HYDROGEOLOGICAL ASSESSMENT OF THE MOUNTAIN VALLEY PIPELINE APPLICATION TO THE VIRGINIA MARINE RESOURCES COMMISSION

Prepared for **Preserve Bent Mountain**
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SUMMARY STATEMENT

Mountain Valley Pipeline (MVP) Joint Permit Application #17-1609 has been submitted to the Virginia Marine Resources Commission for authorization "to install a natural gas pipeline beneath the bed of 18 streams and/or rivers with drainage areas greater than 5 square miles, which are considered to be State-owned subaqueous bottomlands of the Commonwealth along the designed pipeline corridor in Giles, Montgomery, Franklin, Roanoke and Pittsylvania Counties for the Mountain Valley Project (MVP)" (excerpted from the Public Notice, Revision 3, in The Roanoke Times). Streams referenced as "Desktop Identified", which were not subject to field study, have simply been removed from review. "Desktop Identified" included ephemeral, intermittent, and perennial streams; however, these streams are totally excluded from VMRC consideration.

In accordance with the Subaqueous Guidelines promulgated in the Constitution of Virginia Article XI Section 1, the Virginia Marine Resources Commission (VMRC) is tasked with evaluating permits for projects that could adversely impact "navigable-in-fact" perennial streams, assumed to be those with a drainage basin of greater than 5 square miles or a mean annual flow greater than 5 cubic feet per second. Additionally, the VRMC must assume jurisdiction over streams to be "non-navigable-in-fact… unless the landowner could show a grant prior to 1792 in that part of the state draining to the Atlantic Ocean, or prior to 1802 in that part of the State draining toward the Gulf of Mexico." The VMRC must specifically evaluate the potential for adverse impacts to instream beneficial uses, defined in the Code of Virginia §62.1-10 as "… the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values."

Adhering to the Subaqueous Guidelines, the VMRC evaluates permit applications for submarine crossings 1) to insure protection of aquatic resources; 2) to insure that all backfill material serves to restore the depth, pre-existing contours, and natural condition of the original bottom; 3) to insure that any material dredged (such as dry-crossing pipeline trenching construction activities) and placed in adjacent upland areas will not encroach into natural drainage ways; and 4) to insure that any material dredged (such as dry-crossing pipeline trenching construction activities) will not pollute adjacent or nearby underground water supplies. In accordance with the Subaqueous Guidelines, the VMRC must include in its consideration of any permit the effect of the proposed project upon "fisheries resources, wetlands, adjacent or nearby properties; … and water quality".

The proposed MVP stream crossings would result in adverse impacts to aquatic habitats and water quality because:

1) MVP has underestimated the number of proposed stream crossings that will result in permanent adverse impacts to aquatic habitats. In the MVP Draft Environmental Impact Statement (DEIS) and Final Environmental Impact Statement (FEIS) developed for the Federal Regulatory Energy Commission (FERC), MVP provided a list of proposed stream crossings in which there would be "Permanent Acreage Impact", the number of which exceeds that listed under "Permanent Access Road Impact". However, the MVP VMRC application only references streams impacted by permanent access roads, even though streams with permanent adverse impacts from the additional proposed MVP construction are within the same watersheds as those listed for permanent impacts from access roads. Also, it should be noted that the Public Notice indicates 18 crossings; however, Appendix H of the MVP application to VMRC lists 19 crossings. Cumulative permanent degradation of aquatic habitats would result from the MVP proposed crossings of 537 wetlands and streams.

2) MVP has not thoroughly evaluated the cumulative impacts to streams in watersheds where proposed MVP construction will impact more than one tributary stream within the watershed. MVP listed streams separately in watersheds where intermittent, ephemeral, and/or perennial streams are actually unnamed tributaries to the receiving stream within the delineated watershed. Impacts to tributary streams result in cumulative impacts to the receiving stream.

3) MVP has overestimated the effectiveness of Best Management Practices (BMPs) proposed for use during MVP construction, stating that there would be no impacts where BMPs are used. However, the BMPs proposed for use during the MVP construction are not capable of preventing sediment from entering streams. The sediment entering streams from the proposed MVP construction will result in increased turbidity of the stream water, which would reduce the water quality, and would result in embeddedness of the stream bottom, thereby degrading aquatic habitats for benthic organisms and for juvenile fish protection areas.

4) MVP has not provided any explanation of how to re-establish stream bottom conditions in order to provide the pre-existing stream bottom conditions. Such conditions must provide open spaces among gravel and cobble sized sediments. The increased turbidity and sedimentation from the construction areas will cause continued embeddedness because the BMPs are not capable of preventing 100 percent of the sediment from reaching the streams. The MVP proposed use of rip-rap stabilization at culvert installations in streams precludes providing pre-existing stream bottom conditions.

5) The stormwater discharge calculations provided to the Virginia Department of Environmental Quality (VDEQ) are deficient because only small portions of the watersheds, located upgradient of the proposed construction areas, were used

for stormwater discharge to streams. The small portions of watersheds used in the stormwater discharge calculations were not inclusive of the receiving stream, but rather, ended at the proposed construction site perimeter. Therefore, the stormwater discharge calculations presented by MVP to VDEQ in their Stormwater Management Plan and Erosion and Sediment Control Plan are not representative of the actual increased stormwater discharge that would result from the proposed MVP construction. The increased stormwater discharge from the completed construction site would result in continual increase of stream bank erosion, causing continued embeddedness.

6) Where stream bed material is disturbed or removed from the streams, there is the potential for pesticides and chemicals that accumulated at depth, and were subsequently covered by clean sediment, to be released to the water column and to be placed in upland areas where erosion will allow these pollutants to re-enter the stream water. Pesticides and chemicals would have adverse impacts on the aquatic habitats as well as to groundwater, where leaching could cause pollution to migrate downward through sediments to contaminate groundwater.

7) Portions of the proposed MVP construction are located in recognized seismic zones with recent earthquakes and landslides. Landslides release sediment to streams. Earthquakes are known to cause liquefaction of sediments, which are typically found at streams and rivers. Liquefaction causes the sediments to lose integrity, thus becoming unsupportive where the proposed gas pipeline would be located. This creates a condition of pipeline failure where the sediments collapse, potentially releasing radon and lead portions of the pipeline gas.

1.0 MVP UNDERESTIMATED THE NUMBER OF STREAM CROSSINGS THAT WILL PERMANENTLY IMPACT AQUATIC HABITATS

MVP has underestimated the number of proposed stream crossings that will result in permanent adverse impacts to aquatic habitats. In the MVP Final Environmental Impact Statement (FEIS) developed for the Federal Regulatory Energy Commission (FERC), MVP provided a list of proposed stream crossings in which there would be “Permanent Acreage Impact”, the number of which exceeds that listed under “Permanent Access Road Impact”. There are streams identified by MVP under “Permanent Acreage Impact” that cross portions of the same streams listed under “Permanent Access Road Impact” that are not listed as crossings. There are cumulative adverse impacts to streams crossed more than one time. By eliminating the proposed MVP work corridor crossings of the same stream crossed by a proposed MVP access road, MVP has underestimated the number of stream crossings and has also underestimated the adverse impacts. Additionally, it should be noted that the Public Notice indicates 18 crossings; however, Appendix H of the MVP application to VMRC lists 19 crossings.

1.1 EXAMPLE 1: Aquatic Impacts Will Result from Proposed MVP Work Corridor Stream Crossings and Wetland Crossings in addition to Proposed Access Road Crossings in the Kimballton Branch Watershed, Giles County

In Appendix F of the MVP FEIS, Table F1 provides a listing of "Waterbodies Crossed by the Mountain Valley Project". In Giles, Craig, Montgomery, Franklin, Roanoke, and Pittsylvania counties, 294 stream crossings are listed as having "Permanent Acreage Impact" and 33 stream crossings are listed as having "Permanent Access Road Impact".

MVP notes that only the streams with watersheds at least 5 square miles in size will be considered for VMRC jurisdiction. However, MVP has not included all the stream crossings within each specific watershed that is at least 5 square miles in size. As an example, the Stony Creek watershed in Giles County is greater than 5 square miles in size and is, therefore, under the VRMC jurisdiction. Because Kimballton Branch is a tributary to Stony Creek, MVP has included it as being within VRMC jurisdiction.

In the MVP application to VMRC, Table 4 "Proposed Stream Mitigation" lists MVP identified streams S-PP14 and S-PP15 as being crossed by access road MVP-GI-232. These two streams are unnamed tributaries to Kimballton Branch. Field sheets and subwatershed delineations are provided for S-PP14 (**Figure 1.1-1**) and S-PP15 (**Figure 1.1-2**) in MVP Standard JPA-NWP12 Pre-Construction Notification, Virginia, Attachment H-2: Wetlands and Waterbodies Impact Analysis and Compensatory Mitigation Plan.

The delineations for S-PP14 and S-PP15 are depicted as 193.6722 acres and 190.3249 acres, respectively. Both S-PP14 and S-PP15 are first order high gradient streams and are unnamed tributaries to Kimballton Branch. A watershed can refer to the overall system of streams that drain into a river, such as the Stony Creek watershed which is greater than 5 square miles (3,200 acres) in size, 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. First order high gradient tributaries form in headwater areas at the highest elevations in watersheds. Because of the impacts of construction on the functions of headwater areas in the watersheds of upland 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 1) the basis of water quality and aquatic habitat quality within the overall watershed, and 2) the base of the aquatic food chain for the overall watershed.

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 upland 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 in size, to evaluate the impact of construction projects. Such watersheds are considered as subwatersheds within an overall watershed. Using the Kimballton Branch example, Kimballton Branch is a subwatershed of Stony Creek and S-PP14 is a subwatershed of Kimballton Branch.

In Chapter 4 of the DEQ Virginia Stormwater Management Handbook (2013), it is stated in section "4.5.1.5 Increased Imperviousness of the Land Surface" that:

> "Impervious cover has emerged as a measurable, integrating concept used to describe the overall health or, conversely, degradation of a watershed. Research has established that when impervious cover in a watershed reaches between 10 and 25 percent …, ecological stress becomes apparent (Schueler et al., 2009). Beyond 25 percent impervious cover, stream stability is reduced, habitat is lost, water quality is degraded, and biological diversity is diminished."

