MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6 – Geologic Resources

November 2018

MVP Southgate Project
Resource Report 6 – Geologic Resources

Resource Report 6 - Filing Requirements	
Information	**Location in Resource Report**
Minimum Filing Requirements	
1. Identify the location (by milepost) of mineral resources and any planned or active surface mines crossed by the proposed facilities. (§380.12 (h) (1 & 2)). • Describe hazards to the facilities from mining activities, including subsidence, blasting, slumping or landslides or other ground failure.	Section 6.4
2. Identify any geologic hazards to the proposed facilities. (§380.12 (h) (2)) • For the offshore, this information is needed on a mile-by-mile basis and will require completion of geophysical and other surveys before filing.	Section 6.5
3. Discuss the need for and locations where blasting may be necessary in order to construct the proposed facilities. (§380.12 (h) (3))	Section 6.3
4. For LNG Projects in seismic areas, the materials required by "Data Requirements for the Seismic Review of LNG Facilities," NBSIR84-2833. (§380.12 (h) (5))	Not Applicable (not an LNG project)
5. For underground storage facilities, how drilling activity by others within or adjacent to the facilities would be monitored, and how old wells would be located and monitored within the facility boundaries. (§380.12 (h) (6))	Not Applicable (no underground storage proposed)
Additional Information Often Missing and Resulting in Data Requests	
6. Identify any sensitive paleontological resource areas crossed by the proposed facilities. (Usually only if raised in scoping or required by land-managing agency.)	Section 6.6
7. Briefly summarize the physiography and bedrock geology of the project area.	Section 6.2
8. If proposed pipeline crosses active drilling areas, describe plan for coordinating with drillers to ensure early identification of other companies' planned new wells, gathering lines, and aboveground facilities.	Not Applicable
9. If the application is for underground storage facilities: • Describe monitoring of potential effects of the operation of adjacent storage or production facilities on the proposed facility, and vice versa; • Describe measures taken to locate and determine the condition of old oil wells within the field and buffer zone and how the applicant would reduce risk from failure of known and undiscovered wells; and • Identify and discuss safety and environmental safeguards required by state and federal drilling requirements	Not Applicable (no underground storage proposed)

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LIST OF ACRONYMS AND ABBREVIATIONS

FERC or Commission	Federal Energy Regulatory Commission
MLV	mainline valve
MP	milepost
Mountain Valley	Mountain Valley Pipeline, LLC
Project or Southgate Project	MVP Southgate Project
USGS	United States Geological Society

RESOURCE REPORT 6
GEOLOGIC RESOURCES

6.1 INTRODUCTION

Mountain Valley Pipeline, LLC ("Mountain Valley") is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission ("FERC" or "Commission") pursuant to Section 7(c) of the Natural Gas Act to construct and operate the MVP Southgate Project ("Southgate Project" or "Project"). The Southgate Project facilities will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. See Resource Report 1 (General Project Description) for additional Project information.

6.1.1 Environmental Resource Report Organization

Resource Report 6 is prepared and organized according to the FERC *Guidance Manual for Environmental Report Preparation* (February 2017). This report is organized by Project components and describes the existing geologic setting and resources, potential impacts, and mitigation in relation to the Project components. Section 6.2 describes the geologic setting; Section 6.3 describes locations along the pipeline with blasting potential; Section 6.4 describes mineral resources; Section 6.5 discusses geologic hazards; Section 6.6 discusses paleontological resources; and Section 6.7 presents the list of references that formed the basis for Resource Report 6.

6.2 GEOLOGIC SETTING

6.2.1 Pipeline Facilities

The Southgate Project pipeline will be located in Pittsylvania County, Virginia and Rockingham and Alamance Counties, North Carolina in the Piedmont Uplands Section of the Piedmont Physiographic Province (United States Geological Survey ["USGS"], 2004a). The Piedmont Province is the non-mountainous portion of the Appalachian Highland, one of the eight major geologic divisions of the United States. The Piedmont Province consists of deeply weathered bedrock and a relative paucity of solid outcrop. Bedrock is generally buried under a thick (6 to 65 feet) blanket of weathered rock that has formed clay-rich soils. Outcrops are commonly restricted to stream valleys where the soil layer has been removed by erosion. A variety of igneous and metamorphic rocks comprise the bedrock of the Piedmont province including schists, gneiss, and granite. Most of these rocks range in age from Proterozoic to Paleozoic and form the internal core of the ancient Appalachian mountain belt. The province is bounded on the east by the Fall Zone, which separates the province from the Coastal Plain (Fenneman, 1938).

The typical landscape of the Piedmont Upland is a rolling surface of gentle slopes without significant relief (i.e., 50 feet more or less elevation change) cut by or bounded by valleys of steeper slope and greater depth, often up to several hundred feet. The general slope is eastward toward the Coastal Plain. The inner (western) boundary of the province rises in elevation to 700 or 800 feet above mean sea level in northern Virginia and increases to 1,500 feet near the North Carolina boundary. Elevations fall below 1,500 feet in the Carolinas and reach 1,800 feet in Georgia (Fenneman, 1938). Elevations along the pipeline range from approximately 470 to 880 feet above mean sea level. Resource Report 1, Appendix 1-B includes topographic maps of the Southgate Project area.

6.2.2 Aboveground Facilities

Aboveground facilities include the construction of one new compressor station, four new meter (interconnect) stations, pig launchers and pig receivers, and mainline valves ("MLVs") that will be installed at various locations along the pipeline. Table 1.2-2 of Resource Report 1 provides a summary by location of the aboveground facilities for the Project, and these facilities are depicted on the topographic maps in Resource Report 1, Appendix 1-B. The aboveground facilities for the Project are located within the Piedmont Uplands Section of the Piedmont Physiographic Province as described in Section 6.2.1 above (USGS, 2004a). Elevations at these facilities are identified in Table 6.2-1 below.

Table 6.2-1

Elevations at the MVP Southgate Project Aboveground Facilities

Facility	Milepost	State / County	Approximate Minimum Elevation (feet above mean sea level)	Approximate Maximum Elevation (feet above mean sea level)
Lambert Compressor Station / Interconnect / MLV 1	0.0	Virginia / Pittsylvania	648	664
LN 3600 Interconnect	28.2	North Carolina / Rockingham	508	514
T-15 Dan River Interconnect / MLV 4	30.4	North Carolina / Rockingham	504	508
T-21 Haw River Interconnect / MLV 8	73.1	North Carolina / Alamance	484	508
MLV 2	7.4	Virginia / Pittsylvania	726	728
MLV 3	18.3	Virginia / Pittsylvania	660	662
MLV 5	42.2	North Carolina / Rockingham	732	732
MLV 6	55.1	North Carolina / Alamance	716	718
MLV 7	68.2	North Carolina / Alamance	556	558

6.2.3 Surficial Geologic Materials

A review of surficial geologic databases provided information regarding the nature of surficial deposits expected in the Project area. The pipeline transects primarily Holocene and Tertiary residual materials formed by weathering and breakdown of underlying rock in areas of steep to moderate slopes (Soller and Reheis, 2004). These sediments are poorly sorted and stratified ranging from clay to boulders in size and may contain organic material. Table 6.2-2 below summarizes surficial geology by milepost ("MP") in the vicinity of the Southgate Project facilities. Figure 6-A in Appendix 6-A illustrates surficial geology in the Project area.

Table 6.2-2

Surficial Materials in the MVP Southgate Project Area

Project Facilities	From Milepost	To Milepost	Surficial Geology Material
Pipeline Facilities			
H-605	0.00	0.14	Residual materials developed in sedimentary rocks, discontinuous
	0.14	0.44	Residual materials developed in bedrock, discontinuous
H-650	0.00	0.37	Residual materials developed in bedrock, discontinuous
	0.37	2.05	Residual materials developed in sedimentary rocks, discontinuous
	2.05	15.18	Residual materials developed in igneous and metamorphic rocks
	15.18	30.82	Residual materials developed in bedrock, discontinuous
	30.82	73.11	Residual materials developed in igneous and metamorphic rocks
Aboveground Facilities	**Area (acres)**	**Near Milepost**	---
Lambert Compressor Station / Interconnect / MLV 1	3.17	0	Residual materials developed in bedrock, discontinuous
MLV 2	0.02	7.4	Residual materials developed in igneous and metamorphic rocks
MLV 3	0.02	18.3	Residual materials developed in bedrock, discontinuous
LN 3600 Interconnect	0.66	28.2	Residual materials developed in bedrock, discontinuous
T-15 Dan River Interconnect / MLV4	0.68	30.4	Residual materials developed in bedrock, discontinuous
MLV 5	0.02	42.2	Residual materials developed in igneous and metamorphic rocks
MLV 6	0.02	55.1	Residual materials developed in igneous and metamorphic rocks
MLV 7	0.02	68.2	Residual materials developed in igneous and metamorphic rocks
T-21 Haw River Interconnect / MLV 8	0.66	73.1	Residual materials developed in igneous and metamorphic rocks

6.2.3.1 Pipeline Facilities

Residual materials developed in bedrock, discontinuous - These materials were formed by the partial chemical dissolution and physical disintegration of bedrock and, to a lesser extent, colluvial sediments. They include the modern soil profile and extend downward to unweathered rock. Depending on the composition of the source rock or colluvium, these materials can be generally fine- to coarse-grained and commonly are poorly sorted. Unlike mass-movement sediments (e.g., colluvium), these materials were not transported. This material is generally less than 10 feet thick and is patchy in distribution. Particularly in mountainous areas, exposed rock can more commonly be found than residual material (Soller et. al., 2009).

Residual materials developed in igneous and metamorphic rocks - These materials were formed by the partial chemical dissolution and physical disintegration of igneous and metamorphic rock and include the modern soil profile and extend downward to unweathered rock. Depending on the composition of the source rock or colluvium, these materials can be generally fine- to coarse-grained and commonly are poorly sorted. Unlike mass-movement sediments (e.g., colluvium), these materials were not transported. This material is generally less than 10 feet thick and, in many places, is patchy in distribution. Particularly in mountainous areas, exposed rock can more commonly be found than residual material (Soller et. al., 2009).

Residual materials developed in sedimentary rocks, discontinuous - These materials were formed by the partial chemical dissolution and physical disintegration of sedimentary rocks and include the modern soil profile and extend downward to unweathered rock. Depending on the composition of the source rock, these materials can be generally fine- to coarse-grained, and commonly are poorly sorted. Unlike mass-movement sediments (e.g., colluvium), these materials were not transported. This material is generally less than 10 feet thick, and is patchy in distribution. Particularly in mountainous areas, exposed rock can more commonly be found than residual material (Soller et. al., 2009).

6.2.3.2 Aboveground Facilities

Surficial materials underlying the Lambert Compressor Station / Interconnect/MLV 1, MLV 3, LN 3600 Interconnect, and T-15 Dan River Interconnect/MLV-4 consist of residual materials developed in bedrock, discontinuous. This surficial material is described in Section 6.2.3.1 above.

Surficial materials underlying the T-21 Haw River Interconnect/MLV 8, MLVs 2, 5, 6 and 7 consist of residual materials developed in igneous and metamorphic rocks. This surficial material is described in Section 6.2.3.1 above.

6.2.4 Bedrock

Bedrock located in the vicinity of the Southgate Project facilities is summarized by MP in Appendix 6-B and illustrated on Figure 6-B in Appendix 6-A. The bedrock types potentially encountered are described below (USGS, 2018).

6.2.4.1 Pipeline Facilities

Cambrian Leatherwood Granite (lw): Light-gray, medium- to coarse-grained, porphyritic biotite granite.

Proterozoic Z-Cambrian Alligator Back Formation (Zab): Light-gray, medium- to coarse-grained porphyroblastic garnet-mica schist; contains interbeds of dark-gray graphitic mica schist, calc-gneiss, mica gneiss, feldspathic quartzite with blue quartz granule beds, and garnet-hornblende schist.

Proterozoic Z-Cambrian Fork Mountain Formation (Zfm): Light- to medium-gray, fine- to medium grained, polydeformed and polymetamorphosed porphyroblastic aluminosilicate-mica schist, interlayered with medium-gray irregularly-layered garnetiferous biotite gneiss, migmatitic in part; calcsilicate granofels; amphibolite; rare white marble; and, coarse calc-quartzite lenses.

Cambrian/Late Proterozoic Biotite Gneiss and Schist (CZbg): Inequigranular and megacrystic; abundant potassic feldspar and garnet; interlayered and gradational with calc-silicate rock, sillimanite-mica schist, mica schist, and amphibolite. Contains small masses of granitic rock.

Cambrian/Late Proterozoic Felsic Mica Gneiss (CZfg): Interlayered with graphitic mica schist and mica-garnet schist, commonly with kyanite; minor hornblende gneiss.

Cambrian/Late Proterozoic Felsic Metavolcanic Rock (CZfv): Metamorphosed dacitic to rhyolitic flows and tuffs, light gray to greenish gray; interbedded with mafic and intermediate metavolcanic rock, meta-argillite, and metamudstone.

Cambrian/Late Proterozoic Garrisonville Mafic Complex (CZg): Fine- to coarse-grained, massive to foliated amphibolite and hornblendite with lesser metapyroxenite, metawebsterite, and metanorite.

Cambrian/Late Proterozoic Mafic Metavolcanic Rock (CZmv): Metamorphosed basaltic flows and tuffs, dark green to black; interbedded with felsic and intermediate metavolcanic rock and metamudstone.

Cambrian/Late Proterozoic Phyllite and Schist (CZph): Locally laminated and pyritic; includes phyllonite, sheared fine-grained metasediment, and metavolcanic rock. In Lilesville granite aureole, includes hornfels.

Proterozoic – Paleozoic Mylonite Gneiss (my): Includes protomylonite, mylonite, ultramylonite, and cataclastic rocks. Lithology highly variable, depending on the nature of the parent rock, and on intensive parameters and history of deformation.

Permian/Pennsylvanian Granitic Rock (PPg): Megacrystic to equigranular. Castalia, Lillington, Medoc Mountain, Sims, Contentnea Creek, and Elm City intrusives.

Paleozoic/Late Proterozoic Metamorphosed Gabbro and Diorite (PzZg): Foliated to massive.

Upper Triassic Newark Supergroup; Conglomerate, mixed clasts (TRc): Rounded to subangular pebbles, cobbles, and boulders of mixed lithologies including quartz, phyllite, quartzite, gneiss, schist, greenstone, and marble in a matrix of medium- to very-coarse-grained, reddish-brown to gray, locally arkosic, sandstone.

Triassic Newark Supergroup; Triassic Sandstone, Siltstone, Shale, and Coal (TRcs): Sandstone, fine- to coarse-grained, reddish-brown to gray, arkosic in places, micaceous, displays channel-type primary features. Siltstone light- to dark-gray, micaceous. Shale, light- to dark-gray, carbonaceous, micaceous, fossiliferous. Coal, bituminous, banded, moderate- to well-developed, fine- to medium-cleat, partings and inclusions of shale, siltstone, and sandstone

Triassic Newark Supergroup, Dan River Group; Cow Branch Formation (TRdc): Mudstone with minor sandstone, gray, laterally-continuous bedding. Intertongues with Stoneville and Pine Hall formations.

Triassic Newark Supergroup Dan River Group; Pine Hall Formation (TRdp): Sandstone, mudstone, and conglomerate, yellowish orange to brown.

Upper Triassic Newark Supergroup; Sandstone, undifferentiated (TRs): Fine- to coarse-grained, reddish-brown to gray, primary bedding features such as cross-beds, channel lags, and ripple marks , minor conglomerate, siltstone, and shale beds.

Upper Triassic Newark Supergroup; Triassic Sandstone, Siltstone, and Shale (TRss): Sandstone, very fine- to coarse-grained, reddish-brown to gray, micaceous, minor conglomerate beds. Siltstone, reddish-brown to gray, micaceous. Shale, reddish-brown, greenish-gray, gray, yellowish-brown, laminated, fossiliferous. Upward-fining sequences, discontinuous vertically and horizontally.

Proterozoic Z Ashe Formation (Zau): Light-gray, medium-grained muscovite and muscovite biotite gneiss with thick interbeds of muscovite schist and pebbly feldspathic quartzite. Thick lenses of garnet-hornblende schist locally mark the basal and upper contacts with the underlying basement gneiss and the overlying metapelites respectively. The unit is cut by dikes, sills and thick sheets of pegmatite and alaskite, especially concentrated along the zone of transitional contact with Alligator Back mica schist units.

6.2.4.2 Aboveground Facilities

Lambert Compressor Station / Interconnect / MLV 1

Upper Triassic Newark Supergroup; Triassic sandstone, siltstone, and shale (TRss): See description in Section 6.2.4.1 above.

LN 3600 Interconnect

Triassic Newark Supergroup, Dan River Group; Pine Hall Formation (TRdp): See description in Section 6.2.4.1 above.

T-15 Dan River Interconnect / MLV 4

Triassic Newark Supergroup, Dan River Group; Pine Hall Formation (TRdp): See description in Section 6.2.4.1 above.

T-21 Haw River Interconnect / MLV 8

Paleozoic/Late Proterozoic Metamorphosed Gabbro and Diorite (PzZg): See description in Section 6.2.4.1 above.

Mainline Valves

Bedrock underlying the MLV locations are identified in Appendix 6-B and are described in Section 6.2.4.1 above.

6.2.5 Geotechnical Engineering Investigations

The Project is conducting geotechnical investigations at the Lambert Compressor Station and in the vicinity of the proposed horizontal directional drill ("HDD") crossings to identify the subsurface conditions in these areas (see Resource Report 1, Section 1.4.1.1) and to aid in determining the feasibility of the HDD method. Results of the geotechnical investigations conducted to date are provided in Appendix 6-C. *[Note: The Project continues to conduct geotechnical investigations for the Southgate Project. Additional information will be provided in a supplemental filing expected to be filed in early 2019.]*

6.3 BLASTING

Areas where shallow bedrock may be encountered along the pipeline routes were based on attribute data obtained from the U.S. Department of Agriculture, Natural Resources Conservation Service Web Soil Survey (USDA/NRCS, 2018a) and are provided in Resource Report 7, Appendix 7-A. Appendix 7-A identifies the depth to bedrock along each pipeline route and at aboveground facilities. This information, along with geologic information provided in Appendix 6-B, provides preliminary locations of areas crossed by the pipeline where shallow depth to bedrock (less than five feet) may be present and is summarized in Appendix 6-B, Table 6-B-2. These areas may require blasting or other methods of mechanical rock removal during excavation of the pipeline trench. A table presenting areas where potential blasting may be completed and the General Blasting Plan are included in Appendix 6-D.

If required, blasting will be completed in accordance with applicable State and local regulations and performed by Virginia and North Carolina State-licensed blasters. Blasting activities will be monitored by experienced blasting inspectors. Large rock not suitable for use as backfill material will be disposed off-site or may be windrowed along the edge of the right-of-way in upland areas where the landowner has authorized placement.

6.4 MINERAL RESOURCES

Mineral resources mined in the Piedmont Province in Virginia include kyanite, slate, vermiculite, granite, gabro, diabase, and feldspar (VADEQ, 2018a).

Potential commercial mining of naturally occurring uranium deposits has been identified in the vicinity of the Project area at Coles Hill, in Pittsylvania County, Virginia. Two distinct areas have been explored, the North Exploration Area and the South Exploration Area, where the uranium ore body is exposed at the surface. The South Exploration Area is the area closest to the Project, located approximately 3.5 miles north of the Lambert Compressor Station (NRC, 2012; VADEQ, 2018b).

The uranium deposit at Coles Hill is located within privately owned land (Coles Hill LLC) in an area that has been described by others as a ‘restricted area’ and is exposed locally near the surface (PACGCI, 2007). The deposit then extends deep beneath ground surface (RTII, 2012; VU, 2018a). The exploration permit issued by the State of Virginia to Virginia Uranium Inc. allowed drilling that was targeted to a maximum hole depth of approximately 1,500 feet (VADEQ, 2018b).

Based on the distance from the Project and the depth below ground surface of the uranium deposit, there is no evidence to suggest the excavation required to support the Project will encounter the uranium deposit associated with Coles Hill. The Project activities are similar to other roadway and surface infrastructure projects that have been completed in closer proximity to Coles Hill than the Project. As a result, no impacts on uranium mining or to human health and the environment are anticipated during construction and operation of the Project and no monitoring or mitigation measures are proposed.

North Carolina leads the industrial minerals industry in the U.S. in the production of feldspar, lithium minerals, scrap mica, olivine, and pyrophllite; it also leads in the production of clay used for brick manufacturing. North Carolina ranks second in phosphate rock production. Additional mineral production in North Carolina consists of crushed stone, sand and gravel, dimension stone, kaolin, peat, and gem stones (NCDEQ, 2018). Mineral resources within 0.25 mile of the Project were identified from a review of topographic maps, USGS information and state databases (USGS, 2016a and VDMME, 2018a). One site was identified within 0.25 mile of the Project. The site is identified by the USGS as a plant including a rotary kiln and with a commodity type of bloating materials (i.e., for lightweight aggregate concrete products). The USGS database locates the plant approximately 0.2 mile west of MP 26.6 in Rockingham County, North Carolina. No active plant site is visible in this location based on review of available aerial photography. If currently active, based on the distance of the mine from the Project area, no impacts from construction or operation of the Project on the mining operation are anticipated.

The Southgate Project pipeline alignment is located approximately 0.1 miles from the East Alamance Quarry (“Quarry”) near MP 66.8 in Haw River, North Carolina. The Quarry is owned and operated by Martin Marietta Materials Inc. and operates under Permit No. 01-08 from the North Carolina Department of Environmental and Natural Resources. Martin Marietta owns approximately 600 acres, and currently has approximately 375 acres bonded through the permit for crushed stone aggregates. Permit No. 01-08 states the blasting restrictions present for the Quarry, including the restriction for a maximum peak particle velocity of 1.0 inches per second. Based on research from United States Department of the Interior, Bureau of Mines, 2.0 inches per second is an accepted value for blasting proximate to buried pipelines (USDOI, 1980).

The Project facilities will be designed, constructed, operated, and maintained by experienced firms in accordance with or to exceed minimum federal safety standards in 49 Code of Federal Regulations 192 (see Resource Report 11 for more detail). These regulations, which are intended to protect the public and to prevent natural gas facility accidents and failures, apply to all areas along the pipeline route. See Section 6.3 above for information on blasting. No effects on the quarry operation are anticipated from construction or operation of the Project.

No oil or gas wells (active, pending, or plugged) were identified within 0.25 mile of the Project area based on review of Virginia and North Carolina databases (VDMME, 2018b and NCGS, 2016).

6.5 GEOLOGIC HAZARDS

Geologic hazards are natural physical conditions that, when active, can impact environmental features and man-made structures and may present public safety concerns. Such hazards typically include seismicity, soil liquefaction, landslides, subsidence, and volcanism. The Southgate Project is reviewing the Project alignment for landslide or slip-prone areas. Additionally, the Project has contracted a geotechnical firm to assess the soil and rock composition at major waterbody crossings, railroads, and the Lambert Compressor Station (see Appendix 6-C).

6.5.1 Karst

The USGS has prepared maps illustrating karst or the potential for development of karst and pseudokarst features (USGS, 2004b). These maps show areas underlain by soluble rocks and also by volcanic rocks, sedimentary deposits, and permafrost that have potential for karst or pseudokarst development. Karst terrain maps for the Southgate Project area are presented on Figure 6-C in Appendix 6-A and illustrate potential karst terrain underlying the pipeline. Karst terrain crossings are identified by MP in Table 6.5-1 below.

Karst terrain is a landscape formed by the dissolution of soluble bedrock. Karst features form as the result of minerals dissolving out of the rock through rainwater. Slightly acidic rainwater leaches through the soil zone becoming more acidic. This acidic groundwater slowly dissolves the soluble bedrock. Over time, this persistent process can create extensive systems of underground fissures and caves. The surface of karst terrain is often pocked with depressions, and in well-developed karst terrain, chains of sinkholes form what are known as solution valleys and streams that frequently disappear underground. Karst terrain in the Southgate Project area consists of narrow marble belts in the Piedmont Province of Virginia (VDMME, 2015).

Table 6.5-1

Potential Karst Terrain crossed by the MVP Southgate Project Pipeline Facilities

County, State	From Milepost	To Milepost	Crossing Length (feet)	Rock Type	Construction Method
Pittsylvania, Virginia	0.03	1.00	3,696	conglomerate (covered by terrace deposits)	Open-cut and bore (road crossings)
Pittsylvania, Virginia	14.95	15.70	3,960	Conglomerate	Open-cut and bore (road crossings)
Pittsylvania, Virginia	21.20	21.50	1,584	Conglomerate	Open-cut and bore (road crossings)
Pittsylvania, Virginia	21.80	21.91	581	Conglomerate	Open-cut and bore (road crossing)
Pittsylvania, Virginia	22.12	22.30	950	Conglomerate	Open-cut and bore (road crossing)

Heinika, William S. and Paul A. Thayer. 1983. Geologic map of the Spring Garden Quadrangle, Va. Va. Division of Geology and Mineral Resources Publication 48, 1:24,000 scale map. Marr, J.D., Jr. 1984. Geologic map of the Pittsville and Chatham Quadrangles, Va. Va. Division of Geology and Mineral Resources Publication 49, 1:24,000 scale map. Price, V., J.F. Conley, R.G. Piepul, G.R. Robinson, P.A. Thayer, and W.S. Heinika, 1980. Geology of the Whitmell and Brosville quadrangles, Va. Publication 021, 1:24,000 scale map.

No caves or bat portals were identified along areas of karst terrain during field surveys.

The Southgate Project conducted a desktop review of peer-reviewed, publicly-available geologic mapping and determined that there is negligible potential for karst features and related karst hazards to be present within 0.25-mile of the Project alignment. While karst hazards are not anticipated, if karst features are observed during construction, the Southgate Project will employ a karst specialist to conduct a field investigation to inspect and characterize the karst features and potential for subsurface connectivity. The karst specialist will coordinate with the Project qualified geologist to conduct the field inspection and will notify the applicable agencies regarding the karst feature. If the karst feature is determined to have subsurface connectivity and present a potential hazard to pipeline construction and operation, or be a potential conduit to local groundwater resources, appropriate mitigation measures will be identified by the karst specialist, and will be discussed with the applicable agencies prior to implementation.

Potential mitigation measures that may be used are described in the Karst Hazards Assessment in Appendix 6-E.

6.5.2 Seismic Risk

During an earthquake, seismic waves travel out from an earthquake epicenter through the surrounding rock. Ground motion is higher closer to the event, or epicenter. In general, ground motion decreases away from the epicenter, though the amount of ground motion at the surface is related to more than just distance from the epicenter. Some natural materials can amplify ground motion; that is, ground motion is typically less on solid bedrock and greater on thick deposits of clay, sand, or artificial fill.

Seismic hazards can be assessed based on peak ground acceleration. During an earthquake, a particle attached to the earth will move back and forth irregularly. The horizontal force a structure must withstand during an earthquake is related to ground acceleration. Peak ground acceleration is the maximum acceleration experienced by a particle during an earthquake.

The USGS produces ground motion hazard maps at a given level of probability. Peak horizontal acceleration values are represented as a factor of "g". The factor "g" is equal to the acceleration of a falling object due to gravity. Review of the USGS Seismic Hazard Maps (USGS, 2014a and 2014b) for the Southgate Project area indicates the following:

- There is a 2 percent probability of a 6-8 percent "g" exceedance in 50 years in the Project area (illustrated on Figure 6-D in Appendix 6-A); and
- There is a 10 percent probability of a 2-3 percent "g" exceedance in 50 years in the Project area.

The USGS Quaternary Fold and Fault database was searched to identify any Quaternary faults that would be crossed or encountered by the Southgate Project facilities. No faults were identified in the vicinity of the Project facilities through review of the USGS database. Regional faults are presented in Appendix 6-F.

