SOIL PRODUCTIVITY ASSESSMENT OF THE MOUNTAIN VALLEY PIPELINE CORRIDOR ON THE JEFFERSON NATIONAL FOREST
BY NAN GRAY, LICENCED PROFESSIONAL SOIL SCIENTIST
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I have reviewed the December 2022 Mountain Valley Pipeline and Equitrans Expansion Project Draft Supplemental Environmental Impact Statement and the Plan of Development. I provide my opinion as a Licensed Professional Soil Scientist on whether the Forest Service has a reasonable expectation that the post-construction condition of the land disturbance for the Mountain Valley Pipeline will support the vegetation upon which the agency relies to constitute restoration of the construction activities. Based on my 35 years of experience, personal and professional knowledge of the geology and soils of the Craig, Giles, and Montgomery Counties, and the Jefferson National Forest, and the flora and fauna supported in the local ecosystems, as well as what is known about the agency's faulty use of RUSLE predictive soil-loss modeling, my assessment is that the Forest Service lacks sufficient information about the post-construction productivity of the soils to assume that vegetation will grow, the proposed restoration appears aimed at slope stabilization rather than ecosystem restoration, and it is more likely than not that the proposed restoration activities will not be successful.

The Forest Service has not acknowledged the complex chemical and biological structure and functions of native forest soils and the effects of their disturbance by industrial gas pipeline construction.

There are five soil forming factors: climate, parent material, topography, organisms, and time. Forest soils have a thick layer of leaves and sticks and various stages of decomposition of litter material covering the underlying soil. The leaf litter layer is habitat to rotifers, millipedes, nematodes, insects, and newts and other amphibians, and larger forest animals. Native healthy soils have an organic matter litter-layer cover to moderate microclimates, further increasing biodiversity of flora and fauna, and the soils have structure that roots wrap around or penetrate, air and water in balance for soil animals and microorganisms, bacteria and fungi, protozoans and nematodes, roots, and mineral particles of sand, silt, and clay size, sometimes rocks, all held together by the dynamics of soil biology.

Nematodes and Fungi breakdown minerals and release nutrients for the next level biota to ingest for energy, excreting bionutrients for other soil life forms while extending hyphae to continue the trade route of sugars, water, air, animals, decaying organic matter and detritivores (<u>Handbook of Soil Science</u>, p.C-5, C.1.2 Ecology of Soil Microorganisms). Symbiosis of the soil community allows tree roots to exchange sugars for nutrients and air and water and space and safety, secure "footing", "groundedness", stability, for all the living creatures plus forest animals who require a forest canopy and soil for food and shelter, and who distribute tree seeds improving reproduction success (<u>Properties and Management of Forest Soils</u>, p. 3). Leaves on forest floors reduce raindrop impact on soils and allows water to slowly infiltrate forest soils. The humic acid released in decaying forest leaf litter can distinctly lighten the color of soils in one horizon and distinctly darken soils in another horizon. Soil water will move through each of those horizons differently, with water passing through the more porous horizon faster than the other. Water retention is important on south-facing mountain slopes.

The Forest Service does not describe or acknowledge the complex physical nature of native forest soils that existed on the pipeline corridor prior to construction activity on Brush and Sinking Creek Mountains, and the native soil that is still present on Peters Mountain where only tree clearing has occurred.

Nor does the Forest Service acknowledge that the organization of layered functions, the microorganisms and soil structure strength and framework, are destroyed when soil is disturbed by construction equipment digging and scraping and shoving native soil. The air and water get squeezed out, microorganisms exposed to air quickly decompose easily decomposable organic matter and the plants and animals that died by excavation. Then the microorganisms die themselves and the cycle of life in the soil comes to an end. The heavily disturbed soil would be lifeless.

Soil productivity is affected by soil loss factors that are not accounted for in the DSEIS.