MVP has not adequately evaluated the increase in impervious areas resulting from the proposed construction and has not adequately evaluated the cumulative impacts of increased stormwater discharge to streams within watersheds that would be impacted by the proposed MVP construction.

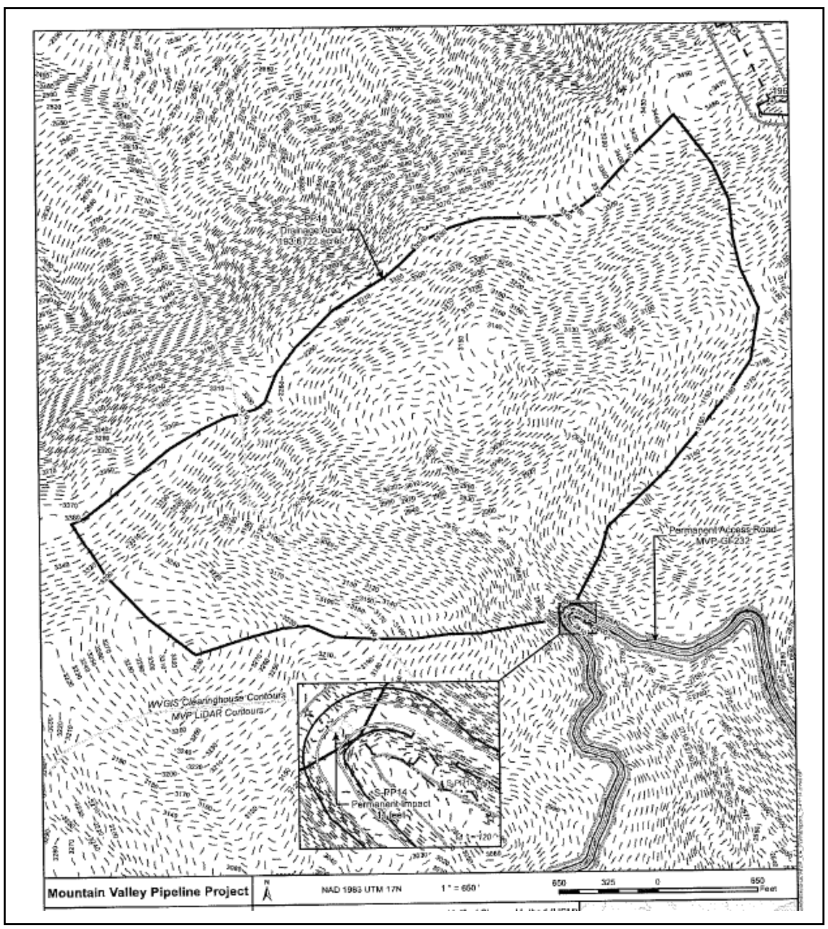


Figure 1.1-1 – MVP subwatershed delineation of S-PP14, depicting the crossing of an unnamed tributary to Kimballton Branch by proposed MVP access road MVP-GI-232. (Excerpted from MVP Standard JPA-NWP12 Pre-Construction Notification, Virginia, Attachment H-2: Wetlands and Waterbodies Impact Analysis and Compensatory Mitigation Plan).

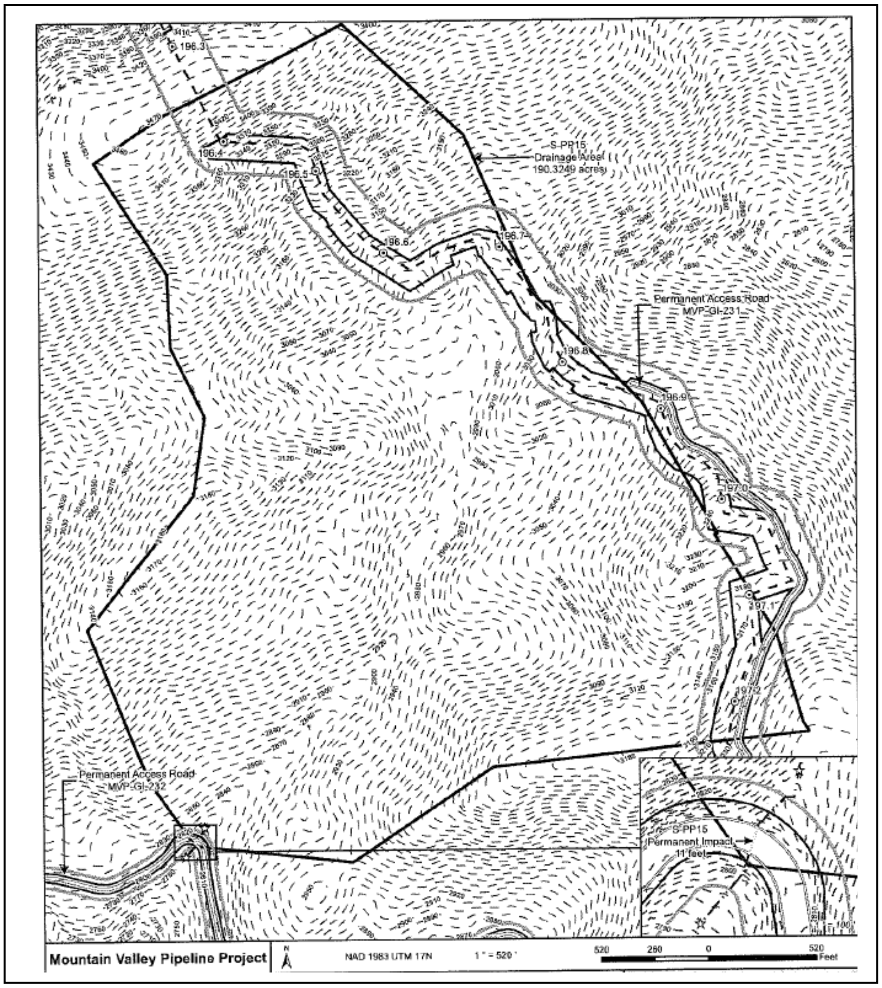


Figure 1.1-2 – MVP subwatershed delineation of S-PP15, depicting the crossing of an unnamed tributary to Kimballton Branch by proposed MVP access road MVP-GI-232. (Excerpted from MVP Standard JPA-NWP12 Pre-Construction Notification, Virginia, Attachment H-2: Wetlands and Waterbodies Impact Analysis and Compensatory Mitigation Plan).

The subwatershed for S-PP14 is adjacent to the subwatershed for S-PP15. The subwatershed for S-PP15 depicts the location of the proposed MVP work corridor as well as the location of the MVP proposed access road MVP-GI-232. Stream S-SS3 and wetland W-KL14 are also listed by MVP as located in the Kimballton Branch watershed. However, these crossings are not included by MVP. Stream S-SS3 and wetland W-KL14 are located in the subwatershed for S-PP15 along the proposed MVP work corridor (**Figure 1.1-3**). The delineated subwatersheds in **Figure 1.1-3** are for the first order stream tributaries to Kimballton Branch. Another unidentified unnamed stream tributary is also crossed by the proposed MVP access road MVP-GI-232 at MVP Mile Post 300. However, this stream crossing is not noted by MVP in MVP Standard JPA-NWP12 Pre-Construction Notification, Virginia, Attachment H-2: Wetlands and Waterbodies Impact Analysis and Compensatory Mitigation Plan.