Seismic activity has been known for several decades to be strongest in and around Giles County and in central Virginia (VTSO, 2018), and earthquakes have also occurred in North Carolina (Taylor, 2014). Historical earthquakes within 50 miles of the Southgate Project facilities are also presented in Appendix 6-F. The Project facilities are located in a relatively lower seismic risk area as compared to other seismically active areas of the United States such as California and Alaska. Further, the facilities will be constructed to meet or exceed federal standards for natural gas pipeline safety (49 Code of Federal Regulations Part 192), and will be constructed in accordance with International Building Code IBC 2012 (Chapter 16 and Section 1613) and American Society of Civil Engineers ASCE 7-10, Minimum Design Loads for Buildings and Other Structures.

Based on the absence of quaternary faults crossed by the Southgate Project, the relatively low seismic risk in the Project area, and the Project's operation of existing facilities in the region, impacts from earthquake-related ground shaking are not anticipated to affect construction or operation of the Project.

6.5.3 Soil Liquefaction

Soil liquefaction is a process whereby the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. The result is a transformation of soil to a liquid state. Typically, three general factors are necessary for liquefaction to occur and can be used as a liquefaction hazard screening (USGS, 2014c). These factors are as follows:

- Presence of young (Pleistocene) sands and silts with very low or no clay content, naturally deposited (beach or river deposits, windblown deposits) or man-made land (hydraulic fill, backfill).
- Soils must be saturated where the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. This is most commonly observed near bodies of water such as rivers, lakes, bays, and oceans, and the associated wetlands.
- Severe shaking. This is most commonly caused by a large earthquake. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. This factor is limited by the distance from the large earthquake epicenter. That is, liquefaction potential decreases as location increases from the epicenter of a large earthquake.

No Pleistocene sands and silts were identified in the Southgate Project area (see Resource Report 7). While saturated soils are crossed by the pipeline alignment in some locations (see Resource Report 2), due to the relatively low seismic risk in the Project area and low probability for severe ground shaking, the likelihood of soil liquefaction to occur in the Project area is low.

6.5.4 Landslides

Landslides occur when rock, sediments, soils, and debris move down steep slopes. Such gravity-induced flow is usually precipitated by heavy rains, erosion by rivers, earthquakes, or human activities (e.g., man-made structures or piles of rock). Areas of unstable soils that may be susceptible to landslides may be characterized by soils that shrink or swell with changes in moisture content and are located in areas with steep relief. Landslide incidence and susceptibility mapping has been completed by the USGS for the Southgate Project area and is presented on Figure 6-E in Appendix 6-A (USGS, 2016b).

Portions of the pipeline will cross areas of steep slope (30 percent or greater). The Southgate Project identified areas potentially requiring steep slope construction through assessment of Lidar from Project flown imagery (April 2018). The Project is currently assessing the Lidar imagery and field verifying areas that may require steep slope construction. A table identifying potential locations of steep slopes crossed by the pipeline is provided in Appendix 6-G. Other factors considered include the orientation of the crossing with respect to the contours, or potential side-slope conditions (14 percent or greater). A table for side-slope conditions crossed by the pipelines are also located in Appendix 6-G.

The Southgate Project will employ special construction techniques where the slopes typically exceed 30 percent, or 14 percent with side slopes. In rugged terrain with vertical slopes, temporary sediment barriers, such as silt sock and reinforced silt fences will be installed during clearing to prevent movement of sediment off the right-of-way. In addition, temporary slope breakers may be installed during grading in accordance with the FERC Plan and the Project-specific E&SCP to reduce water runoff or divert water to vegetated areas. Construction activities on rugged terrain will be similar to the typical construction described in Resource Report 1, Section 1.4.1.1. Permanent slope breakers, or other post-construction stormwater controls, will be installed as needed during restoration.

6.5.5 Land Subsidence

Subsidence is the local downward movement of surface material with little or no horizontal movement. Common causes of land subsidence include dissolution of limestone in areas of karst terrain, over-pumping of groundwater aquifers, extraction of oil and gas from underground formations, and collapse of underground mines. Underground mining, oil and gas well production and large groundwater withdrawals were not identified in the Southgate Project area. Karst terrain can increase the potential for land subsidence and is addressed in Section 6.5.1.

6.5.6 Flooding

Flash floods result from significant rapid increases in water volume and flow rate within waterbodies and onto adjacent floodplains. A flash flood follows heavy or excessive rainfall in a short period of time, generally less than 6 hours. They can occur within minutes or a few hours of excessive rainfall, based on the size of the rain event and/or contributing watershed after a levee or dam has failed (NWS, 2010). Flash floods are more common in the western United States, because the soil is generally dry, sandy, and unable to absorb large amounts of water in a short period of time. Heavy precipitation events can fill dry stream and river beds quickly, sending significant volumes of water downstream. Review of the National Weather Service Experimental Long-Range River Flood Risk map (NWS, 2018) for the Southgate Project area indicates the following:

- There is a moderate (i.e., greater than 10 percent) long-range (July, August, September 2018) flood risk in the vicinity of the Project in Virginia; and,
- There is a less than 10 percent long-range (July, August, September 2018) flood risk in the vicinity of the Project in North Carolina.

Flooding can increase the buoyancy of pipelines, causing them to rise toward the land surface where they may be exposed. Buoyancy effects are probably of greatest concern in areas such as floodplains and river bottoms. To minimize the buoyancy effect upon the pipeline due to flooding in those areas, the pipeline will be designed with concrete coating, concrete weights or gravel-filled blankets, as applicable. In floodplain areas adjacent to waterbodies (see Resource Report 2), the topographic contours will be restored to as close to previously existing contours as practical such that there will be no net loss of flood storage capacity. Banks will be restored in accordance with the FERC (2013) Wetland and Waterbody Construction and Mitigation Procedures and the Southgate Project-specific Erosion & Sediment Control Plan to prevent scouring during rain events.

6.6 PALEONTOLOGICAL RESOURCES

In the Piedmont Province, fossils of dinosaur footprints, freshwater fish, and insects are found in rift basin deposits of the Triassic (William and Mary, 2015). Areas where fossils might be encountered along the pipeline alignment include shallow areas of sedimentary rock (see discussion of shallow bedrock in Section 6.3). Sedimentary rocks of Triassic age (i.e., sandstone, siltstone, and conglomerate) are generally present from approximate MP 0.0 to MP 0.6 and MP 15.0 to 18.7 in Pittsylvania County, Virginia and from approximate MP 24.7 to MP 31.2 at the border of Pittsylvania County, Virginia and Rockingham County, North Carolina. Elsewhere in the Southgate Project area metamorphic rocks including granite, gneiss, and schist are present. However, these rocks are not expected to contain fossils.

In the vicinity of the Southgate Project, the Solite Quarry is known for a variety of insect fossils from the Triassic as well as preserved plant parts, fish, and reptiles. The Solite Quarry straddles the North Carolina-Virginia border approximately 9 miles east of Project alignment at approximate MP 26.1. Fossils from the quarry are well preserved in lacustrine shales, mudstones, and sandstones in the Cow Branch Formation (William and Mary, 2018). No dinosaur body fossils have been found at the Solite Quarry; however, trace fossils indicate that dinosaurs were present in the area (Speights, 2018).

While a portion of the Project alignment crosses the Cow Branch Formation from (MP 26.1 to MP 28.9 and MP 29.4 to MP 31.1 in Rockingham, North Carolina), depth to bedrock in this same area is anticipated to be greater than five feet (see Resource Report 7). Based on the depth to bedrock and the anticipated pipeline trench depth of eight to ten feet, paleontological resources are not anticipated to be excavated during Project construction. Although excavation of paleontological resources is not anticipated, Environmental Inspectors will be trained regarding response if suspected paleontological resources are identified during site preparation or trench excavation. Additionally, the Project will provide pre-construction training to the construction contractors on the procedures to be followed should an unanticipated paleontological discovery be made. The Project's Unanticipated Discovery Plan for Paleontological Resources is included in Appendix 6-H.

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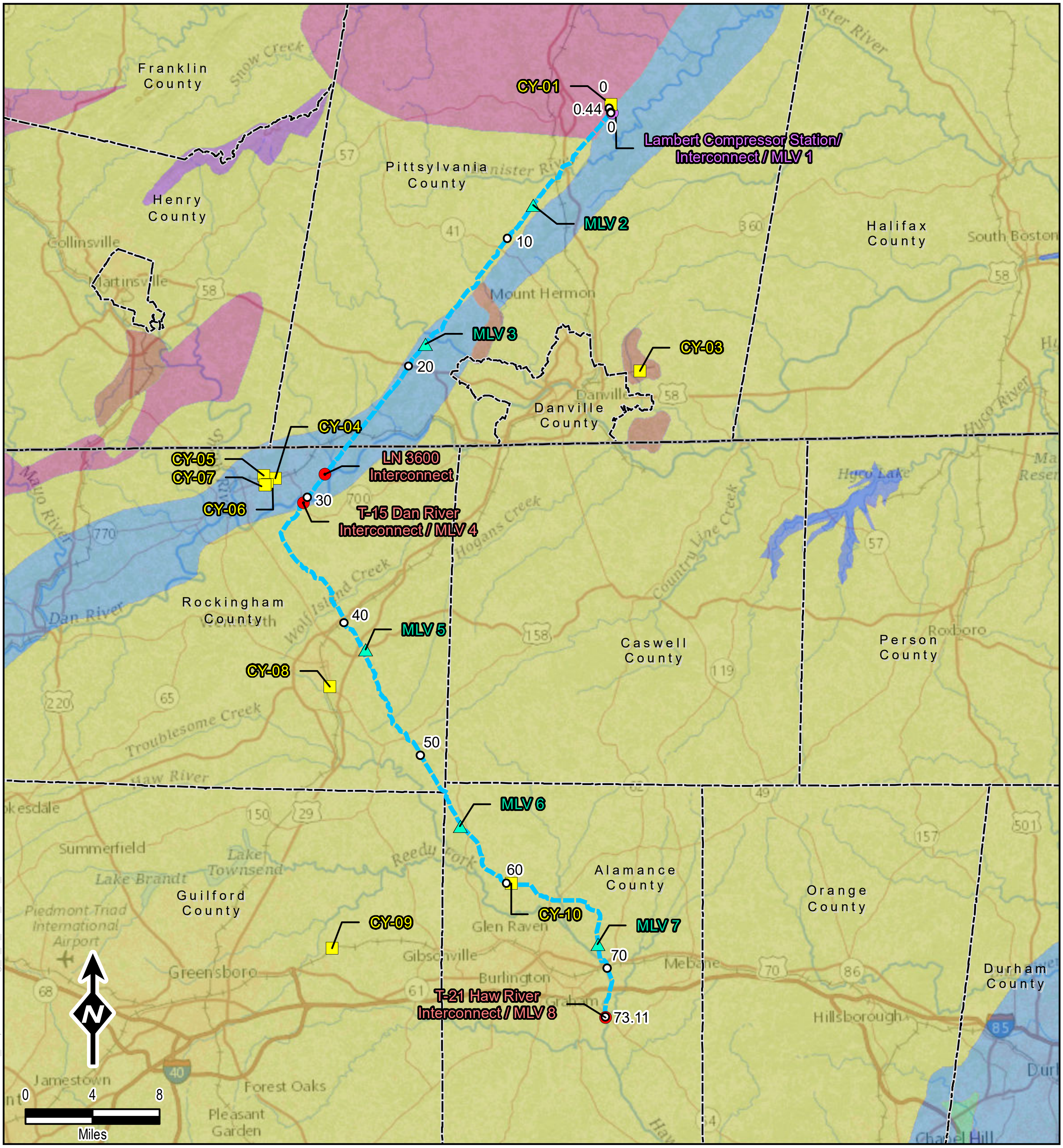
MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-A

Figures



Legend

- Mileposts
- Proposed Pipeline Route
- Compressor Station
- Contractor Yard
- Meter Station
- Valve Site
- State Boundary
- County Boundary

Surficial Geology

- Alluvial sediments, thin
- Colluvial sediments, discontinuous
- Residual materials developed in alluvial sediments
- Residual materials developed in bedrock, discontinuous
- Residual materials developed in igneous and metamorphic rocks
- Residual materials developed in sedimentary rocks, discontinuous
- Water

Data Sources: ESRI, USGS, TRC, EQT

1 inch = 8 miles
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 6-A

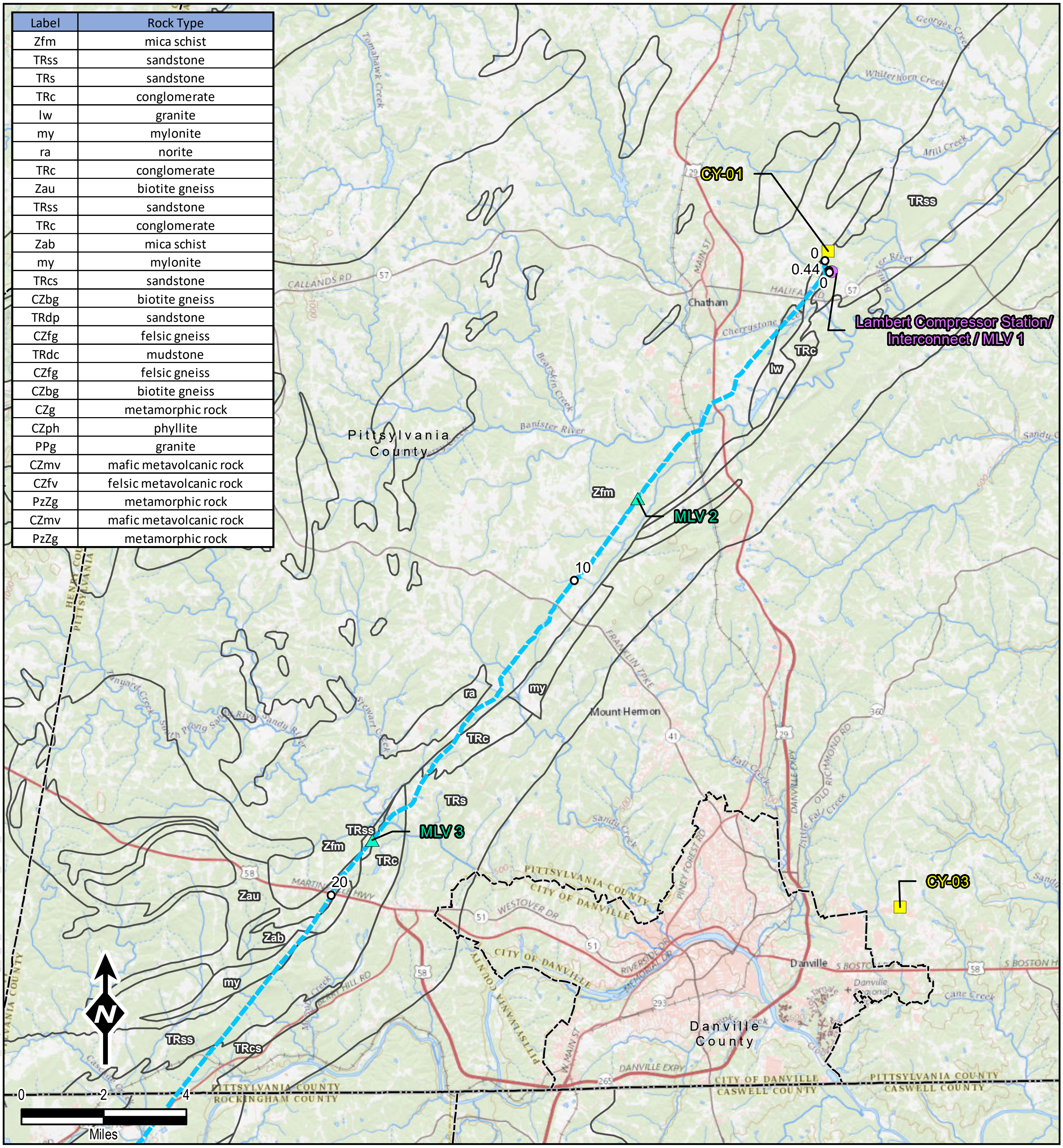
Surficial Geology of the MVP Southgate Project

TRC Results you can rely on

600 Willowbrook Ln
West Chester, PA 19382
October 2018

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\RR6\Fig_6_A_Geo_OCT_2018.mxd

Label	Rock Type
Zfm	mica schist
TRss	sandstone
TRs	sandstone
TRc	conglomerate
lw	granite
my	mylonite
ra	norite
TRc	conglomerate
Zau	biotite gneiss
TRss	sandstone
TRc	conglomerate
Zab	mica schist
my	mylonite
TRcs	sandstone
CZbg	biotite gneiss
TRdp	sandstone
CZfg	felsic gneiss
TRdc	mudstone
CZfg	felsic gneiss
CZbg	biotite gneiss
CZg	metamorphic rock
CZph	phyllite
PPg	granite
CZmv	mafic metavolcanic rock
CZfv	felsic metavolcanic rock
PzZg	metamorphic rock
CZmv	mafic metavolcanic rock
PzZg	metamorphic rock



Legend

- Mileposts
- Compressor Station
- Contractor Yard
- Meter Station
- Valve Site
- Proposed Pipeline Route
- Bedrock Geology
- State Boundary
- County Boundary

1 inch = 3.25 miles
When Printed 8.5x11

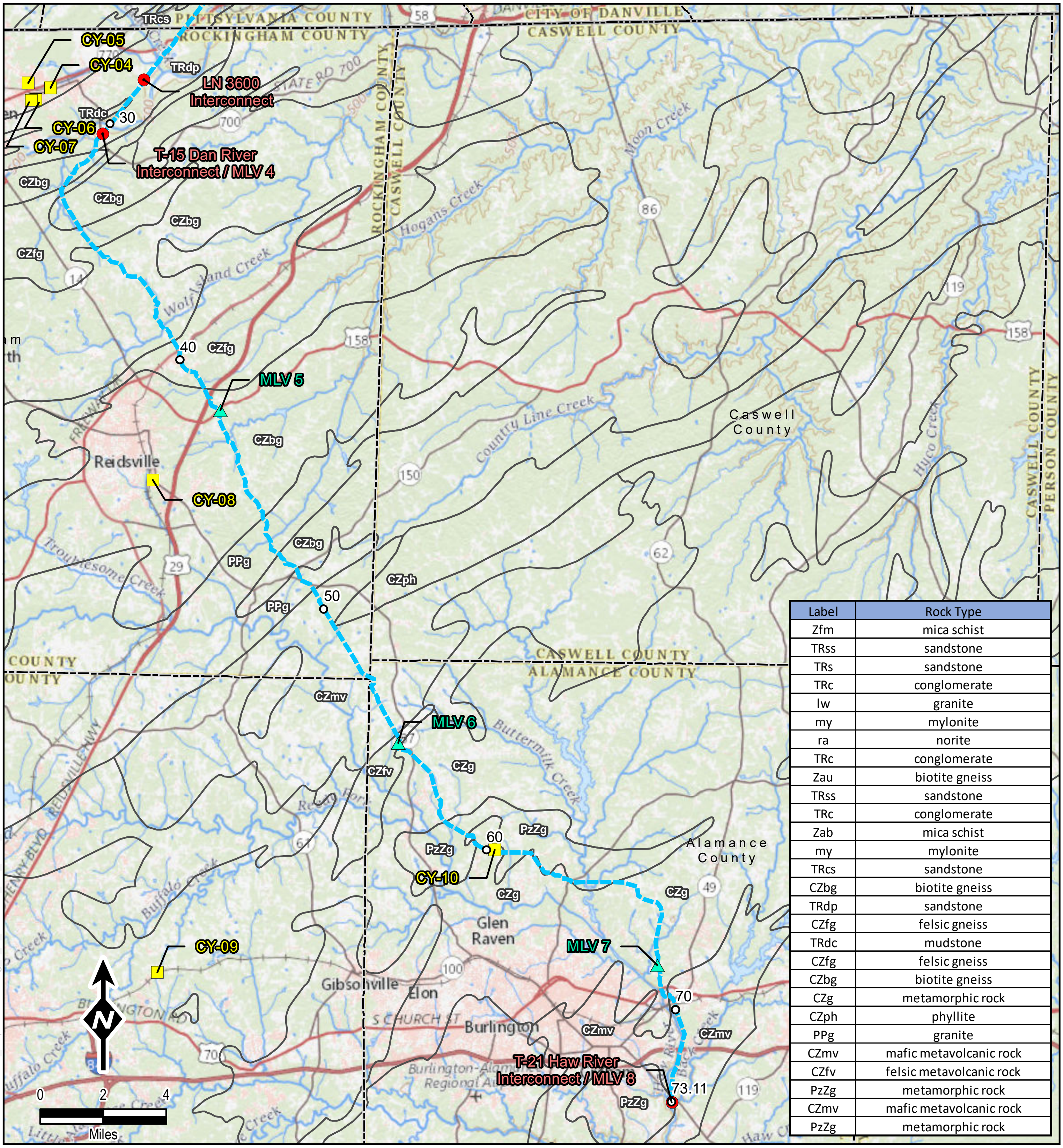
Data Sources: ESRI, USGS, TRC, EQT

Mountain Valley PIPELINE LLC

Figure 6-B
Sheet 1 of 2

Bedrock Geology of the
MVP Southgate Project

TRC Results you can rely on
600 Willowbrook Ln
West Chester, PA 19382
October 2018



Label	Rock Type
Zfm	mica schist
TRss	sandstone
TRs	sandstone
TRc	conglomerate
lw	granite
my	mylonite
ra	norite
TRc	conglomerate
Zau	biotite gneiss
TRss	sandstone
TRc	conglomerate
Zab	mica schist
my	mylonite
TRcs	sandstone
CZbg	biotite gneiss
TRdp	sandstone
CZfg	felsic gneiss
TRdc	mudstone
CZfg	felsic gneiss
CZbg	biotite gneiss
CZg	metamorphic rock
CZph	phyllite
PPg	granite
CZmv	mafic metavolcanic rock
CZfv	felsic metavolcanic rock
PzZg	metamorphic rock
CZmv	mafic metavolcanic rock
PzZg	metamorphic rock

Legend

- Mileposts
- Compressor Station
- Contractor Yard
- Meter Station
- Valve Site
- Proposed Pipeline Route
- Bedrock Geology
- State Boundary
- County Boundary

1 inch = 4.25 miles
When Printed 8.5x11

Data Sources: ESRI, USGS, TRC, EQT

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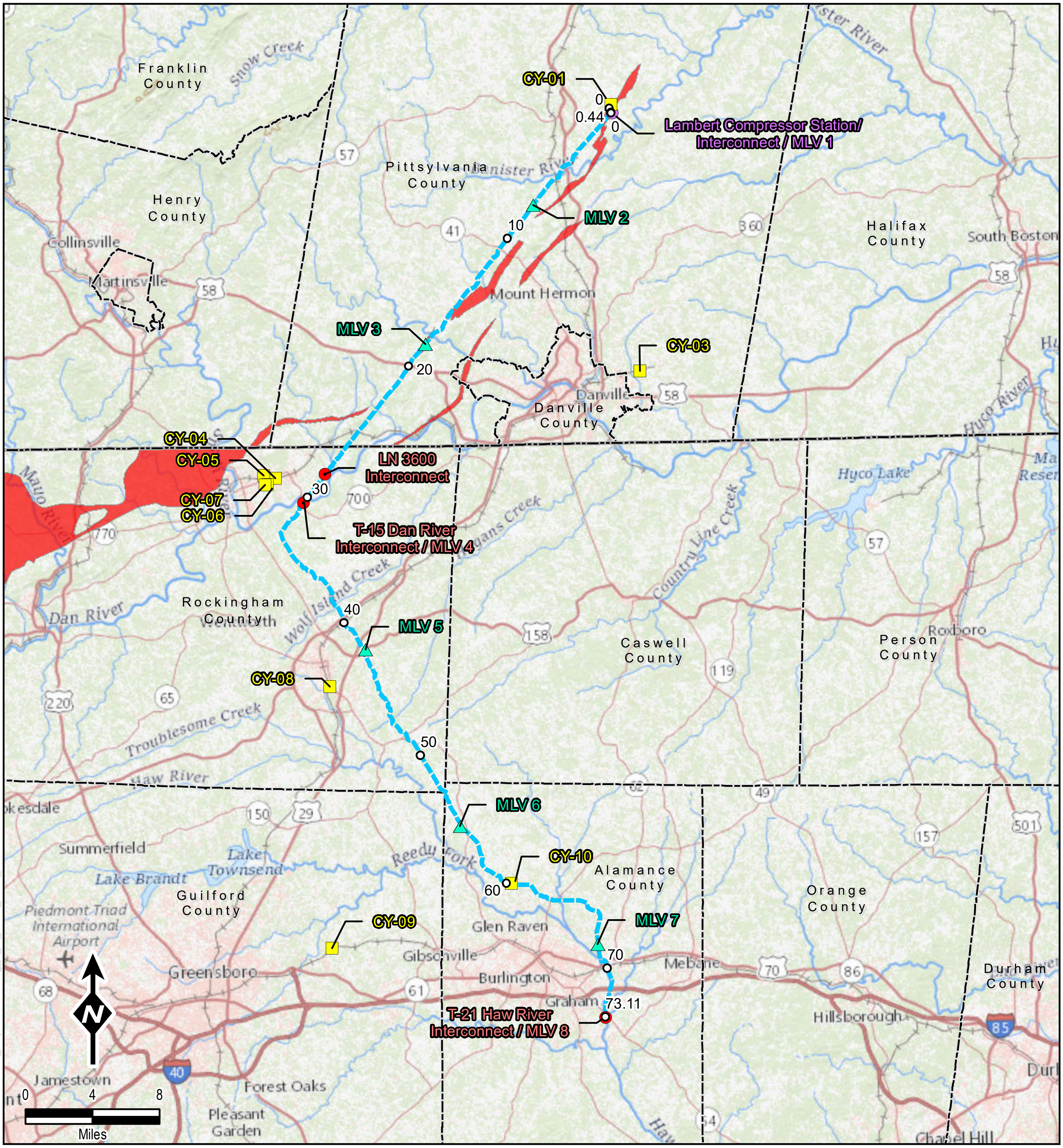
Figure 6-B
Sheet 2 of 2

Bedrock Geology of the MVP Southgate Project

TRC
600 Willowbrook Ln
West Chester, PA 19382
October 2018

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\RR6\Fig_6_B_Bedrock_NC_OCT_2018.mxd



Legend

- Mileposts
- Compressor Station
- Contractor Yard
- Meter Station
- Valve Site
- Karst Formations
- Proposed Pipeline Route
- State Boundary
- County Boundary