According to the DSEIS, the construction of the MVP will disturb 54 acres of the Jefferson National Forest, including the soils. The soils have stories that are not told by the number of acres, they are told by the rocks, the soil types, the weather, and the water. The MVP would change the soil story from one of complex chemical and biological organization to that of excavation, water diversion, rock blasting, materials mixing, compaction, and erosion, each and all of which change soil structure and therefore post-construction productivity.

Soil loss from wind and water erosion will affect the post-construction productivity of the soil. The Forest Service failed to account for erosion losses in post-construction soil productivity. Dr. Johh Czuba has assessed the agency's faulty reliance on RUSLE/RUSLE2 soil-loss modeling to project instream water quality impacts (Czuba, Jonathon A., P.E.). I have reviewed Dr. Czuba's report in which he concluded that the modeling relied upon by the Forest Service likely underestimated soil loss. In his analysis, Czuba concluded that the model is most applicable only for 43% of the MVP study area in the JNF because some slopes in the pipeline corridor exceed the slopes on which predictive capacity of the model is based. Czuba also criticized the post-construction land cover factor that the Forest Service used in the model. I, too, submitted comments to the Forest Service in November 2020 in which I faulted the use of the RUSLE/RUSLE2 modeling based on the slope, cover-type, and soil erodibility and erosivity factors. I attach my November 2020 letter here.

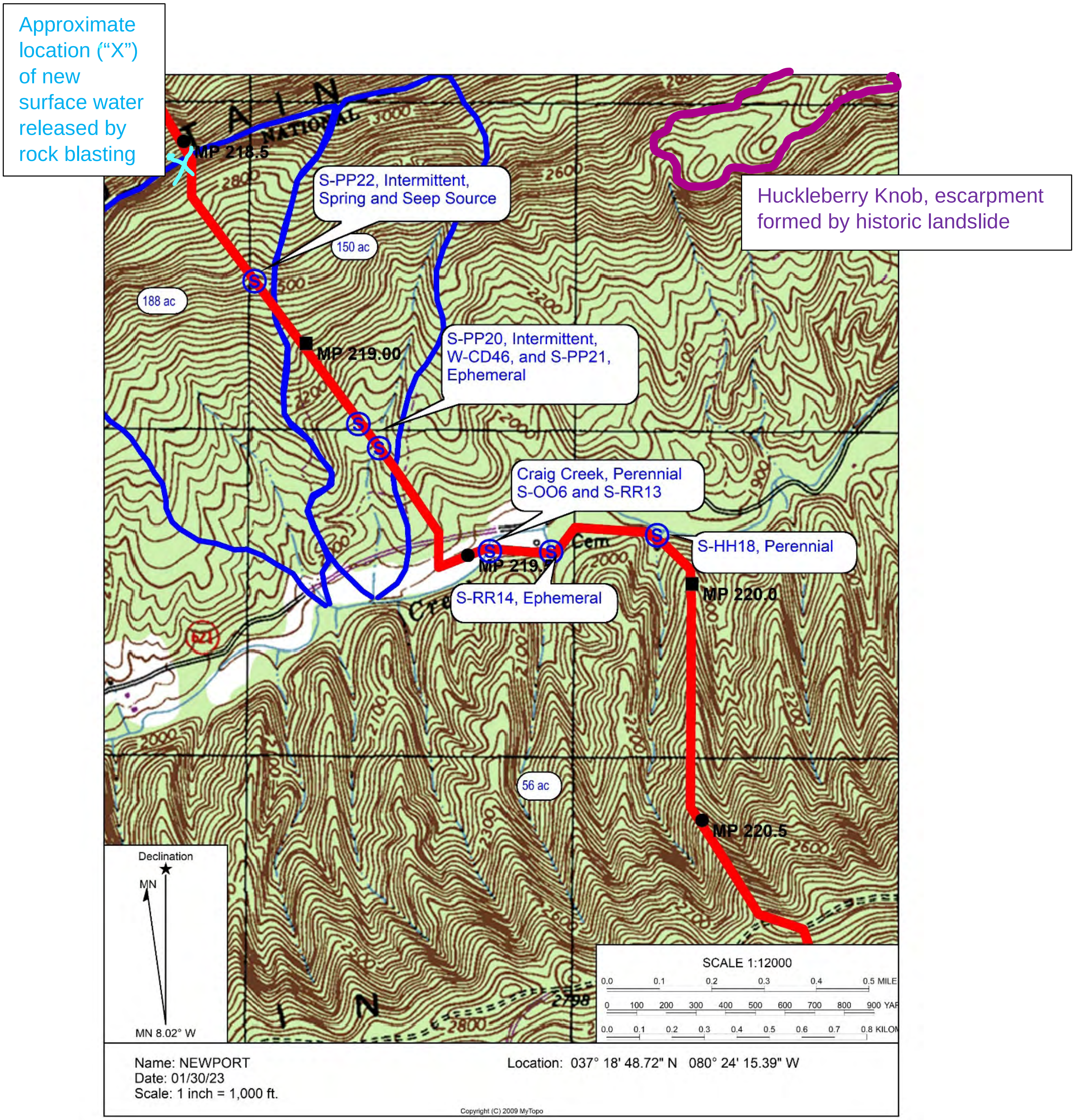
RUSLE and RUSLE2 are soil loss calculations and according to Dr. Czuba, the Geosyntech assessment underestimates the tonnage of soil that will erode from the MVP activity area. The Forest Service has failed to account for any soil loss in its assumption that vegetation will grow on the corridor and the predicted soil loss is underestimated according to Dr. Czuba.

