the potential impact on that resource. For example, impacts to vegetation may be confined to the targeted slopes while noise disturbance could impact wildlife several miles away. Therefore, the size and boundaries of the analysis area for vegetation and wildlife would be very different.

IMPACT TOPICS CONSIDERED

Resources that may be affected by the proposed alternatives were identified by NPS and USFS staff. Impact topics were derived from these resources to ensure that alternatives were compared on the basis of the most relevant topics. The following impact topics were identified on the basis of federal laws, regulations, orders, management policies, and public input received during scoping. A brief rationale for the selection of these impact topics is given below.

NATURAL RESOURCES

- **Avalanche Processes** – Avalanches are a natural disturbance within mountain ecosystems that create unique habitats used by many species of wildlife. If emergency explosive avalanche hazard reduction occurs, avalanche frequency in the project area would likely increase and the natural avalanche disturbance process could change. This document would describe the potential changes to the natural avalanche cycle in GNP and FNF from actions proposed in the alternatives.
- **Water Resources** – Water quality in the project area is excellent. The avalanche paths in the project area drain into Bear Creek less than a mile upstream from the confluence of Bear Creek and the Middle Fork of the Flathead River, a National Wild and Scenic River. Changing the natural avalanche regime, using explosives, or a chemical spill resulting from a derailment could adversely impact water quality in GNP and FNF.
- **Aquatic Species**- Aquatic species impacts are directly correlated to Water Resources impacts. Avalanche paths drain directly into aquatic habitats that contain a wide variety of fish and aquatic invertebrates. Actions proposed by the alternatives are evaluated to determine impacts on aquatic resources in GNP and FNF.
- **Geology and Soils** – The slopes in the avalanche paths contain many rock outcrops. These geologic formations could be impacted by the proposed use of explosives. The steep slopes of John F. Stevens Canyon are susceptible to high levels of erosion. Vegetation loss or soil disturbance from explosive use could increase this susceptibility.
- **Vegetation** – The Park supports over 1,100 species of vascular plants and at least 870 non-vascular plants, including many rare and sensitive species. GNP and FNF plant communities found in the project area are specific to steep avalanche terrain. The plant communities and broad ecological communities are important GNP and FNF resources that could be affected by actions in the avalanche start zones, tracks, along the railroad right-of-way, and/or below the ROW on Forest land.

- **Terrestrial Wildlife**– GNP and FNF are noted for abundant wildlife and as refuges for sensitive and rare species. Habitat for over 300 terrestrial wildlife species is found within the park, and many of these are present in the mountains and drainages of John F. Stevens Canyon. Alternatives are evaluated to determine impacts on wildlife and how actions, including noise, may change wildlife movement patterns in the Canyon.
- **Threatened and Endangered Species and Species of Concern** – The Federal Endangered Species Act requires an examination of impacts on all federally-listed threatened or endangered species. GNP and FNF support populations of endangered gray wolves and these species that are federally listed as threatened: bald eagle, grizzly bear, Canada lynx, and bull trout. The slender moonwort, a Candidate for listing, is also known in GNP. Impacts to species of concern identified by the Montana Natural Heritage Program are also evaluated.
- **Natural Sound**- The area north of the railroad in GNP is recommended wilderness. The area south of US Highway 2 is designated FNF wilderness. One of the components of wilderness is the preservation of natural soundscapes. Natural soundscapes in the canyon are impacted by US Highway 2, train traffic, and human activity. Explosive use would increase the adverse impacts on natural soundscapes for humans and wildlife. Snowshed construction would have associated noise until the structures are completed.
- **Air Quality** – GNP is classified as a mandatory Class I area under the Clean Air Act and park managers are given the responsibility to protect visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality. Construction activities, machinery emissions and train exhaust while idling during delays may have impacts on local air quality. Under all alternatives, potential exists for the release of hazardous materials from a derailed train car that could have effects on air quality in the area.

CULTURAL RESOURCES

- **Historic Structures and Landscapes** – The existing snowsheds and railroad infrastructure in the canyon were originally constructed over 100 years ago. The snowsheds are potentially eligible for listing in the National Register of Historic Places. Certain portions of the railroad have been determined eligible for the National Register of Historic Places as a cultural landscape. The addition of over 5,000 feet of snowshed may change the railroad landscape in the project area. Impacts on snowsheds and the railroad from the action alternatives, especially the impacts of snowshed extensions on existing snowsheds, are evaluated in accordance with Section 106 of the National Historic Preservation Act and NEPA.

SOCIAL AND ECONOMIC RESOURCES

- **Socioeconomics** – Economic considerations include the cost of implementing avalanche hazard reduction methods (e.g., construction of snowsheds, regular use of explosives, snow monitoring and testing), the loss of revenue due to temporary train delays or rerouting of train traffic, potential costs of derailments, and projected changes in train traffic and growth. The impacts on local and regional economies are evaluated.
- **Human Health and Safety** – Avalanches pose a threat to railroad workers along John F. Stevens Canyon. Three BNSF employees have been killed by avalanches since trains first started traveling the Canyon. The proposed use and transport of explosives for

avalanche control can also present safety concerns. A derailment of hazardous substances has the potential to impact public health and safety in the canyon and downstream. The overall effect of each alternative on human health and safety is evaluated.

- **Wilderness** – Both sides of John F. Stevens Canyon are designated or recommended wilderness. On the Park side the project area is recommended wilderness and the northern boundary of the Great Bear Wilderness occurs on the Forest side of the canyon. Actions described in the alternatives are evaluated for their potential impacts on wilderness values.
- **Visual Resources** – The establishment of GNP was rooted in the preservation and appreciation of the scenic resources of the area. Since the Going-to-the-Sun Road is closed during the winter, US Highway 2 is the only road for visitors to travel between the west and east side of the mountains to experience GNP. The travel corridor through the canyon is part of the Northern Continental Divide Scenic Loop. Snowshed construction could result in changes to the visual environment along the project area. Visible impacts during the winter months may include black craters in the snow where detonated explosives landed and did not release avalanches. In addition, explosive impacts may be visible throughout the year in craters, displaced soil, and/or erosion; therefore, the alternatives are analyzed for their effects on scenic and visual resources.
- **Public Use and Experience** – Providing opportunities to experience, understand, appreciate, and enjoy natural and cultural resources is one of the fundamental purposes of GNP. Public use and recreation are important for visitors to NFS lands near the project area. Though the immediate project area is not frequently used in the winter by recreationists; adjacent NPS and NFS lands provide for activities such as skiing and snowshoeing. Snowmobiling occurs only on NFS lands. Wildlife viewing from the highway and trails is a popular activity in the canyon and Marias Pass areas. The project area is adjacent to a heavily traveled highway corridor. Impacts on the overall public experience including the recreational values of natural soundscapes, wilderness, and access are evaluated.

IMPACT TOPICS DISMISSED FROM FURTHER ANALYSIS

- **Agency Operations-** All agency operational costs associated with proposed alternatives in this document would be reimbursed by BNSF. There would be no costs to GNP, FNF, or MDT under any of the alternatives.
- **Wetlands** – There are no known wetlands in the project area. The proposal or alternatives do not include any actions that would adversely affect wetlands, so they have been dismissed from further analysis.
- **Floodplains**– The railroad tracks and the project area are located outside of the 100 year floodplain as are proposed alternative actions. There would be no impacts to floodplains under any of the alternatives.
- **Prime and Unique Farmlands** – In 1980, the Council on Environmental Quality directed that federal agencies must assess the effects of their actions on farmland soils classified by the U.S. Department of Agriculture's Natural Resources Conservation

Service as prime or unique. There are no “prime or unique farmlands” in John F. Stevens Canyon and this topic would not be discussed further.

- **Archaeological Resources-** The Forest Archaeologist conducted a files search and review of the FNF site database and literature sources to identify the location of known, previously-recorded heritage resources within the project area. The literature and file review included a file search from the Montana State Historic Preservation Office (SHPO) and a review of GNP archaeological literature. It identified no recorded archaeological properties in the project area with the nearest recorded sites located approximately three miles to the east near Marias Pass.

  After completion of the pre-survey files search, the USFS Archeologist conducted a field reconnaissance of the proposed project area using a field methodology described in the Forest’s Site Identification Strategy document currently on file with the Montana SHPO in Helena, Montana. Cultural resource personnel inventory the affected areas based upon topography with "high probability areas" (ridge tops, peaks, stream terraces) receiving 100 percent coverage, "medium probability areas" (slopes less than 30 percent, rock outcrops, erosional surfaces) receiving 40 percent coverage, and "low probability areas" (slopes in excess of 30 percent, north-facing slopes, heavily timbered slopes with abundant deadfall and understory) receiving 10 percent coverage. The project area falls within the “low probability areas” designation as the canyon walls are in excess of 30 degrees.

  The Blackfeet and the Confederated Salish and Kootenai Tribes of Montana have been identified as tribal groups concerned with the management of heritage resources on the Flathead National Forest. The tribes were contacted in the initial planning stages of the Middle Fork avalanche hazard mitigation project in order to establish lines of communication between the parties, to advise them on the scope of the undertaking including potential effects, and to make their resource concerns (if any) an official part of the project file. Any archeological sites discovered during the inventory are recorded and their National Register eligibility status evaluated in consultation with the Montana SHPO. A complete inventory to locate and identify significant cultural resources within the project area was completed in June 2005. The pre-survey file search identified no sites in the project area. Additional inventory for avalanche hazard mitigation activities has been conducted to locate other cultural resources in the project area. Consultation with the tribes is on-going. Since no archeological sites have been identified in the area, based on limited surveys, no measurable impact on archaeological resources is anticipated.

- **Ethnographic Resources** - No ethnographic resources were identified during scoping by the Confederated Salish and Kootenai Tribes or the Blackfeet Tribal Business Councils or the Confederated Salish and Kootenai Tribes Preservation Department. A letter from the Blackfeet Tribal Historic Preservation Officer (June 1, 2005) stated that “the Blackfeet Tribe requests to participate in the consultation process for this project.” The Confederated Salish and Kootenai Tribe did not send correspondence regarding this project.

  Park staff consulted with the Confederated Salish Kootenai Tribal Historic Preservation Department on March 16, 2006. The tribe raised no issues with regard to the proposed alternatives.

A letter from the Blackfeet Tribal Historic Preservation Officer (May 26, 2006) stated that the Blackfeet Tribe is opposed to explosive use in the park and would like to see BNSF build snowsheds instead of use explosives. This letter stated that the tribe is concerned that explosive use would be "disruptive and detrimental to the cultural and natural environment."

GNP and FNF recognize that the tribes hold a body of knowledge that may result in the identification of ethnographic resources in the area in the future. If ethnographic resources are identified, consultation.

Consultation would occur in accordance with federal legislation and regulations and National Park Service policy between GNP and the Blackfeet Tribe to identify any ethnographic resources in the area. If specific ethnographic resources are defined, an ethnographic resources impact analysis would be conducted for the Final EIS.

- **Museum Collections** – No museum objects are stored within the project area and no artifacts proposed for inclusion within a museum are known in the area. Therefore, museum collections were dismissed as an impact topic.
- **Environmental Justice** – Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income populations, requires federal agencies to analyze the impacts of park actions on minority populations. The project would not have disproportionate health or environmental effects on minorities or low-income populations or communities. Environmental justice was dismissed as an impact topic in this document.

Table 4-1. Impact thresholds for each topic.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Avalanche Processes	Avalanche processes would not be affected or the effect would be below or at the lower end of detection. Any effects to avalanche processes would be slight and not measurable.	The effects to avalanche processes would be detectable. Effects to avalanche frequency and magnitude would be small, and the area affected would be localized.	The effect to avalanche processes would be readily apparent. Effects would result in a change in magnitude and frequency over a relatively wide area or multiple locations.	The effect on avalanche processes would be readily apparent and would substantially change the frequency and magnitude of avalanches over a large area.	Short-term- Effects last one year. Long-term- Effects last more than one year.
Water Resources	Water quality would not be affected, or changes would be either non-detectable or if detected, would have effects that would be considered slight and not measurable.	Changes in water quality would be measurable, although the changes would be small and the effects would be localized.	Changes in water quality would be measurable and would be noticeable on a widespread scale.	Changes in water quality would be readily measurable, would have substantial consequences, and would be noticed on a regional scale.	Short-term—After implementation, recovery would take less than one year. Long-term—After implementation, recovery would take longer than one year or effects would be permanent.
Aquatic Species	Effects would be at or below the level of detection and the changes would be so slight that they would not be of any measurable or perceptible consequence to the wildlife species' population.	Effects on wildlife would be detectable, although the effects would be localized and would be small and of little consequence to the species' population	Effects on wildlife would be readily detectable and widespread, with consequences at the population level.	Effects on wildlife would be obvious and would have substantial consequences to wildlife populations in the region.	Short-term—After implementation, would recover in less than 1 year. Long-term—After implementation, would take more than 1 year to recover or effects would be permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Geology/Soils	Geological features and processes would not be affected or the effect would be below or at the lower end of detection. Any effects to geological features or processes, soil productivity, or soil fertility would be slight and not measurable.	The effects to geological features or processes, soil productivity, or soil fertility would be detectable. Effects to geologic features and processes or soils would be small, and the area affected would be localized.	The effect to geological features or processes, soil productivity, or soil fertility would be readily apparent. Effects would result in a change in geological features and processes or soils over a relatively wide area or multiple locations.	The effect on geological features or processes, soil productivity, or soil fertility would be readily apparent and would substantially change the character of geological features and processes or soils over a large area.	Short-term- After implementation, would recover in less than 3 years. Long-term- After implementation, would take more than 3 years to recover or effects would be permanent.
Vegetation	No native vegetation would be affected or some individual native plants could be affected, but here would be no effect on native species' populations. The effects would be on a small scale, not measurable, and no species of concern would be affected.	Native plants would be affected over a relatively small area, and a minor portion of a species' population.	Native plants would be affected over a relatively wide area (greater than 5 acres) or at multiple locations, and would be readily noticeable.	There would be a widespread effect on native species' populations or a considerable effect on native plant populations, including species of concern, over a very large area (over 10 acres).	Short-term—After implementation, would recover in less than 3 years. Long-term—After implementation, would take more than 3 years to recover or effects would be permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Wildlife	Effects would be at or below the level of detection and the changes would be so slight that they would not be of any measurable or perceptible consequence to the wildlife species' population.	Effects on wildlife would be detectable, although the effects would be localized and would be small and of little consequence to the species' population	Effects on wildlife would be readily detectable and widespread, with consequences at the population level.	Effects on wildlife would be obvious and would have substantial consequences to wildlife populations in the region.	Short-term—After implementation, would recover in less than 1 year. Long-term—After implementation, would take more than 1 year to recover or effects would be permanent.
Threatened and Endangered Species and Species of Concern	The alternative would affect an individual of a listed species or its critical habitat, but he change would be so small that it would not be of any measurable or perceptible consequence to the protected individual or its population. Negligible effect would equate with a "no effect" determination in U.S. Fish and Wildlife Service terms.	An individual(s) of a listed species or its critical habitat would be affected, but the change would be small. Minor effect would equate with a "may affect, not likely to adversely affect" determination for the species in U.S. Fish and Wildlife Service terms and would require informal consultation.	An individual or population of a listed species, or its critical habitat would be noticeably affected. The effect could have some long-term consequence to individuals, populations, or habitat. Moderate effect would equate with a "may affect" determination in U.S. Fish and Wildlife Service terms and would be accompanied by a statement of "likely…" or "not likely to adversely affect" the species and would require either informal or formal consultation.	An individual or population of a listed species, or its critical habitat, would be noticeably affected with a vital consequence to the individual, population, or habitat. Major effect would equate with a "may affect, likely to adversely affect" or "not likely to adversely affect" determination in U.S. Fish and Wildlife Service terms and would require formal consultation.	Short-term—After implementation, would recover in less than 1 year. Long-term—After implementation, would take more than 1 year to recover or effects would be permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Air Quality	Changes in air quality would not be measurable.	Effects would result in a measurable change in air quality, although the changes would be small and the impacts would be localized.	Effects on air quality would be readily measurable and widespread.	Effects on air quality would be readily measurable on a regional scale, and air quality standards could be exceeded.	Short-term- Would occur during implementation. Long-term- Would be permanent.
Natural Sound ***Natural or Wilderness Areas***	Sound created by the action is not detectable for a statistically significant portion of the area or a statistically significant length of time. For the time when human-caused sound is detectable, its influence on the natural ambient sound pressure level is 1 dBA or less.	Sound created by the action is detectable in 10 percent of the area for 10% of the amount o f time during which the sound is generated. Natural sounds unique to the park are interfered with less than 5% of the time.	Sound created by the action is detectable in 10 % of the area for 50% of the amount o f time during which the sound is generated. Sounds produce levels up to 6dBA over the natural ambient level. Natural sounds that are unique to the park are interfered with less than 10% of the time.	Sound created by the action is detectable in more than 10 % of the area for 50% of the amount of time during which the noise is generated. OR: Detectable sounds produce levels more than 6dBA over the natural ambient level in up to 10% of the area. OR: Natural sounds that are unique to the park are interfered with more than 10% of the time.	Short-term- Would be temporary during implementation. Long-term- Would be permanent or continual.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Natural Sound ***Developed Areas***	Sound created by the action does not add in a statistically significant (5%) way to the total ambient sound environment, either by decibel level or by a new sound frequency signature. Natural sounds that are unique to the park are not interfered with beyond the ambient level of impact over a statistically significant length of time.	Sound created by the action adds to the total ambient sound environment, either by decibel level or by a new sound frequency signature, but not more than 10% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 10% of the time.	Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, but not more than 20% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 20% of the time.	Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, more than 20% of the time. Natural sounds are interfered with beyond the ambient level of impact more than 20% of the time.	Short-term- Would be temporary during implementation. Long-term- Would be permanent or continual.
Historic Structures and Landscapes	Impact(s) is at the lowest levels of detection - barely perceptible and not measurable. For purposes of Section 106, the finding of effect would be "no adverse effect".	Impact would alter a character defining feature(s) of a historic resource, but the work would be in accordance with the Secretary of Interior's *Standards for the Treatment of Historic Properties*. For purposes of Section 106, the finding of effect would be "no adverse effect".	Impact would alter a character defining feature(s) of the historic resource, diminishing the integrity of the resource, but still maintaining its eligibility for the National Register. For purposes of Section 106, the finding of effect would be "adverse effect".	Impact would alter a character defining feature(s) of a national historic landmark, diminishing the integrity of the resource to the extent that its designation is threatened. For purposes of Section 106, the finding of effect would be "adverse effect".	Short-term- Would occur only during implementation. Long-term-Would be permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Socioeconomics	Effects would be below or at the level of detection. Effects would not be measurable.	Effects would be detectable but changes in socioeconomic indicators would be slight and localized.	Effects would be readily apparent and would cause measurable socioeconomic changes on a localized or regional scale.	Effects would be readily apparent and would cause substantial changes to socioeconomic conditions in the region.	Short-term- Would occur only during implementation (up to 10 years). Long-term- Would be continual or permanent.
Public Health and Safety	Public health and safety would not be affected, or the effects would not be measurable.	The effect would be detectable and site specific but would not have an appreciable effect on public health and safety.	The effects would be readily apparent, and site specific or localized and would result in a substantial change in public health and safety in a manner noticeable to staff and the public.	The effects would be readily apparent, localized or regional and would result in a substantial change in public health and safety in a manner noticeable to staff and the public, and be markedly different from existing conditions.	Short-term - Occurs during year winter months (December through March) or less. Long-term -Occurs during winter months over several years or is permanent.
Wilderness	Wilderness would not be affected or the effects would not be measurable.	The effect on wilderness would be detectable, but would be slight and localized.	The effects would be readily apparent, and would result in a substantial change to the localized wilderness landscape that would be noticeable to the public.	The effects would be highly apparent and would change the character of the wilderness area.	Short-term- Occurs for one year or less. Long-term- Occurs for more than one year or is permanent.

Impact Topic	Negligible	Minor	Moderate	Major	Duration
Visual Resources	Effects would not result in any perceptible changes to existing viewsheds	Effects would result in slightly detectable changes to a viewshed or in a small area or would introduce a compatible human-made feature to an existing developed area.	Effects would be readily apparent and would change the character of visual resources in an area.	Effects would be highly noticeable or would change the character of visual resources by adding human-made features into a mostly undeveloped area or by removing most human-made features from a developed area.	Short-term- Would be temporary and removable. Long-term- Would be continual or permanent.
Public Use and Experience	The public would not be affected or changes in public use and experience would not be measurable.	Changes in public use and experience would be detectable, although the changes would be slight.	Changes in public use and experience would be readily apparent.	Changes in public use and/or experience would be readily apparent and have important consequences.	Short-term: Occurs during year winter months (December through March) or less. Long-term: Occurs during winter months over several years or is permanent

CUMULATIVE EFFECTS

The Council on Environmental Quality regulations, which implement the National Environmental Policy Act, require the assessment of cumulative impacts in the decision making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). There are no cumulative impacts under the No Action alternative as there is no federal action to assess. Cumulative impacts can result from individually minor, but collectively significant actions taking place over time.

A cumulative impact section has been established for each impact topic. Cumulative impacts were determined by combining the impacts of avalanche hazard reduction actions with other past, present, and reasonably foreseeable future actions in proximity to the analysis area. Most of the cumulative impacts originate from on-going maintenance of the railroad and US Highway 2. Wildfire suppression, exotic plant control, utility installation, and recreation are just examples of some activities resulting in separate impacts that collectively affect the impact topics. Table 4-2 describes past, ongoing, and reasonably foreseeable future actions. These actions were determined by EIS team specialists from both the National Park Service and National Forest Service. Compliance documents for both agencies were also examined for other actions. Site visits, newspaper articles, and interviews with staff, BNSF staff, members of other agencies, and private individuals provided details, dates, and action information for this analysis.

Table 4-2 Past, ongoing, and reasonably foreseeable future actions assessed for cumulative impacts.

Action	Geographic Location	Activity	Schedule/Time Period
Glacier National Park			
Going-to-the-Sun Highway Rehabilitation	50 miles of the Going-to-the-Sun Road	Rehabilitation of the historic Going-to-the-Sun Road	On-going April-November (pending funding) until 2010
Recreational Use	Trails between Walton Ranger Station and Marias Pass	Visitors hike and ski on these trails	Year round
Snowslip Weather Station (installation and operation)	Snowslip Mountain	Temporary weather station installation	Year round. Installed 2004
Walton Ranger Station Parking Area	Walton Ranger Station along US Highway 2 East of Essex	Improvement in visitor parking and access	Awaiting funding
Weed Control Activities	John F. Stevens Canyon	Weed pulling, spraying and monitoring	On-going summer months
Fire Management	Glacier National Park lands	Wildfire suppression, management, and wildland fire use	Periodic, on-going, summer months

Action	Geographic Location	Activity	Schedule/Time Period
Previous use of helicopter to deliver explosives to cornice on Going-to-the-Sun Road	Near Siyeh Bend, Going-to-the-Sun Road	Helicopter used to deliver hand charges to cornice above road- charges were unsuccessful at triggering avalanche	1996
Flathead National Forest			
Recreational Use	Trails, roads, Bear Creek/Middle Fork of the Flathead River, and campgrounds along John F. Stevens Canyon to Marias Pass	Visitors, hike, bike, horseback ride, raft, kayak, camp, ski, fish, hunt, trap, pick huckleberries, cut firewood, snowmobile and recreate in this area	On-going
Hunting	Flathead National Forest lands	Hunters drive access roads and hunt from vehicles or on foot. Rifle and bows are used.	September through November, Annually
Snowmobile trail grooming	Snowmobile trails in the Flathead (Skyland, Challenge, and Morrison Creek drainages) and Lewis and Clark National Forests	Special use permits are issued to snowmobile clubs to groom logging roads for snowmobile use	On-going winter months (Dec-April) Began 1977
Challenge and Zip's Cabin Rentals	Challenge Creek drainage and Slippery Bill area	The maximum group size of 6 (8 for Zip's) can rent the cabins on a nightly basis for up to 3 consecutive nights	December 1-March 31, annually
Fielding Remote Automated Weather System (RAWS)	Off US Highway 2 near Fielding Guard Station	Temporary fire weather station installation	On-going Installed 2002
Natural Gas Pipeline	West side of Marias Pass 0.6 mile	Natural gas pipeline installation	Completed 2004
Weed Control Activities	John F. Stevens Canyon	Weed pulling, spraying and monitoring	On-going summer months
Fire Management	Flathead National Forest lands	Wildfire suppression and wildland fire management	Periodic during summer months
Timber Salvage	South side of Hungry Horse west side of reservoir	Timber salvage, helicopter use, logging, forest rehabilitation associated with Westside reservoir fires.	2002-2006

Action	Geographic Location	Activity	Schedule/Time Period
Lewis and Clark National Forest			
Recreational Use	Trails, roads and campgrounds along John F. Stevens Canyon to Marias Pass	Visitors, hike, bike, horseback ride, camp, ski, fish, snowmobile and recreate in this area	On-going
Pike Creek Snotel Station	2 miles south of Marias Pass	Snow and weather recording station	On-going
Longwell exploratory gas well permit application	2.5 miles south of US Highway 2 near Hall Creek	Exploratory well drilling and road construction to the well	2005-2006
Trail construction and reconstruction	Lewis and Clark Forest near southeastern border of Glacier National Park	Trail reconstruction, trail establishment, and switchback construction	2002-2003
Montana Department of Transportation			
Regular road maintenance and operations	US Highway 2 along the Middle Fork and Bear Creek	Resurfacing, shoulder maintenance, spot repair, snow removal, sanding, brush removal, mowing, weed control	On-going/annual
Highway Construction	Between W. Glacier and Browning	Timber clearing, road grade construction, stream crossing construction, paving for highway.	1940-1950's, completed 1953
US Highway 2 winter closures	Between Essex and Browning	US Highway 2 is closed during bad winter weather and high avalanche conditions	Periodic during the winter months
US Highway 2 Goods Transportation	Between West Glacier and Browning, Montana	Regular freight traffic of benign and hazardous material on state highway	On-going since early
Road corridor rock blasting	US Highway 2 milepost 155.5 and 166.6	Widening the road corridor by blasting rock	Summer 2006
Burlington Northern Santa Fe Railroad			
Regular railroad maintenance operations	Railroad between West to East Glacier	Building, bridge, snowshed and track maintenance; vegetation removal; snow and avalanche debris removal	On-going, seasonal and periodic

Action	Geographic Location	Activity	Schedule/Time Period
Railroad construction	Railroad in John F. Stevens Canyon	Timber clearing, road grade construction, stream crossing construction, tie and rail lying, roadbed ballasting are activities associated with railroad construction.	1896-1899
Snowshed construction	Railroad along John F. Stevens Canyon	Snowshed construction in avalanche paths along railroad	1910-1950
Train derailments- Non-avalanche caused past and future derailments	Railroad between West to East Glacier	Derailment of railroad cars may create the introduction of hazardous materials, food items, or other substances to USFS or NPS lands. Derailments under cumulative impacts are not caused by avalanches; they are caused by other factors.	Unpredictable
Train traffic frequency increase	Railroad through John F. Stevens Canyon	Train numbers, lengths, and freight amounts are increasing annually	On-going
Transportation of materials	Railroad through John F. Stevens Canyon	Benign and hazardous materials have been, are, and would be transported via railroad	On-going, since late 1800's
US Fish and Wildlife Service			
Grizzly Bear Habitat Conservation Plan	Area between West and East Glacier	Agreement between BNSF and USFWS requiring BNSF to mitigate impacts of habitat loss and railroad-caused mortality of grizzly bears.	2002-2006
Private			
Overflights	Airspace above Glacier National Park and Flathead National Forest	Helicopter and small aircraft tours of the park and forest mountains; flights to the Schafer Meadows airstrip in the Great Bear Wilderness	On-going since 1970's

IMPAIRMENT OF PARK RESOURCES AND VALUES

The fundamental purpose of the National Park System, established by the 1916 Organic Act and reaffirmed by the General Authorities Act of 1970, as amended, begins with a mandate to conserve park resources and values. National Park Service managers must always seek ways to avoid or minimize to the greatest degree practicable, adverse impacts on park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of the park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within parks, that discretion is limited by the statutory requirement that the National Park Service must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that would harm the integrity of the park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- identified as a goal in the Park's General Management Plan or other relevant National Park Service planning document.

Impairment may result from National Park Service activities in managing the park or actions taken by visitors, concessionaires, contractors, or others operating within or outside of the park. Determinations on impairment are made in subsequent sections for each impact topic.

NATURAL RESOURCES ENVIRONMENTAL CONSEQUENCES

AVALANCHE PROCESSES

Methodology

The determination of potential effects to natural avalanche processes was quantitatively estimated based on anticipated changes in avalanche activity as the result of artificially triggering avalanches. A qualitative assessment and professional evaluation were used to estimate a change in the frequency and magnitude of avalanches.

Thresholds of impact for avalanche processes are defined in Table 4-1 and summarized here:

- ***Negligible***: Avalanche processes would not be affected or the effect would be below or at the lower end of detection. Any effects to avalanche processes would be slight and not measurable.
- ***Minor***: The effects to avalanche processes would be detectable. Effects to avalanche frequency and magnitude would be small, and the area affected would be localized.

- ***Moderate***: The effect to avalanche processes would be readily apparent. Effects would result in a change in magnitude and frequency over a relatively wide area or multiple locations.
- ***Major***: The effect on avalanche processes would be readily apparent and would substantially change the frequency and magnitude of avalanches over a large area.
- ***Short-term***: Effects last less than 1 year.
- ***Long-term***: Effects last more than 1 year.

Analysis Area

The analysis area for this impact topic encompasses the identified avalanche paths affected by the proposed alternatives. The area surrounding the avalanche paths that could be impacted by explosives is also included in this analysis.

AVALANCHE PROCESSES IMPACT ANALYSIS

Impacts Common to All Action Alternatives

All of the alternatives anticipate an avalanche forecasting and non-explosive stability testing program, consisting of snowpack investigation and observation, which would have **no impact** on natural avalanche processes. Under all of the alternatives BNSF has the option of constructing snowsheds to protect the railroad. Snowshed construction would have a **negligible, long-term, site-specific** impact on avalanche runout zones; however, natural avalanche paths would not be adversely impacted by snowshed construction in the railroad right of way. Snow depth sensor and weather station installation would have **no impact** on natural avalanche processes. Potential train derailments or hazardous material spills would have **no impact** on natural avalanche processes.

Alternative A (No Action)

Implementation of the no action alternative would allow natural avalanche processes to continue. Other than the slight chance of an avalanche triggered by wildlife or human recreation, weather conditions would remain the dominant force dictating the location, timing, and extent of avalanche activity. There would be **no effect** on natural avalanche processes under Alternative A.

Alternative B: Construction and Modification of Snowsheds

Similar to Alternative A, the implementation of Alternative B would produce no significant change in existing natural avalanche processes. Weather would remain the predominant triggering force of snow avalanches in John F. Stevens Canyon. Topographical analysis shows that new and lengthened snowshed construction would not increase the amount of avalanche debris that flows over the railroad tracks and onto nearby US Highway 2. If a special use permit for explosive use is issued under exceptional emergency circumstances, the artificial triggering of avalanches would have an immediate short-term impact on the timing of natural avalanches in the project area. An isolated explosive use incident would have a negligible impact on natural avalanche processes in the area and there would be no long-term impacts on regular natural avalanche processes. The construction of new snowsheds and the lengthening of existing ones could potentially produce slight changes in the nature of the deposition of avalanche debris near the railroad tracks in the lower reaches of the runout zones. Snowsheds would bridge the terrace of the railroad, restoring the natural angle of debris flow that took place before the railroad was constructed. The effects of this change would be **negligible, beneficial, site-specific, and long-term** on the natural flow of avalanches within the path.

Alternative B Cumulative Effects

Past Actions: Past actions affecting natural avalanche processes in the area are railroad and snowshed construction, and fire suppression activities. The railroad and snowsheds have caused a slight change in velocity and runout patterns of natural avalanches due to the alteration of the natural terrain. In the early 1900's, widespread wildfire created hazardous avalanche conditions in the canyon that inititated snowshed construction. Fire removes vegetative anchor points on an avalanche slope on areas below treeline. Wildfire may measurably increase the frequency and magnitude of natural avalanches with removal of anchor points. Elk slide path is an example of a path where the frequency of natural avalanches increased after the 1910 fires. Once trees and vegetation regrew on the path, natural avalanches occurred very infrequently. Wildfire suppression allowed vegetative anchors to grow on avalanche prone slopes, decreasing the frequency and magnitude of natural avalanche

On-going Actions: Fire suppression in John F. Stevens Canyon would allow vegetative anchors to remain in avalanche paths and may, with further vegetation growth, decrease the frequency and magnitude of natural avalanches. Human caused wildfire may remove vegetation from avalanche paths resulting in increased frequency and magnitude of avalanches, changing the natural process.

Foreseeable Future Actions: Fire suppression is a future action that would increase anchor points on steep slopes decreasing the frequency and magnitude of natural avalanches. Natural and human caused fires have the potential to increase the frequency and magnitude of natural avalanches by removal of vegetative anchors. Human caused wildfire may remove vegetation from avalanche paths resulting in increased frequency and magnitude of avalanches, changing the natural process.

Cumulative Effects Conclusion: The construction and extension of identified snowsheds would offset the adverse impacts on natural avalanche processes created by the construction of the railroad through the avalanche paths by returning the natural slope to the runout zone. Revegetation and fire suppression would increase natural anchor points and reduce the incidence of natural avalanches. Wildfire and logging in the area would decrease the number of anchor points offsetting the benefits of revegetation and fire. The overall cumulative impact of other actions in John F. Stevens Canyon on natural avalanche processes with Alternative B is **adverse, negligible, site-specific and long-term**.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

Implementation of a 10-year use of explosives alternative would have a **major, adverse, site-specific, long-term** impact on natural avalanche processes when avalanche hazard is high. There remains the possibility that weather conditions would not reach the threshold for explosive use regularly or at all during the 10-year period. If avalanche hazard does not exist and explosive use is not employed, there would be no impact on natural avalanche processes. The use of explosives to artificially trigger avalanches would substantially affect the frequency and magnitude of avalanches in the 12 paths where explosives control would be undertaken. Each control mission is likely to produce some snow movement. Depending upon the frequency of explosives control, the frequency of avalanches would likely increase above that which would occur naturally. A more frequent artificial triggering of avalanches should produce a subsequent decrease in the magnitude of avalanches. However, it is probable that the use of explosives could produce an avalanche that is the same or exceeds the magnitude recorded during the avalanche cycles cited in Reardon and Fagre (2005).The condition of increased frequency of smaller magnitude avalanches would exist only during the period in which explosives hazard mitigation is undertaken; after 10 years natural avalanche processes are expected to return to pre-explosive use conditions.

Alternative C Cumulative Effects

Past Actions: Past actions that impact natural avalanche processes are the same as those in Alternative B.

On-going Actions: On-going Actions that impact natural avalanche processes are the same as those in Alternative B.

Foreseeable Future Actions: Future actions that impact natural avalanche processes are the same as those in Alternative B.

Cumulative Effects Conclusion: The construction of identified snowsheds after the 10-year explosive period would offset the adverse impacts on natural avalanche processes created by the construction of the railroad. Fire suppression or human caused fires would change natural anchor points and reduce or increase the incidence of natural avalanches. The overall cumulative impact of other actions in John F. Stevens Canyon on natural avalanche processes of Alternative C is **minor, adverse, site-specific, and long-term**.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Implementation of a continuous, extensive explosives triggering alternative would have **major, adverse, long-term, site-specific** effects upon natural avalanche processes in the 12 paths where explosives mitigation is undertaken. Regular artificial triggering of avalanches would substantially increase the frequency and generally reduce the magnitude of avalanches in John F. Stevens Canyon resulting in a significant impact on natural avalanche processes. Over many years this is likely to have an impact upon avalanche path structure. Disturbance of snow in the start zones would be artificially increased, while less frequent disturbance would likely occur at the toe of the runout zones. Encroachment of vegetation in the runout zones would likely increase with the one-, two-, five-, even ten-year return interval avalanches. Large magnitude, long-return interval avalanches would occur less frequently, but would still be possible. Historic avalanche path runout zones would change with explosive use causing smaller magnitude slides; however, infrequent large magnitude avalanches would likely heavily impact encroaching vegetation as the runout zone disturbance returns to or near historic limits.

Alternative D Cumulative Effects

Past Actions: Past actions are the same as those described for Alternative B.

On-going Actions: On-going actions are the same as described for Alternative B.

Foreseeable Future Actions: Future actions are the same as those described for Alternative B.

Cumulative Effects Conclusion: The construction of extensions on Shed 7 and Shed 9 would offset the adverse impact that the railroad construction had on natural avalanche runout zones in those paths. Fire suppression and human caused fire would change natural anchor points and change the frequency and magnitude of natural avalanches. Natural avalanches in logging areas or burned areas would be more frequent and larger magnitude with the removal of natural anchor points on steep slopes. Natural avalanche frequency is expected to increase with a continuous program of explosive use over the analysis area. The overall cumulative impact of other actions in John F. Stevens Canyon on natural avalanche processes in the analysis area with Alternative D is **moderate, adverse, site-specific and long-term**.

Avalanche Processes Conclusion

Natural avalanche processes would be unchanged (**no effect**) by Alternative A. Alternative B would have **negligible, beneficial, site-specific, long-term** impacts by at least partially restoring the natural flow of avalanche debris near the runout zones. Alternative C would have **major, adverse, site-specific, long-term** impacts on natural avalanche processes by increasing the frequency and decreasing the magnitude of avalanches in the canyon. Similarly, Alternative D would have significant **major, adverse, site-specific, long-term** impacts on natural avalanche processes in the project area.

While Alternatives C and D would result in major impacts on natural processes in 12 avalanche paths, this small area would constitute a very small percentage of avalanche paths within Glacier National Park and Flathead National Forest. While the natural avalanche processes of these 12 paths would be considerably altered on a continuous basis, a long- term explosive program would not impact natural avalanche processes of hundreds of other avalanche paths throughout the region. There would be no significant adverse impacts to natural avalanche processes in the project area whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents. Avalanche processes would be dramatically impacted on a local scale under Alternatives C and D. There would be no impairment to natural avalanche processes on the order of magnitude larger scale of surrounding lands managed by Glacier National Park and Flathead National Forest.

WATER RESOURCES

Methodology

The two attributes of the water resource that are vulnerable to either natural disturbance or to man-caused disturbance are water quantity and water quality. The characteristics of water quantity and water quality that could be potentially affected by the proposed actions were examined by hydrologists. Based upon public comments, similar past environmental assessments, and professional judgment the following *Effects Indicators* were used to focus the analysis and disclose relevant environmental effects of the proposed actions:

Potential water yield increases: A modified avalanche regime is expected to impact water yield. This was evaluated by examination of Pfankuch stream channel stability assessment of the resistive capacity of a stream to adjust to potential flow changes and/or increases in sediment production. This evaluation and assessment is based on professional judgment and Pfankuch stream stability ratings completed in the project area.

Potential sediment yield increases: The naturally existing avalanche regime, snowshed construction, and modified avalanche regime are expected to impact sediment yield. The potential soil erosion/sediment yield from various activities was analyzed using the WEPP erosion models. These models were developed by the U.S. Department of Agriculture and are used nationally to estimate potential soil erosion and sediment yield. The estimates of potential soil erosion/sedimentation for some of the proposed activities can be significantly reduced by use of Best Management Practices (BMP's). For example the use of sediment fences could significantly reduce the potential for any sediment yield to the streams from the snowshed construction activities.

Potential nutrient yield increases: Snowshed construction and modified avalanche regimes are expected to increase nutrient yield into the watershed. This analysis was conducted by hydrologists. Nutrient yield increases in Flathead Lake headwaters, specifically nitrogen and phosphorus, were addressed as the primary concern in the *Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana* (Montana Department of Environmental Quality, 2001). Professional evaluation of the qualitative impacts resulting from alternatives and soil cation exchange in the project area and site-specific research has been conducted for the purposes of impact evaluation.

Potential Chemical Contamination: Explosive by-products and train derailments are expected to have impacts on water quality in the project area. The chemical residue by-products from explosive charges could result in the degradation of the water quality in the snow avalanche pathways where they are used. Some of the explosive chemical residue by-product compounds are considered hazardous to humans in sufficient concentrations. A worse case scenario analysis was done for the potential runoff water concentration of the explosion residue by-products for three different sizes of snow avalanche pathways. That analysis is discussed in the Alternative C & D effects section.

Thresholds of impact are defined in Table 4-1 and are summarized here:

- ***Negligible***: Water quality would not be affected, or changes would be either non-detectable or if detected, would have effects that would be considered slight and local.
- ***Minor***: Changes in water quality would be measurable, although the changes would be small and the effects would be localized.
- ***Moderate***: Changes in water quality would be measurable but would be relatively local.
- ***Major***: Changes in water quality would be readily measurable, would have substantial consequences, and would be noticed on a regional scale.
- ***Short-term***: Effects last less than 1 year.
- ***Long-term***: Effects last more than 1 year.

Analysis Area

The analysis area for this impact topic is based on the grouping of watersheds that could experience potential effects to either water quality or quantity due to the proposed actions in the alternatives. The analysis area is displayed in Map 3-1.

WATER RESOURCES IMPACT ANALYSIS

Impacts Common to All Action Alternatives

There are **no direct or indirect effects** to the water resource from maintaining the avalanche signal wire system. There are **no direct or indirect effects** to the water resource from maintaining the Avalanche Safety Director, avalanche hazard forcasting, or the use of non-explosive stability testing. The delay of trains on the railroad and bussing of Amtrack passengers would have **no direct or indirect effects** on the water resources.

There are possible indirect effects from the existing snowsheds to the water resource. There are 5920 feet of snowsheds in the analysis area built with creosote treated timbers. Creosote, or coal tar creosote, is a by-product of the carbonization of coal (e.g. making coke and/or natural gas). Coal tar creosote is a distillation product of coal tar. Coal tar pitch is a residue of the distillation process. Both coal tar creosote and coal tar pitch are in part composed of polycyclic aromic hydrocarbons. The EPA restricted the use of coal tar creosote products to certified applications in January 1986. Since the snowsheds were built, support timbers have been explosed to rainwater and snowmelt and potentially leached some portion of the coal tar creosote into the surrounding soil, groundwater, or nearby surface waters. Leach and Weinert (1976) identified that coal tar creosote components are slowly released as oil exudation, leaching by rainwater, or volatilization into the air. The amount of chemicals that have concentrated in the soils surrounding the snowsheds or the streams is unknown. Any detectible amount of potential leachates is highly unlikely once the small streams bisected by the railroad mix with the waters of the Middle Fork of the Flathead River. The existing snowsheds would have an **adverse, site-specific, long-term, negligible** impact on water quality.

The potential for an avalanche caused train derailment could cause impacts under each alternative. The potential risk is different for each alternative with Alterantive A having the highest risk if timely delays were not instituted during periods of high avalanche hazard. Alternative B and C would have the lowest risk of avalanche caused derailment after the recommended snowsheds are constructed. Alternative C and D risk of avalanche caused derailments woud depend on the Avalanche Safety Director's assessment of risk and recommendation to delay train traffic for explosive avalanche hazard mitigation.

Several avalanche-caused derailments have occurred in the recent past within the John F. Stevens Canyon and natural conditions would not change under this alternative. BNSF transports hazardous materials on some of the freight/tank cars and there is a risk that a freight/tank car carrying hazardous materials could be derailed by an avalanche in a manner that would expose a stream or the river to hazardous materials contamination. In Montana during the years 1999-2004, there were four railroad derailments that deposited hazardous material in a water body. Nationwide beteween 1991 and 2003 approximately 6% of the hazardous materials incidents were assoicated with railroad transport of those materials (Montana Department of Environmental Quality, 2004). Between 7/1/2004 and 6/30/2005 there were 50,506 rail cars (partically or totally loaded) with materials classified as hazardous that were transported over this section of railroad line. The majority of these materials are classified as Mixed Hazmat/Freight All Kinds. Petroleum based products such as diesel, LPG, or asphalt comprise a much smaller percent of hazdous freight. According to BNSF officials, very few cars containing chlorine or radioactive materials are transported on this route (BNSF August 2005 memo).

In past years, approximately 12,626 rail cars containing hazardous materials passed through the canyon during the four months of January thru April. Many of the chemicals that are transported could effect the aquatic ecosystem at the spill site as well as downstream, which potentially could include portions of the Wild and Scenic River section of the Middle Fork of the Flathead River. It is impossible to accurately quantify the risk to the water resource from an avalanche caused train derailment/hazardous material spill because of many variables including:

the type and amount of the hazardous substance spilled, the amount of hazardous material transported into the stream system, and the containment and cleanup efforts. The effects of a derailment with a hazardous materials spill that enters a stream or the river would range from an **adverse, negligible to major local to regional, short-term to long-term** impact on water resources.

Alternative A: No Action

There are **no impacts** from Alternative A on water resources except those discussed above under the impacts common to all section.

Alternative B: Construction and Modification of Snowsheds

Doppler Radar, Geophones, and/or Avalanche Sentry System: Because such very small areas of ground are disturbed during the installation of this equipment, and the locations are a significant distance from an active stream channel, there would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment.