1 inch = 8 miles
When Printed 8.5x11

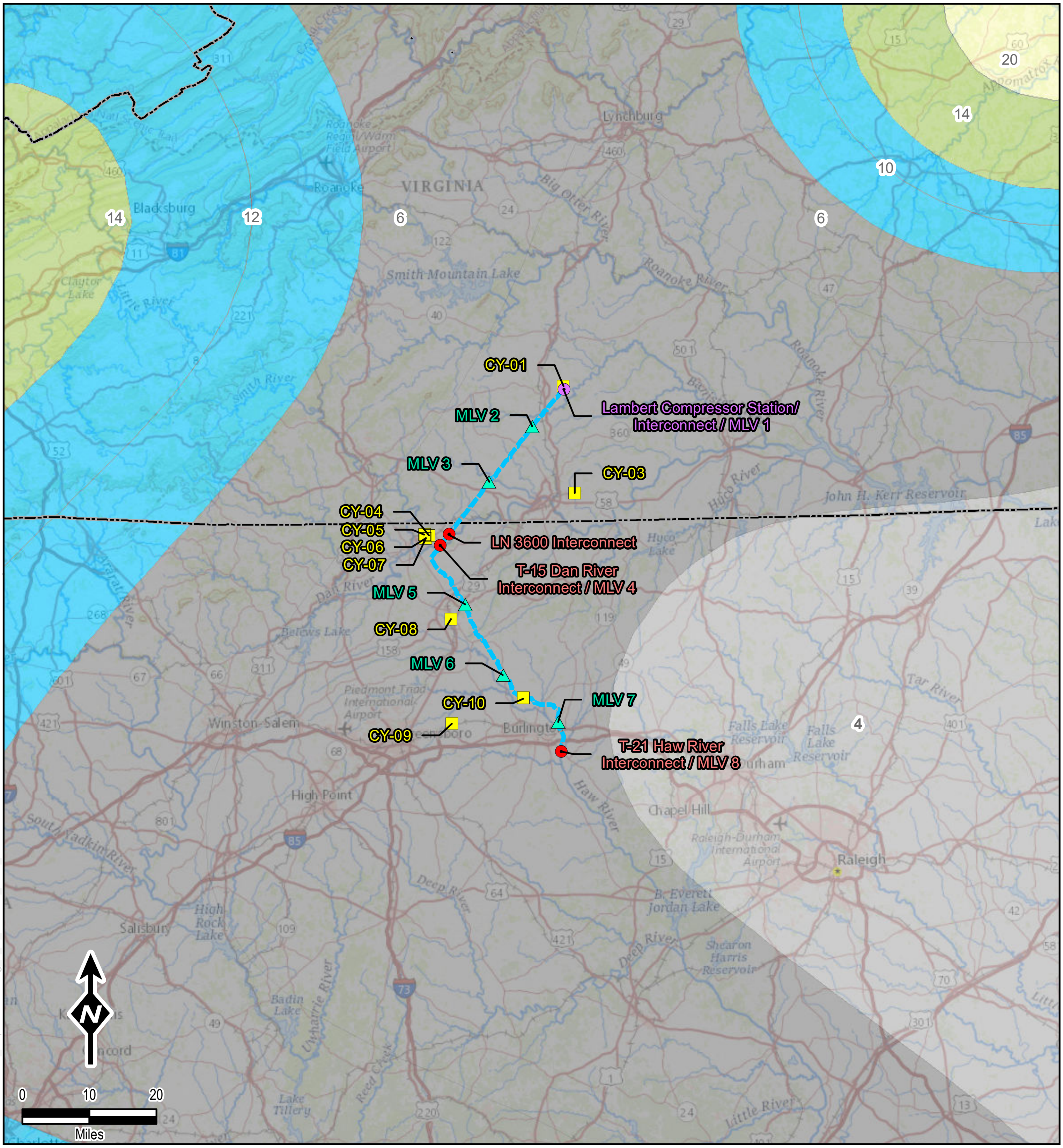
Data Sources: ESRI, USGS, TRC, EQT

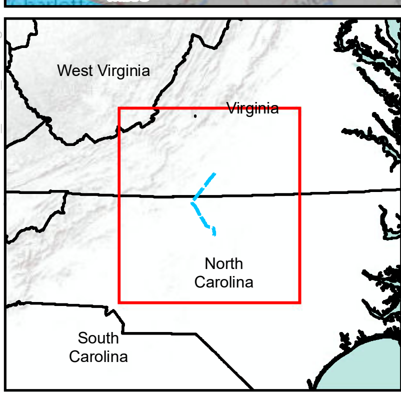
Mountain Valley PIPELINE LLC

Figure 6-C

Karst Material of the MVP Southgate Project

TRC Results you can rely on
600 Willowbrook Ln
West Chester, PA 19382
October 2018





Legend

- Compressor Station
- Proposed Pipeline Route
- Contractor Yard
- State Boundary
- Meter Station
- Valve Site

Peak Acceleration - Expressed as a percent of standard gravity (g)

0	2	4	6	10	14	20	30	40	80

1 inch = 20 miles
When Printed 8.5x11

Data Sources: ESRI, USGS, TRC, EQT

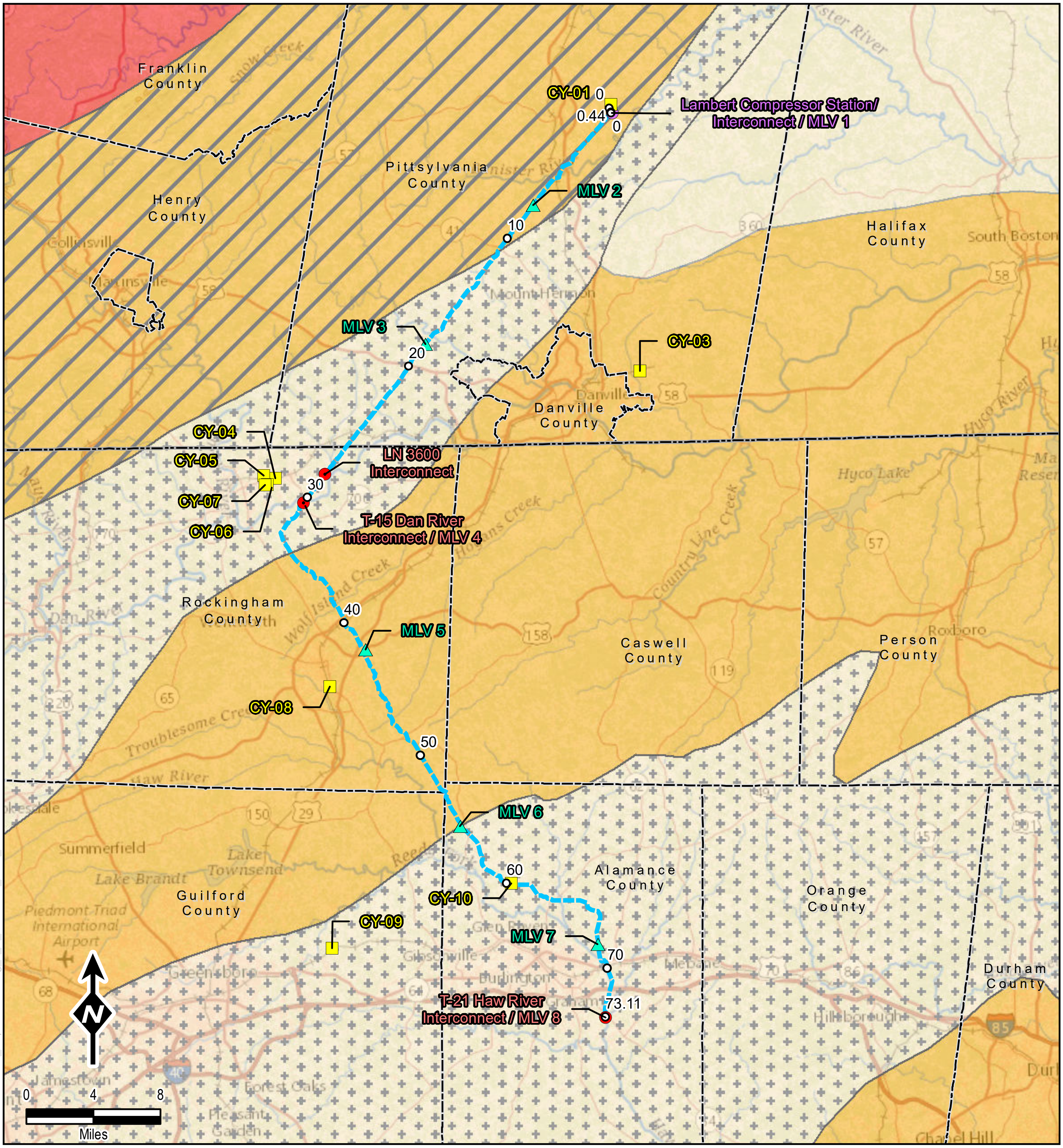
Mountain Valley PIPELINE LLC

Figure 6-D

Seismic Hazard Map of the
MVP Southgate Project
2% Probability of Exceedance in 50 years

TRC Results you can rely on
600 Willowbrook Ln
West Chester, PA 19382
October 2018

S:\1-PROJECTS\NEXTERA\300423_MVP_Southgate\6-MXD\Resource_Reports\RR6\Fig_6_D_Seismic_OCT_2018.mxd



Legend

- Mileposts
- Proposed Pipeline Route
- Compressor Station
- Contractor Yard
- Meter Station
- Valve Site
- State Boundary
- County Boundary

Landslide Incidence

- High Landslide Indicence (Greater than 15% of Area Involved)
- Moderate Landslide Indicence (1.5% - 15% of Area Involved)
- Low Landslide Indicence (Less than 1.5% of Area Involved)

Landslide Susceptibility

- High
- Moderate

Data Sources: ESRI, USGS, TRC, EQT

1 inch = 8 miles
When Printed 8.5x11

Mountain Valley PIPELINE LLC

Figure 6-E

Landslide Hazard Map of the MVP Southgate Project

TRC
600 Willowbrook Ln
West Chester, PA 19382
October 2018

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-B

Bedrock Geology in the MVP Southgate Project Area

Table 6-B-1

Bedrock Geology in the MVP Southgate Project Area

Project Facilities	From Milepost	To Milepost	Crossing Length (Miles)	Formation	Primary Rock	Secondary Rock	Map Symbol
Pipeline Facilities							
H-605	0.00	0.024	0.24	Upper Triassic	sandstone	siltstone	TRss
	0.24	0.36	0.12	Upper Triassic	conglomerate		TRc
	0.36	0.44	0.07	Upper Triassic	sandstone	siltstone	TRss
H-650	0.00	0.39	0.39	Upper Triassic	sandstone	siltstone	TRss
	0.39	0.95	0.56	Upper Triassic	conglomerate		TRc
	0.95	1.20	0.25	Proterozoic Z-Cambrian	mica schist	gneiss	Zfm
	1.20	1.86	0.66	Cambrian	granite		lw
	1.86	14.95	13.09	Proterozoic Z-Cambrian	mica schist	gneiss	Zfm
	14.95	16.19	1.24	Upper Triassic	conglomerate		TRc
	16.19	17.13	0.94	Upper Triassic	sandstone		TRs
	17.13	18.03	0.91	Upper Triassic	sandstone	siltstone	TRss
	18.03	18.70	0.67	Upper Triassic	conglomerate		TRc
	18.70	20.62	1.92	Proterozoic Z	biotite gneiss	amphibolite	Zau
	20.62	21.07	0.45	Proterozoic Z-Cambrian	mica schist	amphibolite	Zab
	21.07	22.35	1.28	Proterozoic - Paleozoic	mylonite	gneiss	my
	22.35	24.57	2.22	Upper Triassic	sandstone	siltstone	TRss
	24.57	26.11	1.54	Triassic	sandstone	siltstone	TRcs
	26.11	28.99	2.88	Triassic	sandstone	mudstone	TRdp
	28.99	29.41	0.42	Triassic	mudstone	sandstone	TRdc
	29.41	31.11	1.70	Triassic	sandstone	mudstone	TRdp
	31.11	32.65	1.54	Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
	32.65	32.95	0.30	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss	CZfg

Table 6-B-1

Bedrock Geology in the MVP Southgate Project Area

Project Facilities	From Milepost	To Milepost	Crossing Length (Miles)	Formation	Primary Rock	Secondary Rock	Map Symbol
	32.95	34.12	1.17	Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
	34.12	34.93	0.82	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss	CZfg
	34.93	39.31	4.38	Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
	39.31	41.28	1.96	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss	CZfg
	41.28	46.15	4.87	Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
	46.15	47.56	1.41	Permian/Pennsylvanian	granite		PPg
	47.56	48.35	0.80	Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
	48.35	49.29	0.94	Permian/Pennsylvanian	granite		PPg
	49.29	50.56	1.27	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock	CZmv
	50.56	50.63	0.06	Cambrian/Late Proterozoic	phyllite	schist	CZph
	50.63	54.77	4.15	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock	CZmv
	54.77	55.22	0.45	Cambrian/Late Proterozoic	felsic metavolcanic rock	mafic metavolcanic rock	CZfv
	55.22	58.32	3.10	Cambrian/Late Proterozoic	metamorphic rock		CZg
	58.32	59.14	0.82	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
	59.14	59.48	0.35	Cambrian/Late Proterozoic	metamorphic rock		CZg
	59.48	59.63	0.14	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
	59.63	60.55	0.92	Cambrian/Late Proterozoic	metamorphic rock		CZg
	60.55	61.32	0.77	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
	61.32	61.54	0.22	Cambrian/Late Proterozoic	metamorphic rock		CZg
	61.54	61.59	0.05	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
	61.59	61.86	0.27	Cambrian/Late Proterozoic	metamorphic rock		CZg
	61.86	62.37	0.51	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
	62.37	63.03	0.66	Cambrian/Late Proterozoic	metamorphic rock		CZg
	63.03	64.52	1.49	Paleozoic/Late Proterozoic	metamorphic rock		PzZg

Table 6-B-1

Bedrock Geology in the MVP Southgate Project Area

Project Facilities	From Milepost	To Milepost	Crossing Length (Miles)	Formation	Primary Rock	Secondary Rock	Map Symbol
	64.52	69.40	4.88	Cambrian/Late Proterozoic	metamorphic rock		CZg
	69.40	72.92	3.52	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock	CZmv
	72.92	73.11	0.19	Paleozoic/Late Proterozoic	metamorphic rock		PzZg
Aboveground Facilities							
	Area (acres)	**Near Milepost**					
Lambert Compressor Station/ Interconnect/ MLV 1	3.17	0		Upper Triassic	sandstone	siltstone	TRss
MLV 2	0.02	7.4		Proterozoic Z-Cambrian	mica schist	gneiss	Zfm
MLV 3	0.02	18.3		Upper Triassic	conglomerate		TRc
LN 3600 Interconnect	0.66	28.2		Triassic	sandstone	mudstone	TRdp
T-15 Dan River Interconnect/ MLV 4	0.68	30.4		Triassic	sandstone	mudstone	TRdp
MLV 5	0.02	42.2		Cambrian/Late Proterozoic	biotite gneiss	mica schist	CZbg
MLV 6	0.02	55.1		Cambrian/Late Proterozoic	felsic metavolcanic rock	mafic metavolcanic rock	CZfv
MLV 7	0.02	68.2		Cambrian/Late Proterozoic	metamorphic rock		CZg
T-21 Haw River Interconnect/MLV8	0.66	73.1		Paleozoic/Late Proterozoic	metamorphic rock		PzZg

Table 6-B-2

Shallow Bedrock Locations

Project Facilities	From Milepost	To Milepost	Crossing Length (mi)	Bedrock Depth (in)	Map Label	Formation Name	Primary Rock Type	Secondary Rock Type
Pipeline								
H-650	21.56	21.76	0.20	18.1	my	Proterozoic - Paleozoic	mylonite	gneiss
	22.20	22.25	0.05	18.1	my	Proterozoic - Paleozoic	mylonite	gneiss
	22.53	22.90	0.37	18.1	TRss	Upper Triassic	sandstone	siltstone
	22.96	23.10	0.14	29.1	TRss	Upper Triassic	sandstone	siltstone
	24.30	24.39	0.09	18.1	TRss	Upper Triassic	sandstone	siltstone
	24.59	24.82	0.23	29.1	TRcs	Triassic	sandstone	siltstone
	24.94	25.00	0.06	18.1	TRcs	Triassic	sandstone	siltstone
	25.46	25.68	0.22	18.1	TRcs	Triassic	sandstone	siltstone
	32.48	32.61	0.14	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	33.74	33.79	0.05	25.2	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	33.83	33.89	0.06	25.2	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	34.45	34.53	0.07	15	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	38.84	39.07	0.22	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	39.17	39.25	0.08	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	39.25	39.31	0.06	25.2	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	39.31	39.37	0.05	25.2	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	40.32	40.51	0.19	15	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	40.52	40.71	0.19	15	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	40.72	40.83	0.12	15	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	41.18	41.28	0.10	15	CZfg	Cambrian/Late Proterozoic	felsic gneiss	mafic gneiss
	41.28	41.32	0.04	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	42.50	42.63	0.14	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	42.88	42.93	0.05	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	43.75	44.21	0.46	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist

Table 6-B-2

Shallow Bedrock Locations

Project Facilities	From Milepost	To Milepost	Crossing Length (mi)	Bedrock Depth (in)	Map Label	Formation Name	Primary Rock Type	Secondary Rock Type
	45.57	45.96	0.39	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	46.24	46.52	0.28	15	PPg	Permian/Pennsylvanian	granite	
	47.01	47.56	0.55	15	PPg	Permian/Pennsylvanian	granite	
	47.56	47.73	0.17	15	CZbg	Cambrian/Late Proterozoic	biotite gneiss	mica schist
	53.74	53.77	0.02	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock
	67.64	67.71	0.07	29.9	CZg	Cambrian/Late Proterozoic	metamorphic rock	
	67.93	67.97	0.04	29.9	CZg	Cambrian/Late Proterozoic	metamorphic rock	
	68.08	68.14	0.06	29.9	CZg	Cambrian/Late Proterozoic	metamorphic rock	
	68.87	68.91	0.04	29.9	CZg	Cambrian/Late Proterozoic	metamorphic rock	
	69.85	69.86	0.02	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock
	70.98	71.04	0.06	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock
	72.57	72.60	0.04	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock
	72.67	72.67	0.00	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock
	72.69	72.82	0.14	29.9	CZmv	Cambrian/Late Proterozoic	mafic metavolcanic rock	felsic metavolcanic rock

NOTE: No aboveground facilities occur in areas of shallow bedrock.

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-C

Geotechnical Investigations Report

[To be provided in a supplemental filing expected to be filed in early 2019.]

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-D

Areas of Potential Blasting and General Blasting Plan

TABLE 1

AREAS OF POTENTIAL BLASTING
By Milepost
for
RIGHT-OF-WAY GRADE
and
PIPELINE TRENCH EXCAVATION

MVP Southgate Project

October 2018

From Milepost	To Milepost	Need for Blasting			Blasting Potential
		Slope	Depth to Bedrock	Rock Type	
0.00	0.95	X			Low
1.20	1.85			X	Low
17.28	33.89	X	X	X	High
34.50	48.23	X	X	X	High
49.29	69.88	X	X	X	High
70.90	72.82	X	X		High
Lambert Interconnect and Main Valve		X	X		Low
LN 3600 Interconnect		X	X		Low
T-15 Dan River Interconnect					None
T-21 Haw River Interconnect					None
Mainline Valves		Included within Mainline Blasting Potential			

Table Developed From:

(1) United States Geological Survey (USGS) Geologic Units by Geographic Area. Pittsylvania County, Virginia and Rockingham and Alamance Counties, North Carolina, 2018.

(2) United States Department of Agricultural, Natural Resources Conservation Service (USDA/NRCS), 2018 Custom Soil Resources Report for Pittsylvania County, Virginia and Rockingham and Alamance Counties, North Carolina.

(3) "Low" – The potential for blasting is possible within this section depending on depth of and location of planned pipeline and related facilities. The potential of blasting to achieve grade exists but has low probability.

(4) "High" – Blasting will be needed within these sections to achieve grade. Blasting will not be continuous.

(5) Possibility of blasting based on Notes 1 and 2 for this Table and Table 6-F MVP Southgate Project Resource Report 6 – Geologic Resources. Blasting based on slope locations where thickness of overlaying soil may be less than trench depth due to erosion and gravitational influences on the soil.

Updated 10/12/.18
New Milepost

MVP Southgate Project

General Blasting Plan

November 2018

TABLE OF CONTENTS

1 INTRODUCTION

The MVP Southgate Project General Blasting Plan (Plan) outlines the procedures and safety measures that the contractor(s) will adhere to while implementing blasting activities during the construction of the MVP Southgate Project. This Plan addresses blasting for the proposed pipeline route alignment and associated Project facilities filed with the Federal Energy Regulatory Commission (FERC or commission).

Mountain Valley Pipeline, LLC (Mountain Valley) is seeking a certificate of public convenience and necessity (certificate) from FERC pursuant to section 7C of the Natural Gas Act to construct and operate the MVP Southgate Project (Project). The Project will be located in Pittsylvania County, Virginia and Rockingham and Alamance Counties, North Carolina. Mountain Valley proposes to construct approximately 73 miles of natural gas pipeline (known as the H-650 pipeline) to provide timely, cost-effective access to new natural gas supplies to meet the growing needs of natural gas users in the south eastern United States. The approximately 73 mile pipeline will be constructed of 24-inch diameter steel and welded pipe starting at milepost 0.00 and ending a milepost 31.0 at which point the pipeline diameter will be reduced to 16-inch diameter steel and welded pipe starting at milepost 31.0 and ending at milepost 73.11.

This plan includes a brief description of the pipeline alignment and overall physio geographic setting and bedrock geology in the vicinity of the Project. Information on shallow bedrock soils and bedrock outcroppings is taken from the Project's Resource Report 6 – Geological Resources. A map depicts the location of the Project's route is provided in Figure 1.2-1 Project overview Resource Report 1- General Project Description.

Information for blast and rip characteristics of the bedrock may be elevated, at least in a general sense, and applied toward an appropriate bedrock excavating method. The hard and intact nature of the unweathered bedrock may possibly be removed by ripping or mechanical means.

Other geologic features may control the effects of blasting, rock fabric, or the arrangement of minerals determines intrinsic rock stressing, and thus influence rock excavation, joint spacing, bedding, and foliation also influence rock excavation.

2 PROJECT ALIGNMENT

The proposed FERC jurisdictional facilities described in this plan will consist of approximately 31.0 miles of 24-inch diameter pipeline and 42.1 miles of 16-inch diameter pipeline for a pipeline length of 73.1 miles; installing one new compressor station that consist of approximately 28,915 horsepower of compression; aboveground sites for interconnects; main line block valves; launchers and receivers; control systems; and other facilities, as further described in Resource Report 1 - General Project Description.

The proposed pipeline, compressor stations, and interconnect facilities are summarized below:

- **Pipeline – Facilities would include:** Installation of approximately 73 miles of 24-inch and 16-inch diameter pipeline with a 1,440 pounds per square inch gauge (psig) maximum allowable operating pressure (MAOP), with portions of the pipeline paralleling existing buried natural gas pipelines. The pipeline will be located in the Virginia County of Pittsylvania and the North Carolina Counties of Rockingham and Alamance.. The proposed pipeline will extend from the existing Mountain Valley Pipeline in Pittsylvania County, Virginia to its terminal at the T-21 Haw River Interconnect in Alamance County, North Carolina.

- **Compression** – The project will consist of the construction of one new compressor station, totaling approximately 28,915 horsepower of new compression.
- **Interconnects** – The Project will have a total of four (4) interconnects at Lambert Interconnect in Pittsylvania County, Virginia; LN 3600 Interconnect in Rockingham County, North Carolina; T-15 Dan River Interconnect in Rockingham County, North Carolina; and T-21 Haw River Interconnect in Alamance County, North Carolina.

3 GEOLOGIC SETTING

The proposed Project route begins in Pittsylvania County, Virginia and proceeds in a southeasterly direction through one Virginia county into North Carolina County of Rockingham and at the Dan River, the route turns southeasterly through the remainder of Rockingham county into Alamance County, North Carolina to the T-21 Haw River interconnect. Along the proposed project route, topography ranges from 470 to 880 feet above mean sea level (amsl) and crosses over several synclines and anticlines, as well as mineral resources that are discussed in detail by Resource Report 6-Geological Resources.

3.1 Regional Physiographic Setting

The proposed Project is located within the Piedmont Uploads Section of the Piedmont Physiographic Province. The project's physiographic settings discussed in detail by Resource Report 6-Section 6.2.1

3.2 Regional Geology

The Project will traverse geology of numerous timeframes and rock types, as discussed in detail in Resource Report 6 – Table 6-B-2 in Resource Report 6.

3.3 Active Faults

The Project alignment was evaluated for the presence of Quaternary-age faulting and the potential for ground movement and failure. The findings of the evaluation are discussed in detail in Resource Report 6–Section 6.5.

3.4 Areas of Shallow Bedrock

The pipeline will be installed to allow a minimum cover of 36 inches in areas of shallow bedrock. Therefore, the proposed Project area was evaluated for areas where bedrock might be encountered above a depth of 80 inches (Resource Report 6 - Appendix A Figure 6-13).

Areas where shallow bedrock may be encountered are discussed in detail in Resource Report 6 – Section 6.2 and Resource Report 7 – Appendix 7-A.

Where unrippable subsurface rock is encountered, approved alternative methods of excavation will first be explored including: rock trenching machines, rock saws, hydraulic rams, jack hammers, blasting, etc. The alternative method to be used will be dependent on the proximity to: structures, pipelines, wells, cables, water resources, etc., and the capabilities of the alternative excavation method. Should blasting for pipeline grade or trench excavation or site development be necessary, care will be taken to prevent damage to underground structures (e.g., cables, conduits, and pipelines) or to springs, water wells, or other water sources. Blasting mats or padding will be used as necessary to prevent the scattering of loose rock (fly-rock). All blasting will be conducted during daylight hours and will not begin until occupants of nearby buildings, stores, residences, places of business, and farms have been notified. Where competent bedrock occurs in the stream bed, blasting may be used to reduce bedrock, so the trench can be excavated. Specific locations requiring blasting will be determined in the field, based on the limitations of the mechanical excavation equipment.

3.5 Mineral Resources

Mineral resources, quarries, and other mineral extraction along and within the proposed route of the pipeline and its related facilities are discussed in detail in Resource Report 6 – Section 6.4

No blasting is foreseen to occur within the limits of active mining areas or past minig areas, both surface and deep.

4 BLASTING SPECIFICATIONS

Blasting for pipeline facilities grade or trench excavation, compressor station and interconnect site development will be considered only after all other reasonable means of excavation have been evaluated and determined to be unlikely to achieve the required results. MVP may specify locations (foreign line crossings, nearby structures, etc.) where consolidated rock will be removed by approved mechanical equipment, such as rock trenching machines, rock saws, hydraulic rams, or jack hammers, instead of blasting. Areas where blasting may be required will be surveyed for features, such as Karst terrain, structures, utilities, and wells. The pre-construction condition of human- occupied buildings will be documented. Occupied buildings and their condition within 150 feet of the blasting area will be documented as to their pre-blast condition, as set forth in Appendix A - Pre-Blast Survey, and their condition after blasting, as set forth in Appendix E - Post-Blast Survey. MVP will provide verbal notification, followed by written documentation, to the buildings' occupant(s) of any blasting activity during both pre-construction and post-construction within 150 feet of a blastlocation.

If blasting is conducted within 150 feet of an active water well, as necessary, MVP will conduct a pre-construction evaluation of the well. Upon request by a landowner who had a pre-construction test, a post-construction test will be performed. Landowners will be contacted by an MVP representative, and a qualified independent contractor will conduct the testing. Wells within 150 feet of proposed Project work areas are tabulated in Resource Report 2 - Water Use and Quality.

MVP will evaluate, on a timely basis, landowner complaints regarding damage resulting from blasting to wells, homes, or outbuildings. If the damage is substantiated, MVP will negotiate a settlement with the landowner that may include repair or replacement.

Before any blasting occurs, Contractor will complete a project/site-specific blasting plan and provide it to MVP for review. No blasting shall be done without prior approval of MVP. In no event shall explosives be used where, in the opinion of MVP, such use will endanger existing facilities and/or structures. The Contractor shall obtain MVP approval, and provide forty-eight (48) hours' notice prior to the use of any explosives. MVP will provide at least a 24-hour notice to occupants of nearby (within 150 feet of blasting area) buildings, stores, residences, businesses, farms, and other occupied areas prior to initiating blasting operations. These notices will be verbal, followed by written documentation of the 24-hour notice.

4.1 Specifications

Blasting shall adhere to the following federal, state, county, township, local, and MVP standards and regulations. These standards and regulations are to be considered as the minimum requirements. Should there be a conflict between jurisdictions, standards, and regulations, the most stringent jurisdictions, standards, and regulations shall be followed.

These blasting requirements for the MVP Project are as follows:

- MVP Project, Resource Report 6 - Geological Resources, Docket No. PF18- 4-000.
- MVP, Design and Construction Manual, Design Standard, Pipeline, 4.11 Blasting Proximate to Buried Pipelines.
- MVP, Design and Construction Manual, Design Standard, Pipeline, 4.17 Blasting Activities During Construction.
- 29 CFR 1926 Subpart U – Blasting and the Use of Explosives.
- 27 CFR 555 Subpart K, U. S. Bureau of Alcohol, Tobacco, and Firearms.
- 30 CFR 816.68 Mine Safety and Health Administration (MSHA).
- 49 CFR Part 192 USDOT.
- 27 CFR Part 55.
- 30 CFR '715.19.
- National Fire Protection Association 495.
- U. S. Bureau of Mines Report of Investigations 8507.
- Virginia 4 VAC25-130-816.11, 4 VAC25-130-816.64, 4 VAC25-110-210, and 3 VAC25-150-250.
- North Carolina Chapter 33 Explosives and Fireworks 2006 North Carolina State Fire Prevention Code (Fire Code).