There is some unaccounted-for water that is already having an erosive impact on the corridor. I investigated the conditions on the crest of Sinking Creek Mountain many times before construction and at distance after the rock crest was blasted with explosives. The blasting released a seep of groundwater that had been confined in rock. Now surface water, the seep has been flowing down the corridor on the rock face and under erosion control devices, as a small trickling spread-out perennial stream and contributing to the surface water burden of the temporary erosion and sediment control devices. The Forest Service has not identified the presence of this previously undetected water source or accounted for its impact on soil loss on the slopes of Sinking Creek Mountain.

Dr. Pamela C. Dodds plotted the water resources on the corridor in the JNF as those features were identified by Mountain Valley Pipeline in information provided to FERC in the certificate-application process (Dodds, Pamela C., Ph.D., LPG). In the figure on the following page, I used a copy of Figure 2.0-3 from Dr. Dodd's report and marked where I observed a seep that was released with blasting at the crest of Sinking Creek Mountain. This water source is not among those plotted using pre-construction field data because it was not released to the surface until the rock was blasted.

The current condition of the corridor is providing a laboratory for how soils impacted by construction will perform. The water bars that were made by compacting disturbed soil material with heavy equipment gain weight with an increase of water content, and freeze-and-thaw with temperature fluctuations, particularly on the south and east facing slopes. Since the soil material is no longer in its complex, native state the soil tends to crumble with the freeze/thaw cycles, contributing to the erosion processes.

Even in an undisturbed state, the southeast facing slope of Sinking Creek Mountain, through which the pipeline corridor is routed, is historically unstable. The Forest Service documented the landslide-prone mountain in a pamphlet titled, "The mountain that moved: geologic wonders of the George Washington and Jefferson National Forests." https://pubs.usgs.gov/gip/mountain/mountain.pdf. Also annotated to the figure on the following page is the location of Huckleberry Knob, which has an escarpment above and below the historic landslide resting place.



Copy of Figure 2.0-3 from Dr. Pamela C. Dodd's 2023 Hydrologic Assessment with the following added features: the location of Huckleberry Knob, which is an escarpment on the front of a historic landslide (drawn in purple) and the location of a "new" seep on the top of Sinking Creek Mountain that was released with rock blasting (aqua-colored "X").

In addition to erosion from water, the disturbed soils on the pipeline corridor are, and will continue to be eroded by wind. A concentrated wind tunnel effect was created by MVP with linear tree clearing. The construction at the crest of Sinking Creek Mountain has exacerbated the tunnel effect. At the crest, the rock was blasted through the hard Tuscarora sandstone to a depth of approximately 30 feet, creating a shelf of approximately 60 feet in length where the pinnacle of the armored crest had been. The tunneling phenomenon makes wind an erosion factor that has not been considered in soil loss estimates and soil productivity.