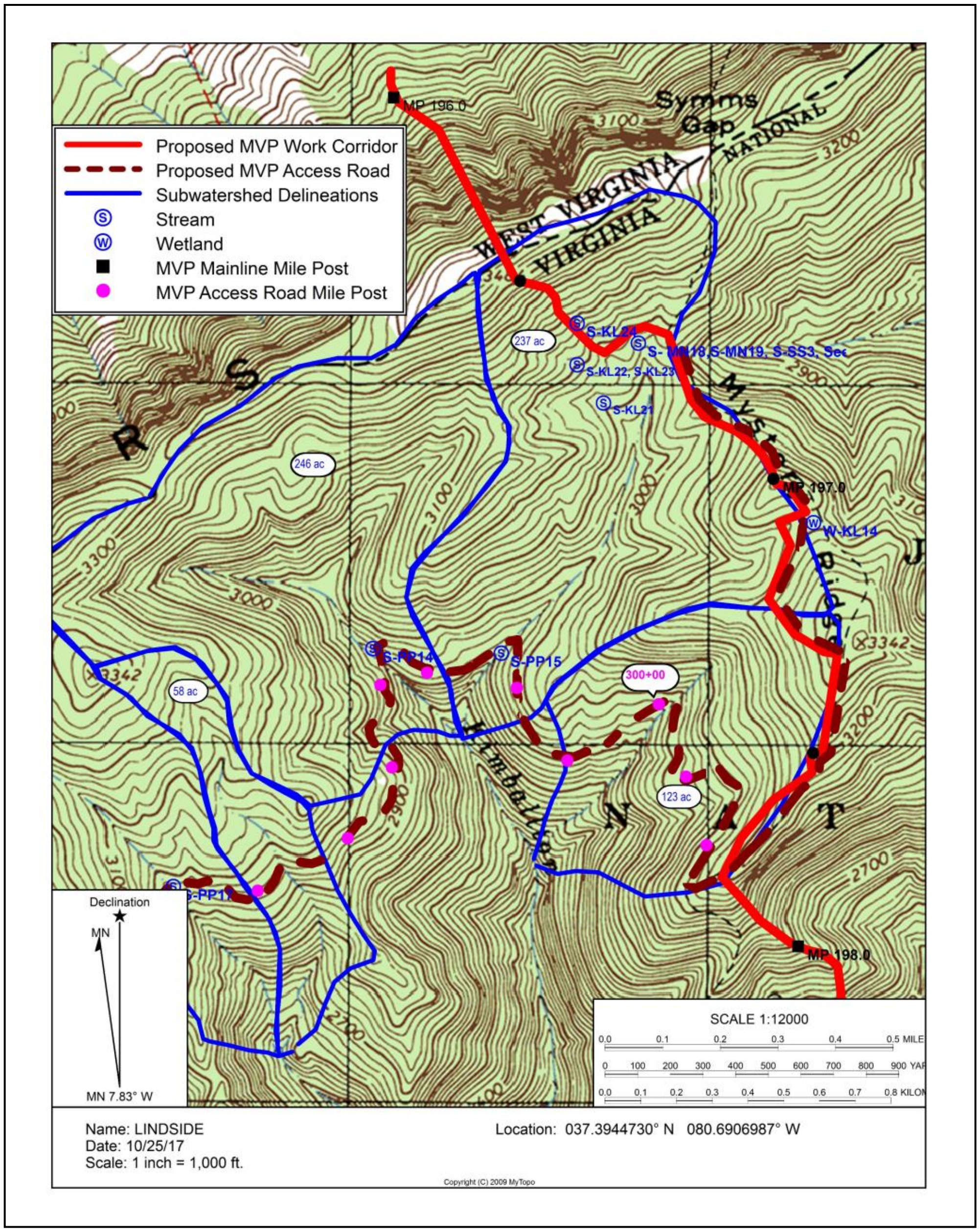


Figure 1.1-3 – Topographic map depicting the subwatershed delineations of unnamed tributaries to Kimballton Branch. (Map developed by P.C. Dodds, Ph.D., using Terrain Navigator Pro software. Delineated subwatersheds differ in acreage from the MVP subwatersheds because the MVP only delineated partial subwatersheds ending at the proposed limit of construction for the access road.)

Table 1.1-1 provides the stream information provided by MVP in the FEIS and in the MVP Aquatic Resource Report for US National Forest Service (National Forest) Lands, Monroe County, West Virginia; Giles and Montgomery Counties, Virginia (June 2017). Not all of the information for stream crossings within the Kiballton Branch watershed has been included in the VMRC application.

Table 1.1-1 – Locations and descriptions of high gradient first order streams listed by MVP in FEIS Appendix F1 and MVP Aquatic Resource Report for US National Forest Service (National Forest) Lands, Monroe County, West Virginia; Giles and Montgomery Counties, Virginia (June 2017). The listed streams and wetlands are those designated by MVP for proposed crossing or close to the limits of disturbance. The associated field sheets provided by MVP include information about seeps, springs, and ephemeral or intermittent sources of water in the headwater areas of the high gradient first order streams.

Specific Subwatershed Location	**Acres in Subwatersheds Delineated**	**Description**
Kimballton Branch Subwatershed Access Road MVP-GI-232 MP 250+00 to MP 272+00	246 acres	MVP identifies the uppermost first order stream segment of Kimballton Branch as S-PP14, described as a perennial stream. This stream is a high gradient first order stream with a headwater area near the apex of Peters Mountain. MVP states that 50 lineal feet of stream S-PP14 would crossed by the proposed access road MVP-GI-232.
Kimballton Branch Subwatershed Access Road MVP-GI-232 MP 272+00 to MP 285+00 AND Mainline Work Corridor between MP 196.5 and MP 196.7	237 acres	MVP identifies this stream as an unnamed tributary to Kimballton Branch, with the lower portion identified as S-PP15, which would be crossed by the MVP Pocahontas access road at Station 278+00. Stream S-PP15 is a high gradient first order stream. MVP identifies the following additional streams that are in the headwater areas of stream S-PP15 and that would be crossed by the proposed MVP work corridor: S-KL24, an intermittent stream that would be crossed at MP196.5; S-KL21, an intermittent stream that would be crossed at MP 196.6; S-KL22, a perennial stream that would be crossed at MP 196.6, S-KL23, a perennial stream that would be crossed at MP 196.6; S-SS3, an intermittent stream that would be crossed at MP 196.7; S-MN18, an intermittent stream that would be crossed at MP 196.7; and S-MN19, an intermittent stream that would be crossed at MP 196.7. MVP states that 15 lineal feet of stream S-PP15, 31 feet of stream S-MN18, and 38 feet of stream S-MN19 would crossed by the proposed access road MVP-GI-232. Wetland, W-KL14, in the uppermost headwater areas of this watershed, would be crossed by the MVP mainline work corridor at MP 197.1, with permanent impacts. Wetland W-KL14 is a PEM wetland, with HGM classification as Slope, kept moist by groundwater recharge.
Kimballton Branch Subwatershed Mainline Work Corridor between MP 197.3 and MP 197.8	123 acres	Although clearly shown on the USGS topographic map as an intermittent stream, MVP did not identify this first order stream tributary to Kimballton Branch which is shown by MVP as being crossed by proposed Access Road MVP-GI-232 MP 300. A deeply incised ravine is also located in this subwatershed delineation, indicative of an ephemeral or intermittent stream. The headwater areas for these streams extend to the proposed MVP work corridor between MP 197.3 and MP 197.8, and are also crossed by the proposed MVP-GI-232 between MP 285+00 and intersection with the proposed MVP work corridor.

1.2 EXAMPLE 2: Aquatic Impacts to Craig Creek Watershed, Montgomery Co.

Craig Creek, with a watershed exceeding 5 square miles, is partially in Montgomery County and is a tributary to the James River. Craig Creek provides a second example of the underestimation by MVP of adverse impacts caused by the proposed MVP construction. MVP proposes to cross Craig Creek in Montgomery County at approximately MP 219.5. Craig Creek is located in the Jefferson National Forest and is listed in the Nationwide Rivers Inventory (NRI) as an "outstandingly remarkable" river segment (https://www.nps.gov/ncrc/programs/rtca/nri/index.html) with respect to historic, cultural, recreational, and geological values. The NRI describes the recreational significance of Craig Creek as "a clean, clear, free-flowing mountain stream". **Figure 1.2-1** provides 1) delineations of subwatersheds to Craig Creek, as well as 2) the locations of Craig Creek tributary streams proposed by MVP for crossing, in addition to 3) the location of the MVP proposed Craig Creek crossing. **Table 1.2-1** provides a listing of the stream crossings, indicating the cumulative adverse impacts that would result from the proposed MVP construction.

MVP has listed the proposed Craig Creek crossing as not having any permanent impact and has therefore not listed the Craig Creek crossing in its Joint Permit Application #17-1609 submitted to the Virginia Marine Resources Commission. In the MVP FEIS Appendix F, the following classifications are listed for Craig Creek: 1) propagation and maintenance of fish and other aquatic life, 2) coldwater trout stream, 3) threatened and endangered species. It is also listed as being crossed by the open-cut dry ditch method and having permanent acreage impact within the "Permanent Easement/Temporary Workspace" project component. As shown on **Figure 1.2-1**, the following UNTs to Craig Creek are also proposed by MVP for crossing: S-PP20 (intermittent; propagation and maintenance of fish and other aquatic life), S-PP21 (ephemeral), S-PP22 (intermittent; propagation and maintenance of fish and other aquatic life), S-RR14 (ephemeral), and S-HH18 (perennial; propagation and maintenance of fish and other aquatic life). Deforestation of areas where the unnamed tributaries are proposed by MVP for crossing will result in adverse impacts to the aquatic habitats in these headwater areas by causing increased light, increased temperatures, and increased surface runoff from precipitation. Deforestation for pipeline construction will increase stormwater discharge from the delineated subwatersheds to Craig Creek. Dewatering of seeps and springs, with drainage pipes to the ground surface will increase stormwater discharge from the delineated subwatersheds to Craig Creek. Trench dewatering with permanent trench breakers and drains directing the groundwater to the ground surface will increase stormwater discharge from the delineated subwatersheds to Craig Creek. The result will be a permanent increase stormwater discharge to Craig Creek which will cause stream bank erosion, thereby releasing sediments to Craig Creek and increasing stream embeddedness, continually. This is in addition to the turbidity and sedimentation resulting from the proposed MVP trenching and construction activities. The increased turbidity and sedimentation (embeddedness) will adversely impact the aquatic habitats that 1) currently support macroinvertebrates for trout and other fish to use as a food source and 2) currently serve as protective areas for juvenile trout and other juvenile fish.

