Indian Creek Watershed Association
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December 22, 2016

RE: **Hydrogeological Assessment of Impacts Caused by Constructing the Mountain Valley Gas Pipeline Across the Greenbrier River at Pence Springs, Summers County, West Virginia**
Docket No. CP16-10-000

TO: **Ms. Kimberly Bose, Secretary, Federal Energy Regulatory Commission** (via e-filing)

Indian Creek Watershed Association hereby files the following report: "Hydrogeological Assessment of Impacts Caused by Constructing the Mountain Valley Gas Pipeline Across the Greenbrier River at Pence Springs, Summers County, West Virginia" by Pamela C. Dodds, Ph.D., Licensed Professional Geologist.

In preparing the DEIS, the FERC failed to meaningfully address the significant concerns raised in Dr. Dodds' earlier hydrogeological report, which provided a preliminary assessment of impacts caused by construction of the MVP in Monroe and Summers Counties (August 2016, Accession #20160815-5135).

For her further analysis of the impacts on Summers County**,** Dr. Dodds has selected three representative sites: the Lick Creek Valley, the headwater areas of the Hungard Creek Watershed which originate on Keeney Mountain, and the crossing of the Greenbrier River at Pence Springs (the subject of this report).

These site reports provide exactly the sort of empirical evaluations missing from the materials in the Draft Environmental Impact Statement for the Mountain Valley Pipeline. Dr. Dodds provides sufficient details on geological principles for the reader to fully understand their implications when they are subsequently applied to the particulars of each site. Her reports also make clear the cumulative impacts of stream crossings, excavation, and other construction activities on the accumulating sediments so damaging to the county's water resources.

The conclusions of this report reinforce our request for (1) detailed, on-the-ground hydrogeological studies, (2) a Revised Environmental Impact Statement for the MVP, and (3) individual 401, 404, and Stormwater permits, rather than general permits.

If the FERC does not require such studies, with an opportunity for public comment, we request that the FERC choose the No Action Alternative.

Respectfully submitted,
Indian Creek Watershed Association Board of Directors
Judy Azulay, President; Scott Womack, Vice President;
Howdy Henritz, Treasurer; Nancy Bouldin, Secretary

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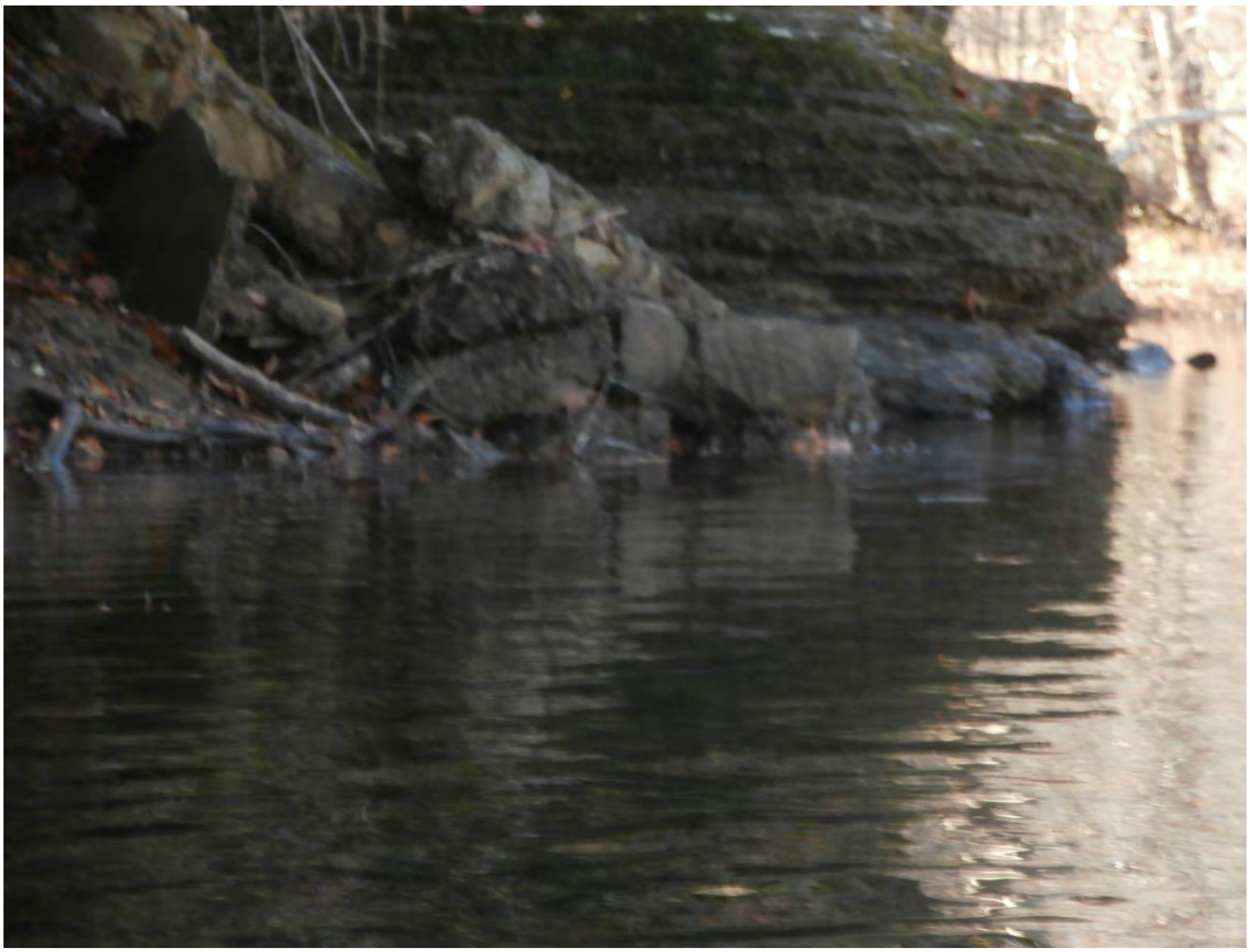
HYDROGEOLOGICAL ASSESSMENT OF IMPACTS CAUSED BY CONSTRUCTING THE MOUNTAIN VALLEY GAS PIPELINE ACROSS THE GREENBRIER RIVER AT PENCE SPRINGS, SUMMERS COUNTY, WEST VIRGINIA



By Pamela C. Dodds, Ph.D., Licensed Professional Geologist
for
Indian Creek Watershed Association

December 2016

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Cover: Cliffs along the Greenbrier River near the proposed MVP gas pipeline construction crossing. Photo taken by Mr. Ty Bouldin, December, 2016.

HYDROGEOLOGICAL ASSESSMENT OF IMPACTS CAUSED BY CONSTRUCTING THE MOUNTAIN VALLEY GAS PIPELINE ACROSS THE GREENBRIER RIVER AT PENCE SPRINGS, SUMMERS COUNTY, WEST VIRGINIA

By Pamela C. Dodds, Ph.D., Licensed Professional Geologist

EXECUTIVE SUMMARY

The Greenbrier River is considered a major river system, forming at the confluence of the East Fork Greenbrier River and West Fork Greenbrier River in Durbin, Pocahontas County, West Virginia and flowing into the New River at Hinton, Summers County, West Virginia. The Greenbrier River is listed in the National Rivers Inventory as exceptional waters. The Greenbrier River and its associated headwater tributaries located at Pence Springs are within the Zone of Critical Concern of the Big Bend Public Service District (PSD), which supplies public water from an intake located downstream of the Greenbrier River crossing.

In its Draft Environmental Impact Statement (DEIS) for the Mountain Valley Project and Equitrans Expansion Project Application, submitted to the Federal Energy Regulatory Commission (FERC) September, 2016, Mountain Valley Pipeline, LLC (MVP) has proposed a gas pipeline construction route which crosses the Greenbrier River at Pence Springs, Summers County, West Virginia. In Table 4.1.1-9 – “Flood Zone and Class of Pipe Crossed by the MVP” of the MVP DEIS, the following crossing length is provided: “MP 170.4 Summers County, Greenbrier River, Crossing length 1841 feet, pipe class 1, minimum depth of cover 3 feet.”

MVP also proposes withdrawal of 5,763,483 gallons of water from the Greenbrier River at the crossing location, which is less than 2 miles upstream of the Big Bend PSD water intake. At the location of the proposed river crossing, steep bedrock cliffs are located on the north bank of the Greenbrier River flood plain. Wetlands are located on the flood plain. Bedrock is evident in the river bed at this proposed crossing.

The proposed construction will cause the following adverse impacts to the Greenbrier River:

1) The proposed work corridor and access road north of the crossing will degrade headwater areas of the Greenbrier River.

The proposed work corridor in the area north of the proposed river crossing intersects 4 direct drain headwater areas to a headwater area tributary to the Greenbrier River. These direct drain headwater areas are within the Zone of Critical Concern of the Big Bend PSD. Bedrock in this area is within 20 inches to

40 inches of the ground surface and will probably require blasting. Deforestation, soil compaction, and blasting within these headwater areas will increase stormwater discharge and decrease groundwater recharge to seeps and springs in the headwater areas of the Greenbrier River.

2) Blasting will be required to place the proposed gas pipeline in the area of the steep cliffs on the north side of the river crossing, impacting groundwater and creating the potential for landslides.

Bedrock outcrops are exposed in cliffs along the north side of the Greenbrier River at the proposed crossing location, immediately adjacent to 2 identified wetlands in the flood plain of the Greenbrier River. Blasting will be required to construct the trench for the placement of the pipeline. Blasting and soil compaction in the work corridor will reduce groundwater recharge and probably change the flow of groundwater to the wetlands in the flood plain as well as to seeps and springs along the river valley of the Greenbrier River. The bedrock consists of Mauch Chunk red shales, siltstone, and sandstone, which have been evaluated by the West Virginia Geological and Economic Survey (WVGES) as the most prone to landslides in West Virginia.