5 PRE-BLAST INSPECTIONS

As required by Resource Report 6 – Geological Resources, MVP shall conduct pre- blast surveys, with landowner permission, to assess the conditions of structures, wells, springs, and utilities within 150 feet of the proposed construction ROW. Should local or state ordinances require inspections in excess of 150 feet from the work, the local or state ordinances shall prevail. The survey will include, at a minimum:

- Informal discussions to familiarize the adjacent property owners with blasting effects and planned precautions to be taken on this project;
- Determination of the existence and location of site-specific structures, utilities, septic systems, and wells;
- Detailed examination, photographs, and/or video records of adjacent structures and utilities; and
- Detailed mapping and measurement of large cracks, crack patterns, and other evidence of structural distress.

The results will be summarized in a Pre-Blast Condition Report that will include photographs and be completed prior to the commencement of blasting. The pre-blast conditions will be documented with the information outlined by “Pre-Blast Survey, MVP Project”. This Pre-Blast Survey Form is considered the minimum information needed. Appendix A presents the Pre-Blast Survey Form. The completion of the Pre-Blast Survey Form is in addition to all other local, county, township, state, or federal reporting/survey data collection and reports.

6 MONITORING OF BLASTING ACTIVITIES

During blasting, MVP contractors will take precautions to minimize damage to adjacent areas and structures. Precautions include:

- Dissemination of blast warning signals in the area ofblasting.
- Backfilling with subsoil (no topsoil to be used) or blasting mats or other approved methods.
- Blast warning in congested areas, in shallow water bodies, or near structures that could be damaged by fly-rock.
- Use of matting or other suitable cover, as necessary, to prevent fly-rock from damaging adjacent protected natural resources.
- Posting warning signals, flags, and/or barricades.
- Following Federal, State, Local, and MVP procedures and regulations for safe storage, handling, loading, firing, and disposal of explosive materials.
- Manning adjacent pipelines at valves for emergency response, as appropriate.
- Posting of portable signage, portable barricades, and visual survey of the blast area access ways to prevent unauthorized entrance into the blast zone by spectators and/or intruders.
- Maintain communications between all persons involved for security of the blast zone during any and all blasting/firing.

Excessive vibration will be controlled by limiting the size of charges and by using charge delays, which stagger each charge in a series of explosions.

If the Contractor must blast near buildings, structures, or wells, a qualified independent Contractor will inspect structures or wells within 150 feet, or farther if required by local or state regulations, of the construction right-of-way prior to blasting, and with landowner permission. Post-blast inspections by company's representative will also be performed, as warranted. All blasting will be performed by registered blasters and monitored by experienced blasting inspectors. Recording seismographs will be installed by the Contractor at selected monitoring stations under the observation of MVP personnel. During construction, the Contractor will submit blast reports for each blast and keep detailed records as described in Section 7.10.

As appropriate, effects of each discharge will be monitored at the outer limits of the construction right of way and closest adjacent facilities by seismographs.

If a charge greater than eight pounds per delay is used, the distance of monitoring will be in accordance with the U. S. Bureau of Mines Report of Investigations 8507.

To maximize its responsiveness to the concerns of affected landowners, MVP will evaluate all complaints of well or structural damage associated with construction activities, including blasting. A toll-free landowner hotline will be established by MVP for landowners to use in reporting complaints or concerns. In the unlikely event that blasting activities temporarily impair a water well, MVP will provide alternative sources of water or otherwise compensate the owner. If well or structural damage is substantiated, MVP will either compensate the owner for damages to the structure and well, or arrange for a new well to be drilled.

7 BLASTING REQUIREMENTS

MVP has standard practices for blasting operations, as outlined by Sections 1.0 and 4.0 of this Blasting Plan. The potential for blasting along the pipeline to affect any wetland, municipal water supply, waste disposal site, well, septic system, spring, or pipelines will be minimized by controlled blasting techniques and by using mechanical methods for rock excavation as much as possible. Controlled blasting techniques have been effectively employed by MVP and other companies to protect active gas pipelines within 15 feet of trench excavation. The following text presents details of procedures for powder blasting.

7.1 General Provisions

- The contractor will provide all personnel, labor, and equipment to perform necessary blasting operations related to the work. The Contractor will provide a permitted blaster possessing all permits required by the local, county, township, and states in which blasting is required during construction, and having a working knowledge of state and local laws and regulations that pertain to explosives.
- Project blasting will be done in accordance with 27 CFR Part 55, 30 CFR '715.19, National Fire Protection Association 495 – Explosive Materials Code; the above referenced Specification; and all other state and local laws, when required; and regulations applicable to obtaining, transporting, storing, handling, blast initiation, ground motion monitoring, and disposal of explosive materials and/or blasting agents.
- The Contractor shall be responsible for supplying explosives and blasting materials that are perchlorate-free in order to eliminate the potential for perchlorate contamination of ground water. Further, the use of ammonium nitrate is prohibited. However, the use of emulsion type explosives, including those having ammonium nitrate as a constituent, such as Dyna 1062 Bulk Emulsion, shall be permitted, as these types of explosives are considered industry standard for area blasting related to large scale earthwork construction. In addition, detonators containing small amounts of perchlorate, such as Dyno Nobel NONEL EZ Dets, are an industry standard and shall be permitted.
- The contractor shall be responsible for securing and complying with all necessary permits required for the transportation, storage, and use of explosives. The Contractor shall be responsible for all damages or liabilities occurring on or off the right-of-way resulting from the use of explosives. When the use of explosives is necessary to perform the work, the Contractor shall use utmost care not to endanger life or adjacent property, and shall comply with all applicable laws, rules, and regulations governing the storage, handling, and use of such explosives. MVP will conduct a pre- and post- surficial leak survey along the centerline of each adjacent live pipeline to the planned blast area. The surficial leak survey will be conducted by MVP’s employees and/or designated representative, with the surficial leak survey extending a minimum of 100- feet (both directions) past the limits of the planned blast area.
- Blasting activities will strictly adhere to all MVP, local, state, and federal regulations and requirements applying to controlled blasting and blast vibration limits in regard to structures, underground gas pipelines, and underground utilities. In addition to following state and federal blasting guidelines, MVP will contact each governmental agency (if project is not undertaken within twelve months as of the date of this Blasting Plan) along the proposed route to determine local ordinances or guidelines for blasting (refer to Table 7.1.1).

TABLE 7.1.1 MVP PROJECT
CONTACTS AND RELATED PERMITTING PRIOR TO BLASTING

JURISDICTION	CONTACT	AGENCY	PERMIT/REGULATION
Virginia	Marshal R. Moore 276.415.9700	DMME Virginia Department of Mines, Minerals, and Energy	Permit and Notification
Virginia	Region 3 Marion Office 276.783.4860	DGIF Virginia Department of Game and Inland Fisheries	Notification: 48 hour notice
Virginia	Office: 804.371.0220 statefiremarshal@ vdfp.virginia.gov	SFMO Virginia State Fire Marshal's Office	Permit and Notification: 24 hour notice
Virginia	Anita Bradburn Realty Specialist Management Branch Huntington District USACE 304.399.5890	US Army Corps of Engineers	Notification: Blasting within 0.25-mile of Weston and Gauley Bridge Turnpike Trail
Virginia	Joby Timm Forest Supervisor O: 540.265.5118 C: 540.339.2523 jtimm@fs.fed.us	US Forest Service	Notification: Blasting within 0.25-mile of the Jefferson National Forest
North Carolina	Matthew Gantt Engineering Supervisor 336-776-9654 matt.ganttencdeur.gov	NC DEQ	Permit and Notification Notice
North Carolina	Tonya Caddle Director- Planning and Inspection 336-342-8137 tcaddieco.rockingham.nc.us	Rockingham CO, NC	Permit and Notification Notice
North Carolina	Robert L. Key Director -Inspection 336-570-4060 Robert.key@alamance-nc.com	Alamance Co, NC	Permit and Notification Notice

The Construction Contractor will be made aware of all applicable procedures and local requirements, and it will ultimately be the Contractor's responsibility to notify officials and receive appropriate blasting permits and authorization.

Typically, local regulations require copies of the blasting Contractor's Certificate of Insurance and License. In some jurisdictions, a Certificate of Bond will also be required, as well as a qualified person hired to oversee the blasting procedure.

The MVP Chief Blasting Inspector (CBI) or designated representative shall have the opportunity to witness all rock excavations or other use of explosives. The Contractor shall conduct all blasting operations in a safe manner which will not cause harm to the existing pipelines and structures in the vicinity. If the CBI determines that any project blasting operations have been conducted in an unsafe manner, the CBI will notify the Contractor of the unsafe activity. If any further unsafe actions occur on the part of the blasting firm, the CBI will request the Contractor terminate the Contract of the blasting firm and hire another blasting company.

Any failure to comply with the appropriate law and/or regulations is the sole liability of the Contractor. The Contractor and the Contractor's permitted blaster shall be responsible for the conduct of all blasting operations, which shall be subject to inspection requirements.

A Blasting Fact Sheet will be distributed to landowners where blasting is proposed and affected landowners will be contacted prior to any blasting activities.

7.2 Storage Use at Sites

Explosives and related materials shall be stored in approved facilities required under the applicable provisions contained in 27 CFR Part 55, Commerce in Explosives. The handling of explosives may be performed by the person holding a permit to use explosives or by other employees under his or her direct supervision, provided that such employees are at least 21 years of age. While explosives are being handled or used, smoking shall not be permitted, and no one near the explosives shall possess matches, open light, or other fire or flame within 50 feet of the explosives, in accordance with OSHA requirements. Suitable devices or lighting safety fuses are exempt from this requirement. No person shall handle explosives while under the influence of intoxicating liquors or narcotics at any time during construction of the Project. Original containers or Class II magazines shall be used for taking detonators and other explosives from storage magazines to the blasting area. Partial reels of detonating cord do not need to be in closed containers, unless transported over public highways. Containers of explosives shall not be opened in any magazine or within 50 feet of any magazine. In opening kegs, or wooden cases, no sparking metal tools shall be used; wooden wedges and either wood, fiber or rubber mallets shall be used. Non-sparking metallic slitters may be used for opening fiberboard cases.

No explosive materials shall be located or stored where they may be exposed to flame, excessive heat, sparks, or impact.

Explosives or blasting equipment that are obviously deteriorated or damaged shall not be used. Explosive materials shall be protected from unauthorized possession and shall not be abandoned.

No attempt shall be made to fight a fire if it is determined the fire cannot be contained or controlled before it reaches explosive materials. In such cases, all personnel shall be immediately evacuated to a safe location and the area shall be guarded from entry by spectators or intruders.

No firearms shall be discharged into or in the vicinity of a vehicle containing explosive materials or into or in the vicinity of a location where explosive materials are being handled, used, or stored.

Contractor shall maintain a daily blast inventory record of all explosive materials transported (to and from blast area), used, and returned to off-site storage, when no storage is located on blast site.

7.3 Pre-Blast Operations

The Contractor is required to submit a planned schedule of blasting operations to the CBI or his designated representative for approval, prior to commencement of any blasting or pre-blast operation, which indicates the maximum charge weight per delay, hole size, spacing, depth, and blast layout. If blasting is to be conducted adjacent to an existing pipeline, approval must be received from the pipeline's Engineering Department. The Contractor shall provide this schedule to the CBI at least five working days prior to any pre-blast operation for approval and use. Where residences or other structures are within 150 feet of the blasting operation, the CBI may require notification in excess of five days. The blasting schedule is to include the blast geometry, drill hole dimensions, type and size of charges, stemming, and delay patterns and should also include a location survey of any dwelling or structures that may be affected by the proposed operation. Face material shall be carefully examined before drilling to determine the possible presence of unfired explosive material. Drilling shall not be started until all remaining butts of old holes are examined for unexploded charges, and if any are found, they shall be re-fired before work proceeds. No person shall be allowed to deepen the drill holes that have contained explosives.

Drill holes shall be large enough to permit free insertion of cartridges of explosive materials. Drill holes shall not be collared in bootlegs or in holes that have previously contained explosive materials. Holes shall not be drilled where there is a danger of intersecting another hole containing explosive material. Charge loading shall be spread throughout the depth of the drill hole or at the depths or rock concentration in order to obtain the optimum breakage of rock.

Loading and firing shall be performed or supervised only by a person possessing an appropriate blasting permit and license. All drill holes shall be inspected and cleared of any obstruction before loading. No holes shall be loaded, except those to be fired in the next round of blasting. After loading, all remaining explosives shall be immediately returned to an authorized magazine.

A maximum loading factor of 4.0 pounds of explosive per cubic yard of rock shall not be exceeded. However, should this loading fail to effectively break up the rock, a higher loading factor shall be allowed if the charge weight per delay is reduced by a proportional amount and approved by the CBI. The minimum safe distance from the blasting area to a live buried pipeline is placed at 10 feet measured horizontally from the edge of the blasting area to the outer edge of the affected pipeline. The site-by-site minimum safe distance between blasting areas and adjacent live natural gas pipelines will be calculated each time blasting is to occur using PIPEBLAST computer modeling program or other recognized industrial standards and applying the measured site conditions. The minimum safe distance and supporting calculations and site measurements are to be submitted for approval to MVP's CBI at least 48 hours before blasting is to occur.

All blasts will be monitored (Seismograph Monitoring-Transverse,Vertical, Longitudinal, PPV, and Acoustic) to ensure the peak particle velocity does not exceed the following specified maximum velocities:

- Four (4) inches per second for underground, welded, steel pipeline.
- Two (2) inches per second for underground, coupled, steel pipelines; above ground and underground structures; or water wells.

The MVP Engineering Department may approve higher peak particle velocities in writing, given site-specific conditions.

The maximum amplitude of the elastic wave created by any blast shall not exceed 0.0636 inches.

The type of explosive and initiation system to be used is as follows:

7.3.1 Dyno Nobel Unimax TM (or equivalent)

An extra-gelatin dynamite with a specific gravity of 1.51 g/cc, a detonation rate of 17,400 f/s (unconfined) and a calculated energy of 1,055 c/g. The cartridge size will generally be 2” x 8” (1.25 lbs/cartridge) or 2” x 16” (2.50 lbs/cartridge).

7.3.2 Dyno Nobel Unigel TM (or equivalent)

A semi-gelatin dynamite with a specific gravity of 1.30 g/cc, a detonation rate of 14,200 f/s (unconfined) and a calculated energy of 955 c/g. The cartridge size will generally be 2” x 8” (1.15 lbs/cartridge) or 2” x 26” (2.30 lbs/cartridge).

7.3.3 Dyno Nobel Dynomax ProTM (or equivalent)

A propagation-resistant dynamite, with a specific gravity of 1.45 g/cc, a detonation rate of 19,700 f/s (unconfined) and a calculated energy of 1,055 c/g. The cartridge size will generally be 2” x 8” (1.225 lbs/cartridge) or 2” x 16” (24.45lbs/cartridge).

7.3.4 Dyno Nobel NONEL TM 17 or 25 Millisecond Delay Connectors or Dyno Nobel NONEL EZ Det TM (or equivalent)

A nonelectric delay detonator with a 25/350, 25/500, or 25/700 millisecond delay.

7.3.5 Dyno Nobel NONEL TM Nonelectric Shock Tube System Detonator (or equivalent)

The Shock Tube will be used to initiate all shots. The Shock Tube will be attached at one point only for initiation of the entire shot and will not be used for down hole priming.

7.3.6 Dyno Nobel 1062 Bulk Emulsion (or equivalent)

An emulsion/gel product commonly used for area blasting such as road alignments or large pads. It contains the following major components: ammonium nitrate (30 to 80% w/w, calcium nitrate, sodium nitrate, and No. 2 diesel fuel (1 to 8% w/w).

Each borehole shall be primed with NONEL EZ DefTM system. The total grains of the detonator system should be limited to prevent blowing stemming out of the drill hole. Boreholes shall be delayed with a minimum of 25 milliseconds (“ms”). Slightly longer delays may be used over steep hills with prior approval of the CBI. Primers shall not be assembled closer than 50 feet (15.25 m) from any magazine. Primers shall be made up only when and as required for immediate needs.

Blasting shall not be permitted if any part of the live pipeline lies within the perimeter of the crater zone, regardless of size of the blast/shot. Crater zone shall be defined as a circle created by turning a radius along the ground surface equal to the length of the depth below the surfaces where the shot is placed.

Tamping shall be done only with wood rods without exposed metal parts, but non-sparking metal connectors may be used for jointed poles. Plastic tamping poles may be used, provided the authority having jurisdiction has approved them. Violent tamping shall be avoided.

Recommended stemming material shall consist of clean crushed stone with d50 – 3/8 inch, which will not bridge over like dirt and will completely fill voids in the hole.

When safety fuse is used, the burning rate shall be determined and in no case shall fuse lengths less than 120 seconds be used. The blasting cap shall be securely attached to the safety fuse with a standard ring type cap crimper.

Pneumatic loading of blasting agents in blast holes primed with electric blasting caps or other static-sensitive initiation systems shall comply with the following requirements:

- A positive grounding device shall be used for the equipment toprevent accumulation of static electricity;
- A semi-conductive discharge hose shall be used; and
- A qualified person shall evaluate all systems to assure they will adequately dissipate static charges under field conditions.

No blasting caps or other detonators shall be inserted in the explosives without first making a hole in the cartridge for the cap with a wooden punch of proper size or standard cap crimper.

After loading for a blast is completed, all excess blasting caps or electric blasting caps and other explosives shall immediately be removed from the area and returned to their separate storage magazines.

7.4 Discharging Explosives

Persons authorized to prepare explosive charges or conduct blasting operations shall use every reasonable precaution, including, but not limited to, warning signals, flags, barricades, or woven wire mats to ensure the safety of the general public and workmen.

The Contractor shall obtain MVP's approval and provide them at least 24-hour notice prior to the use of any explosives. The Contractor shall comply with local and state requirements for pre-blast notifications, such as the One-Calls of Virginia and North Carolina, which require a 72 hour, minimum, notice.

Whenever blasting is being conducted in the vicinity (within 150 feet) of gas, electric, water, fire alarm, telephone, telegraph, and other utilities, (above or below grade) the blaster shall notify the appropriate representatives of such utilities at least 24-hours, or as required by the utility, in advance of blasting. Verbal notice shall be confirmed with written notice. In an emergency, the local authority issuing the original permit may waive this time limit. MVP's CBI is to be notified, both verbally and copied, with the written notice for notifications.

Blasting operations, except by special permission of the authority having jurisdiction and MVP, shall be conducted during daylight hours. No blasting shall occur on Sundays or legal holidays except by special permission of the authority having jurisdiction and MVP

When blasting is done in congested areas or in proximity to a significant natural resource, structure, railway, highway, or any other installation that may be damaged, the blast shall be backfilled before firing or covered with a mat, constructed so it is capable of preventing fragments from being thrown. In addition, all other possible precautions shall be taken to prevent damage to livestock and other property and inconvenience to the property owner or tenant during blasting operations. Any rock scattered outside the right-of-way by blasting operations shall immediately be hauled off or returned to the right-of-way.

Precautions shall be taken to prevent accidental discharge of blasting caps from currents induced by lightning, adjacent power lines, dust and snow storms, or other sources of extraneous electricity. These precautions shall include:

- Suspension of all blasting operations and removal of all personnel from the blasting area during the approach and progress of an electrical storm; and
- The use of lightning detectors is mandatory.

No blast shall be fired until the blaster in charge has made certain that all surplus explosive materials are in a safe place, all persons and equipment are at a safe distance or under sufficient cover, and an adequate warning signal has been given.

No loaded holes shall be left unattended or unprotected. Explosive shall not be primed or fused until immediately before the blast. After each blasting sequence, the Blasting Contractor shall inspect the site for cut-offs and misfires. All explosives or blasting agents shall be verified as discharged prior to starting/resuming excavation.

Only the person making connections between the cap and fuse system shall fire the shot. All connections should be made from the bore hole back to the source of ignition. If there are any misfires while using cap and fuse, all persons shall remain away from the charge for at least 15 minutes. Misfires shall be handled under the direction of the person in charge of the blasting and the construction right-of-way shall be carefully searched for the unexploded charges.

Explosives shall not be extracted from a hole that has once been charged or has misfired unless it is impossible to detonate the unexploded charge by insertion of a fresh additional primer.

7.5 Waterbody Crossing Blasting Procedures

Blasting should not be conducted within or near a stream channel without prior consultation and approval from the appropriate federal, state, and local authorities having jurisdiction to determine what protective measures must be taken to minimize damage to the environment and aquatic life of the stream. At a minimum, a five work day notice must be provided to the appropriate federal, state, and/or local authorities. In addition to the blasting permits a separate permit and approvals are required for blasting within the waters of the states of Virginia and North Carolina.

Rock drill or test excavation will occur within the limits of a flowing stream only after the streamflow has been redirected and maintained via dam and pump or flume crossing, as presented in Resource Report 2 - Section 2.3.1.4 Waterbody Crossing Methods. For those streams that have no flow at the time of rock drill or test excavation activities, the rock testing will be conducted in the streambed and the streambed disturbance created by the rock testing will be restored within the same day of disturbance.

Rock drill or test excavation and resulting blasting will only occur once the streamflow has been redirected and maintained via dam and pump or flume crossing method. For these crossings of flowing streams, work will commence immediately after the initial disturbance and continue until the stream crossing is completely installed and the streambed restored. Stream crossing methods and crossing mitigation measures are presented in Resource Report 2 – Section 2.3.

To facilitate planning for blasting activities for waterbody crossings, rock drilled or test excavations may be used in waterbodies to test the ditch-line during mainline blasting operations to evaluate the presence of rock in the trench-line. The excavation of the test pit or rock drilling is not included in the time window requirements for completing the crossing. For testing and any subsequent blasting operations, streamflow will be maintained through the site. When blasting is required, the FERC timeframes for completing in-stream construction begin when the removal of blast rock from the waterbody is started. If, after removing the blast rock, additional blasting is required, a new timing window will be determined in consultation with the Environmental Inspector. If blasting impedes the flow of the waterbody, the Contractor can use a backhoe to restore the stream flow without triggering the timing window. The complete waterbody crossing procedures are included in MVP's E&SCP.

MVP will immediately halt all construction activities if the loss of streamflow occurs after a blasting event. The construction contractor and MVP's Environmental Inspector will immediately evaluate the loss of water and develop a Contingency Plan to restore streamflow. This Contingency Plan will be provided to the local, state, and federal agencies having jurisdiction over the stream impacted, for their review and approval. Congruent with the contractor's and MVP's Environmental Inspector's evaluation, temporary emergency contingency measures will be employed to halt the loss of streamflow. Immediately upon the agencies' approval of the Contingency Plan, the contractor will implement the measures outlined in the agency-approved Contingency Plan.

The temporary emergency contingency measures and the agency-approved Contingency Plan measures will be implemented in accordance with Resource Report 2

- Section 2.4.1 Construction and Operation Impacts and Mitigation.

7.6 Karst Terrain Blasting Procedures

Karst Terrain Mitigation Plan has been developed for the Karst Terrain areas identified (Resource Report Appendix 6-Section 6.5.1 and Table 6.5.1). This Karst Terrain Mitigation Plan will be followed should any blasting be required for grade and trench excavation.

Blasting in a Karst Terrain will only be considered after all other reasonable means of excavating have been evaluated and determined to be unlikely to achieve the required grade.

Blasting should not be conducted within or near a Karst Area without MVP's Karst Specialist (KS) review and the Karst Blasting Plan obtaining approval from the appropriate federal, state and local authorities having jurisdiction to determine protective measures that must be taken to minimize damage to the Karst Terrain. At a minimum, the individual Karst Terrain Blasting Plan will be provided to the appropriate federal, state and local authorities for review and approval five working days prior to conducting the blasting.

Blasting will be conducted in a manner that will not compromise the structural integrity of the karst hydrology of known karst structures. If rock is required to be blasted to achieve grade, then the following parameters will be adhered to:

- The excavation will be carefully inspected for any voids, openings or other tell-tale signs of solution activity by MVP's KS.

- If the rock removal intercepts an open void, channel, or cave, the work in that area will be stopped until a remedial assessment can be carried out by MVP's KS.
- All use of explosives will be limited to low-force charges that are designed to transfer the explosive force only to the rock which is designated for removal (e.g., maximum charge of 2 inches per second ground acceleration).

7.7 Wetland Crossing Blasting Procedures

Wetland Crossings Mitigation Plan has been developed for the wetland crossings identified (Resource Report 2 - Section 2.4 Wetland Resources). This Wetland Crossings Mitigation Plan will be followed should any blasting be required for trench excavation.

Blasting for trench excavation crossing a wetland will only be considered after all other reasonable means of excavating have been evaluated and determined to be unlikely to achieve the required trench grade.

Blasting should not be conducted within or near a wetland without MVP's Environmental Inspector review and development of a Wetland Crossing Blasting Plan that includes protective measures to minimize damage to wetlands. At a minimum, the individual Wetland Crossing Blasting Plan will be provided to the appropriate federal, state and local authorities for review and approval five working days prior to conducting the blasting.

Blasting will be conducted in a manner that will not compromise the structural integrity of the wetland hydrology of known wetlands. If rock is required to be blasted to achieve trench grade, then the following parameters will be adhered to:

- The excavation will be carefully inspected for any voids, openings, fractures, or other tell-tale signs of dewatering activity by MVP's Environmental Inspector.
- If the rock removal intercepts an open void, channel, or fracture, the work in that area will be stopped until a remedial assessment can be carried out by MVP's Environmental Inspector.
- All use of explosives will be limited to low-force charges that are designed to transfer the explosive force only to the rock which is designated for removal (e.g., maximum charge of 2 inches per second ground acceleration).

7.8 Rock Disposal Due to Blasting

During the course of blasting for grade and trench excavation excess rock fragments that are deemed as unacceptable for trench backfill may be incurred. This excess rock may be used in the restoration of the disturbed right-of-way limits, with the rock buried within the reclamation limits of the right-of-way. With the acceptance, approval and signed individual landowner agreements for the placement of this excess rock, the rock placement will be to a depth that will help stabilize the right-of-way restoration and will be below the root zones of the cover vegetation.

If the excess rock is to be removed from the construction area, it is to be hauled to an approved local- and state-permitted disposal site. This disposal facility will need to demonstrate that it is permitted to accept and dispose of the excess rock from the blasting operations. MVP will obtain a copy of the disposal facility's permit, as issued by the local jurisdiction having authority over the disposal facility and the disposal site within.

7.9 Disposal of Explosive Materials

All explosive materials that are obviously deteriorated or damaged shall not be used and shall be destroyed according to applicable local, state, and federal requirements.

Empty containers and packages and paper or fiberboard packing materials that have previously contained explosive materials shall not be reused for any purpose. Such packaging materials shall be destroyed by burning (outside of the construction right-of- way) at an approved outdoor location or by other approved method. All personnel shall remain at a safe distance from the disposal area.

All other explosive materials will be transported from the job site in approved magazines per local and/or state regulations.

7.10 Blasting Records

A record of each blast shall be made and submitted, along with seismograph reports, to MVP's CBI. The record shall contain the following minimum data for each blast:

- Name of company or contractor;
- Location, date and time of blast;
- Name, signature and license number of contractor and blaster in charge;
- Blast location referenced to the pipeline station/milepost;
- Picture record of the blast area disturbance and of blasted trench;
- Type of material blasted;
- Number of holes, depth of burden and stemming, and spacing;
- Diameter and depth of holes;
- Volume of rock in shot;
- Types of explosives used, specific gravity, energy release, pounds of explosive per delay, and total pounds of explosive per shot;
- Delay type, interval, total number of delays and holes per delay;
- Maximum amount of explosives per delay period of 17 milliseconds or greater;
- Power factor;
- Method of firing and type of circuit;
- Direction and distance in feet to nearest structure and utility neither owned or leased by the person conducting the blasting;
- Weather conditions;
- Type and height or length of stemming;
- If mats or other protection were used; and
- Type of detonators used and delay periods used.