Weather Station and Snow Depth Sensor: Because such very small areas of ground are disturbed during the installation of this equipment, and the locations are a significant distance from an active stream channel, there would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment.

Snowshed Construction: The impacts on water quality from existing snowsheds would be the same as described in the No Action alternative. There would be some short–term potential for soil erosion/sediment yield from the construction of new steel framed and concrete roofed snowsheds. The WEPP soil erosion model was used to estimate the potential soil erosion and sediment entering a stream from the snowshed foundation construction. A short distance to a stream channel (25 feet) and a limited buffer width distance (25 feet) were assumed to produce the estimate. After construction, it was estimated there would be approximately 6 feet of disturbed, exposed soil outside each side of the new snowsheds (11 sites). The estimated soil erosion is 33.3 pounds per year and 1.3 pounds per year of potential sediment yield, for each 100 feet of foundation construction. For the proposed snowshed construction there is estimated to be 124 pounds per year of potential sediment yield entering the 11 stream crossings for the first two years after construction.

In addition to the foundation excavation there is a need to insure proper drainage of any melt-water from snow accumulations on the upstream side of the snowsheds. A small drainage basin and a length of buried culvert on each side railroad fill would be installed to aid in proper drainage at these sites. The WEPP model was used to estimate potential soil erosion and sediment yield. The disturbed area is approximately .07 of an acre at each new snowshed construction site. This would yield an estimated 312 pounds per year soil erosion or approximately 240 pounds per year sediment entering the streams. There are four sites (stream crossings) this type of drainage structure would be installed. This would have a combined total increased sediment yield of approximately 960 pounds per year for the first two years after construction.

The excavated sites would be grass seeded and should have vegetation recovery in 2-3 years, which reduces the soil erosion potential to natural background levels. Additional Best Management Practices (BMP's) to reduce soil erosion (e.g. sediment fences, erosion matting) could significantly reduce the potential for any sediment yield to reach the streams from this activity. This short-term potential sediment increase from the snowshed construction would be within the range of natural variability for the small headwater streams in this area.

The increase in potential sediment delivery due to construction also increases the potential for a very small increase in nutrients supplied to individual streams. The amount of nutrient increase would be within the range of natural variability for the small headwater streams and would be immeasurable when the small streams combine in the waters of the Middle Fork.

Emergency Explosive Use

If an isolated incident of explosive use were permitted for emergency response purposes, the use of cast primer charges in very low numbers would be expected. There would be no impact on water quantity with this action. Small amounts of residue described for explosive use under Alternative C would dilute quickly over a very large area. There would be less residue than is described under Alternative C for explosive avalanche hazard and the amount would be less than the EPA standard of 5 ppb for drinking water. This action would result in an adverse, negligible, short-term, site-specific impact on water resources.

Under Alternative B the impacts to water quality would be **adverse, localized, short-term, and negligible**. There are **no impacts to water quantity** associated with any of the activities proposed under Alternative B.

Alternative B Cumulative Effects

Past Actions: The installation of approximately 4.4 miles of natural gas pipeline would have had very minor, short-term soil erosion/sedimentation potential. Various herbicides used for weed control would not have had a measurable impact on water quality if label instructions were followed. Fire management activities may have had a minor, short-term impact introducing sediment to the watershed if firelines are constructed close to water sources. Fire suppression chemicals if used in the area would have had a minor, short-term impact on water quality.

The construction of the railroad and the highway impacted water resources in the canyon. There are 4.56 miles of railroad located in the analysis area. The railroad construction would have included the clearing of timber from the right-of-way, construction of the road sub-grade, construction of stream crossings, laying of ties and rails, and ballasting of the roadbed. Several years later the construction of the existing snowsheds would have some small effect. The primary effect on the water resource would have been increased sediment yield (and attached nutrients) caused by the exposed soil surface during the construction phase of these projects. The increased sediment yield would have decreased as the ballasting process and the revegetation of the cut and fill slopes occurred. The sediment yield due to the railroad construction has long ago been reduced to a very small background amount. The estimated back ground sediment from the railroad comes from stream crossing areas where water runs off of cut-slopes/fill-slopes is funneled into a stream channel. The estimated sediment input from 12 stream crossings (both perennial and ephemeral streams) is 2,568 pound per year, using the WEPP soil erosion model. There are 4.44 miles of existing highway within the analysis areas. Most of this road construction occurred in the 1940's and 1950's. US Highway 2 was completed in 1953 with a paved surface. Like the railroad, once construction was completed and the revegetation of the cut and fill slopes occurred, only small residual effects to the watershed occur from road construction, primarily sediment yield due to concentrated ditch-water flow. The closure of US Highway 2 during severe winter weather and high avalanche danger could potentially have a beneficial effect, by reducing the risk of highway accidents that potentially could involve hazardous substances. The effect of this action is **beneficial, local, short-term, negligible to moderate** impact.

Present Actions: Highway and railroad maintenance and operations impacts on water quality are on-going. Weed control activities have the potential to contaminate water quality if used incorrectly.

Foreseeable Future Actions: US Highway 2 and the BNSF railroad are primary transportation facilities for all types of materials and machinery across the continental divide. These materials include benign as well as hazardous materials. The effects of a hazardous material spill that enters a stream or the river would range from an **adverse, local to regional, short-term to long-term, negligible to major** impact on water resources.

The estimated back ground sediment from the highway comes from stream crossing areas where water runs off of cut-slopes and fill-slopes and is funneled into stream channels. The estimated sediment input from 12 stream crossings is 16,872 pound per year, using the WEPP soil erosion model. The amount of potential sediment from the highway is greater due to a larger runoff area. These construction projects would have an **adverse, localized, long-term, moderate** impact to the water quality in the analysis area.

There are past, on-going and foreseeable actions of routine road maintenance on US Highway 2 in the project area. This work includes snow plowing, sanding, spot pavement repair, mowing, weed control, and other miscellaneous road maintenance activities. There are very minor impacts to water quality from the sediment input due to the melting of ice/snow close to stream channels that have road sanding materials incorporated in it. This is estimated to be approximately 1000 pound per year. This additional sediment increase can not be discerned from the natural background variation in sediment yield of the streams in the project area. This is an **adverse, localized, long-term, negligible** impact to the water quality.

The majority of typical railroad maintenance activities should have no effects on the water resources. The removal of avalanche debris, if it is in close proximity to a stream could have some **adverse, site-specific, short-term, negligible to minor** impacts to water quality due to sediment input into the stream system.

Weed control activities have the potential to contaminate water quality if used incorrectly.

Cumulative Effects Conclusion: There are several on-going activities that contribute to minor, adverse, long-term, localized impacts of water resources. Construction of snowsheds would have **a short-term, adverse, minor, site-specific** impact introducing sediment and possibly chemicals into the watershed if silt fencing or other mitigation is not used. The alternative action would not cause a measurable increase in water yield, sediment yield, and/or nutrient levels that is outside the measured natural range of variation for the analysis area. These interpretations are based upon past monitoring reports, literature, and professional judgment. Water resources are expected to return to pre-construction conditions after construction is finished. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed, the cumulative impact on water resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. Once snowsheds are constructed, the overall cumulative adverse effect on water resources is expected to lessen with the protection of trains from avalanche caused derailments and spills. There would be no cumulative adverse impact on water resources once snowsheds are built.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

Doppler Radar, Geophones, and/or Avalanche Sentry System: Because such very small areas of ground are disturbed during the installation of this equipment, and the locations are a significant distance from an active stream channel, there would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment.

Weather Station MP-189.8 and Snow Depth Sensor: Because such very small areas of ground are disturbed during the installation of this equipment, and the locations are a significant distance from an active stream channel, there would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment.

Snowshed Construction: The impacts on water quality from existing snowsheds would be the same as described in the No Action alternative. There would be some short–term potential for soil erosion/sediment yield from the construction of new steel framed and concrete roofed snowsheds the same as discussed for Alternative B, if the total length of snowshed construction were to occur. For the proposed snowshed construction the estimated sediment yield increase is 124 pounds per year from foundation construction and 960 pounds per year from drainage structure construction. This sediment yield would be for the first two years after construction. This short-term potential sediment increase from the snowshed construction would be within the range of natural variability for the small headwater streams in this area.

The increase in potential sediment delivery due to construction also increases the potential for a very small increase in nutrients supplied to individual streams. The amount of nutrient increase would be within the range of natural variability for the small headwater streams and would be immeasurable when the small streams combine in the waters of the Middle Fork.

Under Alternative C the impacts to water quality from snowshed construction would be **adverse, localized, short-term, and negligible**.

Explosive Avalanche Hazard Reduction: The goal of the use of explosive charges to mitigate avalanche hazard would be the release of avalanches in a timely manner to reduce unpredictable avalanches and increase the frequency of smaller magnitude avalanches. The smaller magnitude avalanches triggered with explosives would potentially decrease sediment production normally associated with significant vegetation removal and exposure of bare ground when a major snow avalanche occurs in steep mountain-slope stream bottoms. Under natural conditions snow avalanches release when the stress from the weight of the snowpack exceeds the internal strength of the snowpack. Typically when an avalanche is triggered by explosives, an avalanche occurs prior to the maximum amount of snow loading that a slope can maintain. Therefore, the human-caused avalanches tend to be smaller in snow volume than a natural avalanche. Smaller magnitude avalanches result in reduced potential for vegetation removal and the bare ground exposure. This in turn reduces the potential for soil erosion and sediment yield to stream channels. This is especially true for wet snow avalanches with heavy, dense, wet snow that can cause significant erosion in stream bottoms. Therefore, there is reduced potential for sediment production and for the associated nutrient yield with explosive use if avalanches are triggered more frequently than naturally occur. Naturally occurring avalanches and the natural processes of valley building contribute to natural sedimentation levels in the project area. Natural avalanche processes result in valley building processes and a natural sedimentation rate. This sedimentation rate would not differ appreciably from artificially triggered avalanche processes. The impact to (physical) water quality from the proposed use of explosives charged in Alternative C is **beneficial, localized, short-term, and minor**.

The proposed Alternative C would allow for the use of several different methods of avalanche triggering using various explosive devices. The possible explosive delivery system/explosive charge include: 1) helicopter or human delivery of hand charges (cast primer); 2) Avalauncher pneumatic gun delivery (cast booster); 3) Blaster boxes delivery of (cast booster); and 4) Avalhex tower system delivery of (hydrogen). The cast primer and cast booster charges are a combination of the explosives TNT and either RDX, PETN, or HMX (see table below for chemical name and composition). Typically the TNT represents 30 to 80% of the cast primer/booster charge, with 20 to 70% of the charge being RDX, HMX or PETN.

The major detonation components of high explosives are carbon dioxide (CO_2), carbon monoxide (CO), water (H_2O), and nitrogen (N_2). There are several minor explosive by-products that have commonly been detected from TNT- based explosives used for avalanche control. The US Environmental Protection Agency (EPA) has defined health advisories for some of these chemicals or the EPA has defined some as probable human carcinogens (EPA health advisory of an estimated cancer risk of 1 in 10,000). See Table 4-3 for chemical makeup of the various explosives, the most common explosive by-products, and which of those chemicals have health advisories from EPA.

Table 4-3. A list of the USEPA advisories for explosive chemicals and by-products proposed for use in Glacier National Park.

Explosive Constituents	**Listed EPA Health Advisories and/or Probable Human Carcinogens**
2,4,6-Trinitrotoluene (TNT)	Listed Advisory
1,3,5-Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	
Pentaerythritol Tetranitrate (PETN)	
1,3,5,7-Hexahydro-1,3,5,7-Trinitro-1,3,5,7-Tettrazocine (HMX)	
Additional Explosive By-Products	
1,3,5-Trinitrobenzene	
1,3-Dinitrobenzene	Listed Advisory
2,4-Dinitrotoluene	Listed Advisory / Probable Carcinogen
2,6-Dinitrotoluene	Listed Advisory / Probable Carcinogen
2-Amino-4,6-Dinitrotoluene	
4-Amino-2,6-Dinitrotoluene	

Chemical residue/by-products from explosive charges could possibly result in the degradation of the water quality in the snow avalanche pathways where they are used. The 2003 U.S. Geological Survey report *Explosive-Residue Compounds Resulting from Snow Avalanche Control in the Wasatch Mountains of Utah*, 2003, assessed explosives residues in areas of extensive explosive use for avalanche control. The residue/byproduct found in the highest concentration in the snow following the explosion of military munitions typically is RDX (Table 4-3), and for the other explosives (e.g. hand charges and Avalauncher charge) it is 2, 4-Dinitrotoluene (U.S. Army Corps of Engineers – 2000, and U.S.G.S. - 2003). The highest concentration of 2, 4-Dinitrotoluene the USGS measured was 3.7 micrograms/liter in the soot of an explosion crater.

The EPA health advisory drinking water threshold is 5 micrograms/liter for 2, 4-Dinitrotoluene. The measured level of 2, 4, 6-Trinitrotoluene in the soot of an explosion crater was one thousand times less than the cancer risk threshold.

The most abundant chemical found repeatedly in the area of explosive avalanche mitigation was 2, 4-Dinitrotoluene. For that reason it is used herein as an indicator chemical for this effects analysis. The USGS maximum measured concentration of this chemical was 3.7 micrograms/liter in the soot of an explosion crater; the concentrations of 2, 4-Dinitrotoluene would be substantially lower once mixing occurs during the melting of the snowpack. The USGS report stated, "Overall, substantially lower concentrations of explosive residue compounds may be expected in snowmelt, resulting from mixing with meltwater derived from snow that is not associated with Avalanche Hazard Mitigation operations" (USGS 2003). Refer to the discussion in Alternative D and Table 4-4 for the results of an analysis of potential RDX concentration in snow meltwater runoff in three project watersheds. The residual concentrations of 2,4-Dinitrotoluene would be expected to be less than the reported RDX concentrations, because the weight of the hand and Avalauncher charges are approximately half of the 105 mm howitzer charge that was assessed in the study. The weight of a blaster box charge is slightly more than the 105 mm howitzer charge, but there are fewer opportunities for blaster box installations. Therefore, based upon the number of proposed explosive charges per year (hand, Avalauncher & blaster box) the estimated potential maximum residual 2,4-Dinitrotoluene in meltwater runoff is expected to be less than 5 parts per billion, a factor of 1000 less than the EPA drinking water threshold.

The USGS study in the Wasatch Mountains also analyzed surface soil and lake-bottom sediments from two lakes and the surrounding hillsides in an area where hundreds of pounds of 105 mm howitzer explosive charges have been used yearly for several decades of avalanche control. The chemical analysis resulted in the detection of three explosive-residue compounds in the surface soil samples, but nothing was detected in the lake-bottom sediment samples. Based upon this study the use of explosive charges for 10 years as proposed under Alternative C would potentially result in explosive residues/by-products in the soil of the treated hillsides. However, explosive residue/by-products would not be expected to be deposited in a detectable amount in stream or river channel materials. The impact to water quality from the proposed use of explosives charged (hand charges, Avalauncher, Blaster Boxes) in Alternative C is **adverse, localized, long-term, and negligible to minor**. There would be **no direct or indirect effect** to the chemical water quality with the use of the Avalhex System because water is the residue from the hydrogen and oxygen explosion.

The goal of the use of explosive charges is to release of avalanches in a timely manner to reduce unpredictable, large-magnitude avalanches and increase the frequency of smaller magnitude avalanches. By preemptively triggering the snow avalanche releases, more snow could potentially accumulate in the valley bottoms than would have been deposited by the natural snow avalanche regime. Increased snow in the lower elevation valley bottoms would potentially slightly increase the peak stream flows. This is due to the typical situation of more snow melt occurring at lower elevations a warm weather event. The increased stream flow due to this scenario would be expected to be very minor, but there is some potential change from the existing situation due to the proposed avalanche mitigation process. The impact to water quantity due to Alternative C would be **adverse, localized, short-term, and negligible to minor**.

The installation of each blaster box or Avalhex-type system would require the disturbance of some soil above the starting zones during the construction of a foundation. If the foundations are constructed at least 150 feet away from a perennial stream than the estimated annual soil erosion, using the WEPP soil erosion model is 12.8 pounds per year, and the potential sediment yield is 0.4 pounds per year for each site. There are potential twenty three sites depending on the combination of tools that are to be installed. This gives an approximated sediment yield of less than 10 pounds per year (until sites are revegetated) for a maximum of twenty three firing sites. BMP's such as silt fencing or other sediment reduction techniques and revegetation should be used during the construction process if the foundation pads were near to a stream channel. Based upon the best available information there is **no direct or indirect** effect on water quality from the potential foundation pad construction proposed under Alterative C.

Alternative C Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: The present actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: The use of explosives to reduce avalanche hazard could slightly reduce the natural sediment yield and associated nutrient yield that comes from natural snow avalanches. The potential concentration levels of explosive residue/by-products in the melt-water runoff should be very low, significantly less than any current drinking water standard. The use of explosive avalanche mitigation has the potential to very slightly increase the peak stream flow during a warm weather and rain event. The peak flow increases would be due to the increased concentration of snow volumes at lower elevations within each watershed where the avalanche mitigation occured. The rate of snowmelt and resulting runoff is increased at lower elevations due to higher temperatures. There would be some short–term potential for additional soil erosion/sediment yield/nutrient from the construction of the concrete snowshd foundations, snowshed drainage, and concrete foundations for blaster boxes or Avalhex sytems if silt fencing or other mitigation is not used. However, the potential sediment increase would not be discernible from the natural background variation for the sediment yield from other activities in the smaller tributary streams and would not be measurable in the waters of the Middle Fork. Cumulatively these actions would have **no effect to a negligible, adverse, short-term, site-specific** increase to water yield, sediment yield, and/or nutrient levels, that is outside the measured natural range of variation for the analysis area. Water resources are expected to return to pre-construction conditions after construction is finished. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed, the cumulative impact on water resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. Once snowsheds are constructed, the overall cumulative adverse effect on water resources is expected to lessen with the protection of trains from avalanche caused derailments and spills. There would be no cumulative adverse impact on aquatic resources once snowsheds are built.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Doppler Radar, Geophones, and/or Avalanche Sentry System: There would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment because such very small areas of ground are disturbed during the installation of this equipment and the locations are a significant distance from an active stream channel.

Weather Station MP-189.8 and Snow Depth Sensor: There would be **no direct or indirect impact on water quality** associated with the installation or operation of this equipment because such very small areas of ground are disturbed during the installation of this equipment and the locations are a significant distance from an active stream channel.

Snowshed Construction: The impacts on water quality from existing snowsheds would be the same as described in the No Action alternative. Under Alternative D there is 250 feet of new snowshed construction proposed. The estimated sediment yield from this activity is approximately 7 pounds for the first two years following construction. Because of the very small amount of potential sedimentation, immeasurable in a stream, there would be **no direct or indirect effects** to water quality (sediment yield and nutrient yield) from snowshed construction under Alternative D.

Explosive Avalanche Hazard Reduction: The use of explosive charges to trigger snow avalanches would yield chemical residue/by-product compounds. The discussion in Alternative C discussing the potential use of hand charges, Avalhex systems, blaster boxes, and Avalauncher charges is applicable to Alternative D. Under Alternative D, military artillery would also be used for avalanche hazard mitigation. The greatest potential impact to water resources from explosives use would be from the use of a 105 howitzer munitions. The primary chemical compounds in the main charge of an artillery mortar round are a combination of RDX (1, 3, 5-hexahydro-1,3,5-trinitro-1,3,5-triazine) and TNT (2,4,6-trinitrotoluene). The Army Corps of Engineers measured the amounts of explosion residues in snow from mortar round use, in tests at Camp Ethan Allen and Fort Drum (Jenkins, 2000).

An analysis was done to examine the potential chemical loading and dissolution concentration of the RDX in three different project area avalanche path watersheds (of increasing size), to assess the worst case scenario for residue/by-product compound transport into the adjacent stream system. The Army Corps of Engineers research revealed the ratio of TNT residue is only 3% of the amount of RDX residue and is less of a health concern; therefore, RDX was used as maximum residue indicator. The smallest avalanche path analyzed was Jakes which is 5.9 acres in size, and has a weighted annual precipitation of approximately 35 inches. The Shed 5 avalanche path is the next largest area of 35.4 acres in size, with a weighted annual precipitation of approximately 41.5 inches. The largest avalanche path is Shed 10 which is 138.4 acres in size, with a weighted annual precipitation of 46.5 inches.

The estimated number of explosive charges that may be detonated in each avalanche path and the maximum number of target zones and a range of potential "missions" per year are listed in Chapter 2 under Alternative D and in Appendix D. The number of targets was multiplied by the maximum missions to yield the maximum number of explosive charges. For this worst case analysis it was assumed that all of the explosive charges used for mitigation would be a 105 mm howitzer round and none of the smaller types of explosive charges would be used. This was done to assess the maximum chemical residue/by-product yield potential of artillery use. The number of explosive charges per year is: Jakes – 9 charges, Shed 5 – 12 charges, and Shed 10 – 33 charges. Based upon field research the maximum concentration yield measured (micrograms/m^2) of RDX from a single explosion of a mortar round was used as the yield concentration (U.S. Army Corps of Engineers 2000). The RDX yield from the test results of a mortar round charge were portioned base upon weight to the RDX yield of a 105mm round charge. The maximum number of explosive charges per year for the three avalanche pathways was then multiplied by the maximum yield per charge to get an estimate of the yield of RDX in each avalanche pathway. No absorption of the explosive residue by the soil is assumed for this analysis, rather all the potential residue is assumed to be contained within the snowmelt runoff of the avalanche path. Explosive chemical by-products are assumed to release evenly through time during the snowmelt/rainfall runoff events. The weight of the RDX residue was compared to the weight of the potential annual precipitation runoff. The result is an estimate of the potential concentration of the explosive residue in the runoff waters, for each of the three avalanche pathways (Table 4-4).

Table 4-4. Estimate of RDX Residue/By-Product Concentration in the Runoff of Three Avalanche Pathways.

Avalanche Pathway	**Jakes**	**Shed 5**	**Shed 10**
Watershed Size (acres)	5.9	35.4	138.4
Weighted Annual Precipitation (inches)	35.0	41.5	46.5
Maximum Number of Explosive Charges	9	12	33
Potential Concentration of Explosive By-Product RDX in Runoff Water (parts per billion)	4	1	.4

The potential RDX residue levels in the runoff waters are very low. Based upon the best available information, this alternative would not impact water quality in the avalanche paths proposed for explosive avalanche hazard reduction. The potential use of hand charges, blaster-boxes, Avalhex, or Avalauncher techniques at any of the sites would reduce the amount of military ammunition used in each path and the RDX residue input into the stream waters. The long-term use of explosives would result in a continuous input of explosive by-products into the watershed which could over time accumulate into more significant concentrations in either the soil or the runoff waters. The impact to (chemical) water quality from the proposed use of explosives charged in Alternative D is **adverse, localized, long-term, and negligible to minor** impact on water quality.

As discussed in Alternative C, preemptively triggering the snow avalanche releases would result in more snow potentially accumulating in the valley bottoms than would have been deposited by the natural snow avalanche regime. Increased snow in the lower elevation valley bottoms could potentially slightly increase the peak stream flows during a warm weather event. The increased stream flow due to this scenario would be expected to be very minor, but there is some potential change from the existing situation due to the proposed avalanche mitigation process. The impact to water quantity due to Alternative D would be **adverse, localized, short-term, and negligible to minor**.

The use of a 105mm howitzer would require the construction of 4 firing pads and approximately 700 feet of access road to the firing pads along US Highway 2 to allow for the safe/efficient firing of the howitzer. If the artillery pads are constructed at least 150 feet away from a perennial stream than the estimated annual soil erosion, using the WEPP soil erosion model is 831 pounds per year, and the potential sediment yield is 41 pounds per year for each site. BMP's such as silt fencing or other sediment reduction techniques and revegetation should be used during the construction process if the pads were near to a stream channel. Based upon the best available information there is **no direct or indirect** effect on water quality from the artillery pads and access roads proposed under Alterative D.

The installation of each blaster box, Avalhex system, or Avalauncher would require the disturbance of some soil during the construction of a foundation. If the foundations are constructed at least 150 feet away from a perennial stream than the estimated annual soil erosion, using the WEPP soil erosion model is 12.8 pounds per year, and the potential sediment yield is 0.4 pounds per year for each site. There are potential twenty three sites depending on the combination of tools that are to be installed. This gives an approximated sediment yield of less than 10 pounds per year (until sites are revegetated) for a maximum of twenty three firing sites. BMP's such as silt fencing or other sediment reduction techniques and revegetation should be used during the construction process if the foundation pads were near to a stream channel. Based upon the best available information there is **no direct or indirect** effect on water quality from the potential foundation pad construction proposed under Alterative D.

Alternative D Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: The on-going actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: The long-term use of explosives to reduce avalanche hazard could slightly reduce the natural sediment yield and associated nutrient yield that comes from natural snow avalanches. The potential concentration levels of explosive residue/by-products in the melt-water runoff should be very low, significantly less than any current drinking water standard. The use of explosive avalanche mitigation has the potential to very slightly increase the peak stream flow during a warm weather and rain event. The peak flow increases would be due to the increased concentration of snow volumes at lower elevations within each watershed where the avalanche mitigation occured. The rate of snowmelt and resulting runoff is increased at lower elevations due to higher temperatures. There would be some short–term potential for additional soil erosion/sediment yield/nutrient from the extension of two concrete snowshd foundations, snowshed drainage, and concrete foundations for blaster boxes or Avalhex sytems if silt fencing or other mitigation is not used. However, the potential sediment increase would not be discernable from the natural background variation for the sediment yield from other activities in the smaller tributary streams and would not be measurable in the waters of the Middle Fork. Cumulatively these actions would have **no effect to a negligible, adverse, long-term, site-specific** increase to water yield, sediment yield, and/or nutrient levels, that is outside the measured natural range of variation for the analysis area. Water resources are expected to return to pre-construction conditions after extension of two snowsheds are completed. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed or explosive use is employed, the cumulative impact on water resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. There would be no cumulative adverse impact on water resources under this alternative.

Water Resources Conclusion

The water yield would be within the natural range of variability for all the analysis watersheds. There are no significant water quantity increases or decreases that would be caused by either the no-action or the action alternatives. Explosive use under Alternatives C and D has the potential to very slightly increase the peak flow during a warm weather or rain event. The peak flow increases would be due to the potential concentration of increased snow volumes at lower elevations due to the active avalanche mitigation (explosives). Under alternative D, the impacts would continue until the program is no longer in use.

The sediment yield is within the natural range of variability for all the analysis watersheds. Under Alternatives B, C, and D there would be some short–term (1 -2 years) potential for additional soil erosion/sediment yield from the construction of the concrete foundations associated with the new snowshed construction and/or avalanche triggering devices. However, the potential sediment increase is so small that it would not be discernable from the natural background variation for the sediment yield in the smaller tributary streams; and especially not once it is mixed with the waters of the Middle Fork. The more frequent artificial explosive triggering of snow avalanches under Alternatives C and D could reduce the sediment yield (from riparian zones), compared to less frequent larger natural snow avalanches. Under alternative D, the impacts would continue until the program is no longer in use.

The nutrient yield is within its natural range of variability for all the analysis watersheds. Under Alternatives B, C and D there would be some short–term potential for soil erosion/sediment to very slightly increase the nutrient yield. However, the potential sediment increase is so small that it would not be discernible from the natural background variation for the nutrient yield in the smaller tributary streams; and especially not once it is mixed with the waters of the Middle Fork. The more frequent man-caused explosive triggering of snow avalanches under Alternative C and D could reduce the nutrient yield (from eroded sediments in riparian zones), compared to less frequent larger natural snow avalanches. Under alternative D, the impacts would continue until the program is no longer in use.

The potential for chemical contamination of the analysis area watershed from explosive residue/by-products is extremely low. This is due to the small amount of explosive materials potentially used, and the significant dissolution from the unaffected snowpack. The risk to the water resource from a snow avalanche caused - train derailment/hazardous material spill scenario is unknown, but could be very significant. The risk of a snow avalanche causing a derailment is greatest under Alternative A if no additional delays or hazard identification is employed. Under alternative D, the impacts would continue until the program is no longer in use.

Alternative A would have a **negligible, adverse, long-term, site-specific** impact on water quality. Alternative B would have a **minor, adverse, long-term, site-specific** impact on water resources. Alternative C would have a **minor, adverse, long-term, site-specific** impact on water resources. Alternative D would have a **minor, adverse, long-term, site-specific** impact on water resources. A train derailment and spill of hazardous materials depending on the substance, cleanup operations, and containment could cause a range of impacts on water resources that would be **negligible to major, adverse, short-term to long-term, and localized to regional**. The potential for a derailment would be greatest under Alternative A if timely delays are not instituted during periods of high avalanche activity. The potential for avalanche caused derailments under Alternatives C and B would be considerably reduced when snowsheds are completed. The long-term explosive program under Alternative D would reduce the potential for avalanche caused derailments only if the program were instituted in a timely manner immediately upon avalanch hazard identification.

There would be no significant adverse impacts to water resources whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents.

Consequently, there would be no impairment of water resources as a result of the implementation of any of the alternatives.

AQUATIC RESOURCES

Methodology

Current conditions of the aquatic resources in the Flathead River system were assessed through analysis by the US Fish and Wildlife Service, Montana Department of Fish, Wildlife and Parks, US Forest Service, and Glacier National Park. Informal consultation between GNP, FNF, and USFWS biologists has also taken place. Knowledge of the ecological relationships and process associated with the Flathead aquatic system is well established.

This analysis describes impacts on the aquatic system in terms of changes to habitat quality. The response of the aquatic system to further change, particularly Bear Creek because of past human degradation, would be quite rapid. Tolerance levels would also vary by time of year and flow regime. This analysis assesses potential impacts from controlled vs. uncontrolled avalanche activity and potential impacts from train derailments.

Thresholds of impact for aquatic species are defined in Table 4-1 and are summarized here:

- ***Negligible***: Aquatic species would not be affected or the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population.
- ***Minor***: Effects to individual aquatic species are possible, although the effects would be localized, and would be of little consequence to the species' population.
- ***Moderate***: Effects to individual aquatic species are likely, and a sizeable segment of the species' local population could be affected.
- ***Major***: Effects to aquatic species would have significant consequences to species populations in the region.
- ***Short-term***: After implementation, would recover in less than 1 year.
- ***Long-term***: After implementation, would take more than 1 year to recover or effects would be permanent.

Analysis Area

The analysis area for aquatic species includes Bear Creek (beginning at US Highway 2 reference post 191) downstream to the Middle Fork of the Flathead River and ultimately to Flathead Lake. The analysis area is displayed in Figure 3-1.

IMPACT ANALYSIS- AQUATIC RESOURCES

Impacts Common to All Action Alternatives

Avalanche activity can result in short-term impacts on the aquatic environment due to increased sediments, potential erosion, and short-term damming. Direct impacts from an avalanche on the aquatic environment range from negligible to moderate depending on the size and location of the avalanche. These impacts could be adverse by changing water quality or beneficial by creating new types of habitat not previously available (e.g. new spawning habitat). Avalanches naturally reach waterways when their runout zones are insufficient to stop the avalanche.

Avalanche activity would occur under each of the alternatives; however, the magnitude and frequency could change.

Avalanche caused train derailments could contaminate Bear Creek which could result in the direct mortality of fish and invertebrates. The pollutants could potentially reach the Middle Fork of the Flathead River depending on the size of the spill. The physical nature of the hazardous material (liquid, solid, gas) and its solubility in water would greatly affect the impacts on aquatic ecosystems. A small spill reaching Bear Creek may kill organisms in the immediate vicinity but quickly become diluted so as to have little or no impact beyond the spill site. However, a large spill could travel down the Middle Fork of the Flathead River and eventually empty into Flathead Lake. The impacts of a spill would be the same under each alternative but the likelihood of an avalanche-caused derailment and spill would change.

Forecasting equipment including weather stations, Doppler radar, geophones, and a snow depth sensor installed on Forest and Park lands would have no impact on aquatic ecosystems.

Alternative A: No Action

Natural avalanches have a direct impact on aquatic species. Damming of waterways by avalanche debris can disrupt movement in the waterway and sediment releases can change the physical conditions available to aquatic species. However, impacts from natural avalanches would be considered neither beneficial nor adverse, but merely a naturally caused environmental change.

The probability of an avalanche striking a train would not change from the current status and the potential impacts to the aquatic environment would not change. The overall impact to aquatic species from the No Action Alternative would be **no change from current conditions**.

Alternative B: Construction and Modification of Snowsheds

If proper measures are taken to reduce erosion and to prevent chemical spills at the construction sites, there should be no impact on aquatic species during construction of snowsheds. Snowsheds should not alter the frequency or severity of avalanches compared to the No Action Alternative. Snowsheds may actually restore a more natural, historical flow of avalanches down the slope, since they would cover the unnatural bench made by the railroad tracks. Consequently, in some locations, a snowshed may actually increase the amount of snow and debris reaching the waterway. Impacts of restoring this flow would include minor increases in damming and levels of sediment release into the waterway. The use of a small amount of cast primer explosives during an emergency where human life or resources are at risk and all other options have been exercised would have no impact on aquatic species as the dilution of small amounts of explosive chemicals over a large area would have a negligible impact on water quality.

The probability of an avalanche striking a train would be decreased with the addition of snowsheds. The overall impact to aquatic species from Alternative B would be **minor, long-term, localized, and beneficial** because of the restoration of the natural avalanche flow and decreased likelihood of a spill.

Alternative B Cumulative Effects

Past Actions: Aquatic resources are directly and indirectly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic

resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Present Actions: Aquatic resources are directly impacted by water quality and water quantity. The present action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects

Foreseeable Future Actions: Aquatic resources are directly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Cumulative Effects Conclusion: Activities that impact water would impact aquatic species and their habitat. There are several activities occuring that are described in the that contribute to **minor, adverse, long-term, localized** impacts of water resources. Construction of snowsheds would introduce an unnatural source of sediment and possibly chemicals into the watershed and have **a short-term, adverse, minor, site-specific** impact on aquatic resources if silt fencing or other mitigation is not used. The alternative action would not cause a measurable increase in water yield, sediment yield, and/or nutrient levels that is outside the measured natural range of variation for the analysis area. This minor impact would be temporary and would not continue to contribute to cumulative impacts on water quality after snowsheds are constructed. Aquatic resources are expected to return to pre-construction conditions after construction is finished. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed, the cumulative impact on aquatic resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. Once snowsheds are constructed, the overall cumulative adverse effect on aquatic resources is expected to lessen with the protection of trains from avalanche caused derailments and spills. There would be no cumulative adverse impact on aquatic resources once snowsheds are built.

Alternative C: Short-term Explosive Use for Avalanche Hazard Reduction

Avalanche frequency could be slightly increased from this alternative, and these effects could be beneficial or adverse (see Common to All Alternatives). Residues from explosives are not expected to reach the aquatic environment in a measurable amount (see Water Resources section above). The probability of an avalanche striking a train would be reduced but not as effectively as in Alternative B until snowsheds are completed. The overall effect on aquatic species from this alternative would be **negligible, long-term, site-specific, and beneficial**.

Alternative C Cumulative Effects

Past Actions: Aquatic resources are directly and indirectly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Present Actions: Aquatic resources are directly impacted by water quality and water quantity. The present action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects

Foreseeable Future Actions: Aquatic resources are directly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic

resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Cumulative Effects Conclusion: The use of explosives to reduce avalanche hazard could slightly reduce the natural sediment yield and associated nutrient yield that comes from natural snow avalanches. The potential concentration levels of explosive residue/by-products in the melt-water runoff should be very low, significantly less than any current drinking water standard. The use of explosive avalanche mitigation has the potential to very slightly increase the peak stream flow during a warm weather and rain event. The peak flow increases would be due to the increased concentration of snow volumes at lower elevations within each watershed where the avalanche mitigation occured. The rate of snowmelt and resulting runoff is increased at lower elevations due to higher temperatures. There would be some short–term potential for additional soil erosion/sediment yield/nutrient from the construction of the concrete snowshd foundations, snowshed drainage, and concrete foundations for blaster boxes or Avalhex sytems if silt fencing or other mitigation is not used. However, the potential sediment increase would not be discernible from the natural background variation for the sediment yield from other activities in the smaller tributary streams and would not be measurable in the waters of the Middle Fork. Sediment increases and explosive or construction residue would have a minor, adverse, short-term, site-specific impact on aquatic resources. Cumulatively these actions would have **no effect to a negligible, adverse, short-term, site-specific** increase to water yield, sediment yield, and/or nutrient levels, that is outside the measured natural range of variation for the analysis area. Aquatic resources are expected to return to pre-construction conditions after construction is finished. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed, the cumulative impact on aquatic resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. Once snowsheds are constructed, the overall cumulative adverse effect on aquatic resources is expected to lessen with the protection of trains from avalanche caused derailments and spills. There would be no cumulative adverse impacts on aquatic resources once snowsheds are built.

Alternative D: Long-term Explosive Use for Avalanche Hazard Reduction

Impacts to aquatic species would be the same as for those under Alternative C except for a longer duration. Artillery residues are not expected to impact water quality or aquatic resources (see Water Resources section above). The probability of an avalanche striking a train would be reduced but not as effectively as in Alternative B. The overall effect on aquatic species from this alternative would be **negligible, long-term, site-specific, and beneficial**.

Alternative D Cumulative Effects

Past Actions: Aquatic resources are directly and indirectly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Present Actions: Aquatic resources are directly impacted by water quality and water quantity. The present action cumulative effects on aquatic resources are the same as those listed above under Water Resources Alternative B Cumulative Effects

Foreseeable Future Actions: Aquatic resources are directly impacted by water quality and water quantity in the short-term and long-term. The past action cumulative effects on aquatic

resources are the same as those listed above under Water Resources Alternative B Cumulative Effects.

Cumulative Effects Conclusion: The long-term use of explosives to reduce avalanche hazard could slightly reduce the natural sediment yield and associated nutrient yield that comes from natural snow avalanches. The potential concentration levels of explosive residue/by-products in the melt-water runoff should be very low, significantly less than any current drinking water standard. The use of explosive avalanche mitigation has the potential to very slightly increase the peak stream flow during a warm weather and rain event. The peak flow increases would be due to the increased concentration of snow volumes at lower elevations within each watershed where the avalanche mitigation occured. The rate of snowmelt and resulting runoff is increased at lower elevations due to higher temperatures. There would be some short–term potential for additional soil erosion/sediment yield/nutrient from the extension of two concrete snowshd foundations, snowshed drainage, and concrete foundations for blaster boxes or Avalhex sytems if silt fencing or other mitigation is not used. However, the potential sediment increase would not be discernable from the natural background variation for the sediment yield from other activities in the smaller tributary streams and would not be measurable in the waters of the Middle Fork. Aquatic resource impacts are directly tied to the impacts on water resources described in the above section. Cumulatively these actions would have **no effect to a negligible, adverse, long-term, site-specific** increase to water yield, sediment yield, and/or nutrient levels directly affecting aquatic resources that are outside the measured natural range of variation for the analysis area. Aquatic resources are expected to return to pre-construction conditions after extension of two snowsheds are completed. In the event of an avalanche caused derailment and consequent hazardous material spill before snowsheds are constructed or explosive use is employed, the cumulative impact on water resources could range from **negligible to minor, adverse, short-term to long-term, and site-specific to regional** depending on the substance. There would be no cumulative adverse impact on water resources under this alternative.

Aquatic Resources Conclusion

The overall impact to aquatic species from the No Action Alternative would be **no change from current conditions**. The overall impact to aquatic species from Alternative B would be **minor, long-term, localized, and beneficial** because of the restoration of the natural avalanche flow and decreased likelihood of a spill. Under Alternative C, the overall effect on aquatic species would be **negligible, long-term, site-specific, and beneficial** due to the reduction in the likelihood of a derailment/spill. Under Alternative D, the overall effect on aquatic species would be **negligible, long-term, site-specific, and beneficial** due to the reduction in the likelihood of a derailment/spill.

GEOLOGY/SOILS

Methodology

Information on potential impacts to geology and soils was gathered from existing NPS and USFS documents, reports, GIS landcover layers, electronic databases, staff consultation, and scientific literature.

Thresholds of impact for geology and soils are defined in Table 4-1 and summarized here:

- ***Negligible***: Geological features and processes would not be affected or the effect would be below or at the lower end of detection. Any effects to geological features or processes, soil productivity, or soil fertility would be slight and not measurable.
- ***Minor***: The effects to geological features or processes, soil productivity, or soil fertility would be detectable. Effects to geologic features and processes or soils would be small, and the area affected would be localized.
- ***Moderate***: The effect to geological features or processes, soil productivity, or soil fertility would be readily apparent. Effects would result in a change in geological features and processes or soils over a relatively wide area or multiple locations.
- ***Major***: The effect on geological features or processes, soil productivity, or soil fertility would be readily apparent and would substantially change the character of geological features and processes or soils over a large area.
- ***Short-term***: After implementation, would recover in less than 3 years.
- ***Long-term***: After implementation, would take more than 3 years to recover or effects would be permanent.

Analysis Area

The analysis area for this impact topic is based on impacts to geology and/or soils in the identified avalanche paths. The area immediately surrounding the identified avalanche paths that could be hit by explosives is also included in this analysis (Map 3-1).

IMPACT ANALYSIS- GEOLOGY/SOILS

Impacts Common to All Action Alternatives

Installation of a new weather station, infrasonic avalanche detection devices, Doppler radar, geophones, and a snow depth sensor would result in **negligible, adverse, short-term, site-specific** impacts to soils due to disturbance and compaction during construction. There would be no impacts to geology. Only the snow depth sensor would be dug into the ground displacing a small amount of soil. Once the instruments are installed, there would be little or no impacts on soils or geology associated with their operation.

There is potential for avalanche caused derailments under each of the alternatives. The potential varies with the alternative. The range of impacts from avalanche caused derailments depends on the material, the hazard and the cleanup of the material. The **adverse** impacts on soils and geology would range from **negligible to moderate, short-term to long-term,** and **site-specific**. Contaminated soils may have to be removed during cleanup. Geological features may be corroded or contaminated with spilled hazardous materials. The potential for avalanche caused derailment is greatest under Alternative A if the tracks are not closed during high avalanche hazard. Both Alternative B and C include snowshed construction which would provide the greatest protection against avalanche caused derailments. Alternative C would include the use of explosives for avalanche hazard reduction during the construction of snowsheds Alternative D would provide protection against avalanche caused derailments if the tracks are closed and explosive use effectively reduces the avalanche hazard in the analysis area.

Alternative A: No Action

Under Alternative A, there would be no change in existing conditions and natural processes relating to soils and geology. Geology strongly affects where avalanches are prone to occur and avalanches impact local geology by moving sediment and debris down slope, sometimes making slopes and gullies steeper, and depositing material at the base of slopes or in water courses (Butler and Walsh 1990). The morphological changes caused by avalanche activity can indirectly affect the frequency of future avalanches which could alter the rate of geological changes (Butler and Walsh 1990). In Glacier National Park, debris avalanches most often occur within the margins of snow-avalanche paths (Butler and Walsh 1994). Both snow and debris avalanches are considered natural events important to shaping geological resources in the existing ecosystem. There would be **no effect** or change from current conditions under this alternative.

Alternative B: Construction and Modification of Snowsheds

The natural geological processes described under Alternative A would continue to occur under Alternative B. Snowshed construction would occur on ground previously disturbed by the railroad right-of-way. Snowshed construction may create a **minor, site-specific, long-term** soil or geological disturbance on GNP property outside of the ROW boundary. There would be some potential for additional soil erosion from the construction of steel frame structures and concrete walls for snowsheds, as described in the Water Resources section. Once snowsheds are constructed, the natural slope of the avalanche path is expected to allow snow avalanches and sediment transport along a natural avalanche path angle over the railroad track terrace. There would be no more than a **minor** increase in **adverse** impacts to geology and soils with snowshed construction, which would be **long-term and site-specific**. There would be an **adverse, negligible, short-term, site-specific** impact on soils or geology with an isolated incident of cast-primer explosive use if the triggered avalanche disturbed the soil within the avalanche track or runout zone. The overall impact on soils and geology from Alternative B is **adverse, minor, long-term, and site-specific**.

Alternative B Cumulative Effects

Past Actions: Past actions which have had an impact on soils and geology in the cumulative effects area include: installation of weather stations, natural gas pipeline construction, trail construction, past highway construction, past railroad and railroad facilities construction, and past derailments and clean-up. These actions have disturbed soil and exposed soils to erosion. Short-term erosion impacts from weather station installation, pipeline construction, and past derailments and cleanup have been stabilized by revegetation over time. Actions such as trail construction and highway and railroad construction and maintenance have **long-term, adverse, minor, site-specific** impacts on exposed soils. Actively used trails, roads, and the railroad leave soils exposed to **long**-term erosion.

On-going Actions: On-going actions include fire management activities, timber salvage, and resource rehabilitation. These activities can expose soils and increase the rate of erosion if mitigation is not used to lessen the impacts of soil exposure. Once soils are stabilized, erosion no longer occurs andadverse impacts on soils are **negligible**.