3) Construction of the proposed gas pipeline work corridor, access road, and additional work space area in the flood plain on the north bank of the Greenbrier River will destroy the ecological functions of the wetlands.

Deforestation, soil compaction, and blasting in the work corridor will reduce groundwater recharge and the flow of groundwater to seeps and springs in headwater areas and in the wetlands on the Greenbrier River flood plain. Wetlands provide environments for chemical cycling of nutrients. Headwater areas provide the essential aquatic habitats for aquatic species and associated terrestrial fauna and fowl within the entire length of the river continuum in the Greenbrier River watershed.

4) Bedrock exposures in the river bed of the Greenbrier River provide evidence that blasting in the river bed will be necessary. This will result in destruction of aquatic habitats and aquatic biota.

The MVP DEIS failed to list Greenbrier River crossing in Table 4.3.2-8 – “Waterbodies Crossed by the MVP in areas of shallow bedrock”. Bedrock can be observed in the Greenbrier River where the gas pipeline installation is proposed. The MVP DEIS states that, “In-stream blasting has the potential to injure or kill aquatic organisms, displace organisms during blast-hole drilling operations, and temporarily increase stream turbidity. Additionally, shock waves created by blasting may post a threat to aquatic organisms. Chemical by-products from the blasting materials could also be released and could potentially contaminate the water.”

5) Withdrawal of 5,763,483 gallons of water from this crossing location, less than 2 miles upstream of the Big Bend PSD water intake, will negatively impact water supply for residents by reducing the water level.

In addition to withdrawing water for hydrostatic testing, it is stated in the MVP DEIS that 55,000 gallons per day will be required for dust control. The West Virginia Department of Environmental Protection (WVDEP) provides a water withdrawal guidance tool to help determine when it is environmentally safe to withdraw water. “The guidance is based on percentages of mean annual flow, based on a 10-year period that affords an appropriate flow to protect aquatic habitat.” There is no mention of water reduction impacts on public water supply.

6) Construction will result in a cumulative impact of increased turbidity which will permanently degrade aquatic habitats with the Greenbrier River.

The MVP DEIS provides that an assessment was made to determine the monthly sediment load increase due to construction. For the Greenbrier River, the monthly sediment loads are estimated to increase 19 to 52 percent, which will permanently degrade aquatic habitats. Also, the Big Bend PSD is concerned about increased surface runoff, which transports sediment and chemicals to the river and can impact the public water supply intake. When the turbidity returns to baseline levels, the sediment remains. With increased stormwater discharge from the construction sites, increased stream volumes and velocities cause downstream stream bank erosion, resulting in more sediment accumulation in the stream beds. This cumulative damage to aquatic habitats, through time, will not disappear, but rather, will cause the death of aquatic organisms and will reduce water quality. The Greenbrier River is one of the few remaining locations where the Federally listed endangered Clubshell mollusk (*Pleurobema clava*) is able to survive. As a filter feeder, this species is very sensitive to turbidity and sedimentation.

7) The MVP gas pipeline construction will create the potential for pipeline collapse in areas known to have experienced earthquakes.

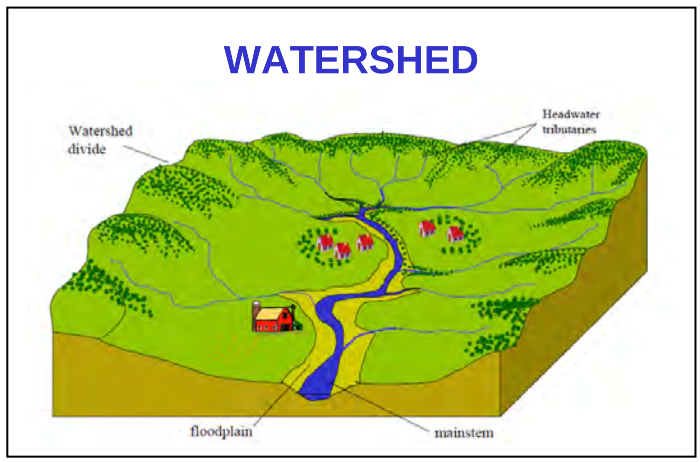
The U.S. Geological Survey (USGS) 2014 Seismic Hazard Map depicts the area of the proposed Greenbrier River crossing in Summers County in a zone of concern for earthquake events. The West Virginia Geological and Economic Survey 2014 earthquake map indicates several recent earthquakes in Summers County. Although MVP discounts the seismic activity as insignificant, the combination of earthquakes in landslide-prone areas where the proposed MVP gas pipeline would be located presents definite concern.

SECTION 1.0

TRIBUTARIES AND HEADWATER AREAS OF THE GREENBRIER RIVER AT PENCE SPRINGS

"Watershed" refers to all of the land that drains to a certain point on a river (Figure 1.0.1). A watershed can refer to the overall system of streams that drain into a river, or can pertain to a smaller tributary. Stream order is a measure of the relative size of streams. The smallest tributary is a first order stream, which originates in the highest elevations. The headwater areas for these first order streams are environmentally sensitive and provide seeps, springs, and wetlands in shaded areas where light is filtered and temperatures are lower, sustaining the aquatic organisms at the very base of the food chain. A second order stream occurs where a first order stream connects with another stream. A third order stream occurs where a second order stream connects with another stream. The watershed for a first order stream can be delineated as a subwatershed within the larger watershed.

Figure 1.0.1 – Headwaters of first order high gradient streams in Summers County are located at the highest elevations on the watershed divides.



Tributaries to the Greenbrier River are mostly first order and second order high gradient streams with environmentally sensitive headwater areas. The Hungard Creek watershed has numerous first and second order UNTs and headwater areas. Hungard Creek, a tributary to the Greenbrier River, would be impacted by increased stormwater discharge and blasting in the proposed MVP work corridor and access roads. In the MVP DEIS, Appendix F, there is a listing of waterbodies crossed by the MVP, which includes the following UNTs identified as tributaries to the Greenbrier River: "TTWV-S-64 – perennial, with associated wetland TTWV-W-23, MP 170.0; TTWV-S-65 – intermittent, MP 170.1; TTWV-S-66 – ephemeral, MP 170.1; TTWV-S-67 – ephemeral, MP 170.3, TTWV-S-68 – ephemeral, MP 170.2, and TTWV-S-139 – perennial, MP 170.5". Numerous other UNTs are listed for Kelley Creek and Wind Creek, which are tributaries to the Greenbrier River within the Big Bend PSD Zone of Critical Concern (ZCC). Figure 1.0.1 depicts the ZCC.

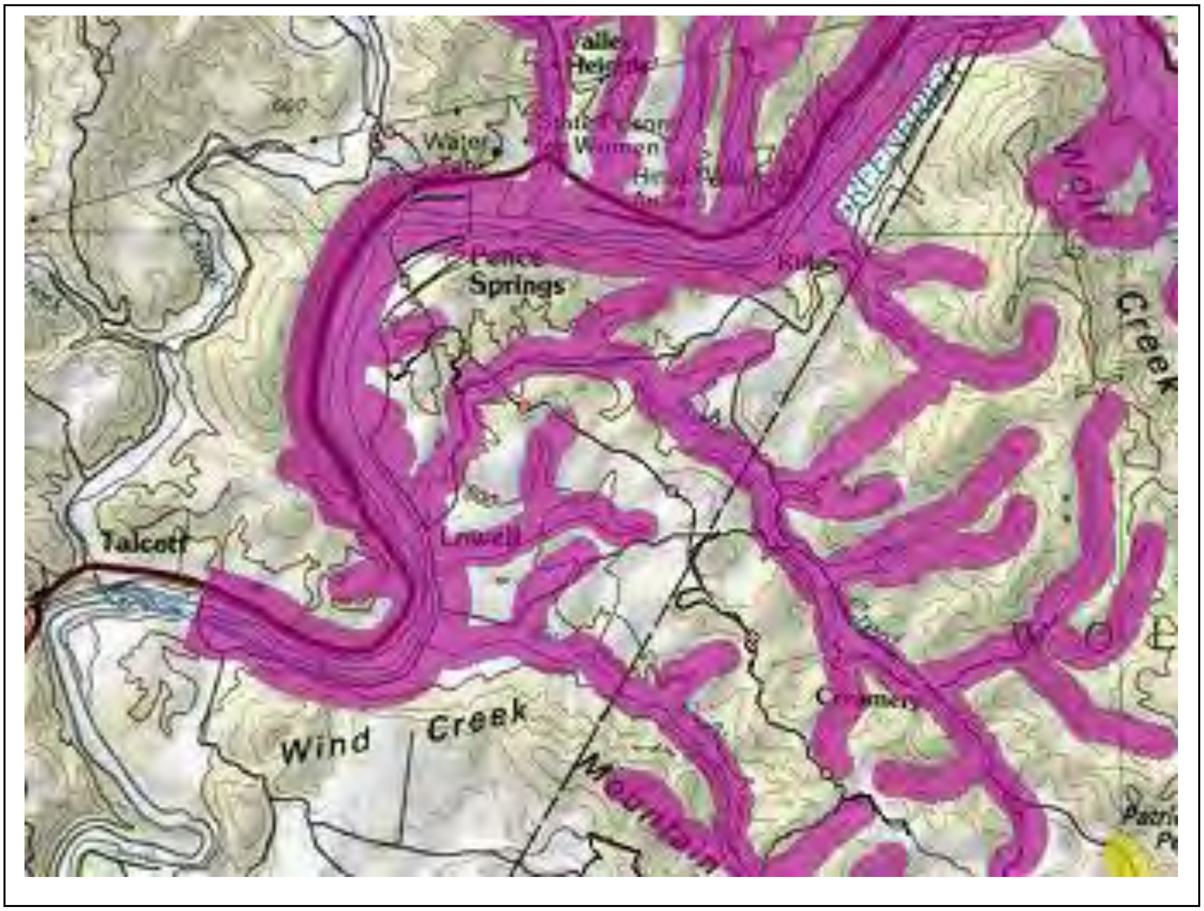


Figure 1.0.1 – Big Bend PSD Zone of Critical Concern, depicted in purple. (Map excerpted from the Indian Creek Watershed Association interactive map project).

