

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses the Everett Railroad, Frankstown Branch Juniata River, and Reservoir Road in Blair Township, Blair County, Pennsylvania, is in accordance with the Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 3 of the Stipulated Order. This HDD is number 5 on the list of HDDs included on Exhibit 3 of the Order.

The installation of the 20-inch diameter pipeline using HDD was initiated before the temporary injunction issued by the Pennsylvania Department of Environmental Protection (PADEP) Environmental Hearing Board on July 25, 2017. The originally permitted 20-inch HDD attempt had multiple inadvertent returns (IRs) during the pilot phase, and ultimately a minor modification to the Chapter 102 and 105 authorizations was submitted to the PADEP on August 3, 2018 to revise the pipeline installation method to a shorter HDD under the Frankstown Branch Juniata River (S-BB48) and Everett Railroad, and a FlexBor under wetland W-BB58 and Reservoir Road.

The 16-inch pipeline HDD is referred to herein as HDD S2-0121.

### **PIPE INFORMATION**

16-Inch: 0.438 wall thickness; X-70.

Pipe stress allowances are an integral part of the design calculations performed for each HDD.

### **ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH**

- Horizontal length: 2,015 feet (ft)
- Entry/Exit angle: 13-20 degrees
- Maximum depth of cover: 85 ft
- Depth under Frankstown Branch Juniata River: 50 ft
- Pipe design radius: 1,600 ft

### **ROOT CAUSE ANALYSIS FOR THE 20-INCH PIPELINE INSTALLATION INADVERTENT RETURNS**

The occurrence of the IR events during the original permitted 20-inch HDD, and modified permit for the FlexBor crossing of Reservoir Road and W-BB58 resulted from the shallow depth of cover on the HDD entry radius for the first 400 ft while proceeding through unconsolidated gravel, sand, silt and clay or fractured weathered bedrock ranging to a depth of 21 to 30 feet below the ground surface, and the presence of groundwater at or just below the land surface. All of the IRs events were concentrated to the west of Reservoir Road during both the original HDD attempts and revised installation plan to bore this length.

The modified and approved 1,700 ft 20-inch HDD under Frankstown Branch Juniata River and Everett Railroad was completed without any IRs.

As discussed below, the plan of construction for the 16-inch pipeline has been further adjusted from that of the 20-inch pipeline as modified. The 16-inch HDD under Frankstown Branch Juniata River and Everett Railroad has been extended to the west to deepen the profile compared to the successful 20-inch HDD; Reservoir Road will be crossed by a conventional auger bore; and the remaining footage between the end of the HDD and the end of the road bore will be completed by conventional open cut.

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

## **GEOLOGIC ANALYSIS**

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS), the HDD site is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, and is underlain by sedimentary rocks consisting of sandstone, siltstone, shale, conglomerate, limestone, and dolomite. The site geology for the redesigned 16-inch HDD profile is mapped west to east as the Devonian age Onondaga and Old Port Formations, undivided (Doo), Keyser and Tonoloway Formations, undivided (DSkt), the Silurian age Wills Creek Formation through Mifflintown Formations, undivided (Swm) (Berg and Dodge, 1981).

The undivided Onondaga and Old Port Formations (Doo) are described as interbedded dark-gray limestone, shaly limestone, and calcareous and noncalcareous shale (Onondaga); and an upper unit of calcareous quartz sandstone and a lower unit of chert, cherty limestone and calcareous shale (Old Port).

The undivided Keyser and Tonoloway Formations consist of dark-gray highly fossiliferous, crystalline to nodular limestone, with shaly limestone near the top (Keyser), and medium-gray laminated limestone containing interbedded zones of medium to dark gray to light olive-gray shale and siltstone (Tonoloway).

The undivided Wills Creek through Mifflintown Formations consist of interbedded olive- and greenish-gray calcareous and noncalcareous shale containing local limestone and sandstone zones, red shale and siltstone occur in lower parts of the formation (Wills Creek) to greenish-gray shale interbedded with medium-gray fossiliferous limestone, with shale predominant at the base and intraformational breccia occurring in the lower part of the formation (Mifflintown).

The bore of Reservoir Road will be within the overburden of the Clinton Group of the Rose Hill Formation.

Karst geology is present at this HDD location. The use of geophysical surveys during this re-evaluation was considered but was ultimately not implemented since SPLP possesses vertical geotechnical data, and a complete log of the horizontal drilling profile of the 20-inch HDD. No additional data is needed to evaluate the adjusted 16-inch HDD profile.

Attachment 1 provides an extensive discussion on the geology and results of the geotechnical investigation performed at this location.

## **HYDROGEOLOGY, GROUNDWATER, AND WELL PRODUCTION ZONES**

Groundwater at the site occurs in a fractured, solution-prone carbonate and clastic sedimentary bedrock aquifer system within the geologic units described above. Water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures. In the carbonate sequences, the water-bearing zones may form in solution-enhanced secondary openings. Most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures that can be sufficiently enlarged by dissolution of the bedrock (Taylor et al., 1982).

Reported depths of 228 domestic and non-domestic wells in the Onondaga Formation ranged from 35 to 500 feet bgs. The median well depth for 144 domestic and 24 non-domestic wells was 141 and 215 feet, respectively. Well yields ranged from 0 to 1,400 gallons gpm and the median well yield was 10 gpm for domestic wells and 66 gpm for non-domestic wells. Water-bearing zones among 88 wells reviewed showed an even distribution to a depth of 300 feet.

The depths of 184 domestic and non-domestic wells completed in the Keyser and Tonoloway Formations range from 27 to 504 feet bgs. The median well depth for domestic wells was 180 feet bgs and the

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

median well depth for non-domestic wells was 225 feet bgs. Well yields ranged from 0 to 315 gpm with the median well yield of 10 gpm for domestic wells and 33 gpm for non-domestic wells. Water-bearing zones are reported to be abundant to a depth of 300 feet bgs.

The depths of 199 domestic and nondomestic wells in Wills Creek Formation ranged from 18 to 495 feet bgs. The median well depth for domestic wells was 100 feet bgs and the median well depth for nondomestic wells was 137 feet bgs. Well yields ranged from 1 to 360 gpm and the median well yield is was 15 gpm for domestic wells and 40 gpm for nondomestic wells. Water-bearing zones are most frequent from depths of 0 to 100 feet bgs, with an average of nearly one zone per 50-foot depth interval.

The reports depths for 132 domestic and nondomestic wells completed in the Bloomsburg and Mifflintown Formation ranged from 34 to 418 feet bgs, with 36 of the wells having a depth of 100 feet bgs or less, and one well greater than 300 feet bgs. The median depths for the domestic wells were 145 feet bgs, while the nondomestic wells had an average depth of 250 feet bgs. Well yields ranged from 1 to 150 gpm and the median well yield was 15 gpm for domestic wells and 18 gpm for nondomestic wells. A review of data from 60 wells indicated that the majority of the water bearing zones are relative shallow; however, zones do appear to be consistently abundant to a depth of 300 feet bgs.

As a condition of the corrected Stipulated Order, other Sunoco subcontractors have researched private water supplies within a 450-foot radius of the Everett Railroad/Reservoir Road HDD. Seven water supply wells were identified within the 450-foot radius. Reported total depths of the private wells ranged from 60 to 225-feet bgs. Information regarding depth to water or yield was not known for any of these wells.

Attachment 1 provides an extensive discussion on the hydrogeology, and results of the geotechnical investigation performed at this location.

### **ADJACENT FEATURES ANALYSIS**

The crossing of the Everett Railroad and Reservoir Road is located in Blair County, approximately 1.3 miles southeast of the borough of Hollidaysburg, Pennsylvania, is located in a semi-rural area with residential home sites along public roadways, small farms where topography is conducive to the activity, and unmanaged woodlands.

The pipeline route is near and crosses under pipeline utilities owned by Enterprise and Buckeye. All three of these pipeline easements appear to be routed to avoid direct impacts to residential home sites as they find a route to cross under the Everett Railroad, and the Frankstown Branch Juniata River.

SPLP identified all landowners within 450 feet and greater from the HDD profile and sent each of these landowners a notice letter via both certified and first-class mail that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy - Executive Assistant, Office of Programs at the Department's Central Office.

As a result of these communications, seven (7) private water supply wells were identified within 450 ft of the original permitted HDD profile. With landowner permission, twelve (12) wells on eleven (11) parcels within and adjacent to the 450 ft buffer were sampled pre, during, and post installation of the 20-inch pipeline. This sampling effort will be repeated during drilling and installation of the 16-inch pipeline.

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

In accordance with the requirements of the Stipulated Order, SPLP will transmit a copy of this HDD analysis to all landowners having a property line within 450 ft of any direction of the revised HDD alignment.

## **ALTERNATIVES ANALYSIS**

As required by the Order, the reanalysis of HDD S3-0011-16 includes an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Mariner II East Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered several different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics.

The HDD as originally permitted was designed to avoid direct impacts to the Frankstown Branch Juniata River, S-BB48, W-BB58, and their associated floodways and riparian habitat. As noted below, SPLP is proposing to change the construction methodology so that S-B48 and W-BB58 will be crossed using open cut techniques, and Reservoir Road will be crossed by a conventional auger bore. The route, however, will remain the same. The alteration of the plans for installation of the 16-inch pipeline will require major modifications of the state Chapter 102 and Chapter 105 permits, and associated authorizations issued by the USACE.

### **Open-cut Analysis**

SPLP specifications require a minimum of 48 inches of cover over the installed pipelines below ground and below the bottom of watercourses. To meet this cover requirement, open cut construction through S-BB48 and W-BB58 would require a minimum authorized open cut work space 50 ft in width to accommodate the 16-inch diameter pipeline, allowing for the pipeline to be installed with sufficient separation for integrity management and in consideration of the effects of trenching in open water on construction workspace. The assessed area of impact by this open cut plan would directly affect 0.24 acres of emergent and shrub-scrub wetland and associated 100-year floodplain. Using open cut construction through these two resources is feasible and will eliminate the risk of IRs at these locations

By contrast, an open cut crossing of the Frankstown Branch Juniata River is not technically feasible since insufficient space exists between the west side of the river and the Everett Railroad to allow for both open cutting the river and receiving a bore from under the railroad in the same space.

### **Use of Conventional Auger Bore**

Planning for a conventional bore must account for the extent or width of the feature (road, stream, etc.) being bored under, as well as the length and width of the setup-entry pit for setting the boring equipment within while operating, and the receiving pit through which the product pipeline is pulled back through after the boring machinery exits.

Based on experience gained during construction of the Mariner II Pipeline project, conventional auger bores should be limited to approximately 200 linear foot at a time, or less, varying by the underlying substrate. Conventional auger bores for the 20-inch pipeline, attempted at longer distances, have at times had alignment drift and elevation deflections occur which have complicated installation.

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

A conventional bore of the Frankstown Branch of the Juniata River, or the Everett Railroad is not feasible. Due to the limited space between the west side of the river and the east side of the railroad a separate bore of these features individually is not possible. A single bore that crosses under both features is not feasible due to the changes in elevation between the east side of the river and west side of the railroad due to the excessive and unsafe depth of excavation that would be required for either a receiving or entry bore pit on the west side of the railroad.

By contrast, a conventional bore of Reservoir Road is feasible and SPLP has prepared an alternative construction plan that includes the conventional bore of Reservoir Road.

### **Re-Route Analysis**

The SPLP pipeline route as currently permitted is in proximity to existing utility corridors containing pipelines operated by Buckeye and Enterprise. Each pipeline easement is routed to minimize impacts to 105 resources while avoiding impacts to residential home sites and make the transition across the river valley as proceeding east. The parallel lay with each of these other pipeline easements was already assessed and dismissed in the original Alternative Analysis as being undesirable due to the resulting effects or impacts.

No practicable re-route option lies to the north or south of the proposed route that would not transect the river, its floodway, and the railroad. Shifting the pipeline route north would still result in crossings Frankstown Branch Juniata River, FEMA 100-year floodplain (Chapter 106 area), forested habitat, require new utility corridor, and would still require bore crossings of the Everett Railroad and Reservoir Road while also increasing the number of residential structures in proximity to the pipeline. An existing easement exists to the south but a shift of the route south would not avoid crossing the Frankstown Branch Juniata River, the Everett Railroad, Reservoir Road, and would require significantly more clearing of forested habitat and require new utility corridor. New utility corridor would require consent of newly-affected landowners or the use of eminent domain/condemnation, and would create a new land encumbrance on every private property crossed. Given site conditions and features north and south of the proposed pipeline alignment, no practicable re-route exists that would result in less impacts to environmental resources.

In summary, due to shifts of the route to the north or south requiring crossing of the Frankstown Branch Juniata River, floodplain, Reservoir Road, Everett Railroad, woodlands, creation of a new "greenfield" corridor, and residential properties to the north of the proposed HDD, there is no identifiable alternative route that would result in less impacts to aquatic and forested woodland resources and existing residences and associated infrastructure in the vicinity of HDD S2-0121.

This re-route analysis conducted for the Everett Railroad HDD is consistent with the conclusions reached in the alternatives analysis previously submitted to PADEP.

### **REVISED CONSTRUCTION PLAN**

SPLP has considered all geologic data and the results of the installation of the 20-inch pipeline and has made further adjustments to the plan of construction for the 16-inch pipeline to include: a second redesign of the 16-inch HDD; a bore of Reservoir Road; and the open cut construction of the lands between the HDD and road bore. A summary of the redesign factors is provided below. The original and redesigned HDD plan and profile for the 16-inch pipeline, and conventional bore of Reservoir Road are provided in Attachment 2.

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

**Revised Horizontal Directional Drill Design Summary: 16-inch**

- Horizontal length: 2,256 ft
- Entry/Exit angle: 9-19 degrees
- Maximum depth of cover: 140 ft
- Depth under Frankstown Branch Juniata River: 59 ft
- Pipe design radius: 2,100 ft

**Bore of Reservoir Road:** 133 ft

**Open cut construction:** 275 ft

**CONCLUSION**

There is no risk of IRs associated with the proposed open cut construction and conventional auger bore. Based on the original and revised profiles for the 16-inch HDD, the revised HDD profile increases the depth in bedrock for a majority of the HDD profile and increases the HDD profile depth below the river; therefore the adjustments to the plan of construction for the 16-inch pipeline represent a reduced risk of IRs. IRs are common on entry and exit of the drilling tool and other measures are required to minimize IR potential. In particular, upon the start of this HDD, SPLP will employ the following HDD best management practices:

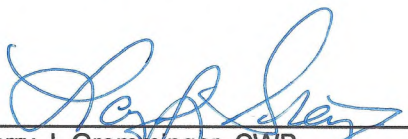
- SPLP will mandate annular pressure monitoring during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus, to help manage development pressures that can induce an IR;
- SPLP inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipeline, is used to ensure adequate “annulus spacing” around the drilling pipeline exits to allow good return flows during the pilot drilling;
- SPLP will implement short-tripping of the reaming tools, as indicated by monitoring of return flows, to ensure an open annulus is maintained to manage the potential inducement of IRs;
- SPLP will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process;
- During all drilling phases, the use of Loss Control Materials (LCMs) will be implemented upon detection of a Loss of Circulation (LOC) or indications of a potential IR are noted or an IR is observed. The use of LCMs, however, is less effective below 70 ft of the ground surface. Accordingly, the preferred corrective action needed to address the presence of fractures or LOC at greater depths below ground will require grouting of the HDD annulus. Two types of grouting may be utilized for corrective actions to seal fractures. These are: 1) grouting using “neat cement”; and 2) grouting using a sand/cement mix. Neat cement grout is a slurry of Portland cement and water which is highly reactive to bentonite and induces solidification. The sand/cement grout mix is a slurry of mostly sand with a small percentage of Portland cement and activators that after setup results in a material having the competency of a friable sandstone or mortar. Both grouting actions require tripping out the drilling tool, and then tripping in with an open-ended drill stem to apply or inject the grout mixes. Either of these grouting actions may be implemented upon the first detection of an LOC with the selection of the treatment based upon the circumstances of the LOC, being small or large in magnitude.

HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)

**FEASIBILITY DETERMINATION**


Based on the information reviewed by the Geotechnical Evaluation Leader, Professional Geologists, Professional Engineers, and HDD specialists, the HDD Reevaluation Team's opinion is that the proposed HDD design and implementation of the management measures contained within this re-valuation report will minimize the risk of IRs

Pertaining to Horizontal Directional Drilling Practices and Procedures; Conventional Construction; Alternatives; and Environmental Effects

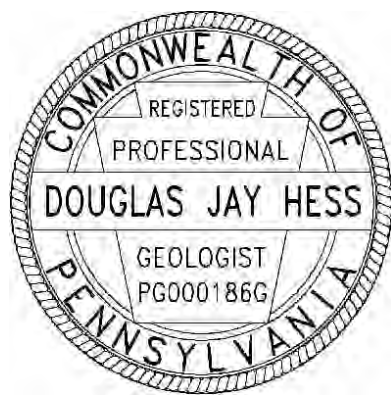
  
\_\_\_\_\_  
Larry J. Greminger, CWB  
Vice President – Environmental  
Geotechnical Evaluation Leader  
Mariner East 2 Pipeline Project

3-4-2019  
Date


Pertaining to the practice of geology

  
\_\_\_\_\_  
Douglas J. Hess, P.G.  
License No. PG-000186-G  
Skelly and Loy, Inc.  
Director of Groundwater  
and Site Characterization  
Geo-Environmental Services

3-4-2019  
Date



Pertaining to the pipeline stress and HDD geometry

  
\_\_\_\_\_  
Jeffrey A. Lowy, P.E  
License No. PE 082759  
Rooney Engineering, Inc.  
Civil Engineer

3/4/19  
Date



**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

**ATTACHMENT 1  
GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT**

March 5, 2019

Mr. Matthew Gordon  
Sunoco Pipeline, LP  
535 Fritztown Road  
Sinking Spring, PA 19608

Engineers

Environmental  
Consultants

Surveyors

Landscape  
Architects

Safety  
Consultants

RE: Sunoco Pipeline, LP Pipeline Project - Mariner East II  
Everett RR/Reservoir Road (S2-0121), PA-BL-0001.0048-RR-16  
Hydrogeologic Re-Evaluation Report for the 16-Inch Pipeline  
Blair Township, Blair County, PA  
RETTEW Project No. 096302011

## EXECUTIVE SUMMARY

1. The 20-inch and 16-inch S2-0121 Everett Railroad/Reservoir Road horizontal directional drill (HDD) locations are included in the Corrected Stipulated Order (CSO) dated August 10, 2017, requiring re-evaluation, including a geologic report. This HDD is listed as No. 5 of the HDDs included on Exhibit 3 of the CSO. This re-evaluation was also prepared as a result of multiple inadvertent returns (IRs) that occurred as the Everett Railroad/Reservoir Road HDD was being completed for the 20-inch pipeline.
2. The site is underlain by carbonate and sedimentary rocks of the Devonian age Onondaga and Old Port Formations, undivided (Doo), Keyser and Tonoloway Formations, undivided (DSkt), and the Silurian age Wills Creek through Mifflintown Formations, undivided (Swm).
3. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults, fractures, and solution openings. The permeability of these features may be enhanced by dissolution of the carbonate bedrock formations.
4. Water-bearing zones in the Onondaga and Old Port Formations occur on average approximately 140 feet below ground surface (bgs), while water-bearing zones in the Keyser and Tonoloway Formations occur on average approximately 180 feet bgs. The average depth to water-bearing zones in the Wills Creek and Mifflintown Formations is approximately 100 feet bgs.
5. The HDD profile for the proposed 16-inch drill has been redesigned to increase its depth under the Frankstown Branch Juniata River (S-BB48).
6. Based on hydro-structural characteristics of the underlying geology, profile of the permitted 16-inch HDD profile, results of the three geotechnical investigations, field observations during installation of the 20-inch pipe, and IRs that occurred during installation of the 20-inch pipe, the Everett Railroad/Reservoir Road HDD site is susceptible to an IR of drilling fluids during HDD operations for the planned 16-inch drill. The redesigned 16-inch HDD profile and HDD best management practices during drilling operations will be used to reduce the risk of an IR.