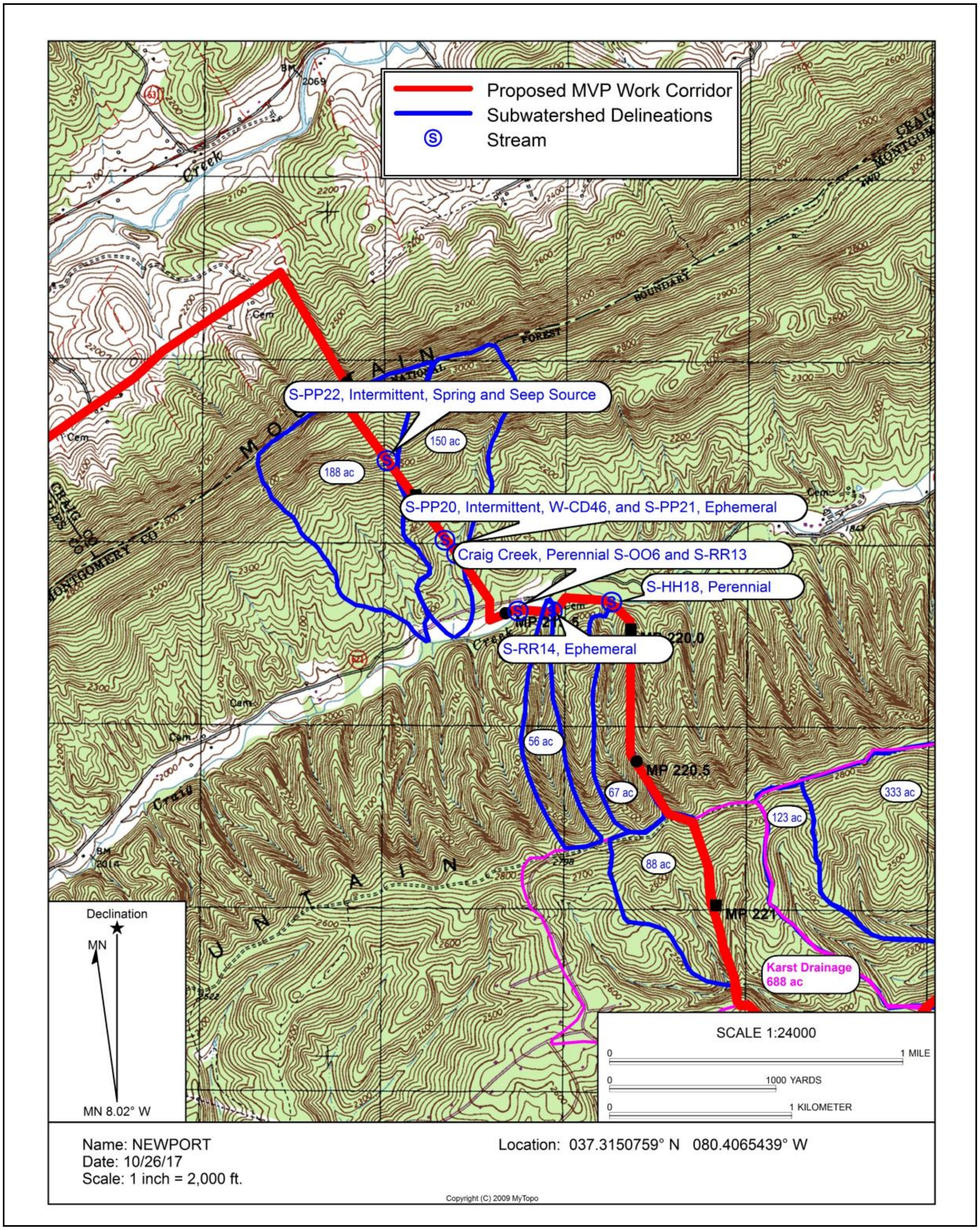


Figure 1.2-1 – Topographic map depicting the subwatershed delineations of unnamed tributaries to Craig Creek. (Map developed by P.C. Dodds, Ph.D., using Terrain Navigator Pro software.)

Table 1.2-1 – Locations and descriptions of first order stream UNTs to Craig Creek and also of Craig Creek. MVP FEIS Appendix F1 and MVP Aquatic Resource Report for US National Forest Service (National Forest) Lands, Monroe County, West Virginia; Giles and Montgomery Counties, Virginia (June 2017) provide identification designations for streams and wetlands proposed for crossing or close to the limits of disturbance and the associated field sheets provide information about seeps, springs, and ephemeral or intermittent sources of water in the headwater areas of the high gradient first order streams. Joint Permit Application #17-1609 submitted MVP to the Virginia Marine Resources Commission provides the lineal feet of proposed crossing lengths.

SPECIFIC SUBWATERSHED LOCATION	ACRES IN SUBWATERSHEDS DELINEATED	DESCRIPTION
Craig Creek Subwatershed MVP MP 218.55 to MP 218.9	188 acres	MVP identifies one stream as an unnamed tributary (UNT) to Craig Creek as S-PP22, described as an intermittent stream to be crossed by the proposed MVP work corridor at MP 218.8. This stream is within the headwater area of another high gradient first order stream tributary to Craig Creek; however, the second stream is not identified by MVP. The headwater areas are near the apex of Sinking Creek Mountain. The proposed crossing would be 83 lineal feet for S-PP22. MVP field notes for S-PP22 state: “Stream sources from spring or seep then returns underground at the end point.”
Craig Creek Subwatershed MVP MP 218.9 to MP 219.35	150 acres	MVP identifies 2 UNTs to Craig Creek as S-PP21, described as ephemeral, and S-PP20, described as intermittent. Wetland W-CD46 is shown associated with S-PP20 on the MVP Erosion and Sediment Control Plan Sheet 13.28ES (MVP Spread 9), but is not listed in the MVP FEIS or in the Joint Permit Application #17-1609. The streams would be crossed by the proposed MVP work corridor at MP 219.1 and MP 219.2, respectively. Both streams are high gradient first order streams with headwater areas near the apex of Sinking Creek Mountain. The proposed crossing would be 97 lineal feet for S-PP21 and 89 lineal feet for S-PP20.
Craig Creek Subwatershed MVP MP 219.65 to MP 219.8	56 acres	MVP identifies one UNT to Craig Creek as S-RR14, described as an ephemeral stream, to be crossed by the proposed MVP work corridor at MP 219.7. This stream is a high gradient first order stream with headwater areas near the apex of Brush Mountain and also along the steep ridges at the delineation perimeters. The proposed crossing would be 78 lineal feet.
Craig Creek Subwatershed MVP MP 219.89 to MP 219.91	67 acres	MVP identifies Craig Creek as S-OO6 (proposed work corridor crossing) and as S-RR13 (proposed access road crossing) and one UNT to Craig Creek as S-HH18. Craig Creek and S-HH18 are both described as perennial. The MVP proposed crossing of S-OO6 is 76 lineal feet and of S-RR13 is 41 lineal feet. Stream S-HH18 would be crossed by the proposed MVP work corridor at MP 219.9. S-HH18 is a high gradient first order stream to Craig Creek, with headwater areas near the apex of Brush Mountain and also along the steep ridges at the delineation perimeters. The proposed crossing would be 78 lineal feet for S-HH18. The proposed MVP work corridor is located along the entire length of the eastern watershed perimeter ridge of this watershed, extending from approximately MP 219.91 to approximately MP 220.75.

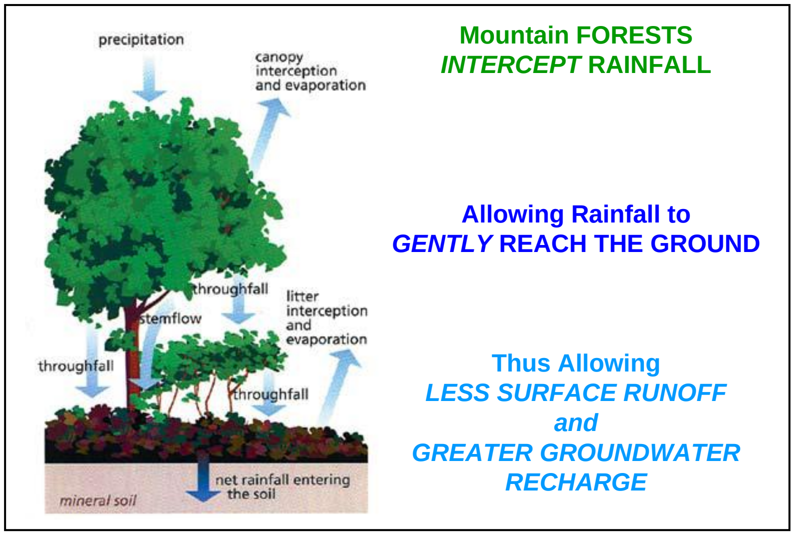
1.3 EXAMPLE 3: Aquatic Impacts to Mill Creek Watershed and Bottom Creek Watershed, Roanoke County

An example of cumulative impacts to aquatic habitats is provided by the multiple stream crossings within the Bottom Creek watershed in Roanoke County. The underestimation of stream crossings proposed by MVP in the Bottom Creek watershed results in the consequent underestimation of adverse impacts to aquatic habitats within the Bottom Creek watershed.

Deforestation, seep and spring dewatering, and trench dewatering constitute the construction activities for the proposed MVP construction that will result in adversely impacting aquatic habitats. These construction activities must be evaluated by VMRC in accordance with the Subaqueous Guidelines in order 1) to insure protection of aquatic resources; 2) to insure that all backfill material serves to restore the depth, pre-existing contours, and natural condition of the original bottom; 3) to insure that any material dredged (such as dry-crossing pipeline trenching construction activities) and placed in adjacent upland areas will not encroach into natural drainage ways; and 4) to insure that any material dredged (such as dry-crossing pipeline trenching construction activities) will not pollute adjacent or nearby underground water supplies. It is further stated in the Constitution of Virginia, Article XI, Section 1 that “Nothing in this statement, however, restricts or impedes the power of the Commission to review each application on its individual merits, apply only those conditions considered appropriate or to consider unusual or mitigating circumstances in the review of applications.” Consequently, the VMRC is not limited in its evaluation of applications with regard to its responsibility to insure the protection of aquatic resources and prevention of contamination.

There are profound consequences resulting from deforestation. As depicted in **Figure 1.3-1**, 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 along perched aquifers or 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 the presence of perched aquifers and also where the bedrock fractures or bedding planes intercept the ground surface. Seeps and springs 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 1.3-1 – Forested areas facilitate groundwater recharge and reduced stormwater runoff.



Headwater areas of first 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.

Bottom Creek has a watershed of approximately 28.4 square miles. Mill Creek is a tributary to Bottom Creek. Mill Creek, also in Roanoke County, has a watershed of approximately 6.89 square miles. **Figure 1.3-2** provides 1) delineations of subwatersheds to Bottom Creek and Mill Creek, as well as 2) the locations of wetlands, springs, and tributary streams proposed by MVP for crossing, in addition to 3) the location of the MVP proposed Bottom Creek and Mill Creek proposed crossings. **Table 1.3-1** provides a listing of the stream crossings in the Bottom Creek watershed and **Table 1.3-2** provides a listing of stream crossings in the Mill Creek watershed. These listings indicate the cumulative adverse impacts that would result from the proposed MVP construction.

The UNTs in the headwater areas of the Bottom Creek watershed and the Mill Creek watershed provide the required environmental factors of filtered light, lower temperatures, moist soil conditions, and soil functions to maintain aquatic habitats for aquatic species at the base of the ecological continuum for Bottom Creek and for Mill Creek. The Virginia Water Quality Standards 9 VAC 24-280 (January 2011) classify Bottom Creek as natural trout waters extending from its confluence with the South Fork Roanoke River upstream, including all named and unnamed tributaries, that is, including Mill Creek and all its tributaries.