The MVP DEIS specifies the intent to withdraw 5,763,483 gallons of water from the Greenbrier River at the Pence Springs crossing location, less than 2 miles upstream of the Big Bend PSD water intake. This will negatively impact water supply for residents by reducing the water level.

In the MVP DEIS, it is further explained in Table 4.3.2-10 – "Hydrostatic Test Water Sources and Discharge Locations for MVP Segment 07A MP 154.5 – 170.6" that 5,763,483 gallons would be withdrawn from the Greenbrier River at MP 170.6. The water would be treated with a biocide prior to hydrostatic testing. After testing, the water would be treated with an anti-biocide and ultimately discharged (after reuse at another area) at MP 170.6, which is the Greenbrier River. This location is less than 2 miles upstream of the Big Bend PSD water intake.

In addition to withdrawing water for hydrostatic testing, it is stated in the MVP DEIS that 55,000 gallons per day will be required for dust control. The West Virginia Department of Environmental Protection (WVDEP) provides a water withdrawal guidance tool to help determine when it is environmentally safe to withdraw water. “The guidance is based on percentages of mean annual flow, based on a 10-year period that affords an appropriate flow to protect aquatic habitat.” The mean annual flow estimate is based on U.S. Geological (USGS) stream gauge data. The closest USGS stream gauge is located near the Monroe County/Greenbrier County line, 12 miles upstream of the Big Bend PSD water intake, which is less than 2 miles downstream of the proposed Greenbrier River crossing at Pence Springs. Therefore, the stream gauge used for determining the time to withdraw water is located more than 10 miles upstream. The stream configuration is different at the location of the USGS stream gauge, with few tributaries and no flood plain. This is in contrast to the numerous nearby tributaries near Pence Springs and the wide floodplain areas. The MVP DEIS does not include any mention of water reduction impacts on public water supply.

In 2007, the U.S. Fish and Wildlife Service (USFWS) prepared a document, “Functional Assessment Approach for High Gradient Streams”, for the U.S. Army Corps of Engineers to use in assessing impacts and mitigation with respect to processing Clean Water Act Section 404 permit applications. High gradient headwater streams are characterized as first and second order ephemeral and intermittent streams with channel slopes ranging from 4% to greater than 10%, with watersheds of approximately 200 acres. The significance of this report relates to the proposed MVP gas pipeline construction with regard to how watersheds are evaluated. Because of the impacts of construction on the functions of headwater areas in the watersheds of first order high gradient streams, it is critical to evaluate these areas not simply as a small acreage within the area encompassing the construction project, but rather as functionally contributing areas which are the basis of water quality and aquatic habitat quality within the overall watershed.

The Federal Government Agencies have established a hierarchical ordering of Hydrological Unit Codes (HUC), described as areas of land upstream from a specific point on the stream (generally the mouth or outlet) that contributes surface water runoff directly to this outlet point (Table 1.0.1).

Table 1.0.1 – Descriptions of Hydrological Unit Codes (HUC).

Code	Official Name	General Description
HUC-2	REGION	Major land areas. The lower 48 states have 18 total, 1 additional each for Alaska, Hawaii, and the Caribbean. (21 Total in US) Called 1st Level - or Watershed 1st Level.
HUC-4	SUBREGION	Each Region has from 3 to 30 Subregions. The Missouri River Region has 30 Subregions. The lower 48 states have 204. (222 Total in US). Called 2nd Level.
HUC-6	BASIN	Accounting Unit. (352 Total in US). Called 3rd Level.
HUC-8	SUBBASIN	Cataloging Unit. The smallest is 448 K Acres (700 mi^2). Most are much larger. National HQ compilations have this as the smallest size unit. (2,149 Total in US) Called 4th Level
HUC-10	WATERSHED	Typically from 40 to 250 K Acres (62 to 390 mi^2) Work continues per new Interagency Guidelines presented to Federal Geographic Date Committee on December 2000. (Was formerly called HUC-11). Called 5th Level or Watershed 5th Level.
HUC-12	SUBWATERSHED	Typically from 10 to 40 K Acres (15 to 62 mi^2) Work continues per new Interagency Guidelines presented to Federal Geographic Date Committee on December 2000. (Was formerly called HUC-14). Called 6th Level or Watershed 6th Level.

HUC designations were developed by Seaber, Paul R., F. Paul Kapinos, and George L. Knapp ("Hydrologic Unit Maps", U.S. Geological Survey Water-Supply Paper 2294; 1987) as a "standardized base for use by water-resources organizations in locating, storing, retrieving, and exchanging hydrologic data, in indexing and inventorying hydrologic data and information, in cataloging water-data acquisition activities…" River basin designations were based on a drainage area of greater than 700 square miles. The HUC designations were not intended to determine specific details for smaller watersheds of tributaries which provide water quality and biotic functions of aquatic organisms for the overall watershed evaluations. In order to evaluate the interactions of precipitation, stormwater discharge, groundwater recharge and retention, and stream baseflow, calculations must be performed at the headwater tributary level. Because first order high gradient streams are well defined (Rosgen, 1994) and are considered to provide the basis for watershed evaluation (USFWS, 2007), it is essential to select these smaller watersheds, typically 200 acres to 600 acres in size, to evaluate the impact of construction projects.

The smallest HUC is the HUC-12 Subwatershed, which typically encompasses an area from 10,000 acres to 40,000 acres. This is in contrast to the acreage within a watershed of a high gradient first order stream in the Appalachian Plateau Physiographic Province, where tributaries to the Greenbrier River are located. Watersheds of first order high gradient streams cannot be compared to the HUC-12 Subwatersheds that range from 10,000 acres to 40,000 acres in size. The impacts to a small watershed cannot be measured in the HUC-12 size designation. The location of construction sites in first order high gradient stream watersheds must also be considered in any evaluation of construction impact because the headwaters of these streams provide the necessary water resources, organic compounds, and food at the very base of the aquatic food chain. In the MVP DEIS, numerous high gradient first order streams are identified at locations where they are crossed by the proposed MVP gas pipeline route. However, no evaluation is presented in the MVP DEIS with respect to construction impacts on these headwater streams.

SECTION 2.0

ECOLOGICAL FUNCTIONS WITHIN UNTs TO THE GREENBRIER RIVER

The River Continuum Concept was developed by Vannote, R.L., G. W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing in 1980 and presented in the Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137. The U.S. Environmental Protection Agency and the U.S. Department of Agriculture have embraced the River Continuum Concept as illustrating the strong connection between headwater areas on mountain ridges and various downstream areas. The River Continuum Concept diagram (Figure 2.0.1) provides pie diagrams of predominant benthic aquatic organisms associated with various locations, starting at the headwaters, along the river continuum. Shredders, predominant in the forested headwaters, break down organic matter used downstream by collectors, predators, and filter-feeders. The filter-feeders are subsequently consumed by larger benthos and fish.

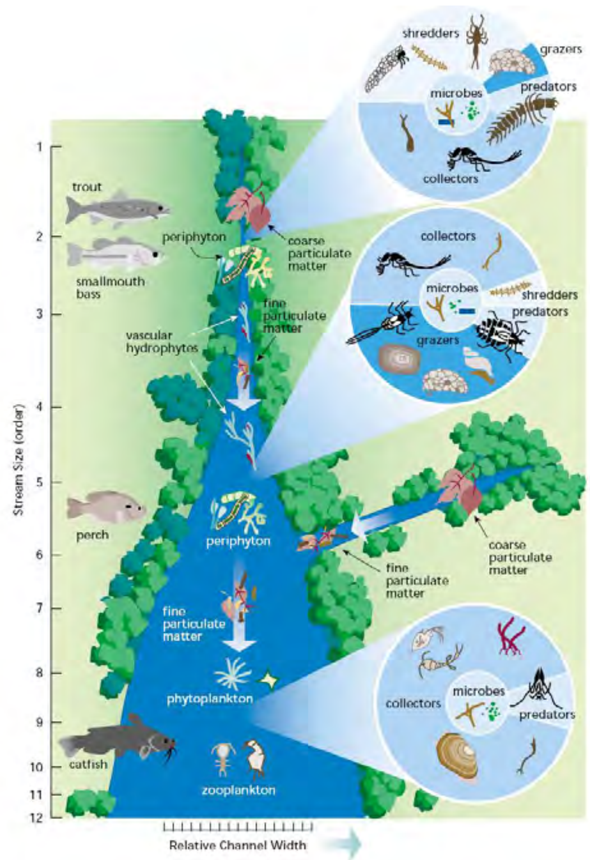


Figure 2.0.1 – The River Continuum (Vannote, et al; 1980) illustrates the food chain connection between headwater areas of first order high gradient streams and the wider, larger downstream areas in the overall watershed.

Ecological communities are typically classified with respect to the vegetation present because it is the most permanent, visible feature of a community. Biodiversity refers to the diversity within an ecological community, with emphasis on the inter-relationships and interdependence among the various species. Trees not only intercept rainfall so that it falls gently to the ground surface and is thus able to penetrate the ground as groundwater recharge, but also store nutrients in their trunks, branches, and roots (West Virginia Department of Natural Resources: http://www.wvdnr.gov/Wildlife/Plants.shtm). Fungi in the soil facilitate transport of nutrients between trees and the soil. The soil stores nutrients which are processed by soil microbes to regulate essential nutrient cycles involving oxygen, carbon dioxide, nitrogen. Roots of the trees and of herbal vegetation help to stabilize the soil so that the soil nutrients are not washed away by stormwater runoff. The ecological communities in the headwater areas of first order high gradient streams consist not only of the vegetation, but also the aquatic benthic macroinvertebrates, fungi, and soil microbes. Insect larvae, commonly grouped as shredders, constitute most of the aquatic benthic macroinvertebrates in the headwater areas because they shred organic material into components used by collectors and predators downstream.