The trees and mountain ridge had buffered the effects of high winds for millennia before being cleared and dynamited by Mountain Valley Pipeline. Now the wind blows up the path of least resistance (bare, disturbed soil in the pipeline corridor) straight up the mountain to the blasted rock conduit at the ridge. Both sides dramatically channel wind up to the top or down the other very steep side of the mountain. Wind concentrated by the blasted area of the Sinking Creek Mountain will dictate erosion to both sides of the mountain.

Wind has the effect of drying out water in soil and vegetation. Wind pushes things down. And Wind pushes things downhill much faster if funneled with confining boundaries, such as rock or tree or soils.

Wind carries soil when soil is exposed due to disturbance. Depending upon the strength of the wind, clays can be carried thousands of miles into the Earth's atmosphere. The red sunsets we see in the USA are Africa's subsoil, in the air. Their topsoils were dispersed and transported long ago by wind, water, and poor management. Soils transported by wind are aeolian soils, loess, dust.

Wind has the effect of focusing attention on fragile environments, and fragile and slow life cycles in soils and its attendant vegetation and animals and water. The drying affect reduces habitat for at least 20 feet from a cut bank of soil, but the drying defines dying and that is likely to further destabilize the symbiotic associations that survive among fungi and plant roots.

The wind-tunneling forces up and down the extreme slopes further limit which vegetation can grow now versus which trees and vegetation grew before disturbance. Vegetation is measurable, and no data has been made available to show that it was ever properly measured or inventoried by qualified specialists on the ground. A once unique ecosystem with a riparian area that extends from the crest of the mountain to the banks of Craigs Creek will now be shaped by wind where there had been tree-and-rock-buffers from its forces. Wind twists trees, reducing their life cycles, shearing roots, which in turn reduces marketability, recreation safety, sources of animal food while leaving weakened trees to absorb nutrients from the soil.

Wind erodes soil by transporting exposed soil from one place to another, and possibly depositing soil in water, as sediment, the effects of which are described by Dodds and Czuba. All the soils crossed by the proposed pipeline on the JNF have wind erodibility susceptibility, that is, it does not take much to disaggregate the soils so that they fall apart, because that is their behavior when trenched or disturbed, and these properties are known by Forest Service staff and published in NRCS Official Soil Descriptions of those Soil Series.

Wind exacerbates soil erosion and further limits productivity on a pipeline corridor constructed through mature forests, up-and-down steep slopes, and over blasted mountain crests, which effects have not been considered.

The Forest Service cannot assume that post-construction soil conditions will support revegetation or restoration as defined by the Forest Service.

The disturbed soils in the pipeline corridor will never be as productive as pre-tree cutting. The corridor is not likely to ever support much more than moss and lichens without high inputs of expensive amendments to meet nutrient demands of transplanted seedlings. A good starting point is to know the productivity of the native soils, although no Order 1 Soil Survey was performed (as described in my November 2020 letter) and so no site-specific data is known for Forest Soil Nutrient Management.

Specifically, on Sinking Creek Mountain the MVP is routed through very hard, resistant acid sandstone, which creates acidic soils of low water holding capacity, low organic matter, low available nutrients for plants, is very confining to roots, and moves in the ground which shears roots.

The trees that grew in the pipeline corridor at the ridge of Sinking Creek Mountain, and have been cut down, were white oak and chestnut oak and red oaks and a few hickories and pine trees. The trees grew to approximately 50 feet tall and at least 100 years old. The Site Index, pre-construction, was probably Site Index of 50 to 60 (Service Forester's Handbook). The pre-construction conditions already limited the production capacity on many parts of the MVP corridor. The denuded, disaggregated, disturbed, redistributed, and eroded soils which would have no soil structure and no water holding capacity, would yield an even lower Site Index, meaning natural recovery of the forest in a degraded site may limit trees to thirty feet tall after 100 years.