Foreseeable Future Actions: The foreseeable actions anticipated for Alternative B which have potential to impact soils and geology include: rock blasting on US Highway 2, addition of parking at Walton Ranger Station, exploratory well drilling and road construction, and road corridor rock blasting. These future actions are expected to expose soils and increase erosion.

The US Highway 2 blasting projects are expected to fracture and remove geological features along the highway corridor. **Minor, adverse, long-term, site-specific** impacts are expected from active road and railroad maintenance, gravel road use and maintenance, and rock removal.

Cumulative Effects Conclusion: Most of the actions listed above involve soil disturbance and a **negligible to minor, adverse, site-specific, short-term** impact on soils. Revegetation and stabilization eventually reduce erosion in disturbed areas. Active management and use on gravel roads, trails, road shoulders, and the railroad ROW result in active erosion over long periods of time affecting soils with a **minor, adverse, long-term, site-specific** impact. The actions proposed in Alternative B are snowshed construction, weather station installation, and snow depth sensor installation. There would be some short–term potential for additional soil erosion from the construction of the concrete foundations associated with the new snowshed construction if silt fences or other erosion mitigation are not used. Weather station installation and snow depth sensor installation would not increase the impact on soils in the cumulative effect area. Snowshed foundation construction may result in: compact and disturbed soils; unnatural erosion; geological disturbance and rock removal. The disturbed soils are expected to stabilize and revegetate over time. Cumulatively, there would be an additional **minor, adverse, short-term, site-specific** impact on soils. The amount of soil and rock disturbance from Alternative B would be minor and would not add substantially to the impacts of other actions in the region on soils and geology. If a derailment occurred, a hazardous material spill could add an additional **adverse, minor to major, short to long-term, site-specific** impact on geological resources

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

Alternative C would have **minor, adverse, site-specific, long-term** impacts overall to soils and geology, a slightly greater impact due to short-term changes in avalanche periodicity. Alternative C proposes short-term explosive avalanche triggering and stability testing resulting in the possibility of introducing an artificial snow slide periodicity for 10 years. It is likely that avalanche frequency would increase and avalanche size would decrease as a result of periodic explosive use during a season. While it is possible that conditions would not warrant avalanche triggering during the 10 year period, it is likely that some form of stability testing and/or triggering would be carried out each of the 10 years. Targeting geological features with explosives would not be permitted, but it is possible that charges could hit unintended targets, including geologic features. The explosives would be aimed at deep snow pack, and expected to have **negligible** to **minor direct** impact on soil and geology at the impact site. There would be little increase in erosion due to impact of explosives. If an unrecovered dud cast primer explosive were to accidentally explode after most or all of the snow was melted, or a geological features was unintentionally hit, it could result in a **minor** impact area with some erosion or rock displacement near the point of explosion. Under certain, saturated soil conditions, a landslide could potentially be triggered. However, the explosives proposed for use in this alternative would contain RECCO technology that can be tracked for easy recovery of unexploded ordnance. Dud recovery may need to be postponed until conditions are safe to travel into the avalanche path but there is not expected to be unexploded ordnance on the slopes for long periods of time.

The installation of Avalhex type systems or blaster box towers would involve placement of fixed cement pads on bedrock. The impacts to geology would be **adverse, minor, short-term and site-specific** in nature. The effects of the triggered avalanches on soils and geology would be similar to those described in Alternative A with **minor** additional impacts from the construction of snowsheds, a weather station, Avalhex type systems or blaster box tower installation, and a snow depth sensor as described in Alternative B.

The use of explosive avalanche hazard mitigation could potentially increase the snowpack depth at lower elevations in the targeted watersheds with more frequent avalanche occurrence. The additional peak flow could increase the risk of channel erosion in some stream reaches during a warm weather or rain event with subsequent higher rates of snowmelt in the analysis area.

Explosive avalanche hazard mitigation would have the effect of reducing the volume/size of naturally occurring avalanches, which would in turn reduce the potential for vegetation removal and the resulting soil erosion. Therefore, there is reduced potential for nutrient input into the stream systems with explosive use. If the avalanches are consistently smaller than normal, vegetation encroachment could begin to occur along the flanks of the avalanche runs. Narrower avalanche paths with more anchor points may impact the magnitude and impact of future avalanches along in addition to the impacts on soils and geology, but this effect would be **minor** over this temporary explosive use period. The period is within the typical range of years between large avalanche events and natural avalanche frequency and magnitude is expected to return to previous levels after the 10 year period.

Studies have found small amounts of explosive residue in snow samples and soil (Jenkins et al. 2000, Naftz et al. 2003), but it is unknown whether or at what level these residues may impact soil quality. Based on the small quantities found in the snow samples, it is not expected that the impacts would be more than **negligible**. The amount of chemical residue that runs off in the snowpack is discussed in the Water Resources section of this chapter.

Alternative C Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: Present actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: Most of the actions listed above involve soil disturbance and a **negligible to minor, adverse, site-specific, short-term** impact on soils. Revegetation and stabilization eventually reduce erosion in disturbed areas. Active management and use on gravel roads, trails, road shoulders, and the railroad ROW result in active erosion over long periods of time affecting soils with a minor, adverse, long-term, site-specific impact. The actions proposed in Alternative C are snowshed construction, weather station installation, snow depth sensor installation, 10-year period of explosive use, and blaster box or Avalhex installation in start zones. There would be some short–term potential for additional soil erosion from the construction of the concrete foundations associated with the new snowshed construction if silt fences or other erosion mitigation are not used. Weather station installation and snow depth sensor installation would not increase the impact on soils in the cumulative effect area. Snowshed foundation construction may result in: compact and disturbed soils; unnatural erosion; geological disturbance and rock removal. The disturbed soils are expected to stabilize and revegetate over time. Blaster box or Avalhex tower pads are expected to impact bedrock or soil in 5 by 5 foot sections per unit. Once the 10-year explosive period is finished, the cement pads would be removed adding a minor impact to soils until natural revegetation or stabilization occurs. Cumulatively, there would be an additional **minor, adverse, short-term, site-specific** impact on soils with the actions under Alternative C. Use of explosives would impact the frequency and magnitude of natural avalanches changing the dynamics of soil transport and avalanche path formation for the explosive use period. It is expected that these impacts would be reduced to pre-project conditions after explosive use is finished and snowsheds are completed. The amount of soil and rock disturbance from Alternative C would be minor and would not add substantially to the impacts of other actions in the region on soils and geology. If a derailment occurred, a hazardous material spill could add an additional **adverse, minor to major, short to long-term, site-specific** impact on geological resources

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Alternative D introduces the possibility of artificial avalanche intervals for an indefinite period by allowing explosive avalanche triggering and stability testing on a continual basis. Avalanche frequency would increase, and the assumption is that the avalanches would generally be smaller in size, but that could not be guaranteed. Targeting geological features with explosives would not be permitted but it is possible that charges could hit unintended targets, including geological features. The explosives would be aimed at deep snow pack zones, and would be expected to have **negligible to minor direct** impacts on soil and geology at the impact site. Potential impacts from unrecovered dud ammunition or unintended direct impacts on geologic features are the same as unrecovered cast primer duds in Alternative C. Triggered avalanche and stability testing effects on soils and geology would be similar to those described in Alternative A although the impacts would be lessened if avalanches are consistently smaller. **Minor** additional impacts from construction of two snowshed extensions a weather station, and a snow depth sensor would also occur as described in Alternative B. An additional **minor** increase in erosion would result, both from construction of 700 feet of access roadway and firing pads off of the previously disturbed US Highway 2 corridor and from installation of blaster boxes or Avalhex type systems type systems as described in the Water Quality section.

If artificially triggered avalanches are consistently smaller than natural avalanches, mature trees could become established along the flanks of the avalanche runs, indirectly affecting the magnitude and impact of future avalanches along with their impact on soils and geology. If an explosively released avalanche were of greater magnitude than would be expected, then impacts on vegetation, soil, and geology would be greater. These impacts may appear to cancel themselves out, but in combination do alter natural processes and would produce **moderate adverse** impacts to the natural avalanche periodicity at these specific sites over the long-term.

Effects of explosive residues would be the same as in Alternative C; it is not expected that the impacts would be more than minor for soils and geology; however, under Alternative D, the impacts would be long-term. Overall, actions under Alternative D would result in a **minor to moderate, adverse, long-term, site-specific** impact to geology and soils.

Alternative D Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: Present actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: Most of the actions listed above involve soil disturbance and a **negligible to minor, adverse, site-specific, short-term** impact on soils. Revegetation and stabilization naturally occur and eventually reduce erosion in disturbed areas. Active management and use on gravel roads, trails, road shoulders, and the railroad ROW result in active erosion over long periods of time affecting soils with a **minor, adverse, long-term, site-specific** impact. The actions proposed in Alternative D are snowshed extensions on Sheds 7 and 9, weather station installation, snow depth sensor installation, 700 feet of access road construction, and firing pad construction. There would be some short–term potential for additional soil erosion from the construction of two concrete foundations associated with the new snowshed extensions if silt fences or other erosion mitigation are not used. Weather station installation and snow depth sensor installation would not increase the impact on soils in the cumulative effect area. Snowshed extension over 250 feet may result in: compacted and disturbed soils; unnatural erosion; geological disturbance and rock and soil removal. The disturbed soils are expected to stabilize and revegetate over time. Blaster box or Avalhex tower pads are expected to impact bedrock or soil in 5 by 5 foot sections per unit. Cumulatively, there would be an additional **minor, adverse, short-term, site-specific** impact on soils with the actions under Alternative D. A continuous program of explosive use would impact the frequency and magnitude of natural avalanches changing the dynamics of soil transport and avalanche path formation over a long-term program.The construction of 700 feet of gravel access road and three firing pads would have a **minor, long-term, site-specific, adverse** impact off the main highway in previously undisturbed areas. The cumulative effect of impacts to soil and rock from Alternative D would be **minor, adverse, site-specific, and long-term** and would not add substantially to the impacts of other actions in the region on soils and geology. If a derailment occurred, a hazardous material spill could add an additional **adverse, minor to major, short to long-term, site-specific** impact on geological resources

Soils and Geology Conclusion

Alternative A would have **no effect** overall to soils and geology. Alternative B would have would have **minor, adverse, site-specific, long-term** impacts overall to soils and geology. Alternative C would have **minor, adverse, site-specific, long-term** impacts overall to soils and geology, a slightly greater impact due to short-term changes in avalanche periodicity. Alternative D would have **minor to moderate, adverse, long-term, site-specific** impacts overall to geology and soils, or the greatest impact of all of the alternatives due to long-term use of explosives causing changes in avalanche periodicity which could alter future geological changes.

There would be no significant adverse impacts to geologic resources whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents. Consequently, there would be **no impairment** of geologic resources as a result of the implementation of any of the alternatives.

VEGETATION

Methodology

Information on vegetation and potential impacts was gathered from existing park documents and reports, GIS landcover layers, park databases, such as the exotic vegetation database, aerial photographs, a roadside survey conducted on May 19, 2005, and scientific literature.

Thresholds of impact for vegetation are defined in Table 4-1 and summarized here:

- *Negligible*: Vegetation would not be affected or the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population.
- *Minor*: Some individual native plants would be affected over a relatively small area, but the effects would be localized, and would be of little consequence to the species' population.
- *Moderate*: Individual native plants would be affected over a relatively wide area or multiple sites and would be readily noticeable. A sizeable segment of a species' population could be affected.
- *Major*: A considerable effect on native plant populations would occur over a relatively large area.
- *Short-term*: Effects last less than 3 years.
- *Long-term*: Effects last more than 3 years.

Analysis Area

The analysis area for this impact topic is based on the grouping of avalanche paths that could experience potential effects to vegetation due to the proposed actions in the alternatives. The area surrounding the avalanche paths that could potentially be hit by explosives is also included in this analysis.

IMPACT ANALYSIS- VEGETATION

Impacts Common to All Action Alternatives

Installation of a new weather station, Doppler radar, geophones, and a snow depth sensor would result in **minor, adverse, short-term, site-specific** impacts to vegetation due to disturbance during construction. Vegetation would be impacted by avalanches under all alternatives, but the frequency and intensity of effect would vary, so effects are described in the alternatives below. Though some alternatives may lessen the likelihood of avalanche caused train derailments (especially Alternatives C and B, followed by D), they remain a possibility under all alternatives, and the impacts would be about the same for each. **Adverse** impacts on vegetation resulting from a derailment involving a hazmat spill would range from **negligible, short-term** and **site-specific** to **moderate, long-term,** and **localized** depending upon the extent and nature of the spill. For example, the effects could range from a **minor, short-term** destruction of vegetation resulting from a small derailment or benign spill to **moderate, long-term, adverse** effects on vegetation due to inability to regenerate over a large area on sterilized soil caused by a highly toxic spill. This would be especially impacting if the spill reaches waterways facilitating further spread of toxins or pollutants to riparian plants downstream.

Alternative A: No Action

Overall, Alternative A would have a **minor to moderate, beneficial, localized** impact on vegetation in the project area. Under Alternative A, natural snow avalanches would continue to occur naturally and periodically, resulting in **minor to moderate, adverse, site-specific, long-term** direct impacts to native vegetation. The effects of natural avalanches on vegetation are described in Chapter 3. While the impacts could be adverse for individual trees or other plants, the overall impact on vegetation is beneficial to maintain habitat for a diverse array of vegetation communities. The area of effect analyzed in this document is localized to the multiple avalanche paths located within the project area. The direct impacts of natural avalanches are described in Chapter 3 Vegetation Affected Environment.

Indirect impacts to vegetation from the continued occurrence of periodic natural snow avalanches are described in Chapter 3, Vegetation Affected Environment and would be **minor to moderate, localized, long-term, and beneficial** overall. The natural disturbance cycle would remain the same under this alternative. **Minor, adverse, site-specific, long-term** impacts could result if weed populations become established on disturbed sites.

Alternative B: Construction and Modification of Snowsheds

The same impacts, both direct and indirect, described under Alternative A would continue to occur under Alternative B. Installation of a new weather station and a snow depth sensor would result in **minor, adverse, site-specific, short-term** impacts to vegetation during construction. Potential snowshed construction would occur on ground previously disturbed by the railroad right-of-way. There would be some potential for additional weed invasion anywhere ground is disturbed for the concrete foundations for the snowsheds. The isolated use of explosives during an emergency where human life and or resources are at risk and all other options have been exercised would cause very little impact to vegetation in the paths where explosives were used. If a triggered avalanche removed vegetation, there would be an **adverse, minor, short-term, site-specific** impact to vegetation. Recolonization of the disturbed area would occur rather quickly after the event. There would be no more than a **minor** increase in **adverse** impacts to vegetation, which would be **short-term and site-specific**.

Alternative B Cumulative Effects

Past Actions: Past actions which have had impact on vegetation in the project area include: installation of weather stations, natural gas pipeline construction, trail construction, past highway and road construction, recreational activities, past railroad and railroad facilities construction, and past derailments and clean-up.

On-going Actions: Actions that are currently going on, have gone on in the past, and would continue to occur in the foreseeable future that impact vegetation include: fire mangement activities, vegetation clearing for railroad and highway right-of-ways, recreational activities, and weed control activities.

Foreseeable Future Actions: The foreseeable actions anticipated for Alternative A which have potential to impact vegetation include: addition of parking at Walton Ranger Station, exploratory well drilling and road construction, and future train derailments and clean-up.

Cumulative Effects Conclusion: Cumulatively the above actions combined with Alternative B actions would result in **minor, adverse, site-specific, short and long-term, adverse** impacts overall due to vegetation removal and disturbance. There would also be overall **beneficial, minor to moderate, long-term** vegetation impacts on a localized scale due to weed control efforts and the effects of natural snow avalanches periodicity and magnitude. Impacts to vegetation include trampling, trimming, and removal, changes to nutrient sources and shading levels, potential for weed spread and competition, and changes to floristic and structural diversity.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

Alternative C proposes explosive avalanche triggering and stability testing resulting in the possibility of introducing an artificial avalanche periodicity for a temporary period of ten years. It is likely that avalanche frequency would be increased, and the assumption is that the avalanches would generally be smaller in size, but that could not be guaranteed. While it is possible that conditions would never warrant avalanche triggering during the 10-year period, it is likely that some form of explosive use would be carried out multiple times during the ten years. The explosives would be aimed at deep snowpack, and be expected to have a **negligible to minor, adverse, short-term, site-specific** direct impact on dormant vegetation below the snow at the impact site. A direct hit on a tree or exposed vegetation would cause damage to individual plants.

If an unrecovered dud explosive were to accidentally explode after most or all of the snow was melted, there could be **minor, adverse** impacts to vegetation surrounding the point of explosion. Under certain, saturated soil conditions, a landslide could potentially be triggered, uprooting and burying some native vegetation. However, the explosives proposed for use in this alternative would contain technology that can be tracked for easy recovery of unexploded charges. Recovery may need to be postponed until conditions are safe to travel into the avalanche path but there is not expected to be unexploded charges on the slopes for long periods of time.

The direct effects of the triggered avalanches on vegetation would be similar to those described in Alternative A, although expected to be **minor more often than moderate** due to anticipated smaller avalanche sizes. **Minor** additional impact from snowsheds, weather station, and snow depth sensor would occur as described in Alternative B.

If the avalanches are consistently smaller magnitude than normal, tree encroachment could begin to occur along the flanks of the avalanche runs, indirectly affecting the magnitude and impact of future avalanches along with their impact on vegetation, but this effect would not be more than **minor** over this 10-year time-period. Studies have found small amounts of explosive residue in snow samples and soil (Jenkins et al. 2000, Naftz et al. 2003), but it is unknown whether or at what level these residues may impact native vegetation. Based on the small quantities found in the snow samples in the study, it is not expected that the impacts on vegetation would be more than **negligible**. Alternative C would have greater adverse impacts than Alternatives A and B with **localized, minor to moderate, short and long-term, adverse** impacts overall.

Alternative C Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: The on-going actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: Cumulatively the above actions combined with the Alternative C actions would result in **localized, minor to moderate, short and long-term, adverse** impacts overall due to vegetation removal and disturbance. Weed control efforts would continue to produce **minor to moderate beneficial** impacts, as would natural and, to a lesser extent, triggered snow avalanches. Impacts to vegetation include trampling, trimming, and removal, changes to nutrient sources and shading levels, potential for weed spread and competition, and changes to floristic and structural diversity.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Alternative D proposes the introduction of an artificial avalanche frequency and magnitude for an indefinite period by allowing explosive avalanche triggering and stability testing on a long-term basis. It is likely that avalanche frequency would be increased, and the assumption is that the avalanches would generally be smaller in size, but that could not be guaranteed. The explosives would be aimed at deep snowpack, and expected to have **negligible to minor direct** impacts on dormant vegetation below the snow at the impact site. A direct hit on a tree or exposed vegetation would cause damage to individual plants. Potential impacts from unexploded ordnance and explosive residues and from alteration of vegetation communities due to changed avalanche frequencies would be the same as in Alternative C.

The direct effects of the triggered avalanches on vegetation would be similar to those described in Alternative A, although expected to be **minor more often than moderate** in the **short-term** due to anticipated smaller avalanche sizes. As described in Alternative C, changes in avalanche frequency and magnitude could result in tree encroachment along the flanks of avalanche paths, indirectly affecting the magnitude and impact of future avalanches and altering the existing mosaic of vegetation communities along these paths. With smaller avalanches confined primarily to the inner zone of the avalanche chute over an extended time period of decades, the shrubby habitat along the flanks of the path could be entirely lost over time. Species that are well-adapted to this environment would become less common in the localized area. This effect could indirectly produce **moderate to major** adverse impacts in the diversity of vegetation communities along avalanche paths in the project area over the long term. Impacts on vegetation are expected to be **moderate to major, adverse, localized, and long-term** because explosive avalanche triggering is expected to last indefinitely. **Minor** additional impact from snowshed extension and installation of asphalt firing pads, 700 feet of gravel access road, a weather station, and a snow depth sensor would occur as described in alternatives B and C. Installation of blaster boxes or Avalhex systems would have similar impact as a weather station.

Alternative D Cumulative Effects

Past Actions: The past actions are the same as described for Alternative B.

On-going Actions: The present actions are the same as described for Alternative B.

Foreseeable Future Actions: The future actions are the same as described for Alternative B.

Cumulative Effects Conclusion: Cumulatively these actions combined with actions in Alternative D would result in **localized, moderate to major, short and long-term, adverse** impacts to vegetation overall due to removal and disturbance of plants and loss of native vegetation communities. Weed control efforts would continue to produce **minor to moderate beneficial** impacts. Impacts to vegetation include trampling, trimming, and removal, changes to nutrient sources and shading levels, potential for weed spread and competition, and changes to floristic and structural diversity.

Vegetation Conclusion

Natural avalanche processes under Alternative A are expected to result in **minor to moderate, beneficial, short and long-term, localized** impacts overall. There would be **site-specific, minor to moderate, short and long-term, adverse** impacts under Alternative B with snowshed construction and disturbance. Alternative C would have greater adverse impacts than Alternatives A and B with **localized, minor to moderate, short and long-term, adverse** impacts overall. The greatest impacts would be from Alternative D with **localized, moderate to major, short and long-term, adverse** impacts to vegetation. Weed control efforts would produce **minor, beneficial** impact on a localized scale under all four alternatives, and natural snow avalanches would have beneficial impact by maintaining a diversity of vegetation communities in Alternatives A, B, and also C over the long-term. These benefits would not likely be realized under Alternative D.

There would be no significant adverse impacts to vegetation whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents. Consequently, there would be no impairment of vegetation as a result of the implementation of any of the alternatives.

WILDLIFE

Methodology

Impact levels were determined based on current conditions, past surveys, and a review of literature pertaining to the effects of explosives use on wildlife. The list of species in the analysis area is in Table 3-8 of the Affected Environment chapter. Impacts on grizzly bear, lynx, wolf, bald eagle, and bull trout are discussed in the *Federally Threatened and Endangered and Species of Concern* section of this chapter.

Thresholds of impact for wildlife are defined in Table 4-1 and are summarized here:

- ***Negligible***: Wildlife species would not be affected or the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population.
- ***Minor***: Effects to individual wildlife species are possible, although the effects would be localized, and would be of little consequence to the species' population.
- ***Moderate***: Effects to individual wildlife species are likely, and a sizeable segment of the species' local population could be affected.
- ***Major***: Effects to wildlife would have significant consequences to species populations in the region.
- ***Short-term***: After implementation, would recover in less than 1 year.
- ***Long-term***: After implementation, would take more than 1 year to recover or effects would be permanent.

Analysis Area

A Wildlife Analysis Area (WAA) was created to define the area of impact for terrestrial wildlife species (Map 3-2). This area encompasses Park and Forest land from one side of the canyon to the other and includes that area which would be impacted directly by explosive avalanche hazard reduction and indirectly through noise disturbance. However, wildlife displaced either temporarily or permanently by repeated explosive use could possibly move outside of this area to other lower quality and/or occupied winter ranges that are miles away.

IMPACT ANALYSIS- WILDLIFE

Impacts Common to All Action Alternatives

Avalanches, whether natural or artificially caused, create a disturbance to wildlife. Animals are often caught in avalanches and the loud noise undoubtedly stresses wildlife present in the area. However, wildlife have evolved with, and are adapted to, naturally-triggered, periodic avalanches. Animals killed by avalanches are frequently consumed by other animals. Carrion in avalanche paths is believed to be an important winter and spring food source for wolverines (Krebs and Lewis 2000), grizzly bears (Mace and Waller 1997b), golden eagles, and undoubtedly to other wildlife species. In addition, the vegetation disturbance caused by avalanches creates an important habitat type used by many wildlife species. Plants (cow parsnip, glacier lily, and graminoids) frequently consumed by large mammals, including grizzly bears, and birds thrive under the open conditions created by avalanche paths (Krajick 1998). Avalanche activity would continue to occur under each of the alternatives; however, the magnitude and frequency would be changed by explosive use.

Train/wildlife collisions would continue to occur under all alternatives. Between 1975, when records were first kept, and the present, 42 bears (black and grizzly) have been documented as killed in collisions with trains (USFWS 2005). Although other species are also killed in collisions with trains, no records are kept.

Wildlife could be impacted by spills caused by avalanches and some alternatives lessen the likelihood of train derailments caused by avalanches. The impacts to wildlife from a spill are difficult to quantify and would vary depending on the substance released, the extent of the spill, and the species in the vicinity of the spill. Grain spills and a syrup spill have occurred in the past and resulted in extensive cleanup, animal behavior problems, and management difficulties. Impacts due to a spill would be **adverse** and range from **negligible to major** depending on the amount and type of material spilled. Impacts could be **short-term to long-term** depending on severity of the derailment. The effects could be minimized if sufficient exclusion and cleanup of the area occurred soon after the spill but long-term impacts could occur if a large amount of a hazardous material were spilled. The size of the area impacted could range from **site-specific to regional** depending on the size of the spill and the substance.

Forecasting equipment including weather stations, Doppler radar, geophones, and a snow depth sensor installed on Forest and Park lands would not impact wildlife other than the initial disturbance caused during their installation, which is expected to be negligible. Any railroad, highway, or trail closures, independent of other actions, would temporarily benefit wildlife by reducing noise and disturbance caused by the normal use of these travel corridors, however the benefit would be negligible.

Alternative A: No Action

Current habitat conditions and winter wildlife use patterns, as described in Chapter 3 *Affected Environment*, are not expected to change under the No Action Alternative. BNSF operations in the analysis area would generally remain the same. Avalanche processes would occur at natural magnitudes and frequencies, possibly killing some wildlife which provides forage for other species.

Existing snowsheds may continue to present travel barriers to some avalanche paths for wildlife. However, because existing snowsheds have been in place for so many years, frequently used game trails have been established around the structures and wildlife populations have adjusted to their presence.

This alternative would not increase the chances of a hazardous substance spill but it also does the least to prevent potential spills caused by avalanches. If train traffic increases along the railroad, the potential for avalanche caused derailments may increase without timely ASD recommended delays. If this alternative is selected, BNSF could build snowsheds to reduce the risk of spills caused by derailment in unprotected avalanche paths.

The overall impact on terrestrial wildlife from the No Action Alternative would be **no change from current conditions.**

Alternative B: Construction and Modification of Snowsheds

According to BNSF, construction of snowsheds could take 5-20 years depending on the number of snowsheds built. Use of heavy equipment would result in the direct disturbance of local wildlife. Human presence and noise produced during construction would preclude the use of the area by some animals. Some disturbance could be minimized by limiting work to summer months when impacts to ungulate winter range would be eliminated and by restricting work to an hour after sunrise and an hour before sunset. Impacts due to construction would be temporary and species should return to pre-project behavior soon after construction is completed.

Many species use avalanche paths throughout the year for foraging and as travel corridors. Snowsheds can create barriers to wildlife movements in these paths depending on the length of the snowshed and if wildlife can traverse the slopes at the end of the sheds. Under this alternative, 5,040 feet of new snowshed could be built. If a snowshed replaces what is currently a steep, cut slope formed during construction of the railroad, a snowshed may not greatly change the accessibility of the avalanche path. However, if the snowshed blocks a more gradual slope it could hinder movement through the path. In addition, if the snowshed ends at a cut slope that is impassable by wildlife species the effects of the barrier are extended beyond the snowshed until the slope decreases.

There are no data on the extent that snowsheds inhibit movement by wildlife, though the regular existence of well-worn animal paths immediately adjacent to the snowsheds would suggest that they are frequently encountered by animals. Larger species such as elk, bear, and lynx are most likely funneled to the ends when the animal encounters the snowshed. Smaller animals such as snakes, toads, and rodents are less likely to travel to the end of a snowshed, especially longer snowsheds. They may be able to get through cracks or crawl over the existing wood timber snowsheds, but this may be more difficult with the proposed cement and steel frame snowsheds.

Bats have not been confirmed using the BNSF snowsheds for roosting; however, no surveys have been conducted. Bats are known to roost in wooden bridges, culverts, and also show a preference for joints in concrete highway bridges (Keeley and Tuttle 1999). The construction design of new snowsheds made of concrete and steel could provide roosting and nursery crevices for bats year-round.

Once snowsheds are constructed, this alternative would most-effectively reduce the likelihood of a derailment, and hence a grain or hazardous waste spill, caused by an avalanche in John F. Stevens Canyon.

If explosives are approved for use in an isolated emergency where human lives or resources are at risk and all other options have been exercised, it is anticipated that this type of action would involve only a minimal number of cast primer charge explosions. The effects to wildlife of cast primer explosives would be mostly behavioral. The loud explosive sounds and subsequent triggered avalanches may result in a flight response from wildlife close to, or in, the targeted avalanche path. The use of low-flying helicopters for delivery of explosives to starting zones would also disturb wildlife. There is a slight chance that an individual animal could be hit with an explosive or that an individual may be caught in an artificially triggered avalanche. However, the approved explosive methods require clear, calm weather and daylight, which would allow wildlife to be seen and avoided during explosive delivery. The impact of emergency explosive action would be temporary, and wildlife is expected to react to the noise and disturbance; however, wildlife behavior and habitat would return to pre-explosive use conditions very soon after the event. Emergency explosive action would have an **adverse, minor to moderate, short-term, site-specific** impact on wildlife.

The overall effect on terrestrial wildlife of new snowsheds including construction impacts, and without any mitigation, would be **adverse** at a **minor to moderate** level, depending on the species. Larger animals are probably inconvenienced by the snowsheds though not blocked from moving to a new area. Smaller animals may be prevented from moving through an avalanche path; though only individuals not populations would be affected. Disturbance during construction would be **short-term;** however, the permanent presence of the snowsheds would result in **long-term** impacts. Impacts would be **site-specific** to the location of the new snowsheds. Mitigation, including the construction of overcrossings and other modifications for wildlife, would lessen adverse impacts to a minor level and could result in a long-term benefit to wildlife. However, the construction of these structures is not certain.

Alternative B Cumulative Effects

Past Actions: All of the past actions listed in Table 4-2 could have impacts on wildlife to some extent. However, the past actions most likely to impact wildlife populations within the WAA include: fire suppression, train spills/derailments, recreational activities, hunting, and the use and maintenance of the railroad and highway.

On-going Actions: All present or ongoing actions listed in Table 4-2 also have an impact to some extent on wildlife in the region. However, the ongoing actions most likely to impact wildlife populations in the WAA include: railroad and highway use and maintenance (including annual increases in amount of traffic), fire suppression, hunting, and recreational use (especially in the winter).

Foreseeable Future Actions: All future actions listed in Table 4-2 would have an impact on wildlife in the area to some extent. However, besides the ongoing actions listed above, there are no specific future projects proposed to occur within the WAA that could impact wildlife populations.

Cumulative Effects Conclusion: The wildlife impacts associated with snowshed construction are primarily short-term noise disturbance during construction and the permanent placement of barriers through avalanche paths. The noise associated with snowshed construction in combination with noise already present because of the railroad and highway would discourage some wildlife from using the analysis area. However, construction noise would be temporary and wildlife present in the area are most likely already accustomed to above normal sound levels due to the presence of the railroad and highway. The railroad tracks may even have become travel corridors for some animals that may feed on food items sporadically spilled from trains. Some of these animals are killed by passing trains. New snowsheds would reduce the likelihood of an avalanche-caused derailment that spill large amounts of animal attractants but smaller spills from leaking train cars would continue to occur.

Since the major fires of the 1920s, fire suppression activities have undoubtedly altered the natural vegetation regimes, and thus the available wildlife habitat, within the Canyon. Controlling fires may have increased forest cover and reduced the size or number of natural avalanche paths. However, the extent of these changes and their impact on local wildlife populations is unknown. The presence of the snowsheds could impede the movement of wildlife through the specific avalanche paths; however, the presence of the railroad and highway present much larger and more disruptive impediments to wildlife movement in the area. Considering all of the actions both inside and near the WAA, the overall cumulative impacts on wildlife from past, present, and future actions are **moderate, long-term, regional, and adverse** primarily due to the fragmentation of habitat and disturbance caused by the highway and railroad. The building of snowsheds adds only **negligibly** to this impact.

Alternative C: Short-term Explosive Use for Avalanche Hazard Reduction

Given current knowledge about the analysis area, explosive use would have the greatest potential for impacting winter habitat for the following species: elk, mountain goat, mule deer, wolverine, gray wolf, lynx, and grizzly bear. The threat of direct mortality to wildlife due to the use of explosives is not expected to be high. Firing would be postponed if wildlife is spotted near a given target; however, firing may occur on days when poor visibility prevents seeing the paths clearly, and some wildlife may not be detected. Wildlife such as elk, deer, and goats are expected to traverse and not linger within avalanche paths because of the relatively deeper snow compared to adjacent forested areas, especially during storm events that create avalanche conditions. However, triggered avalanche debris may travel through the trees, impacting wildlife taking cover from the storm. If a recent avalanche had exposed underlying vegetation, animals may forage on this vegetation in the avalanche path. Animals responding to explosive use in adjacent paths may move into other targeted paths and be more likely to be adversely impacted by triggered avalanches.

Avalanche mortality for elk, mule deer, and mountain goats may be part of the natural regulatory mechanisms that determine population sizes in the area. If the rate of avalanche-caused mortality changes as a result of the use of explosives to release avalanches, that dynamic could be altered. If artificial release of avalanches under controlled conditions reduces avalanche-caused ungulate mortality, there would be secondary effects to scavengers like grizzly bears, wolverine, and golden eagles by reducing important food resources at a critical time. In addition, if a herd of frightened elk or goats are inadvertently chased into the path of an artificially-released avalanche, a significant percentage of the local population could be expunged.

Purposely releasing avalanches more frequently than would naturally occur would change the intensity of avalanches and disrupt the natural avalanche cycle. This could influence vegetation patterns in the avalanche paths and impact habitat important to some wildlife species. Snow in avalanche paths melts earlier than in forested areas in the spring and these areas are important spring forage for wildlife including grizzly bears, wolverine, and elk. With explosives use, large avalanches that typically create the most disturbance and that result in the presence of early successional vegetation may be less frequent. This could allow conifers to become established and, if capable of surviving natural avalanches, could begin reducing early successional habitats. However, given the relatively short time frame of this alternative (10-year time period that explosives would be used), it is doubtful that coniferous tree establishment would be sufficient to significantly affect avalanche path vegetation patterns. In addition, the return to normal avalanche magnitude and frequency after the 10-year time limit would return the natural disturbance process to the avalanche paths and it is probable that any conifers that would have become established would be uprooted during normal avalanche events.

The amount of chemical residues that could attract or poison wildlife remaining at the target locations after firing events are expected to be extremely small (see Water Quality). The rounds used in the Avalauncher are biodegradable (Maple Leaf Powder Company 2005). The amount of explosive residues remaining after the use of handcharges would be minimal and would quickly be diluted in snow melt (see Water Quality). It is unknown if any species of wildlife would be attracted by the chemical compounds in explosive residue. The small amount of residue and the large distribution area would result in minimal scent attractants.

Noise generated from explosives use has the potential to negatively affect wildlife species that utilize winter habitat within the analysis area; wildlife species occupying more distant habitat, such as on Forest Service land to the south of blasting locations, could also be impacted though, to a lesser degree. Larkin et al (1996), in a literature review on the effects of military noise on wildlife, found that documented effects of noise on wildlife often appeared in the 'gray literature of conference proceedings and unpublished reports and manuscripts', rather than in the refereed scientific literature. Nevertheless, of relevance to the proposed avalanche blasting, Larkin et al (1996) discussed the different classes of sound or noise. Two classes of noise relevant to the proposed project include impulse (from blasting) and impact (one object striking another) sound/noise. Most research has been done on the effects of impulse noise because of its impact on the people firing the weapon. The response to noise disturbance varies considerably among species and even among individuals within a group of the same species. Some species may be affected for only the immediate time of the noise while others may be rendered deaf for long periods afterwards (Radle 1998).

Wildlife present in the analysis area have habituated to some extent to 'unnatural' (i.e. human caused) noises and/or events, especially those that are repeated and recurring, such as 50 trains a day, daily traffic on US Highway 2, or daily overflights. However, the proposed avalanche hazard reduction activities would not be regular, recurring events. Explosive use and resulting noise would be episodic in nature and wildlife would experience random explosions in location and time. Wildlife would not readily become accustomed to this new episodic disturbance in their environment. Potentially affected wildlife would respond with alarm and/or distress to the loud and sudden nature of noise from explosives in their winter environment.

Determining the physiological effects of noise on wildlife is difficult because of the initial need to capture and restrain animals which could make the animal more wary of future disturbance (Larkin et al. 1996). However, some reported physiological changes to animals due to exposure to noise include immune system suppression, increased heart rate, increased energy expenditure, and varying degrees of hearing damage (Larkin et al. 1996). Again, these changes vary considerably between species. For example, Saunders and Dooling (1974) found that some birds showed different hearing deficits than mammals when exposed to the same kinds of loud noise. For this reason, it is impossible to say at which decibel level explosives become detrimental to all wildlife.

Any movements cause wildlife to utilize valuable energy needed for winter survival or for reproductive success in the spring. Assuming affected wildlife species are not able to replace 'used energy' in response to blasting noise, animals would become less fit to survive winter conditions. Affected female ungulates would utilize valuable energy that could mean the difference between successful or unsuccessful parturition and survival of their young (Phillips and Alldredge 2002). However, it is not possible to predict with confidence whether blasting noise would result indirectly in mortality because other variables have to be considered including: the life history traits of the species, age, sex, previous exposure to noise, length and duration of noise, and other physical stresses (e.g. drought, predation pressure, available forage) (Radle 1998). Year-round baseline data on population health and existing habitat conditions prior to explosive use is not available.

The most noticeable evidence of wildlife response to explosives/blasting would be behavioral responses. Behavioral effects that might decrease chances of survival and reduce reproductive success include retreat from favorable habitat near noise sources and reduction of time spent feeding with resulting energy depletion (Larkin et al 1996). Winter time is critical for most wildlife species because it is the season with the least amount of forage resources available to an animal. The amount of snow depth, distance from blast noise, proximity to forest cover, and the time of winter (i.e., early or late winter) when explosives are detonated would influence the response by a particular species in the area. During periods of high avalanche hazard, when explosives would be used, is also when animals are most stressed due to cold, moisture, and deep snow. Animal stress would be directly proportional to the amount of snow. Avalanche control activities would exacerbate this stress.

There has been no research involving explosive use for avalanche control and its impact on wildlife. The threshold, or tolerance, that a potentially-affected species has for disturbance before they seek new habitat is unknown for the analysis area. However, for most species near the explosive impact locations, the response would likely be to flee from the noise to areas of less noise and greater security. During this initial flight response there is a chance for animals to be injured or trampled (Joslin 1986). Movements could be short or long distance depending on the species' or individual's response. Some animals may disperse into adjacent avalanche paths, putting themselves at risk of being trapped in an avalanche or being in the next target zone during control efforts. It is possible that herds or groups of elk and/or mountain goat would be displaced temporarily or for long periods.

The direct impacts to smaller species inhabiting small territories depend on the proximity to the explosive target zones. Individuals living in and under the snowpack in high altitude target zones would have direct mortality or injury from direct hits of explosive use or the resulting avalanche. The seismic activity further away from the direct explosion may deafen small animals and/or produce elevated stress levels, winter sleep disturbance, excessive energy use, or disorientation. These impacts would depend on distance away from explosion and protection from habitat. Westworth (1981) found that muskrats in burrows located within 30 meters of an 11.3-kg explosion received minor ear and lung injuries; no long-term changes to muskrat densities or reproduction occurred. Constant explosive disturbance in home ranges of smaller species would cause those animals to leave the area and find suitable habitat elsewhere. Birds may be present near an explosion; however they are able to fly away from the disturbance without a great amount of energy expenditure. Deafness may occur in birds that are near the explosion which would be detrimental to a species that relies heavily on sound for communication as birds do.

The noise associated with helicopter explosive delivery would also impact wildlife in the area. Low level flights displace and/or disrupt normal behavior patterns of wildlife along flight paths. Several studies have documented the behavioral responses of wildlife to various types of aircraft disturbance. Much of this information on federally-listed species, particularly for grizzly bears and bald eagles, was summarized by the Park in a recent *Programmatic Biological Assessment for Administrative Flights 2003-2007* (NPS 2004). There is wide variability in the reaction of all wildlife to aircraft based on the degree of habituation to the activity, availability of escape cover, and the type, noise level, altitude, and movements of the aircraft involved. In regularly disturbed locations, such as along railroad and highway corridors, animals may become habituated to the noise of overflights (Krausman et al. 1986). Like other noises, the primary response of wildlife due to approaching helicopters is to run and seek cover. This response would result in the expenditure of energy. Wildlife response to overflights during the winter may force movement through deep snow and result in excessive energy expenditure, especially during conditions typical of high avalanche hazard.

Klein (1974) reviewed the potential energy losses of animals due to reactions to aircraft overflights. He found that with flight altitudes above 500 feet, no panic response was observed. He suggested that under extreme weather or stress conditions, the net result of several overflights could be deterioration in the condition of the animals. While his studies focused on caribou on the tundra, repeated stresses on any species can accumulate to cause a negative effect on the animals. For avalanche mitigation, flights to and from the target area would be above 500 feet but during charge releases the helicopter would fly approximately 50-100 feet above the start zones for explosive delivery. The helicopter would then fly to a monitoring site where avalanche results would be recorded. Flight patterns in the starting zones may include flying and hovering for several minutes to determine wind patterns.

Behaviors of species, such as elk, that travel in herds are difficult to predict because individual response can influence the entire herd. Czech (1991) found that flight responses due to noise disturbance of herds of Roosevelt elk could often be attributed to the decision of one individual to flee for cover. The author also noted that there was less response from elk when forested cover was available nearby, though some areas within 250 meters of a busy road were avoided altogether. Kuck et al. (1985) reported that elk cows and calves moved from favorable habitat to marginal habitat when simulated mining noises were played back from loudspeakers during the summer. Disturbed calves traveled farther distances and occupied larger home ranges than undisturbed calves. The elk never habituated to the simulated mining noises and often moved to position geographic barriers between themselves and the disturbance. Although the authors found no difference in survival between disturbed and undisturbed calves, there was undoubtedly energy costs associated with greater movements that were not quantified in the study. The most likely impact on elk in the WAA from explosives use would be the flight of elk over the ridge, into the river valley below the tracks, or across the highway into what may be less favorable habitat. These areas may have more snow as they are north facing and less exposed to sunlight and wind action. They may eventually return to their previous range depending on the amount and frequency of explosives use and helicopter overflights.

Mountain goats, which also frequent the WAA during the winter, have shown adverse behavioral responses to helicopter overflights (Goldstein et al. 2005, Cote 1996, Foster and Rahs

1983, Poole and Heard 1998; reviewed by Wilson and Shackleton 2001). Responses to helicopters usually involved movements of the animals away from the area toward cover. Distances moved and duration of responses depended on the distance to the aircraft, the flatness of the terrain, and the proximity of escape cover. Fleeing and hiding responses were observed at helicopter-to-goat distances of <500 meters in Alberta (Cote 1996) and British Columbia (Foster and Rahs 1983). Maintenance behavior was also altered at 500-1,500 meters. In Alaska, changes in maintenance behavior lasted <2 minutes (Goldstein et al. 2005). Penner (1988) experimentally habituated a small population of mountain goats to noises and human presence associated with oil and gas development. The author found that goats could be habituated to a consistent, predictable noise that was introduced gradually, but continued to be disturbed by "initial, novel, or sudden noise and visual stimuli," including helicopters. This suggests that goats in the analysis area would not become accustomed to infrequent and sporadic explosive use or the use of helicopters for dropping handcharges. The presence of a mineral lick just north of the WAA (approximately two miles from the nearest avalanche path proposed for explosives use) attracts large numbers of goats to the area year-round. The cliffs in the analysis area are used during the winter and direct mortality or injury of goats is a possibility with explosives use. Abandonment of the immediate analysis area by goats due to explosives use is also likely, at least on a short-term basis. The mineral lick should be a sufficient distance from the analysis area that it would not be abandoned. However, some approach paths to the lick would likely be abandoned, changing the movement patterns of some goats.

Elk and mountain goats are key prey species for predators and scavengers such as wolves, mountain lions, lynx, and wolverine. Should elk and mountain goat be permanently displaced from this winter range, it is likely that these predatory species should be displaced as well. There would then be a net loss of biological diversity within the WAA. There could also be unintended consequences expressed in other unpredicted portions of the food chain.

Wildlife monitoring would occur as part of this alternative to ensure the effects of avalanche mitigation remain within the range of impacts determined in this document. Monitoring would result in impacts to individuals of the species chosen for observation and may involve the capture and radio-collaring of some individuals. A separate control area may be chosen off-site for monitoring that would allow researchers to determine regional natural variables impacting wildlife as opposed to those impacts directly related to explosive use. The impacts of monitoring would be temporary and would ultimately benefit the species by providing information to Park and Forest managers so decisions regarding explosive use could be adjusted if necessary. Monitoring would not impact an entire population and the overall impact to any species would be negligible.