Headwater areas of first order and second order streams provide the essential aquatic habitats for aquatic species and associated terrestrial fauna and fowl within the entire length of the river continuum in the overall watershed. The soils which have formed in the headwater areas regulate the transport of surface water and also carbon, nitrogen, and oxygen. The shade of the forest canopy provides the filtered light and lower temperatures critical to maintaining the headwater aquatic habitats. Wetlands provide the functions of flood control, groundwater recharge, maintenance of biodiversity, wildlife habitat, maintenance of water quality, and chemical recycling of nutrients.

Cobbles and pebbles within stream beds provide aquatic habitats and protection for aquatic organisms. Insect larvae, which constitute the base of the river continuum food chain, reside on the cobbles and pebbles. Minnows and juvenile fish hide in the spaces between cobbles and pebbles for protection. When sand and silt fill the spaces between the cobbles and pebbles, the aquatic habitats and protection areas are destroyed (Figure 2.0.2).

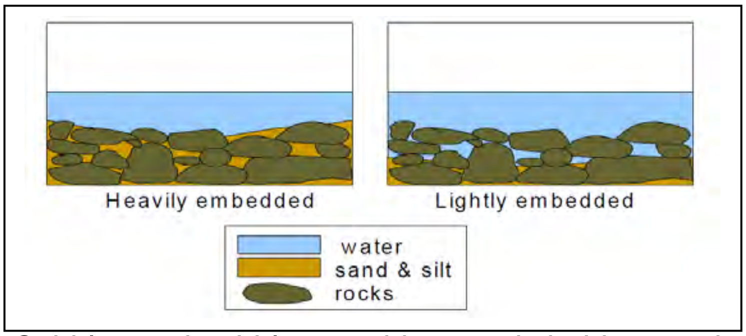


Figure 2.0.2 – Cobbles and pebbles provide aquatic habitats and protection for aquatic organisms. When the aquatic habitats are removed for trenching and stream crossing work spaces, they cannot be restored.

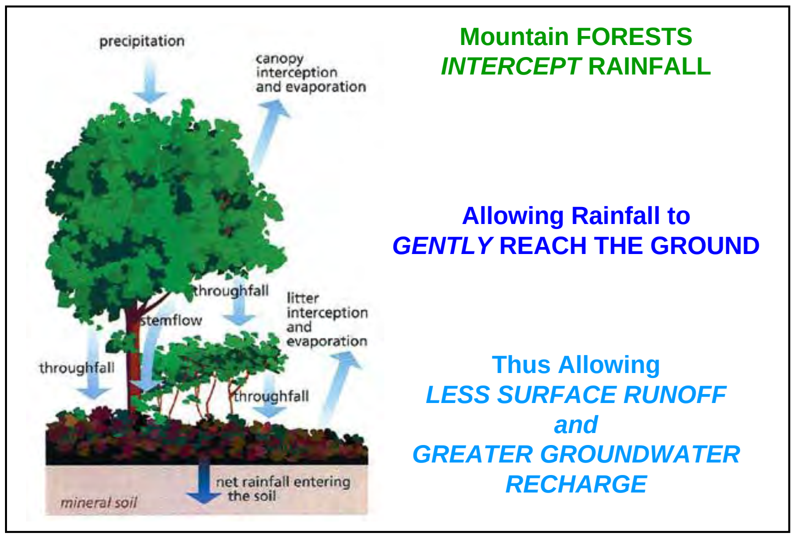
SECTION 3.0

FUNCTIONS OF FORESTED RIDGES WITHIN THE PROPOSED MVP GAS PIPELINE CONSTRUCTION ROUTE

Forested ridges are our greatest defense against drought. The trees on the mountain ridges intercept rainfall so that it gently penetrates the ground as groundwater rather than flowing overland as runoff. This means that 1) the rain will gently fall to the ground and recharge groundwater and 2) the surface flow of rainwater on the ground will be slower than in cleared areas, thereby reducing the velocity and quantity of stormwater drainage. Conversely, where development occurs on forested ridges or where there are numerous roads constructed on forested ridges, the protective tree canopy is lost, the stormwater flow is greater in the cleared areas, groundwater is intercepted by road construction, and increased stormwater drainage results in habitat destruction within streams and the consequent death of aquatic organisms.

As depicted in Figure 3.0.1, when rainwater is intercepted by trees on forested ridges, the rainfall gently penetrates the ground surface and migrates downward through the soil to bedrock. The water then flows through bedrock fractures and along bedding planes to continue migrating downward or to form seeps and springs where the fractures or bedding planes intercept the ground surface. Seeps and springs can occur at various elevations on mountain slopes, depending on where the bedrock fractures or bedding planes intercept the ground surface, and can also occur along streams and rivers. As the quantity of groundwater accumulates beneath the ground surface, a hydraulic gradient forms, causing the groundwater to move downgradient to nearby streams and rivers or to lower areas where the water may reach streams and rivers that are farther away.

Figure 3.0.1 – Forests on ridges facilitate groundwater recharge and reduced stormwater runoff.



SECTION 4.0

GROUNDWATER AND SURFACE WATER ARE ONE INTEGRAL UNIT

In its document, "Sustainability of Ground-Water Resources", the USGS emphasizes that "Groundwater is not a renewable resource". To understand this statement requires an understanding of the global water budget and also an understanding that groundwater and surface water are connected as one integral system. Firstly, the global water budget, or hydrological cycle, consists of precipitation, evaporation, and condensation. It is important to recognize, however, that the hydrological cycle over the ocean (covering approximately three-quarters of the earth) is essentially separate from the hydrological cycle over the continents. Dennis Hartmann, in his book "Global Physical Climatology", provides an excellent summary diagram (Figure 4.0.1) showing the pathways of the hydrological cycle in terms of centimeters per year for the exchange of water. Through time, there has been a delicate balance of the amount of precipitation transferred to the continents from the hydrological cycle over the oceans and the amount of surface water flowing into the ocean. In this slide, the arrow representing the amount of water from the ocean's hydrological cycle indicates that 11 centimeters per year transfers from the ocean to the continent. The arrow showing the runoff from the land surface indicates that 11 centimeters flows back to the ocean from the continent. It is obvious that when groundwater recharge is reduced and streamflow into the oceans is increased, a situation is created where there is no longer a balance: when streamflow to the oceans exceeds the amount of precipitation from the oceans back onto the continents, the water in the continental hydrological cycle is _lost forever_.

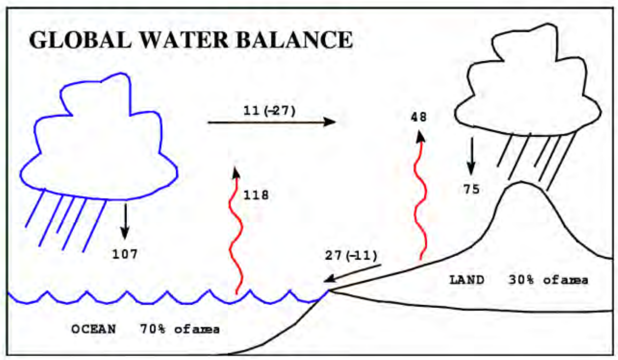


Figure 4.0.1 – Our water resources are finite on our continents. Calculations of the global water balance indicate that water transferred to land from the oceans is balanced by water drainage from land to the oceans. If water drainage to the oceans exceeds the amount of water transferred to land from the oceans, our water resources on land are lost. (Units are in centimeters per year. Diagram by Dennis L. Hartmann, Global Physical Climatology, 1994.)

When precipitation gently reaches the ground surface due to interception by forest trees, the water can penetrate the ground and travel through the bedrock fractures to form seeps and springs at lower elevations. These seeps and springs supply water to wetlands in the headwater areas of first order streams and also provide water directly to streams at lower elevations. During times of low stream water, it is the groundwater that continues the supply of water to the streams. Groundwater from seeps and springs enter the stream from stream banks to maintain aquatic habitats.

Deforestation for construction in the headwater areas of first order high gradient streams reduces the amount of precipitation to recharge groundwater. Compaction of soils for roads and work areas reduces and/or destroys the process of soils to be saturated and to serve as an avenue for groundwater recharge. Blasting for gas pipeline trenches and also for leveling of road and work corridor surfaces destroys or changes the bedrock fractures, compromising the amount of groundwater flow and the direction of groundwater flow to seeps and springs which provide water to wetlands and to streams and rivers.

SECTION 5.0

GEOLOGY AND SOILS OF THE GREENBRIER RIVER AREA WHERE THE GAS PIPELINE ROUTE IS PROPOSED

GEOLOGY

The Greenbrier River at Pence Springs is located in Summers County in the Appalachian Plateau Physiographic Province. The surficial drainage displays a dendritic pattern, and erosional downcutting of the rock by streams has resulted in steep, mountainous terrain with up to 1200 feet of relief. Where the MVP gas pipeline route is proposed to cross the Greenbrier River, the surficial bedrock consists of interbedded, mostly red shale, siltstone, and sandstone, assigned to the Mauch Chunk Group of Mississippian geologic age.