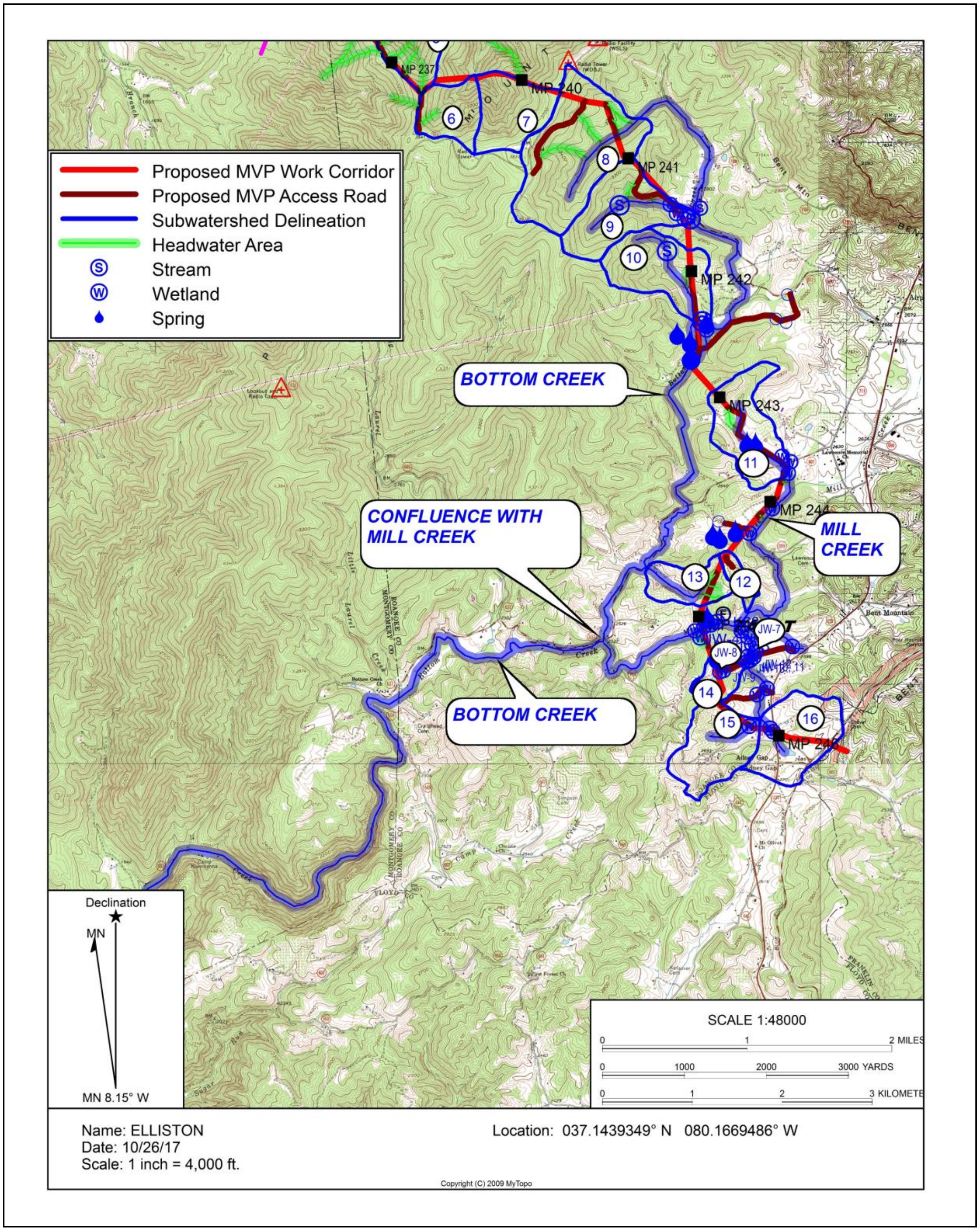


Figure 1.3-1 – Topographic map depicting Mill Creek as a tributary to Bottom Creek. Subwatershed delineations 8-10 are of unnamed tributaries to Bottom Creek. Subwatershed delineations 11-16 are of unnamed tributaries to Mill Creek. (Map developed by P.C. Dodds, Ph.D., using Terrain Navigator Pro software.)

Table 1.3-1 – Locations and descriptions of first order streams, wetlands, and headwater areas within watersheds to Bottom Creek, proposed by MVP for crossings.

LOCATION	ACRES	DESCRIPTION	SPRINGS	WETLANDS
Subwatershed 8 MP 240.2 to MP 241.0	362	MVP estimates 77 lineal feet of impact where mainline crosses the perennial high gradient first order UNT, designated as S-Y14, to Bottom Creek. MVP estimates 85 lineal feet of impact where mainline crosses intermittent UNT, designated as S-Y13, highlighted as a headwater area. MVP mainline also crosses 1 additional headwater area. The MVP access road connecting with the mainline at MP 240.3 crosses 2 headwater areas to S-Y14.		
Subwatershed 9 MP 241.0 to MP 241.7	200	MVP mainline is located within the stream valley of the UNT to Bottom Creek from MP 241.4 to 241.7. MVP estimates 140.0 lineal feet of impact to intermittent UNT designated TTVA-S-021, 43.9 lineal feet of impact to intermittent section of Bottom Creek, designated TTVA-S-022, 45.1 lineal feet of impact to perennial section of Bottom Creek designated TTVA-S-025, 258.6 lineal feet of impact to ephemeral UNT to Bottom Creek designated TTVA-S-023, and does not provide an estimated impact to intermittent UNT to Bottom Creek designated TTVA-S-024. Access road located adjacent to TTVA-S-021 crosses 2 headwater areas.	Numerous springs observed in areas adjacent to stream designations and also within UNT TT-S-021	TTVA-W-005 PEM, Depressional, located near MP 241.6 and TTVA-W-004 PEM, Slope, located near MP 241.5. Both wetlands impacted by mainline
Subwatershed 10 MP 241.8 to MP 242.4	194	MVP estimates 21.0 lineal feet of mainline impact to intermittent UNT designated TTVA-S-26 and 194.4 lineal feet of mainline impact to ephemeral UNT designated TTVA-S-027, 630 lineal feet of mainline impact to perennial UNT designated TTVA-S-028, 13.5 lineal feet of mainline impact to intermittent UNT designated TTVA-S-029, and 101.1 lineal feet of mainline impact to Bottom Creek, designated TTVA-S-030. Mainline crosses 1 undesignated headwater area.	Several springs observed	MVP designated wetland TT-W-006 PSS, Riverine. Also, several wetlands observed
MP 242.5		Access road connecting to mainline at MP 242.5 extends ENE: MVP estimates 63.0 lineal feet of impact to perennial UNT to Bottom Creek, designated TTVA-S-028, 194.4 lineal feet of impact to ephemeral UNT to Bottom Creek, designated TTVA-S-027, and 21.0 lineal feet of impact to intermittent UNT to Bottom Creek, designated TTVA-S-026	Numerous springs observed near Bottom Creek near MP 242.5	

Table 1.3-2 – Locations and descriptions of first order streams, wetlands, and headwater areas within watersheds to Mill Creek.

LOCATION	ACRES	DESCRIPTION	SPRINGS	WETLANDS
Subwatershed 11 MP 242.9 to MP 243.8	178	MVP estimates 85.7 lineal feet of impact where mainline crosses the intermittent high gradient first order UNT, designated as TT-S-031, to Mill Creek. MVP estimates 88.4 lineal feet of impact where mainline crosses perennial UNT, designated as TTVA-S-032, to Mill Creek. Mainline crosses 1 headwater area near MP 243.0 and again near MP 243.4.	Numerous springs observed	MVP designated wetland TT-W-007, PEM, Slope; TT-W-008, PEM Slope; TTVA-W-009, PEM, Depressional; TTVA-W-010, PSS, Riverine; TTVA-W-011, PSS, Riverine.
MP 244.0 to MP 244.5		MVP mainline is in the valley of perennial Mill Creek, impacting approximately 2241 lineal feet of Mill Creek. Mainline crosses 1 headwater area to Mill Creek. MVP access road connecting to mainline at MP 244.2 traverses valley of intermittent UNT, designated TTVA-S-034, to Mill Creek, impacting 285.3 lineal feet.	Numerous springs on hillslope	MVP wetland TT-W-012, PEM, Riverine; TT-W-013, PSS, Riverine
Subwatershed 12 MP 244.5 to MP 244.6	28	MVP access road connecting with mainline at approximately MP 244.55 impacts headwater area to UNT to Mill Creek.		
Subwatershed 13 MP 244.6 to MP 244.8	93	MVP mainline crosses through 3 headwater areas to a UNT to Mill Creek, crossing through 1 of the headwater areas approximately 389 feet.		
MP 244.8 to MP 244.1		MVP estimates 285.3 lineal feet of impact to perennial Mill Creek, designated TTVA-S-035 and also crosses 1 headwater area to Mill Creek. A fault was observed in a bedrock outcrop adjacent to Mill Creek, showing strike of fault is the same as the Mill Creek Valley.	Numerous springs observed along Mill Creek	MVP wetland TTVA-W-014, PSS, Riverine; TTV-W-15, PSS Riverine; TTVA-W-016, PSS, Riverine.