The overall effect of this alternative on wildlife in the area would be **minor to major,** ***significant*****, and adverse,** depending on the frequency of explosive use. Impacts would be **short-term or long-term**. Short-term effects would be the immediate stress placed upon wildlife during avalanche reduction efforts that could lead to physiological or behavioral changes. Long-term impacts would be wildlife displacement from the area. John F. Stevens Canyon bisects one of the largest contiguous wild areas in North America, the Crown-of-the-Continent Ecosystem. Displacement of wildlife out of the corridor could decrease wildlife population connectivity within the ecosystem. Wildlife displaced from the area due to explosive use may eventually return after the 10-year period allowed in this alternative. Effects would also range from **site-specific to widespread**. Site-specific effects may include the altering of habitat within avalanche paths due to less frequent large avalanches and the displacement of wildlife from targeted avalanche paths. On a larger scale, local populations of a species such as elk may be displaced entirely from the John F. Stevens Canyon. The impacts and mitigation of snowshed construction, if instituted, would be the same as in Alternative B.

Alternative C Cumulative Effects

Past Actions: Past actions are the same as those listed in Alternative B.

On-going Actions: On-going actions are the same as those listed in Alternative B.

Foreseeable Future Actions: Future actions are the same as those listed in Alternative B.

Conclusion: The same impacts due to the travel corridor and fire suppression actions would be present under this alternative as in Alternative B. Over the last 50-100 years, wildlife present in the corridor have made behavioral adjustments to the presence of the highway and railroad, though some individuals are killed trying to cross them. Some wildlife may avoid the travel corridor altogether, no comprehensive surveys have been conducted to determine if some local species are entirely absent from the corridor. The level of alarm and/or stress that wildlife experience due to the noise of the travel corridor has been minimized to some extent due to their recurring nature. However, because the proposed explosives use would: 1) introduce a new and different type of noise that would be irregular in its occurrence; and 2) introduce explosives impacts/noise into habitats not currently being impacted (primarily higher elevation avalanche paths), it should be expected that wildlife within hearing distance of blasting noise would not habituate to the sound. Therefore, introducing this new type of noise during the winter would likely add an increased level of stress and cause an increase in the utilization of energy otherwise needed by wildlife to help them survive winter. This alternative would lessen the likelihood of an avalanche-caused derailment though not to the extent that Alternative B would. Alternative C in combination with existing conditions and future actions would cumulatively result in **adverse, localized to widespread, short-term to long-term** effects that could be **moderate to major** on wildlife occupying the analysis area depending on individual species' responses.

Alternative D: Long-term Explosive Use for Avalanche Hazard Reduction

The same type of impacts to wildlife would occur under this alternative as in Alternative C; however, the impacts would be more pronounced because of the longer duration of the control program and the larger noise footprint. Affected wildlife are not expected to habituate to avalanche hazard reduction blasting noise due to the irregular/ infrequent nature of explosive activities during any given winter. Artificial release of avalanches could alter the natural regulatory mechanism that determines population sizes of ungulates and also secondarily affects scavengers. Monitoring effects would be the same under this alternative as in Alternative C.

Firing an artillery shell results in two noise events, one from the gun location and one in the impact zone. Consequently, there are twice as many noise events with artillery than other devices (except the Avalanche Guard which also has two events per round) and the explosion affects a much larger area. Therefore, the chances of direct mortality, injury, stress, or the loss of hearing by wildlife in the area increase with the use of artillery.

The same displacement effects observed under Alternative C would occur under this alternative. Some animals would move out of the area; but with firing events occurring on average 2-3 times a year species, may not leave the area permanently. If the frequency of artillery use increases, there is a greater chance that some species may abandon the area completely; elk could abandon their wintering range and bears may not den on the slopes. The most likely pattern of control efforts would entail working up or down the canyon, firing at avalanche paths in order. Most animals would seek shelter in forested areas where control efforts would not occur. There is the possibility that explosions would push animals across the slopes and into adjoining paths. These paths may be targeted next for control efforts or could be triggered unintentionally by blasting nearby, thus increasing the potential impact on those animals. Greater seismic activity accompanying use of artillery would impact a larger area near the target zone and the potential for adverse impacts on smaller mammals would likely increase. Since winter survival, which includes range utilization and availability, is a key factor in population size, the effects on the overall population of ungulates of displacement from this portion of their winter range on a sustained basis would be considerable.

Artillery rounds are not biodegradable, and small pieces of shrapnel would remain scattered in the snow or on the slopes after detonation. In a study of explosive residues in the Wasatch Mountains of Utah, the concentrations of explosive residues in the snow at actual explosion sites did not exceed EPA Health Advisory standards (HA – technical guidance for Federal, State and local officials), or the 1 in 10,000 estimated cancer risk levels for the various explosive residue compounds (USGS 2003). It was also determined that explosive residues would dissolve in snow melt to such low levels that there would be no effect on water quality (see Water Quality). Consequently, wildlife species are not expected to be affected by residues left after control efforts. However, though unlikely, it is possible that wildlife could be attracted to the residues if they contain salts or attractive scents. This could ultimately result in the animals spending more time in avalanche starting zones.

Overall, Alternative D could result in **moderate to major, *significant*, adverse** impacts to terrestrial wildlife. At the very least, wildlife would be stressed and expend vital energy to seek shelter from the artillery. At worst, some individuals would be killed or injured. Potential injuries from blast effects include hearing loss, internal bleeding, blindness, and brain damage. Injuries may also occur from shrapnel and could include blunt force trauma, laceration, impalement, dismemberment, or body cavity perforation. Some individuals may abandon the area permanently if artillery is used throughout the winter. Spontaneous detonation of unexploded ordnance poses a similar risk to wildlife and people. The impacts would be **short-term or long-term** depending on whether species abandon the area entirely or return soon after firing has stopped. The impacts could be **site-specific to widespread,** again depending on the level of artillery use and the response of wildlife. Site-specific impacts could include changes in foraging habitat within avalanche paths due to more frequent but less intense avalanche events. Regional populations of some species such as elk could abandon their local wintering range, moving into less preferable habitat or habitat already occupied by other individuals.

Alternative D Cumulative Effects

Past Actions: Past actions are the same as those listed in Alternative B.

On-going Actions: On-going actions are the same as those listed in Alternative B.

Foreseeable Future Actions: Future actions are the same as those listed in Alternative B.

Cumulative Effects Conclusion: Cumulative impacts would be the same as in Alternative C; but would be more permanent. The same impacts due to the travel corridor and fire suppression actions would be present under this alternative as in Alternative B. Resulting stress levels and energy expenditures would be higher because of the longer duration of the program and the larger noise footprint. In combination with other recurring noises in the area including railroad operations and highway traffic this impact would be **major, regional, long-term, and adverse**.

Wildlife Conclusion

Alternative A would **not change current conditions** for wildlife in the John F. Stevens Canyon.

Under **Alternative B**, impacts on terrestrial wildlife would be **adverse** at a **minor to moderate** level, depending on the species. Larger animals would be inconvenienced by the snowsheds though not blocked from moving to a new area. Smaller animals may be prevented from moving through an avalanche path; though only individuals not populations would be affected. Disturbance during construction would be **short-term**; however, the permanent presence of the snowsheds would result in **long-term** impacts. Impacts would be **site-specific** to the location of the new snowsheds. The construction of new snowsheds would result in a decreased probability of an avalanche striking a train. If overcrossings are incorporated into snowsheds there could be a long-term benefit to wildlife in the corridor.

The overall effect to terrestrial wildlife from **Alternative C** would be **minor** (e.g. physiological stress) to **major** (e.g. direct mortality), **significant**, and **adverse**, depending on the frequency of explosive use. Impacts would be **short-term** (e.g. temporary increase in heart rate/energy utilization) or **long-term** (displacement from the area). There could be **adverse** impacts on wildlife diversity by permanently displacing some species from the area but species are expected to return to the area after the time period in which explosives would be used. Effects would also range from **site-specific** (altering of habitat within avalanche paths) to **widespread** (displacement from John F. Stevens Canyon).

Alternative D could result in **moderate to major, significant, adverse** impacts to wildlife because of direct mortality, increased stress, and displacement from habitat. The impacts would be **short-term or long-term** depending on whether species abandon the area entirely or return soon after firing has stopped. The impacts could be **site-specific to widespread**, again depending on the level of artillery use and the response of wildlife. Alternative D could have adverse impacts on wildlife diversity within John F. Stevens Canyon by permanently displacing some species from the area, along with those species dependent on them.

There is the potential for significant adverse impacts to wildlife under alternatives C and D. These impacts, if realized, may be considered key to the natural integrity to the southern part of the Park and could be interpreted as constituting an impairment to Park resources.

FEDERALLY THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

Methodology

For each species, a set of factors were identified that currently limit the species' distribution, threaten its recovery, or that are required for the species' survival.

Thresholds of impact for federally threatened and endangered species and species of concern are defined in Table 4-1 and summarized here:

- ***Negligible***: No federally listed species would be affected or an individual of a listed species or its critical habitat would be affected, but the change would be so small that it would not be of any measurable or perceptible consequence to the protected individual or its population. Negligible effect would equate with a "no effect" determination in U.S. Fish and Wildlife Service terms.

- ***Minor***: An individual(s) of a listed species or its critical habitat would be affected, but the change would be small. Minor effect would equate with a "may affect, not likely to adversely affect" determination for the species in U.S. Fish and Wildlife Service terms.
- ***Moderate***: An individual or population of a listed species, or its critical habitat would be noticeably affected. Moderate effect would equate with a "may affect" determination in U.S. Fish and Wildlife Service terms and would be accompanied by a statement of "likely…" or "not likely to adversely affect" the species.
- ***Major***: An individual or population of a listed species, or its critical habitat, would be noticeably affected with a vital consequence to the individual, population, or habitat. Major effect would equate with a "may affect, likely to adversely affect" determination in U.S. Fish and Wildlife Service terms and would require formal consultation.
- ***Short-term***: After implementation, would recover in less than 1 year.
- ***Long-term***: After implementation, would take more than 1 year to recover or effects would be permanent.

Analysis Area

A Wildlife Analysis Area (WAA) was created to define the area of impact for terrestrial wildlife species (Map 3-2). This area encompasses Park and Forest land from one side of the canyon to the other and includes that area which would be impacted directly by explosive avalanche hazard reduction and indirectly through noise disturbance.

Gray Wolf

The Northern Rocky Mountain Wolf Recovery Plan (USFWS 1987) identified three "key" components of wolf habitat:

1. a sufficient, year-round prey base of ungulates (big game) and alternate prey;
2. suitable and somewhat secluded denning and rendezvous sites; and
3. sufficient space with minimal exposure to humans.

In addition to the direct threat of mortality, impacts on wolves from the proposed alternatives would be analyzed in terms of their effects on these three habitat components. Indirect impacts including increased noise levels and effects of potential train derailments are also discussed. Information from wolf monitoring within the Park, from the scientific literature, and from consultation with the USFWS was considered.

Bald Eagle

In delisting the bald eagle from endangered to threatened status in 1995, the USFWS identified the two remaining major threats to the bald eagle:

1. destruction and degradation of habitat and
2. environmental contaminants.

Habitat degradation includes direct cutting of trees for shoreline development, human disturbance associated with recreational use of shorelines and waterways, and contamination of waterways from point and non-point sources of pollution. Contamination enters bald eagles through the food chain and may impair individual birds' reproductive success and health. It may also reduce the abundance of preferred prey. In addition to the threat of direct mortality, impacts to bald eagles are analyzed in terms of these threats.

Grizzly Bear

The goal for grizzly bear management in GNP is to provide sufficient quality habitat to facilitate grizzly bear recovery. An integral part of the goal is to implement measures within the authority of the NPS to minimize human-caused grizzly bear mortalities. The *Glacier National Park Bear Management Plan* (NPS 2001) guides the management of grizzly bears by prescribing measures that are necessary for the protection of the species and the safety of the park visitor. Objectives relative to grizzly bear recovery include:

1. provide adequate space to meet the spatial requirements of a recovered grizzly bear population;
2. manage for an adequate distribution of bears across the landscape;
3. manage for an acceptable level of mortality risk;
4. maintain/improve habitat suitability with respect to bear food production; and
5. meet the management direction outlined in the Interagency Grizzly Bear Guidelines (51 Federal Register 42863) for Management Situations 1, 2, and 3 (see *Affected Environment* or USFWS 1993).

In addition to the threat of direct mortality, impacts on grizzly bears from activities in each alternative are discussed in terms of these objectives.

Canada Lynx

Risk factors identified in the *Lynx Conservation Assessment Strategy* (Ruediger et al. 2000) that are applicable to the Park include:

1) wildland fire management policies that preclude natural disturbance processes,
2) roads and highways,
3) winter recreational trails,
4) habitat degradation by non-native invasive plant species,
5) incidental or illegal shooting and trapping,
6) competition or predation as influenced by human activities, and
7) human developments that degrade and fragment lynx habitat.

In addition, two important habitat components include:

8) young conifer forests where their primary prey, snowshoe hare, is abundant; and
9) travel corridors to move in their large and variable home ranges.

In addition to the threat of direct mortality, impacts on Canada lynx from activities in each alternative are discussed in terms of these risk factors and habitat components.

Bull Trout

Current conditions of the fish populations in the Flathead River system were assessed through analysis of studies by the U.S. Fish and Wildlife Service, Montana Department of Fish, Wildlife and Parks, U.S. Forest Service, and Glacier National Park. Both formal and informal consultation between Park and Forest biologists and the US Fish and Wildlife Service has also taken place. Knowledge of the ecological relationships and process associated with the Flathead aquatic system is well established. This analysis describes impacts on bull trout populations in terms of changes to habitat quality. The response of the aquatic system to further change, particularly Bear Creek because of past human degradation, would be quite rapid. Tolerance levels would also vary by time of year and flow regime. This analysis assesses:

1. potential impacts from controlled vs. uncontrolled avalanche activity and
2. potential impacts from train derailments.

Montana Special Concern Species

Each Species of Concern was considered separately based upon the status of the species in the analysis area and the scientific literature available for the species. In the analysis, some species are grouped based upon their ecological habits (e.g., forest carnivore, migratory bird, and fish).

IMPACT ANALYSIS – THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

Impacts Common to All

The use of the following devices and methods would not affect any of the species under any of the alternatives, with the possible exception of **negligible, site-specific, short-term, adverse** disturbance during installation or maintenance: signal wire, Doppler radar, geophones, non-explosive stability testing, a new weather station, and snow depth sensor. Any railroad, highway, or trail closures would temporarily benefit wildlife by reducing noise and disturbance caused by the normal use of these travel corridors, however the benefit would be negligible.

Individuals of a listed species could be impacted by spills caused by avalanches and some alternatives lessen the likelihood of train derailments caused by avalanches. The impacts to wildlife from a spill are difficult to quantify and would vary depending on the substance released, the extent of the spill, and the species in the vicinity of the spill. Grain spills and a syrup spill have occurred in the past and resulted in extensive cleanup, animal behavior problems, and management difficulties. Impacts due to a spill would be **adverse** and range from **negligible to major** depending on the amount and type of material spilled. Impacts could be **short-term to long-term** depending on severity of the derailment. The effects could be minimized if sufficient exclusion and cleanup of the area occurred soon after the spill but long-term impacts would occur if a large amount of a hazardous material were spilled. The size of the area impacted would range from **site-specific to regional** depending on the size of the spill and the substance.

A spill would probably have little impact on wolves unless it was a very large spill that released a particularly poisonous material. Wolves prefer to have minimal exposure to humans and probably spend little time near the railroad or highway. Wolves are probably not attracted to the railroad tracks on a regular basis by grain spills or carrion as bears are. The effects on wolves would be negligible to moderate, short or long-term, localized, and adverse if a spill occurred.

Based on limited efforts to document use, there is little evidence of bald eagle use of Bear Creek and impacts of spills would likely be very minimal, unless a hazardous substance affected the

Middle Fork several miles downstream. This could kill fish and other aquatic species that eagles feed on, possibly forcing eagles to leave the area and forage elsewhere. It could also result in the poisoning of eagles that eat contaminated fish. Depending on the content, timing, and size of the spill, the lasting effects could impact breeding eagles by reducing available forage in the spring and summer (factor 2). Eagles begin breeding in early March when avalanche activity is still a threat to trains in the corridor. Bald eagles might feed on carrion in the area during late winter when migration begins.

Spilled hazardous materials could result in short- and long-term adverse effects to grizzly bears, including direct mortality and destruction of habitat (factors 3 and 4). Spilled grain or other attractants could attract bears to the tracks where they could be hit by trains, as has occurred in the past.

Canada lynx are known to use the area and feed on carrion near the railroad tracks. However, most items carried by the railroad would not attract lynx if spilled during a derailment. Only a large spill of a hazardous substance would likely impact lynx. The effects of a spill on lynx would be negligible to major, short or long-term, localized, and adverse.

Bull trout could be *significantly* impacted by a hazardous material spill in Bear Creek caused by an avalanche (factor 2). They are present within Bear Creek and the Middle Fork of the Flathead River. Large numbers could be killed depending on the content and size of the spill. Impacts of a spill on bull trout would range from minor to major, short-term or long-term, site-specific to regional, and adverse.

Hazardous material spills could impact special concern species if they are located within the affected area. These impacts run the range of **minor to major, short-term or long-term, site-specific to regional and adverse**. Westslope cutthroat trout and shorthead sculpin would be affected in a similar way as bull trout and other species that rely on aquatic habitats such as the harlequin duck could also be adversely affected by a hazardous material spill. Fisher and wolverine may forage along Bear Creek or in the runout zones of the avalanche paths looking for carrion. Any species feeding on contaminated flesh may be poisoned by a hazardous material spill.

Avalanche activity can result in short-term impacts on the aquatic environment inhabited by bull trout due to increased sediments, potential erosion, and short-term damming. These impacts could be adverse by changing water quality or beneficial by creating new types of habitat not previously available (e.g. new spawning habitat). Avalanches naturally reach waterways when their runout zones are insufficient to stop the avalanche. Avalanche activity would occur under each of the alternatives; however, the magnitude and frequency could change.

Alternative A: No Action

Gray Wolf

There is limited data available for wolves in this area and it is unknown if denning or rendezvous sites are present (factor 2). The closest known pack locations are several miles away and the presence of the railroad and highway probably preclude wolves from regularly using the immediate area of the transportation corridor (factor 3). However, wolves, possibly including denning wolves, occasionally use the WAA for hunting since there are abundant ungulate populations, including elk wintering range. There are no activities expected under the No Action Alternative that would change conditions for ungulates or reduce ungulate populations (factor 1). Overall, there would be **no change from current conditions** for wolves from this alternative.

Bald Eagle

Under this alternative, periodic natural avalanches would continue to occur with effects. Bald eagles have been known to spend the winter along the Middle Fork of the Flathead River (NPS 1999). Natural avalanches would continue to influence vegetative and hydrological processes within this corridor, and have long-term beneficial effects. Long-term beneficial effects include soil and vegetation alteration that favors production of vegetation important as food for species such as snowshoe hare, deer, and elk which has beneficial consequences for bald eagles. Deer and elk killed in avalanches, or by collisions with a train, could provide food for scavenging bald eagles in the area. As avalanches have always been part of this species' environment, this alternative would have **no change from current conditions** for eagles wintering in the area or their habitat (factor 1).

Grizzly Bear

Under this alternative, the analysis area would continue to provide habitat for grizzly bears by managing the area for its wilderness qualities. Though the surrounding area is interrupted by the presence of the railroad and highway, the Park and Forest land encompassing the analysis area provides ample habitat for grizzly bears (factors 1, 2, and 4). Marked bears have been shown to use the analysis area as part of their home ranges including denning (Figure X) and foraging habitat (Waller and Servheen 2005, Waller unpublished data). The No Action Alternative would not change the extent, quality, or use of the existing habitat.

Under this alternative, periodic natural avalanches would continue to occur. Ungulates killed in avalanches provide food for scavenging grizzly bears. Natural avalanches would continue to influence vegetative and hydrological processes within the John F. Stevens Canyon, and have long-term, beneficial effects. Avalanche path dynamics create a unique disturbance vegetation habitat providing an important food source for grizzly bears and other prey species such as snowshoe hare, deer, and elk (factor 4). As avalanches have always been a part of this species' environment, there would be **no change from current conditions** for grizzly bears from the No Action Alternative.

Canada Lynx

Activities in the No Action Alternative are not expected to change conditions or increase the risk factors for lynx or snowshoe hare. The analysis area is currently designated as fire Management Unit B in the Park's Fire Management Plan which allows for prescribed fire, suppression of unwanted fires, and management fires that could be allowed to burn depending on conditions. Forests in the WAA have been altered in the past by fires and on NFS land by logging. The area currently consists of several different age classes of trees (factors 1 and 8). Snowshoe hare and lynx have both recently been confirmed using the analysis area, verifying the presence of appropriate prey and predator habitat (factors 1 and 8). Travel corridors for lynx have not been identified in the WAA (factor 9), though the railroad tracks and highway probably hinder movement to some extent (factors 2 and 7). Lynx have been reported to rarely cross openings greater than 100 meters wide (Koehler 1990) but track surveys in the analysis area have recorded lynx crossing the avalanche paths (Wollenzien 2005). There are few recreational trails in the WAA and none of them receive high amounts of use (factor 3). Weeds are present in the area, especially along the railroad tracks and highway, but no actions in this alternative would increase the spread of weeds (factor 4). Hunting and trapping are not allowed on Park land but are allowed on NFS land. Though, it is illegal to hunt or trap lynx (factor 5). Competition and predation are not expected to increase as a result of activities in this alternative (factor 6). The open vegetation conditions created by natural avalanche paths provide habitat for snowshoe hare, the primary food source for lynx. There would be **no change from current conditions** for lynx under this alternative.

Bull Trout

Avalanches occur naturally along Bear Creek and may have temporary impacts on the aquatic environment. However, these effects have always been part of the waterways natural cycle and conditions would not change for bull trout under this alternative (factor 1). Overall, there would be **no change from current conditions** for bull trout from the No Action Alternative.

Montana Special Concern Species

There would be **no change from current conditions** for any Special Concern Species under this alternative.

Alternative B: Construction and Modification of Snowsheds

Gray Wolf

Avalanche paths are not an important habitat type for wolves, and the railroad/highway corridor likely precludes wolves from using the immediate area for denning or rendezvous sites (factors 2 and 3). Noise produced during construction of snowsheds would additionally discourage wolves, and their prey, from using the habitat in close proximity to the railroad during construction (factor 1). The completed snowsheds would only present a slight inconvenience to wolf movements. An isolated emergency action of explosive avalanche triggering is expected to have little impact on the gray wolf population in the project area due to their large habitat area and transitory nature. Helicopter and explosive noise disturbance may temporarily displace individuals in the immediate explosive use area; however, wolf activity is expected to return to pre-activity conditions once explosive use is concluded. There is the chance that an individual animal would be hit or killed with an explosive or a triggered avalanche. This is a remote possibility; however, it increases the impact level of Alternative B to **moderate**. A direct hit can be mitigated by monitoring the starting zone before releasing explosives. The impacts of an isolated emergency explosive use action under Alternative B are not as great as those under alternatives C and D because the amount of anticipated explosive use is significantly less than in those alternatives. Therefore, impacts to wolves would be **long-term, site-specific, minor to moderate, and adverse**.

Bald Eagle

The construction of new snowsheds would have no permanent impacts to bald eagles. There are no known nest sites in the immediate vicinity of the analysis area and only foraging bald eagles could be impacted. No loss of habitat would occur and no contaminants would be released if proper management practices are employed during construction (factors 1 and 2). An isolated emergency action of explosive avalanche triggering is expected to have a slight impact on bald eagles in the project area. Disturbance from a helicopter or explosive detonation may cause temporary displacement from the area, however, individual birds are expected to return to their original habitat and behavior after the action. Helicopter disturbance would be decreased if flight paths were used that would avoid eagle nesting and roosting sites. There is no possibility for individual bald eagles to be hit during an explosive use action as eagles inhabit stream corridors and are not usually found in high altitude start zones. The impacts of an isolated emergency explosive use action under Alternative B are not as great as those under alternatives C and D because the amount of anticipated use is significantly less than in those alternatives. There could be an **adverse, negligible, short-term, and site-specific** impact from noise during construction of snowsheds.

Grizzly Bear

Levels of direct mortality from train collisions would not change (factor 3). New snowsheds in the analysis area would temporarily inconvenience grizzly bears traveling up an avalanche path but should not impede movements. Bears can easily move to the end of snowsheds and travel around the structures. Noise and activity associated with snowshed construction along the railroad tracks would be greater than the baseline level of activity. Therefore, noise present during construction of snowsheds may discourage the use of these areas temporarily. Habitat suitability with respect to bear food production would be maintained (factor 4) and management direction for the area would not be altered (factor 5). Only small, temporary changes to the availability of habitat with snowshed construction would occur and the overall distribution of bears in the area should not change (factors 1 and 2). Increased construction activity could be expected to temporarily displace some bears from preferred habitat, resulting in **short-term, minor, site-specific, adverse impacts** to grizzly bears. An isolated emergency action of explosive avalanche triggering could have an impact on denning or emerged grizzly bears in the project area. Helicopter disturbance may cause temporary physiological stress on denning bears; however, they are expected to return to normal physiology after the action is concluded. There is a remote possibility that an individual bear that has emerged from a den or an actual den could be hit or killed with an explosive in high altitude start zones during an emergency use action. The impacts of an isolated emergency explosive use action under Alternative B are not as great as those under alternatives C and D because the amount of anticipated use is significantly less than in those alternatives. An emergency explosive action would increase the anticipated impacts on grizzly bears to **long-term, minor to moderate, site-specific, and adverse**.

Canada Lynx

Lynx would be temporarily displaced during construction; however it is unlikely that they use the area near the railroad tracks because of their aversion to human presence. The effects on identified risk factors for lynx would be the same as for Alternative A. Impacts from shed construction would decrease as distance from the shed increases. Lynx could easily move to the end of snowsheds to travel around them and impacts would be **short-term, site-specific, minor, and adverse** during construction. An isolated emergency action of explosive avalanche triggering could have an impact on Canada lynx in the project area. Disturbance caused by a helicopter or explosive may result in temporary displacement and physiological stress. There is a remote possibility that an individual lynx that is in the immediate explosive use area could be hit or killed with a cast primer explosive or the resulting avalanche. The impacts of an isolated emergency explosive use action under Alternative B are not as great as those under alternatives C and D because the amount of anticipated use is significantly less than in those alternatives. An emergency explosive action would increase the anticipated impacts on Canada lynx to **long-term, minor to moderate, site-specific, and adverse**.

Bull Trout

If proper measures are taken to reduce erosion and to prevent chemical spills at the construction sites, there should be no impact on aquatic species during construction of snowsheds. Snowsheds may restore a more natural flow of avalanches down the slope, since they would cover the unnatural bench made by the railroad tracks. Consequently, in some locations, a snowshed may actually increase the amount of snow and debris reaching the waterway. The impacts of restoring this flow could include increases in damming and levels of sediment release into the waterway which could be adverse or beneficial to bull trout (factor 1, see impacts Common to All). The probability of an avalanche striking a train would be decreased with the addition of snowsheds (factor 2). Isolated explosive use for emergency measures is not expected to have an impact on bull trout in the project area. The impacts of an isolated emergency explosive use action under Alternative B are not as great as those under alternatives C and D because the amount of anticipated use is significantly less than in those alternatives. The overall impact to bull trout from Alternative B would be **minor, long-term, localized, and beneficial** because of the restoration of the natural avalanche flow and decreased likelihood of a spill.

Montana Special Concern Species

Snowsheds would present an inconvenience to some species traveling through the avalanche paths such as wolverines and fishers but would probably not create a barrier to their movement. These species could easily move around the snowsheds. It is unknown what habitats boreal toads use in the park, but they have been located in the Middle Fork drainage. If they use avalanche paths, snowsheds could create a barrier to their movements. Westslope cutthroat trout and shorthead sculpin would be impacted by avalanches or emergency explosive use in the same manner as bull trout. Townsend's big-eared bats could benefit from the presence of new snowsheds, which they could use as roosting sites. Construction noise and the presence of construction workers during the summer would affect most species in the area, including bird species, but this impact would be temporary. The overall impacts to species of concern from Alternative B would be **negligible to moderate** (i.e. boreal toads), **short-term to long-term, site-specific, and adverse**.

Alternative B Cumulative Effects

Past Actions: All of the past actions listed in Table 4-2 could have impacts on wildlife to some extent. However, the past actions most likely to impact wildlife populations within the WAA include: Going-to-the-Sun Road rehabilitation, fire suppression, train spills/derailments, recreational activities, hunting, and the use and maintenance of the railroad and highway.

On-going Actions: All present or ongoing actions listed in Table 4-2 also have an impact to some extent on wildlife in the region. However, the ongoing actions most likely to impact wildlife populations in the WAA include: rehabilitation of the Going-to-the-Sun Road, railroad and highway use and maintenance (including annual increases in amount of traffic), periodic fire suppression activities, recreational activities, hunting, train derailments/spills, and recreational use (especially in the winter).

Foreseeable Future Actions: All future actions listed in Table 4-2 would have an impact on wildlife in the area to some extent. However, besides the ongoing actions listed above, there are no specific future projects proposed to occur within the WAA that could impact wildlife populations.

Cumulative Effects Conclusion: The wildlife impacts associated with snowshed construction are primarily short-term noise disturbance during construction and the permanent placement of barriers through avalanche paths. The noise associated with snowshed construction in combination with noise already present because of the railroad and highway would discourage some wolves, bears, lynx, and eagles from using the analysis area. However, construction noise would be temporary and wildlife present in the area are most likely already accustomed to above normal sound levels due to the presence of the railroad and highway. The railroad tracks may even have become travel corridors for some bears that feed on food items sporadically spilled from trains. Some bears are killed by passing trains and this would continue to occur at present levels. New snowsheds would reduce the likelihood of an avalanche-caused derailment that could spill a large amount of animal attractants but smaller spills from leaking train cars would continue to occur. The likelihood of an avalanche-caused hazardous material spill into a bull trout stream is considerably reduced by snowsheds. The presence of the snowsheds could impede the movement of wildlife through the specific avalanche paths; however, the presence of the railroad and highway present much larger and more disruptive impediments to wildlife movement in the area. These impediments could be mitigated by incorporating animal crossing features into shed design and construction.

Since the major fires of the 1920s, fire suppression activities have undoubtedly altered the natural vegetation regimes, and thus the available wildlife habitat, within the Canyon. Controlling fires may have increased forest cover and reduced the size or number of natural avalanche paths. However, the extent of these changes and their impact on local wildlife populations is unknown. The Park determined that the Going-to-the-Sun Road rehabilitation would likely have an adverse effect on grizzly bear populations in the central part of the Park, and the USFWS concurred with this finding. Grizzly bears from this area may be displaced by the ongoing road construction work over the next 8-10 years. Some of those grizzly bears may disperse to the WAA changing population densities and dynamics in the area. Considering all of the actions both inside and near the WAA, the overall cumulative impacts on wildlife from past, present, and future actions are **moderate, long-term, regional, and adverse** primarily due to the fragmentation of habitat and disturbance caused by the highway and railroad. The building of snowsheds adds only negligibly to this impact.

Alternative C: Short-term Explosive Use for Avalanche Hazard Reduction

Monitoring of wildlife would be required for explosives use under this alternative, though it would not lessen the impacts of the control activities. Monitoring of threatened or endangered species conducted under this alternative would be performed in consultation with the USFWS. Wildlife monitoring would result in impacts to individuals of the species chosen for observation and may involve the capture and radio-collaring of some individuals. However, the impacts would be temporary and would ultimately benefit the species by providing information to Park and Forest managers so decisions regarding explosive use could be adjusted if necessary. Monitoring would not impact an entire population and the overall impact to any species would be negligible. If snowsheds are built, the impacts of construction activities would be the same as under Alternative B.

Gray Wolf

Wolf observations are not common in the WAA but their actual level of use of the area is not known. The chances of a direct hit with explosives on a wolf are unlikely because wolves would be unlikely to be in an avalanche path during the deep snow conditions that require explosives use. If there are wolves in the area during explosives use they would most likely leave the area, at least on a temporary basis. Long-term displacement of wolves from the area would most likely occur if wolf prey species such as elk and deer were displaced permanently from the area, which is a possibility under this alternative.

Klein (1974) studied the effects of low-flying aircraft on caribou and other large mammals in arctic Alaska after restrictions were placed on hunting from aircraft and noted that wolves appeared the least disturbed of all species observed. Where overflights are common and predictable for research or tourism, wolves may become habituated to the approach of aircraft. However, in areas where wolves are hunted or trapped from aircraft, they exhibit a strong escape response when pursued by low-level aircraft. Wolves tracked from low level fixed-wing aircraft have been observed moving quickly away from the aircraft into forest cover (NPS files). Overflights may displace wolves from areas within the flight path; however, any displacement is expected to be temporary. Overflights for dropping handcharges would be below 500 feet and are not expected to occur frequently enough that habituation to the disturbance would occur.

Low-level aircraft flights also may have the potential to disturb and displace wolves at important den and rendezvous sites. Wolves in Northwest Montana did not abandon an occupied rendezvous site that was subjected to daily low-level helicopter overflights from a nearby logging operation (Claar et al. 1999). Wolves, even while denning, have demonstrated tolerance to human activities (Thiel et al. 1998). In addition, while a wolf may move her pups in response to a disturbance, human disturbance does not seem to decrease pup survival. Wolves using the area are probably dispersing from a pack or foraging as no known pack or denning locations are known from the area. Disturbance associated with proposed flights in GNP is not expected to adversely affect breeding wolves because low-level flights would not occur during the critical period in late spring and summer when wolves are most sensitive to disturbance at den sites.

The overall impact on wolves from Alternative C depends on the level of use by wolves and the amount of explosives used. Impacts could range from **minor** (i.e. little foraging currently occurs in WAA) **to major** (i.e. direct mortality or displacement from the area), **short-term to long-term** displacement, **localized**, **and adverse**.

Bald Eagle

The bald eagle nesting season starts in early March and avalanche conditions can persist through April. Consequently, explosives could be used during the early nesting period when eagles are especially sensitive to disturbance (Hamann et al. 1999). Currently, there are no known nest sites close enough to the analysis area to be impacted by avalanche hazard reduction efforts. However, new nest locations could be inhabited in the future and regular use of explosive devices in March and April would preclude bald eagles from establishing a nesting territory in the WAA. This is a direct loss of nesting habitat for bald eagles during the period that explosives would be used. In addition, eagle migration, both bald and golden eagles, begins in late February, peaks in March, and declines by April. Occasional migrating birds may pause to feed on carrion in the avalanche paths and be present during avalanche reduction efforts.

Bald eagles forage along the Middle Fork of the Flathead River during the winter months and could be discouraged from using the WAA by frequent explosive and helicopter use. Raptors have been identified as being especially sensitive to aircraft disturbance, particularly during the nesting period (Trimper et al. 1998). However, since bald eagles have not recently nested in the area, do not forage frequently along Bear Creek, and have additional nearby foraging areas the overall impacts to bald eagles would be **minor, long-term, localized, and adverse** from this alternative.

Grizzly Bear

Grizzly bears would most-likely be within their dens during blasting events, though bears could emerge as early as March and remain near their dens. Mortality from an explosive hit is a possibility and the chances depend on the amount of blasting that occurs. Impacts within a den would more likely be due to noise and seismic waves. Reynolds et al (1986) studied responses of denning grizzly bears to noise associated with winter seismic surveys and small fixed wing aircraft in Alaska and found that underground blasts 1-2 km distant of denning grizzly bears caused brief periods of movement in the den but did not cause bears to leave the dens or otherwise disrupt their winter torpor. Explosions from avalanche reduction efforts could be much closer than 1-2 km. Mace and Waller (1997a) routinely observed snowmobile activity within 2 km of denning grizzly bears and did not observe den abandonment. Blix and Lentfer (1992) found that an artificial polar bear den under 1 meter of snow reduced the noise level of a helicopter taking off 3 meters from the den from 115 dB above ground to 77 dB in the den. They also reported that a drilling tower 30 meters from a den produced noise levels within the den of 36-42 dB which is approximately equivalent to the background noise in a residential neighborhood. However, the cold, dry snow of the test area in Alaska may absorb or muffle sound more effectively than the relatively warm, wet snow that produces avalanche conditions in northwest Montana.

As shown in Map 3-2, much of the higher avalanche starting zones in the analysis area are considered potential denning habitat for grizzly bears. This map also shows a buffer area around potential denning habitat in which seismic activities such as blasting could affect bears. Of the identified 78 potential explosives targets, 25 are at 6,000 feet or higher; modeled grizzly bear denning habitat in the analysis area begins at approximately 5,900 feet. Therefore, potential denning habitat would be adversely affected by blasting noise. Some bears in the arctic tundra of northeast Alaska abandoned den construction due to helicopter disturbance, although most bears in this study (Quimby 1974) apparently returned to the den or entered a new den. There is very little data available showing where grizzly bears den in the park including the analysis area.

Indirectly, this alternative could result in mortality of young if a female has given birth to cubs and the female pre-maturely emerges from a den and/or abandons young as a result of blasting noise effects (US Fish and Wildlife Service 1993). The potential indirect impact on all age and sex classes of bears is less clear but includes the utilization of energy that is not replaceable during winter unless carrion was found while bears were out of the den. It is unknown whether premature abandonment would result in mortality.

A summary of the literature by the Interagency Grizzly Bear Committee (IGBC 1987) concluded that there is wide variability in the reaction of grizzly bears to aircraft disturbances. Research in Canada and GNP has documented that grizzly bears moved away from helicopters when approached (Harding and Nagy 1980, Kendall 1986). Kendall (1986) documented that 81% of grizzlies observed during low-level helicopter flights in the Apgar Mountains of GNP displayed a strong reaction. A “strong” reaction was defined as a bear moving faster than a slow walk, while a “mild” reaction was indicated when a bear did not move at all or slowly walked as the helicopter approached. Researchers in Yellowstone National Park (Graham 1978) and GNP (Peacock 1978) observed that grizzlies often fled into timber when approached by fixed-wing aircraft. However, Schleyer (1983) noted that grizzlies on day beds were not disturbed by fixed-wing aircraft monitoring flights. In frequently disturbed locations, animals may be habituated to aircraft activities; however, helicopter use for avalanche hazard reduction is not expected to occur often enough to result in habituation to the noise.

McCourt et al. (1974) noted that grizzly bears in the open tundra of Yukon and Alaska demonstrated greater response to small fixed wing aircraft than either moose or caribou, and unlike the ungulates, the grizzly bears did not exhibit a decrease in response with increased aircraft altitude. The authors recommend avoiding low level flights over areas with known grizzly bear concentrations, and avoiding circling or hovering over bears with helicopters. They also recommend a 1,000-foot above-ground level (AGL) minimum altitude for aircraft flying over open habitats. For dropping charges, helicopters would fly within 500 feet of the ground. Bears could be within their dens or they could have emerged from their den and still inhabit the slopes during avalanche reduction efforts. As mentioned above, the amount of snow cover around a den can considerably lessen the noise from a helicopter (Blix and Lentfer 1992).

Bears that move away from a disturbance expend extra energy and possibly enter an area occupied by another bear and experience stress. Bears that stay in the area may experience stress (McLellan and Shackleton 1989). Klein (1974) reviewed the potential energy losses of animals due to reactions to aircraft overflights. He found that at altitudes above 500 feet, no panic response was observed. He suggested that under extreme weather or stress conditions, the net result of several overflights could be deterioration in the condition of the animals. While his studies focused on caribou on the tundra, repeated stresses on any species can accumulate to cause a negative effect on the animals.

Aune and Kasworm (1989) monitored radio-collared grizzly bear movements in response to oil and gas exploration and seismic activities from 1980 to 1984, in an area along Montana's Rocky Mountain East Front. The seismic surveys were helicopter supported programs using a surface charge (blast) to measure seismic response of the subsurface. Aircraft flying within 1 km of a collared bear caused the bear to move away from the noise as did seismic activities; however, bears were not permanently displaced from their home ranges.

Depending on the amount of blasting that occurs each year, grizzly bear prey species (e.g. elk, deer, goats, and moose) could also abandon the area. If triggered avalanches result in less avalanche-caused ungulate mortality, grizzly bears could be affected by the reduction in carrion during the critical late winter-spring period. This could reduce bear densities in the WAA and force grizzly bears to disperse to other areas, thus increasing bear densities, or conflict, in surrounding locations. Grizzly bear habitat could also be altered by creating more frequent and less severe avalanches. This impact would be negligible as natural avalanche process disruption over a 10-year period is not likely to measurably impact vegetation patterns in the paths.

Bears would likely be displaced from at least the analysis area during the 10-year period, and perhaps from the entire WAA, resulting in direct habitat loss (factor 1). The use of explosives would be contrary to the assigned Management Situation (1) for the area in which management decisions would favor the needs of the grizzly bear when grizzly habitat and other land-use values compete (*Interagency Grizzly Bear Guidelines*) (factor 5). The range of impacts from Alternative C on grizzly bears would be: **moderate** (i.e. grizzly bear prey species abandon the area) **to major** (i.e. a denning female abandons a den with cubs due to explosive use), **short-term** (i.e. temporarily disturbed within den) **to long-term** (i.e. cubs are abandoned and/or bears are displaced from WAA)**,** **localized** (i.e. vegetation patterns within avalanche paths are altered)

to widespread (i.e. bear distributions in area are disrupted due to bears dispersing from WAA), and **adverse**.

Canada Lynx

Canada lynx are known to be present in the area during the winter and have been observed feeding on avalanche-killed carrion. Lynx have a competitive advantage in soft snow during winter months because of their long legs and large feet pads (Buskirk et al. 2000). Therefore, they could be present in the analysis area during storm events. Still, the chances of directly hitting a lynx with explosives are remote and would increase with an increase in explosives use. Like other wildlife, lynx would likely be displaced from the area if explosives are used on a regular basis. The explosive-use threshold at which they would leave the area is unknown. Their movements are also greatly influenced by the presence of their primary prey, the snowshoe hare. Rabbits are not long-distance dispersers so it is unlikely they would leave the area entirely.

Conditions influencing risk factors 1, 2, 3, 5, and 7 would not change from Alternative A. The charges used in this alternative are not expected to disturb soil conditions enough to encourage invasion by weeds (factor 4). If lynx leave the area due to explosives they may move into the home ranges of adjacent lynx and increase competition for resources (factor 6). The amount of habitat and travel corridors available to lynx and snowshoe hare is not expected to change; however, forested areas adjacent to avalanche paths may be avoided if the paths are regularly blasted (factors 8 and 9).

Overall impacts to Canada lynx would depend on their use of the area and the amount of explosives used: **moderate** (i.e. a lynx is harassed enough to leave the WAA at least temporarily) **to major and significant** (i.e. direct mortality), **short-term to long-term** displacement, **localized**, **and adverse**.

Bull Trout

Direct mortality of bull trout is not expected but they would be indirectly impacted if the aquatic environment is altered. Avalanche frequency could be slightly increased from this alternative, and these effects could be beneficial or adverse (factor 1, see Common to All Alternatives). Chemical residues from explosives are not expected to occur at levels that would affect water quality or aquatic species (see Water Quality). The probability of an avalanche striking a train would be reduced but not as effectively as in Alternative B (factor 2). The overall effect on bull trout from this alternative would be **negligible, long-term, site-specific, and beneficial** due to a decrease in the possibility of a spill.

Montana Special Concern Species

Wolverines are known to use avalanche paths for denning and foraging in the winter. They are known to occur within the WAA during the winter, though exact use levels for the WAA are unknown. Avalanche debris provides suitable denning sites and carrion from avalanche-killed ungulates which are important food items for wolverines during the winter (Krebs and Lewis 2000). There is the possibility of direct mortality or displacement due to explosives use. It is unknown to what extent the artificial triggering of avalanches could alter the occurrence of carrion and wolverine feeding patterns. The ongoing GNP wolverine study shows that wolverine regularly move through avalanche start zones (Copeland and Yates 2006), and thus would be vulnerable to disturbance from helicopters or blasting. Female wolverines begin using a natal den in February and would move young to additional maternal dens located nearby in April and May (Copeland and Yates 2006). Krebs and Lewis (1999) found natal dens within avalanche paths. Therefore, active wolverine dens could be impacted by avalanche reduction activities. Displacement of elk, deer, moose, and mountain goats from the WAA could eliminate this area as useful foraging habitat for wolverine.

Fishers could be present in the forested areas adjacent to avalanche paths and could also be displaced from the area by explosives.

A golden eagle nest was located on Snowslip Mountain in 2000. Though it is unknown if the nest site has been used since 2000, golden eagles were sighted in the WAA in 2006 soaring above Snowslip Mountain and feeding on carrion in the WAA (Alban 2006). Golden eagles begin nesting in March or April and impacts of explosives use and helicopters would be the same as for bald eagles. They could be discouraged from using the Snowslip nest site if explosives are being used during this time of year.

Westslope cutthroat trout and shorthead sculpin would be impacted the same as bull trout.

Resident bird species including great gray owl and white-tailed ptarmigan could be present within avalanche paths however it is more likely they would seek shelter in forested areas during storm events that would require avalanche mitigation. Northern goshawk and brown creeper inhabit forested areas and should not be present within avalanche paths. Northern hawk owls and black-backed woodpeckers primarily frequent recently burned forests in the Park and are unlikely to be present in the analysis area during avalanche mitigation efforts. All of these species may be temporarily displaced from adjacent areas within the WAA due to explosive and helicopter noise.