## 1.0 INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the Everett Railroad/Reservoir Road S2-0121 horizontal directional drill (HDD) location on the Sunoco Pipeline, LP (SPLP) Pennsylvania Pipeline Project - Mariner East II (PPP-ME2) Project. The Everett Railroad/Reservoir Road HDD is located in Blair Township, Blair County, Pennsylvania as shown on **Figure 1**. The HDD was originally designed to be drilled under the Everett Railroad, Frankstown Branch Juniata River (S-BB48), one palustrine emergent wetland (BB-58) and Reservoir Road. The first two attempts to complete the 20-inch HDD were undertaken by drilling from east to west, and both attempted failed due to an inability to control the occurrence of inadvertent returns (IRs) after the pilot drilling tool had progressed west of Reservoir Road. SPLP ultimately abandoned this HDD design, and prepared an alternate HDD plan that shortened and shifted the HDD west of wetland BB-58 to pass under only the railroad and Frankstown Branch Juniata River, and to FlexBor Wetland BB-58 and Reservoir Road. The revised 20-inch HDD was successful; however, the revised FlexBor continued to have difficulties due to the nature of the overburden and near surface geology and groundwater saturated conditions during the bore. In an effort to reduce the potential for IRs, the original 16-inch HDD profile has been redesigned, and the overall HDD profile lengthened, by moving the eastern and western HDD entry/exit points. The redesigned HDD profile will now pass under Township Route 396, Everett Railroad and Frankstown Branch Juniata River. This re-evaluation report is part of the response to the Corrected Stipulated Order (CSO) dated August 10, 2017, related to the potential for the IR of drilling fluids during proposed drilling operations. This re-evaluation was also prepared as a result of IRs that occurred as the Everett Railroad/Reservoir Road HDD was being completed for the 20-inch pipeline.

The original 16-inch HDD profile was redesigned on February 4, 2019, by moving the eastern and western HDD entry/exit points and converting the remaining portion of the originally proposed HDD bore profile to employ open cut trenching and conventional auger road boring construction methods. In support of the revised crossing method, SPLP will submit a major permit modification to the Pennsylvania Department of Environmental Protection (PA DEP) to open cut Wetland BB-58 and complete a conventional road auger bore under Reservoir Road. This redesign will result in an overall lengthening of the of the proposed HDD profile by 165 feet. The redesigned western HDD entry/exit is at a surface elevation of approximately 982 feet above mean sea level (AMSL) and the redesigned eastern HDD entry/exit is at a surface elevation of approximately 933 feet AMSL. The redesigned profile will allow for a general deepening of the boring relative to the completed 20-inch pipeline. The proposed 16-inch pipe will be approximately 15 feet deeper than the 20-inch pipe installed under the Frankstown Branch Juniata River. The lengthened HDD profile results in a new horizontal length of 2,180 feet and new pipe length of 2,205 feet. The inclination of the entry and exit angles has been modified which will allow for approximately 15 feet of additional protective cover under the Frankstown Branch Juniata River. The existing 20-inch HDD pipe and proposed 16-inch HDD and auger road bore for the Everett Railroad/Reservoir Road HDD locations are shown on **Figure 1**, and the redesigned 16-inch profile is included as **Attachment A**.

## 2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS), the site is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, and is underlain by sedimentary rocks consisting of sandstone, siltstone, shale, conglomerate, limestone, and dolomite. Local topography is characterized by a northeast to southwest trending succession of long narrow ridges and broad to narrow valleys, with some karst terrain. Natural

slopes are steep and geologic structure includes open and closed plunging folds with narrow hinges and planar limbs, and a variety of faults. These rocks generally have good surface drainage (Sevon, 2000). The Everett Railroad/Reservoir Road HDD is located on the eastern limb of a syncline that has a bedrock strike trending northeast-southwest and dipping to the northwest. Based on the United States Geologic Survey (USGS) 7.5-Minute Hollidaysburg and Frankstown Topographic Quadrangle Maps shown on **Figure 1**, the site is situated at an approximate elevation range of 1,060 to 940 feet AMSL. Surface topography at the site slopes to the east along the HDD towards Frankstown Branch Juniata River. The major surface water feature proximate to the Everett Railroad/Reservoir Road HDD is Frankstown Branch Juniata River which generally flows to the northeast before discharging to the Little Juniata River.

The site geology for the redesigned 16-inch HDD profile is mapped west to east as the Devonian age Onondaga and Old Port Formations, undivided (Doo), Keyser and Tonoloway Formations, undivided (DSkt), the Silurian age Wills Creek Formation through Mifflintown Formations, undivided (Swm) as shown on **Figure 2** (Berg and Dodge, 1981).

The undivided Onondaga and Old Port Formations (Doo) are described as interbedded dark-gray limestone, shaley limestone, and calcareous and noncalcareous shale (Onondaga); and an upper unit of calcareous quartz sandstone and a lower unit of chert, cherty limestone and calcareous shale (Old Port). Bedding features in these formations are described as well bedded and flaggy to thick in nature. Most joints are blocky to seamy; moderately abundant, open and vertical. Joints and bedding plane fractures are moderately to closely spaced and provide secondary porosity of moderate magnitude with low to moderate permeability. These rocks are moderately weathered with the deepest weathering occurring in the shales. Weathering results in small- to medium sized blocks. The overlying mantle is thin and surface drainage is good. From an engineering standpoint, excavation (and drilling) is classified as difficult with slope stability being generally good in the limestone member and fair in the shale member. Foundation stability is classified as good, provided the excavation is completed to sound material and identified solution cavities are investigated and mitigated (Geyer and Wilshusen, 1982).

The undivided Keyser and Tonoloway Formations consist of dark-gray highly fossiliferous, crystalline to nodular limestone, with shaly limestone near the top (Keyser), and medium-gray laminated limestone containing interbedded zones of medium to dark gray to light olive-gray shale and siltstone (Tonoloway). Bedding features within these formations are described as well bedded with flaggy to thick beds, but some beds are massive. Moderate to highly abundant joints exhibiting a platy pattern, are present in this formation. The joints are regularly spaced, with moderate to close spacing between fractures which are open and steeply dipping. Secondary porosity occurs in solution channels and joint-and bedding-plane openings and is described as having moderate magnitude. Permeability is described as low to moderate. This unit is moderately resistant to weathering. Weathering occurs to a shallow to moderate depth resulting in small- to medium-sized irregular blocks. The overlying mantle is thin in most places, and bedrock pinnacles may exist. Excavation is classified as difficult, with bedrock pinnacles presenting a special problem. Drilling rates are typically fast. Foundation stability is good, but a thorough investigation for solution openings should be completed with material excavated until sound material is encountered (Geyer and Wilshusen, 1982).

The undivided Wills Creek through Mifflintown Formations consist of interbedded olive- and greenish-gray calcareous and noncalcareous shale containing local limestone and sandstone zones, red shale and siltstone occur in lower parts of the formation (Wills Creek) to greenish-gray shale interbedded with

medium-gray fossiliferous limestone, with shale predominant at the base and intraformational breccia occurring in the lower part of the formation (Mifflintown). The formation is moderately well to well bedded, fissile to thin. Joints are moderately well to well developed, moderately to highly abundant joints exhibiting seamy to platy pattern with some thin-bedded limestones have a blocky pattern. Fractures that are present are regularly to closely spaced, open and gently to steeply dipping. Bedrock is reported to be slightly resistant to weather with moderately to highly weathered zones being present to moderate depths. Weathered product tends to consist of small flat irregularly shaped fragments with the limestone weathering into small flat blocks. The overlying mantle tends to be thin. From an engineering standpoint, excavation rates range from moderately easy to moderately difficult in the weathered portion and difficult in unweathered bedrock of the Mifflintown Formation, while excavation in the Wills Creek Formation is classified as moderately easy. Fast drilling rates are expected for both formations. Foundation stability is good, but a thorough investigation for collapse potential where carbonate units are present should be completed and excavation should continue until sound material is encountered. These formations have good surface drainage. Permeability and secondary porosity of low to moderate magnitude occurs in joint, bedding, and cleavage plane openings (Geyer and Wilshusen, 1982).

According to the United States Department of Agriculture (USDA) Soil Surveys of Blair County, Pennsylvania, soils in the vicinity of the Everett Railroad/Reservoir Road HDD consist of ten separate soil units. A USDA soils map that depicts the mapped area, along with the soil profile descriptions, is included as **Attachment 2**.

### **3.0 HYDROGEOLOGY**

Groundwater at the site occurs in a fractured, solution-prone carbonate and clastic sedimentary bedrock aquifer system within the geologic units described above. Water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures. In the carbonate sequences, the water-bearing zones form secondary openings that may be enhanced by solutioning and most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures that can be sufficiently enlarged by dissolution of the bedrock (Taylor et al., 1982). A summary of the published data review of water wells completed in the Onondaga and Old Port Formations, undivided Keyser and Tonoloway Formations, undivided and Wills Creek through Mifflintown Formations is provided below.

Reported depths of 228 domestic and non-domestic wells inventoried in the Onondaga Formation ranged from 35 to 500 feet below ground surface (bgs). The median well depth for 144 domestic and 24 non-domestic wells was 141 and 215 feet bgs, respectively. Well yields ranged from 0 to 1,400 gallons per minute (gpm) with a median well yield of 10 gpm for domestic wells and 66 gpm for non-domestic wells. Water-bearing zones among 88 wells inventoried were evenly distributed to a depth of 300 feet bgs. Approximately 25% of the wells drilled deeper than 300 feet bgs penetrated water-bearing zones, with the deepest water-bearing zone reported at 460 feet bgs (Taylor et al., 1982).

The depths of 184 domestic and non-domestic wells completed in the Keyser and Tonoloway Formations ranged from 27 to 504 feet bgs. The median well depth for domestic wells was 180 feet bgs and the median well depth for non-domestic wells was 225 feet bgs. Well yields ranged from 0 to 315 gpm with a median well yield of 10 gpm for domestic wells and 33 gpm for non-domestic wells. Water-bearing zones are reported to be abundant to a depth of 300 feet bgs. Four of the nine wells (44%) drilled deeper than

300 feet had water-bearing zones occurring below 300 feet bgs, with the deepest occurring at 470 feet bgs (Taylor et al., 1982).

The depths of 199 domestic and nondomestic wells completed in the Wills Creek Formation ranged from 18 to 495 feet bgs. The median well depth for domestic wells was 100 feet bgs and the median well depth for nondomestic wells was 137 feet bgs. Well yields ranged from 1 to 360 gpm with a median well yield of 15 gpm for domestic wells and 40 gpm for nondomestic wells. Water-bearing zones are most frequent from depths of 0 to 100 feet bgs, with an average of nearly one zone per 50-foot depth interval. The deepest reported water-bearing zone occurred at 300 feet bgs (Taylor et al., 1982).

The reported depths for 132 domestic and nondomestic wells completed in the Bloomsburg and Mifflintown Formations ranged from 34 to 418 feet bgs, with 36 of the wells having a depth of 100 feet bgs or less and only one well having a depth greater than 300 feet bgs. The median depths for the domestic wells were 145 feet bgs, while the nondomestic wells had an average depth of 250 feet bgs. Well yields ranged from 1 to 150 gpm with a median well yield of 15 gpm for domestic wells and 18 gpm for nondomestic wells. A review of data compiled for 60 wells inventoried indicated that the majority of the water-bearing zones are relative shallow; however, zones do appear to be consistently abundant to a depth of 300 feet bgs. The deepest water bearing zone occurred at 385 feet bgs (Taylor et al., 1982).

Well records for 12 individual water supply wells within a 0.5-mile radius of the Everett Railroad/Reservoir Road HDD were obtained from the Pennsylvania Groundwater Information System (PaGWIS). The well locations are shown on **Figures 2** and **3**. The information obtained from these well records is summarized in the following table.

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gallons per minute)
651430	Unknown	40	520	Unknown	1
651304	Unknown	40	420	Unknown	Unknown
651168	Unknown	40	300	Unknown	25
651086	Unknown	40	180	Unknown	8
58553	Domestic	29	200	Unknown	15
58552	Domestic	21	250	Unknown	10
58539	Domestic	47	237.5	Unknown	4
58532	Domestic	20	125	Unknown	12
58531	Domestic	20	200	Unknown	3
58530	Domestic	20	60	Unknown	15
58529	Domestic	25	135	Unknown	12
58528	Domestic	33	80	Unknown	10

As a condition of the CSO, other Sunoco subcontractors have researched private water supplies within a 450-foot radius of the Everett Railroad/Reservoir Road HDD. RETTEW Associates, Inc. (RETTEW) received a map depicting the results of this effort on February 28, 2019. Seven water supply wells were identified within the 450-foot radius. Additionally, three private wells were identified outside of the 450-foot radius. Reported total depths of the private wells ranged from 60 to 225 feet bgs. Information regarding depth to water was not provided for these wells. Locations of the identified wells are shown on the figure included in **Attachment 3**.

#### **4.0 FRACTURE TRACE ANALYSIS**

Fracture traces underlying, or in close proximity to, the Everett Railroad/Reservoir Road HDD were evaluated using historical aerial photographs from the years 1993 through 2016 (Google Earth, 2017), the USGS Frankstown and Hollidaysburg 7.5 Minute Quadrangle Topographic Maps, and the Geologic Maps of the Frankstown and Hollidaysburg 7.5 Minute Quadrangles (Berg and Dodge, 1981). The photographs and maps were used to approximate the locations of natural linear fracture trace features or lineaments expressed on the ground surface. The linear features may be the surficial representation of deeper high angle fractures, joints, faults or bedding planes within the subsurface which can transmit groundwater through the fractured bedrock aquifer underlying the Everett Railroad/Reservoir Road HDD.

**Figures 2 and 3** depict the results of the fracture trace analysis which were added on the geologic map of the site and aerial base map, respectively. Six fracture traces were identified in close proximity to the proposed Everett Railroad/Reservoir Road HDD that are likely related to the primary geologic structure of the area. Due to the nature of the ridges and folded geology near the site, four of the fracture traces trend approximately northeast-southwest (NE-SW) and nearly perpendicular to the alignment of the Everett Railroad/Reservoir Road HDD. Two fracture traces were identified trending in an approximately northwest-southeast orientation. General surface drainage patterns near the site are characterized by linear stream reaches trending NE-SW that reflect the local geologic structure.

#### **5.0 GEOTECHNICAL EVALUATION**

Three geotechnical drilling investigations were performed at the site. The initial investigation was performed in September 2014, April 2015, and September 2015 during the preliminary investigations of Everett Railroad/Reservoir Road HDD and prior to initiating the 20-inch HDD operations. A second phase of geotechnical drilling was performed in August and September of 2017. A third phase of geotechnical drilling was performed in December 2017. The 2014 and 2015 test borings were advanced by hollow-stem auger drilling methods to a maximum depth of 30 feet bgs or until auger refusal. NQ-sized wireline rock coring methods were utilized in borings that were completed past auger refusal. Soil, residual soil and weathered bedrock were sampled using split-spoon sampling methods. These borings are designated as S2-0120-SB-02, S2-0121 SB-01, S2-0121 SB-02, and S2-0121 SB-03. The second phase test borings completed in 2017 were advanced using mud rotary drilling and NQ-sized wireline rock coring methods. The 2017 borings were designated as B3-4W and B3-4Wa. The third phase of test borings completed in December 2017 were advanced using hollow-stem auger drilling and NQ-sized wireline rock coring methods. These borings were designated as B-01 and B-01A. Geotechnical boring logs are included in **Attachment 1**.

Boring S2-0120 SB-02 was located approximately 700 feet southwest of the eastern entry/exit point of the Everett Railroad/Reservoir Road 20-inch FlexBor. Boring S2-0121 SB-01 was located approximately 250 feet southeast of the western entry/exit point of the Everett Railroad/Reservoir Road 20-inch HDD. Boring S2-0121 SB-02 was located approximately 700 feet northwest of the eastern entry/exit point of the Everett Railroad/Reservoir Road 20-inch FlexBor. Boring S2-0121 SB-03 was located approximately 300 feet southeast of the eastern entry/exit point of the Everett Railroad/Reservoir Road 20-inch FlexBor. Boring B3-4W was located approximately 70 feet northeast of the western entry/exit point of the Everett Railroad/Reservoir Road HDD. Boring B3-4Wa was located approximately 200 feet northwest of the western entry/exit point of the Everett Railroad/Reservoir Road HDD. Borings B-01 and B-01A were located approximate 150 feet to the east of the original 20-inch HDD eastern entry/exit point. The locations of these borings are identified on **Figures 2 and 3**.