Local Native Soils are primarily residual from rotten parent material rock or transported soils. The pipeline corridor spans several ranges of what was previously undisturbed parent material up on the slopes, with accumulations of transported soils on ledges and at the bottoms of the slopes.

Residual Native Soils in the Jefferson National Forest have a thick layer of leaves to walk through with cush underfoot of more decayed leaf matter and mineral soil with rocks. The mineral soils may have three to five distinct horizons of different colors, structure, texture or rocks over bedrock. These soils weathered according to climate, topography, organisms, parent rock material and time into the existent soils.

Native undisturbed soils have a spectrum of diverse organisms and microorganisms sharing space in a symbiotic environment of physical structure and multiple sets of processes of nutrient cycling.

Transported soils have either moved downhill by gravity or water. Where soils are thin, smaller roots form. Where soils have become thicker in zones of accumulation of transported soils, larger roots can grow, bigger trees. Variations in soil thickness change water holding capacity and stability and soil function. Undisturbed, living soils can perform functions that abiotic, post-construction soil-mix cannot perform.

The litter layer of leaves on a forest floor is important to the overall stability of the forest because of all the creatures living in that layer, supporting forest health and offering shelter for microclimates and animals living in the leaf litter. The leaf layer allows water to penetrate soil slowly, without erosion of particles. The decomposition of the leaf layer provides acids to the soils and recycles nutrients and carbon and stores carbon in the soil.

Native Hardwood forests can produce 2-45 tons/Acre/year of leaf litter that covers the forest floor (Properties and Management of Forest Soils). The pipeline right of way, and likely the entire corridor will produce zero (0) tons/Acre/yr of leaf little. The detritovores will not have organic matter to decay, and the whole microorganism food chain is collapsed which in turn affects nutrient cycling and availability for plants. Any trees that may grow in the corridor will never be as large or productive as those that have been removed, thereby further reducing the future nutrition that would come from decayed leaves.

MVP lists the soil types by the one-tenth mile increments. A linear mile is 5280 feet long. This implies that MVP relied on Order 2 published soil survey descriptions for information on soils by assuming every 528 feet the general map agreed with a spot check. This methodology fails to identify many physical properties of the soils that might inform efforts to replant vegetation. A more useful on-site sampling protocol would verify soils every 100 feet for a proper construction scale of 1:30 planning and construction.

Sampling and describing soils every 100 feet along and in the MVP construction corridor is appropriate to know what soil nutrients may be available. The Restoration Plan appended to the Plan of Development shows that plants intended for restoration prefer a soil pH that is higher than that of the native soils (Appendix H to the POD, p 9). One-time applications of fertilizer and agricultural lime as described in the Plan of Development will not have much effect, particularly the lime in changing the pH of forest soils in the JNF unless regular applications are made forevermore- or more than 25 years (Properties and Management of Forest Soils). That is to say, the damage to forest soils and the forest floor will last for more than 25 years and likely much longer than the MVP intends to operate, particularly if the pipe once constructed is later required to be removed.

The rock at the crest of Sinking Creek Mountain has already been blasted. The Forest Service would have to agree that growing trees on bare rock is tough, so the Sinking Creek Mountain crest that has irreparable damage and is now blast-fractured acid sandstone rock with numerous scattered water seeps and would now have zero productivity relative to before the construction started, and a challenge to establishing at least 80% vegetative cover.

The extraordinary soil disturbance required for pipeline construction disables the ecosystem functions and services of the native undisturbed soils. Hydric soil boundaries will change where dewatering redirects water and refocuses it elsewhere. There are no ecosystem services that can be attributed to pipeline construction that will help restore the native soils on the National Forest back to Forest Soils. Additions of lime and fertilizer will not restore the post-construction soil to its preconstruction condition. Supplements do not repair the structure.