Harlequin duck, boreal toad, peregrine falcon, Lewis' woodpecker, olive-sided flycatcher, and black swift are all absent from the WAA during the winter and their preferred habitats should not be altered by this alternative. Townsend's big-eared bat would also not be present during the winter but could use snowsheds as described in Alternative B.

Impacts to Special Concern Species could range from **none to major and significant** (direct mortality), **short-term to long-term, site-specific to localized, and adverse** (except bats which may benefit from new snowsheds).

Alternative C Cumulative Effects

Past Actions: Past actions would be the same as those listed in Alternative B.

On-going Actions: On-going actions are the same as those listed in Alternative B.

Foreseeable Future Actions: Future actions are the same as those listed in Alternative B.

Cumulative Effects Conclusion: The impacts of other actions in or near the analysis area would be the same as in Alternative B. Over the last 50-100 years, wildlife in the area have made behavioral adjustments to the presence of the highway and railroad, though some individuals are killed trying to cross them and some wildlife avoid the travel corridor altogether. The level of alarm and/or stress that wildlife experience due to the noise of the travel corridor has been minimized to some extent due to their recurring nature. However, because the proposed explosives use would: 1) introduce a new and different type of noise that would be irregular in its occurrence; and 2) introduce explosives impacts/noise into habitats not currently being impacted (primarily higher elevation avalanche paths), it should be expected that wildlife within hearing distance of blasting noise would not habituate to the sound. Therefore, introducing this new type of noise during the winter would likely add an increased level of stress and cause an increase in the utilization of energy otherwise needed by wildlife to help them survive winter. Other actions would only add to this level of stress.

This alternative would lessen the likelihood of an avalanche-caused derailment though not to the extent that Alternative B would. These impacts would be similar on other species with large home ranges including wolves, Canada lynx, eagles, wolverine, and fisher. Species not present in the winter such as migratory birds would not be affected unless their habitat was altered substantially by several projects. Alternative C in combination with existing conditions and future actions would cumulatively result in **adverse, localized to widespread, long-term** effects that could be **moderate to major** on wildlife occupying the analysis area depending on individual species' responses. The level of species impact depends on such factors as mobility, home range size, and tolerance for disturbance.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Impacts due to helicopter use would remain the same as under Alternative C. If snowsheds are built, the impacts of construction activities would be the same as under Alternative B.

Gray Wolf

Because of the indefinite duration and larger noise footprint, it is probable that elk and deer would be displaced from their winter range in the WAA (factor 1). Impacts to denning and rendezvous sites would be the same as under Alternative C. If there are rendezvous sites in the WAA they may be abandoned (factor 2). The overall result of explosive use would be a direct loss of habitat due to human activities (factor 3). Impacts to gray wolves would be **moderate** (i.e., prey species leave the WAA) **to major** (direct mortality or long-term displacement)**, long-term, localized to widespread, and adverse**.

Bald Eagle

Impacts to bald eagles under this alternative would be similar to those under Alternative C; however, the impacts would be longer lasting and have a larger effect on the Bear Creek and Middle Fork River corridors because the artillery would be fired from the corridor. Bald eagles would be unlikely to nest in the WAA if explosives are used in March and April when eagles are nest building. This would result in a permanent loss of available nesting habitat (factor 1). Foraging bald eagles would also be displaced from the area during control activities but may return to forage afterwards. Explosive residues are not expected to remain at levels that would contaminate an eagle's food source (factor 2). Since bald eagles currently do not frequently use the analysis area, the overall impacts to bald eagles would be **minor** (temporary loss of potential foraging area) **to moderate** (long-term loss of potential nesting habitat)**, long-term, localized, and adverse** from this alternative.

Grizzly Bear

It is more likely under this alternative that the adverse impacts described under Alternative C would be realized. The permanent use of the artillery and larger noise footprint would likely disturb any denning bears in the WAA and the likelihood of direct injury or mortality would be highest under this alternative, including the risks posed by unexploded, unrecovered munitions (factor 3). Long-term, regular artillery use may adversely impact and displace prey species such as elk and deer that grizzly bears feed on in the winter and early spring (factors 2 and 4). Bears would likely be displaced from the WAA resulting in direct habitat loss (factor 1). The use of explosives would be contrary to the assigned Management Situation (1) for the area in which management decisions would favor the needs of the grizzly bear when grizzly habitat and other land-use values compete (*Interagency Grizzly Bear Guidelines*) (factor 5). The use of helicopters for explosive delivery or to construct or service structures would also disturb grizzly bears. The continuous use of explosives in the WAA under this alternative would likely deter grizzly bears from returning to the area. The overall impact on grizzly bears from this alternative would be **significant and major, long-term, localized to regional, and adverse**.

Canada Lynx

Under this alternative, Canada lynx would be impacted in the same manner as in Alternative C except the impacts would be permanent. Highway and trail use would be temporarily suspended during mitigation activities but this short duration would not greatly benefit the lynx (factors 2 and 3). Artillery impact sites could be disturbed enough to become vulnerable to weed invasions spreading from populations already present along the railroad tracks (factor 4). The incidence of suitable habitat for lynx and their prey would decrease as lynx and hares leave the areas that are shelled (factor 8). Lynx displaced from the area would be forced to move into adjacent areas where competition with other lynx may occur (factor 6). Lynx may avoid the area as a travel corridor if explosives are used on a regular basis during the winter (factor 9), and thus increasing habitat fragmentation. There would be no change in fire management policies (factor 1) or in levels of hunting (factor 5). Overall impacts to lynx would be **moderate** (i.e. a lynx is harassed enough to leave the WAA at least temporarily) **to major** (i.e. direct mortality or permanent displacement), **long-term**, **site-specific to localized**, **and adverse**.

Bull Trout

Under this alternative, bull trout would be impacted the same as in Alternative C, except for a longer duration (factor 1). Artillery residues are not expected to impact water quality, and thus aquatic resources. The probability of an avalanche striking a train would be reduced but not as effectively as in Alternative B (factor 2). The overall effect on aquatic species from this alternative would be **negligible, long-term, site-specific, and beneficial** due to the reduced chances of a spill.

Montana Special Concern Species

Impacts to Special Concern Species would be the same or greater as those in Alternative C but the impacts would be permanent. Artillery munitions would have a much greater potential to directly injure or maim species of special concern, either during control efforts or through unplanned detonations of unexploded ordnance. Impacts would be **none to major** (direct mortality), **long-term, site-specific to localized, and adverse** (except for bats which may benefit from snowsheds).

Alternative D Cumulative Effects

Past Actions: Past actions would be the same as those listed in Alternative B.

On-going Actions: On-going actions are the same as those listed in Alternative B.

Future Actions: Future actions are the same as those listed in Alternative B.

Cumulative Effects Conclusion: The cumulative effects would be the same as under Alternative C, only more pronounced and permanent. Resulting stress levels and energy expenditures would be higher because of the permanence of the program and the larger noise footprint. In combination with other actions in the area, including railroad operations and highway traffic, this impact would be **major, regional, long-term, and adverse**.

Federally Threatened and Endangered Species and Species of Concern Conclusion

Under Alternative A, there would be **no change** from current conditions for all species.

Impacts from Alternative B are primarily **minor** effects related to the construction and presence of new snowsheds. Impacts would be **short or long-term, site-specific, negligible to moderate, and adverse** on wolves, eagles, and bull trout. Impacts would be **short-term, minor, site-specific, and adverse** to grizzly bears and Canada lynx. The overall impacts to species of concern from Alternative B would be **negligible to moderate, short-term to long-term, site-specific, and adverse** (except bats which may benefit from new snowsheds).

Alternative C would likely result in habitat loss for some listed species. Some species would be displaced from the WAA, at least temporarily. There would be **moderate to major**, **short-term or long-term**, **localized**, **and adverse impacts** to wolves. Since bald eagles have not recently nested in the area, do not forage frequently along Bear Creek, and have additional nearby foraging areas the overall impacts to bald eagles would be **minor, long-term, localized, and adverse** from this alternative. The range of impacts on grizzly bears would be: **moderate to major**, **short-term to long-term, localized to widespread**, and **adverse**. Overall impacts to Canada lynx would depend on their use of the area and the amount of explosives used and would range from **moderate to major and significant**, **short-term to long-term**, **localized**, **and adverse**. The impacts to bull trout would be **minor, short or long-term, site-specific to localized, and adverse**. Impacts to Special Concern Species could range from **none to major and significant**, **short-term to long-term, site-specific to localized, and adverse** (except bats which may benefit from new snowsheds).

Alternative D would likely result in habitat loss for some listed species. Some species would be displaced from the WAA, perhaps permanently. Impacts would be more pronounced under Alternative D because of the longer duration of the control program and the larger noise footprint. Impacts to gray wolves would be **moderate to major, long-term, localized to widespread, and adverse**. Since bald eagles currently do not frequently use the WAA, the overall impacts to bald eagles would be **minor to moderate, long-term, localized, and adverse**. The overall impact on grizzly bears from this alternative would be **significant and major, long-term, localized to regional, and adverse**. Overall impacts to lynx would be **moderate to major**, **long-term**, **site-specific to localized**, **and adverse**. The impacts to bull trout would be **minor, long-term, localized, and adverse**. The impacts to Species of Concern would be **none to major**, **long-term, site-specific to localized, and adverse** (except for bats which may benefit from snowsheds).

There is the potential for significant adverse impacts to individuals of a threatened or endangered species, or a Montana species of special concern under alternatives C and D. These impacts, if realized, may be considered key to the natural integrity to the southern part of the Park and could be interpreted as constituting an impairment of Park resources.

AIR QUALITY

Methodology

No air quality modeling has been done for this EIS on emissions or hazardous material spills since there are too many unknown factors. Engine emissions from most types of locomotive engines are known, however we do not know the type or the number of engines that would be delayed nor do we know how long they would be delayed. The railroad carries a number of materials that are considered health hazards if they are not contained. These materials are variable and the amount, location, and hazardous properties of a potential spill are not known for this evaluation.

Current and historic air quality data has been collected at Glacier National Park's Air Quality Station, located at West Glacier, since the mid 1970's. Glacier participates in the National Dry Deposition Network (NDDN), National Atmospheric Deposition Program (NADP), Mercury Deposition Network (MDN), and the Interagency Monitoring of Protected Visual Environments program (IMPROVE).

Most standard blasting materials result in a suite of residues, including various compounds of nitrobenzene, nitrotoluene, dinitrobenzene, dinitrotoluene, trinitrobenzene, trinitrotoluene, RDX, amino dinitrotoluene, dinitroanaline, amino dinitrotoluene, and tertyl. Locomotive engine emissions include oxides of nitrogen, carbon dioxide, hydrocarbons, oxides of sulphur, particulate matter, carbon monoxide and polycyclic aromatic hydrocarbons.

Impacts on air quality have been determined by air quality specialists based on available information, professional knowledge, and familiarity with the analysis area.

Thresholds of impact for air quality are defined in Table 4-1 and are summarized here:

- *Negligible:* Changes in air quality would not be measurable.
- *Minor:* Effects would result in a measurable change in air quality, although the changes would be small and the impacts would be localized.
- *Moderate:* Effects on air quality would be readily measurable and widespread and air quality standards could be exceeded. May be localized or regional in scale.
- *Major:* Effects would be readily measurable on a regional scale, and air quality standards would likely be exceeded.
- *Short-term:* **Effects would occur only d**uring implementation
- *Long-term:* Effects would be continuous or permanent

Analysis Area

The air quality analysis area has the potential to extend in excess of 100 kilometers on either side of the project area due to train delays that may occur if the tracks are shutdown. Hazardous material spills may impact air quality downwind of the spill area depending on the properties of the spilled substance.

IMPACT ANALYSIS- AIR QUALITY

Impacts Common to All Action Alternatives

Emissions from a locomotive are dependent on the type, size, and age of the engine – factors that are highly variable at a given time. The first emissions regulations for railroad locomotives were adopted by the EPA in 1997. The 1997 rule adopted Tier 0-2 emission standards for Nox, HC, CO, PM, and smoke for newly manufactured and remanufactured railroad locomotives. Under the alternatives, trains would be delayed for natural snow stabilization in Alternative A and B and for explosive use in Alternatives C and D. For the Alternatives that involve snowshed construction, once snowsheds are constructed under Alternative B and C, locomotives would not need to be delayed. The location of trains during delays is unknown. The emissions from an engine would have a greater impact on human air quality if the trains are stopped in a populated area than if they are stopped in an unpopulated area due to greater human exposure in populated areas. Since train delays involve stopping trains along the railroad tracks and not in a concentrated group, it is assumed for the purposes of this EIS, that there would be a **negligible, adverse, localized, short-term** impact from idling locomotive engines for Alternative A, B, C, and D. Alternative A may result in more delay time due to natural snow stabilization and the emissions from idling locomotives may have **minor, short-term, site-specific adverse** impacts on air quality. Once snowsheds are constructed under Alternatives B and C, there would be **no effect** on air quality.

The greatest impact on air quality would be the potential release of hazardous gases into the atmosphere from an avalanche caused train derailment. Each alternative has a different chance of train derailment. The no action alternative has the greatest potential for train derailment from avalanches only if the tracks remain open during high avalanche hazard. Alternatives B and C both provide the greatest protection with snowsheds for train derailment. Explosive avalanche hazard mitigation under Alternative C and D provides avalanche protection by release of avalanches and by delaying trains during high avalanche hazard. The reduction in potential for derailment is specifically related to direct snowshed protection or indirect protection with explosive use. Trains passing over Marias Pass carry large quantities of every hazardous material that is transported on highways. These materials, if released into the atmosphere, could cause a range of impacts on people, vegetation, wildlife, and aquatic resources. The impacts on air quality range from **short to long-term, minor to major, localized to regional**.

Alternative A (No Action)

Current conditions for air quality are not expected to change under the No Action Alternative. BNSF operations in the analysis area would remain the same; existing avalanche safety programs, detection systems, forecasting, and non-explosive snowpack stability testing would be the only means for avalanche hazard mitigation. There would be **no effect** on air quality under this alternative with non-explosive avalanche hazard mitigation operations.

Alternative B: Construction and Modification of Snowsheds

According to BNSF, construction of snowsheds could take 5-20 years depending on the number of snowsheds built. Heavy equipment use and snowshed construction would result in a **minor** impact on air quality. BNSF operations in the analysis area would remain the same; existing avalanche safety programs, detection systems, forecasting, and non-explosive snowpack stability testing would continue. There would be little measureable impact on air quality from an isolated emergency use of explosives action. Impacts on air quality from Alternative B would result from construction activities associated with extensions and new snowsheds that could have **negligible to minor, localized, short-term impacts.**

Alternative B Cumulative Effects

Past Actions: Past actions affecting air quality involve development and growth actions. Construction, large machinery use and ground disturbance produce dust, particulate, and emissions in localized situations. US Highway 2 maintenance and operation, railroad maintenance and operation, snowshed construction, past derailment cleanup, helicopter use, recreational use, gas pipeline installation, timber salvage, trail construction, rock blasting, and overflights are previous activities that adversely impact air quality. While particulate and emissions have a minor impact air quality, the effects quickly disipate after the action. No exceedances of particulate standards are exceeded with these actions. Wildfire suppression has a beneficial impact on air quality as smoke impacts air quality on a regional scale. Prescribed burns introduce smoke into the air, but the impact is monitored closely. Prescribed burns are smaller in scale, burn less fuel, and produce much less smoke than large scale wildfires. The impacts on air quality from prescribed burns may appear large in **site-specific** actions, but when compared with the **major** impacts of large-scale wildfire, the impacts of prescribed burns are **minor**.

On-going Actions: Road and railroad maintenance activities, timber salvage, overflights, and recreation (dirt road and snowmobile use) all produce particulate, dust, and emissions resulting in minor, site-specific, adverse impacts. These impacts are temporary as air pollution disipates quickly. Fire suppression and prescribed burns have the same impact as past activities described above.

Foreseeable Future Actions: Overflights, road and railroad maintenance and rehabilitation, prescribed fire use, recreational use (dirt road and snowmobile), dust and emmissions from exploratory gas drilling would all have a minor, site-specific, adverse impact on air quality in the area. Fire suppression would have a beneficial, regional, major, short-term impact on future air quality.

Cumulative Effects Conclusion: The actions discussed above combined with Alternative B actions would have a cumulative impact on air quality within a 50 mile radius of the analysis area with Alternative B of **adverse, minor, short-term, and localized**. **Minor** impacts to air quality are a common occurrence and poor air quality is generally a **short-term** event with natural air movement and dissipation. Air quality could have a cumulative **moderate to major, adverse, short or long-term** impact with a hazardous material derailment or wildfire. Snowshed construction would not add measurably to a regional adverse impact on air quality. National and/or state air quality standards would not be expected to be exceeded under Alternative B once snowsheds are built and the potential for hazardous material spills is reduced.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

The explosive devices considered for use in Alternative C include the Avalauncher, hand charges (foot or helicopter delivery), Avalhex type systems type systems, and blaster boxes, all of which use cast primer explosives. Based on projected explosive use there would be little measurable impact to air quality and air quality related values. Non-explosive BNSF operations in the analysis area would include: existing avalanche safety programs, detection systems, and forecasting. The non-explosive actions would have no impact on air quality. According to BNSF, construction of snowsheds could take 5-20 years depending on the number of snowsheds built. Heavy equipment use and snowshed construction would result in an **adverse, minor, short-term**, **site-specific** impact on air quality.

Impacts on air quality from Alternative C would be from explosive use activities associated with 10 years of avalanche hazard mitigation and snowshed construction activities would have a **minor, localized, short-term impact.**

Alternative C Cumulative Effects

Past Actions: Past actions affecting air quality are the same as those in Alternative B.

On-going Actions: On-going actions affecting air quality are the same as those in Alternative B.

Foreseeable Future Actions: Future actions affecting air quality are the same as those in Alternative B.

Cumulative Effects Conclusion: The actions discussed above combined with Alternative C actions would have a cumulative impact within a 50 mile radius of the analysis area with Alternative C on air quality of **adverse, minor, short-term and site-specific**. Minor impacts to air quality are a common occurrence and poor air quality is generally a short-term event with natural air movement and dissipation. Explosive use over 10 years is not expected to have a measurable impact on air quality. Air quality could have a cumulative **long-term, moderate to major, adverse** impact with a hazardous material derailment or wildfire. Snowshed construction would not add measurably to a large, regional adverse impact on air quality with a hazardous material spill or wildfire. National and/or state air quality standards would not be expected to be exceeded under Alternative C once snowsheds are built and the potential for hazardous material spills is reduced.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

The explosive devices considered for use in Alternative D include the Avalauncher, hand charges (foot or helicopter delivery), Avalhex type systems type systems, blaster boxes, and military artillery, all of which use cast primer explosives with the exception of artillery. Military artillery uses explosive ammunition designed for warfare. Based on projected use there would be little measurable impact on air quality and air quality related values. BNSF operations in the analysis area would include; existing avalanche safety programs, detection systems, and forecasting.

This alternative would decrease the chances of a hazardous substance spill caused by an avalanche but it does not eliminate the potential for an avalanche caused train derailment.

Impacts on air quality from a long-term explosive program in Alternative D would have a **minor, localized, short-term, site-specific** impact**.**

Alternative D Cumulative Effects

Past Actions: Past actions affecting air quality are the same as those in Alternative B.

On-going Actions: On-going actions affecting air quality are the same as those in Alternative B.

Foreseeable Future Actions: Future actions affecting air quality are the same as those in Alternative B.

Cumulative Effects Conclusion: The actions discussed above would have a cumulative impact with Alternative C on air quality of **adverse, minor, short-term and site-specific**. Minor impacts to air quality are a common occurrence and poor air quality is generally a short-term event with natural air movement and dissipation. An indefinite program of explosive use is not expected to have a measurable impact on air quality. Air quality could have a cumulative **long-term, moderate to major, adverse** impact with a hazardous material derailment or wildfire. Snowshed construction would not add measurably to a **moderate to major, regional, adverse** impact on air quality with a hazardous material spill or wildfire. Under Alternative D, national and/or state air quality standards would not be expected to be exceeded.

Air Quality Conclusion

The No Action Alternative would have **no effect** on air quality in the John F. Stevens Canyon. Impacts on air quality under all Alternatives would remain **adverse, negligible, localized, and short-term** during day-to-day operations.

Although building and repairing snowsheds and active avalanche control methods (Alternatives B, C, D) may reduce the potential for derailments due to avalanches there is still a possibility of a derailment and hazardous materials spill. In the case of a derailment leading to a hazardous materials spill, impacts to air quality under all alternatives could have **negligible to major, localized to regional, and short to long-term impacts** depending on the type of material spilled, amount of material spilled, and duration of the incident.

Under Alternatives B and C, construction activities associated with building or rehabilitating snowsheds could have **minor, adverse, localized, short-term impacts.**

There would be no significant adverse impacts to air quality whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents. Consequently, there would be no impairment of air quality as a result of the implementation of any of the alternatives.

NATURAL SOUND

Methodology

Sound levels in the area were assessed through consultation with sound specialists, field visits, and consultation with Forest and Park staff. Alternatives were evaluated based on current sound levels, information gathered from other environmental compliance documents, and literature review.

Decibel levels (dB) are derived from the sound vibration pressure of a certain noise. The decibel scale is a logarithmic scale that is compressed to display the whole range of human exposure to sound. Decibel levels of two or more sounds can not be added together arithmetically, instead, they are a function of cumulative sound vibrations. Decibel levels can change drastically when sounds are made close to different mediums. For example, a noise would sound louder in a rock canyon than it would in the same canyon that is covered by a deep layer of soft snow. Topography, geology, humidity, weather, and vegetation also dampen or amplify sound.

The acronym dBA and dBC are ways of describing noise decibel levels by using different weighting filters. Different noises, such as explosions, music, and normal talking have different frequencies and loudness. A, B, C, and D weighting filters are the method used compare different types of noise across the decibel scale. "A" filters are used to emphasize frequencies where the human ear is most sensitive (quiet sounds of 3-6 kHz). The "B", "C", and "D" filters were designed for comparing progressively louder noise and noise with lower frequencies (D is used for assessment of loud aircraft noise). These filters and corresponding labels are used in this analysis to compare the loudness of different types of noise. For example, normal ambient noise is filtered under the A and B ranges while loud noise and explosive use would be filtered under the C and D range. The C and D ranges are used for picking up lower frequency sound vibrations. The frequency of the sound signature for explosives is relatively low and lends itself to the use of the C filter.

The Environmental Protection Agency has analyzed ambient natural sound levels for specific environments. The ambient natural sound level for a wilderness area is about 35 decibels (EPA 1974), but can often be as low as 20 decibels in winter when the ground is covered with snow. Table 4-5 contains decibel levels for some activities that may help the reader compare different pressure levels associated with common sounds. This table is shown for comparative purposes and most measurements were not taken with ground snow cover.

Table 4-5. Decibel levels (dB) of common environments and equipment. Compiled from the League for the Hard of Hearing (http://www.lhh.org/noise/decibel.htm) and Yellowstone Natural Soundscapes Monitoring Report

Source	**Decibel Level**
Winter Wilderness	20-35 dB
Quiet residential area	40 dB
Conversation	60 dB
Traffic noise	70-85 dB
Snowmobile	80-100 dB
Pneumatic Drill/Heavy Machine	120 dB
Hammer on Nail	120 dB
Jackhammer/Power Drill	130 dB
Artillery fire at 1000 feet	130 dB
Jet engine taking off	150 dB
Fireworks at 3 feet	162 dB
Shotgun	170 dB

Thresholds of impact are defined in Table 4.1 and are summarized here. The document *Interim Technical Guidance on Assessing Impacts and Impairment to Natural Resources* (NPS 2003) has defined the threshold levels for Natural Sound. There are different thresholds of impact for natural and developed areas.

Natural or Wilderness Areas Natural Sound

- ***Negligible***: Sound created by the action is not detectable for a statistically significant portion of the area or a statistically significant length of time. For the time when human-caused sound is detectable, its influence on the natural ambient sound pressure level is 1 dBA (average decibel level) or less.
- ***Minor***: Sound created by the action is detectable in 10 percent of the area for 10% of the amount o f time during which the sound is generated. Natural sounds unique to the park are interfered with less than 5% of the time.
- ***Moderate***: Sound created by the action is detectable in 10 % of the area for 50% of the amount o f time during which the sound is generated. Sounds produce levels up to 6dBA

over the natural ambient level. Natural sounds that are unique to the park are interfered with less than 10% of the time.

- ***Major***: Sound created by the action is detectable in more than 10 % of the area for 50% of the amount of time during which the noise is generated. OR: Detectable sounds produce levels more than 6dBA over the natural ambient level in up to 10% of the area. OR: Natural sounds that are unique to the park are interfered with more than 10% of the time
- ***Short-term***: Would be temporary during implementation.
- ***Long-term***: Would be permanent or continual.

Developed Areas Natural Sound

- ***Negligible***: Sound created by the action does not add in a statistically significant (5%) way to the total ambient sound environment, either by decibel level or by a new sound frequency signature. Natural sounds that are unique to the park are not interfered with beyond the ambient level of impact over a statistically significant length of time.
- ***Minor***: Sound created by the action adds to the total ambient sound environment, either by decibel level or by a new sound frequency signature, but not more than 10% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 10% of the time.
- ***Moderate***: Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, but not more than 20% of the time. Natural sounds are not interfered with beyond the ambient level of impact more than 20% of the time.
- ***Major***: Sound created by the action adds to the total ambient noise environment, either by decibel level or by a new sound frequency signature, more than 20% of the time. Natural sounds are interfered with beyond the ambient level of impact more than 20% of the time.
- ***Short-term***: Would be temporary during implementation.
- ***Long-term***: Would be permanent or continual.

Analysis Area

The natural sound analysis area has the potential to extend several miles on either side of the project area due to slow sound attenuation and infrasonic qualities of explosive noise

IMPACT ANALYSIS- NATURAL SOUND

Impacts Common to All Action Alternatives

Installation of a weather station, snow depth sensor, and avalanche detection technology would have a **negligible, adverse, short-term, site-specific** impact on noise levels in the analysis area. Once the instruments are installed, there would be very little or no noise associated with their operation. Train derailment or a hazardous material spill could introduce a **moderate, site-specific, adverse** impact on natural sound over the **short-term** due to clean up and track repair operations.

Alternative A: No Action

There would not be any introduction of new noise into the analysis area with this alternative. Railroad and highway closures during times of high avalanche risk would eliminate the greatest amount of human-caused noise in the canyon for a short period of time. This alternative would have a **minor, beneficial, site-specific, short-term** impact on natural sound in the analysis area when the railroad is closed.

Alternative B: Construction and Modification of Snowsheds

There would only be an introduction of new noise into the analysis area temporarily during the construction phase of this alternative. Construction would include short, loud bursts of noise with the cement fixture installation and longer periods of noise with power equipment use from April through November. Overall, the impacts on natural sounds with construction would be **minor to moderate, adverse, localized, and short-term**. Once the snowsheds are constructed, the structures would lessen the amount of train noise that is currently heard in the canyon. After construction, this alternative would have a **minor, beneficial, localized, long-term** impact during all seasons of the year as train noise is reduced when traveling through the snowsheds. In the event that an isolated emergency use of explosives occurs, the blasts would have a minor to moderate impact on natural sound in the paths where explosives are used. The impact would be limited in scope and time. While the decibel levels would be high (table 4-6) during helicopter and explosive use, the disturbance to natural sound in avalanche start zones would occur over a short window of time. The amount of explosive use as well as the frequency of use under an emergency measure is not nearly as great as in Alternative C or D. The overall impact of emergency explosive use on natural sound would be **adverse, moderate, short-term, and site-specific**.

Alternative B Cumulative Effects

Past Actions: All maintenance and operational activities for the railroad and US Highway 2 impact natural sound in the canyon. Regular sounds of rail and vehicle traffic have been impacting sound since the 1890's for rail traffic and the 1940's for vehicle traffic. Road construction, fire suppression, logging, trail maintenance and construction, overflights, natural gas pipeline installation, train derailments, and recreation have all had an impact on natural sound in the canyon. The construction of snowsheds early in the century caused a minor, long-term beneficial impact on natural sound in the canyon as the snowsheds dampened train noise while they travel through the snowshed. Train traffic increases offset the benefits of snowsheds on natural sound. Most of these sound impacting activities, with the exception of regular road and rail traffic, occur during the summer months and are sporadic and irregular in their intensity and duration. The past presence of year round rail and vehicle traffic results in a moderate continuous impact on natural sound. Past hunting activity on NFS lands has had sporadic, short bursts of loud sound interupting natural sound in the canyon.

On-going Actions: Railroad and vehicle traffic and maintenance operations would continue to impact natural sound in the canyon continuously. Overflights, fire suppression, and recreational use have an intermittent, moderate impact on areas that are within sound range of the activity. These activities are sporadic and irregular in their intensity and duration. Hunting is expected to add sporadic bursts of loud sound during the hunting season.

Foreseeable Future Actions: Future vehicle and rail traffic noise is expected to stay the same or increase slightly and be continuous. Highway and railroad operations would impact natural sound with sporadic, irregular noise. Overflights, fire suppression, and recreational use would have a moderate, site-specific impact on areas that are within sound range of the activity. These activities are sporadic and irregular in their intensity and duration. Hunting is expected to continue and add loud, sporadic bursts of sound that interupt natural sound during the hunting season. Snowshed construction would add a minimal amount of noise that would be site-specific during the summer months.

Cumulative Effects Conclusion: Natural sound in the analysis area has been impacted by cumulative noise originating from regular vehicle and rail traffic, rail and road maintenance, and recreational use in the canyon bottom. The developed areas would continue to have a **moderate, adverse, long-term, site-specific** impact on natural sound with regular traffic and maintenance activies. Snowpack has a natural dampening effect on all sounds in the canyon. Natural sound of wilderness and recommended wilderness area areas that are higher in elevation are affected by overflights, fire suppression activities, recreational use resulting in **minor to moderate, adverse, short-term, site-specific** impacts. Under this alternative, the construction of snowsheds would create additional noise cumulatively with highway and rail operations and other activities in the canyon. Construction noise would last for several years from April to November. The construction noise would not add measureably more noise to the soundscape than already exists. Cumulative effects on natural sound in low elevation developed areas during construction would remain **moderate, adverse, long-term, and site-specific**. Snowshed construction is not expected to increase noise levels in higher altitude soundscapes in the analysis area. Cumulative effects on high elevation soundscapes is expected to remain **minor to moderate, adverse, short-term, and site-specific** depending on the source, intensity and duration of expected future activities.

Alternative C: Short-term Explosives Use For Avalanche Hazard Reduction

Explosive use would introduce noise and vibration that have a **major, adverse, short-term, site-specific** impact on natural sound in John F. Stevens Canyon. The decibel level would be increased by 6 dBA from ambient sound and would be heard over more than 10% of the project area. Snow hardness can reduce the rate at which attenuation of sound occurs. Icy, hard snow reflects noise while deep powder snow absorbs noise. Depending on the dampening effects of snow and vegetation, people and wildlife would hear and feel the low frequency explosions within the canyon and possibly up to several miles away. It is difficult to determine the distance that the explosions would be heard without baseline site-specific data collection and monitoring. The noise in this alternative is highly variable due to weather conditions, snowpack, and number of starting zones targeted. It is estimated that approximately 0-275 explosions per year would occur under this alternative. Table 4-6 provides sound level data for 1 and 2 KG explosives. When using handcharges, all sizes of cast primer explosives may be used. Avalaunchers use 1-2 kg cast primer explosives. Blaster boxes use 3 kg cast primer explosives. A comparative list of explosive use methods and corresponding decibel levels is presented in Table 2-5.

Table 4-6. Predicted decibel levels for 1 and 2 KG cast primer explosive charges (PK15 Day/Night Focus/Average) (US Army 2003)

Distance From Source (feet)	1 KG Explosive (dBC) PK15(met)[1] Day/Night Focus /Average Met	2 KG Explosive (dBC) PK15(met)[1] Day/Night Focus /Average Met
1000	143.0/142.5/133.5	145.5/145.0/136.0
2000	133.5/132.0/122.5	136.0/134.5/125.0
4000	123.5/122.0/111.0	126.0/124.5/113.5
8000	116.0/113.5/102.5	118.5/116.0/105.0

[1]The metric PK 15(met) accounts for statistical variation in received single event peak noise levels due to weather. It is the calculated peak noise level, without frequency weighting , expected to be exceeded by 15 percent of all events that might occur.

Dave Hamre recorded sound levels from several different explosive charges including artillery. The sound recordings were taken with wet snow cover. The sound levels generated at 250 feet from the recorder were 90-98.5 dBC from several 3 KG charge detonations. A 1 KG charge generated at 90 dBC sound level at 250 feet from the recorder. Sound decibel ranges can be accounted for by vegetation, weather, snow cover, topography, and sound recording techniques. Sound level information for the Avalhex is 146.07 dBC at 260 feet, 140 dBC at 518 feet, and 134 dBC at 1,036 feet. The metric dbC emphasizes the low frequency compression aspect of noise and is most suitable for describing noise impacts from explosives. Helicopters would be used when weather conditions allow, to deliver 1, 2, or 4 kg cast primer hand charges on a targeted starting zone. Noise levels of a Bell 206 Long Ranger helicopter flying at an elevation of 500 feet are estimated at 70 decibels. The noise level drops to approximately 68 db at an elevation of 1000 feet. The impact of the explosive noise is sporadic in nature but would greatly impact natural soundscapes.

There would only be an introduction of new noise during from April through November for the snowshed construction phase of this alternative. Construction would include short, loud bursts of noise with the cement fixture installation and longer periods of noise with power equipment use. Overall, the impacts on natural sounds from construction would be **minor, adverse, localized, and short-term**. Once the snowsheds are constructed, 5,040 feet of new snowshed structures would reduce the amount of train noise that is currently heard in the canyon. During the 10-year explosive program the impacts on natural sound would depend on the amount of explosive use and be **moderate, short-term, site-specific, and adverse**. After the 10-year explosive use program, natural soundscapes should experience a **minor, beneficial, site-specific, long-term** impact throughout the year with the new snowsheds.

Alternative C Cumulative Effects

Past Actions: Past actions that impact natural sound are the same as Alternative B.

On-going Actions: On-going Actions that impact natural sound are the same as Alternative B.

Foreseeable Future Actions: Future actions that impact natural avalanche processes are the same as Alternative B.

Cumulative Effects Conclusion: Natural sound in the analysis area has been impacted by cumulative noise originating from regular vehicle and rail traffic, rail and road maintenance, recreational use, and hunting in the canyon bottom. The developed areas would continue to have a **moderate, adverse, long-term, site-specific** impact on natural sound with regular traffic and maintenance activies. Snowpack has a natural dampening effect on all sounds in the canyon. Natural sound of wilderness and recommended wilderness area areas that are higher in elevation are affected by overflights, fire suppression activities, recreational use resulting in **minor to moderate, adverse, short-term, site-specific** impacts. Under this alternative, the construction of snowsheds would create additional noise cumulatively with highway and rail operations and other activities in the canyon. Construction noise would last for several years from April to November. The construction noise would not add measureably more noise to the soundscape than already exists. Impacts on natural sound in low elevation developed areas during construction would remain **moderate, adverse, long-term, and site-specific**. Snowshed construction is not expected to increase noise levels in higher altitude soundscapes in the analysis area. A 10-year period of explosive use would impact natural sound in higher altitudes where explosives detonate and/or helicopter use is necessary. The impact on natural sound in undeveloped areas cumulatively with other high altitude actions would be **major, adverse, short-term, and site-specific**. The amount of explosive use would depend on the number of avalanche cycles in a year. If one or more winters during the 10-year period had a greater than average amount of avalanche hazard, the impacts on natural areas could be significant. The detonation of explosives in starting zones would not add appreciably to the impact of noise in the canyon bottom near the highway and railroad. Sporadic bursts of noise from September to November from hunting and then fromDecember through April for explosive use would increase the amount of natural sound interruption in the canyon. The cumulative effect on low elevation, developed soundscapes is expected to remain **minor to moderate, adverse, short-term, and site-specific** depending on the source, intensity and duration of expected future activities.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Explosive use, including military artillery, would introduce noise and vibration that have a **major, adverse, short-term, site-specific** impact on natural sound and other resources in John F. Stevens Canyon. The decibel level would be increased by 6 dBA from ambient sound and would be heard over more than 10% of the project area. Snow hardness can reduce the rate at which attenuation of sound occurs. Icy, hard snow reflects noise while deep powder snow absorbs noise. Depending on the dampening effects of snow and vegetation, people and wildlife would hear and feel the low frequency explosions within the canyon and possibly up to several miles away. It is difficult to determine the distance that the explosions would be heard without baseline site-specific data collection and monitoring. The noise in this alternative is highly variable due to weather conditions, snowpack, and number of starting zones targeted. It is estimated that approximately 0-275 explosions per year would occur under this alternative. Table 4-6 provides sound level data for 1 and 2 KG explosives. When using handcharges, all sizes of cast primer explosives may be used. Avalaunchers use 1-2 kg cast primer explosives. Blaster boxes use 3 kg cast primer explosives. A comparative list of explosive use methods and corresponding decibel levels is presented in Table 2-5.

Avalhex type systems, blaster boxes, and helicopter explosive methods would be permitted under this alternative and sound level information is listed in Alternative C impacts above. Table 4-7 provides sound level data for the howitzer delivered explosives. It is important to note that Howitzers present two loud noises with use, the firing of the unit and the ammunition explosion upon impact. Table 4-7 provides firing noise levels from the Howitzer. With snow cover, the explosive decibel levels are expected to be lower than those in Table 4-7. Dave Hamre conducted sound level recordings with a 105 howitzer. The sound recording device was 250 feet away from the blast and the recorded sound was 91 dBC. The measured sound from the propellant charge, 1,200 feet away was approximately the same decibel level.

Table 4-7. Predicted decibel levels for 105mm Howitzer firing (PK15 Day/Night Focus/Average) (US Army 2003).

Distance From Source (feet)	**105mm Howitzer decibel rating (dBC) PK15(met) Day/Night Focus/Average Met**
1000	130.5/129.0/118.0
2000	129.0/127.5/116.5
4000	125.5/123.5/112.5
8000	119.5/118.5/106.5

The impact of explosive noise is sporadic in nature but would impact natural soundscapes greatly. People living close to this noise source would be annoyed and could complain about noise from the proposed activities. Response of community members to noise depends on many factors. Some of these factors are the characteristics of the noise, including the intensity and spectral characteristics, duration, repetitions, abruptness of onset or cessation, and the noise climate or background noise against which a particular noise event occurs. Social surveys show that the following are all factors related to annoyance and/or complaints:

- The degree of interference of the noise with activity.
- The previous experience of the community with the particular noise.
- The time of day during which the intruding noise occurs.
- Fear of personal danger associated with the activities of the noise sources.
- Socioeconomic status and educational level of the community.
- The extent that people believe that the noise output could be controlled

Additional possible impacts to be considered include structural damage to nearby buildings, physiological damage to humans, and the likelihood of receiving noise complaints. Studies (Siskind 1989) have shown that homeowners become concerned about structural rattling and possible damage when the level exceeds 120 decibels peak (dBP describes peak decibels). The threshold to crack a poorly mounted windowpane is approximately 150 dBP. The threshold for physiological damage is approximately 140 dBP. The threshold for annoyance is much lower than 140 dBP, and varies greatly among individuals. There is one residence in close proximity to the east end of the analysis area. While there are no other developments that may be impacted by the noise of blasting, this information is given for comparative purposes. Table 4-8 contains guidelines developed by the Naval Surface Warfare Center for estimating the potential for complaints from impulsive noise.

Table 4-8. Impulsive noise guidelines.

Predicted Sound Level (dBP)	Risk of Complaints
< 115	Low risk of noise complaints.
115 – 130	Moderate risk of noise complaints.
130 – 140	High risk of noise complaints, possibility of damage.
> 140	Threshold for permanent physiological damage to unprotected human ears. High risk of physiological and structural damage claims.

Based on the range of noise levels expected from detonating a 1,2, or 3 KG explosive charge and firing the 105mm howitzer, the expected noise levels would cause a moderate risk of noise complaints from areas within 4000 to 8000 meters of the proposed 1, 2 and 6 kg detonations, and a high risk of complaints 2000 meters and closer. The expected noise levels would cause a moderate risk of noise complaints from areas within 1000 to 8000 meters of the proposed 105mm howitzer firing and a high risk of complaints 1000 meters and closer.

During the summer season, there would only be an introduction of new noise into the analysis area from the snowshed construction phase of this alternative. Snowshed modification of Shed 7 and Shed 9 would include short, loud bursts of noise with the cement fixture installation and longer periods of noise with power equipment use. Overall, the impacts on natural sounds with construction would be **minor, adverse, localized, and short-term**. Once the snowsheds are lengthened, the longer structure would have a **minor** reduction in the amount of train noise that is currently heard in the canyon. Continuous use of explosives would offset the **minor beneficial, long-term** impact of the snowshed extensions on natural sound resulting in a **major, sporadic, adverse, long-term, localized** impact overall under Alternative D.

Alternative D Cumulative Effects

Past Actions: Past actions that impact natural sound are the same as Alternative B.

On-going Actions: On-going actions that impact natural sound are the same as Alternative B.

Foreseeable Future Actions: Future actions that impact natural sound are the same as Alternative B.

Cumulative Effects Conclusion: Natural sound in the analysis area has been regularly impacted by cumulative noise originating from regular vehicle and rail traffic, rail and road maintenance, and recreational use in the canyon bottom. The developed areas would continue to have a **moderate, adverse, long-term, site-specific** impact on natural sound with regular traffic and maintenance activies. Snowpack has a natural dampening effect on all sounds in the canyon. Natural sound of wilderness and recommended wilderness area areas that are higher in elevation are affected by overflights, fire suppression activities, recreational use resulting in **minor to moderate, adverse, short-term, site-specific** impacts. Under this alternative, the construction of 2 snowshed extensions would create additional noise cumulatively with highway and rail operations and other activities in the canyon. Construction noise would last for 1 to 2 years from April to November. The construction noise would not add measureably more noise to the soundscape than already exists. Impacts on natural sound in low elevation developed areas during construction would remain **moderate, adverse, long-term, and site-specific**. Snowshed construction is not expected to increase noise levels in higher altitude soundscapes in the analysis area. A continuous program of explosive use would impact natural sound in higher altitudes where explosives detonate and/or helicopter use is necessary. The impact on natural sound in undeveloped areas cumulatively with other high altidude actions would be **moderate, adverse, short-term, and site-specific** for Alternative D. Sporadic bursts of noise from September to November from hunting and then fromDecember through April for explosive use would increase the amount of natural sound interruption in the canyon. The howitzer would affect noise in the canyon greatly as two explosions occur upon firing. The initial firing explosion at the gun site propels the ammunition to the detonation zone. The actual detonation is a separate explosion within the start zone. If one or more winters had a greater than average amount of avalanche hazard, the impacts on natural and developed areas could be significant. Under Alternative D, the sound of artillery ammunition is expected to travel several miles under the right snow conditions. The overall cumulative impact on low elevation, developed soundscapes is expected to be **moderate, adverse, short-term, and site-specific** depending on the source, intensity and duration of expected future activities.

Natural Sound Conclusion

Alternative A would have **no effect** on natural sound in John F. Stevens Canyon. Under Alternatives B and C, the **minor, adverse, site-specific, short-term** noise of snowshed construction is mitigated after snowshed completion by a **minor, beneficial, site-specific, long-term** reduction in the overall train noise in the canyon. If 5,040 feet of new snowshed is constructed in the analysis area, train noise would be reduced having a beneficial impact. Explosive use in Alternatives C and D would have a **major, adverse, site-specific to localized** effect on natural sound. The decibel levels that emanate from explosive use are high enough to impact normal human hearing depending on the person's proximity to the explosions. Alternative C would be a **long-term,** 10-year impact and Alternative D would be a **long-term,** continuous impact due to the indefinite nature of the program.

With Alternative C and D, there may be adverse impacts on natural sound whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation of the park; 2) key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; 3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service planning documents. There would not be impairment under Alternatives A and B. There could be impairment under Alternatives C and D for people "to enjoy [park lands] in a state of nature" or for preservation of natural sound in the area depending on the intensity and frequency of explosive use.

CULTURAL RESOURCES

HISTORIC STRUCTURES AND LANDSCAPES

Methodology

The Forest Archaeologist conducted a file search and review of FNF site database and literature sources to identify the location of known, previously-recorded heritage resources within the analysis area. Likewise, the GNP Cultural Resource Specialist reviewed the park's cultural resource inventory for previously identified historic properties within the analysis area.

After completion of the pre-survey files search the FNF Cultural Resource staff conducted a field reconnaissance of the proposed analysis area using a field methodology described in the Forest's Site Identification Strategy (SIS) document currently on file with the Montana State Historic Preservation Office (SHPO) in Helena, Montana. Section 106 under the National Historic Preservation Act requires a determination of effect for actions under each alternative. This preliminary determination of effect is based on initial consultation with the Montana SHPO and is listed for each alternative.

