Mountain Valley PIPELINE LLC

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July 25, 2016

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Mountain Valley Pipeline, LLC
Docket No. CP16-10-000
Supplemental Materials

Dear Ms. Bose:

On October 23, 2015, Mountain Valley Pipeline, LLC ("Mountain Valley") filed a certificate application with the Federal Energy Regulatory Commission ("Commission") for the Mountain Valley Pipeline Project in the above-identified docket.

On June 16, 2016, Mountain Valley filed certain supplemental materials in the docket, including a hydrologic analysis. Mountain Valley marked the analysis as privileged and confidential because it is part of the Biological Evaluation, which is privileged and confidential. Upon further review, Mountain Valley is re-submitting the analysis as public.

If you have any questions, please do not hesitate to contact me at (412) 553-5786 or meggerding@eqt.com. Thank you.

Respectfully submitted,

Mountain Valley Pipeline, LLC

Matthew Eggerding
Counsel, Midstream

Attachment

cc: All Parties
Paul Friedman, OEP
Lavinia DiSanto, Cardno, Inc.
Doug Mooneyhan, Cardno, Inc.

Pesi 593.02

HYDROLOGIC ANALYSIS OF SEDIMENTATION

MOUNTAIN VALLEY PIPELINE

JEFFERSON NATIONAL FOREST
EASTERN DIVIDE RANGER DISTRICT

7 June 2016

Prepared for:

U.S. Department of Agriculture, Forest Service
Jefferson National Forest
Eastern Divide Ranger District
110 South Park Avenue
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Prepared on behalf of:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 Introduction

Mountain Valley Pipeline, LLC (MVP), a joint venture between EQT Midstream Partners, LP and affiliates of NextEra Energy, Inc., Con Edison Gas Midstream, LLC, WGL Holdings, Inc., Vega Energy Partners, Ltd., and RGC Midstream, LLC, is seeking a Certificate of Public Convenience and Necessity (Certificate) from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act authorizing it to construct and operate the proposed Mountain Valley Pipeline Project (Project) located in 17 counties in West Virginia and Virginia. MVP plans to construct an approximately 301-mile, 42-inch-diameter natural gas pipeline to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies (LDCs), industrial users and power generation in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region.

The proposed pipeline will extend from the existing Equitrans, L.P. transmission system and other natural gas facilities in Wetzel County, West Virginia to Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia. In addition to the pipeline, the Project will include approximately 171,600 horsepower (hp) of compression at three compressor stations currently planned along the route, as well as measurement, regulation, and other ancillary facilities required for the safe and reliable operation of the pipeline. The pipeline is designed to transport up to 2.0 million dekatherms per day of natural gas.

Approximately 3.43 miles of the proposed alignment cross Jefferson National Forest (JNF) lands in Monroe County, West Virginia and Giles and Montgomery counties, Virginia. Additionally, the approximate 6-mile Pocahontas Road (Forest Road 972) in Giles County, Virginia is currently proposed to provide access to portions of the alignment near Peters Mountain. No ancillary facilities or new access roads are proposed to be constructed on JNF lands; however, five additional temporary workspaces are proposed to be placed along Pocahontas Road.

Construction of MVP within the JNF (and private lands) has potential to introduce temporary excess sediment into waterways within the JNF and downstream areas, which may result in changes to water quality and potentially temporarily impact aquatic biota. Although MVP will implement specific conservation measures (i.e., erosion and sediment controls) to minimize impacts to waterways, these measures are unlikely to prevent all sediment inputs. Sedimentation of streams by erosion is a natural process, but land development and disturbance may accelerate this process. Increased erodibility, due to the loosening and exposure of fine particles increases the likelihood of sediment-laden runoff from the Project into nearby waterways.

In order to quantify the amount of sediment expected within waterways and associated potential impacts to threatened, endangered, and sensitive (TES) species within the JNF and in downstream areas, a hydrological analysis of sedimentation was developed through consultation with Mr. Ken Landgraf, Natural Resources Group Staff Officer, and Ms. Dawn Kirk, Forest Service fisheries biologist. A contracted hydrogeologist, Hydrogeology Inc., investigated the potential for downstream sedimentation impacts by analyzing proposed construction activities on JNF and surrounding private lands in relation to the watersheds that are crossed by the Project.