Subwatershed 14 MP 245.2 to MP 245.5	51	MVP estimates 173 lineal feet of impact to intermittent UNT, designated S-Y7, to Mill Creek, 84 lineal feet of impact to perennial UNT, designated S-Y8, to Mill Creek, and 33 lineal feet of impact to intermittent UNT, designated S-Y9, to Mill Creek. MVP estimates 34 lineal feet of access road impact to perennial UNT, designated S-Z17, to Mill Creek, impact (lineal feet not provided) to perennial UNT, designated TTVA-S-036, to Mill Creek.		MVP wetland TT-W-017, PEM, Riverine; wetland TTVA-W-018, PEM Riverine, wetland TTVA-W-019, PEM, Riverine
Subwatershed 15 MP 245.5 to MP 245.9	166	MVP crosses UNT to Mill Creek with wetlands present. MVP access road connecting with mainline at approximately MP 245.6 crosses several wetlands, impacts 359.5 lineal feet of ephemeral UNT, designated TTVA-S-037, UNT to Mill Creek, impacts 18 lineal feet of perennial UNT, designated S-Q20, to Mill Creek, impacts 32.0 lineal feet of perennial UNT, designated TTVA-S-038, to Mill Creek, and impacts 291.1 lineal feet of ephemeral UNT, designated TTVA-S-039, to Mill Creek.		MVP wetland TTVA-W-021, PSS, Slope; TTVA-W-022, PEM, slope; TT-W-020, PEM, Slope; TTVA-W-023, PEM, Depressional
Subwatershed 16 MP 245.9 to MP 246.4	182	MVP mainline impacts 96 lineal feet of perennial UNT, designated S-B21, to Mill Creek, impacts 147 feet of ephemeral UNT, designated S-B25, to Mill Creek and numerous wetlands.		MVP Wetland W-B24, PSS, Riverine, W-B25, PSS2, slope, TT-W-024, PEM, Depressional

It is stated in the Mountain Valley Pipeline Project Standard JPA-NWP12 Pre-Construction Notification, Virginia, Attachment E: Threatened and Endangered Species and Sensitive Stream Resources (September 2017) that, “The Project does not cross any Tier III water segments.” However, tributaries to the Tier III (Exceptional State Waters) segment of Bottom Creek (Roanoke and Montgomery Counties) would be impacted by the proposed MVP crossings. Bottom Creek headwater areas would be crossed by the proposed MVP construction. Bottom Creek extends from its headwater areas through Roanoke County and Montgomery County, where it flows into the South Fork Roanoke River. The 2.2-mile portion of Bottom Creek designated as Tier III is located in Montgomery County approximately 2 miles downgradient of the confluence of Bottom Creek and Mill Creek. Degradation of headwater areas and upstream portions of Bottom Creek and Mill Creek would impact the Tier III portion of Bottom Creek.

MVP has not provided the VMRC with an accurate number of stream crossings within the Bottom Creek/Mill Creek watershed that would be permanently adversely impacted. MVP reported permanently impacted streams (**Table 1.3-3**) in its Draft Environmental Impact Statement (DEIS), but failed to include it in its Joint Permit Application #17-1609 to the VMRC.

Table 1.3-3 – Excerpted information from MVP's list of permanently impacted streams crossed by the proposed MVP construction. This information was provided in the MVP DEIS Appendix F-1, but was not provided to VMRC. Note that the mile post numbers were changed subsequent to the MVP DEIS submittal. The mile post numbers in parentheses are those in the DEIS. The updated mile post numbers are listed below the previously assigned mile post numbers.

Waterbody ID	Waterbody Name	MP	Flow Regime	Permanent Impact	Project Component
S-Y14	UNT to Bottom Creek	(238.8) 240.8	Perennial	Yes	Permanent ROW
S-Y13	UNT to Bottom Creek	(238.8) 240.8	Intermittent	Yes	Permanent ROW
TTVA-S-021	UNT to Bottom Creek	(239.4) 241.4	Intermittent	Yes	Permanent ROW
TTVA-S-022	Bottom Creek	(239.6) 241.6	Intermittent	Yes	Permanent Access Road MVP-RO-281
TTVA-S-027	UNT to Bottom Creek	(240.3) 242.3	Ephemeral	Yes	Permanent Access Road MVP-RO-283
TTVA-S-028	UNT to Bottom Creek	(240.3) 242.3	Perennial	Yes	Permanent Access Road MVP -RO-283
TTVA-S-30	Bottom Creek	(240.4) 242.4	Perennial	Yes	Permanent ROW
TTVA-S-31	UNT to Mill Creek	(241.1) 243.1	Intermittent	Yes	Permanent ROW
TTVA-S-032	UNT to Mill Creek	(241.7) 243.7	Perennial	Yes	Permanent ROW
TTVA-S-035	Mill Creek	(242.9) 244.9	Perennial	Yes	Permanent ROW
S-Z17	UNT to Mill Creek	(243.3) 245.3	Perennial	Yes	Permanent Access Road MVP-RO-287
S-Y7	UNT to Mill Creek	(243.3) 245.3	Intermittent	Yes	Permanent ROW
S-B22	UNT to Mill Creek	(243.8) 245.8	Perennial	Yes	Permanent ROW
S-B25	UNT to Mill Creek	(243.9) 245.9	Ephemeral	Yes	Permanent ROW
S-B21	UNT to Mill Creek	(243.9) 245.9	Perennial	Yes	Permanent ROW

2.0 PERMANENT ADVERSE IMPACTS TO STREAMS CROSSED BY THE PROPOSED MVP CONSTRUCION WOULD RESULT IN DEGRADATION OF ECOLOGICAL FUNCTIONS WITHIN THE ENTIRE WATERSHED

Headwater areas within watersheds are environmentally sensitive and provide seeps, springs, and wetlands in shaded areas where light is filtered by the tree canopy and temperatures are lower, sustaining the aquatic organisms at the very base of the food chain. 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 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.

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. 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.

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.

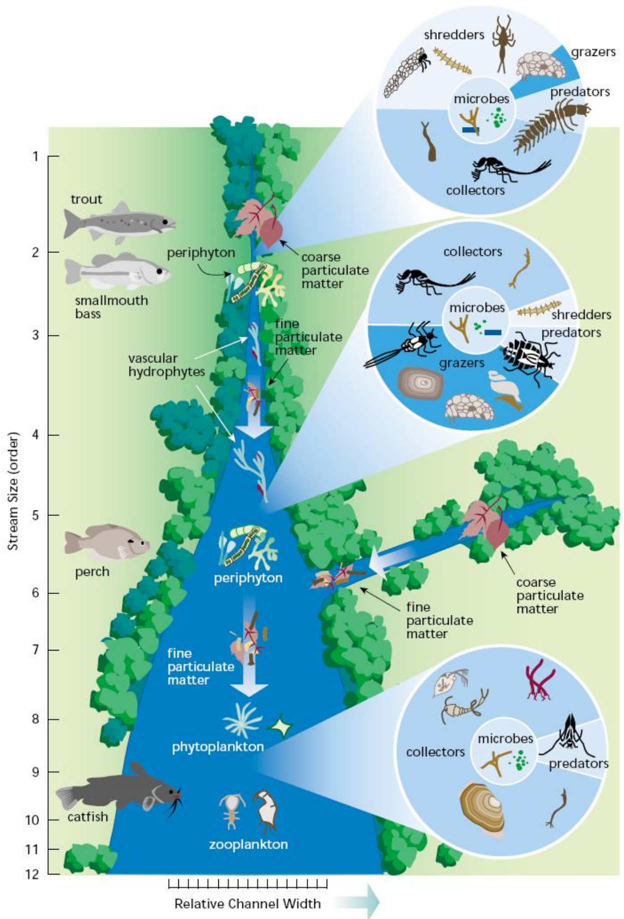


Figure 2.0-1 – The River Continuum (Vannote, et al; 1980) illustrates the food chain connection between headwater areas and the wider, larger downstream areas in the overall watershed.

2.1 Mitigation Credits in Remote Watersheds Will Not Protect Adversely Impacted Watersheds

Stream mitigation credits are proposed to offset the permanent stream impacts caused by “culverting of streams crossing proposed permanent access roads.” The cumulative damage caused by permanent stream impacts exceeds the general impact descriptions provided by MVP because of location of such impacts within stream headwater areas. Within the headwater areas, aquatic organisms at the base of the food chain are necessary for the ecological continuity of the entire stream. The purchase of mitigation credits in remote watersheds, unconnected to the impacted watersheds, cannot offset the permanent damage to the ecological continuum within the impacted streams.

2.2 Proposed MVP Construction BMPs Would Not Protect Aquatic Habitats

Best Management Practices (BMPs) include sediment erosion control structures intended to reduce stormwater runoff velocities and to reduce the amount of sediment transported in the stormwater runoff. In the MVP Joint Permit Application #17-1609 submitted to the VMRC, the following BMPs are included for use in the proposed pipeline construction areas:

- Temporary Diversion Dike
- Silt Fence, Super Silt Fence and Belted Silt Retention Fence
- Compost Filter Sock
- Temporary Slope Breakers
- Trench Plugs
- Erosion Control Blanket/Flexterra/or equivalent
- Vegetative Stabilization

There are numerous ratings for BMPs, providing a range of percent effectiveness values. However, there is agreement that none of the BMPs can provide 100 percent effectiveness. In the Universal Soil Loss Equation guidance document prepared by Peter Wood (Construction Site Soil Loss and Sediment Discharge Calculation, Guidance Document and Calculation Tool, 2015, Wisconsin Department of Natural Resources), the percent effectiveness is provided for the following: silt fence, 40 percent; vegetative buffer, 40 percent. It is stated in the Virginia Department of Environmental Quality (VDEQ) Erosion and Sediment Control Handbook (1992) that sediment traps and sediment basins can achieve, at best, only 60 percent effectiveness. It should be noted that sediment basins are not included in the list of BMPs in the MVP SWM or ESC plans. Also, MVP has not adequately delineated watersheds for stormwater discharge calculations. Instead of delineating a watershed that includes the entire area draining to the receiving stream, MVP has provided watershed delineations which include only portions of watersheds which are upgradient of and inclusive of the proposed MVP construction areas. The MVP stormwater discharge calculations are based on inadequate watershed delineations that do not extend to the receiving stream. Without incorporating the stormwater discharge from an entire watershed of a receiving stream, the increased amount of stormwater discharge cannot be adequately evaluated. Therefore, the amount of sediment transported by the stormwater discharge also cannot be adequately evaluated. Sediment basins constitute the only commonly used BMP to detain water in a manner consistent with the requirements of the Code of Virginia; however, MVP has not listed the use of sediment basins as one of the BMPs that would be used in the proposed construction. Without adequate stormwater discharge calculations, a sediment basin cannot be properly sized. Even if MVP intended to use sediment basins, they could not be properly sized because of the inadequate stormwater discharge calculations.

Only the peak stormwater discharge from the actual watershed can provide a basis to determine the increased stream bank erosion downstream. Increased peak stormwater discharge from construction activities will result in increased sedimentation in streams 1) directly, because BMPs are not 100 percent effective in preventing sediment transport to streams; and 2) indirectly, because peak stormwater discharge will cause stream bed scour and stream bank erosion downstream, resulting in the introduction of turbidity and sediment to the streams.