The generalized subsurface profile at the site, as observed in the borings, is described as follows:

- Variable and residual soil depths vary from boring to boring; 30 feet at S2-0120 SB-02, 30 feet at S2-0121 SB-01, 21 feet at S2-0121 SB-02, 9.8 feet at S2-0121 SB-03, 9.0 feet at B3-4Wa, 8.5 feet at B3-4W, and 30 feet at B-01. The residual soils are described as follows:
  - **Boring S2-0120 SB-02:** Topsoil, fine to medium SAND (SM) with little silt and trace to some gravel. The boring was completed to 30 feet bgs and groundwater was encountered at 9.8 feet bgs.
  - **Boring S2-0121 SB-01:** Topsoil, mottled silty CLAY (CL) with some fine sand and trace gravel, silty CLAY (CL) with some fine sand, with little fine to coarse shale fragments. The boring was completed to 30 feet bgs and groundwater was encountered at 11 feet bgs.
  - **Boring S2-0121 SB-02:** Topsoil, mottled silty CLAY (CL) with some fine sand, clayey GRAVEL (GC), mottled silty CLAY (CL) with some fine sand and trace to little fine to coarse gravel, decomposed limestone weathered to a fine to coarse GRAVEL (GM/SM) with some fine to medium sand, some silt. Auger refusal occurred at 21 feet bgs and groundwater was encountered at 13 feet bgs.
  - **Boring S2-0121 SB-03:** Fill with a matrix of SILT (ML) fine to medium sand, fine to coarse gravel, fine to medium SAND and SILT (SM) with little fine to coarse gravel. Auger refusal occurred at 10 feet bgs and groundwater was not encountered. Five unsuccessful attempts were made to advance the boring deeper before abandoning the location.
  - **Boring B3-4W:** Topsoil, very stiff gravelly lean CLAY (CL), trace sand and trace organic matter. Groundwater was not encountered.
  - **Boring B3-4Wa:** Stiff sandy lean CLAY (CL), trace gravel and organic matter, very stiff fat CLAY (CH) with sand and weathered rock. Groundwater was not encountered.
  - **Boring B-01:** Medium stiff, moist, sandy lean CLAY (CL) with shale fragments, medium dense SANDSTONE and SHALE fragments (GP-GC) with moist clayey sand, medium dense, moist to dry SHALE (samples contained poorly graded gravel, with silt) (GP), very dense, dry SHALE (samples as poorly graded gravel) (GP). Auger refusal occurred at 30 feet bgs and groundwater was not encountered.
  - **Boring B-01A:** No soil samples were collected at this location.
- From the initiation of coring operations to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and are described as follows:
  - **Boring S2-0120 SB-02:** Rock coring was not completed at this location.

- **Boring S2-0121 SB-01:** Rock coring was not completed at this location.
- **Boring S2-0121 SB-02:** Rock coring was not completed at this location.
- **Boring S2-0121 SB-03:** Rock coring was not completed at this location.
- **Boring B3-4W:** Boring B3-4W was completed to a total depth of 71 feet bgs.
  - From 8.5 to 16 feet bgs brown to gray, friable weathered rock was encountered. From 16 to 26 feet bgs, hard, moderately weathered, gray, argillaceous LIMESTONE with thin to medium bedding was encountered. The primary joint sets were iron stained, and high angle, with close to very close spacing and were slightly open, smooth, and planar. The secondary joint set was low angle, with moderately close spacing, open, rough, planar, and fresh. A zone of lost recovery was encountered from 19.8 to 21 feet bgs; probably the result of a completely weathered interbedded shale/claystone layer.
  - From 26 to 47 feet bgs, hard, slightly weathered, brown to gray, argillaceous LIMESTONE with thin to medium bedding was encountered. The primary joint sets were iron stained, high angle, with close to very close spacing and were slightly open, rough, and planar. The secondary joint set was low angle, moderately close to closely spaced, open to slightly open, rough, planar, and fresh. A zone of lost recovery (wash out) was encountered at 39 to 39.4 feet bgs, probably the result of a completely weathered interbedded shale layer intercepting highly fractured zones, was also encountered from 42.7 to 43 feet bgs.
  - From 47 to 56 feet bgs, hard, severely weathered, gray, argillaceous LIMESTONE with thin to medium bedding was encountered. The primary joint sets were iron stained, high angle, with very close to close spacing and were open, rough, and planar. Highly fractured zones were encountered from 42.7 to 43, 48.2 to 48.8, 49.9 to 50.6, 51 to 51.6 feet bgs. A zone of lost recovery (wash out) was encountered at 50.6 to 51 feet bgs, probably the result of a completely weathered shale layer and a void. A probable karst zone was encountered from 51.6 to 55 feet bgs.
  - From 56 to 75 feet bgs, hard, moderately weathered, gray, argillaceous LIMESTONE with thin to medium bedding was encountered. The primary joint sets were iron stained, high angle, with close to moderately close spacing and were open to slightly open, rough, planar and clay filled. Highly fractured zones were also encountered from 60.5 to 61 and 67.8 to 68.5 feet bgs, while a vuggy zone was encountered from 66 to 67.4 feet bgs.
  - Rock recovery ranged from 30% to 100% and rock quality designation (RQD) values ranged from very poor (10) to fair (73). Groundwater was encountered at 54.5 feet bgs.
- **Boring B3-4Wa:** This boring was completed to a total depth of 300 feet bgs.
  - From 9 to 28 feet bgs, light gray and red to orange-brown, dense, highly weathered MUDSTONE with sand and clay was encountered.
  - From 28 to 47 feet bgs, dark gray to black, dense, highly weathered SHALE was encountered.
  - From 47 to 54 feet bgs red and orange-brown, dense, highly weathered MUDSTONE was encountered.

- From 54 to 93 feet bgs, dark gray to black, very dense, highly weathered SHALE was encountered. Between 74 and 77 feet bgs, the SHALE was interbedded with highly weathered brown and orange-brown mudstone.
- From 93 to 100 feet bgs, orange-brown, very dense, highly weathered MUDSTONE was encountered.
- From 100 to 105 feet bgs dark gray to black, very dense, highly weathered SHALE was encountered.
- From 105 to 120 feet bgs, dark gray to black, very dense, highly weathered SHALE interbedded with sandstone was encountered.
- From 120 to 137 feet bgs, dark gray, very dense, highly weathered SHALE interbedded with siltstone was encountered.
- From 137 to 180 feet bgs, moderately hard to hard, slightly to moderately weathered, gray to dark gray LIMESTONE with occasional calcite veins and interbedded calcareous shale was encountered. The primary joint set was high angle and closely spaced, slightly open to open, discolored to decomposed. Highly fractured intervals were encountered between 143.2 to 143.8, 152.5 to 152.8 and 161.6 to 162 feet bgs. No joint sets were observed between 175 and 180 feet bgs.
- From 180 to 190 feet bgs, moderately hard to hard, slightly to moderately weathered, gray to brown LIMESTONE with occasional calcite veins was encountered. The primary joint set was moderately dipping to high angle and were close to moderately closely spaced, rough to smooth, discolored to decomposed and moderately open to open. A void was encountered between 185 and 186.6 feet bgs and a highly calcareous clay layer was encountered from 187.5 to 187.8 feet.
- From 190 to 195 feet bgs moderately hard to hard, moderately to highly weathered, light brown to brown LIMESTONE with occasional calcite veins was encountered. The primary joint set was moderately dipping to high angle, closely spaced and were decomposed and open. Voids were encountered between 190.4 and 191.2 feet bgs.
- From 195 to 215.2 feet bgs, moderately hard to hard, slightly weathered, gray LIMESTONE with occasional calcite veins was encountered. The primary joint sets were moderately dipping, moderately closely spaced, and were smooth to rough, discolored and tight to slightly open.
- From 215.2 to 237 feet bgs, moderately hard to hard, slightly to highly weathered, gray to brown LIMESTONE with occasional calcite veins was observed. The primary joint sets were high angle, closely to moderately closely spaced, and were rough, decomposed and moderately open to open. A soft completely weathered brown and gray MUDSTONE layer was encountered at 220.9 feet bgs, while a brown clayey fine to coarse sand layer was encountered between 225 and 226 feet bgs.
- From 237 to 240 feet bgs, soft to very soft, highly weathered, red-brown MUDSTONE with no joints was encountered.
- From 240 to 260 feet bgs, soft to medium hard, moderately to highly weathered, red and orange-brown MUDSTONE was encountered. The primary joint set was horizontal to moderately dipping, had close to wide spacing, and was smooth, decomposed and tight to moderately open. From 255 to 256.4 feet bgs, a zone of completely weathered bedrock was encountered.

- Between 260 and 265 feet bgs, soft to medium, moderately to highly weathered, red to purple to orange-brown and white MUDSTONE was encountered. The primary joint set was horizontal to low angle, had close to moderately close spacing and was smooth, discolored, and slightly to moderately open.
- From 265 to 280.7 feet bgs, soft to medium hard, moderately to highly weathered red to purple to orange-brown and white MUDSTONE interbedded with occasional sandstone was encountered. The primary joint set was horizontal to low angle, had close to moderately close spacing and was rough to smooth, discolored to decomposed, and moderately open to open.
- From 280.7 to 300 feet bgs, soft to medium, moderately to highly weathered, red to purple to orange-brown and white MUDSTONE interbedded with sandstone was encountered. The primary joint set was low angle to moderately dipping, had close to moderately close spacing and was smooth, discolored to decomposed, and slightly open to open. A weakly cemented sandstone layer was observed between 295 and 295.6 feet bgs.
- Rock recoveries ranged from 12% to 100% and RQD values ranged from very poor (0) to excellent (100). Groundwater was encountered at 100 feet bgs.
- **Boring B-01:** Boring B-01 was completed to a total depth of 131.5 feet bgs.
  - From 30 to 39.5 feet bgs light brown and light gray, very fine- to fine-grained, very thin- to thin-bedded, weathered to very weathered, very soft to soft SANDSTONE was encountered. An extremely broken interval containing clay was encountered between 31 and 33.5 feet bgs and a broken interval with clay was observed between 36.5 to 39.5 feet bgs.
  - From 39.5 to 131.5 feet bgs, gray, very fine-grained, thin to medium bedded, slightly weathered, moderately hard SHALE interbedded with claystone was encountered. A broken interval was observed between 41.5 to 42.2 feet bgs, while a broken interval with vertical fractures was observed between 71.5 to 73.5 and 126 to 126.3 feet bgs. The shale became medium to thick bedded at 76 feet bgs and thin to thick bedded at 96.5 feet bgs. An interval of vertical fractures was encountered at 85.9 to 86.9 feet bgs and a clay seam was observed between 113.8 to 114 feet bgs.
  - Rock recovery ranged from 84% to 100% and RQDs ranged from very poor (0) to excellent (90). Groundwater was not encountered during coring operations.
  - **Boring B-01A:** Boring B-01A was completed to a total depth of 250 feet bgs.
  - From 40 to 88 feet bgs, gray, very fine-grained, very thin bedded, highly weathered, soft SHALE was encountered. At 42 feet bgs, the shale became very thin to thin bedded and at 52 feet bgs the shale becomes very thin to medium bedded. At 67 feet bgs the shale became interbedded with claystone. An interval of vertical fractures and broken rock was observed between 75.4 to 79.1 feet bgs, while broken bedrock with vertical fractures was observed at 83.5 feet bgs.
  - From 88 to 117 feet bgs gray, very fine-grained, thin- to thick-bedded, highly weathered, medium hard SHALE with quartz veining was encountered. Vertical fractures were encountered between 93.2 to 94.1 feet bgs, while an extremely broken interval was observed between 95.3 to 95.7 feet bgs. The shale became gray and red-gray at 111.2 feet bgs.

- From 117 to 159 feet bgs, gray, very fine-grained, thin- to thick-bedded, highly weathered, medium to moderately hard SHALE was encountered. A very thin clay seam was observed between 136.7 and 136.8 feet bgs. Broken and vertical fractures were observed between 142 to 143.8 feet bgs, while a broken interval was observed between 158.5 to 159 feet bgs.
- From 159 to 197 feet bgs, red gray and gray, thin-to medium-bedded, slightly weathered, medium to moderately hard, SHALE interbedded with claystone was encountered. Vertical fractures with clay were observed between 174.9 to 176.3 feet bgs, while vertical fractures with broken bedrock was observed between 178.5 to 182 feet bgs. A broken interval was encountered between 184.5 to 185.5 feet bgs.
- From 197 to 217 feet bgs, red gray and gray, thin- to thickly-bedded, slightly weathered, medium to moderately hard, SHALE with interbedded claystone was encountered. An interval of vertical fractures and broken bedrock was observed from 205.3 to 207 feet bgs.
- From 217 to 250 feet bgs, gray, thin- to thickly-bedded, slightly weathered, medium to moderately hard SHALE interbedded with claystone was encountered.
- Rock recovery ranged from 10% to 100% and RQD values ranged from very poor (0) to excellent (100). Groundwater was not encountered.

Unconfined compressive strength testing was performed on core samples and the results are summarized in the table below.

Boring	Sample Depth (feet bgs)	Compressive Strength (pounds per square inch)
B3-4Wa	147	3,152
B3-4Wa	166	27,880
B3-4Wa	187	534
B3-4Wa	205	10,361

Please note that RETTEW Associates, Inc. (RETTEW) or Skelly and Loy did not oversee or direct the geotechnical drilling program associated with HDD S2-0121 including, but not limited to, the selection of boring locations and target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco Pipeline, LP contractors. RETTEW and Skelly and Loy relied on these reports and incorporated the data into the general geologic and hydrogeologic framework included in this report.

## 6.0 GEOPHYSICAL SURVEY

The CSO states that the use of geophysical surveys should be considered in karst areas; however, the use of geophysical surveys during this re-evaluation was considered but was ultimately not implemented at the Everett Railroad/Reservoir Road HDD location because the data generated from these surveys will not

reduce the risk of an IR near the eastern entry/exit point of the HDD as observed while the pilot hole for the 20-inch pipeline was being completed.

## **7.0 FIELD OBSERVATIONS**

### **• FEBRUARY 1, 2018 FIELD INVESTIGATION**

A field investigation was performed by RETTEW on February 1, 2018, to identify rock outcrops for fracture fabric analysis and to identify additional potential sensitive receptors to IRs. No readily accessible bedrock outcrops or sensitive receptors were identified in the vicinity of the Everett Railroad/Reservoir Road HDD during the field reconnaissance.

### **• FIELD OBSERVATIONS DURING 20-INCH HDD ACTIVITIES**

RETTEW staff were on-site during 20-inch HDD operations. The initial drilling events performed by Blacklick Energy Services (Blacklick) took place between June 26 and July 13, 2017. On July 13, 2018, Blacklick terminated advancement of the pilot boring and demobilized their equipment. Michels Directional Crossings (Michels) resumed pilot hole drilling from September 2 through September 5, 2017. Michels suspended drilling on September 5, 2017, due to the occurrence of an IR that resulted in the discharge of approximately 10 gallons of drilling fluids to wetland BB-58.

Michels resumed pilot hole advancement on April 9, 2018, and after advancing the pilot hole to a trajectory length of 287 feet another IR occurred and all drilling activities were suspended pending Pennsylvania Department of Environmental Protection (PA DEP) restart approval. Following PA DEP's restart approval, Michels resumed drilling activities on May 31, 2018, and continued to advance the pilot hole until June 7, 2018, when it was decided to install surface casing through the unconsolidated material in an effort to minimize the potential for future IRs or the re-activation of existing IRs. The surface casing was keyed into competent bedrock on June 12 and grouted in place on Jun 13, 2018. Michels resumed advancing the pilot hole on June 14, 2018, and continued until another IR occurred on June 15, 2018, which resulted in all drilling activities being suspended.

In an effort to further reduce the potential for additional IRs, SPLP submitted a minor permit modification to the PA DEP requesting a modification to the existing 20-inch drilling profile. The new profile shortened the overall length of the boring and moved the eastern entry/exit point from the east side of Reservoir Road to the eastern floodplain of Frankstown Branch Juniata River. The remainder of the original HDD profile (wetland BB-58 and Reservoir Road) would be completed utilizing FlexBor drilling methods.

Following PA DEP approval of the minor permit modification, Michels started the pilot boring for the redesigned 20-inch HDD profile on August 15, 2018. Michels encountered a void on August 16, 2018, resulting in a total loss of returns (LOR). Michels experienced additional LORs on August 17, 2018, and September 4, 2018, but continued to advance the boring and completed the pilot hole on September 5, 2018. While the pilot hole was being completed on September 5, 2018, and while the pilot bit was in the unconsolidated material, a "punch out" IR occurred within the limits of disturbance; however, no impacts occurred to Waters of the Commonwealth. Michels completed the 30-inch ream and swab passes between September 7 and 17, 2018, and the 20-inch product line was pulled through the boring on September 24 and 25, 2018.

Ursa Major Directional Crossing, LLC (Ursa Major) was retained to complete the FlexBor portion of the boring. Ursa Major began to advance the pilot hole on October 4, 2018. The FlexBor drilling method did not utilize bentonite-based drilling fluid, only potable water and air were used to circulate cuttings back to the returns pit during drilling activities. On October 17, 2018, surfacing sediment-laden groundwater was observed within wetland BB-58. This event was treated as an IR and drilling activities were suspended pending PA DEP restart approval. Following receipt of PA DEP's restart approval, Ursa Major resumed pilot hole advancement on October 24, 2018, but stopped that day when additional surfacing of sediment-laden groundwater was observed in an upland area discharging into wetland BB-58. PA DEP approved the restart of drilling activities on October 25, 2018, and on October 27, 2018, the pilot hole was completed. Ursa Major completed 4 ream passes (10-, 15-, 20- and 30-inch reamers) between November 1 and December 2, 2018. After completing two swab passes, Ursa Major completed the 20-inch product line pipe pull on December 5, 2018.

## **8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION**

Based on review of published geologic and hydrogeologic information, results of geotechnical investigations, and field observations during the completion of the 20-inch HDD, the Everett Railroad/Reservoir Road HDD is underlain by carbonate and clastic sedimentary rocks of the Onondaga and Old Port Formations (undivided), Keyser and Tonoloway Formations (undivided) and Wills Creek and Mifflintown Formations (undivided). The hydrogeologic setting is dominated by groundwater flow that occurs in secondary openings formed along geologic features that include bedrock bedding planes, joints, and fractures. The secondary openings may be enlarged or enhanced to some degree by dissolution of the underlying carbonate bedrock. Water-bearing zones in the Onondaga and Old Port Formations occur on average approximately 140 feet bgs, while water-bearing zones in the Keyser and Tonoloway Formations occur on average approximate 180 feet bgs. The average depth to water-bearing zones in the Wills Creek and Mifflintown Formations is approximately 100 feet bgs.