2.0 Methods

In order to estimate erosion due to disruption of land from construction activities for the Project in the JNF, a hydrologic analysis of sedimentation is performed. This analysis uses the Revised Universal Soil Loss Equation (RUSLE; Renard et al. 1997) to estimate loss of soils due to Project activities. The RUSLE provides generalized annual estimates of erosion rates and sediment loads based on climate, soil, topography, and land use/management factors and can be used to determine sediment loads and yields for catchments within the vicinity of Project construction.

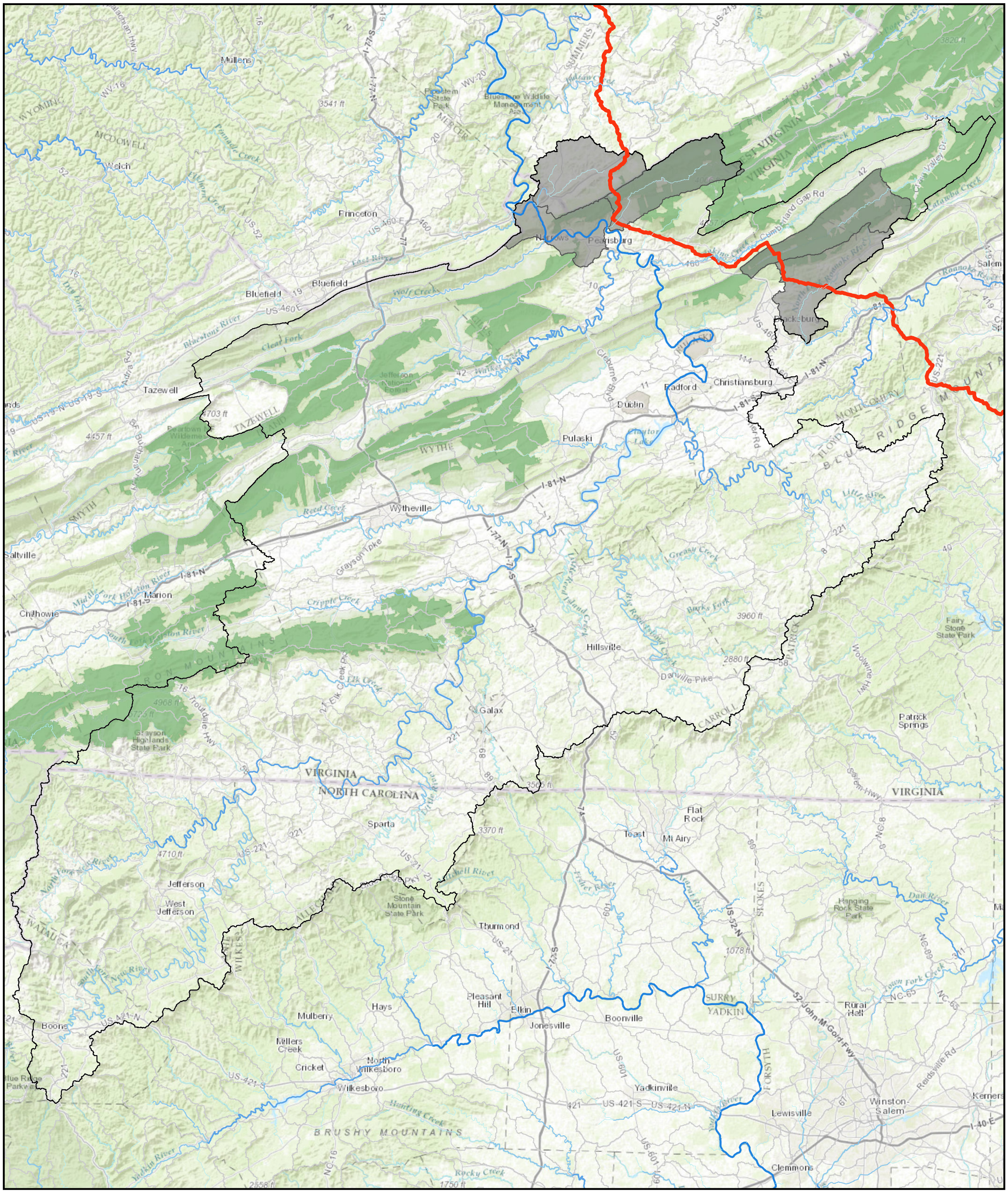
2.1 Hydrologic Study Area

To assess impacts of the Project on sedimentation within streams in the JNF, a hydrologic study area is defined. This area is defined using subwatersehds (i.e., Hydrologic Unit Code [HUC] 12) from the U.S. Geological Survey's Watershed Boundary Dataset and is specified to contain: (1) all subwatersheds that intersect the JNF boundaries and the Project Area, (2) all subwatersheds upstream of the intersecting subwatersheds (i.e., all upstream catchment areas), and (3) subwatersheds downstream of the intersecting subwatersheds that demonstrate substantial increases in cumulative sediment loads (i.e., > 10 %; Figure 1).