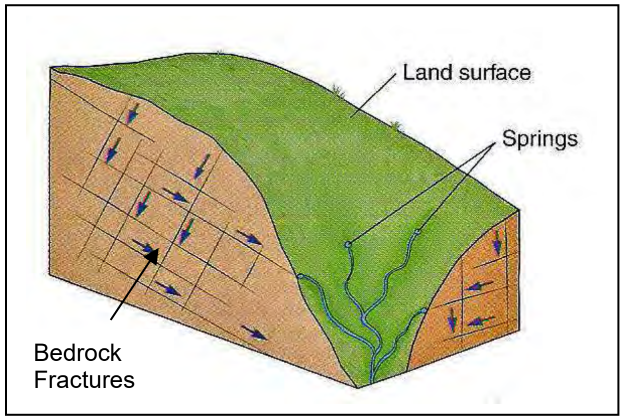
In the abstract, "19 Landslides in West Virginia" (by Peter Lessing and Robert B. Erwin; West Virginia Geological Survey, P.O. Box 879, Morgantown, West Virginia 26505; http://reg.gsapubs.org/content/3/245.abstract), it is stated that landslide-prone areas occur mostly on slopes of 15% to 45% on red shale bedrock. Landslides are, therefore, of great concern where blasting would occur in the areas of the Mauch Chunk Group red shale, siltstone, and sandstone along the proposed MVP work corridor adjacent to the Greenbrier River.

Fractures and partings along fractures occur in the Mauch Chunk Group. The fractures generally occur at angles to the relatively horizontal bedding planes of the shale, siltstone, and sandstone (Figure 5.0.1). Bedrock is also observed in the river bed of the Greenbrier River at the proposed MVP crossing location (Figure 5.0.2). Where bedding planes or fractures in the rock intercept the ground surface, it is common for springs or seeps to occur (Figure 5.0.3).

Figure 5.0.1 – Bedding planes and vertical fractures of the bedrock adjacent to the Greenbrier River near the proposed MVP crossing. Bedrock is also present in the river bed.

Figure 5.0.2 – Bedrock in the river bed of the Greenbrier River where the proposed MVP river crossing is located.

Figure 5.0.3 – Fractures within any rock provide conduits through which groundwater may flow downward or at angles to the ground surface. Where bedding planes of the rock or where fractures in the rock intercept the ground surface, it is common for springs or seeps to occur. Seeps and springs also provide water directly to streams.



Seismic Hazards

In the abstract, "West Virginia Earthquakes: Crustal Adjustments Along The Rome Trough Or Something Else?" (by Ronald R. McDowell, J. Eric Lewis, and Phillip A. Dinterman; West Virginia Geological and Economic Survey, 1 Mont Chateau Road, Morgantown, WV 26508; http://www.wvgs.wvnet.edu/www/presentations/2014/WV-seismic_2014.pdf), it is stated that there have been isolated earthquakes since 1966 which are associated with ancient faults. A map is provided (Figure 5.0.4) showing that most of these earthquakes have occurred in the western part of West Virginia within an area known as the Rome Trough. However, it is evident on the map that several earthquakes have occurred near Pence Springs in Summers County.

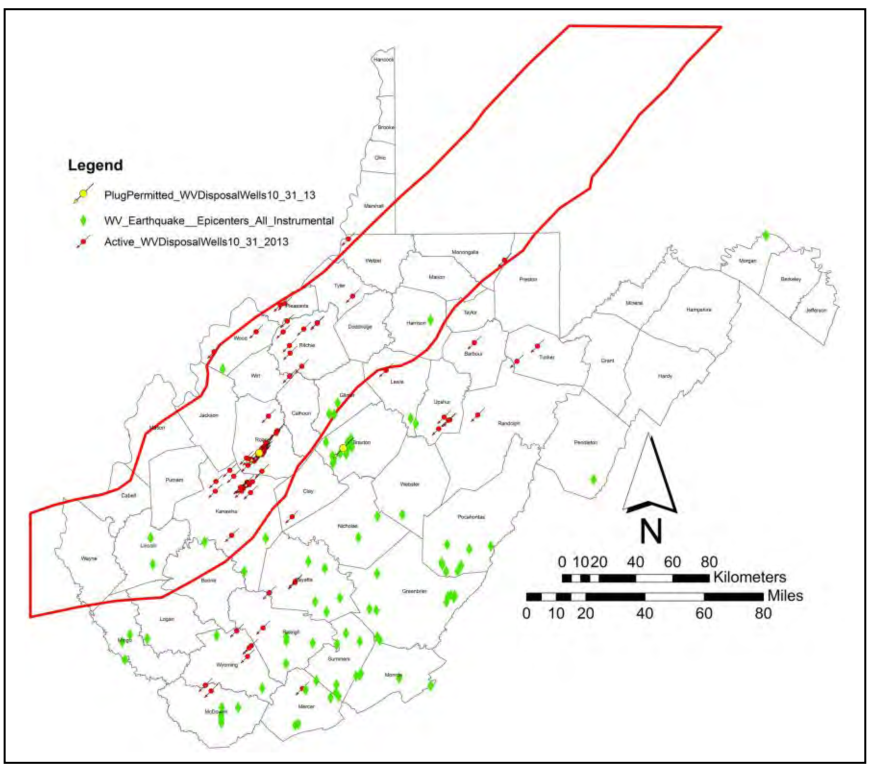


Figure 5.0.4 – WVGES map showing the locations of earthquake epicenters.

The U.S. Geological Survey provides a map, as shown in Figure 5.0.5, which depicts Summers County to be in an area of concern for seismic hazard (http://earthquake.usgs.gov/earthquakes/states/west_virginia/images/westvirginia_haz.jpg).

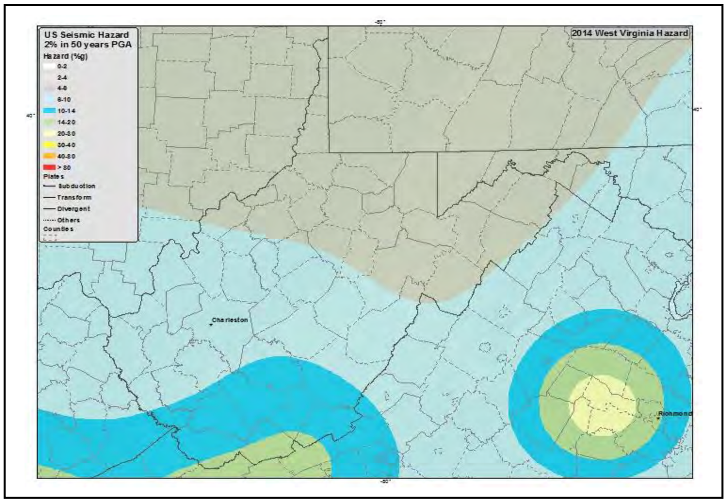


Figure 5.0.5 – USGS 2014 Seismic Hazard map showing zones of concern.

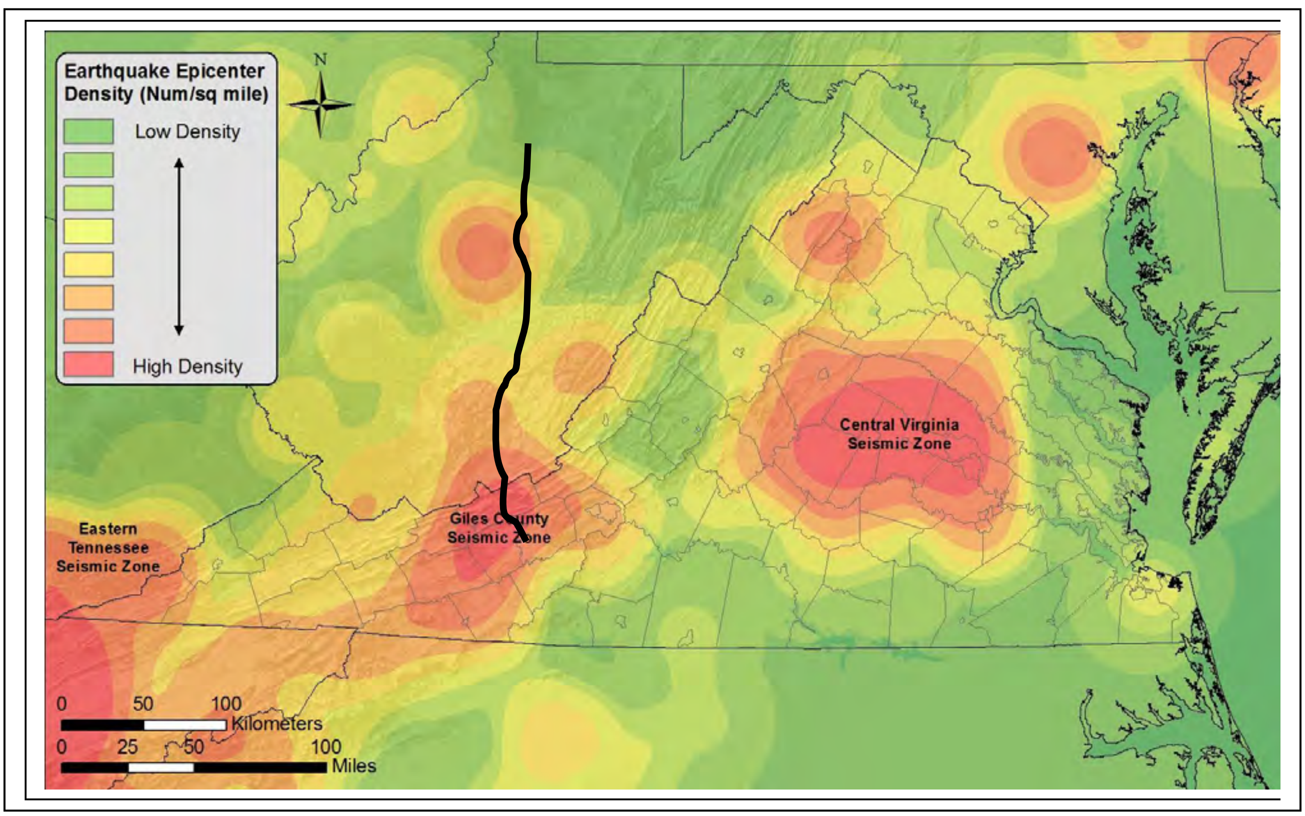


Figure 5.0.6 – Map showing the densities of earthquake epicenters, provided as a color scale indicating the relative densities in numbers per square mile. (Map from https://dmme.virginia.gov/DGMR/EQHazardMapping.shtml).