The originally designed 16-inch HDD profile was relatively shallow at the eastern and western entry/exit points. The original profile also passed through soil overburden, the overburden and bedrock interface and fractured and weathered bedrock over an extended area in comparison to the land surface, wetland (BB-58), buried utilities, Everett Railroad, and streambed (S-BB48) locations. Based on the hydro-structural characteristics of the underlying geology described in this report, the IRs that occurred during the installation of the 20-inch pipe, the Everett Railroad/Reservoir Road HDD is susceptible to an IR of drilling fluids during HDD operations. As a result, the 16-inch HDD profile was redesigned by lengthening the profile and by moving the eastern and western HDD entry/exit points and by converting the portion of the original profile under Wetland BB-58 and Reservoir Road to open-cut construction. The 16-inch HDD profile has been modified to reach a greater depth than the as-built 20-inch HDD boring to allow for a deeper crossing beneath the above-referenced features. The revised profile is approximately 58 feet below the Frankstown Branch Juniata River (this is approximately 15 feet deeper than the as-built 20-inch pipe). From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling best management practice (BMPs), will be used to reduce the risk of an IR and/or a loss of drilling fluid. Drilling BMPs are described in the Horizontal Directional Drill Analysis component of the overall re-evaluation package.

## 9.0 REFERENCES

A.R. Geyer and P.J. Wilshusen, 1982, *Engineering Characteristics of the Rocks of Pennsylvania*, Pennsylvania Department of Environmental Resources, Office of Resource Management, Topographic and Geologic Survey, Environmental Geology Report 1, Second Edition, 300 pages.

Google Earth Pro, 2019, Version 7.3.2, accessed January 15, 2019.

L.E. Taylor, W.H. Werkheiser, N.S. duPont, M.L. Kriz, 1982, *Groundwater Resources of the Juniata River Basin, Pennsylvania*, Pennsylvania Geologic Survey, 4th Series, Water Resource Report 54, 144 pages.

Pennsylvania Bureau of Topographic and Geologic Survey, Department of Conservation and Natural Resources, 2001, Bedrock Geology of PA, Edition: 1.0, Digital Map. accessed January 15, 2019; [HTTP://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspxDL](http://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspxDL) Data: Page oexp.zip [HTTP://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspx].

Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Groundwater Information System (PaGWIS) database, website address: <http://www.dcnr.pa.gov/Conservation/Water/Groundwater/PAGroundwaterInformationSystem/Pages/default.aspx>, accessed February 16, 2019.

T.M. Berg and C.M. Dodge, compilers and eds., 1981, *Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania*, Pennsylvania Geological Survey, 4th series, Map 61, 636 pages

United States Department of Agriculture, Natural Resources Conservation Service, Published Soil Surveys for Pennsylvania, Blair County, Pennsylvania: website address: <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>, accessed February 11, 2019.

W.D. Sevon, 2000, *Physiographic Provinces of Pennsylvania*, Pennsylvania Bureau of Topographic and Geologic Survey, Harrisburg, Pennsylvania, Map 13.

### 10.0 CERTIFICATION

The studies and evaluations presented in this report (other than Section 5.0) were completed under the direction of a licensed professional geologist (PG) and are covered under the PG seals that follow.

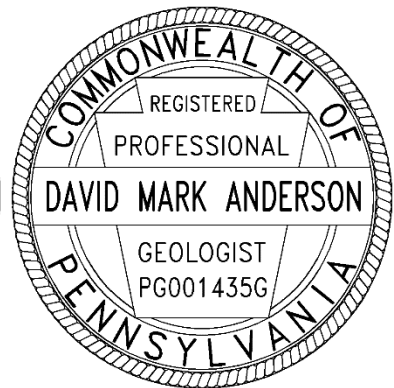
By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information herein.



Douglas J. Hess, PG  
License No. PG000186G



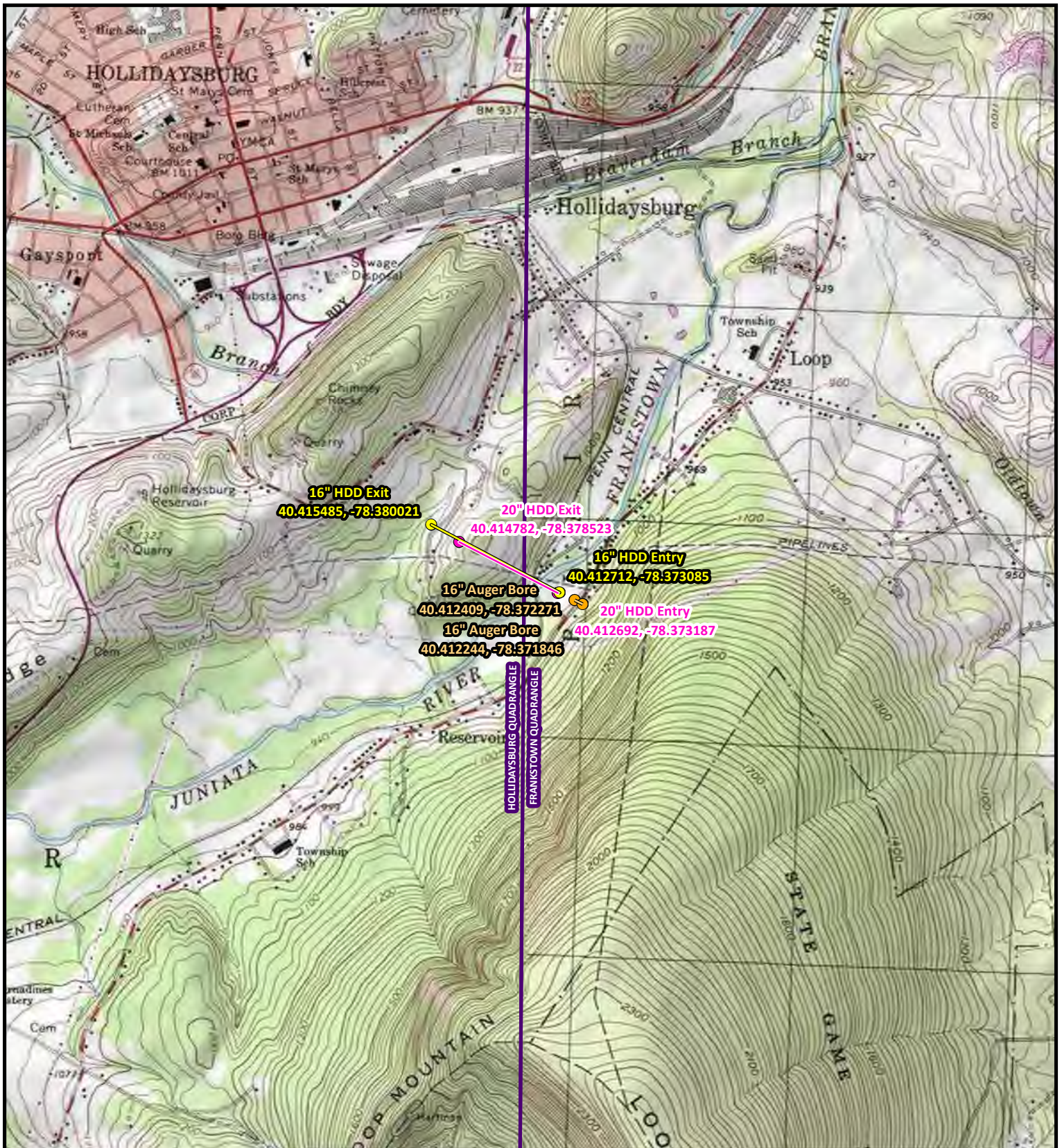
David M. Anderson, PG  
License No. PG001435G



### Enclosures

Z:\Shared\Projects\09630\096302011\GS\Hydrogeology Review\Everett Railroad\S2-0121 Reservoir Road\Everett Railroad Hydro Report Final 03-05-19.docx

**FIGURES**

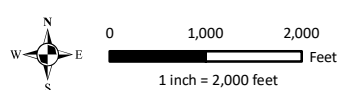


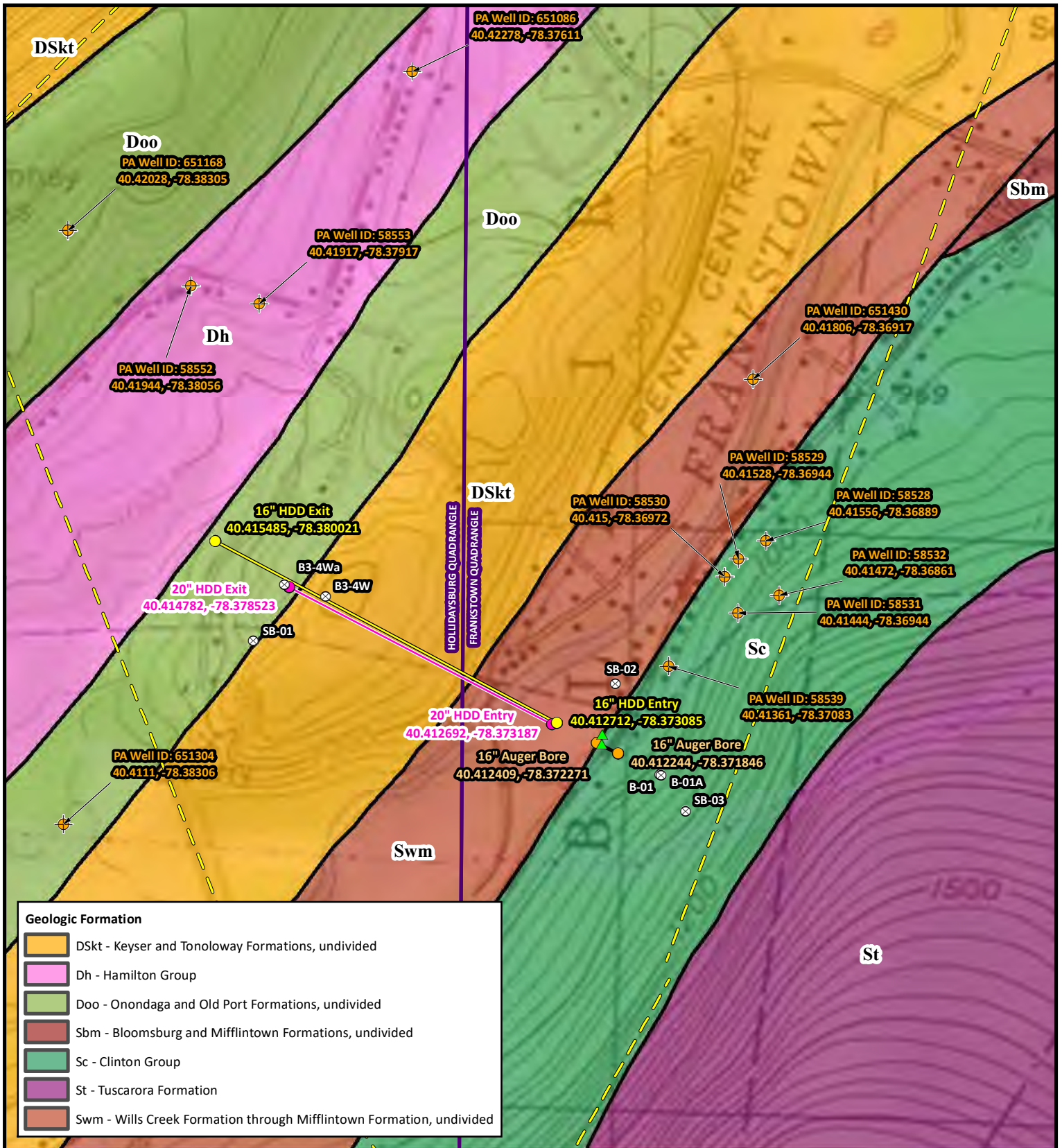
**Sunoco Pipeline, L.P.**  
**Everett Railroad/Reservoir Road**

**Figure 1 - Topographic Basemap**

Blair Township, Blair County, PA  
 Project No. 096302011

- 16" Auger Bore     — 16" Auger Bore
- 16" HDD Entry/Exit     — 16" HDD Profile
- 20" HDD Entry/Exit     — 20" HDD Profile

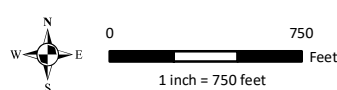




- ▲ Inadvertent Return
- ⊕ Residential Well
- ⊗ Soil Boring
- 16" Auger Bore
- 16" HDD Entry/Exit
- 20" HDD Entry/Exit
- Inferred Fracture Trace
- 16" Auger Bore
- 16" HDD Profile
- 20" HDD Profile

**Sunoco Pipeline, L.P.**  
**Everett Railroad/Reservoir Road**

**Figure 2 - Geologic Map**  
 Blair Township, Blair County, PA  
 Project No. 096302011

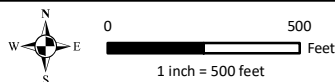




- |  |                    |  |                         |
|--|--------------------|--|-------------------------|
|  | Inadvertent Return |  | 16" Auger Bore          |
|  | Soil Boring        |  | 16" HDD Profile         |
|  | 16" Auger Bore     |  | 20" HDD Profile         |
|  | 16" HDD Entry/Exit |  | Inferred Fracture Trace |
|  | 20" HDD Entry/Exit |  | NHD Stream              |
|  | Residential Well   |  | Municipal Boundary      |

**Sunoco Pipeline, L.P.**  
**Everett Railroad/Reservoir Road**

**Figure 3 - Aerial Basemap**  
 Blair Township, Blair County, PA  
 Project No. 096302011



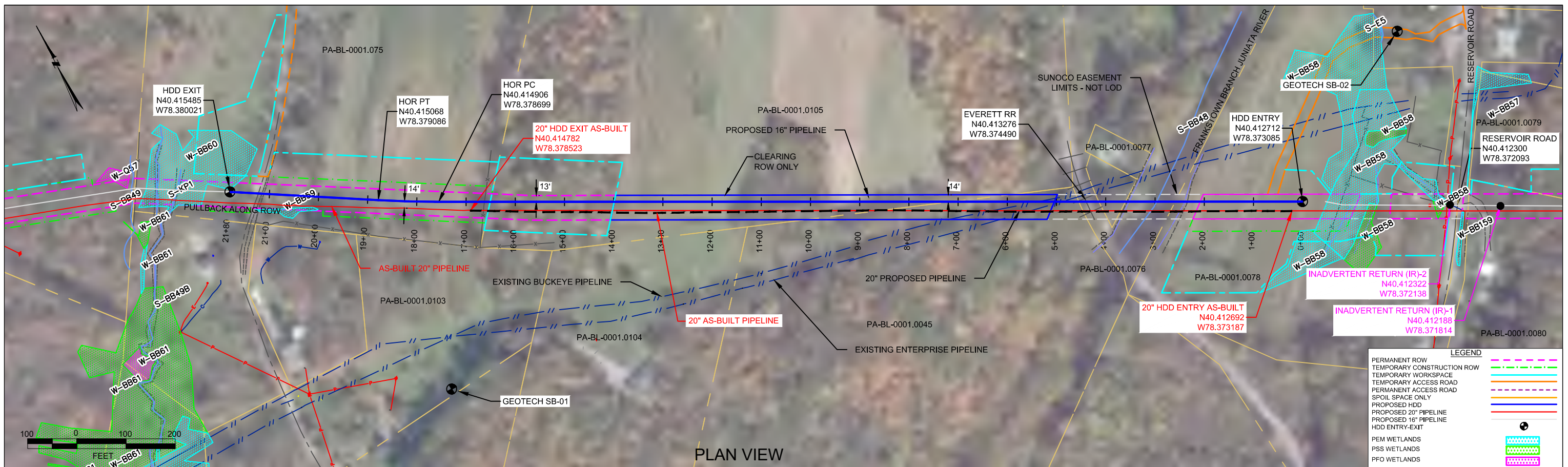
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



3/1/2019

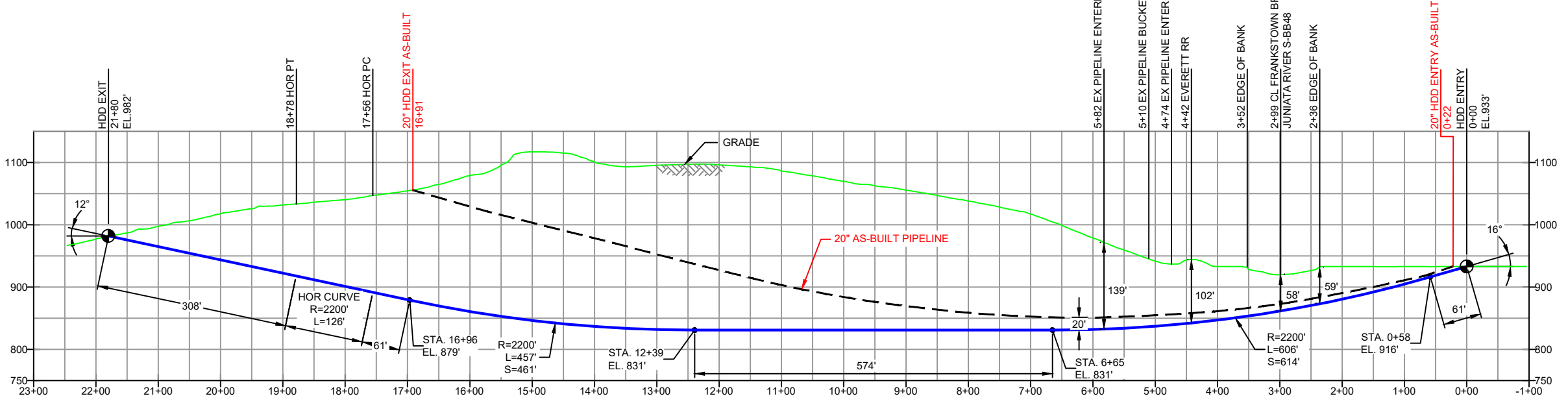
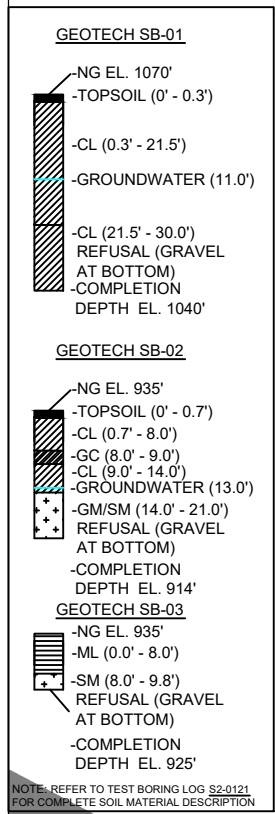