The Project is contained within four subbasins belonging to three different hydrologic regions:

- Upper New (8-digit HUC 05050001) and Middle New (05050002) subbasins of the Ohio Region
- Upper James Subbasin (8-digit HUC 02080201) of the Mid-Atlantic Region
- Upper Roanoke Subbasin (8-digit HUC 03010101) of the South Atlantic-Gulf Region

Of 243 subwatersheds within these three subbasins, 5 subwatersheds intersect both the JNF and the Project's Limits of Disturbance (LOD; Table 1).



Stream

Proposed Route (Project)

Subwatershed

Hydrologic Study Area

Jefferson National Forest (JNF) Boundary

Intersecting JNF and Project Subwatershed

N

W E

S

Figure 1. Hydrologic study area for the Mountain Valley Pipeline within the Jefferson National Forest in Virginia and West Virginia.

Project No. 593

0 10 20 Miles

Base Map: "US Topographic Maps"

ESI

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Table 1. Subwatersheds intersected by both the Jefferson National Forest (JNF) and the Mountain Valley Pipeline in Virginia and West Virginia.

Subwatershed Name	HUC12	State	Subwatershed Area (mi^2)*	Area within JNF (mi^2)*
Stony Creek	050500010902	VA,WV	48.9	39.6
Clendennin Creek-Bluestone Lake	050500020403	VA,WV	38.9	7.5
Rich Creek	050500020601	VA,WV	53.3	1.3
Trout Creek-Craig Creek	050500020501	VA	51.9	38.4
Dry Run-North Fork Roanoke River	030101010201	VA	51.3	3.3

* Subwatershed Area and Area within JNF are estimates of the total area of the subwatershed and the area of the subwatershed that is contained in the JNF, respectively.

The Stony Creek Subwatershed is a headwater subwatershed that contains Laurel Branch, Iron Spring Branch, Dixon Branch, Pine Swamp Branch, Kimballton Branch, North Fork Stony Creek, and Stony Creek. The outlet of the subwatershed is outside the JNF where Stony Creek flows into the New River.

The Clendennin Creek-Bluestone Lake Subwatershed is downstream of the Stony Creek Subwatershed and largely comprises an area draining directly to the mainstem of the New River but also contains several tributaries including Clendennin Creek, Curve Branch, Limestone Creek, and Piney Creek. The subwateshed predominantly drains private lands, but the headwaters of Clendennin Creek and Curve Branch originate within the JNF and portions of the catchment of the mainstem New River are also within the JNF.

Near the outlet of the Clendennin Creek-Bluestone Lake Subwatershed, the Rich Creek Subwatershed meets the mainstem of the New River. This headwater subwatershed contains Brush Creek, Crooked Creek, Crooked Run, Dry Creek, Painter Run, Rich Creek, Scott Branch, and Tigger Run. Only a small proportion of the Rich Creek Subwatershed is contained within the JNF, and only streams within the southwestern portion of subwatershed drain JNF lands.

The Trout Creek-Craig Creek Subwatershed is a headwater system of the Upper James that contains Craig Creek, Trout Creek, Mill Creek, Turnpike Creek, Cabin Branch, Adaline Branch, Sandy Branch, Muddy Branch, Dickey Farm Branch, and Pickles Branch. The majority of the subwatershed is within the JNF; however, much of the Craig Creek mainstem and surrounding floodplain are not contained within the jurisdictional boundaries of the JNF.

A small portion (0.35 acre) of Project is proposed to intersect the JNF and the Dry Run-North Fork Roanoke River Subwatershed. This subwatershed is a headwater system of the Upper Roanoke that drains to the North Fork Roanoke River and contains Wright Branch, Smith Run, Slate Lick Run, Sites Branch, Pepper Run, Mill Creek, Indian Run, Gallion Branch, and Dry Run.