Thresholds of impact for historic structures and landscapes are defined in Table 4-1 and are summarized here:

- ***Negligible***: Impact(s) is at the lowest levels of detection - barely perceptible and not measurable. For purposes of Section 106, the finding of effect would be "no adverse effect".
- ***Minor***: Impact would alter a character defining feature(s) of a historic resource, but the work would be in accordance with the Secretary of Interior's *Standards for the Treatment of Historic Properties*. For purposes of Section 106, the finding of effect would be "no adverse effect".
- ***Moderate***: Impact would alter a character defining feature(s) of the historic resource, diminishing the integrity of the resource, but still maintaining its eligibility for the National Register. For purposes of Section 106, the finding of effect would be "adverse effect".
- ***Major***: Impact would alter a character defining feature(s) of a national historic landmark, diminishing the integrity of the resource to the extent that its designation is threatened. For purposes of Section 106, the finding of effect would be "adverse effect".
- ***Short-term***: Would occur only during implementation.
- ***Long-term***: Would be permanent.

Analysis Area

The analysis area for the historic structures and railroad landscape is between mileposts 1159 and 1164 on the BNSF railroad line.

IMPACT ANALYSIS-HISTORIC STRUCTURES AND LANDSCAPES

Impacts Common to All Action Alternatives

Avalanche forecasting, snow depth sensor installation, weather station installation and avalanche detection device installation would not be close to or impact the railroad or snowsheds and would have **no effect** on historic structures or cultural landscapes in the canyon.

Alternative A: No Action

No direct or indirect changes would occur to existing snowsheds or the railroad under this alternative. Therefore, there would be **no effect** on historic structures or cultural landscapes from Alternative A.

Alternative B: Construction and Modification of Snowsheds

The proposed lengthening of the snowsheds is a potential adverse effect on the National Register characteristics of the snowshed structures. BNSF has proposed to color new concrete snowsheds to match the color and texture of the existing treated timbers. This action may mitigate some of the impacts to the existing snowsheds; however, compliance with Section 106 of the National Historic Preservation Act and consultation with the SHPO would need to occur after BNSF snowshed extension design and prior to actual construction or extension of snowsheds. Other mitigation options developed in consultation with the SHPO under 36CFR800 may be interpretation or recording the resource.

The impacts of extending existing snowsheds a total of 1,500 feet would be **major, long-term, site-specific, and adverse** and the finding of effect for Section 106 purposes would be "adverse effect". With mitigation of color treating the new sheds to resemble existing sheds these effects may be lessened to **moderate, long-term, site-specific, and adverse**. For Section 106 purposes, the finding of effect would be "no adverse effect" if conditional mitigation was implemented in snowshed extension design with concurrence from the Montana SHPO. The Montana SHPO is reviewing this determination.

Actions under Alternative B would have a **moderate, adverse, site-specific, and long-term** impact on the National Register characteristics from the construction of 3,540 feet of new snowsheds in areas where snowsheds have not been previously visible. Isolated emergency explosive use measures would have no impact on existing snowsheds or the railroad in the project area. For Section 106 purposes, the finding of effect would be "no adverse effect" to the railroad resource.

Alternative B Cumulative Effects

Past Actions: Past railway maintenance and repair of the snowsheds and railroad have had a beneficial, long-term impact on the longevity of the infrastucture and its purpose. Past fire suppression activities have had a beneficial long-term impact on the snowsheds and railroad as the infrastructure was protected from fire. Past fires have originated on the railroad ROW. Burnout Shed was burned in a previous fire and no longer performs the avalanche protection use it for which it was built.

On-going Actions: The current on-going actions of maintenance and repair of the snowsheds and railroad have a beneficial impact on the strutures as they are kept in working order and not left in a state of disrepair. Current fire policy in the canyon would protect snowsheds or the railroad from fires.

Foreseeable Future Actions: Future repair and maintenance of snowsheds and railroad would continue to have a beneficial long-term impact on the railroad infrastructure. Fire mangagement and suppression in the canyon would have a beneficial impact on snowsheds and the railroad as the structures would be protected from wildfire. Future fires originating from the railroad or trains may have an adverse impact on historic structures or the landscape.

Cumulative Effects Conclusion: Maintenance and repair activities along the railroad have a past, present, and future **major, beneficial, long-term, site-specific** impact on the railroad infrastructure in the canyon. These activities have had and would have a beneficial effect on historic buildings, structures, or landscapes that are either listed in the National Register of Historic Places or eligible for listing in the National Register of Historic Places. Fire management or suppression activities in the canyon are expected to protect snowsheds from wildfire and have a **moderate, beneficial, long-term, site-specific** impact on snowsheds in the canyon. Past and future fires originating from the railroad and train traffic could cause a **moderate, adverse, site-specific or localized, long-term** impact on snowsheds or the railroad if the infrastructure is burned.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

The impacts of snowshed construction are expected to be the same as those described in the impact analysis for Alternative B. Mitigation options developed in consultation with the SHPO under 36CFR800 may be design, interpretation, or recording the resource. Up to 10 years of explosive use is not expected to have an impact on historic structures or landscapes. The overall impact on historic buildings, structures, and landscapes is **moderate, adverse, site-specific, and long-term**.

Alternative C Cumulative Effects

Past Actions: The cumulative effects of past actions on historic structures and landscapes are the same as in Alternative B.

On-going Actions: The cumulative effects of on-going actions on historic structures and landscapes are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects of future actions on historic structures and landscapes are the same as in Alternative

Cumulative Effects Conclusion: Maintenance and repair activities along the railroad have a past, present, and future **major, beneficial, long-term, site-specific** impact on the railroad infrastructure in the canyon. These activities have had and would have a beneficial effect on historic buildings, structures, or landscapes that are either listed in the National Register of Historic Places or eligible for listing in the National Register of Historic Places. Fire management or suppression activities in the canyon are expected to protect snowsheds from wildfire and have a **moderate, beneficial, long-term, site-specific** impact on snowsheds in the canyon. Past and future fires originating from the railroad and train traffic could cause a **moderate, adverse, site-specific or localized, long-term** impact on snowsheds or the railroad if the infrastructure is burned.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

Only two extensions on Snowsheds 7 (100 feet) and 9 (150 feet) are expected under this alternative and the impacts on those two snowsheds would be the same as those described under Alternative B. Mitigation options developed in consultation with the SHPO under 36CFR800 may be design, interpretation, or recording the resource. Overall, this alternative is expected to have a **minor, adverse, site-specific long-term** impact on snowsheds in the project area with a "no adverse effect" determination for 106 purposes. The impacts on the railroad are expected to be **negligible, adverse, site-specific, and long-term** with a "no adverse effect" determination for Section 106 purposes.

Alternative D Cumulative Effects

Past Actions: The cumulative effects of past actions on historic structures and landscapes are the same as in Alternative B.

On-going Actions: The cumulative effects of on-going actions on historic structures and landscapes are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects of future actions on historic structures and landscapes are the same as in Alternative

Cumulative Effects Conclusion: Maintenance and repair activities along the railroad have a past, present, and future **major, beneficial, long-term, site-specific** impact on the railroad infrastructure in the canyon. These activities have had and would have a beneficial effect on historic buildings, structures, or landscapes that are either listed in the National Register of Historic Places or eligible for listing in the National Register of Historic Places. Fire management or suppression activities in the canyon are expected to protect snowsheds from wildfire and have a **moderate, beneficial, long-term, site-specific** impact on snowsheds in the canyon. Past and future fires originating from the railroad and train traffic could cause a **moderate, adverse, site-specific or localized, long-term** impact on snowsheds or the railroad if the infrastructure is burned.

Historic Structures and Landscapes Conclusion

Since BNSF has the option of building snowsheds for avalanche mitigation under all alternatives, impacts to historic structures would be the same under all alternatives. Without mitigation of materials and coloring, the impacts of extending existing snowsheds would be **major, long-term, site-specific, and adverse** with a Section 106 determination of "adverse effect". With mitigation of coloring and designing the new snowsheds to resemble the existing snowsheds these effects would be lessened to **moderate, adverse, long-term, and site-specific**. Mitigation options developed in consultation with the SHPO under 36CFR800 may be design, interpretation, or recording the resource. This mitigation may be changed to a finding of "no adverse effect" for Section 106 purposes depending on BNSF's design and Montana SHPO concurrence.

There would be no significant adverse impacts to historic structures, buildings or landscapes whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents. Consequently, there would be no impairment of historic structures as a result of the implementation of any of the alternatives.

SOCIAL AND ECONOMIC RESOURCES

SOCIOECONOMIC RESOURCES

Methodology

The following analysis of the economic impacts of alternatives is presented for two general accounting frameworks: county level employment and output impacts (regional economic impacts) and benefit/cost impacts. This analysis was conducted by Bioeconomics, an independent, private contractor located in Missoula, Montana.

The regional economic accounting framework is used to estimate changes in local area economic activity such as employment, personal income, or total economic output which might result from an economic change in the area. Common uses of this type of framework and analysis include estimating the impacts on local employment and income of a large business either entering or leaving a local area. In order to perform a regional economic analysis it is necessary to have baseline data on the structure and size of the local economy being examined, as well as an estimate of the direct expenditure changes associated with the alternatives being examined.

The benefit/cost accounting framework is used to examine the economy-wide impacts of a proposed action. A social benefit cost analysis compares all costs associated with a specific action with the benefits associated with avoidance of major avalanche caused damage or delays.

The comparison of socioeconomic costs and benefits associated with the 4 alternatives relies on cost estimates and risk estimates gathered from a wide variety of sources. The primary sources for the largest category of current avalanche related costs are Hamre and Overcast (2004) and Reardon et al. (2005). The Hamre analysis brought together estimates of risk to current train traffic from avalanche danger with estimated losses associated with different classes of rail cars and their potential for avalanche collision. The Reardon analysis extensively details the hydrologic cycles associated with avalanche events in the John Stevens Canyon, as well as describes historic avalanche events and their impacts on the canyon's transportation corridor. Cost estimates for additional components of avalanche prediction, control, and protection were gathered from communications with BNSF and Amtrak personnel, as well as from internet data and information sources and contacts with the National Park Service, National Forest Service, U.S. Geological Services, and private sources.

In the following analysis estimates for equipment, infrastructure, and programs are presented as annual costs. These annualized values are, in the case of infrastructure and equipment, based on the initial cost and productive life of the item. Additionally, future expenditures are discounted at a 7 percent real rate, based on direction from the Office of Management and Budget (OMB Circular 94-A).

National Environmental Policy Act regulations require analysis of social and economic impacts resulting from proposed major federal actions in an environmental impact statement. This assessment of the economic effects of the alternative actions follows the general principles outlined in the U.S. Water Resource Council's Economics and Environmental Principles for Water and Related Land Resources Implementation Studies (U.S. Department of the Interior 1983). The DOI guidance document is intended to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water and land resource implementation studies.

Thresholds of impact for socioeconomic resources are defined in Table 4-1.

- ***Negligible***: Effects would be below or at the level of detection.
- ***Minor***: Effects would be detectable but would be slight.
- ***Moderate***: Effects would be readily apparent.
- ***Major***: Effects would be readily apparent and would cause substantial changes to socioeconomic conditions in the region.
- ***Short-term***: Would occur only during implementation (varies by site to a period of 10 years).
- ***Long-term***: Would be continual or permanent.

Analysis Area

The analysis area for the Socioeconomic Resources section is the BNSF Railway company, local Flathead County communities, and other economically impacted areas or entities.

IMPACT ANALYSIS-SOCIOECONOMIC RESOURCES

Impacts Common to All Action Alternatives

There are a number of impacts likely to arise from the implementation of the actions associated with all 4 alternatives (A-D). The following discussion outlines these common impacts which may be associated to greater or lesser extents with avalanche risk mitigation.

Potential social and economic impacts of avalanche-caused derailments

The primary concern related to winter rail traffic through John Stevens Canyon is the concern for avoiding avalanche-caused derailments and associated injury, loss of life, or spillage of rail cargo. While spills of cargo such as grain can have their own costs associated with cleanup and impacts on wildlife, of greater concern is the potential for spills of hazardous substances. Between 1999 and 2004 there were 64 rail accidents in Montana involving trains carrying hazardous substances. Fifteen of these accidents resulted in spills of hazardous cargo on land or soil, 4 resulted in spills involving waterways, and in 8 accidents, the nature of the spills was not specified (The State of Montana Multi-Hazard mitigation Plan and Statewide Hazard Assessment, October, 2004). A major derailment could result in a significant spill of any number of hazardous substances transported by rail. Such a spill along the heavily used Flathead River could result in significant impacts to fishing and other water-based recreation. The speculative nature of such a potential accident precludes estimation of the possible economic impacts of such an accident beyond noting that **adverse** impacts could range from **negligible to major, short-term to long-term, and site-specific to regional** .

Potential social and economic impacts of temporary delays on railroad traffic

The Socioeconomic Discussion found in Chapter 3 describes the historic and current data related to avalanche-caused delays through John Stevens Canyon. As detailed in Table 3-17, based on data complied by Reardon et al. (2005), the average annual delay to BNSF and Amtrak trains due to avalanches is quite small (7.1 hours). While relatively minor when viewed as an annual average, this statistic masks the large variability of avalanche closures ranging from no closures in most years to as much as 48 to 72 hour closures in the case of extreme avalanche activity.

BNSF representatives report no instances, to date, of trains or freight being re-routed to circumvent delays along the GNP route (Personal Communication, Lane Ross, BNSF, July 18, 2005). In general, past delays experienced due to avalanches have resulted in relatively minor socioeconomic disruptions (delays in delivery of UPS shipments, for example) rather than major disruptions related to non-delivery of key commodities.

Because all alternatives rely on predictions of avalanche danger and recommended closures of the transportation corridors during periods of high avalanche danger, implementation of each of the alternatives would at some point lead to temporary delays and their associated economic impacts. The length of these delays is largely dependent on weather patterns as well as other avalanche risk reduction measures taken. USGS representatives estimated that on average, conditions leading to closure of the canyon would occur on average two times per winter. These conditions (if left to stabilize naturally) could be expected to last between 12 and 48 hours before travel in the corridor could resume. The use of an active avalanche forecasting and hazard reduction program, therefore, would likely lead to preventative delays under all alternatives that are in excess of the average annual delays due to slides and accidents in the past.

Potential social and economic impacts on transport and delay of goods

Delays in rail traffic due to avalanche danger or obstruction have the potential to lead to impacts extending beyond BNSF and the local Glacier NP area. BNSF representatives report the following commodities that are time sensitive in nature.

1) If grain cars are delayed the commodity could miss vessel sailing departure times or require vessels to hold. The extent of this disruption would depend on the duration of the delay as well as how much grain is already stockpiled at destination port elevators. Resulting delays in returning eastbound empty cars would delay the next westbound load, and impact overall grain car cycle performance.
2) Intermodal high priority trains carry parcel (UPS and Postal) traffic. Depending on duration, delays may result in missed sorts at the UPS and postal bulk mail sort facilities.
3) Intermodal stack business carries international traffic to / from the ports. Depending on duration, delays could result in import container traffic accumulating at ports. On the westbound side, these delays would delay railcar supplies getting to the ports.

In addition to the delay concerns above, concern has been expressed about the potential impacts of a delay in chlorine shipments for municipal water treatment in the Seattle Area. Annual 2004 records of hazardous cargo shipments specify only five fully loaded rail cars carrying chlorine passed through the canyon over the year. The infrequent nature of shipments of this key commodity suggests that it is possible for BNSF to schedule transport of the chemical when avalanche caused delays are not expected.

The extent of any economic impact associated with delays in train traffic is highly dependent on a number of factors. Estimation of the average costs associated with such delays would be speculative, and therefore is not presented in the following analysis. All the alternatives allow for the possibility of considerable delays associated with either closures during high avalanche danger or closures due to explosive control operations. Only extensive construction of new snowsheds would avoid disruptions and costs associated with considerable avalanche caused freight delays.

Potential social and economic impacts of rerouting train traffic on other railways or highways

The potential exists for an avalanche danger or event to occur which would close the tracks through John Stevens Canyon for a period long enough to necessitate rerouting traffic around the affected route. Conversations with BNSF personnel indicate that to date no rerouting of BNSF-carried cargo has happened (Pers. Comm. Lane Ross July 18, 2005). Projected delays under the alternatives detailed in this report are not expected to exceed (on a per event level) delays resulting from past slides. Therefore, it is assumed that very little or no rerouting of BNSF traffic would occur under the Alternative A-D scenarios.

In the case of Amtrak traffic, there is a history of passengers being bussed around the canyon in times of rail closure or high avalanche danger. The bussing of passengers around the canyon leads to an estimated 5-8 hour delay (Personal Communication, Whitefish Amtrak Office). The analysis below recognizes these delays and the economic costs associated with them. These potential costs are included in cost/benefit estimates for each of the alternatives.

Economic analysis of different methods of stability testing and avalanche hazard mitigation methods

The four alternatives outline various combinations of investments in infrastructure and avalanche prediction and control programs. Table 2-2, 2-3, and 2-4 details the components of each of the four alternatives considered in this analysis. The action alternatives offer varying combinations of prediction and control mechanisms including new snowshed construction, improved prediction methods and associated infrastructure, and avalanche control using explosives. The investments in avalanche prediction, control and mitigation are designed to varying degrees to offset the current ongoing costs and risks associated with relatively unmitigated avalanche danger.

ALTERNATIVE A: NO ACTION

The estimated costs associated with Alternative A are drawn largely from the estimates outlined in Chapter 3. Alternative A, however, adds to the Chapter 3 estimates the component of a BNSF Avalanche Safety Director (ASD) who could call for restrictions or delays through John F. Stevens Canyon during periods of high avalanche danger.

United States Geological Survey personnel have examined the historic record of precipitation and avalanches within the canyon for the period from 1977 to 2004 (personal communication, Blase Reardon, USGS. Aug 4, 2005). Based on the analysis Reardon estimated that conditions for high avalanche danger within the canyon would occur on average slightly less than 2 times per winter. During these periods of high avalanche danger, the ASD would recommend restrictions or delays of rail traffic through the canyon. Based on an analysis of winter storm and avalanche cycles since 1977, these delays would likely last between 12 and 48 hours before the snowpack stabilized enough on its own to lift the travel advisory (Personal Communication and data supplied by Blase Reardon, USGS. Aug 4, 2005).

Costs to BNSF of Preventative Avalanche Delays

Based on historic records (Table 3-17) the average annual delay time due to major avalanche events within the canyon is 7.1 hours/year. In the absence of new snowshed construction, use of an ASD who could likely recommend 1 to 3 delays averaging 30 hours apiece per year in times of high avalanche danger, would lead to significantly longer delays than under past operations. From an economic perspective, the use of an avalanche prediction and stability testing program, while leading to significant average annual costs associated with preventative delays has the benefit of reducing the risk of very large costs associated with a major train/avalanche accident. A preventative delay lasting 30 hours would be the same as the delay associated with the 2004 accident and derailment. Further, it is estimated by USGS personnel that one to three such delays would occur on average per year.

Operational costs associated with a 30 hour delay in rail traffic through the canyon can be roughly estimated based on BNSF estimates of minor delay costs. Because an average of 38 trains per day pass through John Stevens Canyon during winter months, the number of trains affected by a delay (and therefore the costs to BNSF and Amtrak) depend directly on the length of the delay. While a short, 20 minute, delay may affect only one train, a longer multi-hour delay affects an increasing number of trains. Bioeconomics estimated that based on an assumed hypothetical equal distribution of trains throughout a 24 hour day, and equal numbers of eastbound and westbound trains that a 30 hour delay would lead to direct operational costs to BNSF of approximately $330,000 per delay. If delays are frequent enough, additional costs might be associated with shippers choosing alternative transport methods or routes during periods of higher likelihood of avalanche delay. The likelihood of or possible extent of such losses in freight are uncertain and not estimated in this analysis. Based on a range of 1 to 3 delays per year, estimated costs are between $300,000 and $990,000 annually.

Costs to Amtrak Users of Preventative Avalanche Delays

Two times per day the Amtrak “Empire Builder” passenger train passes through John Stevens Canyon on its Chicago-Seattle route. A delay of 30 hours due to extreme avalanche danger would affect 3 scheduled Amtrak trains. When an Amtrak train is delayed in the winter along this route the passengers are often bussed around the canyon resulting in a typical 7.5 hour delay in travel. On a typical winter “Empire Builder” train there are approximately 275 passengers (Personal communication, Whitefish Amtrak Station personnel. Aug 9. 2005). Delays due to avalanche danger impose costs associated with more time spent traveling on Amtrak passengers. The value of lost travel time can be conservatively estimated at 50 percent of the average wage rate (California Department of Transportation, “Categories of Travel Time” at www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/benefits/travel_time/categories.html)

Based on 3 trains delayed for 30 hours, 275 passengers per train, 7.5 hour average delay, and 50% of the mean US wage rate ($8.90), the average cost of delay to Amtrak passengers is estimated to be $55,000 per delay. (wage rate based on US average, May 2004, www.bls.gov). It is estimated that between one and three delays would occur in a winter. It is unknown at this time how a program including avalanche risk prediction and proscribed delays of the rail line during periods of high risk would impact the baseline level of minor winter delays estimated in Chapter 3 (Table 3-17). Because delays during high risk periods would reduce minor delays during those periods (at the cost of longer delays outside the canyon), there may be substantial reduction in minor delays over the winter season. There is, however, considerable uncertainty as to the extent of such a reduction in minor delays. Therefore for the analysis of the “non-snowshed components” of the following 4 alternatives it is assumed that the cost to BNSF of minor delays due to avalanche activity or danger would range from $169,000 to $337,900 annually (representing a zero to 50% reduction in minor delays).

Estimated Risk/Cost of Avalanche caused Train or Rail damage

All active alternative measures have been developed to mitigate avalanches with potential to result in train and/or rail damage. Hamre and Overcast (2004) expressed this risk on a numerical scale as a function of the frequency of train traffic and the historic record of slide activity in the canyon. This numeric scale, called the Avalanche Hazard Index (AHI), ranges from 1, the level equivalent to a non-avalanche risk, upwards. Hamre and Overcast estimated the unmitigated AHI for John Stevens Canyon to be 110.45, or over 110 times the level of risk expected in the absence of avalanche danger. Hamre and Overcast also examined several scenarios of track protection and avalanche risk mitigation and estimated AHI levels under these scenarios. All three of their scenarios significantly reduced the computed AHI with extensive construction of snowsheds (equivalent to construction of all sheds recommended in Alternative B) being the safest with an AHI of 7.71, or a 93% reduction in risk level. A scenario with a smaller level of snowshed installation and an active forecasting program with minimal explosive control measures and limited travel restrictions were estimated to have an AHI of 10.89. This economic analysis of alternatives assumes that while the mix of measures employed under a specific alternative to mitigate avalanche danger would change from one alternative to another, the goal of significant reduction in the AHI would be achieved under all of these alternatives. This analysis assumes that a final AHI of 10.0 or lower (a 91% or greater reduction in risk and associated costs) would likely be achieved under each alternative. This 91% reduction in risk leads to a proportional reduction in estimated annual average costs associated with avalanche caused train or rail damage. Under Alternative A the estimate for this annual residual risk/cost after implementation of protection and control measures ranges from approximately $7,000 under the actual historical cost scenario to $147,000 under the hypothetical risk/cost scenario. Therefore, the estimated avoided costs of avalanche-caused accidents under Alternative A ranges from $75,000 to $1.48 million annually. It should be noted that all the alternatives are designed to reduce the AHI to 10 or lower. The mixture of measures and costs associated with achieving a lower AHI changes across alternatives, the resulting risk level and associated estimated avoided cost does not vary appreciably among alternatives.

Table 4-9. Estimated annual costs associated with Alternative A **(No Action).**

	Estimated Annual Cost	
Cost/ Risk category	**Low**	**High**
Estimated Costs of Minor Delays to BNSF	$169,000	$337,900
Estimated Costs of Train Delays or Travel Restrictions		
Delay costs to BNSF	$330,000	$990,000
Delay costs to Amtrak Passengers	$55,000	$165,000
Estimated cost of Snowshed maintenance	$40,000	$40,000
Cost Snow / Debris Removal	$340,000	$340,000
Cost Avalanche detection systems	$105,000	$105,000
Total Estimated Cost	$1,039,000	$1,978,000

SUMMARY OF ALTERNATIVE A: SOCIOECONOMIC IMPACTS

Alternative A: Impacts to the Local Economy

Under the Alternative A, there would be **a negligible impact** on the local area economy. No substantial construction is contemplated under Alternative A. Impacts are primarily associated with the potential major risk associated with a major avalanche-caused accident or derailment along the John Stevens Canyon route.

The primary avalanche mitigation measures of monitoring and delays during periods of high avalanche risk under Alternative A would be expected to lead to a significant reduction in risk associated with an avalanche-caused rail accident.

Alternative A: Economic Impacts to BNSF and the Traveling Public

Impacts of Alternative A to BNSF and the traveling public are predicted to be between $330,000 and $990,000 in direct operational costs to BNSF and between $55,000 and $165,000 per year in costs to Amtrak passengers due to major delays. BNSF is also estimated to incur between $169,000 and $337,900 in operational costs due to minor delays associated with avalanche risk. While it seems that this impact would be great financially, the benefits of removing the avalanche caused spill potential and eliminating railroad delays would have **moderate**, **long-term, beneficial,** impacts on BNSF economics. The impacts to BNSF and the traveling public are **adverse, minor, long-term, and regional**.

An additional impact to BNSF under Alternative A is continued maintenance of existing snowsheds ($40,000 per year), and the annual cost of the current BNSF avalanche detection and cleanup program ($445,000).

Alternative A: Economic Impacts to Recreation

Alternative A is a status quo alternative. As such, actions taken under this alternative are unlikely to significantly impact recreation in the canyon. The exception to this would be in the case of a major accident impacting recreational resources in the area, or access to them.

ALTERNATIVE B: CONSTRUCTION AND MODIFICATION OF SNOWSHEDS

The socioeconomic analysis of Alternative B includes estimation of the annual costs associated with implementing the avalanche forecasting and detection program, as well as estimating the annual costs associated with snowshed construction.

Alternative B Snowshed Construction Costs

The primary avalanche control measure under Alternative B is the construction of new protective snowsheds (3,540 feet) and extension of existing snowsheds (1,500 feet) to protect the tracks through high danger avalanche zones. Estimation of the cost of constructing new snowsheds is complicated by very site-specific attributes and requirements for each shed. BNSF has recently received bids for extensions on sheds 7 and 9. The bid for extending shed 9 by 100 feet was $2.0 million (or $20,000/foot). The bid for the 150-foot extension of Shed 7 was $3.5 million (or approximately ($23,000/foot) (personal communication, Byron Burns, Bridge Engineer, BNSF Kansas City. Aug 8, 2005).

For purposes of this analysis, an estimated cost of $20,000 per linear foot is used for snowshed construction costs. This low end of current bids reflects the realization that even though some sheds may present considerable challenges relative to those seen in the extension of Sheds 7 and 9, some efficiency would come with construction of nearly 5,000 feet of sheds. Assuming that BNSF constructed all of the recommended sheds under Alternative B (5,040 feet) at an estimated cost of $20,000 per foot; construction of all the new sheds would cost $100.8 million. Sheds would be constructed over a multi-year period prioritizing the construction based on the highest danger avalanche paths being mitigated first. Under this alternative construction of the sheds would be at the discretion of BNSF, based on their assessment of risks and costs.

Estimation of the amortized annual cost of new snowshed construction requires several assumptions. It is first assumed that the sheds could be funded and built over a 10-year period following the completion of this EIS. Additionally, it is conservatively assumed that the new sheds would have a useful life of 50 years. This second assumption likely understates the life of the new facilities as the current snowsheds, built primarily of timber supports (rather than concrete and steel) have already been in place for over 90 years. Using a real discount rate of 7 percent, a 10-year construction period, and a 50-year useful life, the annual costs associated with the new or extended snowsheds amortized over their useful life would be $5.49 million. To the extent that the sheds were built over a period longer than 10 years or that their lifespan exceeded the assumed 50 year period, the estimated annual cost of construction would be lowered. Additionally, the estimated annual amortized cost of new snowsheds is sensitive to the assumed real discount rate. While federal guidelines suggest a real rate of 7% (OMB, Circular 94-a), use of a lower discount rate that might be more appropriate for current economic conditions would lead to considerably lower estimated annual amortized costs. For instance using a 3% real rate and the construction assumptions listed above, annual costs would be $2.95 million over the 50-year life of the sheds. For this analysis, the OMB dictated 7% rate use used in amortization.

In addition to the capital costs of new snowshed construction, annual maintenance of the sheds would also be required. The current annual maintenance costs for the existing sheds in the canyon are approximately $40,000 (Hamre and Overcast, 2004). Hamre also estimates the annual maintenance costs of all new sheds at $39,000. Therefore, depending on the extent of construction of new sheds under this alternative, it is estimated that annual shed maintenance costs would range between $40,000 and $79,000.

In this analysis, the costs associated with construction activity delays are assumed to be included in the snowshed construction costs.

Alternative B Avalanche Prediction Program Costs

The Alternative B avalanche prediction and stability testing program would be a significant refinement from the past BNSF avalanche mitigation program. This program could include use of advanced detection equipment (geophones and Doppler radar) as well as additional weather recording devices to supplement information for an avalanche safety director (ASD). The ASD would analyze weather, precipitation, and snowpack stability data in order to assess the safety of continued operation of BNSF and Amtrak trains through John Stevens Canyon during winter months.

Costs associated with Delays during high risk periods

As described under the analysis of Alternative A impacts, it is estimated that between 1 and 3 delays averaging 30 hours would occur each winter. These delays are estimated to cost BNSF between $330,000 and $990,000 per year in direct operational costs. Additionally, the delays are estimated to cost Amtrak passengers between $55,000 and $165,000 per year in opportunity costs of lost time. Delays and restrictions are expected to be substantially decreased once the snowsheds are built.

Costs associated with Avalanche Detection

The implementation of an avalanche detection system beyond the current signal fence system in John Stevens Canyon would entail installation of equipment specific to this task. Hamre and Overcast (2004) estimated the costs associated with this program. Table 4-10 shows the Hamre estimates of capital and ongoing cost of a geophone/Doppler radar detection system, and the estimated cost of an Infrasonic Avalanche Sentry system. Under this Alternative it is assumed that one or the other of these systems would be utilized, therefore, the two systems are presented as the high and low estimates of annual detection costs.

Table 4-10. Estimated annual cost of avalanche detection systems[a].

Component	Capital Cost	Estimated Annual Cost[b]
Geophone/Doppler Radar System	$1,700,000	$161,000 (high estimate)
Infrasonic Avalanche Sentry System	$900,000	$85,000 (low estimate)

[a] Capital cost estimates based on Hamre and Overdraft (2004) (p.58) estimates for detection and protection systems necessary for alternative with only a minimum amount of new shed construction (250 feet) and from NPS estimate of capital costs of Avalanche Sentry System for canyon. Capital costs are amortized over 20 year useful life at 7% real discount rate.

Estimated Risk/Cost of Avalanche caused Train or Rail damage

As noted in the analysis of Alternative A impacts, the economic analysis of alternatives assumes that while the mix of measures employed under a specific alternative to mitigate avalanche danger would change from one alternative to another, the goal of significant reduction in the AHI would be achieved under all of these alternatives. The 91% reduction in risk leads to a proportional reduction in estimated annual average costs associated with avalanche caused train or rail damage. Under Alternative B the estimate for this residual risk/cost after implementation of protection and control measures ranges from $7,000 under the scenario using historic accident costs to $147,000 annually under the hypothetical cost scenario. The cost of an isolated emergency response measure using explosives would not appreciably increase the annual costs of the Alternative B estimates. The explosive use costs would not be a cost of avalanche hazard reduction, instead they would be absorbed in emergency response or hazardous material spill operation costs.

SUMMARY OF ALTERNATIVE B: SOCIOECONOMIC IMPACTS

Table 4-11 presents a summary of the estimated annual costs for BNSF associated with the Alternative B actions to mitigate avalanche danger. The annual cost estimates are presented for two different scenarios: 1) a scenario under which BNSF chose not to build new snowsheds, but rather relied on delays and detection technologies to mitigate avalanche danger, and 2) a scenario where all recommended snowsheds were built over a 10-year period.

While only two scenarios were examined under this alternative, it would be possible for BNSF to choose some other mix of snowshed construction and avalanche detection (such as building one-half of the suggested new sheds on only the most problematic of paths). If BNSF went with scenario 1, the impacts would be the same as in Alternative A. If BNSF built 5 new snowsheds and extended 7 snowsheds under scenario 2, there would be a **moderate, adverse, long-term, regional** impact on BNSF. The impact on local economies with this alternative, depending on the extent local companies are used for construction, would be **minor, beneficial, long-term, and local.**

Table 4-11. Estimated annual costs associated with Alternative B.

Cost/ Risk category	Estimated Annual Cost			
	No new Snowsheds		New Snowsheds Option[a]	
	Low	High	Low	High
Estimated cost of minor delays to BNSF	$169,900	$337,900	0	0
Estimated Costs of Train Delays or Travel restrictions				
Delay costs to BNSF	$330,000	$990,000	0	0
Delay costs to Amtrak Passengers	$55,000	$165,000	0	0
Cost Snow / Debris Removal	$340,000	$340,000	$170,000	$170,000[b]
Cost Avalanche prediction/detection systems				
Maintain Signal Fences	0	0	0	0
Maintain Snowsheds	$40,000	$40,000	$79,000	$79,000
Cost of new snowshed construction	0	0	$5,490,000	$5,490,000
Cost of BNSF Avalanche Safety Program	$100,000	$100,000	0	0
Capital cost of avalanche detection equipment (Doppler radar, geophones)	$85,000	$161,000	0	0
Total Estimated Cost	$1,119,900	$2,133,900	$5,739,000	$5,739,000

[a] This option presents estimated costs once snowshed construction has been completed

[b] It is assumed that snow removal would be 50% of no new snowshed scenario

Alternative B: Impacts to the Local Economy

Under Alternative B, possible changes in impacts to the local area economy may occur to the extent that BNSF constructs additional snowsheds within the canyon. The construction of snowsheds under this alternative could lead to major and ongoing construction activity in the local economic area over a multi-year period. It is, however, unknown the degree to which local construction firms and labor would benefit from specialized construction projects such as the snowsheds. While construction firms from Montana or the local economic area may not receive the contracts for snowshed construction, local spending by workers on the project would affect the local economy. It is therefore estimated that direct annual construction costs of up to $5.7 million per year over a 10 year period would result in minor to moderate beneficial income and employment impacts on a local level.

A second potential local economic impact associated with Alternative B is the significant lowering of risk associated with an avalanche-caused rail accident in the canyon. This impact is measured in avoided average long-term costs, rather than direct expenditures in the economy. Lowering the winter accident risk in the canyon leads to a commensurate lowering of the risk of future accidents.

Alternative B: Economic Impacts to BNSF and the Traveling Public

Total economic impacts of Alternative B to BNSF and the traveling public are predicted to range between $330,000 and $990,000 in direct operational losses to BNSF from avalanche-related operational delays and closures. Amtrak passengers are estimated to bear between $55,000 and $165,000 per year cost associated with delays and bussing around the John F. Stevens Canyon.

BNSF would also bear the direct cost of snowshed construction to the degree that they chose that mitigation option. Depending on the level of snowshed construction, BNSF could face annualized costs between $0 and $5.49 million per year over the life of new snowsheds constructed.

An additional impact to BNSF under Alternative B is continued maintenance of existing and new snowsheds ($40,000 to $79,000 per year), and the annual cost of the proposed BNSF avalanche detection and cleanup program $170,000 to $601,000

Alternative B: Economic Impacts to Recreation

Under Alternative B there would be no mandatory closures of winter recreation trails or areas. As such, actions taken under this alternative are unlikely to impact recreation in the canyon.

Alternative B Cumulative Effects

Past Actions: Recreational use within the park and surrounding forest lands, construction of the West Glacier to Marias Pass natural gas pipeline, timber salvage and rehabilitation, and US Highway 2 maintenance, and operations have had a minor, beneficial, intermittent impact on local income and employment and on net economic values. These activities have had relatively small impacts on visitor use and enjoyment of the area, and on regional expenditures, both in the context of the Flathead and Glacier County region.

On-going Actions: Recreational use within the park and surrounding forest lands, timber salvage and rehabilitation, and US Highway 2 maintenance, and operations have a minor, beneficial, intermittent impact on local income and employment and on net economic values. These activities have had relatively small impacts on visitor use and enjoyment of the area, and on regional expenditures, both in the context of the Flathead and Glacier County region. Ongoing reconstruction of Going to the Sun Highway has a minor to moderate negative short-term impact on park visitor net economic values and expenditures, and a minor beneficial short-term impact on regional construction expenditures and employment.

Foreseeable Future Actions: Recreational use within the park and surrounding forest lands, timber salvage and rehabilitation, and US Highway 2 maintenance, and operations all have a minor, beneficial, intermittent impact on local income and employment and on net economic values. These activities have relatively small impacts on visitor use and enjoyment of the area, and on regional expenditures, both in the context of the Flathead and Glacier County region. Ongoing reconstruction of Going to the Sun Highway has a minor to moderate negative short-term impact on park visitor net economic values and expenditures, and a minor, beneficial, short-term impact on regional construction expenditures and employment. The Walton Ranger Station Parking Area construction would have a minor, beneficial, long-term impact on visitor recreation values and a negligible, beneficial, long-term impact on regional spending and employment.

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse to minor, beneficial, short-term** impacts on socioeconomics in the analysis area. The impacts on socioeconomics in the analysis area are mainly from the activities of construction, development, highway and railroad operation. The cumulative impact of an avalanche caused derailment on socioeconomics is **minor to major, adverse, short-term to long-term and site-specific to**

regional depending on the substance type and size of the spill. Once snowsheds are built, the chance for avalanche caused derailments is greatly diminished.

ALTERNATIVE C: SHORT-TERM EXPLOSIVES USE FOR AVALANCHE HAZARD REDUCTION

Estimated cost of snowshed construction

The primary long-term avalanche hazard reduction measure under Alternative C would be the construction of new protective snowsheds or extension of existing snowsheds to protect the tracks through high danger avalanche zones. This alternative proposes the construction of 3,540 feet of new sheds and the extension of existing sheds by between 250 and 1,200 feet. The costs of snowsheds under Alternative C are estimated at $382,000 to $5,490,000.

Estimated costs associated with Alternative C explosive control measures

Table 4-12 outlines the estimated annual costs associated with limited use of explosives to control avalanches for a maximum 10-year period. The estimates presented in Table 4.12 assume that BNSF would choose to install Avalhex type systems or blaster box towers and systems within high elevation slide paths. These systems could be used through the 10 year snowshed construction period. The cost of these control systems would be amortized over this 10 year period with no assumed residual value at the end of the period. The cost for the Avalhex or Blaster Box systems, shown in Table 4-12 was estimated for the Avalhex. It is assumed that the 2 systems would have a similar number of installations and original and operations costs. It is estimated that use of these control measures would cost between $754,300 and $764,700 per year during the ten year period.

Table 4-12. Estimated annual cost of explosive use under Alternative C.

Control component	**Estimated Annual Cost**	
	Low (1 event/year)	**High** (3 events/year)
Annual cost of Avalaunchers[a]	$1,400	$1,400
Annual cost of Avalauncher ammunition and hand charges[b]	$1,100	$3,300
Annual cost of Avalex or Blaster Box charges[b]	$2,600	$10,800
Annual cost of Helicopter time[c]	$3,200	$3,200
Annual amortized cost of Avalhex type systems systems	$646,000	$646,000
Annual cost of in-house BNSF control program[d]	$100,000	$100,000
Total estimated Annual Cost of Explosive control equipment	$754,300	$764,700

[a] Based on $10,000 initial price and 10 year life, amortized at 7% real rate (per.comm. Dave Hamre. Aug 18, 2005)

[b] 22 to 66 shots at $50/shot for Avalauncher and hand charges and 33 to 99 shots at $110/shot for Avalhex type systems and $80/shot for Blaster Box systems.

[c] 4 hour flight time per season at $800/hour for helicopter.

[d] estimate from pers. Comm. Dave Hamre. Aug. 17, 2005.

Estimated cost of delays to BNSF and the traveling public

The use of explosive control of avalanche danger during a 10-year snowshed construction period under Alternative C would lead to reductions in potential delays associated with avalanche danger in the canyon. However, use of explosives in the canyon would necessitate delays for safety purposes during explosive use and cleanup.

Based on estimates of explosive use in the canyon, avalanche hazard reduction would require an average of 55 explosive shots per event (personal communication, Stan Bones, Flathead NF. July 25, 2005). It is estimated that delivering the explosives, assessment, and debris removal would require an approximate 15 hour delay per event. Based on this assessment and BNSF operational delay cost calculations, it is estimated that average costs per delay would be $38,700. With an estimated one to three delays per year, under Alternative C it is estimated that BNSF delay costs would range from $38,700 to $116,000 annually.

For Amtrak riders it is estimated that all trains delayed would face the costs of a 7.5 hour delay as riders would be bussed around the canyon. In the case of events where risk can be controlled adequately by explosive use, this delay would affect only one Amtrak train on average. The estimated average annual opportunity cost of lost time due to delays to Amtrak riders under Alternative C is estimated to range from $18,400 to $55,000.

While the primary focus of this analysis has been the railroad passing through John Stevens Canyon, travel on US Highway 2 through the canyon would also be impacted by the use of explosives in avalanche control within the canyon. Alternative C would result in BNSF train delays and traffic closures on US2 during periods of explosive use and cleanup. Over the past five years highway traffic counters near Browning, MT show that in an average winter (January-March) 24 hour period approximately 1,150 vehicles may travel the US 2 corridor. Because of lack of specific data on the composition of that traffic (commercial vs. private, local vs. non-local, etc) it is difficult to estimate the economic costs associated with considerable delays along the route. However, using the assumption that the vehicles would drive an alternate route (the same as traveled by re-routed Amtrak passengers), a rough estimate of impacts can be derived. Based on the assumptions of 48 vehicles per hour of closure impacted, a 40.5 cent/mile vehicle allowance, and an $8.90 per hour time allowance for the vehicle driver, the estimated costs associated with traveling the additional 223 miles (5 hours) of the alternative route would be approximately $6,500 per hour of closure. The estimated 15 hour delay per avalanche control event would lead to an estimated $97,500 to $292,500 in added transportation costs annually (for between 1 and 3 control events respectively).

These estimates assume that full explosive control is used during the 10-year period allowed. Additionally, once sheds are completed for a path, explosive control of that path would no longer be necessary or allowed. The potential impact of these complications on the above delay cost estimates is unknown. If BNSF were to decline to commit to building certain snowsheds, a large storm event could lead to somewhat longer delays due to higher explosive use than those estimated (due to mandatory closure of the canyon during high danger periods). Conversely, steady progress in protecting slide areas with snowsheds over the 10-year period could lead to considerable reductions in necessary explosive control in later years of the period, and associated shorter control-related closures.

Estimated costs to recreation

Under Alternative C there would be no mandatory closures of winter recreation trails during control periods. However, closure of sections of US Highway 2 would deny access to three trails commonly used for winter recreation: Ole Creek, Scalplock, and Fielding Creek. Data collected over the past five winters (chapter 3) show that on average it is estimated that these three trails see total winter use of approximately 875 user days. The large majority of this use occurs between December 1 and March 30. Therefore recreational trail use averages approximately 7 user days per calendar day. Restrictions on these trails due to explosive use would impact between 1 and 3 days per winter impacting (on average) 7 to 21 user days. In the scope of total winter use in the Marias Pass area, this represents a **negligible** impact. However, the whole Marias Pass recreation area would not have access from the west side of the divide during the highway closures. The highway closure may impact more people using the National Forest snowmobile and ski trails than people using Glacier National Park due to assumed higher use numbers on Forest land. According to NFS personnel, there are no recreational use numbers for Flathead or Lewis and Clark National Forests adjacent to the analysis area. The Marias Pass area is a destination for skiers, snowmobilers, and snowshoers. It is expected that the closures would have a **negligible** impact overall on recreation. The impact is mitigated further by the possibility that users could choose to ski alternate trails west of the closure area during closures. Finally, most avalanche cycles occur when large snowstorms are followed by rain. Under these conditions, it is less likely that ski or snowmobile demand for the trails in the area would be high.

A loss of between 7 and 21 user ski days in the park per season leads to an associated loss in net economic value to skiers. Net economic value is the value a person places on an experience over and above what they must pay for that experience. A December 1992 study of net economic values associated with recreation activities reported a mean net economic value associated with winter outdoor recreation (Crane Management Consultants, 1992). The net economic value of a winter recreation day from this report, adjusted for inflation is $52.50. Based on an estimated loss of between 7 and 21 user days, it is estimated that use of explosives under Alternative C would lead to an annual loss in net economic value to skiers of between $370 and $1,100.