Within 48 hours following a blast, a Blast Report is to be provided to the MVP's CBI. The Blast Report shall provide the information outlined by "Blast Report MVP Project". This Blast Report form is considered the minimum information needed. Appendix B and C present the Blast Report forms. In addition to the completed Blast Report, the blast design is to be attached and made part of the Blast Report. The Blast Report MVP Project is in addition to all other local, county, township, state, or federal reporting requirements. Copies of these Blast Reports are to be provided to the CBI.

At the conclusion of each blasting event, the Blasting Contractor is to conduct and inventory blasting/explosive materials with a written inventory report attached to the Blast Report. All blasting/explosive materials are to be accounted for. Any discrepancies are to be immediately reported to the governing agencies and the MVP's CBI.

The person taking the seismograph reading shall accurately indicate the exact location of the seismograph, if used, and shall also show the distance of the seismograph from the blast.

Seismograph records should include:

- Name of person and firm operating and analyzing the seismograph record;
- Seismograph serial number;
- Seismograph reading; and
- Maximum number of holes per delay period of 17 milliseconds orgreater.

Within 72 hours following a blast, at sites monitored by a seismograph, a Seismograph Report is to be provided to the MVP's CBI. Appendix D presents the Seismograph Report Form for the MVP Project. In addition to the completed Seismograph Report, the seismograph readings and written interpretations are to be attached to the report. This reporting is in addition to all other local, county, township, state, or federal reporting requirements. Copies of these Seismograph Reports are to be provided to the CBI.

8 POST-BLASTING INSPECTION

An approved independent contractor, with landowner permission, will examine the condition of structures within 150 feet, or as required by state or local ordinances, of the construction area after completion of blasting operations, to identify any changes in the conditions of the these properties or confirm any damages noted by the landowner. The independent contractor, with landowner approval, will conduct a resampling of wells within 150 feet, or as required by state or local ordinances, of the construction area. Should any damage or change occur during the blasting operations, an additional survey of the affected property may be made.

Upon receiving notice that a structure or other damages have possibly occurred due to the blasting operations, the Blasting contractor is to conduct a post-blast conditions survey. The post-blast conditions survey shall be conducted within 48 hours after being notified or at the landowner's schedule and permission. The post-blast conditions will be documented with the information outlined by "Post-Blast Survey for the MVP Project". This post-blast form is considered the minimum information needed. Appendix E presents the Post-Blast Survey form.

APPENDIX A

PRE-BLAST REPORT

(Pipeline Facilities Grade, Trench Excavation, Compressor Station, and Interconnect Site)

MVP SOUTHGATE PROJECT

PRE-BLAST SURVEY

MVP SOUTHGATE PROJECT

STRUCTURE INFORMATION

Owner Name:	
Mailing Address:	
Telephone No.:	
Street Address or Physical Address:	
Latitude:	Longitude:
County/Township:	State:
Nearest Pipeline Station/Milepost:	
Company Structure No.:	

OCCUPANT INFORMATION

Occupant Name:
Mailing Address:
Telephone No.:

SURVEYOR'S INFORMATION

Company Conducting Survey:
Mailing Address:
Telephone No.:
Contact Person to Discuss Survey:
Name of Approved Surveyor:
State of Approval:

STRUCTURE LOCATION MAP

Survey Map:	8 ½" x 11" copy of construction alignment sheet or site specific plan/drawing showing MVP Southgate Project and structure surveyed. Attach map to survey.

SITE PLAN SKETCH

Site Plan:	8 ½" x 11" sketch showing all structures and relative locations, driveways, sidewalks, outbuildings, water wells, septic systems' components, and other man-made features as applicable. Use arrows to show site grade and slope. Include a North arrow and direction and distance to MVP Southgate Project. The site plan sketch shall show the distance from the blast's end points to the adjacent natural gas pipeline(s) and/or/site developments.

Exterior Inspection

(Check all that apply)

Page 2

Age of Structure

__________________years

- ❑ estimated
- ❑ provided by owner or occupant
- ❑ other (explain) _______________

Use of Structure

- ❑ private dwelling
- ❑ commercial building
  - ❑ retail
  - ❑ factory
  - ❑ office
  - ❑ warehouse/storage
- ❑ multi-family dwelling
- ❑ single-family rental
- ❑ apartment building
- ❑ other (explain) _______________

Type of Structure

- ❑ conventional dwelling
- ❑ mobile home
- ❑ mobile home with frame addition
- ❑ modular
- ❑ commercial (describe) _________
- ❑ other (explain) _______________
- ❑ single story
- ❑ two story
- ❑ other (describe) _____________

Frame Materials

- ❑ conventional wood frame
- ❑ timber frame
- ❑ steel
- ❑ masonry

Foundation Material

- ❑ poured concrete
- ❑ stone block
- ❑ cinder block
- ❑ concrete block
- ❑ other (explain) ______________________

Foundation Type

- ❑ crawl space
- ❑ full basement
- ❑ partial basement
- ❑ block on footing with center piers
- ❑ piers/posts/pillars with underpinning
- ❑ piers/posts/pillars w/out underpinning
- ❑ other (describe) ____________________

If dwelling is a mobile home, are tie-downs in use? ❑ yes ❑ no

Exterior Finish Materials

- ❑ brick
- ❑ concrete block
- ❑ cinder block
- ❑ stone
- ❑ stucco
- ❑ brick or stone laminate
- ❑ wood siding
- ❑ aluminum siding
- ❑ vinyl siding
- ❑ shingle (describe type) _______________
- ❑ other (explain) ______________________

Exterior Inspection (cont.)

(Check all that apply)

Page 3

Roofing Material(s)

- ❑ shingles
  - ❑ asphalt
  - ❑ cedar or other wood
  - ❑ other (explain)____________________
- ❑ slate
- ❑ tile
- ❑ tin or other metal
- ❑ tar & chip
- ❑ tarpaper
- ❑ other (explain)_______________________

- ❑ Gutters installed ❑ yes ❑ no
- ❑ Down spouts installed ❑ yes ❑ no
  Routed away from foundation
  ❑ yes ❑ no

Roof Configuration

- ❑ sloped
- ❑ flat

Chimney Material

- ❑ block
- ❑ gravel
- ❑ tar & chip ❑ other (explain)

Sidewalk/Walkway Material(s)

- ❑ concrete
- ❑ wood
- ❑ brick
- ❑ pavers/patio blocks
- ❑ flagstone
- ❑ other (explain)_______________________
- ❑ brick
- ❑ stone
- ❑ metal ❑ other (explain)

Driveway Material(s)

- ❑ concrete
- ❑ asphalt

Exterior Photos Labeled to Match Checklist Items.

Comments (including a description of any substandard construction):

____
____
____
____
____
____
____
____

Well/Water Supply System

(*check all that apply*)
Page 4

❑ Public Service Water Supply (*if not checked, complete the remainder of this page, and include a water analysis of untreated water).*

Water Use

❑ domestic
❑ irrigation domestic garden
❑ irrigation commercial crops
❑ livestock
❑ combined domestic and agricultural
❑ commercial (explain)
____
❑ no water source at the site (explain)
____
❑ cistern

Size______gallons
Age______years
Supplied by:
- ❑ rainwater
- ❑ spring
- ❑ runoff/stream

Location:
- ❑ aboveground
- ❑ buried

Material:
- ❑ concrete
- ❑ plastic
- ❑ metal
- ❑ other (explain) ________________

❑ spring
❑ stream
❑ other (explain)____________________

❑ dug well
depth_____ft. age_______
- ❑ brick lining
- ❑ stone lining
- ❑ other (explain)________________

❑ Pump type & size__________________
____

❑ drilled well
❑ steel casing
❑ plastic casing
❑ other (explain)
Casing depth __________ft.
Casing diameter ________ in.
Well screen/liner diameter ________ in.
Depth_______ft. to_________ft.
Well screen type
Vent type/size _________________
Well driller ___________________
Pump type & Size ______________

Water Quantity

Has well ever gone dry ❑ yes ❑ no
Has well capacity ever been measured
❑ yes ❑ no If yes, list data (recharge rate):________gpm
How many people use this water supply? _______________________

Water Quality

Does the water cause staining?
❑ yes ❑ no
Stain color: ______________
Items stained: _____________

Are there particulates (solids) in the water? ❑ yes ❑ no
If yes describe the particles (color, texture): ___________
Does the water have an odor?
❑ yes ❑ no If yes describe the odor
____

Well/Water Supply System

(*check all that apply*)

Page 5

Well/Water Supply (continued)

Is there a treatment system?

❑ yes ❑ no

Type of treatment:______________________
plant

Is the water sampling point prior to treatment?
❑ yes ❑ no

Sampling Information

May the well be unsealed to measure Depth to water and collect a water sample?
❑ yes ❑ no

Depth of water:____________ft.

May the well be pumped to measure recharge characteristics? ❑ yes ❑ no

Recharge rate_____________gpm

Date sampled: _________________________

Date measured: ________________________

Well sample no. ______________________

Septic/Sewage Treatment System

❑ public service system

❑ aeration system

❑ package

❑ septic tank

- ❑ concrete
- ❑ plastic
- ❑ metal
- ❑ other (explain) ____________

❑ drain field

❑ other (explain) ________________ Ground level

Location Information

❑ water well
- ❑ latitude ❑ longitude

❑ springs
- ❑ latitude ❑ longitude

❑ septic/sewage
- ❑ latitude ❑ longitude

Attach lab analysis of the pre-treatment water and any available written well documentation. Provide source of documentation. Photos of water well(s), water supply, water treatment system, and septic/sewage treatment system and area.

STRUCTURE

(*check all that apply*)

Page 6

Interior Inspection

Provide written documentation of any defects. Written documentation must be accompanied by photos or room sketches for each interior room.

Each interior room sketch must include type of construction materials and covering for each wall, the floor and the ceiling.

Each wall that is found to be defect free must be labeled "room completely surveyed" or "no defects observed".

Show areas hidden from view (hidden by furniture, etc.).

Interior photos of a room should be appropriately labeled to match written documentation to the photo (i.e. room and wall number).

Include a key to abbreviations used.

Include a floor plan sketch with rooms labeled and indicate direction of progression of the inspection.

Comments (include any substandard construction):

Additional Buildings

Additional Building (attach additional sheets for each additional building).

Type of building

- ❑ barn
- ❑ garage
- ❑ well house
- ❑ storage
- ❑ other (explain) ___________________

Age ____________

- ❑ estimated
- ❑ owner provided

STRUCTURE

(*check all that apply*)
Page 6

Exterior finish material ___________________
Frame materials ________________________
Roof materials _________________________
Floor materials ________________________
Foundation materials ____________________

Is interior finished ❑ yes ❑ no
Interior finish ________________________

Provide written documentation and photos of exterior and interior with room sketches for each interior room of the additional building.

Comments

Owner/resident

____
____
____
____

Surveyor

____
____
____
____
____
____
____

Structure

(*Non-Residential*)

Page 7

Structural Information

Structure

❑ Overhead Utility
   ❑ Electric   ❑ Telephone   ❑ Cable   ❑ Other

❑ Buried Utility
   ❑ Electric   ❑ Telephone   ❑ Cable   ❑ Water   ❑ Sewage   ❑ Gas   ❑ Other

Structure Information

Owner ____________________
Mailing address ____________________
Contact name ____________________
Contact telephone no. ____________________
Location of structure   Latitude ____________   Longitude ____________
County, Township ____________   State ____________
Nearest pipeline station/mile post ____________________
Structure description ____________________
____
Structure ID number ____________________

Company conducting survey ____________________
Mailing address ____________________
Telephone no. ____________________
Contact person to discuss survey ____________________
Name of approved surveyor ____________________
State of approval ____________________

Surveyor's Information

Structure Location Map

Survey Map: 8 ½" x 11" copy of construction alignment sheet or site specific plan/drawing showing MVP Southgate Project pipeline or site and structure surveyed. Attach map of survey.

Site Plan Sketch

Site Plan: 8 ½" x 11" sketch showing structures and related facilities, as applicable. Use arrows to show site grade, slope, and ground clearances. Include a north arrow with direction and distance from structure to MVP Southgate Project. The site plan sketch shall show the distance from the blast's end points to the pipeline trench and/or site developments. Provided photographs keyed to the site plan sketch showing the structure(s).

Structure

(*Non-Residential*)
Page 8

Site Plan: 8 ½" x 11" sketch showing structures and related facilities, as applicable. Use arrows to show site grade, slope, and ground clearances. Include a north arrow with direction and distance from structure to MVP Southgate Project. The site plan sketch shall show the distance from the blast's end points to the pipeline trench and/or site developments. Provided photographs keyed to the site plan sketch showing the structure(s).

Type of Aerial Structure

❑ Woods – Poles

❑ Metal Poles

❑ Metal Towers

❑ Other (describe)

Type of Buried Structure

❑ Pipe
❑ PVC ❑ Cast Iron ❑ Steel ❑ Other

❑ Cable
❑ Direct Burial ❑ Conduit ❑ Other

Surveyor's Comments

____
____
____
____
____
____
____

(Attached additional pages and photos as needed.)

APPENDIX B

BLAST REPORT

(Pipeline Grade or Trench Excavation)

MVP SOUTHGATE PROJECT

BLAST REPORT

(Pipeline Grade or Trench Excavation)

Blasting Company: ______________________________

Address ______________________________

____

Company Blast Number: ______________________________

Date and Time of Blast ______________ Date ______________ Military Time

Environment

Weather ______________ Wind From ______________

Temperature ______________ °F/°C Wind Velocity ______________ MPH

Terrain of Blast Area ______________________________

Blast Area

Blast Location ______________ Pipeline Station/Mile Post To ______________ Pipeline Station/Mile Post ______________ County/Township ______________ State

Type of Material Blasted ______________________________(Geologist Description)

____

Blast Layout

No. of Holes ______________
No. of Volume Producing Holes ______________
No. of Rows ______________
Hole Diameter ______________
Hole Depth ______________
Sub Drilling ______________
Face Height ______________
Drilling Angle ______________
Total Drilling Footage ______________

Burden ______________
Spacing ______________
Backfill Depth ______________
Stem Type ______________
Water Depth ______________
Stem Length ______________
Mats Used ______________
Hole Diagram ☐ Attached
Hole Layout and Numbering ☐ Attached

Blast Design

Initiation ______________
Firing Device ______________
Max. Wt. of Expl. Per Delay ______________
Max. No. of Holes per Delay ______________
Max. Wt. of Explosive per Hole ______________
Type of Circuit ______________
Type of Delay and Interval ______________

Rock Volume of Shot ______________
Weight ______________
Provider Factor ______________
Rock Density ______________
Specific Gravity ______________
Energy Release ______________
Power Factor ______________

BLAST REPORT

(Pipeline Grade or Trench Excavation)

Page 2

Products

Type of Construction Delays

____
____
____
____
____
____

Nearest Structure

Structure Type ____
Structure Name ____
Structure Location Latitude ________________ Longitude ____________
Compass Point ____
Direction from Outer Limits of Blast Area to Structure

Bearing ____
Distance ____

Protection

Mat Type (If Used) ____
Mat Weight (Per Mat) ____
Other than mat blast protection used (description)______________________________
____

Safety Measures

Type of Safety Measures Implemented to Protect Blast Area from Unauthorized Personnel

____
____
____

Location(s) of Safety Measures

Measure: Lat. __________ Long. __________ Measure: Lat. __________ Long. __________
Measure: Lat. __________ Long. __________ Measure: Lat. __________ Long. __________

Dates Safety Measures Placed______________________________

Date: __________ Measure __________ Date: __________ Measure __________
Date: __________ Measure __________ Date: __________ Measure __________

Dates Safety Measures Removed

Date: __________ Measure __________ Date: __________ Measure __________
Date: __________ Measure __________ Date: __________ Measure __________

BLAST REPORT

(Pipeline Grade or Trench Excavation)

Page 3

Communication System

Type System used to Maintain Safe Blast Area

____

Location of System(s)

____

Notices of Blast

Company/Person Providing Notice ______________________
Verbal Date and Time of Notice ______________________
Written Notice Date ______________________
Written Notice Provided By ______________________

Seismograph

Type Seismograph ______________________
Model and Serial Number ______________________
Calibration Date ______________________
Calibration Certificate Provided
Date and Time Seismograph Set ______________________
Date and Time Seismograph Removed ______________________
Seismograph Location Lat. ________ Long. ________
Seismograph Distance from Blast ______________________
Seismograph Compass Direction from Blast ______________________
Printed Copy of Read Out to be Provided ______________________
Reader and Firm ______________________
Analyst and Firm ______________________
Installer and Firm ______________________
Trigger Level ____________ in/s ____________ dB
Calibration ☐ Yes ☐ No
Geophone Min. Freq. ____________ Hz
Traverse ____________ in/s ____________ Hz
Vertical ____________ in/s ____________ Hz
Longitudinal ____________ in/s ____________ Hz
Peak Partial Velocity ____________ in/s ____________ Hz
Acoustic ____________ dB ____________ Hz
Vector Sum ____________ in/s - - -

(Detailed Seismograph Report Provided By Appendix D.)

BLAST REPORT

(Pipeline Grade or Trench Excavation)

Page 4

Pictures

Picture(s) of blast area disturbance before blasting
Picture(s) date and time

Picture(s) of blasted trench after blast
Picture(s) date and time

Comments/Explanations of Blaster

____
____
____
____
____
____
____
____

Blaster

Signature of Blaster in Charge ______________________________ Date __________
Printed Name of Blaster in Charge ____
Blaster in Charge License Number ____
Blaster in Charge License Expiration Date ____
Blasting Company License Number ____
Blasting Company License Expiration Date ____________________________________
Signature of Blasting Company Person in Charge ________________________________
Printed Name of Blasting Company Person in Charge __________________________________

Date Report Submitted to MVP Southgate Project

Date ______________________________

APPENDIX C

BLAST REPORT

(Compressor station or Interconnect Site Development)

MVP SOUTHGATE PROJECT

BLAST REPORT

(Compressor station or Interconnect Site Development)

Blasting Company: ______________________________

Address ______________________________

____

Company Blast Number: ______________________________

Date and Time of Blast ____________ Date ____________ Military Time

Environment

Weather ____________ Wind From ____________

Temperature ____________ °F/°C Wind Velocity ____________ MPH

Terrain of Blast Area ______________________________

Blast Area

Blast Location ____________ Pipeline Station/Mile Post To ____________ Pipeline Station/Mile Post ____________ County/Township ____________ State

Type of Material Blasted ______________________________(Geologist Description)

____

Blast Layout

No. of Holes ____________
No. of Volume Producing Holes ____________
No. of Rows ____________
Hole Diameter ____________
Hole Depth ____________
Sub Drilling ____________
Face Height ____________
Drilling Angle ____________
Total Drilling Footage ____________

Burden ____________
Spacing ____________
Backfill Depth ____________
Stem Type ____________
Water Depth ____________
Stem Length ____________
Mats Used ____________
Hole Diagram ☐ Attached
Hole Layout and Numbering ☐ Attached

Blast Design

Initiation ____________
Firing Device ____________
Max. Wt. of Expl. Per Delay ____________
Max. No. of Holes per Delay ____________
Max. Wt. of Explosive per Hole ____________
Type of Circuit ____________
Type of Delay and Interval ____________

Rock Volume of Shot ____________
Weight ____________
Provider Factor ____________
Rock Density ____________
Specific Gravity ____________
Energy Release ____________
Power Factor ____________

BLAST REPORT

(Compressor station or Interconnect Site Development)

Page 2

Products

Type of Construction Delays

____
____
____
____
____
____

Nearest Structure

Structure Type ____
Structure Name ____
Structure Location Latitude ____________________ Longitude ______________
Compass Point ____
Direction from Outer Limits of Blast Area to Structure

Bearing ____
Distance ____

Protection

Mat Type (If Used) ____
Mat Weight (Per Mat) ____
Other than mat blast protection used (description)____
____

Safety Measures

Type of Safety Measures Implemented to Protect Blast Area from Unauthorized Personnel

____
____
____

Location(s) of Safety Measures

Measure: Lat. __________ Long. __________ Measure: Lat. __________ Long. __________
Measure: Lat. __________ Long. __________ Measure: Lat. __________ Long. __________

Dates Safety Measures Placed____

Date: __________ Measure __________ Date: __________ Measure __________
Date: __________ Measure __________ Date: __________ Measure __________

Dates Safety Measures Removed

Date: __________ Measure __________ Date: __________ Measure __________
Date: __________ Measure __________ Date: __________ Measure __________

BLAST REPORT

(Compressor station or Interconnect Site Development)

Page 3

Communication System

Type System used to Maintain Safe Blast Area

____

Location of System(s)

____

Notices of Blast

Company/Person Providing Notice ______________________
Verbal Date and Time of Notice ______________________
Written Notice Date ______________________
Written Notice Provided By ______________________

Seismograph

Type Seismograph ______________________
Model and Serial Number ______________________
Calibration Date ______________________
Calibration Certificate Provided
Date and Time Seismograph Set ______________________
Date and Time Seismograph Removed ______________________
Seismograph Location Lat. ________ Long. ________
Seismograph Distance from Blast ______________________
Seismograph Compass Direction from Blast ______________________
Printed Copy of Read Out to be Provided ______________________
Reader and Firm ______________________
Analyst and Firm ______________________
Installer and Firm ______________________
Trigger Level ____________ in/s ____________ dB
Calibration ☐ Yes ☐ No
Geophone Min. Freq. ____________ Hz
Traverse ____________ in/s ____________ Hz
Vertical ____________ in/s ____________ Hz
Longitudinal ____________ in/s ____________ Hz
Peak Partial Velocity ____________ in/s ____________ Hz
Acoustic ____________ dB ____________ Hz
Vector Sum ____________ in/s - - -

(Detailed Seismograph Report Provided By Appendix D.)

BLAST REPORT

(Compressor station or Interconnect Site Development)

Page 4

Pictures

Picture(s) of blast area disturbance before blasting
Picture(s) date and time

Picture(s) of blasted trench after blast
Picture(s) date and time

Comments/Explanations of Blaster

____
____
____
____
____
____
____
____

Blaster

Signature of Blaster in Charge ________________________ Date ________
Printed Name of Blaster in Charge ________________________
Blaster in Charge License Number ________________________
Blaster in Charge License Expiration Date ________________________
Blasting Company License Number ________________________
Blasting Company License Expiration Date ________________________
Signature of Blasting Company Person in Charge ________________________
Printed Name of Blasting Company Person in Charge ________________________

Date Report Submitted to MVP Southgate Project

Date ________________________

APPENDIX D

SEISMOGRAPH REPORT

MVP SOUTHGATE PROJECT

SEISMOGRAPH REPORT
MVP SOUTHGATE REPORT

Seismograph Company: ______________________________

Address ______________________________

____

Blast Location (Pipeline Grade or Trench Excavation)

______________ to ______________ ______________ ______________

Pipeline Station/Mile Post | Pipeline Station/Mile Post | County/Township | State

Blast Location (Compressor Station or Site Development_

______________ ______________ ______________ ______________

Latitude | Longitude | County/Township | State

Seismograph

______________ ______________ ______________

Type | Model | Serial Number

______________________________ ❑ Yes ❑ No

Calibration Date | Calibration Certificate Attached

Blast Monitoring

Blasting Company's Blasé Number ______________________________

Blast Date and Time Date ______________ Time ______________

(Military Time)

Seismograph Location Latitude ______________ Longitude ______________

Seismograph Location Description ______________________________

____

Seismograph Distance from Blast in Feet and Compass Direction

____

Seismograph Distance from Structure in Fee and Compass Direction

____

Trigger Level ______________ in/s ________ dB

Calibration Signal ______ Yes ______ No

Geophone Min. Freq. ______________ Hz

Mic. Min. Freq. ______________ Hz

Traverse ________ in/s ________ Hz

Vertical ________ in/s ________ Hz

Longitudinal ________ in/s ________ Hz

Peak Partial Velocity ____ in/s ____ Hz

Acoustic ________ dB

Vector Sum ________ in/s - - -

SEISMOGRAPH REPORT

MVP SOUTHGATE REPORT

Page 2

Blast Monitoring (Continued)

Reader and Firm ______________________________
Analyst and Firm ______________________________
Installer and Firm ______________________________

Seismic Analysis

Velocity Waveform Analysis ❑ Attached
Zero Crossing Half0Wave Frequency Analysis ❑ Attached

Blast Data

Number of Holes per Delay ______________________________
Max. Number per Delay Period

Delay Period ____________ Milliseconds

No Seismograph Trigger

Event Time Begin Date ____________________ Time ____________
End Date ____________________ Time ____________

Events Over Trigger ____________________
Record Time ____________________ Seconds
Seismic Trigger ____________________ in/s
Sound Trigger ____________________ dB
Battery Level ____________________

Shake Table Calibrated Date Date ____________________ By ____________________

Dynamic Calibration Graph Cal Test Results

Longitudinal	_______ Pass	_______ Fail
Transverse	_______ Pass	_______ Fail
Vertical	_______ Pass	_______ Fail
Sound	_______ Pass	_______ Fail

SEISMOGRAPH REPORT
MVP SOUTHGATE REPORT
Page 3

Person Analyzing Readings

Signature of Seismograph Reader Date

Printed Name of Seismograph Reader

Name of Company/Firm Analyzing Readings

The Seismograph Report, copy of seismograph readings, location sketch of seismograph placement, and Description documenting the location of each seismograph are to be attached to the Blast Report. A Seismograph Report is to be completed for each seismograph/ When no “trigger” event is encountered, a Seismograph Report is to be submitted with the No Seismograph Trigger Section of the report completed.

APPENDIX E

POST-BLAST

SURVEY REPORT

MVP SOUTHGATE PROJECT

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

STRUCTURE INFORMATION

Owner Name:	
Mailing Address:	
Telephone No.:	
Street Address or Physical Address:	
Latitude:	Longitude:
County/Township:	State:
Nearest Pipeline Station/Milepost:	
Company Structure No.:	

OCCUPANT INFORMATION

Occupant Name:
Mailing Address:
Telephone No.:

SURVEYOR'S INFORMATION

Company Conducting Survey:
Mailing Address:
Telephone No.:
Contact Person to Discuss Survey:
Name of Approved Surveyor:
State of Approval:

REQUEST FOR POST-BLAST SURVEY

Name of Company/Person Requesting Post-Blasting Survey:
Mailing Address:
Telephone No.:
Physical Address:
Statement of Damage:

STRUCTURE LOCATION MAP

Survey Map:	8 ½" x 11" copy of construction alignment sheet or site specific plan/drawing showing MVP Southgate and structure surveyed. Attach map to survey.

SITE PLAN SKETCH

Site Plan:	8 ½" x 11" sketch showing all structures and relative locations, driveways, sidewalks, outbuildings, water wells, septic systems' components, and other man-made features as applicable. Use arrows to show site grade and slope. Include a North arrow and direction and distance to MVP Southgate Project. The site plan sketch shall show the distance from the blast's end points to the adjacent natural gas pipeline(s).