2.2 Impact Approach

The following approach is taken to estimate soil loss rates from Project construction. The RUSLE, as described below, is used to estimate sediment loads (metric tons yr^{-1}) and sediment yields (metric tons/mi^2 yr^{-1}) for subwatersehds within the hydrologic study area (Figure 1). These calculations are made using both current and expected land use classes during construction of the Project and are used as different treatments. Current sediment loads and yields are considered baseline conditions (i.e., baseline treatment) and provide a measure of the present sediment loads within each subwatershed in the vicinity of the Project. This baseline treatment is then used to assess potential increases of soil loss expected under Project construction (i.e., proposed action treatment).

In order to simulate construction impacts, areas within the construction LOD are reclassified to bare-soil (see Section 2.3.4 below) (Galetovic 1998), which have higher predicted soil loss rates than any other land class used in the analysis. The model is then reapplied and results are compared to baseline conditions to assess the potential impact of Project construction. This analysis exclusively focuses on sediment increases due to pipeline construction, but soil losses after the land has been revegetated are expected to be similar to those of a shrub/scrub landscape.

2.3 Estimating Erosion and Soil Loss

Soil loss is calculated for all subwatersheds within the hydrologic study area using the RUSLE. The RUSLE takes the product of several derived metrics in order to estimate expected soil loss under different land use, management, topographic, and climatic conditions. Sediment load (A) is estimated at a rate of metric tons $year^{-1}$ using the following equation:

$$A = R \times K \times (L \times S) \times C \times P, \qquad \text{Eq. 1}$$

where R is the erositvity index, K is the soil erodibility factor, L is the slope length factor, S is the slope steepness factor, C is a cover-management or land use factor, and P is a support practice factor. These factors, along with their respective derivations are discussed further below.

2.3.1 Soil Erosivity Factor

Because the RUSLE does not directly model hydrology, runoff estimates are not available to simulate erosion; instead, a rainfall erosivity factor is calculated that characterizes the potential effect of runoff on soil erosion. To calculate R, average annual precipitation estimates (PRISM Climate Group 2012) from 1980 to 2010 are used within the following formula:

$$R = 0.059 \times 0.0483 \times P^{1.61}, \qquad \text{Eq. 2}$$

where P is precipitation expected within a raster cell (in millimeters), and R is the rainfall erosivity in hundreds of foot-ton-inch acre^{-1} hour^{-1} year^{-1} (Renard and Freimund 1994). In this equation, 1.61 and 0.0483 are estimated regression coefficients from Renard and Freimund (1994), and 0.059 is a conversion factor to U.S. customary units. Note that in this approach, annual estimates are used due to the complexity of integrating the RUSLE into the Geographical Information System (GIS) environment (see below); however, rainfall changes seasonally, thus sedimentation impacts may depend on the season in which construction takes place.

2.3.2 Soil Erodibility Factor

The soil erodibility factor (K) accounts for variability in the inherent erodibility of soils and is a function of integrated influences, including infiltration, rainfall, composition, and overland runoff. Fortunately, this metric is currently available within the National Resources Conservation Service's SSURGO (Soil Survey Staff 2015a) and STATSGO2 (Soil Survey Staff 2015b) soil databases. Note that although the K-factor is available in these datasets, it needs to be aggregated among soil components and horizons. To accomplish this, the kwfact parameter (K-factor, Whole Soil) from the dominant condition among components is used, and no aggregation is made among horizons but rather the surface layer is used instead.

In most areas within the hydrologic study area, the more detailed SSURGO dataset is used, but SSURGO K-factors are not readily available in all areas. Specifically, this value was not populated for surface layers in SSURGO soil map area VA606. Therefore, when SSURGO data are not available, the kwfact is calculated with STATSGO2 K-factors, which have lower resolution but sufficient correspondence with SSURGO factors (Breiby 2006)

2.3.3 Topographic Factor

The L and S factors within the RUSLE individually represent slope length and steepness, respectively, but combine to form what is known as a topographic factor. This topographic factor is a function of the landscape terrain. Following Moore and Wilson (1992)_ENREF_9, LS for each raster cell i is calculated as:

$$LS_i = \left(\frac{A_{s_i}}{22.13}\right)^m \times \left(\frac{\sin \beta_i}{0.0896}\right) \times (m+1), \qquad \text{Eq. 3}$$

where A_{s_i} is the specific catchment area or the upslope contributing area per unit width of contour, β is the slope angle in radians, and m and n are constants. The specific catchment area is calculated as the product of a flow accumulation estimate and the cell resolution (e.g., 10 meters) and results in the units of square meters per meter (m^2 m^{-1}). As suggested by Galetovic (1998), the slope length component of this equation is truncated at 400 feet (121.92 m). Although the values of m and n can vary among different terrains, the parameters typically range from 0.4 to 0.6 and 1.0 to 1.4, respectively. For this analysis, m and n are set at 0.4 and 1.0, respectively. These values are chosen because of the high forest cover and complex topography (Oliveria et al. 2013)