**ATTACHMENT 1**  
**HDD PROFILES AND GEOTECHNICAL BORING LOGS**



BLAIR COUNTY, PENNSYLVANIA - BLAIR TOWNSHIP  
S2-0121-16

PLAN VIEW  
PROFILE VIEW



- DESIGN AND CONSTRUCTION:**
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
  - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
  - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
  - CROSSING PIPE SPECIFICATION:  
HDD HORZ. LENGTH (L=): 2180'  
HDD PIPE LENGTH (S=): 2205'  
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW  
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCURE R95)
  - INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
  - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
  - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
  - CARRIER PIPE NOT ENCASED.
  - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
  - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
  - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
  - BLASTING NOT PERMITTED.
  - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
  - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
  - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

**NOTES**

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP. FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-3.32	TO	ES-3.34	DESCRIPTION
SHEET 20	TO	SHEET 20	AERIAL SITE PLAN
		EP9	RELOCATED DRILL ENTRY
		EP8	DESIGN CHANGE PER DPS
		EP7	RELOCATED DRILL ENTRY/EXIT - DESIGN CHANGE PER ENVIRONMENTAL
		EP6	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP
		EP5	ATWS USE RESTRICTION NOTE ADDED ON EAST SIDE OF DRILL
		EP4	ATWS ADDED ON EAST SIDE OF DRILL
DWG NO	DWG NO	NO.	DESCRIPTION

BY	DATE	CHK	DATE	APP	DATE
MRS	02/04/19	RMB	02/04/19	CAG	02/04/19
MRS	01/16/19	RMB	01/16/19	CAG	01/16/19
MRS	11/29/18	RMB	11/29/18	CAG	11/29/18
MRS	04/10/18	RMB	04/10/18	CAG	04/10/18
MRS	03/28/18	RMB	03/28/18	CAG	03/28/18
MRS	02/21/18	RMB	02/21/18	CAG	02/21/18

**Sunoco Logistics Partners L.P.**

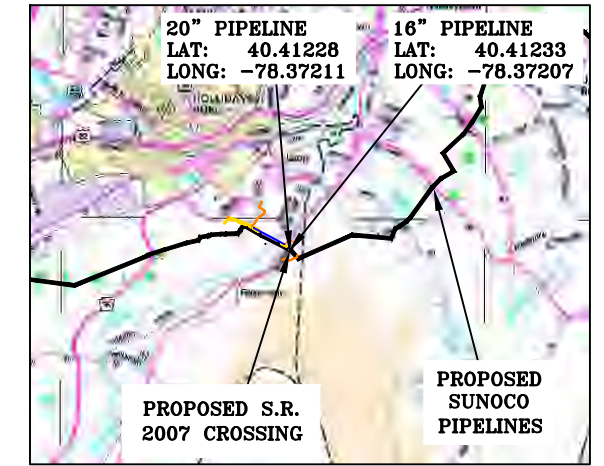
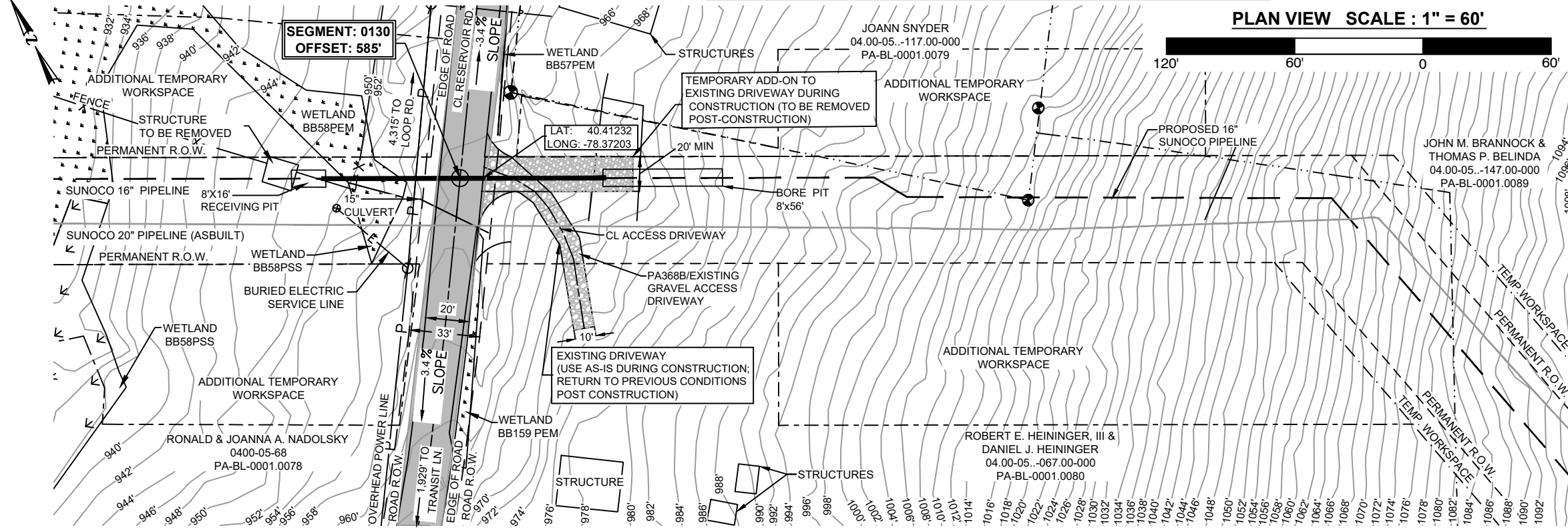
**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

HORIZONTAL DIRECTIONAL DRILL  
EVERETT RR/ RESERVIOR RD  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'  
DWG. NO. PA-BL-0001.0048-RR-16

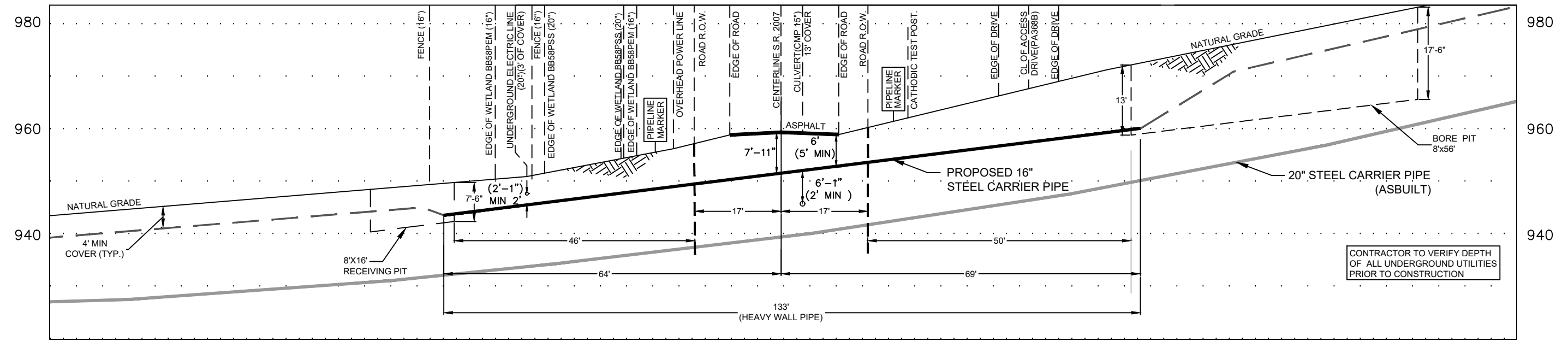
**BLAIR TOWNSHIP, BLAIR COUNTY, PENNSYLVANIA**



**DRAWING LEGEND**

	PERMANENT R.O.W.
	TEMPORARY WORKSPACE
	ROAD R.O.W.
	POWER POLE
	OVERHEAD POWER LINE
	ADDITIONAL TEMPORARY WORKSPACE
	PROPERTY LINE
	MONUMENT/HDD EXIT
	ELECTRIC LINE
	LIGHT POLE
	PIPELINE
	GRAVEL COVER

**RESERVOIR ROAD / S.R. 2007**



- ROAD NOTES**  
(APPLIES TO 16" PIPELINE)
- 16" WELDED STEEL PIPE 16" OD x .438 WT., X-70, API 5L, PSL2, ERW, BFW
  - COATING: 14-16 MILS OF 3M SCOTCHKOTE TM 6233 FBE WITH 40 MILS MIN. DFT POWERCRETE R95
  - DESIGN FACTOR: 0.50 (HOOP STRESS)
  - DESIGN PSI: 1480 PSIG TEST PSI: 1850
  - WELDING PROCESSES: ALL WELDING IS DONE IN ACCORDANCE TO PENNDOT AND APPROVED SUNOCO PROCEDURES.
  - THE COATING ON THE CARRIER PIPE SHALL BE INSPECTED IMMEDIATELY PRIOR TO ITS INSTALLATION AND ALL DAMAGED COATING SHALL BE REPAIRED IN ACCORDANCE WITH SUNOCO PIPELINE SPECIFICATIONS
  - PIPELINE CROSSING SHALL BE AS NEAR TO PERPENDICULAR TO THE ROADWAY CENTERLINE AS PRACTICAL
  - INSTALL CATHODIC PROTECTION TEST LEADS AS SPECIFIED ON THE ALIGNMENT SHEETS OR SUNOCO CORROSION TECHNICIAN
  - WELDED JOINTS INSIDE R.O.W. SHALL BE 100% X-RAYED
  - PENNDOT LEGAL RIGHT OF WAY WIDTH 33'
  - BORE LENGTH: +/- 102'-10" (16") (APPROX).

- CONSTRUCTION NOTES**
- CONTRACTOR WILL MAINTAIN 4' OF COVER TO THE TOP OF PIPE OUTSIDE OF ROAD R.O.W. USING FIELD BENDS
  - CONTRACTOR SHALL USE THE "ONE CALL" SYSTEM PRIOR TO BEGINNING WORK. CONTRACTOR SHALL BE RESPONSIBLE TO LOCATE AND VERIFY ALL PARALLEL AND CROSSED UTILITIES PRIOR TO EXCAVATION OR CONSTRUCTION (AND MONITOR DURING EXCAVATION OR CONSTRUCTION). THIS DRAWING SHALL NOT CONSTITUTE VERIFICATION OF LOCATION, QUANTITY, SIZE, DEPTH, OR TYPES OF EXISTING UTILITIES.
  - EMERGENCY CONTACT INFORMATION: SEE INCLUDED COMPANY INFORMATION
  - UPON COMPLETION, UTILITY WILL BE REGISTERED WITH PENNSYLVANIA ONE-CALL SYSTEM
  - ALL WORK AND MATERIALS SHALL CONFORM WITH PENNDOT AND ALL FEDERAL REGULATIONS AND STANDARDS
  - SUNOCO PIPELINE, L.P. WILL BE AVAILABLE 24/7 FOR EMERGENCY AT 800-786-7440 IF SUCH A PROBLEM SHOULD ARISE.
  - THIS PLAN IS FOR PERMITTING PURPOSES ONLY

- PER PUBLICATION 16M; DESIGN MANUAL PART 5, CHAPTER 1.3.D FOR UNCASD PIPELINE:**
- CATHODIC PROTECTION TEST LEADS ARE INSTALLED AS SPECIFIED ON THE ALIGNMENT SHEETS PER SUNOCO'S CORROSION PROGRAM.
  - PLASTIC PIPE WILL NOT BE USED; ONLY WELDED STEEL.
  - DUCTILE IRON OR REINFORCED CONCRETE WILL NOT BE USED; ONLY WELDED STEEL.
  - THE WALL THICKNESS SHOWN ON THE DRAWINGS MEET OR EXCEED ALL APPLICABLE FEDERAL AND INDUSTRY STANDARDS.
  - THE OPERATING STRESS LEVELS INDICATED ON THE DRAWINGS ARE IN ACCORDANCE WITH THE FEDERAL PIPELINE SAFETY REGULATIONS.

**PROFILE**  
HORIZ. SCALE : 1" = 20'  
VERT. SCALE : 1" = 20'

**COORDINATE SYSTEM**  
PENNSYLVANIA STATE PLANE SOUTH NAD 83 US FEET  
R.O.W. INGRESS  
X=1795255.37  
Y=393665.87  
R.O.W. EGRESS  
X=1795284.82  
Y=393650.60

**24/7 CONTACT INFO & PIPE MARKER INFO:**  
**SUNOCO PIPELINE L.P.**  
525 FRITZTOWN ROAD  
SINKING SPRING, PA 19608  
PHONE NUMBER: 800-786-7440  
NATURAL GAS PIPELINE  
CENTERLINE REV DATE: 05-04-2016

PA368B DRIVEWAY EPS APP#: 106403  
ROAD CROSSING EPS APP#: 103204

**SUNOCO**  
RESERVOIR ROAD / S.R. 2007  
BLAIR TOWNSHIP, BLAIR CO., PA

03/31/15	SCALE	AS SHOWN
REVISED	AS NOTED	DWG #: PPP-PA-BL-0001.0078-RD-16
02/25/19		

Prepared by **TETRA TECH ROONEY**

**A**



**LEGEND:**

⊙ Geotechnical Soil Boring (SB) Locations



**TETRA TECH**

GEOTECHNICAL BORING LOCATIONS  
 HDD S2-0121  
 BLAIR COUNTY, BLAIR TOWNSHIP, PA  
 SUNOCO PENNSYLVANIA PIPELINE PROJECT

**TETRA TECH**

240 Continental Drive, Suite 200  
 Newark, Delaware 19713  
 302.738.7551  
 fax: 302.454.5988

**TEST BORING LOG**

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT	Project No.:	103IP3406
Project Location:	t396, HOLLIDAYSBURG, PA	Page 1 of 1	
HDD No.:	S2-0121	Dates(s) Drilled:	04-22-15
Boring No.:	SB-01	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	S. HOFFER
		Groundwater Depth (ft):	11.0
		Total Depth (ft):	30.0
Boring Location Coordinates:	40° 24' 50.193" N	78° 22' 45.249" W	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.3			TOPSOIL (4")						
1	3.0	5.0	0.3		13	CL	MOTTLED (SHADES OF BROWN) SILTY CLAY WITH SOME FINE SAND, TRACE FINE GRAVEL.	2	5	5	5	10	
2	8.0	10.0			19		BROWN SILTY CLAY WITH A LITTLE FINE SAND, TRACE FINE GRAVEL.	2	3	3	6	6	
3	13.0	15.0			24		MOTTLED (RED, LIGHT GRAY, BROWN) SILTY CLAY (USCS: CL)	2	4	8	11	12	
4	18.0	20.0			24		LIGHT BROWN SILTY CLAY, TRACE F-C GRAVEL	1	3	5	9	8	
				21.5									
5	23.0	25.0	21.5		18		CL	LIGHT BROWN, GRAY, REDDISH BROWN, SILTY CLAY WITH SOME FINE SAND, WITH A LITTLE F-C SHALE FRAGMENTS (USCS: CL)	2	6	10	11	16
6	28.0	30.0			18	LIGHT BROWN, GRAY, REDDISH BROWN, SILTY CLAY WITH SOME FINE SAND, WITH A LITTLE F-C SHALE FRAGMENTS .		11	14	17	13	31	
				30.0									
							WET ON SPOON AT 19'						
							WATER LEVEL THRU AUGERS AT 11'.						
							CAVED AT 26', WATER LEVEL ON CAVE AT 12'.						

Notes/Comments:  
Pocket Pentrometer Testing  
 S1: 2.5 TSF      15': > 4 TSF  
 8': 1.5 TSF      19': 3.25 TSF  
 10': 0.75 TSF    20': 1.75 TSF  
 13': 1.0 TSF     24': 2.5 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

\* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.  
 N: Number of blows to drive spoon from 6" to 18" interval.



**TETRA TECH**

240 Continental Drive, Suite 200  
 Newark, Delaware 19713  
 302.738.7551  
 fax: 302.454.5988

**TEST BORING LOG**

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: RESERVOIR ROAD, HOLLIDAYSBURG, PA			Page 1 of 1		
HDD No.: S2-0121		Dates(s) Drilled: 04-22-15		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 13.0		Total Depth (ft): 21.0	
Boring Location Coordinates:			40° 24' 47.940" N		78° 22' 18.857" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.7			TOPSOIL (8")						
1	3.0	5.0	0.7		19	CL	MOTTLED (REDDISH BROWN, BROWN, GRAY) SILTY CLAY WITH SOME FINE SAND.	1	5	5	10	10	
			8.0	9.0		GC	CLAYEY GRAVEL LENSE (ANGULAR QUARTZ, FINE TO COARSE)						
2	8.0	10.0	9.0		10	CL	MOTTLED BROWN AND GRAY SILTY CLAY WITH SOME FINE SAND, TRACE TO LITTLE FINE TO COARSE GRAVEL. (USCS: CL)	22	22	10	12	32	
			14.0										
3	13.0	14.7	14.0		17	GM/SM	DARK GRAY DECOMPOSED LIMESTONE, WEATHERED TO A F-C GRAVEL, SOME F-M SAND, SOME SILT.	8	9	40	50/2"	49	
4	18.0	18.5			4	GM/SM	DARK GRAY DECOMPOSED LIMESTONE, WEATHERED TO A F-C GRAVEL, SOME F-M SAND, SOME SILT.	50/6"				>50	
			21.0										
							AUGER REFUSAL AT 21'.						
							WET ON SPOON AT 14'						
							WATER LEVEL THROUGH AUGERS AT 13'						
							CAVED AT 14', WATER LEVEL ON CAVE AT 9'.						