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

Exterior Inspection
(Check all that apply)
Page 2

Age of Structure

__________________years

- ❑ estimated
- ❑ provided by owner or occupant
- ❑ other (explain) ________________

Use of Structure

- ❑ private dwelling
- ❑ commercial building
  - ❑ retail
  - ❑ factory
  - ❑ office
  - ❑ warehouse/storage
- ❑ multi-family dwelling
- ❑ single-family rental
- ❑ apartment building
- ❑ other (explain) ________________

Type of Structure

- ❑ conventional dwelling
- ❑ mobile home
- ❑ mobile home with frame addition
- ❑ modular
- ❑ commercial (describe) _________
- ❑ other (explain) ________________
- ❑ single story
- ❑ two story
  - ❑ other (describe) ___________

Frame Materials

- ❑ conventional wood frame
- ❑ timber frame
- ❑ steel
- ❑ masonry

Foundation Material

- ❑ poured concrete
- ❑ stone block
- ❑ cinder block
- ❑ concrete block
- ❑ other (explain) ______________________

Foundation Type

- ❑ crawl space
- ❑ full basement
- ❑ partial basement
- ❑ block on footing with center piers
- ❑ piers/posts/pillars with underpinning
- ❑ piers/posts/pillars w/out underpinning
- ❑ other (describe) ____________________

If dwelling is a mobile home, are tie-downs in use? ❑ yes ❑ no

Exterior Finish Materials

- ❑ brick
- ❑ concrete block
- ❑ cinder block
- ❑ stone
- ❑ stucco
- ❑ brick or stone laminate
- ❑ wood siding
- ❑ aluminum siding
- ❑ vinyl siding
- ❑ shingle (describe type) _______________
- ❑ other (explain) ______________________

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

Exterior Inspection (cont.)
(Check all that apply)
Page 3

Roofing Material(s)

- ❑ shingles
  - ❑ asphalt
  - ❑ cedar or other wood
  - ❑ other (explain)____________________
- ❑ slate
- ❑ tile
- ❑ tin or other metal
- ❑ tar & chip
- ❑ tarpaper
- ❑ other (explain)______________________

Gutters installed ❑ yes ❑ no
Down spouts installed ❑ yes ❑ no
Routed away from foundation
❑ yes ❑ no

Roof Configuration

- ❑ sloped
- ❑ flat

Chimney Material

- ❑ block
- ❑ brick
- ❑ stone
- ❑ metal
- ❑ other (explain) ________________

Sidewalk/Walkway Material(s)

- ❑ concrete
- ❑ wood
- ❑ brick
- ❑ pavers/patio blocks
- ❑ flagstone
- ❑ other (explain) ______________________

Driveway Material(s)

- ❑ concrete
- ❑ asphalt
- ❑ gravel
- ❑ tar & chip
- ❑ other (explain) ________________

Exterior Photos Labeled to Match Checklist Items.

Comments (including a description of any substandard construction):

____
____
____
____
____
____

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

Well/Water Supply System (*check all that apply*)
Page 4

❑ Public Service Water Supply (*if not checked, complete the remainder of this page, and include a water analysis of untreated water).*

Water Use

❑ domestic
❑ irrigation domestic garden
❑ irrigation commercial crops
❑ livestock
❑ combined domestic and agricultural
❑ commercial (explain)
____
❑ no water source at the site (explain)
____
❑ cistern
Size______gallons
Age______years
Supplied by:
❑ rainwater
❑ spring
❑ runoff/stream
Location:
❑ aboveground
❑ buried
Material:
❑ concrete
❑ plastic
❑ metal
❑ other (explain) _______________

❑ spring
❑ stream
❑ other (explain)____________________

❑ dug well
depth_____ft. age_______
❑ brick lining
❑ stone lining
❑ other (explain)_______________
❑ Pump type & size_____________
____

❑ drilled well
❑ steel casing
❑ plastic casing
❑ other (explain) ______________
Casing depth__________ft.
Casing diameter________in.
Well screen/liner diameter_______in.
Depth ft. to_________ft.
Well screen type ______________
Vent type/size ________________
Well driller ___________________
Pump type & size ______________

Water Quantity

Has well ever gone dry ❑ yes ❑ no
Has well capacity ever been measured
❑ yes ❑ no If yes, list
data (recharge rate):________gpm
How many people use this water supply? ______________________

Water Quality

Does the water cause staining?
❑ yes ❑ no
Stain color: ______________
Items stained: _____________

Are there particulates (solids) in the water? ❑ yes ❑ no
If yes describe the particles (color, texture): ___________
Does the water have an odor?
❑ yes ❑ no If yes describe the odor
____

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

Water Well/Septic-Sewage System
Page 5

Well/Water Supply (continued)

Is there a treatment system?
❑ yes ❑ no
Type of treatment:______________________
Is the water sampling point prior to treatment? ❑ yes ❑ no

Sampling Information

May the well be unsealed to measure depth to and of water? ❑ yes ❑ no
Depth of water:___________ft.
Ground level to water:_____ft.
May the well be pumped to measure recharge characteristics? ❑ yes ❑ no
Recharge rate____________gpm
Date measured: ________________________
Date sampled: _________________________
Well sample no.: _______________________

Septic/Sewage Treatment System

❑ public service system
❑ aeration system
❑ package plant
❑ septic tank
  ❑ concrete
  ❑ plastic
  ❑ metal
  ❑ other (explain) _____________
❑ drain field
❑ other (explain) ________________

Location Information

❑ water well
  ❑ latitude ❑ longitude
❑ springs
  ❑ latitude ❑ longitude
❑ septic/sewage
  ❑ latitude ❑ longitude

Attach lab analysis of the pre-treatment water and any available written well documentation. Provide source of documentation. Photos of water well(s), water supply, water treatment system, and septic/sewage treatment system and area.

Interior Inspection

Provide written documentation of any defects. Written documentation must be accompanied by photos or room sketches for each interior room.

Each interior room sketch must include type of construction materials and covering for each wall, the floor and the ceiling.

Each wall that is found to be defect free must be labeled "room completely surveyed" or "no defects observed".

Show areas hidden from view (hidden by furniture, etc.).

Interior photos of a room should be appropriately labeled to match written documentation to the photo (i.e. room and wall number).

Include a key to abbreviations used.

Include a floor plan sketch with rooms labeled and indicate direction of progression of the inspection.

Comments (include any substandard construction): ___________________________________
____
____
____

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

Additional Buildings
Page 6

Additional Building (attach additional sheets for each additional building).

Type of building
- ❑ barn
- ❑ garage
- ❑ well house
- ❑ storage
- ❑ other (explain) ___________________

Age ____________
- ❑ estimated
- ❑ owner provided

Exterior finish material _____
Frame materials ________________________
Roof materials _________________________
Floor materials _________________________
Foundation materials ____________________
Is interior finished ❑ yes ❑ no
Interior finish ________________________

Provide written documentation and photos of exterior and interior with room sketches for each interior room of the additional building.

Comments

Owner/resident: ____
____
____
____

Surveyor: ____
____
____
____

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

DAMAGE SUMMARY
Page 7

Damaged Facility: ______________________________
List Facility Damaged

Type of Damage: ______________________________
(Attach sketch of damaged facility, facility location, and photograph)

Date of Blast and Time: ________________ ________________
Date Military Time
(Attach copy of blast design and blast report)

Pipeline Trench Location:________________to ________________ ________________ ______
Pipeline Station/Milepost Pipeline Station/Milepost County/Township State

Pipeline Trench to Damage Location: ______________________________
Distance from Blasting Site (in Feet) and Location Compass Direction

Seismograph Report: ______________________________
(Attach Seismograph Report)

Pipeline Trench Fracture Zone: ________________ ________________
Length in Feet Width in Feet

Changes Implemented Blast Design: ______________________________
Weight of Change

____
Distribution of Change in Blast Hole

____
Weight of Explosive per Delay

____
Shot Hole Pattern

____
Supplier/Manufacturer of Explosive

____
Explosive Grade

Ground Geology: ______________________________
List Changes Before Blast and After Blast

POST-BLAST SURVEY
MVP SOUTHGATE PROJECT

DAMAGE SUMMARY
Page 8

Provide Written Comments of: **MVP Chief Blasting Inspector**
Blaster
Post-Blast Surveyor
Seismologist
Facility Owner

Provide written comments of suggested changes to future blast designs for the Mountain Valley project.

Provide written comments as to actions to be taken to correct the damages.

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-E

Karst Hazard Assessment

KARST HAZARDS ASSESSMENT

MVP SOUTHGATE PROJECT

Prepared for:

Mountain Valley Pipeline, LLC

Suite 1700
625 Liberty Avenue
Pittsburgh, PA 15222-3111

October 2018

Prepared by:

Draper Aden Associates
Engineering • Surveying • Environmental Services

DAA Project Number: B14188B-33

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1.0 INTRODUCTION

This report presents a Karst Hazards Assessment (KHA) for the MVP Southgate Project (Project or Southgate Project). The Southgate Project facilities will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina.

The KHA presents the results of a desktop review of documentation to catalogue potential karst terrain mapped within the proposed Project alignment in Virginia and North Carolina. Karst-forming bedrock contain an abundance of carbonate minerals that tend to dissolve when in contact with percolating rainfall and snowmelt. This is a chemical weathering process that enhances secondary porosity of the bedrock and results in karst topography that is characterized at the ground surface by sinkholes, losing streams, and caves. Potential karst hazards include the following conditions: unstable ground, soil piping into subsurface karst forming a sinkhole, shallow caves. or landscapes with complicated and sensitive groundwater hydrology.

The geology underlying the Project is not known to support notable karst-forming processes. However, there is potential for karst features based on mapped carbonate bedrock in the vicinity of the Project within Virginia (no mapped karstic geology was identified in North Carolina). Field verification will be conducted along the Project alignment to verify whether karst features are present within the specific areas identified in this desktop study, as discussed below..

The KHA is part of Resource Report 6, which was prepared and organized according to the Federal Energy Regulatory Commission (FERC) Guidance Manual for Environmental Report Preparation (February 2017). Resource Report 6 describes existing geologic setting and resources, potential impacts, geologic hazards and mitigation in relation to Project components.

2.0 EVALUATION OF POTENTIAL KARST TERRAIN

The KHA was completed under the direction of Draper Aden Associates Karst Specialist Team (KST), which holds over 140 years of combined experience in the identification and assessment of karst hydrology and geomorphic processes.

Figure 1 illustrates the proposed Southgate Project alignment and three (3) areas of detail being evaluated for potential karst terrain. Figure 2 and Figure 3 illustrate the areas of detail that are shown in Figure 1, and depict mapped bedrock underlying the Project alignment. Figure 4 illustrates another area where potential karst bedrock may occur, as discussed below.

Weary and Doctor (2014) created a 1:500,000 scale digital map of karst in the United States, which appears to indicate that the Project alignment may intersect karst terrain (Figure 1). Specifically, Weary and Doctor (2014) identified a conglomerate unit as potential karst forming, which is comprised of mixed clasts of the Upper Triassic, Newark Supergroup, Mesozoic Basin, and described as:

> *c: conglomerate, mixed clasts. Rounded to subangular pebbles, cobbles, and boulders of mixed lithologies including quartz, phyllite, quartzite, gneiss, schist, green stone, and marble in a matrix of medium- to very-coarse-grained, reddish-brown to gray, locally arkosic, sandstone.*

The conglomerate unit was noted to have karst potential due to the possible presence of marble, which is a metamorphic rock type that contains carbonate mineralogy.

However, when the Weary and Doctor (2014) map is compared to Virginia Division of Geology and Mineral Resources (DGMR) geologic quadrangle maps that are at a larger scale (1:24,000), the length and rock units are better understood.

Based on information depicted in the 1:24,000 scale DGMR geologic quadrangles there are five (5) locations where the conglomerate unit occurs along the Project alignment (Table 1). These five locations are also depicted in Figures 2 through 4. Note that Figure 2 and Figure 3 also illustrate in dashed blue line the potential karst area identified by Weary and Doctor (2014), however, the scale of that mapping exercise is extremely coarse.

The conglomerate unit is described by the DGMR as:

> *cg: a thick-bedded, poorly sorted, sandy, cobble and boulder lithic conglomerate with minor amounts of poorly sorted, pebbly, coarse- and very coarse-grained, cross-bedded arkose and lithic arkose; multicolored, subrounded clasts are in a light- and medium-gray, poorly sorted, densely packed lithic arkose matrix; unit intensely sheared, silicified, and cut by quartz veins along and near border fault.*

As shown in the DGMR geologic mapping (depicted in Figures 2 through 4), no marble or carbonate-containing bedrock are mapped in the vicinity of the Project alignment. Therefore, the potential for karst terrain, and karst hazards, is likely negligible.

The KST will complete field verification where the Project alignment crosses the areas of potential karst (e.g., conglomerate) to confirm whether karst features are present. If karst features are not present, the potential for karst hazards will be confirmed to be negligible.

3.0 CONCLUSION

As discussed in this report, the potential for karst terrain and corresponding karst hazards along the Southgate Project alignment, listed in Table 1 and shown in Figures 2 through 4, is likely to be minimal. The KST will complete field verification of potential karst terrain along the Project alignment (as discussed above). If karst features are not present, the potential for karst hazards is negligible.

4.0 BIBLIOGRAPHY

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Table 1

Locations where the Project alignment intersects conglomerate that may represent karst terrain (pending field verification)

County, State	From Milepost	To Milepost	Crossing Length (feet)	Rock Type	Construction Method
Pittsylvania, Virginia	0.03	1.00	3,696	conglomerate (covered by terrace deposits)	Open-cut and bore (road crossings)
Pittsylvania, Virginia	14.95	15.70	3,960	Conglomerate	Open-cut and bore (road crossings)
Pittsylvania, Virginia	21.20	21.50	1,584	Conglomerate	Open-cut and bore (road crossings)
Pittsylvania, Virginia	21.80	21.91	581	Conglomerate	Open-cut and bore (road crossing)
Pittsylvania, Virginia	22.12	22.30	950	Conglomerate	Open-cut and bore (road crossing)

Heinika, William S. and Paul A. Thayer. 1983. Geologic map of the Spring Garden Quadrangle, Va. Va. Division of Geology and Mineral Resources Publication 48, 1:24,000 scale map. Marr, J.D., Jr. 1984. Geologic map of the Pittsville and Chatham Quadrangles, Va. Va. Division of Geology and Mineral Resources Publication 49, 1:24,000 scale map. Price, V., J.F. Conley, R.G. Piepul, G.R. Robinson, P.A. Thayer, and W.S. Heinika, 1980. Geology of the Whitmell and Brosville quadrangles, Va. Publication 021, 1:24,000 scale map.

No potential karstic geology was identified by this desktop study in North Carolina along the Project alignment.

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-F

Earthquakes and Active Fault Hazard Analysis

EARTHQUAKE AND ACTIVE FAULT HAZARD ANALYSES

MVP SOUTHGATE PROJECT

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October, 2018

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Draper Aden Associates
Engineering • Surveying • Environmental Services

DAA Project Number: B14188B-33

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1.0 INTRODUCTION

Draper Aden Associates evaluated historic earthquakes within 50 miles of the proposed MVP Southgate Project (Southgate Project) alignment, probabilistic earthquake-generated ground movement hazards, and the potential for the proposed Southgate Project alignment to cross one or more active geologic faults. The Southgate Project facilities will be located in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. Draper Aden Associates completed this evaluation in accordance with the Federal Energy Regulatory Commission (FERC) Guidance Manual for Environmental Report Preparation (FERC, 2017).

From Section 4.6.4 of the FERC Guidance Manual (2017):

> *Discuss the seismic risk across the project area. Identify the site seismicity areas for potential soil liquefaction, and areas for potential surficial fault rupture for all pipeline and aboveground facilities. Consult state and USGS seismicity maps for these data (see example shown on figure 4.6.4-1). Identify past and recent seismic events, and characterize the potential ground shaking from future earthquakes using the USGS seismic hazard mapping model or other models that allow for the calculation of peak ground acceleration for various return periods, including 10 percent (top) and 2 percent (bottom) probabilities of exceedance in 50 years, and for specific locations for soft rock site conditions.*

The following sections describe our assessment of earthquake and geologic fault hazards.

1.1 Historical Earthquakes within 50 Miles of the MVP Southgate Project

The majority of earthquakes with greater than moment magnitude 5.0 occur along active tectonic plate boundaries. Active plate boundaries include subduction zones, where dense oceanic crust is descending beneath lighter continental crust (such as Indonesia or the western coast of South America), convergent boundaries, where continental plates collide (such as the convergence of the Indian sub-continent and Asia), and transverse boundaries where tectonic plates are "sliding" against one another (such as the San Andreas fault in California). Eastern North America is considered a passive tectonic boundary, and unlike active boundaries, does not experience the frequency or intensity of seismic activity.

Virginia and North Carolina do experience occasional earthquakes related to far-field tectonic stress and residual stress from past orogenic (mountain building) events. Information on historical earthquakes proximal to the proposed Project alignment in Virginia and North Carolina was taken from the U.S. Geological Survey (USGS) Earthquake Information Center (USGS, 2018).

Table 6.1 lists historical earthquakes measured or documented within 50 miles of the proposed Southgate Project alignment in Virginia and North Carolina. Recorded earthquakes within 50 miles of the proposed Southgate Project alignment had a moment magnitude of 3 or less, which generally represents low-level concerns for ground movement (Table 6.1).

1.2 Probabilistic Earthquake-induced Ground Motion

Probabilistic earthquake-induced ground motions were evaluated for the proposed Southgate Project alignment based on work completed by the USGS (Peterson et al, 2014). Peak ground acceleration estimates for the proposed Southgate Project alignment range from 0.06g to 0.08g (i.e. a fraction of gravitational acceleration g), with a two-percent (2%) probability of occurrence within 50 years, or within a mean return period of 2,500 years (Figure 6.1).

Figure 6.2 and Figure 6.3 show the proposed Southgate Project alignment and spectral response acceleration at 5Hz (0.12g to 0.2g) and 1Hz (0.04g to 0.06g), respectively, (USGS, 2014).

Based on the analyses illustrated in Figures 6.1 through 6.3 (discussed above), there is generally low-level concern regarding probabilistic ground motion associated with earthquakes in the vicinity of the proposed Southgate Project alignment with a return period of 2,500 years.

1.2.1 Discussion on earthquake-induced ground movement

Earthquake-induced ground movement may present a concern for above-ground facility design. It is generally accepted that earthquake ground shaking alone does not pose a significant threat to the integrity of modern buried, welded, steel high-pressure pipelines; however, the level of ground shaking is a factor in determining potential for permanent ground displacement hazards that can threaten pipeline integrity such as liquefaction, settlement slope instability, lateral spread displacement, and dynamic compaction. The following presents a summary of the level of ground shaking hazard along the proposed Southgate Project alignment relevant to the design of aboveground installations.

In accordance with current building code requirements, the ground motions summarized in this section are associated with an annual probability of exceedance of approximately 1/2500 (i.e., return period of 2,500 years). The peak ground acceleration is a parameter of most importance for assessing the severity of permanent ground displacement hazards for buried pipelines. Peak ground acceleration can also be related to peak ground velocity, a parameter important for judging the impact of seismic wave propagation on buried pipelines.

For aboveground pipeline facilities that are typically required to meet building code requirements for non-structural components, spectral ground motions at frequencies of

1 Hz and 5 Hz are more relevant. Tools provided by USGS (Peterson et al., 2014) were discussed above, and used herein to determine relevant ground motion parameters along the proposed Southgate Project alignment. The USGS ground motion values are based upon sites between class B (rock) and C (dense soil). This site class corresponds to sites with an average shear wave velocity of 760 m/sec in the top 30 meters of soil. The building code requires adjustment of the USGS basic ground motion parameters for sites that have significantly different average shear wave velocities; however, the default USGS site classification is judged to be broadly applicable to the proposed Southgate Project alignment.

Based on USGS modeling (2014) that is illustrated in Figure 6.1 through Figure 6.3 (herein), Table 6.2 presents a summary of peak ground acceleration, as well as spectral accelerations, for the proposed Southgate Project alignment. In summary, peak ground acceleration is anticipated to be less than 0.08g, and 5Hz spectral acceleration 0.2g and 1 Hz spectral acceleration 0.06g, with a probabilistic return period of 2,500 years. These results present, in general, a low-level concern for earthquake-induced ground motion hazards for the proposed Southgate Project alignment.

1.3 Quaternary Age Fault or Possible Fault Features

Activation of existing faults (surfaces between or within rock bodies along which displacement has, at one time, occurred) can produce seismic events. Faults along which movement has occurred within the Holocene Epoch (approximately 11,500 years ago to present) are generally considered to present a potential risk for seismic hazards to natural gas pipelines. The proposed Southgate Project alignment was conservatively (i.e., maximize hazard assessment) evaluated for the presence of Quaternary (1.8 million years ago to present) age faulting and the potential for ground movement and failure.

The USGS (2006) compiled geological information on Quaternary faults throughout the United States. Particular application of this resource is for the Central and Eastern United States (CEUS), which is defined as the region extending from the Rocky Mountain Front eastward to the Atlantic seaboard, and encompasses the proposed Southgate Project alignment in Virginia and North Carolina. Within the CEUS study area encompassing more than 60 percent of the contiguous U.S., 69 features are identified and categorized into four classes (Class A, B, C, and D) based on what is known about the feature's Quaternary activity. The CEUS contains only 13 Class A features, where there is convincing evidence of Quaternary activity. Of the remaining 56 features, 11 require further study in order to confidently define their potential as possible sources of earthquake-induced ground motion (Class B). The remaining features considered by USGS either lack convincing geologic evidence of Quaternary tectonic faulting or have been studied carefully enough to determine that they do not pose a significant seismic hazard (Classes C and D).

Table 6.3 summarizes the assessment of known or potential Quaternary age faults in Virginia and North Carolina (USGS, 2006; Crone and Wheeler, 2000; Wheeler, 2006; Law et al., 1994). Figure 6.4 illustrates the proposed Southgate Project alignment and the locations of the Quaternary age faults or possible fault features listed in Table 6.3. As shown in Table 6.3 and Figure 6.4, there are no identified faults (Class A, B, C, D) that demonstrate potential to be active within the vicinity of the proposed Southgate Project alignment.

2.0 CONCLUSION

Potential earthquake-induced seismic hazards presented to the proposed Southgate Project construction and operation are low to negligible based on probabilistic estimates of ground motion. Pipeline design and construction considerations, including potential for soil liquefaction, will evaluate ground motion parameters noted in Table 6.2, but the resulting low-level seismic coefficients are not anticipated to affect pipeline design considerations.

The proposed Southgate Project alignment does not cross a known or inferred Class A, B, or C fault or fault zone with evidence of tectonic origin and Quaternary movement. Therefore, avoidance considerations are not required.

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TABLES

Table 6.1

Historical Earthquakes within 50 Miles of the MVP Southgate Project in Virginia and North Carolina

Facility	Distance from Route/ Facility (miles)	Date of Earthquake	Magnitude of Earthquake	Location of Earthquake
Pipeline Facilities				
H-650 Pipeline	6	1978-02-25	2.7	Virginia-North Carolina border region
	31	1981-03-04	2.8	North Carolina
	21	1993-07-12	2.7	Virginia-North Carolina border region
	42	2006-10-17	2.6	7 kilometers south of Winston-Salem, North Carolina
	44	2006-10-17	1.5	5 kilometers west, southwest of Winston-Salem, North Carolina
	44	2006-10-18	1.3	5 kilometers west of Winston-Salem, North Carolina
	44	2006-10-18	2.4	Virginia-North Carolina border region
	44	2006-11-03	2.5	5 kilometers south, southwest of Winston-Salem, North Carolina
	41	2008-08-18	2.7	2 kilometers north, northeast of Cave Spring, Virginia
	46	2009-05-16	3.0	Virginia
Aboveground Facilities				
Lambert Compressor Station / Interconnect / Mainline valve	42	2000-08-18	2.7	Virginia
Russell Compressor Station	31	1978-02-25	2.7	Virginia-North Carolina border region
LN 3600 Interconnect	28.0	1978-02-25	2.7	Virginia-North Carolina border region
T-15 Dan River Interconnect	30	1978-02-25	2.7	Virginia-North Carolina border region
T-21 Haw River Interconnect / Mainline Valve	11	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 12.5)	36	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 18.4)	33	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 28.4)	30	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 43.4)	21	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 53.4)	13	1978-02-25	2.7	Virginia-North Carolina border region
Mainline valve (MP 67.7)	7	1978-02-25	2.7	Virginia-North Carolina border region
Source: USGS, 2018. Historical Earthquakes. https://earthquake.usgs.gov/earthquakes/map.				

Table 6.2 Peak Ground and Spectral Acceleration (fraction of gravity, g). Maximum of ranges shown in Figure 6.1, Figure 6.2 and Figure 6.3, respectively (taken from Petersen et al, 2014).		
Peak Ground Acceleration (Figure 6.1)	**Spectral Acceleration 5-Hz (Figure 6.2)**	**Spectral Acceleration 1-Hz (Figure 6.3)**
0.08 g	0.2 g	0.06 g

Table 6.3	Summary of Known or Inferred Quaternary age Faults in Virginia and North Carolina (USGS, 2006). See Figure 6.4 for Referenced # Feature
1	Feature Identity: Central Virginia seismic zone CEUS Class (see note): A Approximate Distance to Closest Proposed Alignment (miles): ~95 Description: Moderate level of diffuse seismicity. 5.8 M earthquake occurred on August 23, 2011. Hypocenter was in Louisa County, 5 miles SSW of Mineral and 37 miles NW of Richmond. Thought to be of tectonic origin with liquefaction fields caused by moderate to large historical and Holocene earthquakes.
2	Feature Identity: Pembroke faults CEUS Class (see note): B Approximate Distance to Closest Proposed Alignment (miles): ~75 Description: Small, normal faults with up to 11 m displacement. Non-tectonic origin. Fault trace fillings contain delicate grain-scale textures precluding sudden slip. Likely caused by dissolution of underlying carbonate bedrock.
3	Feature Identity: Linside fault zone CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): ~85 Description: Located on northwest edge of the Giles County Seismic Zone (see earlier discussion). Normal fault zone displacing Devonian folded bedrock. No Quaternary movement of the fault zone is demonstrated.
4	Feature Identity: Everona fault – Mountain Run fault zone CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): ~94

Table 6.3	**Summary of Known or Inferred Quaternary age Faults in Virginia and North Carolina (USGS, 2006). See Figure 6.4 for Referenced # Feature**
	Description: Faults appear to have reactivated with Mesozoic extension of the Culpeper Basin. Quaternary age movement has not been demonstrated for the fault zone.
5	Feature Identity: Lebanon Church fault CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): ~125 Description: Reverse fault offsets base of gravels overlying Precambrian bedrock. No Quaternary movement of the fault is demonstrated.
6	Feature Identity: Old Hickory faults CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): >135 Description: Small reverse faults with up to 6 m of throw placing Coastal Plain gravels over Paleozoic metamorphic bedrock. Faulting was coeval with deposition of faulted Coastal Plain sediment of Pliocene age. No Quaternary movement of the fault zone is demonstrated.
7	Feature Identity: Stanleytown – Villa Heights faults CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): ~19 Description: Both faults are short (<300 m) with steep dip and <6 m slip. Both faults appear to be related to landslides.
8	Features Identity: Hares Crossroads faults CEUS Class (see note): C Approximate Distance to Closest Proposed Alignment (miles): ~65 Description: Single reverse fault exposed in a road cut offsets the basal contact of the Coastal Plain sediments of undetermined age. The dip-slip was measured at approximately 2.8 m vertically and 2 m horizontally. The faulting is no demonstrably of Quaternary age.