The Forest Service defines restoration as “The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions” (36 C.F.R. § 219.19). The plan to add soil amendments and plant saplings and grass seed mixes will not achieve soil restoration under the Forest Service’s definition of restoration. Soil restoration is the foundation of ecosystem restoration (The Nature and Properties of Soils). The practices described in the Plan of Development may contribute to post-construction stabilization of the slope, as intended, but the practices will not restore the soil.

Furthermore, the proposed rate of fertilizer application is extraordinary, even if it were for the purpose of agricultural crop production on flat land. (Plan of Development, Appendix H, p H-7). The soil amendment rates stated in Appendix H to the POD far exceed the need of any agricultural production soil tested by me locally and regionally in my 35 years of experience. Compared to Forest Soils, agricultural soils have far greater nutrient replenishment requirements annually because each crop harvest removes nutrients. Functioning forest ecosystems hold their nutrients and symbiotically recycle and repurpose exudates.

The pipeline corridor is narrow and steep and easily eroded. No fertilizer is appropriate at the rates listed in Appendix H for the Forest Soils, especially in a narrow steep wet corridor with highly disturbed construction-soil. The disturbed soil has little or no binding sites to which the nutrients can bond. Most of the soil amendments applied at the rates in Appendix H would run off the corridor and accumulate at the bottom of the slopes and/or runoff into water courses, the consequences of which have not been considered.

Fertilizers should not be applied until laboratory soil tests results recommend fertilizers. Further, there are few slopes in JNF suitable for disking the soils to incorporate the fertilizer. Fertilizer not incorporated into the soil misses its target vegetation, is mineralized, or is unavailable to plant roots unless placed next to the roots.

Suitable fertilizer additions can create temporary improvement in site quality which may spur short term growth. However, some plants may take up some nutrients, others will not, which creates an imbalance between species. Excess nutrients can make trees more susceptible to insects, more palatable to deer browse, and decrease soil mycorrhizae depending on soil conditions which impacts the availability of nutrients. (Properties and Management of Forest Soils, see Chapter 20, Effects of Antropogenic [sic] Chemicals on Forest Ecosystems, pp 376-377).

The pH of Forest Soil may not be affected by lime (Properties and Management of Forest Soils, p 269). Although the Forest Service includes lists of recommended species of tree and shrub saplings for revegetation with associated soil pH needs and instructions for placement when planting, there are no guidelines for soil testing to assure suitable pH and rate of supplemental nutrition at the time of transplanting (POD, Appendix H, Attachment H-4). In Appendix H, page H-8, MVP states, "Soil chemistry tests will be conducted in areas where revegetation potential is low or revegetation is unsuccessful. The fertilizer and liming rates described above will be adjusted accordingly based on the results of site-specific soil tests. Soil chemistry data will be submitted to the FS following testing, and any modifications to the fertilizer or lime application rates described above will be provided to the FS for approval prior to use."

Rather than waiting until after revegetation has failed as proposed by MVP, the standard practice is to test the soils before the soils are disturbed and with the extreme disturbance proposed for the MVP, also prior to attempted revegetation. If the Forest Service were honest about the post-construction soil conditions, it would admit that the revegetation potential is low and revegetation will be a challenge across the JNF, thereby requiring soil testing before any attempt at revegetation across the entire corridor.

In standard practices, soil supplementation should be applied with as much precision as possible to avoid over-application which will result in nutrient runoff, particularly on the slopes of the JNF, and unnecessary financial expenditure.

The Forest Service notes the need for transplants to be watered but there is no plan for watering the transplants across the corridor on the JNF. The Forest Service did not consider revegetating with nitrogen-fixing plants and soil-conserving plants to reduce fertilizer use (Properties and Management of Forest Soils p 299, see nutrient-depleted sites), and plants with a lower water demand which may be more suited to the post-construction dewatered slopes.

The Soil Surveys for Giles and Montgomery Counties (cited by MVP in "Mountain Valley Pipeline Soil Profile Descriptions Report for Jefferson National Forest" April 2016) include both general and cautionary guidance for specific land uses, and particularly where water management is a construction goal, which guidance has not been considered in the proposed pipeline construction activity on the JNF. (Soil Survey of Montgomery County, p 9, 55, and Table 7 "Woodland Management and Productivity"). The productivity, stability, and limitations of these soils are predictable. Nevertheless, there is no scientific basis for the stated plans for post-construction soil supplementation.