Notes/Comments:  
Pocket Pentrometer Testing  
 4': 3.5 TSF  
 9': > 4 TSF

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

\* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.  
 N: Number of blows to drive spoon from 6" to 18" interval.



**TETRA TECH**

240 Continental Drive, Suite 200  
 Newark, Delaware 19713  
 302.738.7551  
 fax: 302.454.5988

**TEST BORING LOG**

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: RESERVOIR ROAD, HOLLIDAYSBURG, PA			Page 1 of 1		
HDD No.: S2-0121		Dates(s) Drilled: 09-12-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: M.HYNES	
Drilling Contractor: HYNES		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 9.8	
Boring Location Coordinates:			40° 24' 40.873" N		78° 22' 13.688" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
							NO TOPSOIL						
1	3.0	5.0	0.0		9	ML	FILL: MATRIX OF SILT, FINE TO MEDIUM SAND, FINE TO COARSE GRAVEL. (USCS: ML).	6	3	3	8	6	
2	8.0	9.8		9.8	14	SM	ORANGE BROWN, LIGHT BROWN, AND LIGHT GRAY FINE TO MEDIUM SAND AND SILT, WITH A LITTLE F-C GRAVEL. (POTENTIAL FILL).	8	12	23	50/3"	35	
							AUGER REFUSAL AT 10'.						
							FIVE ATTEMPTS WERE MADE TO DRILL THROUGH FILL ZONE WITH NO SUCCESS (ATTEMPTS WERE MADE ALONG EDGE OF ACCESS ROAD). DEEPEST AT THESE ATTEMPTS WAS 3' BEFORE HITTING REFUSAL. DECISION BY TT/REI WAS TO ABANDON THIS LOCATION.						

Notes/Comments:  
Pocket Pentrometer Testing

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

\* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.  
 N: Number of blows to drive spoon from 6" to 18" interval.



**REGIONAL GEOLOGY SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S2-0121**

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S2-0120		SB-02	<b>Keyser/Tonoloway Fm</b> -dark-gray, highly fossiliferous, crystalline to nodular limestone with shaly limestone near its top. <b>Wills Creek Fm</b> -variegated gray, grayish-red, yellowish-gray and greenish-gray calcareous shale with interbedded limestone, dolomite, and sandstone zones	Upland to mid-ridge	Keyser / Tonoloway Fm- Wills Creek Fm	Shale - calcareous shale-siltston- limestone-dolomite (Tonoloway) to Claystone-silty claystone- argillaceous limestone (Wills)	400	3-13	
S2-0121	Reservoir Road	SB-01	<b>Onondaga and Old Port Formation</b> (undivided) consists of two members - the upper Selinsgrove Limestone and the lower calcerous Needmore Shale.	Ridge & Valley	Onondaga-Old Port	Limestone and calcareous shale with occasional chert	100-200	4-32	
		SB-02	<b>Wills Creek Fm</b> -variegated gray, grayish-red, yellowish-gray and greenish-gray calcareous shale with interbedded limestone, dolomite, and sandstone zones		Wills Creek Fm	Calcareous shale	445-620	12-28	
		SB-03	<b>Clinton Group</b> -contains the Keefer and Rose Hill Formations. The <u>Keefer Formation</u> is a light-gray to yellowish-brown, very fine to coarse-grained, fossiliferous, siliceous sandstone that is locally hematitic or conglomeratic. It is well bedded with beds thin to thick and crossbedded. It is about 24 to 55 feet thick. The <u>Rose Hill Formation</u> is a light-olive-gray shale, with some siltstone and two grayish-red to reddish-black sandstone units. The upper shale contains interbedded limestone.		Clinton Group (Keefer and Rose Hill Fms)	sandstone to siltstone (Keefer) to shale with siltston (Rose Hill)	890	12-28	

*Note* : Source of well log data - <http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm>. All other sources as referenced in comments section.

**GEOTECHNICAL LABORATORY TESTING SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S2-0121**

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S2-0120	SB-02	1	3.0	5.0	6.5	17.0	-	-	-	-
		3	13.0	15.0	10.8	11.0	-	-	-	-
		4	18.0	20.0	6.1	20.0	-	-	-	-
		5	23.0	25.0	13.4	33.3	-	-	-	-
		6	28.0	30.0	7.7	19.2	-	-	-	-
S2-0121	SB-01	1	3.0	5.0	20.9	76.5	-	-	-	-
		2	8.0	10.0	18.6	82.9	-	-	-	-
		3	13.0	15.0	20.1	99.4	38	20	19	CL
		4	18.0	20.0	31.7	95.7	-	-	-	-
		5	23.0	25.0	24.6	73.2	41	24	17	CL
	SB-02	1	3.0	5.0	15.7	71.6	-	-	-	-
		2	8.0	10.0	15.3	74.7	39	22	17	CL
		3	13.0	14.7	7.9	25.0	-	-	-	-
		4	18.0	18.5	3.7	18.3	-	-	-	-
	SB-03	1	3.0	5.0	17.2	69.9	31	24	7	ML
2		8.0	9.8	5.1	39.7	-	-	-	-	

**Notes:**

- 1) Sample depths based on feet below grade at time of exploration.

# FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

## GRANULAR SOILS

(Sand, Gravel & Combinations)

<u>Density</u>	<u>N (blows)*</u>
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 or more

### Particle Size Identification

Boulders	8 in. diameter or more
Cobbles	3 to 8 in. diameter
Gravel	Coarse (C) 3 in. to ¾ in. sieve Fine (F) ¾ in. to No. 4 sieve
Sand	Coarse (C) No. 4 to No. 10 sieve (4.75mm-2.00mm) Medium (M) No. 10 to No. 40 sieve (2.00mm – 0.425mm) Fine (F) No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)

### Relative Proportions

<u>Description Term</u>	<u>Percent</u>
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

## COHESIVE SOILS

(Silt, Clay & Combinations)

<u>Consistency</u>	<u>N (blows)*</u>
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

### Plasticity

<u>Degree of Plasticity</u>	<u>Plasticity Index</u>
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	> 22

## ROCK

(Rock Cores)

<u>Rock Quality Designation (RQD), %</u>	<u>Rock Quality Description</u>
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

**\*N - Standard Penetration Resistance.** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

**Groundwater** observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

**UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]**

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications		
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve size	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3  Not meeting $C_u$ or $C_c$ requirements for GW  Atterberg limits below A Line or $I_p$ less than 4  Atterberg limits above A line with $I_p$ greater than 7  Limits plotting in hatched zone with $I_p$ between 4 and 7 are borderline cases requiring use of dual symbols	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		
			GC	Clayey gravels, gravel-sand-clay mixtures		
			Clean sands (Little or no fines)	SW		Well graded sands, gravelly sands, little or no fines
				SP		Poorly graded sands, gravelly sands, little or no fines
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows:  Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols <sup>(1)</sup>	
			SC	Clayey sands, sand-clay mixtures		
		Clean sands (Little or no fines)	C <sub>u</sub> = $\frac{D_{60}}{D_{10}}$ greater than 6 C <sub>c</sub> = $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	Not meeting C <sub>u</sub> or C <sub>c</sub> requirements for SW		
				Atterberg limits below A Line or I <sub>p</sub> less than 4		
			Limits plotting in hatched zone with I <sub>p</sub> between 4 and 7 are borderline cases requiring use of dual symbols	Atterberg limits above A line with I <sub>p</sub> greater than 7		
				Atterberg limits below A Line or I <sub>p</sub> less than 4		
Limits Plotting in hatched zone with I <sub>p</sub> between 4 and 7 are borderline cases requiring use of dual symbols	Atterberg limits above A line with I <sub>p</sub> greater than 7					
	For soils plotting nearly on A line use dual symbols i.e., I <sub>p</sub> = 29.5, w <sub>L</sub> = 60 gives CH-MH. When w <sub>L</sub> is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.					
Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications		
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt and clays (Liquid limit less than 50)	ML	inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		OL	Organic silts and organic silty clays of low plasticity			
	Silt and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
		CH	Inorganic clays of high plasticity, fat clays			
		OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils	Pt	Peat and other highly organic soils			

(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example GW-GC. well-graded gravel-sand mixture with clay binder.

October 16, 2017



Directional Project Support, Inc.  
33311 Lois Lane, Suite A  
Magnolia, TX 77354

Attn: Mr. Robert Sessions  
P: (318) 542 6657  
E: fielduspl@hotmail.com

Re: Geotechnical Site Characterization  
Mariner East 2 Pipeline Project  
Spread 3 – Everett RR  
Commonwealth of Pennsylvania  
Drawing # PA-BL-0001.0048-RR  
PO # 20170811-2  
Terracon Project No. J217P078

Dear Mr. Sessions:

This letter provides a summary of the bedrock characterization for the Mariner East 2 Pipeline Project crossing to be located at Everett RR (Drawing # PA-BL-0001.0048-RR) in the Commonwealth of Pennsylvania. Our services were performed in general accordance with our proposal number PJ2175108 dated July 28, 2017. Our scope of services included advancing two borings, designated as B3-4W and B3-4Wa, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test boring B3-4W was drilled and terminated at 71.0 feet on August 24, 2017. The boring was relocated to B3-4Wa which was drilled between September 13 and 16, 2017 to 300.0 feet. Test boring locations are shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of sedimentary rock comprised of limestone over residual mudstone. Final test boring logs documenting overburden soil and bedrock conditions as well as photographs of the rock core samples are attached.

Rock compressive strength testing was performed on samples from approximately 20-foot intervals within the bedrock strata at B3-4Wa. As an exception to the planned 20-foot intervals, rock samples from 226 feet to 256 feet were not tested due to highly weathered conditions. Unconfined compressive strength test results are shown on the attached reports.

**Geotechnical Site Characterization**

Mariner East 2 Pipeline – Spread 3 Everett RR ■ Pennsylvania

Drawing # PA-BL-0001.0048-RR / PO #20170811-2

October 16, 2017 ■ Terracon Project No. J217P078



When laboratory soil testing results are available, we will submit a complete data report for the subject crossing. In the meantime, if you have questions, or if we may be of further service, please contact us.

Sincerely,

**Terracon Consultants, Inc.**

A handwritten signature in blue ink, appearing to read "Lawrence J. Dwyer", is written over a light blue horizontal line.

Marc A. Gullison, E.I.T.  
Staff Geotechnical Engineer

Lawrence J. Dwyer, P.E. (CT 15120)  
Principal

Attch:

**TEST BORING LOCATION PLAN**

**EXPLORATION RESULTS** (Boring Logs, Laboratory Data, Rock Core Photographs)

**SUPPORTING INFORMATION** (Unified Soil Classification System, Description of Rock Properties)

## **TEST BORING LOCATION PLAN**



**APPROXIMATE  
BORING  
LOCATION**

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	JGS	Project No.	J217P078
Drawn by:	SBL	Scale:	N.T.S.
Checked by:	LJD	File Name:	J217P078 BLP
Approved by:	LJD	Date:	September, 2017



201 Hammer Mill Road Rocky Hill, Ct 06067  
PH. (860) 721-1900 FAX. (860) 721-1939

**TEST BORING LOCATION PLAN**

Everett RR HDD Cores B3-4W and B3-4Wa  
PA-BL-0001.0048-RR  
Blair County, Pennsylvania

Exhibit

**A-2**

## **EXPLORATION RESULTS**

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH									
5.0	<b>SANDY LEAN CLAY</b> , trace gravel and organic matter, brown, stiff, (Reworked soil/fill)	1111+/-		X	11	4-4-4 N=8			
9.0	<b>FAT CLAY (CH)</b> , with sand and weathered rock, brown, very stiff	1107+/-		X	13	7-9-13 N=22			
	Highly weathered MUDSTONE with sand and clay, orange-brown, dense	10		X	12	8-17-30 N=47			
	Similar, light gray and red	15		X	12	15-15-17 N=32			
		20		X	13	15-15-15 N=30			
	Similar, gray brown	25		X	16	17-17-24 N=41			
	Highly weathered SHALE, dark gray to black, dense	30		X	14	16-17-20 N=37			
		35							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

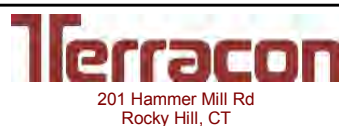
Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

- ▽ 100' on 9/14/17
- ▽ 105' on 9/15/17



Boring Started: 09-13-2017

Boring Completed: 09-16-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J217P078 - SPREAD 3 GPJ TERRACON\_DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

<b>GRAPHIC LOG</b>	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	<b>DEPTH (Ft.)</b>	<b>WATER LEVEL OBSERVATIONS</b>	<b>SAMPLE TYPE</b>	<b>RECOVERY (in.)</b>	<b>FIELD TEST RESULTS</b>	<b>RQD (%)</b>	<b>Core rate (min/ft)</b>	<b>Penetrometer Test (tsf)</b>
	<b>DEPTH</b>								

		40		X	12	15-12-30 N=42			
		45		X	14	18-40-69 N=109			
		50		X	8	65-100/5"			
		55		X	8	90-100/3"			
		60		X	8	75-100/4"			
		65		X	15	50-73-100/4"			
		70		X	16	35-47-75 N=122			

Highly weathered MUDSTONE, red and orange-brown, very dense

Highly weathered SHALE, dark gray to black, very dense

Stratification lines are approximate. In-situ, the transition may be gradual.

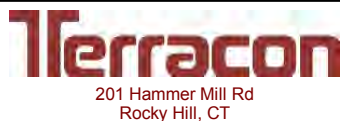
Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS
▽ 100' on 9/14/17 ▽ 105' on 9/15/17



Boring Started: 09-13-2017	Boring Completed: 09-16-2017
Drill Rig: CME-850	Driller: Terracon/Peter M.
Project No.: J217P078	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH									

75	Similar, interbedded with highly weathered brown and orange-brown mudstone from 74 to 77 feet	75		X	10	37-100/5"			
80		80		X	14	26-32-35 N=67			
85		85							
90		90		X	14	30-50-52 N=102			
95	Highly weathered MUDSTONE, orange-brown, very dense	95		X	4	100/5"			
100	Highly weathered SHALE, dark gray and black, very dense	100	▽	X	10	40-100/5"			
105	Similar, interbedded with sandstone	105	▽						

Stratification lines are approximate. In-situ, the transition may be gradual.

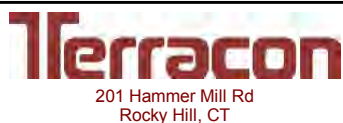
Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS	
▽	100' on 9/14/17
▽	105' on 9/15/17



Boring Started: 09-13-2017	Boring Completed: 09-16-2017
Drill Rig: CME-850	Driller: Terracon/Peter M.
Project No.: J217P078	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17



# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

<b>GRAPHIC LOG</b>	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- DEPTH _____ ELEVATION (Ft.) _____	<b>DEPTH (Ft.)</b>	<b>WATER LEVEL OBSERVATIONS</b>	<b>SAMPLE TYPE</b>	<b>RECOVERY (in.)</b>	<b>FIELD TEST RESULTS</b>	<b>RQD (%)</b>	<b>Core rate (min/ft)</b>	<b>Penetrometer Test (tsf)</b>
--------------------	---	--------------------	---------------------------------	--------------------	-----------------------	---------------------------	----------------	---------------------------	--------------------------------

145.0	Run 1, Moderately hard to hard, slightly to moderately weathered, gray to dark gray LIMESTONE with occasional calcite veins and interbedded calcareous shale, primary joint set, high angle, close spacing, slightly open to open, smooth, discolored to decomposed  Highly fractured from 143.2 to 143.8 feet	145			52		64	1 2 2 1.5 1.5	
150.0	Run 2, Similar	150			52		61	1.5 2 2 2 2	
155.0	Run 3, Similar, highly fractured from 152.5 to 152.8 feet	155			60		83	2.5 2 2 2 2	
160.0	Run 4, Similar	160			60		95	2.5 2 1.5 1.5 1.5	
165.0	Run 5, Similar, highly fractured from 161.6 to 162 feet	165			60		92	3 2.5 1.5 1.5 1.5	
170.0	Run 6, Similar	170			60		98	2 2 2 2 2	
175.0	Run 7, Similar	175			60		94	2.5 2 2 1.5 1.5	

Stratification lines are approximate. In-situ, the transition may be gradual.