The Virginia Department of Mines, Minerals, and Energy developed an Earthquake Epicenter Density map (Figure 5.0.6) for areas in VA and WV. Three major earthquake zones are identified. Notice that the Giles County Seismic Zone extends into Monroe and Summers Counties, West Virginia. The black line is the approximate location of the proposed MVP gas pipeline.

SOILS

Specific soils series develop based on the following factors: parent material, topography, climate, living organisms, and time. Soils scientists estimate that a time period greater than 100 years is required for one inch of soil to form (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/soils/?cid=nrcs144p2_036333). Soil is therefore considered to be a non-renewable resource. The soils which would be traversed by the proposed MVP gas pipeline route in the Pence Springs area formed primarily on interbedded shale, siltstone, and sandstone. Soils which are described as “channery” contain “channer”, which are relatively flat rock fragments up to 6 inches in length. Along the proposed MVP gas pipeline route in Summers County, the soils predominantly described as channery, stony, or as having rock ledges or outcrops. Such channery soils will not be suitable as bedding or backfill material around the pipeline because the channers could damage the pipeline.

Soil permeability is a measure of how water can be transported through the soil. Soils in the areas proposed for the MVP Route and access roads exhibit moderate to rapid permeability. Such soils facilitate the downward flow of rainfall penetrating the ground surface to recharge the groundwater and to flow to and through rock fractures that form springs or seeps where the ground surface intercepts the rock fractures. If these essential soils are removed for pipeline construction and/or if blasting is conducted that will alter the system of fractures, the amount of groundwater flow and the direction of groundwater flow will change, such that flow of water to sustain springs and seeps will be destroyed.

Soil erosion is a major concern in the area proposed by MVP for gas pipeline construction. The Soil Survey of Mercer and Summers Counties, West Virginia, by the USDA Soil Conservation Service in cooperation with the WV University Agricultural and Forestry Experiment Station, with fieldwork conducted 1971-1979, published by the National Cooperative Soil, issued July, 1984, provides the interpretation that the land in the Pence Springs area is best suited for forests.

Detailed soil descriptions in the Soil Survey also provide the depths to bedrock for specific soils. Within the proposed MVP construction areas on land adjacent to the Greenbrier River crossing at Pence Springs, the depth to bedrock is mostly 20 to 40 inches (1.7 to 3.3 feet) and the depth to bedrock is 76 inches (6.3 feet) in isolated areas. Blasting will probably be required for all areas less than 10 feet to bedrock in order to provide space for the required pipe bedding material below the pipe and cover material above the pipe.

GROUNDWATER

Table 4.3.1 in the MVP DEIS provides a listing of aquifers crossed by the MVP. This list indicates that the Appalachian Plateau regional aquifer system (USGS, 1997), which flows through Mississippian bedrock (sandstone, shale, and limestone) in Summers County, will be crossed in the Pence Springs area. In "Aquifer-Characteristics Data for West Virginia", by Mark D. Kozar and Melvin V. Mathes (U.S. Geological Survey, prepared in cooperation with the WV Bureau for Public Health, Office of Environmental Health Services, Water Resources Investigation Report 01-4036; 2001; http://pubs.usgs.gov/wri/wri01-4036/pdf/wri014036.pdf), the Mississippian bedrock aquifer system is reported to have relatively high transmissivity rates, meaning that fractures in the shales, siltstones, and sandstones of the Mauch Chunk Group are capable of transferring water from the land surface downward to recharge groundwater. The groundwater flow through rock fractures and bedding planes is described as diffuse flow (White, 1988).

Numerous undocumented springs and seeps occur within the headwater areas of tributaries to the Greenbrier River where the bedrock bedding planes and fractures intercept the ground surface. These smaller springs and seeps are critical to the ecosystems in the headwater areas of first order and second order high gradient streams because they supply the water necessary for the headwater area aquatic species, which comprise the base of the river continuum food chain for the Greenbrier River.

SECTION 6.0

MVP GAS PIPELINE CONSTRUCTION WITHIN THE GREENBRIER RIVER CROSSING AREA

WORK CORRIDOR LEVELING AND DEWATERING

The work corridor north and south of the proposed Greenbrier River crossing is described by MVP as being approximately 125 feet wide. The work corridor will be leveled by deforestation, excavation, and grading (Figure 6.0.1). The MVP DEIS provides a description of trench dewatering procedures: "Trench dewatering may be necessary to inspect the bottom of the trench in areas where water has accumulated. Trench water would be discharged through sediment removal devices in well-vegetated upland areas away from waterbodies and wetlands." On the left side of Figure 6.0.1, a hill has been excavated to its intersection with a ravine. Water can be observed in the trench by the ravine where the pipeline is to be placed. Groundwater from the hillside would also flow toward the ravine and the pipeline trench. However, MVP provides no discussion concerning the interception of groundwater on cut slopes/hillsides.

Figure 6.0.1 – Leveled work corridor for pipeline installation, showing cut hillsides and evident dewatering into the pipeline trench. Heavy equipment and pick-up trucks provide a scale.

PIPELINE TRENCH DESCRIPTION

The trench in the land areas adjacent to the proposed Greenbrier River crossing will be as much as 10 feet deep in order to place the bedding material below the 42-inch pipe and the cover material over the pipe. Trench descriptions in the MVP Resources Report 1 describe that up to 2 feet of cover would be required at the base of the trench where rock is present to prevent the rock from damaging the pipe. There will be approximately 3 feet of cover material. Trench descriptions in the MVP Resources Report 1 describe that up to 2 feet of cover would be required at the base of the trench where rock is present to prevent the rock from damaging the pipe. In the MVP DEIS Table 4.1.1-9 – "Flood Zone and Class of Pipe Crossed by the MVP" provides that at MP 170.4 Summers County (at Pence Springs), the Greenbrier River crossing length is 1841 feet, with a minimum cover depth of 3 feet.

SECTION 7.0

IMPACTS TO WATERBODIES AND WETLANDS FROM THE PROPOSED MVP GAS PIPELINE CONSTRUCTION

DESTRUCTION OF AQUATIC HABITATS

Within the Greenbrier River flood plain at the proposed MVP gas pipeline crossing, there are 2 wetlands identified by MVP: "TTWV-W-76, PFO wetland and W-MM20, PFO wetland". These wetlands will be impacted by the work corridor, an access road, and a work space area. Additionally, there are several wetlands along the proposed MVP work corridor within headwater areas to tributaries to the Greenbrier River within the Big Bend PSD ZCC. Where MVP designated wetlands and intermittent and ephemeral streams in headwater areas are located, it is apparent that groundwater from seeps or springs maintains the hydrology within these locations. Deforestation, soil compaction, and blasting will reduce groundwater flow and reduce the hydraulic head that moves groundwater toward the tributary streams and toward the Greenbrier River. Seeps and springs provide water to tributary streams and to the Greenbrier River during times of drought.

DEGRADATION OF RIVER WATER QUALITY

Within the Greenbrier River, blasting would be necessary to place the proposed gas pipeline where bedrock is encountered in the river bed. The MVP DEIS failed to list Greenbrier River crossing in Table 4.3.2-8 – "Waterbodies Crossed by the MVP in areas of shallow bedrock". Bedrock can be observed in the Greenbrier River where the gas pipeline installation is proposed. The MVP DEIS states that, "In-stream blasting has the potential to injure or kill aquatic organisms, displace organisms during blast-hole drilling operations, and temporarily increase stream turbidity. Additionally, shock waves created by blasting may post a threat to aquatic organisms. Chemical by-products from the blasting materials could also be released and could potentially contaminate the water."

It is stated in the Big Bend PSD Source Water Assessment Report (2003) that turbidity and the biological and chemical health of the surface water in the ZCC are of the greatest concern to the Big Bend PSD. In relation to turbidity, surface runoff is expressed as a critical concern. The proposed MVP gas pipeline construction would cause increased surface runoff. Blasting bedrock in the river bed of the Greenbrier River would result in increased turbidity, death of aquatic organisms, and chemical contamination of the river water due to chemical by-products of the blasting materials.

The MVP DEIS provides the following description of the adverse impacts of sedimentation: "Increased sedimentation and turbidity resulting from in-stream and adjacent construction activities would displace and impact fisheries and aquatic resources. Sedimentation could smother fish eggs and other benthic biota and alter stream bottom characteristics, such as converting sand, gravel, or rock substrate to silt or mud. These habitat alterations could reduce juvenile fish survival, spawning habitat, and benthic community diversity and health. Increased turbidity could also temporarily reduce dissolved oxygen levels in the water column and reduce respiratory functions in stream biota. Turbid conditions could also reduce the ability for biota to find food sources or avoid prey." Additionally, the Greenbrier River is one of the few remaining locations where the Federally listed endangered Clubshell mollusk (*Pleurobema clava*) is able to survive. As a filter feeder, this species is very sensitive to turbidity and sedimentation.