2.3.4 Cover and Management Factor

The cover and management factor (C) accounts for the effects of vegetation, management, and erosion control practices. In the hydrologic sedimentation analysis for the JNF, baseline C-factors are generated from the 2011 National Land Cover Database (NLCD; Homer et al. 2015) using the values listed in Table 2, which are taken from several literature sources, including Dissmeyer and Foster (1980), Galetovic (1998), Mitasova et al. (2001), and MTDEQ (2006). To simulate the disruption caused by pipeline and associated access roads a C-factor of 1 is used for a 125-foot (38.1-meters) construction corridor around the centerline for the proposed action treatment (Table 2). Note that although additional temporary workspaces (ATWS) are not explicitly incorporated into the analysis, all proposed ATWS within the JNF (n=5) are within the designated 125-foot construction corridor that is used for the analysis.

Table 2. Conservation and management factors applied for different land uses within the study area.

Vegetative Cover Type	Management Factor ($\boldsymbol{C}$)
Deciduous Forest	0.003
Evergreen Forest	0.003
Mixed Forest	0.003
Woody Wetlands	0.006
Developed Open Space	0.003
Developed, Low Intensity	0.001
Developed, Medium Intensity	0.001
Developed, High Intensity	0.001
Shrub/Scrub	0.010
Emergent Herbaceous Wetlands	0.003
Cultivated Crops	0.100
Pasture/Hay	0.010
Grassland/Herbaceous	0.010
Open Water	0.000
Barren Land	0.001
Pipeline or Access Road Construction	1.000

2.3.5 Practice Factor

The support practice factor is incorporated into the MUSLE to account for agricultural conservation practices and erosion and sediment control measures. Since present conservation practices for the entire study area are not available, a P factor of 1 is used. Note that applying a P factor of 1 likely overestimates the soil loss due to construction projects and agricultural practices. According to a review conducted by the U.S. Environmental Protection Agency (USEPA 1993), soil containment may average as high as 85 percent under proper application of soil and erosion control best management practices (BMPs); however, this estimate was in reference to coastal areas, and given the complexity of the terrain within the JNF, containment from BMPs will likely be less than 85 percent but still substantial.

2.4 Estimating Sediment Delivery

The RUSLE provides an estimate of the expected soil loss per unit of interest for the entire study area; however, not all sediment is expected to continue into downstream areas. The proportion that does continue downstream is expected to vary with catchment size, with the headwaters producing relatively more sediment than lower, flatter portions of the watershed. Based on this concept, sediment ratios are used to predict the proportion of sediment expected to reach the outlet of each subwatershed. More specifically, the sediment delivery ratio is modeled following Boyce (1975) as:

$$SDR_w = 0.31 \times A_w^{-0.3}, \qquad \text{Eq. 4}$$

where A_w is the area of the subwatershed and SDR_w is the estimated sediment delivery ratio. Thus, to calculate the expected net sediment load (L_w) for the subwatershed, the following equation based from Fernandez et al. (2003) is used:

$$L_w = \sum_{i=1}^{n} SDR_w \times A_i * a, \qquad \text{Eq. 5}$$

where i indexes the n raster cells within the subwatershed, A_i is the expected sediment loss for cell i based on the RULSE from Eq. 1, and a is a conversion factor from square meters to acres. In this study 10-meter resolution rasters are used with a cell area of 100 square meters. Thus, a is equal to 0.0247105.

Calculating sediment loads in this manner assumes sediments are continually transported downstream and accumulate over time; however, most sediments will likely stop at the nearest dam. Although the ultimate fate of anthropogenic sediments are estuarine and/or marine environments (e.g., Gulf of Mexico), instream impoundments (e.g., mill, low-head, reservoir, etc.) can arrest the majority of these sediments (Maneux et al. 2001).

Using these sediment loads, sediment yields (Y_w) are calculated by dividing the load by the area of the subwatershed.