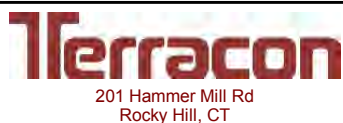
Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS
▽ 100' on 9/14/17 ▽ 105' on 9/15/17



Boring Started: 09-13-2017	Boring Completed: 09-16-2017
Drill Rig: CME-850	Driller: Terracon/Peter M.
Project No.: J217P078	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. - GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated  
Magnolia, TX 77354**

**SITE: Spread 3**

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH									
180.0	Run 8, Similar, no joints observed  936+/-	180			60		100	2 1.5 1.5 2 1.5	
185.0	Run 9, Moderately hard to hard, slightly to moderately weathered, gray to brown LIMESTONE with occasional calcite veins, primary joint set, moderately dipping to high angle, close to moderately close spacing, rough to smooth, discolored to decomposed, moderately open to open  931+/-	185			57.5		93	2 2 2 2 1.5	
190.0	Run 10, Void from 185 to 186.6 feet  Similar to Run 9, highly weathered, calcareous clay layer from 187.5 to 187.8 feet  926+/-	190			41		63	0.5 1.5 3 2 1.5	
195.0	Run 11, Void from 190.4 to 191.2 feet  Moderately hard to hard, moderately to highly weathered, light brown to brown LIMESTONE with occasional calcite veins, primary joint set, moderately dipping to high angle, close spacing, decomposed, open  921+/-	195			50.5		55	2.5 2.5 3.5 4 3.5	
200.0	Run 12, Moderately hard to hard, slightly weathered, gray LIMESTONE with occasional calcite veins, primary joint set, moderately dipping, moderately close spacing, smooth to rough, discolored, tight to slightly open  916+/-	200			60		100	3.5 3 3 2.5 2.5	
205.0	Run 13, Similar  911+/-	205			60		100	3.5 3.5 3 2.5 2	
210.0	Run 14, Similar, moderately close spacing  906+/-	210			60		100	3 2.5 2.5 2 2	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

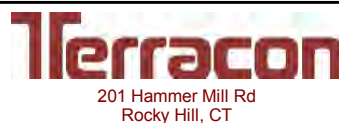
Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

- ▽ 100' on 9/14/17
- ▽ 105' on 9/15/17



Boring Started: 09-13-2017

Boring Completed: 09-16-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. - GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated  
Magnolia, TX 77354**

**SITE: Spread 3**

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH									
215.0	Run 15, Similar  901+/-	215			60		100	2.5 2.5 2 2	
220.0	Run 16, Similar to 215.2 feet  At 215.2 feet: Moderately hard to hard, slightly to highly weathered, gray to brown LIMESTONE with occasional calcite veins, primary joint set, high angle, close to moderately close spacing, rough, decomposed, moderately open to open  896+/-	220			51		68	3 2.5 2.5 1.5 2	
225.0	Run 17, Similar to 220.9 feet  At 220.9 feet: Soft, completely weathered, brown and gray MUDSTONE  891+/-	225			22		30	1.5 0 0.5 1 1	
230.0	Run 18, Similar, with a brown clayey fine to coarse sand layer from 225 to 226 feet  886+/-	230			49		52	0.5 1 2 0.5 0.5	
235.0	Run 19, Similar  881+/-	235			43		63	1.5 1.5 1.5 1 1	
240.0	Run 20, Similar to 237 feet  At 237 feet: Very soft to soft, highly weathered, red-brown MUDSTONE, no joints observed  876+/-	240			32		28	2.5 3 4 4.5 2	
245.0	Run 21, Soft to medium hard, moderately to highly weathered, red and orange-brown MUDSTONE, primary joint set, horizontal to moderately dipping, close to wide spacing, smooth, decomposed, tight to moderately open  871+/-	245			60		95	2.5 2 4 2.5 3	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

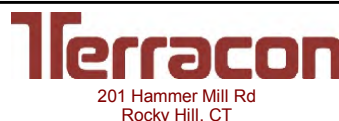
Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

- 100' on 9/14/17
- 105' on 9/15/17



Boring Started: 09-13-2017

Boring Completed: 09-16-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. - GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)								
DEPTH									
250.0	Run 22, Similar, with highly weathered layers 866+/-	250			60		74	4.5 2.5 2.5 2.5 2.5	
255.0	Run 23, Similar 861+/-	255			56.5		73	4 3 3 2 2.5	
260.0	Run 24, Similar, completely weathered from 255 to 256.4 feet 856+/-	260			44		36	3 2 3.5 2.5 2.5	
265.0	Run 25, Soft to medium, moderately to highly weathered, red to purple to orange-brown and white MUDSTONE, primary joint set, horizontal to low angle, close to moderately close spacing, smooth, discolored, slightly to moderately open 851+/-	265			60		97	3 2.5 2 2 2	
270.0	Run 26, Soft to medium, moderately to highly weathered, red to purple to orange-brown and white MUDSTONE interbedded with occasional sandstone, primary joint set, horizontal to low angle, close to moderately close spacing, rough to smooth, discolored to decomposed, moderately open to open 846+/-	270			33		40	3 2.5 2.5 1 1.5	
275.0	Run 27, Similar 841+/-	275			42		55	3 1.5 1.5 2 2.5	
280.0	Run 28, Similar 836+/-	280			12		0	3 2 1.5 1 1	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

- ▽ 100' on 9/14/17
- ▽ 105' on 9/15/17



Boring Started: 09-13-2017

Boring Completed: 09-16-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4Wa Everett RR West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated  
Magnolia, TX 77354**

**SITE: Spread 3**

<b>GRAPHIC LOG</b>	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.41482° Longitude: -78.37862°  Approximate Surface Elev: 1116 (Ft.) +/- DEPTH _____ ELEVATION (Ft.) _____	<b>DEPTH (Ft.)</b>	<b>WATER LEVEL OBSERVATIONS</b>	<b>SAMPLE TYPE</b>	<b>RECOVERY (in.)</b>	<b>FIELD TEST RESULTS</b>	<b>RQD (%)</b>	<b>Core rate (min/ft)</b>	<b>Penetrometer Test (tsf)</b>
--------------------	---	--------------------	---------------------------------	--------------------	-----------------------	---------------------------	----------------	---------------------------	--------------------------------

285.0	Run 29, Similar to 280.7 feet  At 280.7 feet: Soft to medium, moderately to highly weathered, red to purple to orange-brown and white MUDSTONE interbedded with occasional sandstone, primary joint set, low angle to moderately dipping, close to moderately close spacing, smooth, discolored to decomposed, slightly open to open	285					NR	3 2 2 2	
290.0	Run 30, Similar	290		53			88	2.5 1.5 1 1 1.5	
295.0	Run 31, Similar	295		34			40	2 2 1 1 1	
300.0	Run 32, Similar, except weakly cemented sandstone layer from 295 to 295.6 feet	300		7			0	3 3 3 2.5 2	

**Boring Terminated at 300 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:  
NR - Not recorded

WATER LEVEL OBSERVATIONS
▽ 100' on 9/14/17
▽ 105' on 9/15/17



Boring Started: 09-13-2017	Boring Completed: 09-16-2017
Drill Rig: CME-850	Driller: Terracon/Peter M.
Project No.: J217P078	Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4W Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.414642° Longitude: -78.377782°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
0.3	Topsoil	1115.5+/-							
	<b>GRAVELLY LEAN CLAY (CL)</b> , trace sand, trace organic matter, dark brown, very stiff								
8.5	Weathered rock, brown to gray, friable  Begin rock core at 16 feet	1107.5+/-			8	4-8-8 N=16			
16.0	Run 1, Hard, moderately weathered, gray, argillaceous LIMESTONE, thin to medium bedding, primary joint set: high angle, close to very close spacing, slightly open, smooth, planar, iron stained joints, secondary joint set: low angle, moderately close, open, rough, planar, fresh  At 19.8 to 21 feet, lost recovery, washed out, probable completely weathered interbedded shale/claystone	1100+/-			14	30-49-40 N=89			
21.0	Run 2, Similar	1095+/-			13	22-28-25 N=53			
26.0	Run 3, Hard, slightly weathered, brown to gray, argillaceous LIMESTONE, thin to medium bedding, primary joint set: high angle, close to very close spacing, slightly open, rough, planar, iron stained joints; secondary joint set: low angle, moderately close to close, open to slightly open, rough, planar, fresh	1090+/-			46		15	1 1.75 1.5 2 1.75	
					53		38	1.5 1 1 .75 1	
					60		72	1 1 1.25 1 1	
		30							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

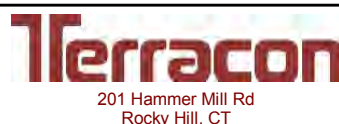
Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

54.5' AB



Boring Started: 08-24-2017

Boring Completed: 08-24-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-2

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J217P078 - SPREAD 3 GPJ TERRACON\_DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4W Everett RR West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated  
Magnolia, TX 77354**

**SITE: Spread 3**

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.414642° Longitude: -78.377782°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Approximate Surface Elev: 1116 (Ft.) +/-								
	DEPTH ELEVATION (Ft.)								
31.0	1085+/-				60				
	Run 4, Similar							1 1.25 1 1 1.25	
36.0	1080+/-	35			60		65		
	Run 5, Similar								
	At 39 to 39.4 feet, lost recovery, washed out, probable weathered interbedded shale				55		65	1 1.25 1 1.25 1	
41.0	1075+/-	40							
	Run 6, Similar to above								
	At 42.7 to 43 feet, highly fractured zone				60		73	1.25 1.5 1.25 1 1.25	
46.0	1070+/-	45							
	Run 7, Similar								
	At 47 feet: Hard, severely weathered, gray, argillaceous LIMESTONE, thin to medium bedding, primary joint set: high angle, very close to close spacing, open, rough, planar, iron stained joints				56		23	1.25 1.25 1 1.25 1	
51.0	1065+/-	50							
	At 48.2 to 48.8, 49.9 to 50.6 and 51 to 51.6 feet: highly fractured zones At 50.6 to 51 feet: lost recovery-washed out, probable completely weathered shale								
	Run 8, Similar								
	At 51.6 to 55 feet: encounterd void, probable karst zone				18		10	1.5 1.5 1.25 1.25 6	
56.0	1060+/-	55	▽						
	Run 9, Hard, moderately weathered, gray, argillaceous LIMESTONE, thin to medium bedding, primary joint set: high angle, close to moderately close spacing, open to slightly open, rough, planar, clay-filled, iron stained joints				60		47	1.25 0 0 0 2	
	At 60.5 to 61 feet: highly fractured zone	60							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

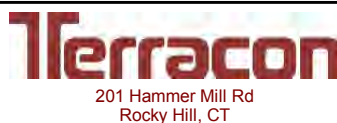
Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

▽ 54.5' AB



Boring Started: 08-24-2017

Boring Completed: 08-24-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-2

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# BORING LOG NO. B3-4W Everett RR West

**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated  
Magnolia, TX 77354

**SITE:** Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0048-RR 20170811-2 Latitude: 40.414642° Longitude: -78.377782°  Approximate Surface Elev: 1116 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH	ELEVATION (Ft.)								
61.0	1055+/-				60				
Run 10, Similar								3 1.75 1.75 1.5 2	
66.0	1050+/-	65			60		52		
Run 11, Similar									
At 66 to 67.4 feet: vuggy zone									
At 67.8 to 68.5 feet: highly fractured zone									
71.0	1045+/-	70			60		66	2 2.75 1.75 1.75 2.5	
<b>Boring Terminated at 71 Feet</b>									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:  
Mud rotary with wireline

Abandonment Method:  
Grouted to surface

Notes:

**WATER LEVEL OBSERVATIONS**

54.5' AB



Boring Started: 08-24-2017

Boring Completed: 08-24-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-2

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL - J217P078 - SPREAD 3.GPJ TERRACON DATATEMPLATE.GDT 10/13/17

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

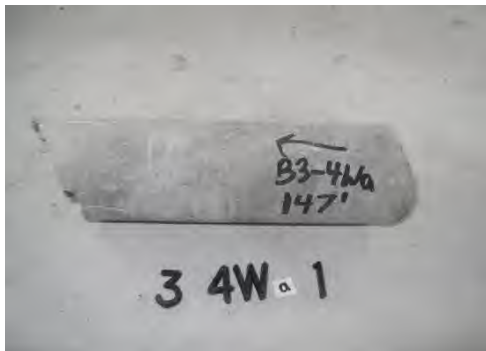
Boring No.: B3-4Wa  
 Sample No.: 1  
 Sample Depth: 147 feet  
 Sampling Date: 9/13/17

Lithology : Limestone  
 Moisture Content : As received  
 Lab Temperature : 70° F  
 Loading Rate: 55 psi/s  
 Time to Failure: 3 min

Diameter: 1.96 in  
 Length: 4.29 in  
 L/D: 2.19  
 End Area: 3.02 in<sup>2</sup>

Maximum Axial Load at Failure: 9,510 lb  
 Compressive Strength: 3,152 psi  
 Compressive Strength: 21.73 Mpa  
 Unit Weight 166 pcf


Before the Test



After the Test



Drawing # : PA-BL-0001.0048-RR  
 PO # : 20170811-2  
 Crossing : Everett RR  
 Spread : Spread 3

Project:	Mariner East Pipeline	 77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Performed by:	C. Santana
Project No:	J217P078		Test Date:	10/16/2017
Location:	Spread 3		Reviewed By :	L. Dwyer
Client :	Directional Project Support Inc.		Review Date :	10/16/2017

*The information contained in this report may not be reproduced except in its entirety without the express written consent of Terracon, Inc. Reports are relevant only to the items tested and may not be attributed to other work. Testing was performed in general accordance with the stated ASTM test method.*

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

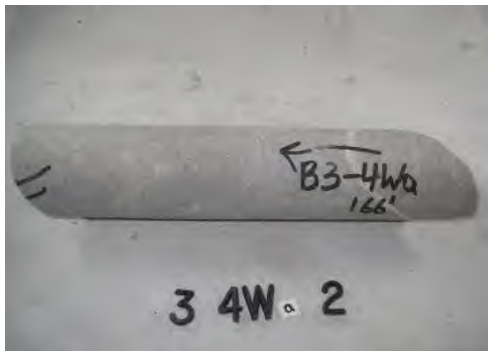
Boring No.: B3-4Wa  
 Sample No.: 2  
 Sample Depth: 166 feet  
 Sampling Date: 9/13/17

Lithology : Limestone  
 Moisture Content : As received  
 Lab Temperature : 70° F  
 Loading Rate: 55 psi/s  
 Time to Failure: 25 min

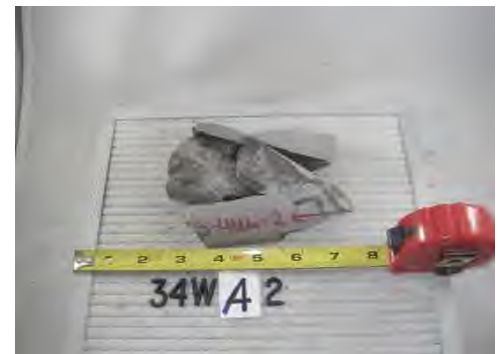
Diameter: 1.96 in  
 Length: 4.62 in  
 L/D: 2.36  
 End Area: 3.02 in<sup>2</sup>

Maximum Axial Load at Failure: 84,120 lb  
 Compressive Strength: 27,880 psi  
 Compressive Strength: 192.23 Mpa  
 Unit Weight 167 pcf


Before the Test



After the Test



Drawing # : PA-BL-0001.0048-RR  
 PO # : 20170811-2  
 Crossing : Everett RR  
 Spread : Spread 3

Project:	Mariner East Pipeline	 77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Performed by:	C. Santana
Project No:	J217P078		Test Date:	10/16/2017
Location:	Spread 3		Reviewed By :	L. Dwyer
Client :	Directional Project Support Inc.		Review Date :	10/16/2017

*The information contained in this report may not be reproduced except in its entirety without the express written consent of Terracon, Inc. Reports are relevant only to the items tested and may not be attributed to other work. Testing was performed in general accordance with the stated ASTM test method.*

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

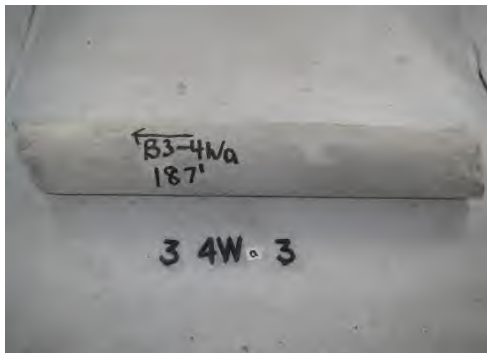
Boring No.: B3-4Wa  
 Sample No.: 3  
 Sample Depth: 187 feet  
 Sampling Date: 9/13/17

Lithology : Limestone  
 Moisture Content : As received  
 Lab Temperature : 70° F  
 Loading Rate: 55 psi/s  
 Time to Failure: 0 min

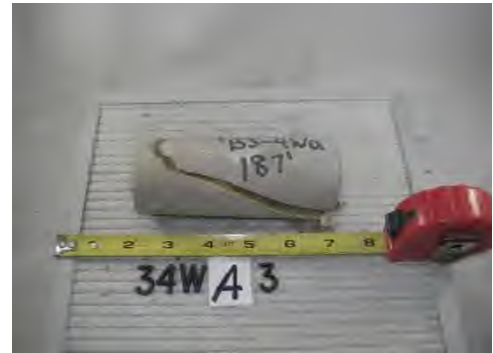
Diameter: 1.96 in  
 Length: 4.60 in  
 L/D: 2.35  
 End Area: 3.02 in<sup>2</sup>

Maximum Axial Load at Failure: 1,610 lb  
 Compressive Strength: 534 psi  
 Compressive Strength: 3.68 Mpa  
 Unit Weight 159 pcf


Before the Test



After the Test



Drawing # : PA-BL-0001.0048-RR  
 PO # : 20170811-2  
 Crossing : Everett RR  
 Spread : Spread 3

Project:	Mariner East Pipeline	 77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Performed by:	C. Santana
Project No:	J217P078		Test Date:	10/16/2017
Location:	Spread 3		Reviewed By :	L. Dwyer
Client :	Directional Project Support Inc.		Review Date :	10/16/2017

*The information contained in this report may not be reproduced except in its entirety without the express written consent of Terracon, Inc. Reports are relevant only to the items tested and may not be attributed to other work. Testing was performed in general accordance with the stated ASTM test method.*

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

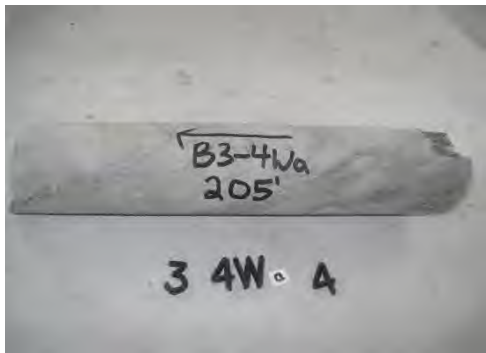
Boring No.: B3-4Wa  
 Sample No.: 4  
 Sample Depth: 205 feet  
 Sampling Date: 9/13/17

Lithology : Limestone  
 Moisture Content : As received  
 Lab Temperature : 70° F  
 Loading Rate: 55 psi/s  
 Time to Failure: 9 min

Diameter: 1.96 in  
 Length: 4.43 in  
 L/D: 2.26  
 End Area: 3.02 in<sup>2</sup>

Maximum Axial Load at Failure: 31,260 lb  
 Compressive Strength: 10,361 psi  
 Compressive Strength: 71.43 Mpa  
 Unit Weight 166 pcf


Before the Test



After the Test



Drawing # : PA-BL-0001.0048-RR  
 PO # : 20170811-2  
 Crossing : Everett RR  
 Spread : Spread 3

Project:	Mariner East Pipeline	 77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Performed by:	C. Santana
Project No:	J217P078		Test Date:	10/16/2017
Location:	Spread 3		Reviewed By :	L. Dwyer
Client :	Directional Project Support Inc.		Review Date :	10/16/2017

*The information contained in this report may not be reproduced except in its entirety without the express written consent of Terracon, Inc. Reports are relevant only to the items tested and may not be attributed to other work. Testing was performed in general accordance with the stated ASTM test method.*



Photograph 1: B3-4Wa, Samples C-1 to C-4 (140 to 160 feet)



Photograph 2: B3-4Wa, Samples C-5 to C-8 (160 to 180 feet)