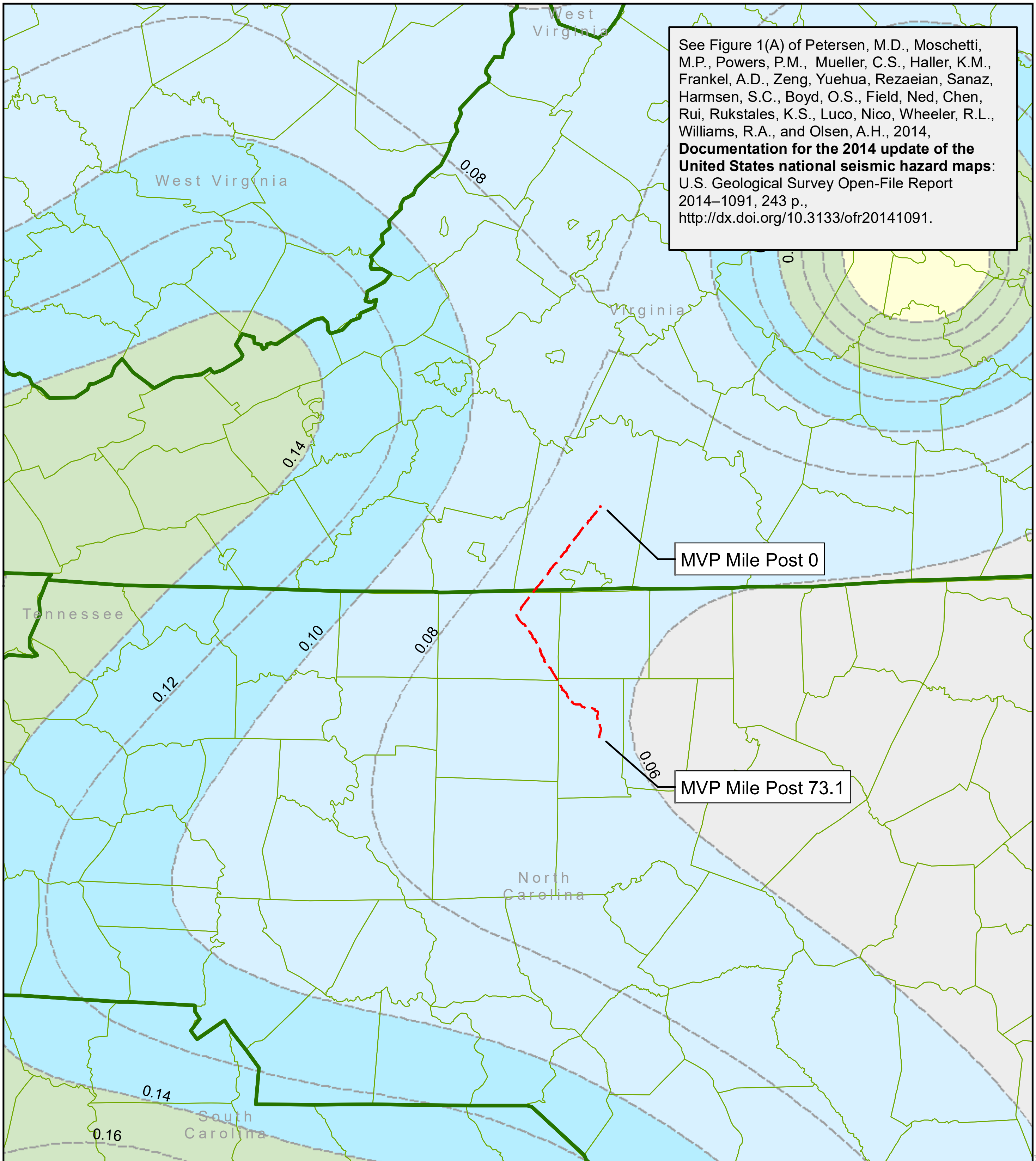
Table 6.2 Notes on CEUS feature class designation (USGS, 2006):

- Class A fault = Geologic evidence demonstrates the existence of a Quaternary fault of tectonic origin, whether the fault is exposed for mapping or inferred from liquefaction or other deformational features.

- Class B fault = Geologic evidence demonstrates the existence of a fault or suggests Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature to Class C but not strong enough to assign it to Class A.

- Class C fault = Geologic evidence is insufficient to demonstrate (1) the existence of tectonic fault, or (2) Quaternary slip or deformation associated with the feature.

FIGURES



Southgate Project

N

NAD 1983 UTM 17N

1:2,000,000

0 25 Miles

All Locations Approximate

Mountain Valley PIPELINE

Figure 6.1: Probabilistic Peak Ground Acceleration

10-30-18

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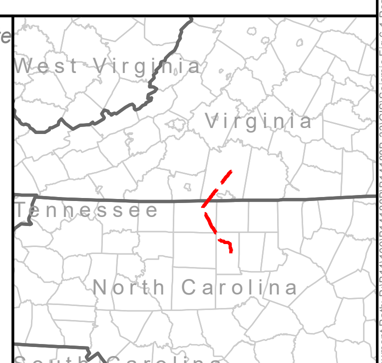
Legend

Seismic Hazards

Peak acceleration, expressed as a fraction of standard gravity (g) with 2% probability of exceedance in 50 years. V_{S30} = 760 m/s.

- 0.04
- 0.06
- 0.10
- 0.14
- 0.20
- Southgate Proposed Route



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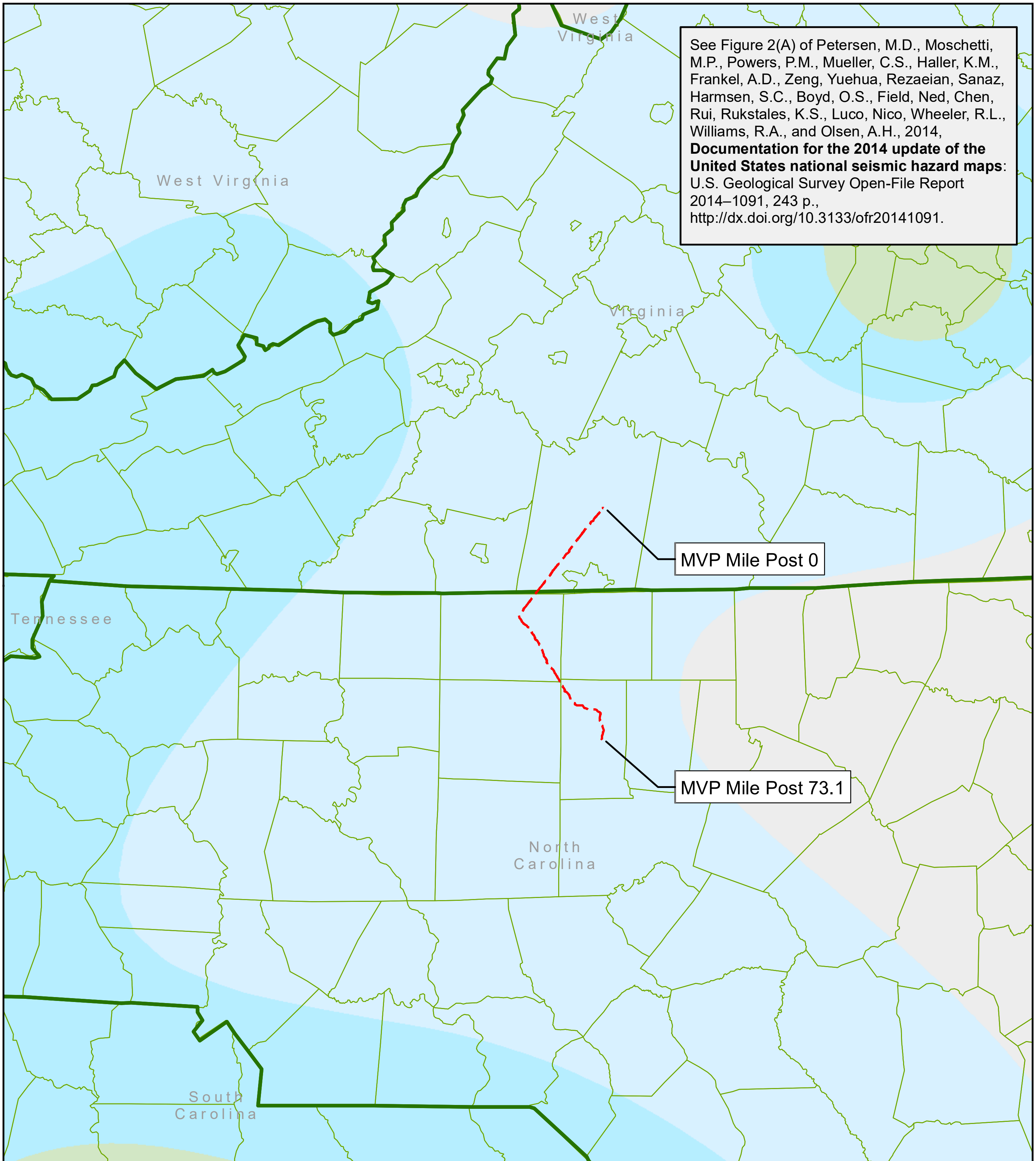


Southgate Project

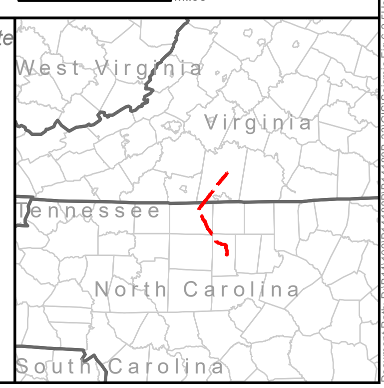
N

NAD 1983 UTM 17N

1:2,000,000

0 25 Miles

All Locations Approximate



Mountain Valley PIPELINE

Figure 6.2:
5 Hz Spectral Acceleration

10-30-18

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http://dx.doi.org/10.3133/ofr20141091

Legend

Seismic Hazards

Spectral response acceleration for 5-hertz, expressed as a fraction of standard gravity (g) with 2% probability of exceedance in 50 years, V_{S30} = 760 m/s, 5% damped oscillator.

- 0.08 - 0.12
- 0.12 - 0.2
- 0.2 - 0.28
- 0.28 - 0.4

Southgate Proposed Route

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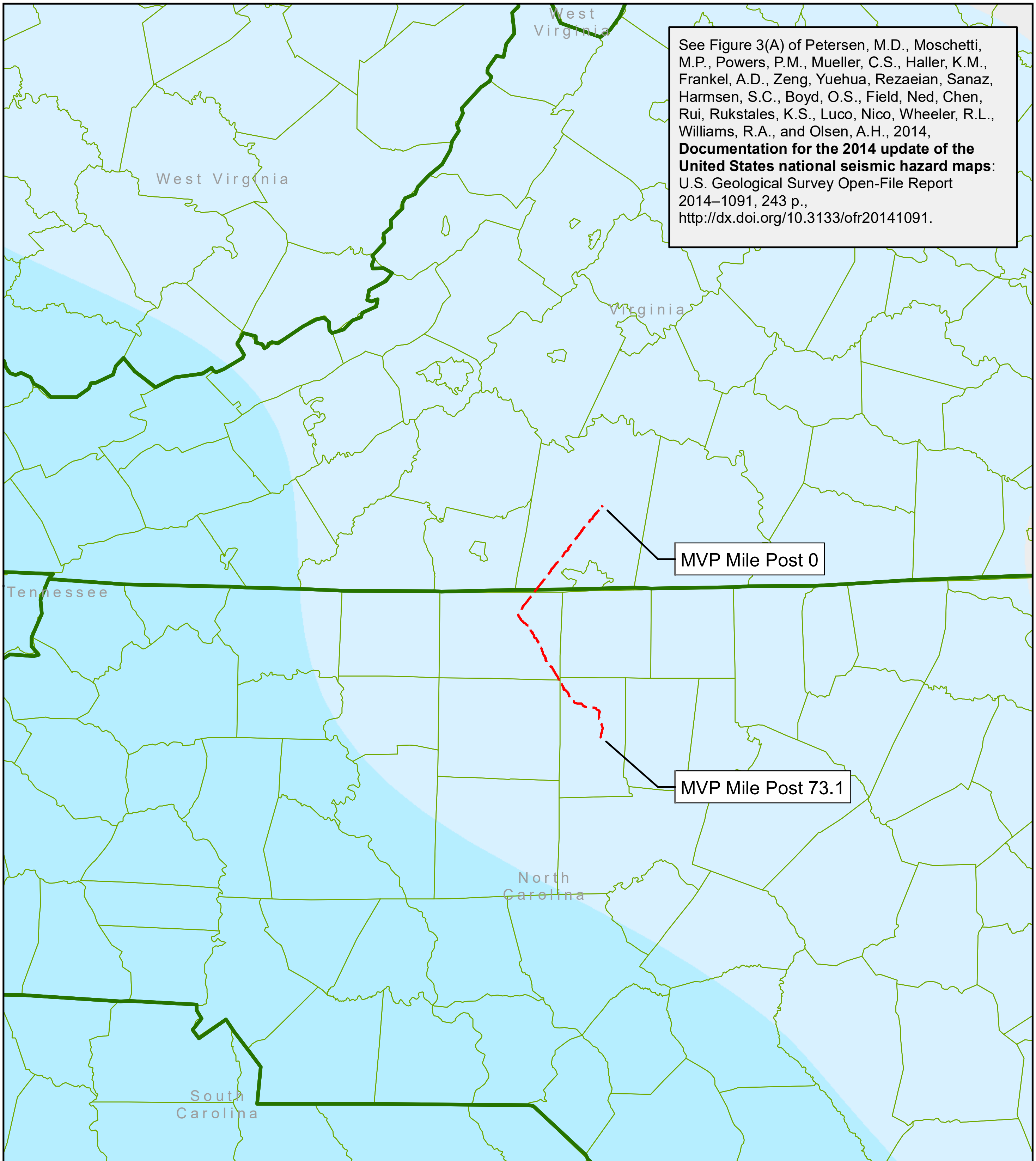


Southgate Project

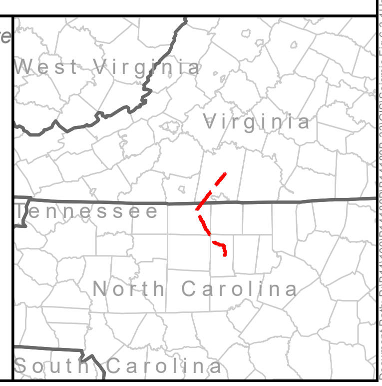
N

NAD 1983 UTM 17N

1:2,000,000

0 25 Miles

All Locations Approximate



Mountain Valley PIPELINE

Figure 6.3:
1 Hz Spectral Acceleration

10-30-18

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http://dx.doi.org/10.3133/ofr20141091

Legend

Seismic Hazards

Spectral response acceleration for 1-hertz, expressed as a fraction of standard gravity (g) with 2% probability of exceedance in 50 years. V_{S30} = 760 m/s, 5% damped oscillator.

- 0.03 - 0.04
- 0.04 - 0.06
- 0.06 - 0.1

Southgate Proposed Route

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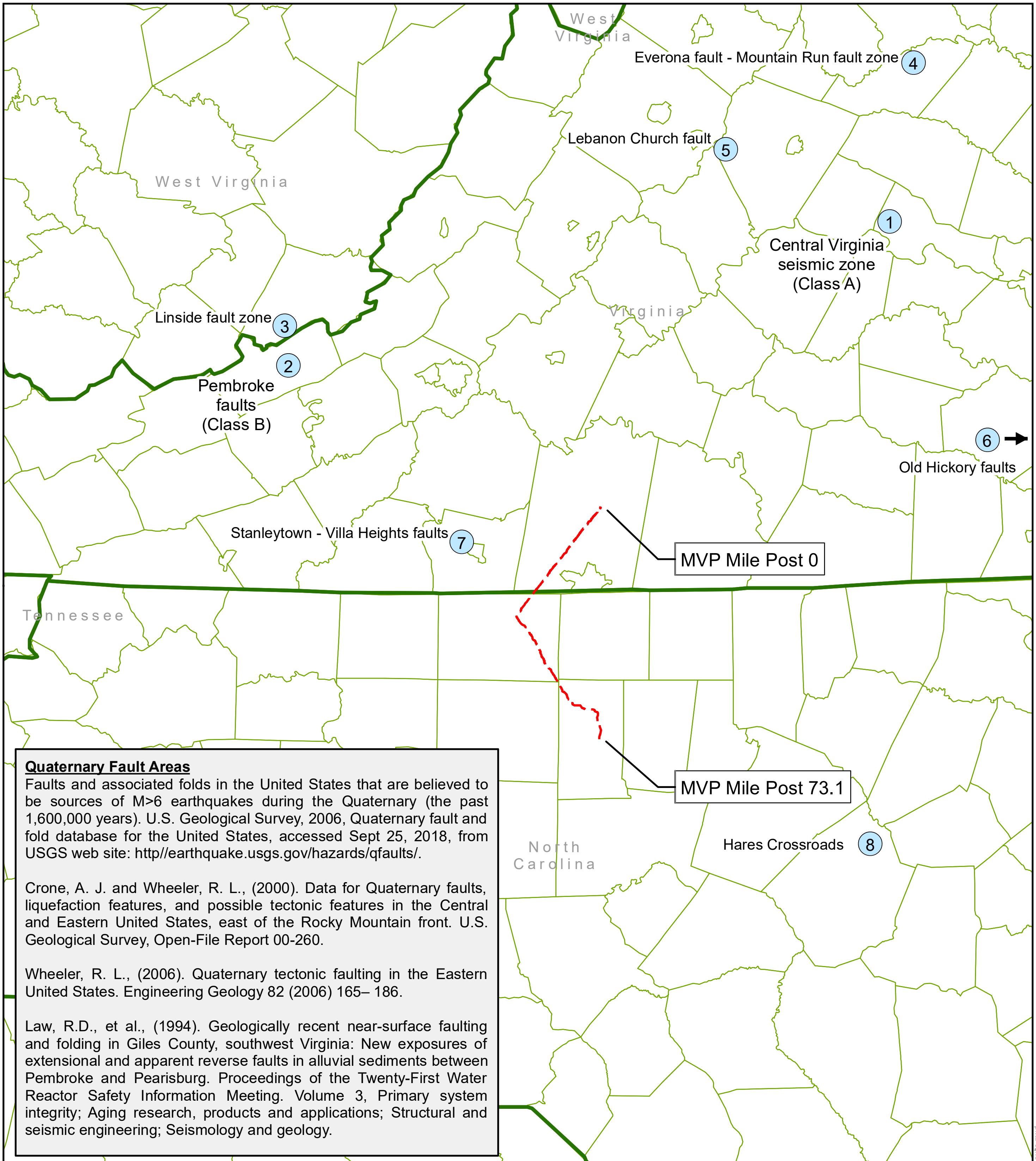

Quaternary Fault Areas

Faults and associated folds in the United States that are believed to be sources of M>6 earthquakes during the Quaternary (the past 1,600,000 years). U.S. Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed Sept 25, 2018, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/.

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Southgate Project

N — NAD 1983 UTM 17N — 1:2,000,000 — 0 25 Miles

All Locations Approximate

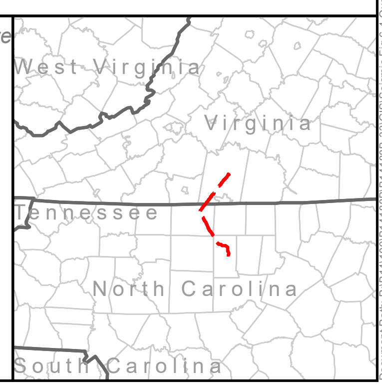
Mountain Valley PIPELINE

Figure 6.4: Quarternary Age Fault or Possible Fault Features

10-30-18

Draper Aden Associates
Engineering • Surveying • Environmental Services

http//earthquake.usgs.gov/hazards/qfaults



Legend

- 1 Central Virginia Seismic Zone (Class A)
- 2 Pembroke Fault Zone (Class B)
- 3–8 Fault Features (Class C)
- Southgate Proposed Route

Document Path: P:\B14\100\B14188\B14188B-33\GIS\Seismic Fig 6-4 Quaternary Faults.mxd

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-G

Potential Areas of Steep Slopes and Side Slopes Crossed by the MVP Southgate Project

Table 6-G-1

Potential Areas of Steep Slopes Crossed by the MVP Southgate Project

Route	Steep Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Lateral (H-605 Pipeline)	30 to 50	0.12	0.13	25
Southgate Mainline (H-650 Pipeline)	30 to 50	4.12	4.12	27
Southgate Mainline (H-650 Pipeline)	30 to 50	4.84	4.85	25
Southgate Mainline (H-650 Pipeline)	50 to 66	5.11	5.12	21
Southgate Mainline (H-650 Pipeline)	50 to 66	5.24	5.25	28
Southgate Mainline (H-650 Pipeline)	30 to 50	5.25	5.25	28
Southgate Mainline (H-650 Pipeline)	30 to 50	5.65	5.66	24
Southgate Mainline (H-650 Pipeline)	50 to 66	6.99	6.99	29
Southgate Mainline (H-650 Pipeline)	30 to 50	7.60	7.61	25
Southgate Mainline (H-650 Pipeline)	30 to 50	7.98	7.99	75
Southgate Mainline (H-650 Pipeline)	30 to 50	8.58	8.58	29
Southgate Mainline (H-650 Pipeline)	50 to 66	8.58	8.59	29
Southgate Mainline (H-650 Pipeline)	30 to 50	8.59	8.59	34
Southgate Mainline (H-650 Pipeline)	66 to 80	9.95	9.95	30
Southgate Mainline (H-650 Pipeline)	50 to 66	9.95	9.96	24
Southgate Mainline (H-650 Pipeline)	30 to 50	9.96	9.96	18
Southgate Mainline (H-650 Pipeline)	30 to 50	10.08	10.09	44
Southgate Mainline (H-650 Pipeline)	30 to 50	10.29	10.30	25
Southgate Mainline (H-650 Pipeline)	30 to 50	11.04	11.06	76
Southgate Mainline (H-650 Pipeline)	50 to 66	11.83	11.84	24
Southgate Mainline (H-650 Pipeline)	30 to 50	12.78	12.79	52
Southgate Mainline (H-650 Pipeline)	66 to 80	13.46	13.47	35
Southgate Mainline (H-650 Pipeline)	30 to 50	13.47	13.48	33
Southgate Mainline (H-650 Pipeline)	30 to 50	17.27	17.28	51
Southgate Mainline (H-650 Pipeline)	50 to 66	17.29	17.30	31
Southgate Mainline (H-650 Pipeline)	30 to 50	17.30	17.31	49
Southgate Mainline (H-650 Pipeline)	30 to 50	17.76	17.76	26
Southgate Mainline (H-650 Pipeline)	30 to 50	17.92	17.93	50
Southgate Mainline (H-650 Pipeline)	30 to 50	18.01	18.02	94
Southgate Mainline (H-650 Pipeline)	30 to 50	20.39	20.41	118
Southgate Mainline (H-650 Pipeline)	30 to 50	20.63	20.64	72
Southgate Mainline (H-650 Pipeline)	30 to 50	21.52	21.54	73
Southgate Mainline (H-650 Pipeline)	30 to 50	21.54	21.55	42
Southgate Mainline (H-650 Pipeline)	30 to 50	22.00	22.01	27
Southgate Mainline (H-650 Pipeline)	30 to 50	22.35	22.36	32
Southgate Mainline (H-650 Pipeline)	30 to 50	22.81	22.83	133
Southgate Mainline (H-650 Pipeline)	30 to 50	22.84	22.85	39
Southgate Mainline (H-650 Pipeline)	30 to 50	23.23	23.24	72
Southgate Mainline (H-650 Pipeline)	30 to 50	23.30	23.30	36
Southgate Mainline (H-650 Pipeline)	30 to 50	24.37	24.37	31
Southgate Mainline (H-650 Pipeline)	30 to 50	24.78	24.79	77

Table 6-G-1 Potential Areas of Steep Slopes Crossed by the MVP Southgate Project				
Route	**Steep Slope Group**	**Milepost Begin**	**Milepost End**	**Length of slope crossed (feet)**
Southgate Mainline (H-650 Pipeline)	30 to 50	24.99	25.00	56
Southgate Mainline (H-650 Pipeline)	30 to 50	25.16	25.17	45
Southgate Mainline (H-650 Pipeline)	30 to 50	26.19	26.20	21
Southgate Mainline (H-650 Pipeline)	30 to 50	27.49	27.50	22
Southgate Mainline (H-650 Pipeline)	66 to 80	27.52	27.52	16
Southgate Mainline (H-650 Pipeline)	30 to 50	27.52	27.52	10
Southgate Mainline (H-650 Pipeline)	30 to 50	28.82	28.85	142
Southgate Mainline (H-650 Pipeline)	30 to 50	28.95	28.96	63
Southgate Mainline (H-650 Pipeline)	30 to 50	29.35	29.35	21
Southgate Mainline (H-650 Pipeline)	66 to 80	29.36	29.37	61
Southgate Mainline (H-650 Pipeline)	50 to 66	29.37	29.39	129
Southgate Mainline (H-650 Pipeline)	30 to 50	29.39	29.40	46
Southgate Mainline (H-650 Pipeline)	30 to 50	29.41	29.42	51
Southgate Mainline (H-650 Pipeline)	30 to 50	29.45	29.45	22
Southgate Mainline (H-650 Pipeline)	30 to 50	29.49	29.50	51
Southgate Mainline (H-650 Pipeline)	50 to 66	30.05	30.06	31
Southgate Mainline (H-650 Pipeline)	30 to 50	31.06	31.06	22
Southgate Mainline (H-650 Pipeline)	30 to 50	31.06	31.07	36
Southgate Mainline (H-650 Pipeline)	30 to 50	31.09	31.12	139
Southgate Mainline (H-650 Pipeline)	30 to 50	31.28	31.29	68
Southgate Mainline (H-650 Pipeline)	30 to 50	31.30	31.31	57
Southgate Mainline (H-650 Pipeline)	30 to 50	31.31	31.32	31
Southgate Mainline (H-650 Pipeline)	30 to 50	31.67	31.68	97
Southgate Mainline (H-650 Pipeline)	30 to 50	31.70	31.70	34
Southgate Mainline (H-650 Pipeline)	30 to 50	31.72	31.73	66
Southgate Mainline (H-650 Pipeline)	30 to 50	31.86	31.87	51
Southgate Mainline (H-650 Pipeline)	30 to 50	31.87	31.88	40
Southgate Mainline (H-650 Pipeline)	66 to 80	31.88	31.89	54
Southgate Mainline (H-650 Pipeline)	30 to 50	31.89	31.89	10
Southgate Mainline (H-650 Pipeline)	66 to 80	31.93	31.93	29
Southgate Mainline (H-650 Pipeline)	50 to 66	31.93	31.94	32
Southgate Mainline (H-650 Pipeline)	50 to 66	32.02	32.03	28
Southgate Mainline (H-650 Pipeline)	30 to 50	32.04	32.04	40
Southgate Mainline (H-650 Pipeline)	30 to 50	32.27	32.27	31
Southgate Mainline (H-650 Pipeline)	30 to 50	32.46	32.47	60
Southgate Mainline (H-650 Pipeline)	30 to 50	32.47	32.48	26
Southgate Mainline (H-650 Pipeline)	30 to 50	32.50	32.52	80
Southgate Mainline (H-650 Pipeline)	30 to 50	32.55	32.56	40
Southgate Mainline (H-650 Pipeline)	50 to 66	32.56	32.57	20
Southgate Mainline (H-650 Pipeline)	30 to 50	32.57	32.57	36
Southgate Mainline (H-650 Pipeline)	30 to 50	32.59	32.60	92