2.5 Data Analysis

Using the RUSLE, sediment loads and yields are compared for both baseline and proposed action treatments. All parameters are developed within a GIS environment using a 10-meter resolution. Given that the NLCD has a coarser resolution, nearest neighbor resampling is used to align the database with other datasets.

Note that the RUSLE analysis is performed using the entire MVP line within the intersecting subwatersheds of the JNF and not just the construction corridor within the JNF. Thus, impacts within the study area include actions outside of the JNF. In order to estimate the potential impacts of actions on JNF lands, the sediment load above baseline for each subwatershed is multiplied by the proportion of the LOD that is contained within the JNF jurisdictional boundaries.

3.0 Results

One hundred and seven subwatersheds are within the hydrologic study area for the proposed action. These subwatersheds contain a cumulative drainage area of 3,943.5 square miles spanning over the continental divide with 3,676.8 square miles draining to the New River, 111.7 square miles draining to the James River, and 51.3 square miles draining to the Roanoke River. The majority of the study area is forested (64%), but developed and planted/cultivated land uses account for 7 and 27 percent, respectively, according to the 2011 NLCD. Approximately 12.1 percent (478 mi^2) of the study area is within the JNF.

The proposed action within the JNF is largely confined to three subwatersheds within the study area: Stony Creek, Clendennin Creek-Bluestone Lake, and Trout Creek-Craig Creek. In addition to these subwatersheds, the proposed action also crosses the Rich Creek (050500020601) and Dry Run-North Fork Roanoke River (030101010201) subwatersheds; however, the proposed action only comprises less than 0.02 percent of each of these catchments (0.31 and 4.71 ac, respectively).

3.1 Baseline Erosion and Soil Loss

Calculated using a weighted mean, baseline soil yields within the study area are projected at 82.1 tons per square mile per year. Expected soil yields are greatest within the Upper Roanoke portion of the study area (87.4 tons/mi^2 yr^{-1}) and lowest within the Lower New River portion of the study area (71.7 tons/mi^2 yr^{-1}). Within subwatersheds crossed by the proposed Project, baseline sediment yields range from 50.2 to 87.4 tons per square mile per year (Table 3). Given the large hydrologic study area, sediment loads in streams downstream of the Project area vary greatly. As expected, total sediment loads (i.e., loads accounting for all upstream catchment areas) are smallest with the headwater systems and increase with catchment area (Table 4). At the three most downstream points within the study area in the New River, Craig Creek, and North Fork Roanoke River, expected baseline sediment loads are 310; 367; 5,850; and 4,480 tons per year, respectively.

Table 3. Predicted yearly sediment yields and loads for baseline and proposed action conditions for Mountain Valley Pipeline Project in intersecting subwatersheds within the Jefferson National Forest.

Subwatershed Name	Area (mi^2)	LOD (mi^2)	LOD in JNF (mi^2)	Sediment Yield ($tons/mi^2 yr^{-1}$)		Baseline Sediment Load* ($tons\ yr^{-1}$)	Load Above Baseline for Actions on All Lands		Load Above Baseline for Actions on JNF Lands	
				Baseline	Proposed		Load* ($tons\ yr^{-1}$)	Percent Increase	Load* ($tons\ yr^{-1}$)	Percent Increase
Rich Creek	53.3	0.27	0.01	61.17	85.58	3260.69	1300.94	39.90	34.91	1.07
Stony Creek	48.9	0.46	0.15	70.43	116.25	3442.75	2240.12	65.07	705.92	20.50
Clendennin Creek-Bluestone Lake	38.9	0.22	0.19	50.23	97.98	1955.72	1859.14	95.06	1614.34	82.54
Trout Creek-Craig Creek	51.9	0.12	0.09	58.64	69.75	3041.75	576.24	18.94	434.93	14.30
Dry Run-North Fork Roanoke River	51.3	0.53	<0.01	87.38	151.53	4479.55	3288.62	73.41	3.35	0.07

* Sediment loads are presented only for the subwatershed and do not account for upstream subwatersheds.

Table 4. Total expected sediment loads in downstream streams and associated percent increase in sediment loads expected from Mountain Valley Pipeline Project in the Jefferson National Forest.