Stream water turbidity increases with the introduction of sediment from stormwater discharge and also from stream bank erosion. Stream embeddedness (**Figure 2.2-1**) increases when sediment is deposited within openings among cobbles within a stream bed. The Save Our Streams program, sponsored at the state level in Virginia, include turbidity and embeddedness in stream monitoring protocol. Turbidity is typically measured as nephelometric turbidity unit (NTU) by using a Secchi disk. Embeddedness is measured by pebble count techniques. It is important to evaluate and monitor streams prior to, during, and after any construction which will contribute sediment to streams. However, MVP documents do not address evaluation and monitoring of streams to determine the impacts of sediment transport and deposition to streams.

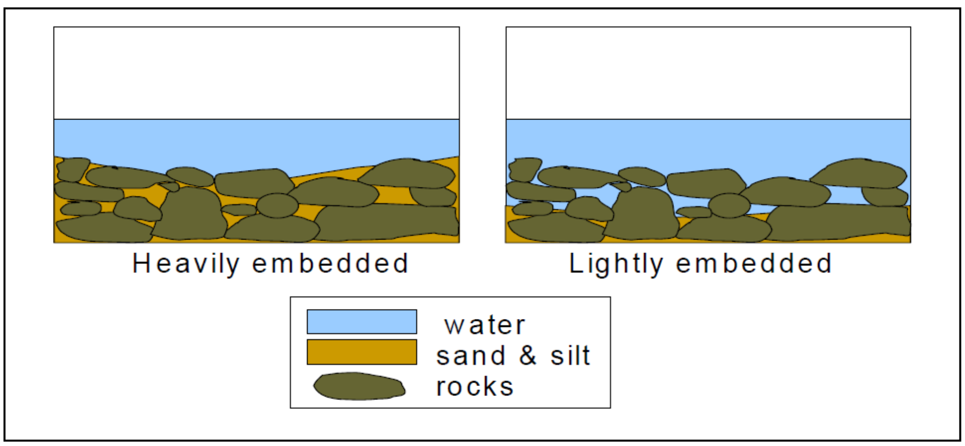


Figure 2.2-1 – Cobbles and pebbles provide aquatic habitats and protection for aquatic organisms. Insect larvae, which constitute the base of the river continuum food chain, reside on the cobbles and pebbles. Minnows and juvenile fish (including trout) hide in the spaces between cobbles and pebbles for protection. When sand and silt fill the spaces between the cobbles and pebbles, the aquatic habitats and protection areas are destroyed. When the aquatic habitats become heavily embedded or are removed for trenching and stream crossing work spaces, they cannot be restored.

The consequences of embeddedness are provided by Jessup and Dressing (2015) as: "1) Displacement of interstitial habitat space; 2) Clogging of water movement under the channel bed (hyporheic zone); 3) Decreased or altered primary algal productivity; 4)

Increased macroinvertebrate drift; 5) Abrasion or smothering of gills and other organs; 6) Uptake of sediment-bound toxicants that are increasingly associated with fine particles; and 7) Larger scale homogenization or disturbance of habitat types."

It is stated in the DEQ's Virginia Stormwater Management Handbook, "4.5.3. Habitat and Ecological Impacts", that "As the gravel stream bottom is covered in sediment, the amount and types of microorganisms that live along the stream bottom decline. The stream receives sediment from runoff, but additional sediment is generated as the stream banks are eroded and this material is deposited along the stream bottom, burying the substrate material of the stream bed, which is habitat for many benthic organisms." The VMRC would not be able to approve the MVP Joint Permit Application #17-1609 because, adhering to the Subaqueous Guidelines, the VMRC must evaluate permit applications for submarine crossings "to insure protection of aquatic resources". The VMRC must specifically evaluate the potential for adverse impacts to instream beneficial uses, defined in the Code of Virginia §62.1-10 as "… the protection of fish and wildlife habitat."

In the MVP JPA-NWP12 Pre-Construction Notification, Virginia, Attachment H-2: Wetlands and Waterbodies Impact Analysis and Compensatory Mitigation Plan (September 2017), it is stated that there will be no impacts where BMPs are used. However, increased sedimentation into streams caused by the proposed MVP construction constitutes the impact of increased embeddedness. MVP recognizes that BMPs are not 100 percent effective in preventing sediment from entering the receiving stream. In its soil loss calculations provided to the Jefferson National Forest Eastern Divide Ranger District (June 2017), the Revised Universal Soil Loss Equation (RUSLE) was used to estimate increased soil loss from the proposed MVP construction. The value selected unilaterally for the MVP soil loss estimates was for silt fence, which MVP stated was 79% effective in containing sediment. The use of a 79% sediment containment effectiveness for silt fence is based on a M.S. thesis by Gregg Steven Dubinsky, 2014, "Performance Evaluation of Two Silt Fence Geosythetic Fabrics During and After Rainfall Event". The study used 4 feet x 8 feet sheets of plywood with compacted sediment on the surfaces, tilted at 10%, 25%, and 33% slopes with rain event simulations. The results were reported in the conclusion of the evaluation: "Overall measured results showed that woven and nonwoven fabrics achieved performance efficiencies of 57 and 59 percent in turbidity, and 59 and 62 percent in suspended sediment concentrations, respectively. Projected results also showed that the woven and nonwoven fabrics would have achieved performance efficiencies of 80 and 78 percent in turbidity, and 78 and 79 percent in suspended sediment concentrations, respectively." The actual results, therefore, were less than the projected 79% effectiveness value used in the RUSLE calculations that were supposed to be based on the effectiveness reported in Mr. Dubinsky's thesis. Additionally, Mr. Dubinsky reported that performance efficiencies were less during the simulated rainfall events than after the rainfall simulation ended. **Figure 2.2-2** provides a photograph of the equipment used to conduct the silt fence evaluation, which is clearly not a field test. This photograph illustrates various silt fence failures.

Figure 2.2-2 – Silt fence failures observed during Mr. Dubinsky's experiments: (A) pullout of fabric from middle stake on 33% slope; (B) overtopping on 33% slope (C) corner stake failure on 33% slope; and (D) corner stake tear on 25% slope.

2.3 Potential Release of Pesticides and Chemicals During Trenching in Streams Would Contaminate Stream Water

Agricultural areas are present adjacent to numerous areas proposed by MVP for stream crossings. For example, MVP Erosion and Sediment Control Plan Sheet 13.28ES (MVP Spread 9) clearly shows agricultural areas adjacent to Craig Creek in Montgomery County. MVP lists the open-cut dry ditch method of trenching across 35 lineal feet of Craig Creek for pipeline installation. Studies confirm that excavation of buried sediments, which may contain pesticides and fertilizer chemicals from agricultural activities, may be released during trenching excavation/dredging activities (Gilliam and Hamilton, 2006; Nowell, et al, 2000; Shambaugh, 2009). The increased stormwater discharge from the subwatersheds proposed for pipeline construction activities will cause stream bank erosion, potentially releasing pesticides and fertilizer chemicals from agricultural activities. Stockpiling of excavated/dredged stream bed sediments may result in leaching of pesticides and fertilizer chemicals into the ground, thereby contaminating groundwater. Groundwater interfaces with stream water, providing water during times of drought. This could serve as an avenue of releasing the leached pesticides and fertilizer chemicals to Craig Creek and to other streams with adjacent agricultural areas. Additionally, MVP proposed silt fence as the BMP to use at the base of stockpiles. Sediment from the stockpiled material will escape from the stockpile, introducing contaminated sediment to streams because silt fence is not 100 percent effective in containing sediment. The MVP Erosion and Sediment Control Plan Sheet 13.28ES also highlights the steep slope areas to be crossed by the proposed MVP construction. BMPs, especially silt fence and filter socks, are even less effective in steep slope areas. Algal blooms can result from the increased amount of fertilizer available. Algal blooms are known to cause death of aquatic organisms. Toxic pesticides are also known to cause death of aquatic organisms.

2.4 Geologic Maps Indicate the Presence of Continuing Landslides which can Result in Release of Sediments to Streams where the MVP Construction is Proposed

Schultz (1993) provides information concerning the large rock block landslides in the Sinking Creek Mountain area. Faulted bedrock dips to the southeast in this area. Interbedded shale strata are interpreted to be the sliding surfaces. **Figure 2.4-1** is an excerpt of the "Geologic Map of Large Rock Block Slides at Sinking Creek Mountain, Appalachian Valley and Ridge Province, Southwestern Virginia…" (Schultz, 1993) that provides details of the bedrock units underlying the Sinking Creek Mountain/Craig Creek area where the proposed MVP construction would cross the Jefferson National Forest.

Southworth and Schultz (1986) report that the Sinking Creek Mountain Complex is the largest known slide complex in eastern North America. The area of the slide mass is estimated to be 20 square miles at a thickness of 50 feet to 300 feet. The east-west length of the slide is approximately 20 miles up to 60 miles and the north-south width of the slide is 0.4 mile to 1 mile. The trigger for the slide is thought to be paleo-seismic.

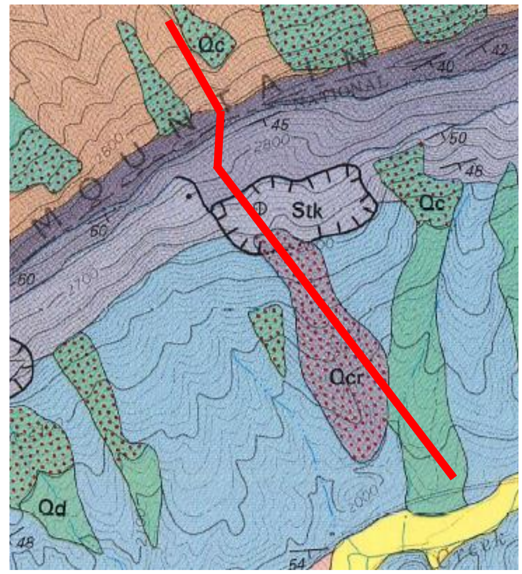


Figure 2.4-1 – Map excerpted from Schultz (1993) illustrating the approximate proposed MVP work corridor through colluvial landslide areas and rock block landslide areas. The bedrock is shown as dipping to the southeast toward Craig Creek in Montgomery County, VA. (The superimposed red line represents the approximate location of the proposed MVP main corridor).