Estimated cost of resource monitoring

BNSF would be required to fund resource monitoring of noise, wildlife, vegetation, water, and soils during the 10-year period of allowed explosive use. Glacier NP personnel estimate the annual cost of this ongoing monitoring would be $650,000 per year based on ecological monitoring programs conducted in similar environments. An infrasonic avalanche detection system would be installed to determine success of explosive use, magnitude and frequency of avalanches. The estimate capital cost for this system is $550,000, or an annualized cost of $52,000.

Table 4-13 details estimated annual costs associated with the Alternative C control options. The estimates in Table 4-13 assume no snowshed protection during the 10-year construction period for sheds, and full protection after that 10-year period.

Table 4-13. Estimated annual costs associated with Alternative C.

Cost/ Risk category	Estimated Annual Cost			
	During snowshed construction		After 10-year construction period	
	Low	High	Low	High
Estimated cost of minor delays to BNSF	$169,900	$337,900	0	0
Estimated Costs of Train Delays or Travel restrictions				
Delay costs to BNSF	$38,700	$116,000	0	0
Delay costs to Amtrak Passengers	$18,400	$55,000	0	0
Delay costs to US 2 Traffic	$97,500	$292,500	0	0
Cost Snow / Debris Removal	$340,000	$340,000	$170,000	$170,000
Cost Avalanche prediction/detection systems				
Maintain Signal Fences	0	0	0	0
Maintain Snowsheds	$40,000	$40,000	$79,000	$79,000
Cost of explosive operations to mitigate avalanche danger	$654,300	$664,700	0	0
Cost of contracted or in-house avalanche control services (ASD)	$100,000	$100,000	0	0
Cost of new snowshed construction	$382,000	$5,490,000	$382,000	$5,490,000
Cost of avalanche detection systems	$52,000	$52,000	0	0
Cost of resource monitoring program	$650,000	$650,000	0	0
Cost associated with lost recreation	$370	$1,100	0	0
Total Estimated Cost	**$7,321,200**	**$8,139,200**	**$631,000**	**$5,739,000**

SUMMARY OF ALTERNATIVE C: SOCIOECONOMIC IMPACTS

Alternative C: Impacts to the Local Economy

Under Alternative C, possible changes in impacts to the local area economy may occur to the extent that BNSF constructs additional snowsheds within the canyon. The construction of snowsheds under this alternative could lead to major and ongoing construction activity in the local economic area over a multi-year period. It is unknown the degree to which local construction firms and labor would benefit from specialized construction projects such as snowsheds. While construction firms from Montana or the local economic area may not receive the contracts for snowshed construction, local spending by workers on the project would affect the local economy. It is therefore estimated that direct annual construction costs of up to $8.1

million per year over a 10 year period would result in **minor to moderate, beneficial, long-term** income and employment impacts on a local level.

A potential local economic impact associated with Alternative D is the measurable decrease in the potential for an avalanche-caused derailment in the canyon. This impact is measured in avoided average long-term costs, rather than direct expenditures in the economy. Lowering the winter accident risk in the canyon leads to a commensurate lowering of the risk of a future accident with the potential for substantial disruption of economic activity in the area.

If BNSF does not construct sheds as recommended in the *Avalanche Risk Analysis*, the economic impact of 10-years of explosive use and monitoring of Alternative C on BNSF would be **minor, adverse, and long-term**. If BNSF built 5 new snowsheds and extended 7 snowsheds under Alternative C, there would be a **moderate, adverse, long-term, regional** impact on BNSF economically. While it seems that this impact would be great financially, the benefits of removing the avalanche caused spill potential and eliminating railroad delays would have **moderate, long-term, beneficial,** impacts on BNSF economics. While snowshed construction is expensive, the cost benefit is beneficial, causing an overall **minor, adverse, long-term** impact on BNSF. The impact on local economies with this alternative, depending on the extent local companies are used for construction, would be **minor to moderate, beneficial, long-term, and local.**

Alternative C: Economic Impacts to BNSF and the Traveling Public

Total annual economic impacts of Alternative C to BNSF and the traveling public are predicted to be between $38,700 and $116,000 in direct operational losses to BNSF from avalanche-related operational delays and closures. Amtrak passengers are estimated to bear an average $18,400 to $55,000 per year cost associated with delays and bussing around closures in John Stevens Canyon. Additionally, calculated costs to BNSF from minor delays associated with avalanche risk are estimated to be $169,000 to $337,000 annually.

Costs to travelers from explosive control and cleanup delays on US Highway 2 are estimated as between $97,500 to $292,500 annually

Assuming BNSF chooses to construct all recommended snowsheds during the 10-year construction period, estimated costs of delays to BNSF, Amtrak, and US 2 travelers would only occur during the 10-year construction period. Following that period, the BNSF tracks would be protected by snowsheds, and delays associated with avalanches on US 2 would be decreased from current levels.

BNSF would bear the direct cost of all snowshed construction. Depending on the level of snowshed construction, BNSF could face annual amortized costs between $0 and $5.16 million per year over the life of new snowsheds constructed.

An additional impact to BNSF under Alternative C is continued maintenance of existing and newly constructed snowsheds ($40,000 - $79,000 per year), and the annual cost of the proposed BNSF avalanche detection and cleanup program ($170,000 - $392,000).

A final cost to BNSF of Alternative C would be costs associated with implementation of a limited explosive control program over the allowed five year period. This cost is assumed to be $0 to $1,404,300 per year. The high-end cost estimate for this component includes $650,000 per year for resource monitoring during period of explosive use.

Alternative C: Economic Impacts to Recreation

Under Alternative C there would be an estimated loss associated with lost recreational opportunities of between $370 and $1,100 per year during the 10-year construction and explosive control period. After 10 years, these losses would return to zero.

ALTERNATIVE C CUMULATIVE EFFECTS

Past Actions: Same as under Alternative B.

On-going Actions: Same as under Alternative B

Foreseeable Future Actions: Same as under Alternative B

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse to minor, benefical, short-term** impacts on socioeconomics in the analysis area. The impacts on socioeconomics in the analysis area are mainly from the activities of construction, development, and highway and railroad operation. The cumulative impact of an avalanche caused derailment on socioeconomics is **minor to major, adverse, short-term to long-term and site-specific to regional** depending on the substance type and size of the spill. Once snowsheds are built, the chance for avalanche caused derailments is greatly diminished. The delays due to explosive control of avalanche danger and the explosive control program would have a negligible impact on recreational values, and a negligible to minor, beneficial short term impact on local-area expenditures.

ALTERNATIVE D: LONG-TERM EXPLOSIVES USE FOR AVALANCHE HAZARD REDUCTION

Estimated cost of snowshed construction

Alternative D calls for the construction of approximately 250 feet of new snowsheds (extension to existing sheds 7 and 9) BNSF has solicited and received bids for these two sheds totaling $5.5 million. Using a real discount rate of 7 percent, a 2 year construction period, and a 50 year useful life, the annual costs associated with two extended snowsheds amortized over their useful life would be $382,000. This would be a **minor, adverse, long-term** impact on BNSF costs.

Estimated cost of delays to BNSF and the traveling public

The use of explosive control of avalanche danger under Alternative D would lead to reductions in potential travel delays associated with avalanche danger in the canyon. However, use of explosives and artillery in the canyon would itself necessitate safety delays during explosive use and cleanup.

U.S. Forest Service personnel have estimated average delay time required to use explosives within the canyon (personal communication, Stan Bones, Flathead NF. July 25, 2005). Based on these estimates, control would require an average of 55 explosive shots per event. It is estimated that explosive delivery and debris clean up would require an approximate 15 hour delay per event. Based on these closure times and the estimates of direct operational costs of delays from BNSF it is estimated that average costs per delay would be $38,700. With an estimated one to three delays per year, under Alternative D it is estimated that BNSF delay costs would range from $38,700 to $116,000 a year in perpetuity.

For Amtrak riders it is estimated that all trains delayed would face the costs of a 7.5-hour delay as riders are bussed around the canyon. In the case of events where risk can be controlled adequately by explosive use, this delay would affect only one Amtrak train on average (rather than the 3 trains delayed under a full 30-hour delays of Alternatives A and B). The estimated average annual cost of delays to Amtrak riders under Alternative D is estimated to range from $18,400 to $55,000 in perpetuity.

While the primary focus of this analysis has been the rail lines passing through John F. Stevens Canyon, travel on US Highway 2 through the canyon would also be impacted by the use of explosives in avalanche control within the canyon. Alternative D calls for coordinated delays of US2 and the BNSF lines during periods of control and cleanup. Recent years highway traffic counters near Browning, MT show that in an average winter (January-March) 24 hour period approximately 1,150 vehicles may travel the US 2 corridor. Because of lack of specific data on the composition of that traffic (commercial vs. private, local vs. non-local, etc) it is difficult to estimate the economic costs associated with significant delays along the route. However, using the assumption that the vehicles would drive an alternate route (the same as traveled by re-routed Amtrak passengers), a rough estimate of impacts can be derived. Based on the assumptions of 48 vehicles per hour of closure impacted, a 40.5 cent/mile vehicle allowance, and an $8.90 per hour time allowance for the vehicle driver, the estimated costs associated with traveling the additional 223 miles (5 hours) of the alternative route would be approximately $6,500 per hour of closure. The estimated 15 hour closure per avalanche control event would lead to an estimated $97,500 to $292,500 for the traveling public in added transportation costs annually (for between 1 and 3 control events respectively).

Estimated costs to recreation

Under Alternative D there would be mandatory closures of winter recreation trails within a 5 mile distance north of the highway when artillery is used as a control measure. The three trails that would be impacted by these closures are Ole Creek, Scalplock, and Fielding. Data collected over the past five winters (chapter 3) show that on average it is estimated that these three trails see total winter use of approximately 875 user days. The large majority of this use occurs between December 1 and March 30. Therefore recreational trail use averages approximately 7 user days per calendar day. Closures due to explosive use would impact between 1 and 3 days per winter impacting (on average) 7 to 21 user days. In the scope of total winter use in the Marias Pass area, this represents a **negligible** impact. The impact is mitigated further by the possibility that users could choose to ski alternate trails in the area during closures. Finally, most avalanche cycles occur when large snowstorms are followed by rain. Under these conditions, it is less likely that ski demand for the trails in the area would be high.

A loss of between 7 and 21 user ski days per season leads to an associated loss in net economic value to skiers. Net economic value is the value a person places on an experience over and above what they must pay for that experience. A December 1992 study of net economic values associated with recreation activities reported a mean net economic value associated with winter outdoor recreation (Crane Management Consultants 1992). The net economic value of a winter recreation day from this report, adjusted for inflation is $52.50. Based on an estimated loss of between 7 and 21 user days, it is estimated that use of artillery under Alternative D would lead to an annual loss in net economic value to skiers of between $370 and $1,100.

Estimated cost of resource monitoring

BNSF would not fund ongoing resource monitoring of impacts associated with noise and impacts to wildlife, soils, water, and vegetation under Alternative D.

Estimated cost of explosive control program

Table 4-14 outlines the estimated annual costs associated with use of explosives and military artillery to control avalanches within the John Stevens Canyon. Under this alternative hand charges, helicopter control, use of pneumatic Avalaunchers, remotely controlled Blaster Boxes and/or Avalhex type systems and artillery are permitted. It is estimated that use of these control measures would cost between $132,600 and $561,900 per year. This estimate includes $100,000 per year for operation of an in-house prediction and control program by BNSF. The low-end estimate of explosive control costs assumes that BNSF relies only on military artillery for control of high elevation avalanche paths. The high-end estimate assumes that artillery would be used as a final measure in addition to a primary high elevation control method using the significantly more costly Avalhex or Blaster Box type systems.

Table 4-14. Estimated annual cost of explosive use under Alternative D.

Control component	Estimated Annual Cost	
	Low	**High**
Annual Cost of Avalhex or Blaster Box type systems[a]	0	$428,250
Annual cost of Avalaunchers[b]	$1,400	$1,400
Annual cost of artillery pads (6)	$11,300	$11,300
Annual cost of Artillery lease and fees[c]	$3,600	$3,600
Annual cost of charges and ammunition[c]	$13,125	$14,100
Annual cost of control program[d]	$100,000	$100,000
Annual cost of Helicopter time[e]	$3,200	$3,200
Total estimated Annual Cost of Explosive control equipment	$132,625	$561,850

[a] Estimate for tower systems with a 20 life cycle, amortized at 7% . Pers. Comm.. Stan Bones, Flathead N.F (July 27, 2005). and Dave Hamre (Aug. 17, 2005).

[b] Estimated $10,000 purchase price apiece for 2 launchers and a 20 year useful life, amortized at 7%.

[c] Frequency of shots from Stan Bones, Flathead NF (July 27, 2005). Cost of ordnance, and artillery lease, pers. Comm. Dave Hamre (Aug 17, 2005).

[d] Estimate by Hamre (pers. Comm. Aug 17, 2005)

[e] Helicopters are needed to load Avalhex type systems and unload them. Estimate for 4 hours at $800 per hour.

Table 4-15 shows a summary of all estimated costs associated with Alternative D avalanche control measures.

Table 4-15. Estimated annual costs associated with Alternative D actions to mitigate avalanche danger.

Cost/ Risk category	**Estimated Annual Cost**	
	Low	**High**
Estimated cost of minor delays to BNSF	$169,900	$337,900
Estimated Costs of Train Delays or Travel restrictions		
Delay costs to BNSF	$39,000	$116,000
Delay costs to Amtrak Passengers	$18,000	$55,000
Delay costs to US Highway 2 travelers	$97,500	$292,500
Cost Snow / Debris Removal	$340,000	$340,000
Maintain Signal Fences	0	0
Maintain Snowsheds	$40,000	$40,000
Cost of new snowshed construction	$382,000	$382,000
Cost of explosive operations to mitigate avalanche danger	$32,600	$461,900
Cost of contracted avalanche control services (ASD)	$100,000	$100,000
Cost of avalanche detection systems	$85,000	$161,000
Cost associated with lost recreation activities	$370	$1,100
Total Estimated Cost	$1,304,370	$2,287,400

Summary of Alternative D: Socioeconomic Impacts

Under Alternative D, the socioeconomic impacts on BNSF would be **minor, adverse, and long-term**. The socioeconomic impacts on the local economy would be **minor, beneficial, long-term, and local** depending on the amount of construction that occurs at a local level for snowsheds 7 and 9. Overall, the socioeconomic impacts would be **minor, adverse, long-term, and BNSF-specific**.

Alternative D: Impacts to the Local Economy

Under Alternative D, possible changes in impacts to the local area economy may be associated with BNSF constructing 2 small additional snowsheds within the canyon. It is unknown the degree to which local construction firms and labor would benefit from specialized construction projects such as the snowsheds. While construction firms from Montana or the local economic area may not get the contracts for snowshed construction, local spending by workers on the project would affect the local economy. It is estimated that annual construction costs of up to $2.75 million over a 2 year construction period would have a minor, beneficial, short term impact on local-area income and employment.

A potential local economic impact associated with Alternative D is the measurable decrease in the potential for an avalanche-caused derailment in the canyon. This impact is measured in avoided average long-term costs, rather than direct expenditures in the economy. Lowering the winter accident risk in the canyon leads to a commensurate lowering of the risk of a future accident with the potential for substantial disruption of economic activity in the area.

Alternative D: Economic Impacts to BNSF and the Traveling Public

Total economic impacts of Alternative D to BNSF and the traveling public are predicted to be between $39,000 and $116,000 in direct operational losses to BNSF from avalanche control-related operational delays and closures. Amtrak passengers are estimated to bear between $18,000 and $55,000 per year in cost associated with delays and bussing around closures in John Stevens Canyon. Travelers of US Highway 2 are estimated to incur between $97,500 and $292,500 in additional travel-related costs due to highway closures under Alternative D.

An additional impact to BNSF under Alternative D is continued maintenance of existing snowsheds ($40,000 per year), and the annual cost of the proposed BNSF avalanche detection and cleanup program ($425,000 - $501,000).

A final cost to BNSF of Alternative D would be costs associated with implementation of an ongoing explosive control program. This cost is estimated to be $32,600 to $461,900 per year, depending on the explosive delivery system chosen.

ALTERNATIVE D CUMULATIVE EFFECTS

Past Actions: Same as under Alternative B.

On-going Actions: Same as under Alternative B.

Foreseeable Future Actions: Same as under Alternative B.

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse to minor, beneficial, long-term** impacts on socioeconomics in the analysis area. The impacts on socioeconomics in the analysis area are mainly from the activities of construction, development, and highway and railroad operation. The cumulative impact of an avalanche caused derailment on socioeconomics is **minor to major, adverse, short-term to long-term and site-specific to regional** depending on the substance type and size of the spill. The construction of 2 short snowsheds would somewhat reduce the chance for avalanche caused derailments. The delays due to explosive control of avalanche danger and the explosive control program would have a negligible impact on recreational values, and a negligible to minor, beneficial, short term impact on local-area expenditures compared to Alternative A.

SOCIOECONOMIC CONCLUSION

Comparison of alternatives under benefit/cost accounting framework

The side-by-side comparison of the benefits and costs of Alternatives A – D is shown in Table 4-16. Benefits are presented as a comparison between avoided risk and associated estimated cost. This avoided risk of damage by avalanche results from the implementation of various methods of avalanche prediction, control, and protection outlined under the alternative descriptions. In the final analysis, all 4 alternatives (including Alternative A) have as a goal a considerable reduction in the avalanche hazard index. Based on the measures listed under the alternatives and estimates of hazard levels derived by Hamre and Overcast (2004) it is estimated that all alternatives would reduce risk costs by 90 percent or more. This avoided risk is in comparison to the historical risk level within the canyon.

The estimated benefits associated with this avoided risk are presented as a range in Table 4-16. The low-end estimate is based on baseline risk levels as represented by actual costs associated with avalanche-rail accidents over the period 1979-2004. This low-end estimate of costs associated with avoided risk is $75,000 annually. A second estimate of avoided risk is based on hypothetical costs of rail-avalanche accidents. This estimate is based on historic records of slide frequency within the canyon and current levels of train traffic. This estimate of avoided costs, based on probabilities derived by Hamre and Overcast, is $1.48 million annually.

As all four alternatives have the same computed economic benefit (or avoided cost) of between $75,000 and $1.48 million annually, from an economic perspective the comparison of alternatives is one of cost comparison. If all costs associated with specific actions were included in the analysis, the preferred alternative would be the lowest cost alternative. In the case of this analysis, however, there remains considerable uncertainty as to possible costs associated with the alternatives. Among the possible economic impacts not addressed in this analysis are the following:

1) Impacts on wildlife. These impacts range from possible avoided costs of reductions in bear deaths due to fewer train accidents resulting in foodstuff spills to costs associated with wildlife impacts resulting from use of explosives or artillery. Impacts on or avoided losses of species such as the federally listed grizzly bear could be substantial. However, specific species impacts are unknown at this point, and are thus not included in this analysis. Additionally, analysis of possible wildlife-based recreational losses (i.e. wildlife viewing and hunting opportunities) associated with wildlife abandoning winter range due to explosive avalanche hazard reduction is not included in this analysis.

2) Impacts on social values such as values associated with preserving natural avalanche cycles, soundscapes, wildlife, and recreational access within G NP. Estimation of such values would require a population survey which is beyond the scope of this analysis. Several comments received during the public scoping process dealt with these issues.

3) Benefits to highway traffic from avalanche control activities. Because both the highway and the rail lines pass through the canyon, control of avalanche danger to benefit train operations may also provide benefits to highway traffic.

Table 4-16 shows that among the alternatives those utilizing protection by construction of new snowsheds are the most expensive because of the capital costs. However, the snowshed alternatives provide the most protection for avalanche caused spills and reduction in delays. As noted in the description of the alternatives, construction of new snowsheds is at the discretion of BNSF. For Alternatives B and C scenarios are examined for no new snowshed construction and full construction of sheds at all recommended slide paths. It is likely that careful analysis of individual avalanche paths and associated risks would identify other combinations of shed construction and other prediction/control methods that are superior to those detailed in Table 4-16 in terms of cost minimization associated with achieving the desired level of avoided risk. Given, however, that snowshed construction on the part of BNSF is voluntary and thus unknown at this time, this analysis identifies costs associated with only options for no or full construction of new sheds.

Table 4-16. Comparison of estimated annual costs across alternatives.

Alternative	Delay costs	Snowshed costs [1]	Prediction & Detection	Explosive Avalanche Hazard Reduction	Resource Monitoring Costs	Costs to Recreational Users	Maintenance, cleanup, other costs	Total costs
A – (low estimate)	$554,000	$40,000	$105,000	0	0	0	$340,000	$1,039,000
A – (high estimate)	$1,493,000	$40,000	$105,000	0	0	0	$340,000	$1,978,000
B – No snowshed option (low estimate)	$554,000	$40,000	$85,000	0	0	0	$340,000	$1,019,000
B – No snowshed option (high estimate)	$1,493,000	$40,000	$161,000	0	0	0	$340,000	$2,034,000
B – Snowshed option (low estimate)	0	$5,569,000	0	0	0	0	$170,000	$5,739,000
B – Snowshed option (high estimate)	0	$5,569,000	0	0	0	0	$170,000	$5,739,000
C – First 10 years (low estimate)	$324,500	$422,000	$52,000	$754,000	$650,000	$1,000	$340,000	$2,543,500
C – First 10 years (high estimate)	$801,400	$5,530,000	$52,000	$764,700	$650,000	$1,100	$340,000	$8,139,200
C – After 10 years (low estimate)	0	$382,000	0	0	0	0	$149,000	$631,000
C – After 10 years (high estimate)	0	$5,569,000	0	0	0	0	$170,000	$5,739,000
D – (low estimate)	$325,000	$420,000	$85,000	$133,000	0	$1,000	$340,000	$1,304,000
D – (high estimate)	$801,400	$422,000	$161,000	$562,000	0	$1,000	$340,000	$2,287,400

[1]Snowshed costs include new snowshed construction added to snowshed maintenance costs

HEALTH AND SAFETY

Methodology

Health and safety was assessed through avalanche hazard indices, which are a common method of analyzing avalanche risk along a travel corridor. The indices are derived from a combination of avalanche frequency, magnitude, and historic records of weather, avalanche activity and transportation data. The hazard index gives a comparable risk factor for management or reduction of human risk exposure.

In 1994, Dave Hamre adapted *The Avalanche Hazard Index* by Peter Schaerer to reflect the higher avalanche risk exposure rate of railroads. The differences lie in a long train being exposed along a whole length of railroad as opposed to a car having only a short exposure equal to its length. The whole length of a train is affected if a small section is hit by an avalanche. Furthermore, a train is long enough that it may be subjected to several avalanche paths at a time, increasing its exposure and risk index. The predicted frequency and magnitude of avalanches based on historical data and encounter probability based on the amount of traffic traveling through the avalanche paths are variables Hamre incorporates into his railroad avalanche hazard index model. The baseline information on frequency and magnitude was derived from historic railroad records of avalanche activity, topography, slope elevation, historic weather data, current vegetative cover, and tree ring core analysis. Hamre examined the hazards of both avalanche paths without snowsheds and avalanche paths that have breached snowshed protection. Railroad traffic was examined and broken down into different categories of freight cars, locomotives, passenger vehicles (Amtrak), and mini-dozers. The amount of time each vehicle is in an avalanche path, the frequency of each car category (freight cars are much more numerous than locomotives), damage assessments for each category, and the statistical probability of avalanche exposure for each category are the variables used to compute the railroad avalanche hazard index (AHI). The whole report can be found in Appendix A. Table 1-1 lists the classification of unmitigated AHI ranges (AES, 2004). The unmitigated AHI does not include the delays that have been part of BNSF operations in the past. The calculated AHI does not take into account the current avalanche safety program, railroad restrictions, and avalanche safety measures that have been implemented. These actions would decrease the AHI as the human and property exposure is eliminated.

Table 4-17. Unmitigated AHI range classification.

Unmitigated AHI	Classification
<1	Very Low
1-10	Low
10-40	Moderate
40-100	High
>100	Very High

The complexity of the AHI computation is further complicated by the nature of the project area. If a train stops to avoid hitting avalanche debris, it may be exposed to various other avalanche paths while waiting for the debris to be cleared. The AHI computation for a moving and a non-moving target are quite different. Hamre developed assumptions concerning the probability of other paths sliding in a given period while trains were waiting for the tracks to be cleared. Table 1-1 shows the AHI for each path and how it was derived. The total avalanche hazard index for the project area is a sum of the AHI of each individual path. An index allows different variables to be compared, in this case, different avalanche potentials for specific avalanche paths. The indices are added together to reach a total AHI in order to compare the variables from one location to another. The AHI is not an average hazard for the project area, but instead allows different paths and different areas to be compared. The total AHI for the entire project area is 110.45. An acceptable risk level for highway traffic is between 1 and 40 with avalanche control work recommended when the AHI is over 40 (Schaerer 1989). The goal of BNSF is to reduce the risk to a rating of less than 10 (Hamre, 2004).

Thresholds of impact for health and safety are defined in Table 4-1.

- ***Negligible***: Public health and safety would not be affected, or the effects would not be noticeable.
- ***Minor***: The effect would be detectable, but would not have an appreciable effect on public health and safety.
- ***Moderate***: The effects would be readily apparent, and would result in a substantial change in public health and safety in a manner noticeable to staff and the public.
- ***Major***: The effects would be readily apparent, would result in a substantial change in pubic health and safety in a manner noticeable to staff and the public and be markedly different from existing conditions.
- ***Short-term***: Occurs during year winter months (December through March) or less.
- ***Long-term***: Occurs during winter months over several years or is permanent.

Analysis Area

The analysis area for health and safety include the canyon walls to the ridges south and north of the BNSF Railroad line between mileposts 1159 and 1164.

IMPACT ANALYSIS- HEALTH AND SAFETY

Impacts Common to All Alternatives

Infrasonic avalanche detection technology, weather station, and snow depth sensor installation are components of Alternatives B, C, and D. The installation of this equipment would allow avalanche forecasters to have more information regarding weather patterns in the analysis area. Forecasters need current, accurate weather information for avalanche hazard analysis. The avalanche detection technology would allow forecasters and BNSF to detect avalanches that have crossed the railroad tracks or natural activity higher in elevation signaling an unstable snowpack. The technology for advanced detection systems would provide an automatic warning system lowering train exposure to further avalanche activity. Once an avalanche is detected, the whole analysis area can be closed to prevent further avalanche activity from affecting human safety. Railroad delays would be enacted with both the explosive and non-explosive alternatives. During railroad delays, approximately 725 Amtrak passengers could be bussed around the canyon on US Highway 12, eliminating the risk to passengers.

Under each alternative, BNSF employees and Amtrak passengers could have advanced warning systems that would lower the avalanche risk exposure rate. The weather station and snow depth sensors would give avalanche forecasters more information to make better decisions concerning railroad access and closures. Installation of avalanche detection technology on BNSF right-of-way property would have a **moderate, long-term, beneficial, localized** impact on public health and safety. Installation of the snow depth sensor on NPS land and a new weather station on NFS land would result in a **moderate, long-term, beneficial, localized** impact on public health and safety. These hazard mitigation measures would lower the avalanche hazard index for each alternative by restricting or halting train travel through the canyon during times of high avalanche hazard.

Public health and safety would be affected by derailments or hazardous material spills in many different ways. The impacts could range from **negligible to major, site-specific to regional, short-term to long-term, and adverse** depending on the substance, cleanup procedures, cleanup duration, and the proximity of railroad, highway workers, and other members of the public. A hazardous material spill could have major, adverse, long or short-term impacts on human health and safety. For example, a chlorine gas spill in southwestern Montana caused the evacuation of residents in a large area around the spill. The alternatives have various means of derailment prevention and protection.

Alternative A: No Action

BNSF may choose to use weather data and avalanche forecasting to determine elevated avalanche risk and implement delays and restrictions on train traffic under current operations. BNSF has implemented a safety plan and avalanche awareness and rescue training. The increased awareness of avalanche hazard and safety program implementation has lowered the AHI in the canyon. A conservative forecaster may recommend that BNSF delay operations in the canyon until snow in each avalanche path stabilizes. This delay would lower the avalanche hazard index to zero. Human health and safety impacts during snowshed construction would be dependent on the accuracy of forecasting and avalanche hazard assessment. There is always the risk of error when humans are forecasting or assessing avalanche hazard.

According to the avalanche hazard analysis report, delays or snowshed coverage provide the most dramatic decrease in the avalanche hazard index. If BNSF does not delay or restrict train traffic when the avalanche hazard increases, train traffic would be exposed to a higher avalanche hazard index. According to the analysis, the canyon currently has an unmitigated AHI of 110.45. Train delays would result in a **major, beneficial, short-term, site-specific** impact on human health and safety. Frequently, when one avalanche occurs, other avalanche paths in the same area are also prone to instability. Impacts to public health and safety from no train traffic restrictions or delays would run the **range of negligible to major, adverse, and short-term**. Employee or passenger fatality would be a **major adverse, long-term** impact.

Alternative B: Construction and Modification of Snowsheds

Snowshed construction and modification would be completed beginning in the avalanche paths that have the highest avalanche hazard index. The *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana* states that snowsheds are the avalanche hazard mitigation method that reduces the AHI the most with the exception of total railroad closure in the canyon (Hamre and Overcast, 2004). The report goes on to assess the residual AHI (from the original 110.45) with this alternative would be 7.71 (Hamre and Overcast, 2004). Snowshed construction and modification must occur on all of the recommended avalanche paths (see Table 2-3) to reduce the AHI to 7.71. Once constructed, snowsheds are an investment in complete human protection. The risk of derailment caused by avalanche is reduced substantially. This alternative would have a snowshed completion period during which humans and trains may be at risk from avalanche activity. The snowshed completion period may last for several years. If the railroad continued normal operations during the interim construction period, there could be the risk of serious injury or death from avalanches. Train restrictions, delays, and safety training during the interim construction period, would minimize the safety risk and result in a **negligible, adverse, short-term** impact on human heath and safety. If restrictions or delays were not imposed on train traffic through the canyon during periods of high risk, a fatality or hazardous material spill could make the impact range between **minor and major, adverse, and short or long-term** depending on the substance or the degree of injury. The emergency response explosive use measure in this alternative would improve rescue response or prevention of a hazardous material spill in the event that an avalanche caused incident occurred. This measure would only be permitted if human health and safety and or park resources were at immediate risk from an avalanche caused emergency while snowsheds are constructed and all other options have been exercised. Human health and safety impacts during snowshed construction would be dependent on the Avalanche Safety Director and human fallibility during forecasting and avalanche hazard assessment. There is always the risk of error when humans are forecasting or assessing avalanche hazard. Overall, this alternative would have a **major, long-term, site-specific, beneficial** impact on health and safety with the construction of recommended snowsheds.

Alternative B Cumulative Effects

Past Actions: Recreational use in the area has inherent risk in the canyon. Increased highway and railroad traffic have a minor, adverse, long-term impact on human health and safety in the canyon as the individual probability of accident or fatality increases with more traffic. Snowslip weather station and Pike Creek SNOTEL sites provide site-specific weather information for avalanche forecasters and have a minor, beneficial, long-term impact on health and safety as more timely highway and railroad delays can be implemented. These structures would improve health and safety conditions and avalanche awareness in the canyon. Regular year-round train and highway maintenance would have a beneficial impact on human health and safety as train and road traffic through the canyon would meet railroad and highway safety standards. Fire management would be directed to protect human safety and, when possible, man-made structures; however, this does not include the control of fires in avalanche paths to maintain and promote tree growth. Fire management would result in a beneficial impact on human health and safety.

On-going Actions: Recreational use in the area has inherent risk in the canyon. Increased highway and railroad traffic have a minor, adverse, long-term impact on human health and safety in the canyon as the individual probability of accident or fatality increases with more traffic. Snowslip weather station and Pike Creek SNOTEL sites provide site-specific weather information for avalanche forecasters and have a minor, beneficial, long-term impact on health and safety as more timely highway and railroad delays can be implemented. These structures would improve health and safety conditions and avalanche awareness in the canyon. Regular year-round train and highway maintenance would have a beneficial impact on human health and safety as train and road traffic through the canyon would meet railroad and highway safety standards. Fire management in the canyon would allow natural tree growth and vegetation to anchor snow in avalanche paths and would have a beneficial impact on human health and safety. Fire management would reduce the risk of death or injury from wildfire in the canyon.

Foreseeable Future Actions: Recreational use in the area has inherent risk in the canyon. Increased highway and railroad traffic have a minor, adverse, long-term impact on human health and safety in the canyon as the individual probability of accident or fatality increases with more traffic. Snowslip weather station and Pike Creek SNOTEL sites provide site-specific weather information for avalanche forecasters and have a minor, beneficial, long-term impact on health and safety as more timely highway and railroad delays can be implemented. These structures would improve health and safety conditions and avalanche awareness in the canyon. Regular year-round train and highway maintenance would have a beneficial impact on human health and safety as train and road traffic through the canyon would meet railroad and highway safety standards. Fire management in the canyon would allow natural tree growth and vegetation to anchor snow in avalanche paths and would have a beneficial impact on human health and safety. Fire management would reduce the risk of death or injury from wildfire in the canyon. Recommended snowshed construction on the railroad would considerably increase railroad personnel and passenger safety. Snowshed construction would not increase health and safety anywhere else in the canyon. Snowshed construction and railroad delays that are currently occurring would have the same benefit for health and safety. A hazardous material spill on the railroad or the highway would have a range of impacts depending on the substance spilled. The range of impacts on public health and safety would be negligible to major, adverse, short-term to long-term and localized.

Cumulative Effects Conclusion: Alternative B would increase health and safety in the canyon and result in a cumulative **moderate, beneficial, long-term, site-specific** impact. Other factors increasing health and safety in the canyon would be standardized safety feature installation on roads and highways, recreational safety awareness, and better avalanche hazard forecasting with existing weather instruments. More winter highway delays may occur due to better forecasting methods which would have a short-term beneficial impact on health and safety of motorists in the canyon. A hazardous material spill would result in a range of impacts on public health and safety that would be **negligible to major, adverse, short-term to long-term and site specific to regional**. Once snowsheds are built, the potential for an avalanche caused hazardous material spill would be less than the Alternative A and D.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

The impact of train restrictions and delays during explosive use and snow stabilization under Alternative C would be **moderate, beneficial, and short-term**. With no exposure to avalanches, threats to health and safety would be eliminated. The *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana* rates the residual avalanche hazard index of this Alternative as 10.89. Once snowsheds are built, the AHI would be decreased by the current AHI for each avalanche path (Hamre and Overcast, 2004). The immediate lengthening of Shed 7 and Shed 9 (AHI 15.55 and 6.69 respectively), would quickly reduce the AHI along with short-term explosive use in other paths. This alternative would have an element of risk concerning the hazardous conditions under which the railroad is closed and avalanche hazard reduction work is conducted. While the railroad is open to train traffic, the risk of avalanche may be present. Human health and safety could be impacted by the human fallibility of avalanche forecasting, malfunctioning equipment, or failure to delay or restrict trains through the canyon. The reduction of the avalanche hazard index is dependent upon identification of elevated avalanche hazard and rapid action by BNSF. The impact on the health and safety of humans traveling on the railroad tracks with mitigation of delays and explosive use would be **moderate, beneficial, site-specific, and short-term**. With snowshed construction and lengthening, the AHI would be reduced to 7.71 after snowshed completion resulting in a **moderate, beneficial, long-term, site-specific** impact on human health and safety. This alternative allows for gradual, steady reduction in the analysis area AHI. A 10-year program of explosive use would be used to mitigate some of the avalanche risk in the canyon until snowsheds are built or modified. Alternative C would result in a 93% reduction in avalanche risk. Certified personnel would conduct explosive use would follow all state and federal safety blasting and storage regulations in explosives handling. There is the potential for employees using explosive equipment to suffer injury or death if equipment or operator error occurs. There is a small amount of risk to human health and safety within the analysis area with the use of cast primer explosives and the potential for unexploded duds in the analysis area. Mandatory and timely removal of unexploded ordnance in the analysis area would result in a **minor, beneficial, short-term** impact to human health and safety as avalanche personnel take on a certain level of risk when recovering unexploded ordnance. Overall, this alternative would have a **moderate, beneficial, short-term, site-specific** impact on health and safety.

Alternative C Cumulative Effects

Past Actions: Past actions are the same as in Alternative B.

On-going Actions: On-going activities are the same as in Alternative B.

Foreseeable Future Actions: Future activities are the same as in Alternative B.

Cumulative Effects Conclusion: Alternative C would increase health and safety in the canyon and result in a cumulative **moderate, beneficial, long-term, site-specific** impact. Other factors increasing health and safety in the canyon would be standardized safety feature installation on roads and highways, recreational safety awareness, and better avalanche hazard forecasting with existing weather instruments. More winter highway delays may occur due to better forecasting methods which would have a short-term beneficial impact on health and safety in the canyon. A hazardous material spill would result in a range of impacts on public health and safety that would be **negligible to major, adverse, short-term to long-term and site specific to regional.** Once snowsheds are completed, the potential for an avalanche caused hazardous material spill would be less than the Alternative A and D.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

The long-term use of explosives for avalanche hazard mitigation includes railroad track delay during the explosive operation. The impact on human health and safety during these delays could be **major, beneficial, short-term** impact. The *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana* rates the residual avalanche hazard index of this alternative as between 10.89 and 8.25, with explosive control of avalanche paths between 70 and 80 percent of the hazardous area (Hamre and Overcast, 2004). The *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana* incorporates the building of Shed 7 and Shed 9 into the continuous explosive program. Realistically, avalanche hazard indices would only be reduced to their lowest point with this alternative when these two snowsheds have been built across paths with the highest hazard indices (Hamre and Overcast, 2004). The immediate lengthening of Shed 7 and Shed 9 (AHI 15.55 and 6.69 respectively), would reduce the AHI by 22.24 in addition to the reduction from long-term explosive use. This alternative would have an element of risk concerning the hazardous conditions under which the railroad is delayed and explosive operations are conducted. While the railroad is open to train traffic, the risk of avalanche may still be present. Human health and safety could be impacted by the fallibility of avalanche forecasting, malfunctioning equipment, or failure to delay the railroad in a timely manner. The reduced hazard index is dependent upon conservative, preventative railroad delays for explosive avalanche hazard reduction. The impact on the health and safety of humans traveling on the railroad tracks with this alternative with delay mitigation would be **moderate, site-specific, beneficial, and short-term**. The use of explosives may not always be successful and an element of avalanche risk may remain after explosives have been detonated. Certified personnel would conduct explosive use would follow all state and federal safety blasting and storage regulations in explosives handling. There is a small amount of risk to human health and safety outside the analysis area with the use of explosives and artillery. Artillery ammunition could travel up to 6.9 miles if the ammunition is left fully charged. The recreational closure with a 7 mile buffer zone around the analysis area and mandatory registers for trail use would mitigate these impacts to **negligible, adverse, and short-term**. Mandatory and timely removal of unexploded ordnance in the analysis area would result in a **moderate, beneficial, long-term**, **site-specific** impact to human health and safety. There is a risk to blasting personnel from the use of cast primer and artillery explosives use, dud recovery, and general work in defined avalanche conditions. Overall, the impacts on health and safety under alternative D are **moderate, beneficial, short-term, and site-specific**.

Alternative D Cumulative Effects

Past Actions: Past actions are the same as in Alternative B.

On-going Actions: On-going activities are the same as in Alternative B.

Foreseeable Future Actions: Future activities are the same as in Alternative B.

Cumulative Effects Conclusion: Alternative D would increase health and safety in the canyon and result in a cumulative **moderate, beneficial, long-term, site-specific** impact. Other factors increasing health and safety in the canyon would be standardized safety feature installation on roads and highways, recreational safety awareness, and better avalanche hazard forecasting with existing weather instruments. More winter highway delays would occur due to better forecasting methods, which would have a short-term, beneficial impact on health and safety in the canyon. A hazardous material spill would result in a range of impacts on public health and safety that would be **negligible to major, adverse, short-term to long-term and site specific to regional.**

Human Health and Safety Conclusion

Each alternative has an element of avalanche risk that could affect human health and safety. Any potential for human injury or fatality could result in a **major, adverse, long-term** impact. Impacts on human health and safety could be **major, beneficial, site-specific, and short-term** if forecasting and operation delays are timely and conservative. Alternative A has the highest unmitigated residual AHI, according to the *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana*, and the impacts would range from **negligible to major, adverse, and short-or long-term**. Avalanche forecasting, hazard identification, safety training, and delay recommendations have lowered the AHI considerably under Alternative A to a **major, beneficial, site-specific and short-term**. Alternative B has the lowest residual AHI in the analysis, however, the AHI would not be its lowest until snowsheds are built or modified. The resulting impact with this alternative would depend on closure mitigation and be **major, beneficial, site-specific, and long-term**. Alternative C would have a gradual decrease in AHI, which would ultimately be reduced to the level of Alternative B once snowsheds are built or modified. The impacts under Alternative C are **moderate, beneficial, and short-term** with delay and explosive use mitigation. Both Alternative B and C would have **long-term, major, beneficial** impacts once snowsheds are built or modified. Compared to the other alternatives, Alternative D would have a relatively high residual AHI that would continue indefinitely. Alternative D would have a **moderate, beneficial, site-specific, and long-term** impact on human health and safety. Under the two explosive use alternatives, C and D, unexploded ordnance if not found immediately, could pose a moderate, adverse, long-term impact to humans in the area. Under Alternatives C and D, avalanche safety personnel take on a certain amount of risk while working with explosives and dud recovery.

WILDERNESS

Methodology

Several sources of noise and disturbance can be experienced within the wilderness areas in the analysis area. Quality of human wilderness experience depends on individual perspective and expectations. Some individuals are willing to accept permanent fixtures, noise, and visual impacts along the edge of wilderness areas, while others are not willing to compromise the integrity of wilderness values for any type of non-conforming use.

Information for impact derivation for this topic is difficult to quantify. Because wilderness is a human concept that includes an individual's perception of wilderness, impacts may have an entirely different meaning to separate individuals and groups. In this section, the impacts are based on staff professional opinion and perception, public comment, and actual proposed additions to recommended wilderness. There are no proposals to install equipment in the Great Bear Wilderness, however, some of the proposed equipment installation and explosive measures may be visible and audible within the Great Bear Wilderness on NFS land. The impacts on the Great Bear Wilderness area would be analyzed along with impacts on recommended areas in Glacier National Park.

Thresholds of impact are defined in Table 4-1.

- *Negligible*: Wilderness would not be affected or the effects would not be noticeable.
- *Minor*: The effect would be detectable, but would not have an appreciable effect on wilderness.
- *Moderate*: The effects would be readily apparent, and would result in a substantial change to the wilderness landscape that would be noticeable to the public.
- *Major*: The effects would be highly apparent and would change the character of the wilderness area.
- *Short-term*: Occurs for one year or less.
- *Long-term*: Occurs for more than one year or is permanent

Analysis Area

The analysis area is the Great Bear Wilderness south of the analysis area on Forest lands and Glacier National Park recommended wilderness north of the railroad.

IMPACT ANALYSIS-WILDERNESS

Impacts Common to All Action Alternatives

Avalanche detection technology, weather station, and snow depth sensor installation are components of Alternatives B, C, and D. The installation of avalanche detection equipment would be on BNSF right-of-way property. The snow depth sensor is the only equipment that would be permanently fixed in NPS recommended wilderness. This fixed equipment would have a **minor, adverse, site-specific, long-term** effect on wilderness, as it would be camouflaged.

An avalanche caused derailment could run the range of **negligible to major, adverse, short or long-term** depending on the spilled material. A hazardous material spill could have **major, adverse, long or short-term** impacts on wilderness depending on the spilled material. Impacts from a spill may change natural vegetation patterns, wildlife movements, cause recreational closures or be highly visible from the Great Bear Wilderness or NPS recommended wilderness areas.

Alternative A: No Action

Under the No Action Alternative, conditions would not change from current conditions and there would be **no impact** on wilderness. The temporary Snowslip weather station would be removed after current USGS research is concluded.

Alternative B: Construction and Modification of Snowsheds

Snowshed construction and modification would have **minor, adverse, short-term, site-specific** impacts on wilderness within and adjacent to the analysis area. Construction activities would produce **short-term** noise and disturbance. The additional noise of construction would not be greater than the normal operation of the railroad or highway. The completed snowsheds would be visible from Glacier National Park recommended wilderness and the Great Bear Wilderness which would be a **minor, adverse, long-term, site-specific** impact. There are no established trails within the analysis area. The immediate analysis area gets very little use by skiers or hikers as the valley walls are steep and avalanche activity can be hazardous during the winter months. The use of explosives and helicopter for emergency response would be a temporary measure and would have little residual impact on wilderness. The emergency use of explosives would have loud explosions disturbing natural sound, natural avalanche processes, and closures of recreational areas during the explosive use. Explosive use under emergency conditions would likely only occur in a few avalanche paths during an isolated incident. Impacts would be **minor, adverse, short-term and site-specific**. The visual impact to wilderness resources would be offset by a **minor, beneficial, long-term** decrease in railroad noise due to snowshed coverage in the canyon. Snowslip weather station would be removed after the snowsheds are completed.