The MVP performed a quantitative modeling assessment for the Greenbrier River crossing at Pence Springs, with a resulting estimate that monthly sediment loads would increase by 19 to 52 percent. However, it is stated in the MVP DEIS that, "Construction and operation of the Projects would likely result in only short-term impacts on water resources... These impacts, such as increased turbidity, would return to baseline levels over a period of days or weeks following construction." The findings provided herein support the conclusion that there would be cumulative adverse impacts resulting from construction of the proposed pipeline within the headwater areas, within the tributaries to the Greenbrier River, and within the Greenbrier River. Increased turbidity results in increased sedimentation in the stream beds, which adversely impacts aquatic habitats. When the turbidity returns to baseline levels, the sediment remains. With increased stormwater discharge from the construction sites, increased stream volumes and velocities cause downstream stream bank erosion, resulting in more sediment accumulation in the stream beds. This cumulative damage to aquatic habitats, through time, will not disappear, but rather, will cause the death of aquatic organisms and will reduce water quality within the Big Bend PSD ZCC. There is no indication from the proposed MVP work description or Best Management Practices (BMPs) that there is any comprehension or consideration of the in-stream aquatic habitats (Figure 2.0.2) that will be destroyed by open trenching. There is no mention of restoring the embeddedness required by aquatic organisms as adequate habitat.

MITIGATION PROPOSED FOR WETLANDS AND STREAMS

The MVP mitigation approach for destroying wetlands and streams is to purchase credits in mitigation banks. All wetlands and first order high gradient streams within a watershed serve to maintain the aquatic ecology within that specific watershed. Simply creating a wetland bank in another watershed will never offset the damage to the watershed where the wetland is destroyed. Where a first order high gradient stream is destroyed, the damage can never be offset by restoring a stream in an entirely different watershed.

SECTION 8.0

CONCLUSIONS

The findings of this report provide evidence that construction of the proposed MVP gas pipeline will result in adverse impacts on the Greenbrier River, its tributaries, headwater areas, wetlands, and groundwater. The adverse impacts would be cumulative.

1) Construction of the proposed MVP gas pipeline will adversely impact headwater aquatic habitats which serve as the base of the food chain for the entire river continuum ecosystem.

Where seeps, springs, and wetlands are adversely impacted in the headwater areas of the Greenbrier River and its tributaries, the effects will continue along the entire river continuum. Impacts to aquatic habitats and organisms at the base of the food chain in the headwater areas would cause negative impacts to successive downriver aquatic organisms.

2) Construction of the proposed MVP gas pipeline will remove soil and compact soil, causing adverse impacts to springs and wetlands and to the hydrologic function of transporting water from the watershed to wetlands and first order stream channels.

Soil microorganisms require soil moisture in order to function in their capacity to 1) fix nitrogen for uptake by plant roots; 2) transform iron and manganese to increase their solubility and availability to higher organisms in the food chain; 3) detoxify sulfur; 4) oxidize organic carbon; and 5) transform phosphorus into soluble reactive phosphorus for uptake by higher organisms in the food chain. Dewatering and compaction of the soil during construction activities for a 125-foot wide work corridor and during trenching activities will destroy the soil microorganisms. Simple replacement of surficial topsoil after construction cannot restore the function of microorganisms in their capacity to provide organic compounds to the higher organisms in the headwater area ecosystem.

Water transport includes surface water flow necessary to create channels, both ephemeral channels in ravines as well as stream channels. It is stated in the MVP Erosion and Sediment Control Plan (E&SCP) for West Virginia counties (February 2016) that the gas pipeline construction requires leveling a 125-foot wide corridor on ridge tops as well as the mountain slopes between the ridges: "Given the ruggedness of the terrain and steep slopes, the full 125-foot construction right-of-way will be necessary in forested areas for the safe construction of the Project. MVP will neck down to a 75-foot construction right-of-way at streams and wetlands wherever possible." When the land above the headwater areas is destroyed by leveling the ground surface, there is destruction of the slopes that would normally provide the sufficient amount of surface water to the ravines and stream channel. By leveling the ground surface, the existing soils which normally become saturated during precipitation events are removed and the remaining soils are compacted. This results in destroying the condition of saturated soils that allow surface water to flow slowly into the headwater areas. Additionally, the storage of water in soils facilitates the creation of hydric soils necessary to establish wetlands. The wetlands provide environments for chemical cycling of nutrients. With removal of soils in the headwater areas and compaction of the subsoil, the stormwater surface flow will increase in velocity, causing erosion within the stream bed and along the stream banks. The resulting erosion will cause deposition of silt and clay within the pebbles and cobbles, destroying the aquatic habitats of the microbes and insect larvae. Additionally, trenching for the gas pipeline installation provides conduits which remove and lower the groundwater. When the groundwater is diverted into ditches, it is transported away as surface water and the groundwater table is lowered. The depletion of groundwater reduces the hydraulic head necessary to supply groundwater to downgradient seeps and springs in headwater areas and also along streams. Therefore, the reduction of groundwater recharge caused by deforestation, soil removal, and soil compaction removes the capacity for groundwater to supply water to the first order streams during drought conditions (baseflow), with the consequent death of aquatic organisms. The depletion and redirection of groundwater along the pipeline trench, as well as changes in the direction of groundwater movement caused by blasting, destroys springs, seeps, and wetlands in the headwater areas of first order streams.

3) Construction of the proposed MVP gas pipeline will adversely impact the hydraulic function of transporting water in ephemeral channels in ravines, in the channel, and through the sediments.

Water within an ephemeral channel or in a stream will determine the existence of aquatic habitats within the sediments and will interact with groundwater in the sediments of the stream bed and stream banks. The flow of water determines the size and amount of sediments that are deposited. Where the water velocity is great enough to move silt and sand away from areas of pebbles and cobbles, aquatic habitats are created for microbes and insect larvae which break down organic matter to provide food for larger aquatic species. Stream water velocities great enough to move pebbles and cobbles will obviously also result in the destruction of the aquatic habitats. Additionally, the velocity of the stream water controls the spacing and depth of stepped pools in the stream bed. The typical deep pools that form within the first order high gradient streams provide aquatic habitats for juvenile fish to live. In the MVP DEIS, the widths of access road easements are shown as 40 feet. In order to construct a flat roadbed, fill material will be required for construction, indicating wide embankment areas associated with the roadbeds. In the narrow ravines within first order stream tributaries to the Greenbrier River, the embankment area would extend into the stream beds if mountain slopes adjacent to the streams are not excavated/blasted to provide the necessary road widths. Therefore, either the streams will be directly impacted, or the seeps and springs in the adjacent mountain slope will be impacted, thereby reducing the flow of groundwater to the streams. The access roads are located not only in headwater areas, but also in the floodplains adjacent to the Greenbrier River at Pence Springs.

4) Deforestation for construction of the proposed MVP gas pipeline will adversely impact the geomorphologic function of conserving water in the ecosystem as well as transporting wood and sediment to create diverse bed forms and dynamic equilibrium.

Pipeline construction requires deforestation within an area at least 125 feet wide. The relatively dense tree canopy in the headwater areas intercepts rainfall so that it gently penetrates the ground as groundwater rather than flowing overland as runoff. This means that 1) the rain will gently fall to the ground and recharge groundwater and 2) the surface flow of rainwater on the ground will be slower than in cleared areas, thereby reducing the velocity and quantity of stormwater drainage. Woody debris in the forested headwater areas constitutes an important contribution to first order streams because the small woody debris provides particulate organic matter and the large woody debris, when transported to the stream bed, provides protected areas for aquatic organisms and also helps create the stepped pools needed by juvenile fish. MVP states in its E&SCP that the permanent ROW will be 50 feet wide and that "Future land use will be a maintained vegetated natural gas pipeline ROW." (page 3, E&SCP). The disturbed ROW will, therefore, not provide the function of the original forested area. Also, the soil compaction in the remainder of the 125-foot will not facilitate growth of the original forested area. Therefore, the proposed MVP gas pipeline construction on forested ridge-tops will adversely impact the geomorphologic function of the forested ridges.

5) Construction of the proposed MVP gas pipeline will adversely impact the physicochemical functions of temperature oxygen regulation, and also the processing of organic matter and nutrients.

The deforestation required for pipeline construction will also adversely impact the function of the relatively dense tree canopy that provides filtered light and relatively cooler, regulated temperatures. Aquatic organisms in the headwater areas and upper reaches of the first order stream channels require the filtered light and cooler, regulated temperatures in order to survive. The deep, stepped pools of stream water must provide the cooler temperatures required for certain aquatic organisms to survive.

6) Construction of the proposed MVP gas pipeline on ridge-tops will adversely impact biological functions of biodiversity and life cycles of aquatic and riparian life.

The ecology of the entire watershed is embraced in the river continuum concept, starting at the headwaters of first order high gradient streams and continuing downstream with changes of predominant benthic aquatic organisms along the river continuum. Shredders, predominant in the forested headwaters, break down organic matter used downstream by collectors and filter-feeders. The filter-feeders are subsequently consumed by larger benthos and fish farther downstream. The downstream healthy fish populations can only exist with specific water velocities, stream bed forms, temperature, and water chemistry.

Ecological systems of first and second order high gradient streams are described in detail in the "Functional Assessment Approach for High Gradient Streams, West Virginia", written for the U.S. Army Corps of Engineers (USACE) by the U.S. Fish and Wildlife Service (USFWS) June 2007, published by the USACE (http://training.fws.gov/courses/csp/csp3112/resources/Wetland_Assessment_Methodologies/FunctionalAssessment-HighGradientStreams.pdf) and "A Function-Based Framework for Stream Assessment and Restoration Projects", by Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller; 2012; U..S Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC EPA 843-K-12-006. (https://www.fws.gov/chesapeakebay/StreamReports/Stream%20Functions%20Framework/Final%20Stream%20Functions%20Pyramid%20Doc_9-12-12.pdf)

7) The proposed MVP mitigation approach for wetlands and streams is deficient.

The MVP mitigation approach does not incorporate an understanding of the importance of headwater areas that supply surface and groundwater to the headwater streams and wetlands. Additionally, the MVP mitigation approach does not recognize the importance of headwater aquatic organisms as being the base of the food chain in the river continuum. Purchasing mitigation credits in areas outside of the actual watersheds for first order high gradient streams will not compensate for the cumulative damage to the specific watershed impacted or to the receiving water bodies downstream.