2.5 Seismic Hazards are Prominent in the Landslide Areas

Horton, et al (2015) report that earthquakes trigger landslides, citing landslides that were triggered by the earthquake in Mineral, VA, in 2011. Landslides resulting from the Mineral, VA earthquake occurred in an area extending as much as 152 miles from the epicenter. On May 12, 2017, a 2.8M earthquake in Giles County, VA, evidently caused a landslide on May 13, 2017 within 6.2 miles from the epicenter. The epicenter of the earthquake was approximately 10 miles from the area where the MVP construction is proposed to cross Peters Mountain in the Jefferson National Forest. On September 13, 2017, a 3.2M earthquake occurred near Lindside, Monroe County, WV, approximately 1.57 miles from the proposed MVP work corridor. The earthquake epicenter was less than 5 miles from the proposed MVP crossing of the Appalachian Trail at the apex of Peters Mountain (the boundary between Monroe County, WV and Giles County, VA), at approximate MP 196.45. As provided in the MVP Resource Report 6, seismic activity can result in liquefaction of the soils which are typically found at streams and rivers. Liquefaction causes the soils to lose integrity, thus becoming unsupportive where the gas pipeline would be located. This creates a condition of pipeline failure where the soils collapse. Soil liquefaction could, therefore, increase sedimentation into streams and also introduce contamination from ruptured pipelines, such as radon or lead which are naturally occurring constituents in the gas produced from the Marcellus Shale.

The Virginia Department of Mines, Minerals, and Energy developed an Earthquake Epicenter Density map (**Figure 2.5-1**) which depicts the area proposed for the MVP construction through Giles County, Montgomery County, Roanoke County, and Franklin County as positioned within the Giles County Seismic Zone.

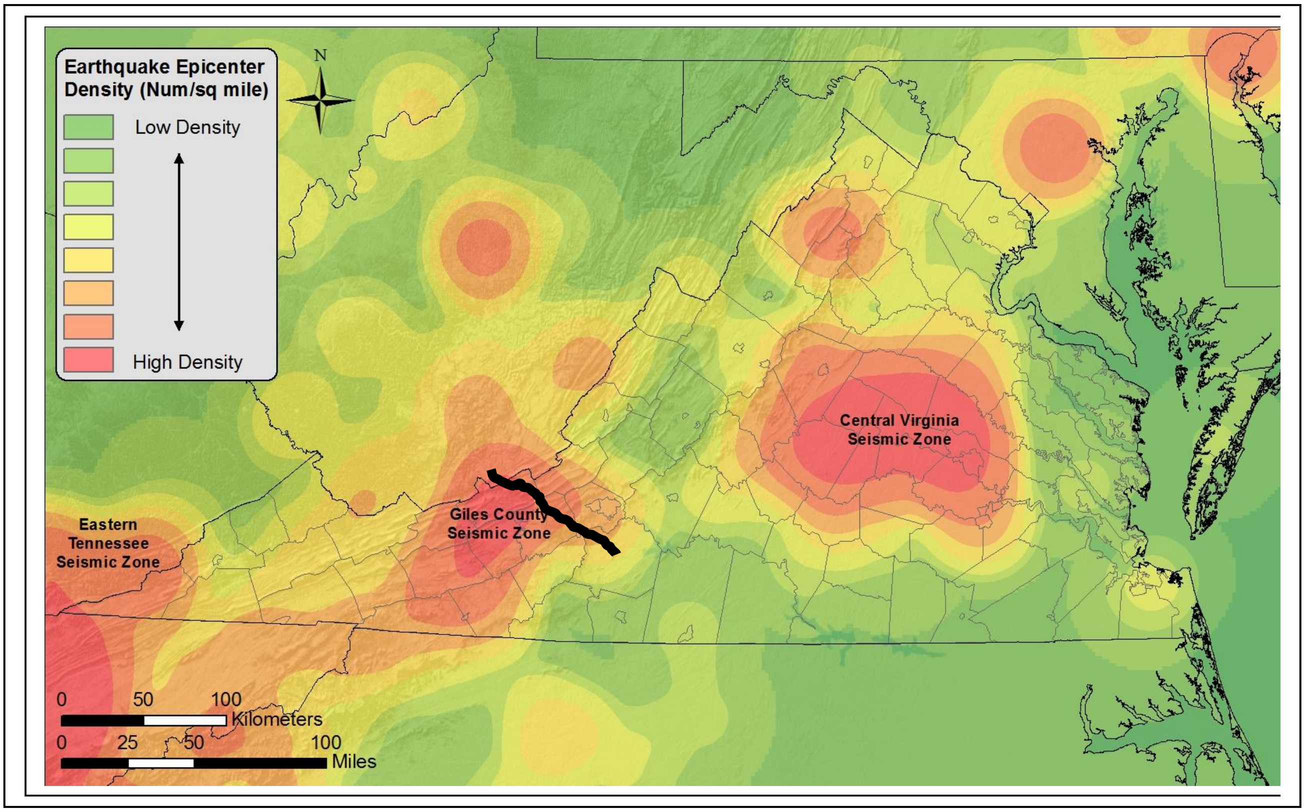


Figure 2.5-1 – Map showing the densities of earthquake epicenters, provided as a color scale indicating the relative densities in numbers per square mile. Three major earthquake zones are identified. Notice that Giles County, Montgomery County, Roanoke County, and Franklin County are located within the Giles County Seismic Zone. The black line is the approximate location of the proposed MVP gas pipeline. This map is from https://dmme.virginia.gov/DGMR/EQHazardMapping.shtml.

3.0 CONCLUSIONS

Adhering to the Subaqueous Guidelines, the VMRC should deny the MVP Joint Permit Application #17-1609 because there would be adverse impacts to aquatic resources resulting from the MVP proposed stream crossings, including increased stream bed embeddedness, degradation of water quality due to increased turbidity, degradation to water quality due to release of pesticides, degradation to water quality due to soil liquefaction, degradation to water quality due to radon and lead contamination in the event of a pipeline rupture, release of sediments to streams from stockpiled trench excavation material, degradation of water quality due to migration of contaminants from stockpiled material from trench excavation areas.

The proposed MVP stream crossings would result in adverse impacts to aquatic habitats and water quality because:

1) MVP has underestimated the number of proposed stream crossings that will result in permanent adverse impacts to aquatic habitats. In the MVP FEIS and DEIS, MVP provided a list of proposed stream crossings in which there would be “Permanent Acreage Impact”, the number of which exceeds that listed under “Permanent Access Road Impact”. However, the MVP VMRC application only references streams impacted by permanent access roads, even though streams with permanent adverse impacts from the additional proposed MVP construction are within the same watersheds as those listed for permanent impacts from access roads. Also, it should be noted that the Public Notice indicates 18 crossings; however, Appendix H of the MVP application to VMRC lists 19 crossings. Cumulative permanent degradation of aquatic habitats would result from the MVP proposed crossings of 537 wetlands and streams.

2) MVP has not thoroughly evaluated the cumulative ecological impacts to streams in watersheds where proposed MVP construction will impact more than one tributary stream within the watershed. MVP listed streams separately in watersheds where intermittent, ephemeral, and/or perennial streams are actually unnamed tributaries to the receiving stream within the delineated watershed. Impacts to tributary streams result in cumulative impacts to the receiving stream.

3) MVP has overestimated the effectiveness of Best Management Practices (BMPs) proposed for use during MVP construction, stating that there would be no impacts where BMPs are used. However, the BMPs proposed for use during the MVP construction are not capable of preventing sediment from entering streams. The sediment entering streams from the proposed MVP construction will result in increased turbidity of the stream water, which would reduce the water quality, and would result in embeddedness of the stream bottom, thereby degrading aquatic habitats for benthic organisms and for juvenile fish protection areas.

4) MVP has not provided any explanation of how to re-establish stream bottom conditions in order to provide the pre-existing stream bottom conditions. Such conditions must provide open spaces among gravel and cobble sized sediments. The increased turbidity and sedimentation from the construction areas will cause continued embeddedness because the BMPs are not capable of preventing 100 percent of the sediment from reaching the streams. The MVP proposed use of rip-rap stabilization at culvert installations in streams precludes providing pre-existing stream bottom conditions.

5) The stormwater discharge calculations provided to the Virginia Department of Environmental Quality (VDEQ) are deficient because only small portions of the watersheds, located upgradient of the proposed construction areas, were used for stormwater discharge to streams. The small portions of watersheds used in the stormwater discharge calculations were not inclusive of the receiving stream,

but rather, ended at the proposed construction site perimeter. Therefore, the stormwater discharge calculations presented by MVP to VDEQ in their Stormwater Management Plan and Erosion and Sediment Control Plan are not representative of the actual increased stormwater discharge that would result from the proposed MVP construction. The increased stormwater discharge from the completed construction site would result in continual increase of stream bank erosion, causing continued embeddedness.

6) Where stream bed material is disturbed or removed from the streams, there is the potential for pesticides and chemicals that accumulated at depth, and were subsequently covered by clean sediment, to be released to the water column and to be placed in upland areas where erosion will allow these pollutants to re-enter the stream water. Pesticides and chemicals would have adverse impacts on the aquatic habitats as well as to groundwater, where leaching could cause pollution to migrate downward through sediments to contaminate groundwater.

7) Portions of the proposed MVP construction are located in recognized seismic zones with recent earthquakes and landslides. Landslides release sediment to streams. Earthquakes are known to cause liquefaction of sediments, which are typically found at streams and rivers. Liquefaction causes the sediments to lose integrity, thus becoming unsupportive where the proposed gas pipeline would be located. This creates a condition of pipeline failure where the sediments collapse, potentially releasing radon and lead portions of the pipeline gas.

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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.

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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:

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PROFESSIONAL ORGANIZATIONS

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National Ground Water Association