Table 6-G-1

Potential Areas of Steep Slopes Crossed by the MVP Southgate Project

Route	Steep Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	30 to 50	32.66	32.67	26
Southgate Mainline (H-650 Pipeline)	30 to 50	32.75	32.76	25
Southgate Mainline (H-650 Pipeline)	30 to 50	33.12	33.13	40
Southgate Mainline (H-650 Pipeline)	66 to 80	33.13	33.14	75
Southgate Mainline (H-650 Pipeline)	30 to 50	33.14	33.15	21
Southgate Mainline (H-650 Pipeline)	30 to 50	33.16	33.17	34
Southgate Mainline (H-650 Pipeline)	30 to 50	33.25	33.26	23
Southgate Mainline (H-650 Pipeline)	30 to 50	33.27	33.28	30
Southgate Mainline (H-650 Pipeline)	30 to 50	33.30	33.32	64
Southgate Mainline (H-650 Pipeline)	30 to 50	33.33	33.34	89
Southgate Mainline (H-650 Pipeline)	30 to 50	33.38	33.39	47
Southgate Mainline (H-650 Pipeline)	30 to 50	33.68	33.69	56
Southgate Mainline (H-650 Pipeline)	30 to 50	33.70	33.70	41
Southgate Mainline (H-650 Pipeline)	50 to 66	33.73	33.73	23
Southgate Mainline (H-650 Pipeline)	50 to 66	33.74	33.75	47
Southgate Mainline (H-650 Pipeline)	30 to 50	33.75	33.77	103
Southgate Mainline (H-650 Pipeline)	30 to 50	33.79	33.80	28
Southgate Mainline (H-650 Pipeline)	30 to 50	33.81	33.82	42
Southgate Mainline (H-650 Pipeline)	30 to 50	33.82	33.83	47
Southgate Mainline (H-650 Pipeline)	30 to 50	33.88	33.89	52
Southgate Mainline (H-650 Pipeline)	30 to 50	33.92	33.94	94
Southgate Mainline (H-650 Pipeline)	30 to 50	33.99	34.00	23
Southgate Mainline (H-650 Pipeline)	30 to 50	34.15	34.16	23
Southgate Mainline (H-650 Pipeline)	30 to 50	34.21	34.24	112
Southgate Mainline (H-650 Pipeline)	30 to 50	34.29	34.30	42
Southgate Mainline (H-650 Pipeline)	50 to 66	34.30	34.31	42
Southgate Mainline (H-650 Pipeline)	30 to 50	34.51	34.52	21
Southgate Mainline (H-650 Pipeline)	30 to 50	34.52	34.53	50
Southgate Mainline (H-650 Pipeline)	30 to 50	34.55	34.56	20
Southgate Mainline (H-650 Pipeline)	30 to 50	34.59	34.60	27
Southgate Mainline (H-650 Pipeline)	30 to 50	34.85	34.86	52
Southgate Mainline (H-650 Pipeline)	30 to 50	35.07	35.08	21
Southgate Mainline (H-650 Pipeline)	30 to 50	35.14	35.14	31
Southgate Mainline (H-650 Pipeline)	30 to 50	35.36	35.36	24
Southgate Mainline (H-650 Pipeline)	30 to 50	35.57	35.57	20
Southgate Mainline (H-650 Pipeline)	30 to 50	35.92	35.93	25
Southgate Mainline (H-650 Pipeline)	66 to 80	35.98	35.99	54
Southgate Mainline (H-650 Pipeline)	30 to 50	37.01	37.02	21
Southgate Mainline (H-650 Pipeline)	30 to 50	37.03	37.05	94
Southgate Mainline (H-650 Pipeline)	30 to 50	37.16	37.16	22
Southgate Mainline (H-650 Pipeline)	30 to 50	37.18	37.19	22

Table 6-G-1

Potential Areas of Steep Slopes Crossed by the MVP Southgate Project

Route	Steep Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	30 to 50	37.27	37.28	43
Southgate Mainline (H-650 Pipeline)	30 to 50	37.29	37.29	22
Southgate Mainline (H-650 Pipeline)	30 to 50	37.30	37.30	29
Southgate Mainline (H-650 Pipeline)	30 to 50	37.35	37.36	38
Southgate Mainline (H-650 Pipeline)	30 to 50	37.58	37.59	24
Southgate Mainline (H-650 Pipeline)	30 to 50	37.72	37.72	31
Southgate Mainline (H-650 Pipeline)	30 to 50	38.24	38.25	23
Southgate Mainline (H-650 Pipeline)	66 to 80	38.54	38.55	76
Southgate Mainline (H-650 Pipeline)	30 to 50	38.60	38.61	28
Southgate Mainline (H-650 Pipeline)	30 to 50	38.76	38.76	35
Southgate Mainline (H-650 Pipeline)	30 to 50	38.78	38.80	93
Southgate Mainline (H-650 Pipeline)	30 to 50	39.03	39.04	39
Southgate Mainline (H-650 Pipeline)	30 to 50	39.05	39.06	45
Southgate Mainline (H-650 Pipeline)	30 to 50	39.06	39.07	24
Southgate Mainline (H-650 Pipeline)	30 to 50	39.10	39.10	28
Southgate Mainline (H-650 Pipeline)	50 to 66	39.67	39.68	26
Southgate Mainline (H-650 Pipeline)	50 to 66	39.69	39.70	27
Southgate Mainline (H-650 Pipeline)	30 to 50	40.54	40.55	44
Southgate Mainline (H-650 Pipeline)	30 to 50	40.56	40.56	36
Southgate Mainline (H-650 Pipeline)	66 to 80	40.57	40.57	24
Southgate Mainline (H-650 Pipeline)	30 to 50	40.64	40.64	25
Southgate Mainline (H-650 Pipeline)	30 to 50	40.74	40.74	23
Southgate Mainline (H-650 Pipeline)	30 to 50	40.75	40.75	41
Southgate Mainline (H-650 Pipeline)	30 to 50	40.88	40.89	40
Southgate Mainline (H-650 Pipeline)	30 to 50	41.11	41.11	39
Southgate Mainline (H-650 Pipeline)	30 to 50	41.56	41.57	23
Southgate Mainline (H-650 Pipeline)	30 to 50	41.57	41.58	25
Southgate Mainline (H-650 Pipeline)	50 to 66	41.67	41.67	20
Southgate Mainline (H-650 Pipeline)	30 to 50	41.67	41.68	32
Southgate Mainline (H-650 Pipeline)	30 to 50	42.25	42.26	44
Southgate Mainline (H-650 Pipeline)	30 to 50	43.69	43.69	28
Southgate Mainline (H-650 Pipeline)	30 to 50	43.70	43.71	31
Southgate Mainline (H-650 Pipeline)	30 to 50	43.81	43.82	23
Southgate Mainline (H-650 Pipeline)	30 to 50	43.93	43.93	36
Southgate Mainline (H-650 Pipeline)	50 to 66	43.98	43.99	53
Southgate Mainline (H-650 Pipeline)	30 to 50	44.02	44.03	32
Southgate Mainline (H-650 Pipeline)	50 to 66	44.03	44.03	24
Southgate Mainline (H-650 Pipeline)	30 to 50	44.03	44.03	9
Southgate Mainline (H-650 Pipeline)	50 to 66	44.06	44.06	20
Southgate Mainline (H-650 Pipeline)	30 to 50	44.14	44.14	26
Southgate Mainline (H-650 Pipeline)	30 to 50	44.15	44.19	169

Table 6-G-1

Potential Areas of Steep Slopes Crossed by the MVP Southgate Project

Route	Steep Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	30 to 50	44.56	44.57	22
Southgate Mainline (H-650 Pipeline)	30 to 50	45.72	45.73	45
Southgate Mainline (H-650 Pipeline)	30 to 50	45.83	45.85	134
Southgate Mainline (H-650 Pipeline)	30 to 50	46.48	46.49	37
Southgate Mainline (H-650 Pipeline)	50 to 66	46.50	46.50	39
Southgate Mainline (H-650 Pipeline)	30 to 50	46.53	46.54	29
Southgate Mainline (H-650 Pipeline)	30 to 50	46.89	46.91	78
Southgate Mainline (H-650 Pipeline)	50 to 66	47.01	47.02	26
Southgate Mainline (H-650 Pipeline)	30 to 50	47.35	47.36	27
Southgate Mainline (H-650 Pipeline)	30 to 50	47.37	47.39	142
Southgate Mainline (H-650 Pipeline)	30 to 50	47.42	47.44	125
Southgate Mainline (H-650 Pipeline)	50 to 66	47.44	47.45	39
Southgate Mainline (H-650 Pipeline)	30 to 50	47.45	47.46	36
Southgate Mainline (H-650 Pipeline)	30 to 50	47.46	47.47	50
Southgate Mainline (H-650 Pipeline)	30 to 50	47.54	47.56	107
Southgate Mainline (H-650 Pipeline)	30 to 50	47.57	47.57	31
Southgate Mainline (H-650 Pipeline)	30 to 50	47.58	47.59	83
Southgate Mainline (H-650 Pipeline)	30 to 50	47.60	47.61	55
Southgate Mainline (H-650 Pipeline)	30 to 50	47.61	47.62	26
Southgate Mainline (H-650 Pipeline)	30 to 50	47.65	47.66	33
Southgate Mainline (H-650 Pipeline)	30 to 50	47.66	47.66	23
Southgate Mainline (H-650 Pipeline)	30 to 50	47.67	47.67	23
Southgate Mainline (H-650 Pipeline)	30 to 50	47.67	47.68	26
Southgate Mainline (H-650 Pipeline)	30 to 50	47.76	47.77	58
Southgate Mainline (H-650 Pipeline)	30 to 50	47.78	47.79	55
Southgate Mainline (H-650 Pipeline)	30 to 50	51.50	51.50	28
Southgate Mainline (H-650 Pipeline)	30 to 50	58.91	58.91	31
Southgate Mainline (H-650 Pipeline)	30 to 50	63.58	63.58	40
Southgate Mainline (H-650 Pipeline)	30 to 50	63.65	63.65	24
Southgate Mainline (H-650 Pipeline)	30 to 50	64.03	64.04	56
Southgate Mainline (H-650 Pipeline)	30 to 50	64.47	64.48	20
Southgate Mainline (H-650 Pipeline)	30 to 50	68.74	68.74	20
Southgate Mainline (H-650 Pipeline)	30 to 50	68.79	68.80	20
Southgate Mainline (H-650 Pipeline)	30 to 50	69.10	69.11	60
Southgate Mainline (H-650 Pipeline)	30 to 50	69.37	69.38	23
Southgate Mainline (H-650 Pipeline)	30 to 50	69.39	69.40	30
Southgate Mainline (H-650 Pipeline)	30 to 50	69.62	69.62	22
Southgate Mainline (H-650 Pipeline)	30 to 50	69.76	69.77	22
Southgate Mainline (H-650 Pipeline)	50 to 66	69.80	69.80	20
Southgate Mainline (H-650 Pipeline)	30 to 50	69.89	69.89	20
Southgate Mainline (H-650 Pipeline)	30 to 50	69.91	69.92	24

Table 6-G-1

Potential Areas of Steep Slopes Crossed by the MVP Southgate Project

Route	Steep Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	30 to 50	70.02	70.03	21
Southgate Mainline (H-650 Pipeline)	30 to 50	70.50	70.51	23
Southgate Mainline (H-650 Pipeline)	30 to 50	70.61	70.62	33
Southgate Mainline (H-650 Pipeline)	50 to 66	70.75	70.76	47
Southgate Mainline (H-650 Pipeline)	30 to 50	70.76	70.77	21
Southgate Mainline (H-650 Pipeline)	30 to 50	71.13	71.13	20
Southgate Mainline (H-650 Pipeline)	30 to 50	71.19	71.20	28
Southgate Mainline (H-650 Pipeline)	30 to 50	71.21	71.22	78
Southgate Mainline (H-650 Pipeline)	30 to 50	71.25	71.26	54
Southgate Mainline (H-650 Pipeline)	30 to 50	71.31	71.32	28
Southgate Mainline (H-650 Pipeline)	30 to 50	71.49	71.49	33
Southgate Mainline (H-650 Pipeline)	30 to 50	71.62	71.63	37
Southgate Mainline (H-650 Pipeline)	30 to 50	71.82	71.83	70
Southgate Mainline (H-650 Pipeline)	30 to 50	71.90	71.92	103
Southgate Mainline (H-650 Pipeline)	30 to 50	72.19	72.20	24
Southgate Mainline (H-650 Pipeline)	30 to 50	72.71	72.72	30
Southgate Mainline (H-650 Pipeline)	50 to 66	72.72	72.72	40
Southgate Mainline (H-650 Pipeline)	30 to 50	72.72	72.73	25
Southgate Mainline (H-650 Pipeline)	30 to 50	72.91	72.91	20
Southgate Mainline (H-650 Pipeline)	50 to 66	72.94	72.94	20
Southgate Mainline (H-650 Pipeline)	30 to 50	72.94	72.94	15

Methodology:
1. Steep Slope percentages are grouped as follows:
   30-50%
   50-66%
   66-80%
   80%+
2. Only crossings that are longer than 20 feet are considered. Some locations may seem smaller but they are still considered if they are a continuation of another slope group.
3. For crossings that have multiple variations of slope group within small lengths, an average slope group is assigned.
4. The length of slope crossed might be slightly shorter than actual mile post lengths because of small stretches of data that are not in slope groups.

Note: Results based on desktop analysis. Data to be verified in field.

Table 6-G-2

Potential Areas of Side Slopes Crossed by the MVP Southgate Project

Route	Side Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	14 to 18	8.63	8.71	298
Southgate Mainline (H-650 Pipeline)	14 to 18	9.00	9.02	70
Southgate Mainline (H-650 Pipeline)	14 to 18	9.97	10.03	283
Southgate Mainline (H-650 Pipeline)	14 to 18	15.51	15.58	244
Southgate Mainline (H-650 Pipeline)	18 to 25	16.01	16.02	40
Southgate Mainline (H-650 Pipeline)	14 to 18	16.55	16.58	98
Southgate Mainline (H-650 Pipeline)	14 to 18	16.59	16.60	43
Southgate Mainline (H-650 Pipeline)	18 to 25	17.77	17.81	168
Southgate Mainline (H-650 Pipeline)	18 to 25	17.98	18.01	157
Southgate Mainline (H-650 Pipeline)	18 to 25	18.04	18.05	52
Southgate Mainline (H-650 Pipeline)	14 to 18	19.49	19.50	62
Southgate Mainline (H-650 Pipeline)	18 to 25	19.54	19.60	233
Southgate Mainline (H-650 Pipeline)	14 to 18	19.63	19.64	40
Southgate Mainline (H-650 Pipeline)	18 to 25	21.58	21.60	87
Southgate Mainline (H-650 Pipeline)	18 to 25	21.74	21.78	155
Southgate Mainline (H-650 Pipeline)	14 to 18	22.00	22.04	134
Southgate Mainline (H-650 Pipeline)	14 to 18	22.36	22.38	87
Southgate Mainline (H-650 Pipeline)	18 to 25	22.65	22.74	406
Southgate Mainline (H-650 Pipeline)	18 to 25	23.16	23.17	60
Southgate Mainline (H-650 Pipeline)	18 to 25	23.27	23.31	179
Southgate Mainline (H-650 Pipeline)	18 to 25	25.15	25.22	216
Southgate Mainline (H-650 Pipeline)	18 to 25	28.56	28.58	67
Southgate Mainline (H-650 Pipeline)	14 to 18	28.71	28.74	70
Southgate Mainline (H-650 Pipeline)	14 to 18	29.01	29.06	177
Southgate Mainline (H-650 Pipeline)	25+	29.10	29.14	100
Southgate Mainline (H-650 Pipeline)	25+	29.36	29.43	89
Southgate Mainline (H-650 Pipeline)	18 to 25	31.34	31.37	86
Southgate Mainline (H-650 Pipeline)	18 to 25	31.67	31.69	56
Southgate Mainline (H-650 Pipeline)	18 to 25	31.88	31.95	236
Southgate Mainline (H-650 Pipeline)	25+	32.18	32.20	46
Southgate Mainline (H-650 Pipeline)	18 to 25	32.55	32.59	75
Southgate Mainline (H-650 Pipeline)	14 to 18	32.78	32.89	355
Southgate Mainline (H-650 Pipeline)	18 to 25	33.28	33.30	89
Southgate Mainline (H-650 Pipeline)	18 to 25	33.35	33.41	217
Southgate Mainline (H-650 Pipeline)	14 to 18	33.45	33.47	47
Southgate Mainline (H-650 Pipeline)	18 to 25	33.64	33.67	146
Southgate Mainline (H-650 Pipeline)	18 to 25	33.70	33.73	104
Southgate Mainline (H-650 Pipeline)	18 to 25	33.88	33.92	110
Southgate Mainline (H-650 Pipeline)	18 to 25	33.95	34.01	280
Southgate Mainline (H-650 Pipeline)	18 to 25	34.33	34.35	93
Southgate Mainline (H-650 Pipeline)	18 to 25	34.56	34.60	171

Table 6-G-2

Potential Areas of Side Slopes Crossed by the MVP Southgate Project

Route	Side Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	18 to 25	35.03	35.11	283
Southgate Mainline (H-650 Pipeline)	14 to 18	35.21	35.26	160
Southgate Mainline (H-650 Pipeline)	18 to 25	35.30	35.34	190
Southgate Mainline (H-650 Pipeline)	14 to 18	35.52	35.53	48
Southgate Mainline (H-650 Pipeline)	18 to 25	35.55	35.56	56
Southgate Mainline (H-650 Pipeline)	18 to 25	35.93	35.95	57
Southgate Mainline (H-650 Pipeline)	14 to 18	36.18	36.22	85
Southgate Mainline (H-650 Pipeline)	18 to 25	36.67	36.74	252
Southgate Mainline (H-650 Pipeline)	18 to 25	36.90	36.93	135
Southgate Mainline (H-650 Pipeline)	14 to 18	36.96	36.98	93
Southgate Mainline (H-650 Pipeline)	14 to 18	37.05	37.09	158
Southgate Mainline (H-650 Pipeline)	14 to 18	37.21	37.22	40
Southgate Mainline (H-650 Pipeline)	18 to 25	37.53	37.55	74
Southgate Mainline (H-650 Pipeline)	14 to 18	37.63	37.66	122
Southgate Mainline (H-650 Pipeline)	14 to 18	37.78	37.81	122
Southgate Mainline (H-650 Pipeline)	14 to 18	37.84	37.86	74
Southgate Mainline (H-650 Pipeline)	14 to 18	37.90	37.92	77
Southgate Mainline (H-650 Pipeline)	14 to 18	38.02	38.05	117
Southgate Mainline (H-650 Pipeline)	18 to 25	39.05	39.09	136
Southgate Mainline (H-650 Pipeline)	14 to 18	39.37	39.45	291
Southgate Mainline (H-650 Pipeline)	14 to 18	39.48	39.49	71
Southgate Mainline (H-650 Pipeline)	14 to 18	40.64	40.66	63
Southgate Mainline (H-650 Pipeline)	18 to 25	41.42	41.50	423
Southgate Mainline (H-650 Pipeline)	18 to 25	41.58	41.59	78
Southgate Mainline (H-650 Pipeline)	18 to 25	41.69	41.77	384
Southgate Mainline (H-650 Pipeline)	18 to 25	41.97	41.99	85
Southgate Mainline (H-650 Pipeline)	18 to 25	42.13	42.16	99
Southgate Mainline (H-650 Pipeline)	18 to 25	42.35	42.42	309
Southgate Mainline (H-650 Pipeline)	14 to 18	42.46	42.48	113
Southgate Mainline (H-650 Pipeline)	18 to 25	42.84	42.85	41
Southgate Mainline (H-650 Pipeline)	18 to 25	43.80	43.82	48
Southgate Mainline (H-650 Pipeline)	25+	43.86	43.88	78
Southgate Mainline (H-650 Pipeline)	18 to 25	43.99	44.02	102
Southgate Mainline (H-650 Pipeline)	18 to 25	44.07	44.10	132
Southgate Mainline (H-650 Pipeline)	14 to 18	45.06	45.09	108
Southgate Mainline (H-650 Pipeline)	14 to 18	45.86	45.91	221
Southgate Mainline (H-650 Pipeline)	14 to 18	45.95	45.98	85
Southgate Mainline (H-650 Pipeline)	25+	47.47	47.50	131
Southgate Mainline (H-650 Pipeline)	14 to 18	47.99	48.02	97
Southgate Mainline (H-650 Pipeline)	18 to 25	49.64	49.68	173
Southgate Mainline (H-650 Pipeline)	25+	49.73	49.81	415

Table 6-G-2

Potential Areas of Side Slopes Crossed by the MVP Southgate Project

Route	Side Slope Group	Milepost Begin	Milepost End	Length of slope crossed (feet)
Southgate Mainline (H-650 Pipeline)	14 to 18	50.73	50.74	40
Southgate Mainline (H-650 Pipeline)	18 to 25	51.45	51.53	326
Southgate Mainline (H-650 Pipeline)	18 to 25	52.19	52.24	213
Southgate Mainline (H-650 Pipeline)	14 to 18	54.36	54.38	64
Southgate Mainline (H-650 Pipeline)	18 to 25	54.47	54.49	75
Southgate Mainline (H-650 Pipeline)	25+	54.51	54.54	131
Southgate Mainline (H-650 Pipeline)	14 to 18	59.23	59.26	135
Southgate Mainline (H-650 Pipeline)	14 to 18	62.41	62.42	59
Southgate Mainline (H-650 Pipeline)	18 to 25	63.20	63.27	220
Southgate Mainline (H-650 Pipeline)	18 to 25	63.50	63.52	130
Southgate Mainline (H-650 Pipeline)	14 to 18	67.15	67.16	50
Southgate Mainline (H-650 Pipeline)	18 to 25	68.28	68.31	149
Southgate Mainline (H-650 Pipeline)	14 to 18	68.47	68.48	41
Southgate Mainline (H-650 Pipeline)	14 to 18	68.48	68.49	48
Southgate Mainline (H-650 Pipeline)	14 to 18	68.55	68.56	51
Southgate Mainline (H-650 Pipeline)	14 to 18	68.67	68.68	44
Southgate Mainline (H-650 Pipeline)	18 to 25	69.08	69.11	124
Southgate Mainline (H-650 Pipeline)	18 to 25	69.24	69.25	48
Southgate Mainline (H-650 Pipeline)	18 to 25	69.33	69.45	445
Southgate Mainline (H-650 Pipeline)	18 to 25	69.54	69.63	388
Southgate Mainline (H-650 Pipeline)	14 to 18	70.58	70.59	47
Southgate Mainline (H-650 Pipeline)	18 to 25	70.60	70.63	96
Southgate Mainline (H-650 Pipeline)	18 to 25	71.09	71.27	616
Southgate Mainline (H-650 Pipeline)	14 to 18	71.78	71.80	78
Southgate Mainline (H-650 Pipeline)	18 to 25	71.85	71.88	144
Southgate Mainline (H-650 Pipeline)	18 to 25	72.16	72.21	180
Southgate Mainline (H-650 Pipeline)	18 to 25	72.73	72.76	160
Southgate Mainline (H-650 Pipeline)	14 to 18	72.85	72.88	147

Methodology

1. Side Slope percentages are grouped as follows:
   - 14-18%
   - 18-25%
   - 25%+
2. Only crossings that are longer than 40 feet are considered. Some locations may seem smaller but they are still considered if they are a continuation of another slope group.
3. For crossings that have multiple variations of slope group within small lengths, an average slope group is assigned.
4. The length of slope crossed might be slightly shorter than actual mile post lengths because of small stretches of data that are not in slope groups.

Note: Results based on desktop analysis. Data to be verified in field.

MVP Southgate Project

Docket No. CP19-XX-000

Resource Report 6

Appendix 6-H

Unanticipated Discovery Plan for Paleontological Resources

Unanticipated Discovery Plan for Paleontological Resources

MVP Southgate Project

FERC Docket No. CP19-XX-000

November 2018

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1.0 INTRODUCTION

Mountain Valley Pipeline, LLC ("Mountain Valley") plans to construct an approximately 73-mile long natural gas pipeline ("Southgate Project" or "Project") and associated aboveground facilities in Pittsylvania County, Virginia and Rockingham and Alamance counties, North Carolina. The Project is entirely situated in the Piedmont Uplands Section of the Piedmont Physiographic Province. Most of the Piedmont bedrock is composed of igneous and metamorphic rocks, which are generally buried under a thick (6 to 65 feet) blanket of weathered rock that has formed clay-rich soils, and outcrops are commonly restricted to stream valleys where the soil layer has been removed by erosion.

Although fossils are generally rare in the Piedmont, fossils of dinosaur footprints, freshwater fish, and insects are found in Triassic period rift basin deposits. Areas where fossils might be encountered along the pipeline alignment include shallow areas of Triassic-age sedimentary rock, which are generally present from approximate MP 0.0 to MP 0.6 and MP 14.9 to 18.7 in Pittsylvania County, Virginia and from MP approximate MP 24.7 to MP 31.2 at the border of Pittsylvania County, Virginia and Rockingham County, North Carolina. The igneous to metamorphic rocks found elsewhere along the Project are not expected to contain fossils.

This *Unanticipated Discovery Plan for Paleontological Resources* ("Plan") has been developed to establish procedures in the event of unanticipated discoveries of paleontological resources, and summarizes the efforts Mountain Valley will employ to recognize and manage any significant fossils that may be encountered during construction.

2.0 STATE AND FEDERAL PALEONTOLOGICAL LAWS

There are no State or Federal Paleontological laws governing this plan. The Project does not cross State or Federal lands, and neither Federal (The Paleontological Resources Preservation Act [16 U.S.C. § 470]))], North Carolina (https://www.ncleg.net/gascripts/statutes/Statutes.asp), nor Virginia (https://law.lis.virginia.gov/vacode) laws govern the discovery of fossils on private lands.

3.0 UNANTICIPATED DISCOVERIES OF PALEONTOLOGICAL RESOURCES

Mountain Valley is aware that fossil remains may be encountered during construction of the Project facilities. Prior to construction, the Southgate Project will address paleontological resources as part of the environmental training provided to all Mountain Valley personnel. This training will address the nature of paleontological resources and best management practices if paleontological materials are inadvertently discovered during construction. Project personnel will be trained to notify the Environmental Inspector ("EI") if an unanticipated discovery occurs. In addition, the training will include a discussion of the policy prohibiting the collection of paleontological resources.

The following steps will to be followed in the event an unanticipated discovery of paleontological materials is made during Project construction:

1 The Contractor will immediately notify the Lead Environmental Inspector ("EI") (or Chief Inspector, if the EI is not immediately available) of an unanticipated discovery.

2 In the event of a discovery of non-vertebrate fossils, all activities can continue in and around the discovery site while notification is made. In the event of an unanticipated discovery of

vertebrate fossils (including bones, teeth, or footprints), the Lead EI or Chief Inspector will issue a *Stop Task Order* to the Contractor's Site Foreman to ensure that the activity within 100 feet of the unanticipated discovery ceases.

3 The Southgate Project Environmental Manager, Lead EI, or a representative designated by these individuals will then notify an on-call professional paleontologist retained by Mountain Valley, within 24 hours. The paleontologist will examine the find, evaluate its significance, and determine if additional mitigation (collection and curation) are applicable.

4 If based on that inspection the paleontologist determines that the discovery is not of scientific significance, the paleontologist will report that determination to the Lead EI. The Lead EI will document that determination and notify the Chief Inspector to resume work.

5 If the paleontologist determines that the find is of scientific significance, he/she will inform the Southgate Project, the Lead EI, and the Chief Inspector of that determination.

a. Within 24 hours of that determination, the Project will notify the FERC of that determination. Work within the flagged or fenced off discovery location will not resume until authorized by the FERC.

b. In consultation with staff of the Virginia Division of Geology and Mineral Resources or the North Carolina Museum of Natural Sciences, as appropriate, the paleontologist shall then develop an appropriate plan for documentation and recovery of the find. Upon authorization by the FERC, the Project will implement the documentation and recovery plan.

All paleontological materials of scientific significance discovered during construction will be recorded using methods consistent with modern professional paleontology standards, and scientifically significant vertebrate fossils will be collected and curated into an approved museum or academic repository. Notwithstanding, if paleontological resources are in imminent danger of destruction, the Project will, without delay, apply prudent methods to preserve as much paleontological information as possible. Such salvage activities will follow standard paleontological procedures as much as possible, but human safety concerns or the immediacy of the threat to the paleontological resource may require less exact methods of material extraction, including rapid shovel excavation or use of backhoes or other heavy equipment.

c. At the conclusion of the work, a meeting or site visit may be held with the FERC, the Project, the paleontologist, and the relevant state professional staff to review the results of the work accomplished.

d. Upon receiving authorization from the FERC, the Lead EI and Chief Inspector will grant clearance to the construction team to resume work.

4.0 CONTACTS

FEDERAL AGENCY CONTACT	
Federal Energy Regulatory Commission Amanda Mardiney Office of Energy Projects 888 First Street, NE RM 62-30 Route Code PJ-11.2 Washington, D.C. 20426-0002 Tel: (202) 502-8081 Email: amardiney@ferc.gov	
STATE AGENCY CONTACTS	
Virginia	
Virginia Department of Mines, Minerals, and Energy **Division of Geology and Mineral Resources** 900 Natural Resources Drive, Ste. 500 Charlottesville, VA 22903 Tel: (434) 951-6341 Email: dgmrinfo@dmme.virginia.gov	
North Carolina	
North Carolina Museum of Natural Sciences **Paleontology Research Laboratory** 121 W. Jones Street Raleigh, NC 27601 Tel: (919) 707-8279 Email: lindsay.zanno@naturalsciences.org	