				Load Above Baseline for Actions on All Lands		Load Above Baseline for Actions on JNF Lands	
Stream	Location	Drainage Area (mi^2)	Baseline Sediment Load (tons yr^{-1})	Load (tons yr^{-1})	Percent Increase	Load (tons yr^{-1})	Percent Increase
Stony Creek	Above Confluence with New River	48.90	3442.75	2240.12	65.07	705.92	20.50
New River	Below Confluence of Stony Creek	3679.19	305150.15	10899.49	3.57	705.92	0.23
Rich Creek	Above Confluence with New River	53.30	3260.69	1300.94	39.90	34.91	1.07
New River	Above Confluence of East River	3771.43	310366.56	14059.57	4.53	2355.18	0.76
Craig Creek	Below Confluence with Trout Creek	51.87	3041.75	576.25	18.94	434.93	14.30
Craig Creek	Above Confluence with Johns Creek	111.74	5850.43	576.25	9.85	434.93	7.43
North Fork Roanoke River	Above Confluence with Wilson Creek	51.30	4479.55	3288.62	73.41	3.35	0.07

3.2 Proposed Action Erosion and Soil Loss

Five subwatersheds that intersect the proposed route and the JNF have potential for temporarily increased sediment yields due to the proposed action (Table 3). In total, the rate of sediment expected to be displaced due to Project construction within the vicinity of the JNF is estimated at 9,265.06 tons per year or a 57 percent increase over baseline. It should be noted, however, that these estimates do not incorporate erosion and sediment control practices, and therefore, largely overestimate the impact of construction.

Model results suggest the highest expected percent increase in sediment load will occur within the Clendennin Creek – Bluestone Lake subwatershed (95%), and the smallest increase in sediment yield will occur within the Trout Creek – Craig Creek subwatershed (19 %). However, these estimates are based on proposed actions on JNF and private lands. Based on the proportion of the LOD contained in the JNF, total sediment expected to be displaced from actions on JNF lands is estimated at 2,793.46 tons per year or a 17.3 percent increase over baseline, but these estimates do not incorporate erosion and sediment control practices, which will substantially reduce sediment displacement. The highest sediment increases from actions on JNF lands are within the Clendennin Creek-Bluestone Lake subwatershed, and increased loads within Rich and Dry Run-North Fork Roanoke River subwatersheds represent only a 1.07 and 0.07 percent increase over baseline.

To better examine potential impacts on the biota of streams downstream of construction activities, sediment loads were also put into the context of actual stream segments with total sediment loads (Table 4). In this context, loads above baseline originate from subwatersheds crossed by the proposed action and are expected to be transported to streams downstream of the Project area outside the subwatershed of origin. Based on this approach, substantial increases in sediment loads from the proposed action are largely confined to headwater systems. This is true for actions on both private and JNF lands with the exception of the North Fork Roanoke River where a substantial amount of sediment detached from cumulative actions on private and JNF lands is expected to continue to downstream areas outside the hydrologic study area. Given the additional areas of the LOD within the upper Roanoke downstream of the hydrologic study area, increased sediment loads are likely to continue downstream until the sediment is arrested behind the first dam (i.e., Niagara Dam) or is deposited into Smith Mountain Lake. However, this area of impact is largely due to actions outside of the JNF. For actions occurring on the JNF, impacts in downstream areas outside of headwater subwatersheds are small (i.e., <10 %) with increases of sediment loads within the three most downstream points within the study area in the New River, Craig Creek, and Roanoke River of 1.07, 7.43, and 0.07 percent, respectively (Table 4).

4.0 Conclusions

The proposed route of the MVP traverses the JNF by crossing five separate subwatersheds belonging to the New River, James River, and Roanoke River drainages. Results from the hydrologic analysis of sedimentation show that these subwatersheds are expected to experience temporary increases in sediment yield over baseline conditions during construction with the highest expected increases occurring within the Clendennin Creek-Bluestone Lake Subwatershed. Sediment loss from the proposed action will likely be transported into downstream streams and rivers; however predicted total sediment loads demonstrate that these impacts will largely be confined to the headwater and tributary systems.

As previously indicated, it is important to note that this hydrologic analysis of sedimentation applied for the Project did not incorporate erosion and sediment control measures or best management practices that will reduce sedimentation into these waterbodies, and thus, did not properly address the reductions in soil loss and sediment yield for the proposed action. Sediment yields are greatly influenced by the amount of bare soil exposed to erosive forces and the distance and method of transport of the eroded soil to the stream system. Therefore, measures that reduce the exposure of bare soil (e.g., gravel surfacing, rapid revegetation, mulching) and measures that reduce sediment transport (e.g., locating disturbances away from stream channels, installing erosion and sedimentation reduction measures) can substantially reduce sediment yield. The results presented in this analysis, therefore, represent a worst case scenario (i.e., no containment). However, MVP will implement specific conservation measures (i.e., erosion and sediment controls) to minimize impacts to waterways.