8) Construction of the proposed MVP gas pipeline will require deforestation and blasting, both of which will reduce groundwater recharge and cause significant changes to the amount of groundwater available as a drinking water source, as well as to groundwater flow routes.

Groundwater flows along bedrock bedding planes and fractures, forming seeps and springs where the bedding planes and fractures intercept the ground surface. The seeps and springs also occur within streams and along stream banks, providing water to streams during drought conditions. Deforestation results in reduced groundwater recharge, with the consequent decreased availability of groundwater. Blasting causes changes in the bedrock fractures, resulting in changes in the direction of groundwater flow. Consequently, seeps and springs will not receive the groundwater that was available prior to construction.

9) Construction of the proposed MVP gas pipeline will cause increased stormwater discharge and increased turbidity and sedimentation.

Increased stormwater discharge causes downstream stream bank erosion, introducing sediment into the streams. Increased amounts of silt and sand in the stream are deposited in openings between cobbles and pebbles, destroying the aquatic habitats and protective areas for minnows and juvenile fish. Blasting to remove bedrock at the proposed MVP crossing will introduce sediment and harmful chemicals to the water, impacting the water supply intake located less than 2 miles downstream.

10) Construction of the proposed MVP gas pipeline will result in landslides on the pervasive steep slopes underlain by the Mauch Chunk red shale bedrock.

The West Virginia Geological and Economic Survey has provided documentation that landslides occur on steep slopes where the underlying bedrock is red shale. The Mauch Chunk red shale bedrock is the predominant unit in the area of Pence Springs where the MVP crossing of the Greenbrier River is proposed. Regardless of best management practices, erosion and landslides will occur within these areas.

11) The proposed MVP construction zone is within areas of earthquake concern.

Earthquakes have occurred in the Pence Springs area. Earthquakes not only cause ground shaking, which assists in causing landslides, but also causes the soil to behave as a fluid. When this happens, the soil loses its integrity and supportive capability, such that the pipeline would not be supported and could collapse due to lack of support.

12) Construction of the Proposed MVP Gas Pipeline Will Cause Cumulative Damage.

The Council on Environmental Quality (CEQ) regulations that implement the National Environmental Policy Act define cumulative effects as “the impact on the environment which results from the incremental consequences of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions” (40 CFR § 1508.7). Cumulative effects include both direct and indirect, or induced, effects that would result from the Project, as well as the effects from other projects (past, present, and reasonably foreseeable future actions) not related to or caused by the Project. Cumulative impacts may result when the environmental effects associated with a Project are added to temporary (construction-related) or permanent (operations-related) impacts associated with other past, present, or reasonably foreseeable future projects. Although the individual impact of each separate project might not be significant, the additive or synergistic effects of multiple projects could be significant. The cumulative effects analysis evaluates the magnitude of cumulative effects on natural resources such as wetlands, water quality, floodplains, and threatened and endangered species, as well as cumulative effects on land use, socioeconomics, air quality, noise, and cultural resources. The CEQ regulations (40 CFR § 1508.8) also require that the cumulative effects analysis consider the indirect effects which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.

The cumulative damage that would result from construction of the proposed MVP gas pipeline is inconsistent with the protection of West Virginia water resources and is in violation of the West Virginia Water Resources Protection Act (WV Code §22-26-1) et seq., which was enacted to determine the quantity of water resources in West Virginia. By enacting this statute, the Legislature provided for claiming and protecting state waters for the use and benefit of its citizens; evaluating the nature and extent of its water resources; and identifying activities that impede the beneficial uses of the resource ("West Virginia Water Resources Management Plan", Water Use Section, West Virginia Department of Environmental Protection, November 2013; http://www.dep.wv.gov/WWE/wateruse/WVWaterPlan/Documents/WV_WRMP.pdf).

In the MVP DEIS, it is recognized that there will be cumulative impacts. However, these impacts are dismissed as insignificant because of the proposed mitigation and because the project is within a "narrow" corridor. There is no acknowledgement that the corridor, access roads, and work spaces are within areas that are environmentally critical to maintaining surface water and groundwater resources and to maintaining the functions of the river continuum.

It is stated in the MVP DEIS that, "Construction and operation of the Projects would likely result in only short-term impacts on water resources... These impacts, such as increased turbidity, would return to baseline levels over a period of days or weeks following construction." The findings provided herein support the conclusion that there would be cumulative adverse impacts resulting from construction of the proposed pipeline within the Greenbrier River and its associated headwater areas and tributaries. Increased turbidity results in increased sedimentation in the stream beds, which adversely impacts aquatic habitats. When the turbidity returns to baseline levels, the sediment remains. With increased stormwater discharge from the construction sites, increased stream volumes and velocities cause downstream stream bank erosion, resulting in more sediment accumulation in the stream beds. This cumulative damage to aquatic habitats, through time, will not disappear, but rather, will cause the death of aquatic organisms and will reduce water quality.

The findings of this report support the conclusion that there would be significant environmental destruction and degradation within the Greenbrier River if the MVP pipeline were to be constructed.

SECTION 9.0

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Curriculum vitae for

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My education includes a bachelor's degree in Geology and a doctoral degree in Marine Science (specializing in Marine Geology), both from the College of William and Mary in Williamsburg, VA. I have a Credential in Ground Water Science from Ohio State University and I am a Licensed Professional Geologist. I have held teaching positions at the high school level and at the college level, and have provided geology and hydrogeology presentations, workshops, and classes to state and federal environmental employees, to participants in the Regional Conference in Cumberland, MD for the American Planning Association, and to participants in the WV Master Naturalist classes. I have served as an expert witness in hydrogeology before West Virginia government agencies.

As a Hydrogeological Consultant (2000 – Present), I have conducted hydrogeological investigations, provided hydrogeological assessment reports, served as an expert witness in hydrogeology before the West Virginia Public Service Commission in three cases and before the West Virginia Environmental Quality Board in one case, and provided numerous presentations and workshops in hydrogeology to state and federal environmental employees (including USFWS and WV FEMA Managers), participants in the Regional Conference in Cumberland, MD for the American Planning Association, participants at civic and landowner meetings, and participants in the WV Master Naturalist classes.

As a Senior Geologist for the Virginia Department of Environmental Quality (1997-1999), I determined direction of groundwater flow and the pollution impacts to surface water and groundwater at petroleum release sites and evaluated corrective actions conducted where petroleum releases occurred. At sites where the Commonwealth of Virginia assumed responsibility for the pollution release investigation and corrective action implementation, I managed the site investigations for the Southwest Regional Office of the Virginia Department of Environmental Quality (DEQ). This included project oversight from contract initiation through closure.

As a Senior Geologist and Project Manager for the Environmental Department at S&ME, Inc. (Blountville, TN, 1992-1997), I conducted geology and groundwater investigations. I supervised technicians, drill crews, geologists, and subcontractors. The investigations were conducted in order to obtain permits for landfill sites and to satisfy regulatory requirements for corrective actions at petroleum release sites. My duties also included conducting geophysical investigations using seismic, electrical resistivity, and ground penetrating radar techniques. I conducted numerous environmental assessments for real estate transactions. I also conducted wetlands delineations and preparation of wetlands mitigation permits.

As the District Geologist for the Virginia Department of Transportation (1985-1992), my job duties included obtaining and interpreting geologic data from fieldwork and review of drilling information in order to provide foundation recommendations for bridge and road construction. My duties included supervision of the drill crew and design of asphalt and concrete pavements for highway projects. Accomplishments included preliminary foundation investigations for interstate bridges and successful cleanup of leaking underground gasoline storage tanks and site closures at numerous VDOT facilities.

While earning my doctoral degree at the College of William and Mary, I worked as a graduate assistant on several grant-funded projects. My work duties included measuring tidal current velocities and tidal fluctuations at tidal inlets; land surveying to determine the geometry and morphology of numerous tidal inlets; determining pollution susceptibilities of drainage basins using data from surface water flow parameters, hydrographs, and chemical analyses; developing a predictive model for shoreline erosion during hurricanes based on calculations of wave bottom orbital velocities resulting from various wind velocities and directions; performing sediment size and water quality analyses on samples from the Chesapeake Bay and James River; conducting multivariate statistical analyses for validation of sediment laboratory quality control measures; reconnaissance mapping of surficial geologic materials in Virginia, North Carolina, and Utah for publication of USGS Quaternary geologic maps; teaching Introductory Geology laboratory classes at the College of William and Mary; and serving as a Sea Grant intern in the Department of Commerce and Resources, Virginia.

EDUCATION:

College of William and Mary
Williamsburg, VA 23185
Ph.D., 1984
Major: Marine Science (Marine Geology)

College of William and Mary
Williamsburg, VA 23185
B.A., 1972
Major: Geology

Flint Hill Preparatory
Fairfax, VA
High School Diploma, 1968

JOB-RELATED TRAINING COURSES:

2007: Certified Volunteer Stream Monitor, West Virginia (Dept. of Environmental Protection)
2006: Certified Master Naturalist, West Virginia (Dept. of Natural Resources)
1996: Karst Hydrology, Western Kentucky University
1996: Global Positioning Systems (GPS) for Geographic Information Systems (GIS) applications, seminar conducted by Duncan-Parnell/Trimble
1995: Safe Drinking Water Teleconference, sponsored by the American Water Works Association
1992-1998: OSHA Hazardous Waste Site Supervisor training with annual updates
1990: Credential in Ground Water Science, Ohio State University

JOB-RELATED LICENSE:

Licensed Professional Geologist: TN #2529

PROFESSIONAL ORGANIZATIONS

West Virginia Academy of Sciences

National Speleological Society