I have casually observed from a distance the appearance of the Columbia gas pipeline on the east and west slopes of Peter's Mountain in Giles County, Virginia and

Monroe County, West Virginia, which pipeline also was constructed on the JNF. I have also reviewed aerial photography of the corridor (Dominion Pipeline Monitoring Coalition). Some grasses that were planted post-construction grew for a season, however, in subsequent years and until the last time I saw it in the fall of 2022, the corridor has appeared barren and denuded. The current condition of the Columbia gas pipeline does not appear to be restored as defined by the Forest Service and it is the best representation of the potential for the restoration of soil structure and productivity on the proposed route of the MVP.

Whatever tools used to predict what would happen to the disturbed Forest Soils, were either not properly used or not properly interpreted or fully ignored. Given the complexity and importance of the forest floor to the stability of Forest Soils, the Forest Service cannot assume or reasonably predict that the once-forested corridor will be restored to anything comparable to the surrounding undisturbed area.

I wish to support and integrate my observations and knowledge with my colleagues, Dodds' and Czuba's good work.

REFERENCES:

Thirty-five years of professional field experience and many years of continuing education to maintain professional soil scientist licenses.

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Professional Field Excursions which covered Mt. Lake, Canoed the New River to study river deposits, explored Damplands, Intermittently Wet Lands, and Wetlands around Sinking Creek Mountain including Huckleberry Knob and Newport, Virginia", in part of two Field Excursions: Virginia Association of Professional Soil Scientists in June 2002 and South East Friends of the Pleistocene April 2015, 13 years later.

Professional Profile

Nan Gray, LPSS
P.O. Box 3
Newport, Virginia 24128
Telephone: (540) 544-7791
Email: soilwork@pemtel.net
Text: (540) 599-7791

- RELEVANT EXPERIENCE

1988-Present

General Practitioner of Soil Science since 1988, when I started Soil Works, Inc., consulting in field mapping soils and landscapes for land uses such as conservation easements, road layout, fracture trace analysis, water well siting, shrink-swell clay problem solving, soil and geomorphic interpretations, agronomic practices, karst, wetland delineations, septic drainfield suitability and design, pond and dam material suitability, farming, erosion and sediment control, GPS and GIS mapping, nutrient and pollution movement in soils.

Soil Works, Inc. was a Small, Woman and Minority (SWaM) owned business and a Disadvantaged Business Enterprise (DBE) with Virginia Department of Transportation until recently. I provided professional soil science services for a variety of land uses to the Private Sector and to Government Agencies.

1986-1988 Chemist/Laboratory Manager, Coal Laboratory and Forest Soils Laboratory, Virginia Polytechnic Institute and State University, Blacksburg, Virginia
1983-1986 Graduate Student in Agronomy and Chemistry Tutor, U of Illinois, Champaign, Illinois
1982-1983 Technician, Soil Characterization Laboratory, University of Illinois, Champaign, Illinois

- EDUCATION

MS, Agronomy, University of Illinois
BS, Chemistry, Wilmington College, Ohio

Continuing Education through Virginia Polytechnic Institute and State University (Virginia Tech), North
Carolina State University, Virginia Association of Professional Soil Scientists (VAPSS), Virginia
Department of Health, Virginia Geological Field Conferences, Southeast Friends of the Pleistocene Field
Excursions, National Society of Consulting Soil Scientists, Soil Science Society of America, Geological Society of America, Family and Friends

- PROFESSIONAL LICENSES

Licensed Professional Soil Scientist (LPSS) in Virginia and North Carolina

Master Alternative Onsite Soil Evaluator License (MAOSE) in Virginia

- PROFESSIONAL MEMBERSHIPS

Soil Science Society of America

Virginia Association of Professional Soil Scientists (past-President, Board Member)