Alternative B Cumulative Effects

Past Actions: Fire management, regular train and highway operations, development in the canyon, Snowslip weather station installation, train spill cleanup, overflights, and recreational use all have a **minor, adverse, long-term, site-specific** impact on Glacier National Park or Flathead Forest wilderness surrounding the analysis area. Revegetation and weed control activities (if effective)have a **moderate to major, beneficial, long-term, site-specific** impact on wilderness areas.

On-going Actions: Fire management, regular train and highway operations, construction in the canyon, Snowslip weather station operation, train spill cleanup, overflights, and recreational use all have a **minor, adverse, long-term, site-specific** impact on Glacier National Park or Flathead National Forest wilderness surrounding the analysis area. Revegetation and weed control activities have a **moderate to major, beneficial, long-term, site-specific** impact on wilderness areas.

Foreseeable Future Actions: Fire management, regular train and highway operations, construction in the canyon, Snowslip weather station operation, train spill cleanup, overflights, and recreational use all have a **minor, adverse, long-term, site-specific** impact on Glacier National Park or Flathead Forest wilderness surrounding the analysis area. Revegetation and weed control activities have a **moderate to major, beneficial, long-term, site-specific** impact on wilderness areas.

Cumulative Effects Conclusion: The impacts on wilderness in the analysis area are mainly from noise and visual effects of construction, development, highway and railroad operation. While there are **minor, adverse, long-term, site-specific** impacts on wilderness in John F. Stevens Canyon, the impacts are concentrated closely to the highway and railroad. Moving further away from the traffic corridor, the impacts diminish rapidly. Snowshed construction would create **minor, adverse, long-term, site-specific** impacts on wilderness. It would be difficult to distinguish construction noise from on-going train operations. There would be a **negligible, beneficial, site-specific** cumulative impact on wilderness after the snowsheds are built. Under this alternative, avalanche caused derailments would be less likely with the extensive coverage of snowsheds. The cumulative impact of an avalanche caused derailment on wilderness is minor to major, adverse, short-term to long-term and site-specific depending on the substance spilled.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

The 10-year period of explosive use for avalanche hazard mitigation alternative would have a **moderate, adverse, long-term, localized** impact on wilderness in John F. Stevens Canyon. Noise from explosive blasting and helicopter use would have the greatest impact on wilderness values. The project area, which includes Glacier National Park recommended wilderness, would be closed to recreational use during explosive use periods. If unexploded charges are in the area, recreational access would be restricted until the duds are retrieved. Access to adjacent wilderness in the GNP or FNF from the highway would not be possible during explosive use due to highway and recreational closures. Noise from explosive use would be audible from the northern boundary of the Great Bear Wilderness and craters in the snow may be visible from the Great Bear Wilderness. The Avalauncher and hand charges do not pose a threat to wilderness beyond the defined analysis area as the cast primer explosives do not travel very far. Weather instruments, Avalhex type systems and blaster box systems would be temporary installations in recommended wilderness start zones causing a **moderate, long-term, adverse, localized** impact on wilderness. These structures installed in recommended wilderness are not for the purpose of managing wilderness and therefore do not meet the *minimum requirement/ minimum tool analysis* under the Wilderness Act. This action would be against NPS policy and would require approval for a non-conforming use in recommended wilderness. Snowslip weather station, Avalhex type towers, and blaster box towers would be removed after the permit expires. Disturbance from noise, fixed equipment in start zones (to be removed after the permit expires), and decreased access due to closures would have the greatest impact on wilderness under this alternative.

Alternative C Cumulative Effects

Past Actions: Past actions are the same as in Alternative B.

On-going Actions: On-going activities are the same as in Alternative B.

Foreseeable Future Actions: Future activities are the same as in Alternative B.

Cumulative Effects Conclusion: The impacts on wilderness in the analysis area are mainly from noise and visual effects of construction, development, highway and railroad operation. While there are **minor, adverse, short-term, localized** impacts on wilderness in John F. Stevens Canyon, the impacts are concentrated closely to the highway and railroad. Moving further away from the traffic corridor, the impacts diminish rapidly. Snowshed construction would create **minor, adverse, long-term, site-specific** impacts on wilderness. Construction would take place over several years. It would be difficult to distinguish construction noise from on-going train operations. The addition of explosive use into the canyon would increase noise in the wilderness starting zones, however, the above activity noise and visibility would be very distant from the explosion sites. The impacts of explosive use would increase the amount of time loud noise such as gunfire from hunting season occurs in the Canyon. The explosive use would occur only during the winter months and deep snow coverage would dampen the cumulative effects of activity in the canyon. Helicopter use for explosive dropping would increase the amount of time per year that overflights are seen and heard over the recommended park wilderness and designated forest wilderness. The cumulative effects of the above activities in conjunction with up to 10-years of explosive use would be **moderate, adverse, long-term, and localized** over the analysis area. Under this alternative, avalanche caused derailments would be less likely with the extensive coverage of snowsheds after the 10-year period of explosive avalanche hazard mitigation. After the 10-year period, noise is expected to be reduced by the new snowsheds, causing an overall **minor, long-term, beneficial, site-specific** impact on wilderness. The cumulative impact of an avalanche caused derailment on wilderness is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

The continuous program of explosive use for avalanche hazard mitigation alternative would have a **major, adverse, long-term, localized** impact on wilderness in John F. Stevens Canyon. Noise from continuous winter explosive blasting and helicopter use would have the greatest impact on wilderness values. The analysis area, which includes Glacier National Park proposed wilderness, would be closed to recreational use during explosive use periods and the wilderness in the closure would be inaccessible. If unexploded duds remain in the area, closures could affect wilderness access until duds are retrieved. Access to adjacent wilderness in the Park or the Forest from the highway would be difficult during explosive use due to highway and recreational closures. Noise from explosive use would be audible from the northern boundary of the Great Bear Wilderness and craters may be visible from the Great Bear Wilderness. The Avalauncher and hand charges do not pose a threat to wilderness beyond the defined analysis area as the cast primer explosives do not travel very far. Weather instruments, Avalhex type systems and blaster box systems would be permanent installations in recommended wilderness start zones causing a **major, long-term, adverse, site-specific** impact on wilderness. These structures installed in recommended wilderness are not for the purpose of managing wilderness and therefore do not meet the *minimum requirement/ minimum tool analysis* under the Wilderness Act. This action would be against NPS policy and would require approval for a non-conforming use in recommended wilderness. If the non-conforming uses were approved, the wilderness study and recommendation to Congress may be amended and re-submitted to exclude this area from the wilderness recommendation. Ultimately, this action would decrease the amount of wilderness in the regional area. Unexploded ordnance, craters, and shrapnel from military artillery ammunition in the analysis area would be visible and may present a threat to human safety in wilderness. Shrapnel is composed of metal shards, visible to the naked eye, scattered over the target areas. Shrapnel from military ammunition is very difficult to remove and would remain in starting zones for decades. Unexploded charges in recommended wilderness would result in a year-round closure until the charge is retrieved. Snowslip weather station and a snow depth sensor would be permitted in wilderness on a continuous basis.

Alternative D Cumulative Effects

Past Actions: Past actions are the same as in Alternative B.

On-going Actions: On-going activities are the same as in Alternative B.

Foreseeable Future Actions: Future activities are the same as in Alternative B.

Cumulative Effects Conclusion: The impacts on wilderness in the analysis area are mainly from noise and visual effects of construction, development, highway and railroad operation. While there are **minor, adverse, sporadic, site-specific** impacts on wilderness in John F. Stevens Canyon, the impacts are concentrated closely to the highway and railroad. Moving further away from the traffic corridor, the impacts diminish rapidly. Snowsheds 7 and 9 expansion construction would create **minor, adverse, long-term, site-specific** impacts on wilderness. It would be difficult to distinguish construction noise from on-going train operations. The impacts of explosive use would increase the amount of time loud noise such as gunfire from hunting season occurs in the Canyon. The addition of explosive use into the canyon would increase noise in the wilderness starting zones, however, the above activity noise and visibility would be very distant from the explosion sites. The noise would occur only during the winter months and deep snow coverage would dampen the cumulative effects of activity in the canyon. Helicopter use for explosive delivery would increase the amount of time per year that overflights are seen and heard over the recommended Park wilderness and designated Forest wilderness. The cumulative effects of the above activities in conjunction with a program of continuous explosive use would be **moderate, adverse, long-term, and localized** over the analysis area. Under this alternative, avalanche caused derailments are subject to BNSF's success with avalanche forecasting, imposing delays, and explosive avalanche hazard mitigation. The cumulative impact of an avalanche caused derailment on wilderness is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled.

Wilderness Conclusion

Under Alternative A, there would be **no effect** on wilderness. Under each action alternative, there is the potential for **minor, adverse, long-term**, **localized** impacts to proposed wilderness within Glacier National Park with the installation of a fixed snow depth sensor. The construction or lengthening of snowsheds under Alternatives B, C, and D would have a **minor, short-term, adverse, localized** impact on recommended wilderness from noise and construction activities; however, snowshed completion would have a **minor, beneficial, long-**

term, localized impact on recommended GNP and designated FNF wilderness as railroad noise would be decreased within the sheds and less noise from trains would be heard in wilderness areas. Alternatives C and D both have greater impacts on recommended GNP wilderness than Alternatives A and B with recreational restrictions, explosive use, explosive equipment installation, temporary or permanent structures in wilderness starting zones, and helicopter use. The impacts on human perception of both recommended and designated wilderness areas with explosive use under Alternative C are **moderate, adverse, localized, and long-term** over the 10-year period. Although a shorter period of permitted explosive use could cause the impact to be short-term. Alternative D has a greater impact on recommended and designated wilderness that would be **major, adverse, long-term, and localized**. The difference between Alternative C and D is the continuous use of explosives, military artillery, and possible permanent structures in recommended wilderness under Alternative D. In addition to other explosive methods described in Alternative C, the use of military artillery leaves shrapnel, possible duds, and does not have a sunset date creating more impact than other alternatives on recommended GNP wilderness. Avalhex, blaster box, and weather system infrastructure would be temporary under Alternative C and permanent under Alternative D. A continuous explosive program along with permanent infrastructure in recommended wilderness would have the greatest level of impact of the alternatives and may ultimately have a bearing on the suitability of the area for wilderness designation. Explosive noise and visibility of permanent structures under Alternative D would be an impact on FNF Great Bear Wilderness.

There would be no significant adverse impacts to wilderness resources whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents.

VISUAL RESOURCES

Methodology

When conducting analysis of effects from management activities on the visual landscape, the U.S. Forest Service utilizes the Visual Management System developed in *Landscape Aesthetics - A Handbook for Scenery Management Number 701 (1995)*. This system provides for the evaluation of physical features of the landscape using "scenic attractive classes." The levels of concern people have for scenery are included in this system. The information is synthesized to develop Scenic Integrity Levels (SIL) that are based on management areas that have been previously designated by the Forest Plan (the Flathead Forest Plan has been guiding management actions on the Flathead National Forest since 1985). Management areas (refer to Chapter 1 for a description of the emphases of each of these management areas) found within the railroad corridor of the project area (this corridor is located on National Forest System lands) and the corresponding SILs are described in Table 4-18 below.

Table 4-18 Management areas and scenic integrity level descriptions.

Management Area	SIL
Management Area 12	**Moderate** - Refers to landscapes where the valued landscape character “Appears slightly altered." Noticeable deviations must remain visually subordinate to the landscape character being viewed.
Management Area 2C	**High** - Refers to landscapes where the valued landscape character "appears" intact. Deviations may be present but must repeat form, line, color, texture and pattern common to the character so completely that they are not evident.
Management Area 5	**High** - Refers to landscapes where the valued landscape character "appears" intact. Deviations may be present but must repeat form, line, color, texture and pattern common to the character so completely that they are not evident.

SILs do not apply to National Park Service lands. It was deemed that most of the effects to the visual landscape as a result of potential hazard reduction activities would occur from viewing on the National Forest side of the canyon towards the Park side of the canyon. SILS have been integrated within the impact thresholds in Table 4-1 and have been summarized below:

Thresholds of impact are defined in Table 4-1.

- ***Negligible:*** The valued landscape character “appears” intact. Deviations may be present, but must repeat form, line, color, texture, and pattern common to the character so completely that they are not evident.
- ***Minor:*** The valued landscape character “appears slightly altered.” Noticeable deviations must remain visually subordinate to the landscape character being viewed.
- ***Moderate:*** The valued landscape character “appears moderately altered.” Deviations begin to dominate the valued landscape character being viewed but they borrow valued attributes such as size, shape, edge effect, and pattern of natural openings, vegetative type changes outside the landscape being viewed. The deviations are compatible or complementary to the landscape being character.
- ***Major:*** Scenic integrity “appears heavily altered.” Deviations may strongly dominate the landscape character. They may not be appropriately in size, shape, edge effect, or patterns. Elements such as unnatural edges, size, or landings dominate the composition.

Analysis Area

The analysis area for visual resources is the area along the US Highway 2 corridor, the railroad corridor, and the slopes above the railroad corridor within the affected project area.

IMPACT ANALYSIS- VISUAL RESOURCES

Impacts Common to All Action Alternatives

Avalanche detection technology, avalanche forecasting, weather station, and snow depth sensor installation are components of Alternatives B, C, and D. The above actions would have **no impact** on visual resources. The installation of avalanche detection technology would be on BNSF right-of-way property and would be virtually undetectable from other railroad infrastructure from the road or the surrounding area. A train derailment could have a **negligible to moderate, adverse, short-term to long-term, site-specific** impact on visual resources for the length of time that vegetation, snow, and soil disturbance, debris and wrecked equipment may be visible.

Alternative A: No Action

There are no impacts to visual resources under Alternative A and there would be no change from current conditions.

Alternative B: Construction and Modification of Snowsheds

Snowshed construction would have a **moderate, adverse**, **long-term, site-specific** impact on visual resources in the analysis area. The addition of 5,040 feet of new snowsheds (includes extensions on existing snowsheds) would be visible from the highway, the railway, and the surrounding landscape. The mitigated color matching with existing historic snowsheds would make the snowsheds blend better into the surroundings; however, these new structures would still change the visual landscape for those users of US Highway 2 and the railway corridor. Snowsheds would dominate the analysis area as a visual feature since almost a mile of new structures would be added to the mile of structures already in existence. Since railway snowsheds are relatively rare in the United States there may be some that find the additional snowsheds pleasing to the eye, particularly railway buffs. However, there may be others that find the existing snowsheds as well as additional snowsheds out of place in this landscape. It should be noted, though, the railway has been in the same location for over 100 years and many of the existing snowsheds have been in place for over 50 years. If snowsheds did not exist in this 6 mile stretch of the canyon, these new snowsheds would no doubt be more of an intrusion in this landscape. An isolated emergency explosive use action would have little measurable impact on visual resources in the project area. An artificially triggered avalanche may be visible in a few avalanche paths; however, these are not distinguishable from naturally triggered avalanches readily visible in the canyon. Helicopters used in the operation would be visible for a short period of time while the action occurs. Explosive craters in avalanche start zones would result when avalanches are not released. The craters would be ringed with black residue and may be seen from viewpoints in the canyon depending on snow cover, weather, and avalanche debris. Once the snow melts or more snow covers the area, visible craters would disappear.

In the visual resource section in Chapter 3, four critical viewpoints along US Highway 2 were identified to provide a pictorial representative view of some of the existing snowsheds.

At Viewpoint 1, located near Snowslip Inn, a new 900 foot snowshed (in place of existing Shed 4C – Burn Out, or actually a cement wall) would be constructed and visible to highway users as well as private land owners. At Viewpoint 2, an existing snowshed (Shed 5) would be extended by about 100 feet. At Viewpoint 3, near the Silver Stairs pullout, an existing snowshed (Shed 9) would also be extended by 100 feet. At Viewpoint 4, about a half mile before Devil Creek

Campground, an existing snowshed (Shed 8) would be extended by about 100 feet. According to the Scenic Integrity Levels mentioned above, areas in view of viewpoints 1 and 2 would be rated as high and the area in view of viewpoints 3 and 4 would be rated as moderate.

Of all the viewpoints, the change to the visual landscape may be the most at Viewpoint 1. This is because a new shed would be constructed in a place where only a partial shed (i.e. a cement wall) occurs now. Additionally, this viewpoint is more readily visible to adjacent landowners and other US Highway 2 users. However, this new shed would still meet the intent of the high scenic integrity level given to this area because it is replacing an already existing structure. The other sheds seen in the described viewpoints, as well as other new sheds (or extended sheds) not described by the viewpoints, would also meet the high and moderate scenic integrity levels. Visitors to the Devil Creek Campground would not be able to see any of the existing or new structures due to a vegetation buffer directly adjacent to the north side of US Highway 2.

The difference between new snowsheds and existing snowsheds would probably not be noticeable to railway passengers since the new structures would be designed to blend in with the existing structures. Passengers would still be able to look beyond the supports of the snowsheds and see into the canyon corridor and beyond.

Alternative B Cumulative Effects

Past Actions: Fire management, regular train and highway operations, development in the canyon, train derailments and spill cleanup, and overflights, have been readily apparent to the casual observer and have a **minor, adverse, short-term to long-term, site-specific** impact on visual resources of Glacier National Park or the Flathead National Forest. Most visual intrusions from human activity in the canyon occur in the travel corridor. Revegetation and weed control activities have a **minor, beneficial, long-term, site-specific** impact on visual resources as native vegetative communities are restored by these activities.

On-going Actions: Fire management, regular train and highway operations, construction in the canyon, weed control activities, Snowslip weather station operation, train spill cleanup, overflights, and recreational use, all have a **minor, adverse, short-term to long-term, site-specific** impact on Glacier National Park or the Flathead National Forest viewsheds surrounding the analysis area. Most visual intrusions from human activity in the canyon occur in the travel corridor. Revegetation and weed control activities have a minor, beneficial, long-term, site-specific impact on visual resources.

Foreseeable Future Actions: Fire management, regular train and highway operations, construction in the canyon, weed control activities, Snowslip weather station operation, train spill cleanup, overflights, and recreational use, all have a **minor, adverse, short-term to long-term, site-specific** impact on Glacier National Park or Flathead National Forest visual resources surrounding the analysis area. Visible intrusions from future human activity are expected to occur along the travel corridor. Revegetation and weed control activities have a **minor, beneficial, long-term, site-specific** impact on visual resources in the analysis area.

Cumulative Effects Conclusion: Cumulatively, there would be **moderate, adverse, short-term to long-term, site-specific** impacts on visual resources in the analysis area. The impacts on visual resources in the analysis area are mainly from private land development, the railway and existing snowsheds, overflights, and US Highway 2. With distance from the traffic/railroad corridor, these impacts diminish rapidly. New snowsheds and snowshed extensions would be readily visible from the travel corridor and from viewpoints along the canyon walls. However, they would not significantly affect or add to the existing visual landscape since features described above have already affected the viewscape for many years. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be clearly noticeable from the analysis area. The cumulative impact of an avalanche caused derailment on visual resources is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled and whether there are visible changes to the environment in the spill area.

Alternative C: Short-term Explosives Use for Avalanche Hazard Reduction

The impacts of snowshed construction on visual resources would be the same as Alternative B. Avalhex and blaster box systems would be visible, even if camouflaged with natural colored paint, from most of the analysis area. Helicopters used for explosive use would be visible during the period that explosives are dropped into start zones and monitored for success. This increase in overflights would not be noticeable except to people who are observing the project area over long periods of time. Fixed towers in the starting zones would increase the scope of visual intrusions in the canyon to include the starting zones in the Park. The towers may be visible depending on the location of the viewer and ice coating on the structures. Towers on ridgetops of other mountains are visible during the winter months. The visual impact from the towers would last 10 years. The visual impacts of fixed towers and helicopter use would be **minor, adverse**, and **site-specific**. The fixed towers would be a **long-term** impact and helicopter use would be a **short-term** impact. Explosive craters in avalanche start zones would result when avalanches are not released. The craters would be ringed with black residue and may be seen from viewpoints in the canyon depending on snow cover, weather, and avalanche debris. Once the snow melts or more snow covers the area, visible craters would disappear.

Alternative C Cumulative Effects

Past Actions: The cumulative effects are the same as in Alternative B.

On-going Actions: The cumulative effects are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects are the same as in Alternative B.

Cumulative Effects Conclusion: Cumulatively, there would be **moderate, adverse, long-term, site-specific** impacts on visual resources in the analysis area. The impacts on visual resources in the analysis area are mainly from private land development, the railway and existing snowsheds, overflights, and US Highway 2. With distance from the traffic/railroad corridor, these impacts diminish rapidly. New snowsheds and snowshed extensions would be readily visible from the travel corridor and from viewpoints along the canyon walls. However, they would not significantly affect or add to the existing visual landscape since features described above have already affected the viewscape for many years. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be clearly noticeable from the analysis area. Towers in Park starting zones would be visible over the 10 year period creating a visual intrusion in an area where structures were previously absent. The cumulative impact of an avalanche caused derailment on visual resources is **minor to major, adverse, short-term to long-term, and site-specific** depending on the substance spilled and whether there are visible changes to the environment in the spill area.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

The impacts of snowshed construction on visual resources would be less than in Alternative B as only two sheds would be extended. The shed extensions would have a **negligible, long-term, adverse** impact on the visual resources of the analysis area. Avalhex and blaster box systems would be visible, even if camouflaged with natural paint, from most of the analysis area. Helicopters used for explosive use would be visible during the period that explosives are dropped into start zones and monitored for success. The impacts of fixed towers and helicopter use would be **minor, adverse, long-term and site-specific**. The fixed towers would be a **long-term** impact and helicopter use would be a **short-term** impact. Under Alternative D, military artillery ammunition is likely to leave craters and/or evidence of explosive use. The impact of artillery use on visual resources is expected to be **minor, adverse, long-term, and localized**. Color contrast of soil and/or rock disturbance may be visible to people on roads or in the surrounding area. Explosive craters in avalanche start zones would be ringed with black residue and may be seen from the canyon depending on snow cover, weather, and avalanche debris. Once snow melts or new snow covers the area, explosive craters would disappear. Metal shards and shrapnel from artillery ammunition scattered throughout the explosive use target zones would be visible to people. Shrapnel is difficult to remove and would likely remain in the starting zones, accumulating with each year of artillery use.

Alternative D Cumulative Effects

Past Actions: The cumulative effects are the same as in Alternative B.

On-going Actions: The cumulative effects are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects are the same as in Alternative B.

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse, short-term to long-term, site-specific** impacts on visual resources in the analysis area. The impacts on visual resources in the analysis area are mainly from private land development, the railway and existing snowsheds, overflights, and US Highway 2. With distance from the traffic/railroad corridor, these impacts diminish rapidly. New snowsheds and snowshed extensions would be readily visible from the travel corridor and from viewpoints along the canyon walls. However, they would not significantly affect or add to the existing visual landscape since features described above have already affected the viewscape for many years. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be clearly noticeable from the analysis area. Towers in Park starting zones would be visible creating a permanent visual intrusion in an area where structures were previously absent. The cumulative impact of an avalanche caused derailment on visual resources is minor to major, adverse, short-term to long-term and site-specific depending on the substance spilled and whether there are visible changes to the environment in the spill area.

Visual Resources Conclusion:

Alternative A would have **no impact** on visual resources. The actions associated with construction of or lengthening snowsheds would have the most projected change in comparison to program options. Large-scale snowshed construction and extension would be visible from US Highway 2 and the canyon walls and would have a **moderate, adverse, long-term, site-specific** impact on visual resources with Alternative B and C. Fixed towers, helicopter use and soil/snow disturbance would have **minor, adverse, long-term, site specific** impacts on visual resources under Alternative C and D. After revegetation (10 plus years) occurs under Alternative C, the effects would no longer be visible. Under Alternative D, the continuous use of explosives, fixed tower installation, and helicopter use are expected to have **minor, adverse, long-term, site-specific** impacts on visual resources.

There would be no significant adverse impacts to visual resources whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation and proclamation of Glacier National Park or the Flathead National Forest; (2) key to the natural or cultural integrity of the Park or Forest; or (3) identified as a goal in the park's General Management Plan (NPS 1999) or other relevant National Park Service or US Forest Service planning documents.

PUBLIC USE AND EXPERIENCE

Methodology

An important part of the National Park Service mission is the provision for public use and enjoyment of the National Parks. Public use and experience is a difficult topic to analyze, as it is highly subjective and based on individual perspective. Public use and experience is dependent on the impacts to important features and values as they relate to an individual's experience. This analysis is largely qualitative and may not speak to the unique experience expectations that individuals want to incorporate into their unique visits. Furthermore, the immediate analysis area is not a destination that is frequented by many visitors seeking a winter park experience. The terrain is steep, there are no trails, and the railroad hinders public access to the valley walls. While the analysis area is not a destination, it is readily visible to people traveling the canyon or recreating in the area. The elements of natural soundscapes, wilderness, and human safety are tied in with this impact topic, as those are some of the components of a quality public experience from most people's perspective. The information used to analyze this topic is taken from previous public surveys and park staff contacts with the public. The 2001 Glacier National Park visitor use survey found that people visit the park to do the following: view the scenery, recreational activities change their normal routine, socialize with family and friends, view wildlife, and take photographs. Trail register numbers, highway counter numbers, and US Highway 2 closure information show the amount of public use around the analysis area and how many people are expected to be impacted by the alternatives. The Forest Service does not collect exact numbers of people using NFS lands, so Park Service and Montana Department of Transportation numbers are the only available data to quantify numbers of people using the canyon.

Thresholds of impact for public use and experience are defined in Table 4.1.

- ***Negligible***: The public would not be affected or changes in public use and/or experience would not be measurable.
- ***Minor***: Changes in public use and/or experience would be detectable, although the changes would be slight.
- ***Moderate***: Changes in public use and/or experience would be readily apparent.
- ***Major***: Changes in public use and/or experience would be readily apparent and have important consequences. The public would be aware of the effects associated with the alternative.
- ***Short-term***: Occurs during year winter months (December through March) or less.
- ***Long-term***: Occurs during winter months over several years or is permanent.

Analysis Area

The analysis area extends from the railroad north to the ridgeline including the 7-mile buffer zone for artillery use (Closure Area on Map 2-5) and to the recreational areas east of the project area.

IMPACT ANALYSIS- PUBLIC USE AND EXPERIENCE

Impacts Common to All Action Alternatives

Installation of a weather station, snow depth sensor, and avalanche detection technology would have a **minor, adverse, long-term, localized** impact on public use and experience in the canyon. Once the instruments are installed, there would be very little or no noise, visual impact, or distraction associated with their operation. Avalanche detection technology would be installed on right-of-way property and the weather station would be installed on NFS lands adjacent to US Highway 2. These instruments would be located in areas of previous development and would not be readily detectable by the public. The snow depth sensor would be located on recommended wilderness Park land but would be difficult to see due to its small size and camouflage paint. The sensor would be hidden from most people's view and would have a **minor, adverse, long-term, site-specific** impact on public use and experience. An indirect impact of these instruments would be the improved avalanche hazard awareness that forecasters would gain from increased weather information. This information may benefit visitors if they are warned of increasing avalanche hazard along US Highway 2 through the canyon. An avalanche caused derailment or hazardous material spill on the railroad would have a **negligible to major, short-term to long-term, localized to regional, adverse** impact on public experience and recreation depending on closures, visual impact, and the material and clean up duration. The possibility of an avalanche caused hazardous spill or derailment on the railroad may adversely affect public use and experience if US Highway 2 is closed or access to destination spots or hiking trails are restricted.

Alternative A: No Action

There would be **no impact** on public use and recreation under this alternative. There would be no additional noise, visual impact, health and safety issues or closures under this alternative. Public desire to view scenery, recreate, experience a change in routine, spend time with family and friends, view wildlife, and take photographs would not be impacted by this alternative. Avalanche hazard may reroute Amtrak approximately 725 passengers (3 trains with 275 passenger capacity each) a winter over US Highway 12 and they would not have access to the scenic railroad through the canyon. This action may **adversely** impact their overall train trip, however, the impact to their health and safety would be **beneficial and long-term**. The overall impact to public use and experience of Amtrak riders under this alternative would be **negligible, adverse, and short-term**.

Alternative B: Construction and Modification of Snowsheds

There would be a **negligible, adverse, long-term-term** impact on public use and recreation under this alternative until snowsheds are completed. In the short-term, while snowsheds are being completed, there may be additional noise and visual impacts to people using the area. The visual impact of 5,040 feet of new snowsheds may have a **moderate, adverse or beneficial, long-term, site-specific** impact on public experience as some people enjoy seeing railroad infrastructure and some do not like to see human development in a beautiful natural area. Public desire to view scenery, recreate, experience a change in routine, spend time with family and friends, view wildlife, and take photographs would not be impacted by this alternative. Until snowsheds are completed, avalanche hazard may reroute approximately 725 Amtrak passengers over US Highway 12 and they would not have access to the canyon until snowsheds are completed. This may impact their overall train trip, however, the impact to their health and safety of avalanche avoidance would be **beneficial and long-term**. Once snowsheds are completed, public use and experience is expected to have a **minor, beneficial, long-term** impact as snowsheds would decrease the possibility of avalanche caused derailments and allow Amtrak passengers to travel through the scenic canyon during periods of high avalanche risk. Views may be limited with new snowsheds over less than a mile (5,040 feet) of a 6-mile area, but the panoramic vistas in this area of the canyon are already concealed by steep, close canyon walls. A recreational closure would be imposed on the area if an emergency explosive use measure is permitted. This may affect people traveling to recreational areas on US Highway 2 or it may impact people wanting to recreate in the immediate project area. The amount of time the area may be closed for emergency response is difficult to predict and is highly situational. This closure would not be a regular occurrence and recreation would not be impacted after the operation is completed. An emergency situation may impact recreational use for a longer period than the explosive use operation. The impacts resulting from an isolated emergency explosive use operation are **negligible to minor, adverse, short-term, and localized**. Once snowsheds are constructed, the US Highway 2 corridor may close more than it has in past years due to greater avalanche risk awareness and better avalanche forecasting techniques, however; public health and safety would be improved. There would be an overall **minor, beneficial, long-term** impact on public use and experience in John F. Stevens Canyon with snowshed completion under this alternative.

Alternative B Cumulative Effects

Past Actions: Fire management, regular train and highway operations, train derailments and spill cleanup, overflights, and increased recreation on Park and Forest lands have a **minor, adverse, long-term, site-specific** impact on Glacier National Park or Flathead Nationanl Forest public use and experience surrounding the analysis area. These activities have changed visual resources, created additional noise, and affected access in John F. Stevens Canyon and affect public use and experience of GNP or FNF. Most adverse impacts on public use and enjoyment originate from human caused visual and audible intrusions in the canyon. Fire management, most highway repair delays, and the greatest amount of recreation occurs during the summer months. Weed control and revegetation activities increase native plant populations and benefit public use and enjoyment. Trail maintenance, Challenger Cabin rental, and recreational facility maintenance have a **minor, beneficial, short-term, site-specific** impact on public use and enjoyment.

On-going Actions: Fire management, regular train and highway operations, train derailments and spill cleanup, trail construction, overflights, and increased recreation on Park and Forest lands have a **minor, adverse, long-term, site-specific** impact on GNP or FNF public use and experience surrounding the analysis area. These activities change visual resources, create additional noise, and have an effect on access in John F. Stevens Canyon impacting public use and experience of GNP or FNF. Most adverse impacts on public use and experience originate from human caused visual and audible intrusions in the canyon. Fire management, most highway repair delays, and the greatest amount of recreation occurs during the summer months.

Weed control and revegetation activities occur during summer months and increase native plant populations and benefit public use and enjoyment. Trail maintenance, Challenger Cabin Rental, and recreational facility maintenance have a **minor, beneficial, short-term, site-specific** impact on public use and enjoyment.

Foreseeable Future Actions: Fire management, regular train and highway operations, trail construction, construction in the canyon, weed control activities, weather station operation, train derailments and spill cleanup, overflights, and increased recreational use all have a **minor, adverse, long-term, site-specific** impact on GNP or FNF public use and experience surrounding the analysis area. These activities change visual resources, created additional noise, and affected access in John F. Stevens Canyon and affect public use and experience of GNP or FNF. Weed control and revegetation activities increase native plant populations and benefit public use and enjoyment. Trail maintenance, Challenger Cabin Rental, and recreational facility maintenance have a **minor, beneficial, short-term, site-specific** impact on public use and enjoyment.

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse, site-specific, long-term** impacts on public use and experience in the analysis area. The impacts on visual resources in the analysis area are mainly from new structures and activities of construction, development, and highway and railroad operation. While there are **minor, adverse, long-term, site-specific** impacts on visual resources in John F. Stevens Canyon, the impacts are closely related with the highway, railroad, and private property. With distance from the traffic/railroad corridor, the impacts diminish rapidly. Snowshed construction would be readily visible and audible in the travel corridor and from the canyon walls, although snowshed construction would not cause access restrictions. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be noticeable from the analysis area. The cumulative impact of an avalanche caused derailment on public use and experience is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled and whether there are visual, audible, and access changes in the spill area. Once snowsheds are built, the chance for avalanche caused derailments is greatly diminished and public use and experience is not expected to have any impacts except the visual aspect of snowsheds in the canyon.

Alternative C: Short-term Explosive Use For Avalanche Hazard Reduction

Explosive use would introduce intermittent noise that has a **minor to moderate** impact on public use and experience in John F. Stevens Canyon. Snow hardness may dampen or increase the intensity of the sound of the explosion depending on weather conditions during the explosive exercise. Icy, hard snow reflects noise while deep powder snow absorbs noise. Approximately 110-165 explosions per year would occur under this alternative over the 10-year period. The analysis area between mileposts 185 and 191 would be closed during the explosive operation to the ridgeline (2,327 acres). This closure would have a **negligible, adverse, short-term, localized** impact on the public in this location as this area is not used regularly by the public and there are no trails in the analysis area. The resultant closure of US Highway 2 approximately two times per year for explosive use would have a **minor, adverse, short-term, localized** impact on public access to trails and trailheads east of the analysis area. Until snowsheds are completed, avalanche hazard may reroute approximately 725 Amtrak passengers over US Highway 12 and they would not have access to the canyon until avalanche hazard has subsided or snowsheds are completed. This may affect their overall train trip, however, the impact to their health and safety would be **beneficial and short-term** until snowsheds are completed. Views may be limited with new snowsheds over less than a mile (5,040 feet) of a 6-mile area, but the panoramic vistas in this area of the canyon are already concealed by steep, close canyon walls. The visual impact of 5,040 feet of new snowsheds may have a **moderate, adverse or beneficial, long-term, site-specific** impact on public experience as some people enjoy seeing railroad infrastructure and some do not like to see human development in a beautiful natural area. The **long-term, adverse** impact to public recreation and wildlife viewing under this alternative would be **minor to moderate** depending on visible wildlife reaction to explosive use. Impacts to scenery, visits with friends and family, photography, and change in public routine would be **negligible to minor** depending on access issues and desire to visit lands adjacent to the analysis area. Businesses providing recreational lodging and services may be **adversely** impacted by explosive use road closures as access to areas east of the analysis area would be restricted by two or three highway closures per year. Once snowsheds are completed, public use and experience is expected to have a **minor, beneficial, long-term** impact as snowsheds would decrease the possibility of avalanche caused derailments and allow Amtrak passengers to travel through the canyon. Once snowsheds are constructed, the US Highway 2 may close more than it has in past years due to greater avalanche risk awareness and better avalanche forecasting techniques, however; public health and safety would be improved. There would be an overall **minor to moderate, adverse, long-term, site-specific** impact on public use and experience in John F. Stevens Canyon under this alternative. The adverse impacts are expected to become beneficial impacts once snowsheds are completed.

Alternative C Cumulative Effects

Past Actions: The cumulative effects are the same as in Alternative B.

On-going Actions: The cumulative effects are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects are the same as in Alternative B.

Cumulative Effects Conclusion: Cumulatively, there would be **minor, adverse, site-specific, long-term** impacts on public use and experience in the analysis area. The impacts on visual resources in the analysis area are mainly from new structures and activities of construction, development, highway operation, and railroad operation. While there are **minor, adverse, long-term, site-specific** impacts on visual resources in John F. Stevens Canyon, the impacts are closely related to the highway, railroad, and private property. With distance from the traffic/railroad corridor, the impacts diminish rapidly. Snowshed construction would be readily visible and audible in the travel corridor and from the canyon walls, although snowshed construction would not cause access restrictions. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be noticeable from the analysis area. Avalhex and blaster box towers would be visible in Park starting zones from the project area for the 10-year period. BNSF explosive use is expected to close US Highway on average two to three times a year, changing the route of people wanting to travel over US Highway 2 during these periods. Helicopter explosive delivery would increase overflights in the area, which has an adverse impact on public use and experience. The cumulative impact of an avalanche caused derailment on public use and experience is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled and whether there are visual, audible, and access changes in the spill area. Once snowsheds are built, the chance for avalanche caused derailments is greatly diminished and public use and experience is not expected to have any impacts except the visual aspect of snowsheds in the canyon.

Alternative D: Long-term Explosives Use for Avalanche Hazard Reduction

The long-term explosive use program including military artillery would introduce noise that has a **moderate, adverse, long-term,** impact on public use and experience in John F. Stevens Canyon. Although, the explosive noise would be periodic during the winter months; highway closures, explosive area restrictions, and wildlife habitat changes would have a **moderate, adverse** impact on recreation in John F. Stevens Canyon and the surrounding areas. Snow hardness may dampen or increase the intensity of the sound of the explosion depending on weather conditions during the explosive exercise. Icy, hard snow reflects noise while deep powder snow absorbs noise. It is estimated that approximately 110-165 explosions per year would occur under this alternative. A 7-mile radius from the railroad recreational closure would be imposed during explosive use. The closure would encompass Ole Creek, Autumn Creek, Fielding Creek, Scalplock, and Park Creek trails and include mandatory sign-in/sign-out registers and public closure notices at the trailheads (See Map 2-5). This recreational closure would have a **moderate, adverse, short-term** impact on the public and businesses that use these trails. These trails are very popular winter ski and snowshoe areas. The resultant closure of US Highway 2 approximately on average two to three times per year for explosive use would have a **minor, adverse, short-term** impact on public access to trails and trailheads east of the analysis area. Avalanche hazard may reroute approximately 725 Amtrak passengers over US Highway 12 and they would not have access to the canyon until avalanche hazard decreases. This may affect their overall train trip, however, the impact to their health and safety would be **beneficial and long-term**. The **short-term, adverse** impact to public wildlife viewing under this alternative would be **moderate** and could become **long-term** if wildlife leaves the area due to explosive disturbance. Impacts to scenery, visits with friends and family, photography, and change in public routine would be **minor, adverse and short-term**. The trails that are impacted by this alternative are an important winter destination for many people visiting this part of Glacier National Park and Flathead National Forest. Regular annual highway and trail closures, noise from explosives, and impacts to resources that the public wants to view would have a **moderate, adverse, long-term** impact on public use and experience under this alternative. This impact is expected to be continual during the winter months indefinitely.

Alternative D Cumulative Effects

Past Actions: The cumulative effects are the same as in Alternative B.

On-going Actions: The cumulative effects are the same as in Alternative B.

Foreseeable Future Actions: The cumulative effects are the same as in Alternative B.

Cumulative Effects Conclusion: Cumulatively, there would be **moderate, adverse, site-specific, long-term** impacts on public use and experience in the analysis area with a continuous program of winter avalanche hazard reduction. The impacts on visual resources in the analysis area are mainly from new structures and activities of construction, development, highway operation, and railroad operation. While there are **minor, adverse, long-term, site-specific** impacts on visual resources in John F. Stevens Canyon, the impacts are closely related to the highway, railroad, and private property. With distance from the traffic/railroad corridor, the impacts diminish rapidly. The weather station, snow depth sensor, avalanche detection devices, and forecasting would not be noticeable from the analysis area. Avalhex and blaster box towers would be visible in Park starting zones indefinitely. BNSF explosive use is expected to close US Highway on average two to three times a year, changing the route of people wanting to travel over US Highway 2 during these periods. Helicopter explosive delivery would increase overflights in the area, which has an adverse impact on public use and experience. The greatest cumulative impact on public use and experience would be the large closure including several popular trails and the annual noise of explosive use during the winter months. The cumulative impact of an avalanche caused derailment on public use and experience is **minor to major, adverse, short-term to long-term and site-specific** depending on the substance spilled and whether there are visual, audible, and access changes in the spill area.

Public Use and Experience Conclusion

Alternative A has **no impact** on public use and experience as there would be no change from current conditions. Alternative B would have **negligible, adverse, long-term-term, site-specific** impacts on public use and experience until recommended snowsheds are built. Alternative C has 10-year period of explosive use resulting in noise, recreation closures, and wildlife impacts that would have a **minor to moderate, adverse, long-term, localized** impact on public use and experience. Once snowsheds are built under alternative B and C, the impact on visitor use and experience would be **minor, beneficial, long-term, and site-specific**. A continuous explosive use operation under Alternative D would increase noise, decrease public access, and may impact wildlife in the area. Due to the expected impacts of a long-term explosive use program under Alternative D, the impacts on public use and experience would be **moderate, adverse, long-term, and site-specific**.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section describes whether any long-term management possibilities or the productivity of park resources are being traded for the immediate use of land under any of the alternatives.

The analysis area is approximately 2,350 acres. Under all of the alternatives, snowshed construction and equipment installation may displace wildlife temporarily, but would not affect long-term productivity of wildlife in the area. Sediment and nutrients from erosion and minute amounts of explosive chemicals may enter the watershed from explosive avalanche control activities, equipment installation, and snowshed construction. The alternatives would not impact vegetation productivity in the long-term under Alternatives A, B, and C. Alternative D may alter vegetation patterns in the long-term. Short-term explosive use under an adaptive management program may impact long-term wildlife productivity. Snowshed extensions on existing snowsheds would be mitigated so as not to detract from historic distinguishing features. Short-term closures of the analysis area and US Highway 2 may impact recreation and access, but this would only occur for short time periods and would not impact future generations or species.

The long-term use of explosives in Alternative D would adversely impact the productivity of wildlife using the analysis area. Localized populations would leave the area due to noise and human disturbance. Small animals that are not able to travel away from explosive use may be considerably impacted or killed. Seismic activity in close proximity to grizzly bear dens may cause lower success rates of reproduction and den abandonment. These impacts may be irreversible and it is unknown if wildlife would continue using the area during the winter months when explosives are used. The longer explosive use occurs; long-term productivity of resources in the analysis area would be impacted.

Alternative C and D would have major impacts on wilderness, natural sound and natural avalanche processes that would be expected to return to pre-explosive conditions after the use of explosives under Alternative C, but not with continuous explosive use under Alternative D. Resource monitoring under Alternative C would be designed to stop adverse impacts once they occur with defined resource thresholds.

UNAVOIDABLE ADVERSE IMPACTS

Explosive use is expected to have measurable adverse impacts on wildlife, threatened and endangered species, natural soundscapes, wilderness, recreation, vegetation, and natural avalanche processes. Noise is part of the nature of explosives and wildlife response is an unavoidable consequence of explosive use. Explosive avalanche hazard reduction is designed to change natural avalanche processes. The use of explosives for avalanche hazard reduction may cause significant, long-term, major unavoidable impacts on wildlife, threatened and endangered species, natural soundscapes, wilderness, and natural avalanche processes under Alternative C. The resource monitoring program is designed to detect and record any adverse impacts before they become irreversible. The resources are expected to recover from these impacts after the 10-year period of explosive use is over. The resources wildlife, threatened and endangered species, natural avalanche processes, natural sound, and wilderness are not expected to rebound from the anticipated significant, moderate to major, long-term, adverse impacts of a continuous explosive program under Alternative D.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This section summarizes the irreversible and irretrievable commitments of resources that are associated with alternatives. Irreversible commitments cannot be changed over the long-term or are permanent. An impact to a resource is irreversible if the resource cannot be reclaimed, restored, or otherwise returned to its condition before the disturbance. Irretrievable commitments are those that result in the loss of production or use of a resource. An impact to a resource is irretrievable if, once gone, the resource cannot be replaced or the resource does not return to pre-action conditions after the action has occurred.

While explosive use occurs in Alternative C, the resource monitoring program is designed to stop irreversible impacts or irretrievable commitments of resources before they occur. The up to 10-year permitted use of explosives under Alternative C is intended to allow the habitat, natural processes, and resources to return to pre-explosive use conditions. The long-term explosive use program under Alternative D would result in an irretrievable loss of natural avalanche processes in 12 avalanche paths. This loss of natural avalanche activity would result in an irretrievable loss of avalanche path specific vegetation patterns that certain wildlife depends on. The extent of irretrievable loss of wildlife in the analysis area is uncertain, however, death of individuals would be more likely with long-term use of explosives. The continued use of explosives is expected to irretrievably impact threatened, endangered and species of concern in the analysis area and those that may use the analysis area in the future. The loss of 2,350 acres of the analysis area for wildlife is an irretrievable resource under Alternative D. Denning grizzly habitat would be directly impacted by noise and explosions. Foraging habitat for lynx, wolf, grizzly and bald eagle would be impacted by sporadic, explosions rocking the habitat. Wintering habitat for elk, deer, and other prey species would be irretrievably committed under Alternative D. The forfeit of natural sound and wilderness values with explosive use would result in an irretrievable commitment of resources under Alternative D.

This page left intentionally blank.