These measures will be outlined within MVP's sediment and erosion control plan that will be developed in conjunction with the JNF and Virginia Department of Environmental Quality.

5.0 Literature Cited

Boyce, R. C. 1975. Sediment routing with sediment selievery ratios. Pages 61-65 *in* Present and Prospective Technology for Predicting Sediment Yields and Sources: Proceedings of the Sediment-Yield Workshop. U.S. Department of Agriculture, Agricultural Research Service, ARS-S-40, Oxford, MS.

Breiby, T. 2006. Assessment of soil erosion risk within a subwatershed using GIS and RUSLE with a comparative analysis of the use of STATSGO and SSURGO soil databases. Volume 8, Papers in Resource Analysis. Saint Mary's University of Minnesota Central Services Press, Winona, MN.

Dissmeyer, G. E. and G. E. Foster. 1980. A guide for predicting sheet and rill erosion on forest land. U.S. Department of Agriculture, U.S. Forest Service, Southeastern Area, Technical Publication SA-TP 11, Atlanta, GA. 40 pp.

Fernandez, C., J. Q. Wu, D. K. McCool, and C. O. Stockle. 2003. Estimating water erosion and seimdent yield with GIS, RULSE, and SEDD. Journal of Soil and Water Conservation 58:128-136.

Galetovic, J. R. 1998. Guidelines for the use of the Revised Universal Soil Loss Equation (RUSLE) version 1.06 on mined lands, construction sites, and reclaimed lands. T. J. Toy and G. R. Foster, eds. The Office of Technology Transfer, Western Regional Coordinating Center, Office of Surface Mining, Denver, Colorado. 148 pp.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81:345-354.

Maneux, E., J. L. Probst, E. Veyssy, and H. Etcheber. 2001. Assessment of dam trapping efficiency from water residence time: application to fluvial sediment transport in the Adour, Dordogne, and Garonne River basins (France). Water Resources Research 37:801-811.

Mitasova, H., W. M. Brown, M. Hohmann, and S. Warren. 2001. Using soil erosion modeling for improved conservation planning: a gis-based tutorial. University of Illinois at Urban-Champaign, Geographic Modeling Systems Laboratory, Champaign, IL. Available online at http://www4.ncsu.edu/~hmitaso/gmslab/reports/CerlErosionTutorial/denix/denixstart.html.

Moore, I. D. and J. P. Wilson. 1992. Length-slope factors for the Revised Universal Soil Loss Equation: simplified method of estimation. Journal of Soil and Water Conservation 47:423-428.

MTDEQ. 2006. Ruby River watershed total maximum daily loads and framework for a water quality restoration plan. Montanta Department of Environmental Quality, Helena, MT. 658 pp.

Oliveria, A. H., M. A. da Silva, M. L. N. Silva, N. Curi, G. K. Neto, and D. A. F. de Freitas. 2013. Development of topographic factor modeling for application in soil erosion models. Pages 111-138 *in* Soil Processes and Current Trends in Quality Assessment (M. C. H. Soriano, ed.). InTech, Rijeka, Crotia. 433 pp.

PRISM Climate Group. 2012. Precipitation normals 1981-2010. Oregon State University, Corvallis, Oregon. Available online at http://www.prism.oregonstate.edu/normals/.

Renard, K. G., G. R. Foster, G. A. Weesies, D. K. McCool, and S. C. Yoder. 1997. Predicting soil erosion by water: a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook No. 703, 404 pp.

Renard, K. G. and J. R. Freimund. 1994. Using monthly precipitation data to estimate the R-factor in the revised USLE. Journal of Hydrology 157:287-306.

Soil Survey Staff. 2015a. Soil Survey Geographic (SSURGO) Database. U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

Soil Survey Staff. 2015b. U.S. General Soil Map (STATSGO2). U.S. Department of Agriculture, Natural Resources Conservation Service. Available online at http://sdmdataaccess.nrcs.usda.gov/.

USEPA. 1993. Guidance specifying management measures for sources of nonpoint pollution in coastal waters. U.S. Environmental Protection Agency, Office of Water, Washington D.C. 822 pp.