Photograph 3: B3-4Wa, Samples C-9 to C-12 (180 to 200 feet)



Photograph 4: B3-4Wa, Samples C-13 to C-16 (200 to 220 feet)



Photograph 5: B3-4Wa, Samples C-17 to C-20 (220 to 240 feet)



Photograph 6: B3-4Wa, Samples C-21 to C-24 (240 to 260 feet)



Photograph 7: B3-4Wa, Samples C-25 to C-28 (260 to 280 feet)



Photograph 8: B3-4Wa, Samples C-29 to C-32 (280 to 300 feet)



Photograph 1: B3-4W, Samples C-1 to C-4 (16 to 36 feet)



Photograph 2: B3-4W, Samples C-5 to C-8 (36 to 56 feet)



Photograph 3: B3-4W, Samples C-9 to C-11 (56 to 71 feet)

## **SUPPORTING INFORMATION**

# UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification			
				Group Symbol	Group Name <sup>B</sup>		
<b>Coarse-Grained Soils:</b> More than 50% retained on No. 200 sieve	<b>Gravels:</b> More than 50% of coarse fraction retained on No. 4 sieve	<b>Clean Gravels:</b> Less than 5% fines <sup>C</sup>	$Cu \geq 4$ and $1 \leq Cc \leq 3$ <sup>E</sup>	GW	Well-graded gravel <sup>F</sup>		
		<b>Gravels with Fines:</b> More than 12% fines <sup>C</sup>	$Cu < 4$ and/or $1 > Cc > 3$ <sup>E</sup>	GP	Poorly graded gravel <sup>F</sup>		
		<b>Sands:</b> 50% or more of coarse fraction passes No. 4 sieve	<b>Clean Sands:</b> Less than 5% fines <sup>D</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>F,G,H</sup>	
			<b>Sands with Fines:</b> More than 12% fines <sup>D</sup>	Fines classify as CL or CH	GC	Clayey gravel <sup>F,G,H</sup>	
	<b>Fine-Grained Soils:</b> 50% or more passes the No. 200 sieve	<b>Silts and Clays:</b> Liquid limit less than 50	<b>Inorganic:</b>	$PI > 7$ and plots on or above "A"	CL	Lean clay <sup>K,L,M</sup>	
				$PI < 4$ or plots below "A" line <sup>J</sup>	ML	Silt <sup>K,L,M</sup>	
			<b>Organic:</b>	Liquid limit - oven dried	< 0.75	OL	Organic clay <sup>K,L,M,N</sup>
				Liquid limit - not dried			Organic silt <sup>K,L,M,O</sup>
<b>Silts and Clays:</b> Liquid limit 50 or more		<b>Inorganic:</b>	$PI$ plots on or above "A" line	CH	Fat clay <sup>K,L,M</sup>		
			$PI$ plots below "A" line	MH	Elastic Silt <sup>K,L,M</sup>		
		<b>Organic:</b>	Liquid limit - oven dried	< 0.75	OH	Organic clay <sup>K,L,M,P</sup>	
			Liquid limit - not dried			Organic silt <sup>K,L,M,Q</sup>	
<b>Highly organic soils:</b>	Primarily organic matter, dark in color, and organic odor			PT	Peat		

<sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve

<sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>C</sup> Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

<sup>D</sup> Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$E \quad Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

<sup>F</sup> If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>I</sup> If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>J</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

<sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>L</sup> If soil contains  $\geq 30\%$  plus No. 200 predominantly sand, add "sandy" to group name.

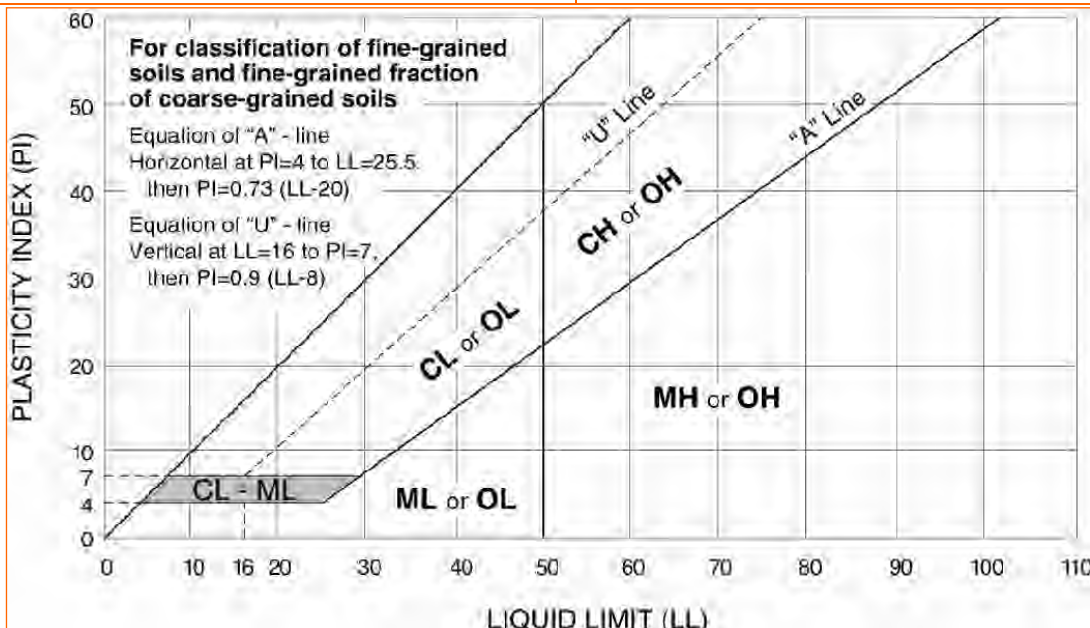
<sup>M</sup> If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>N</sup>  $PI \geq 4$  and plots on or above "A" line.

<sup>O</sup>  $PI < 4$  or plots below "A" line.

<sup>P</sup>  $PI$  plots on or above "A" line.

<sup>Q</sup>  $PI$  plots below "A" line.



## DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
<b>Fresh</b>	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
<b>Very Slight</b>	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
<b>Slight</b>	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
<b>Moderate</b>	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
<b>Moderately Severe</b>	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
<b>Severe</b>	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
<b>Very Severe</b>	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
<b>Complete</b>	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
<b>Very Hard</b>	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
<b>Hard</b>	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
<b>Moderately Hard</b>	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
<b>Medium</b>	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
<b>Soft</b>	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
<b>Very Soft</b>	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock <sup>1</sup>		
Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) <sup>1</sup>		Joint Openness Descriptors	
RQD, as a percentage	Diagnostic description	Openness	Descriptor
Exceeding 90	Excellent	No Visible Separation	Tight
90 – 75	Good	Less than 1/32 in.	Slightly Open
75 – 50	Fair	1/32 to 1/8 in.	Moderately Open
50 – 25	Poor	1/8 to 3/8 in.	Open
Less than 25	Very poor	3/8 in. to 0.1 ft.	Moderately Wide
		Greater than 0.1 ft.	Wide

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

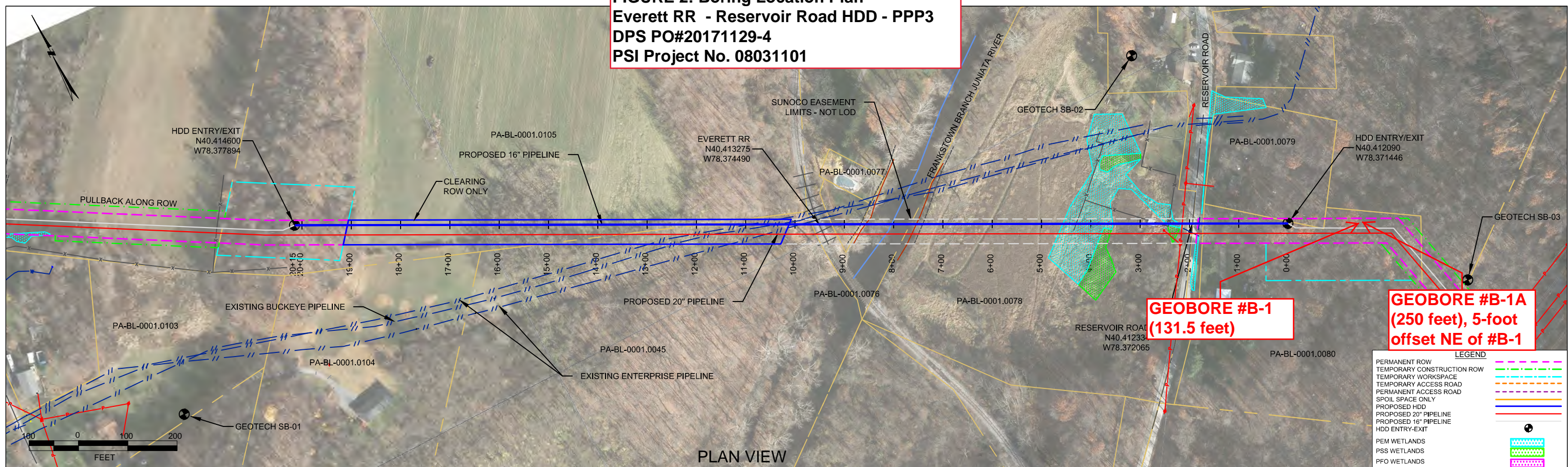
### Figure 1 - Site Vicinity Plan

Make online reservations at  
[www.visitPAparks.com](http://www.visitPAparks.com)  
or call toll-free 888-PA-PARKS

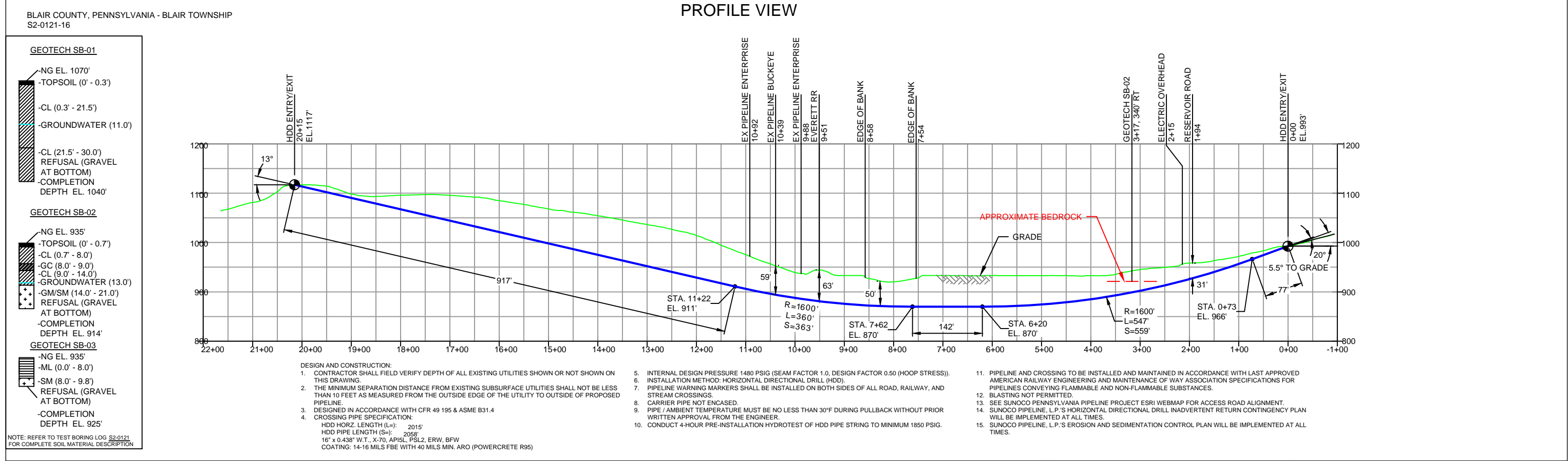
Visit us at <http://www.dcnr.state.pa.us>



**FIGURE 2: Boring Location Plan**  
**Everett RR - Reservoir Road HDD - PPP3**  
**DPS PO#20171129-4**  
**PSI Project No. 08031101**



**PLAN VIEW**



**PROFILE VIEW**

**BLAIR COUNTY, PENNSYLVANIA - BLAIR TOWNSHIP**  
**S2-0121-16**

**GEOTECH SB-01**

- NG EL. 1070'
- TOPSOIL (0' - 0.3')
- CL (0.3' - 21.5')
- GROUNDWATER (11.0')
- CL (21.5' - 30.0')
- REFUSAL (GRAVEL AT BOTTOM)
- COMPLETION DEPTH EL. 1040'

**GEOTECH SB-02**

- NG EL. 935'
- TOPSOIL (0' - 0.7')
- CL (0.7' - 8.0')
- GC (8.0' - 9.0')
- CL (9.0' - 14.0')
- GROUNDWATER (13.0')
- GM/SM (14.0' - 21.0')
- REFUSAL (GRAVEL AT BOTTOM)
- COMPLETION DEPTH EL. 914'

**GEOTECH SB-03**

- NG EL. 935'
- ML (0.0' - 8.0')
- SM (8.0' - 9.8')
- REFUSAL (GRAVEL AT BOTTOM)
- COMPLETION DEPTH EL. 925'

NOTE: REFER TO TEST BORING LOG S2-0121 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- DESIGN AND CONSTRUCTION:**
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
  - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
  - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
  - CROSSING PIPE SPECIFICATION:  
 HDD HORZ. LENGTH (L=) 2015'  
 HDD PIPE LENGTH (S=) 2058'  
 16" x 0.438" W.T., X-70, API 5L, PSL2, ERW, BFW  
 COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
  - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
  - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
  - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
  - CARRIER PIPE NOT ENCASED.
  - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
  - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
  - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
  - BLASTING NOT PERMITTED.
  - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
  - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
  - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

**NOTES**

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

**REVISIONS**

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	REVISED PROFILE WITH 2017 LIDAR	MRS	03/20/17	RMB	03/20/17	CAG	03/20/17
3	DESIGN CHANGE	DLM	09/08/16	RMB	09/08/16	AAW	09/08/16
2	REVISED PER ENGINEERING COMMENTS	DLM	08/26/16	RMB	08/26/16	AAW	08/26/16
1	ADDED "CLEARING ROW ONLY" ANNOTATION	MRS	03/28/16	RMB	03/28/16	AAW	03/28/16
0	ISSUED FOR CONSTRUCTION	MRS	12/22/15	RMB	12/22/15	AAW	12/22/15

**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
 (303) 792-5911

**SUNOCO PIPELINE, L.P.**

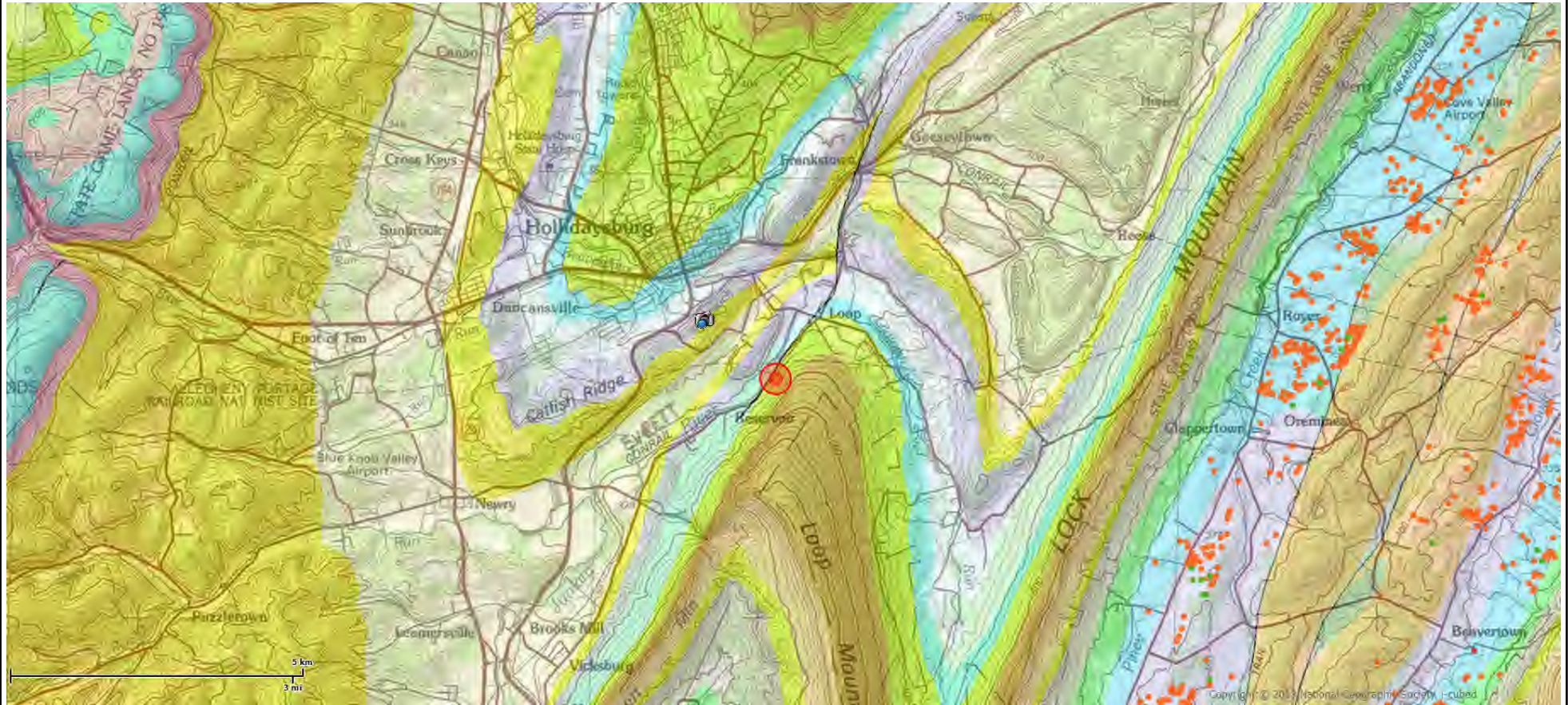
HORIZONTAL DIRECTIONAL DRILL  
 EVERETT RR/ RESERVOIR RD  
 PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-BL-0001.0048-RR-16

**Figure 3 - Site Geology Plan**

Make online reservations at  
[www.visitPAparks.com](http://www.visitPAparks.com)  
or call toll-free 888-PA-PARKS

Visit us at <http://www.dcnr.state.pa.us>



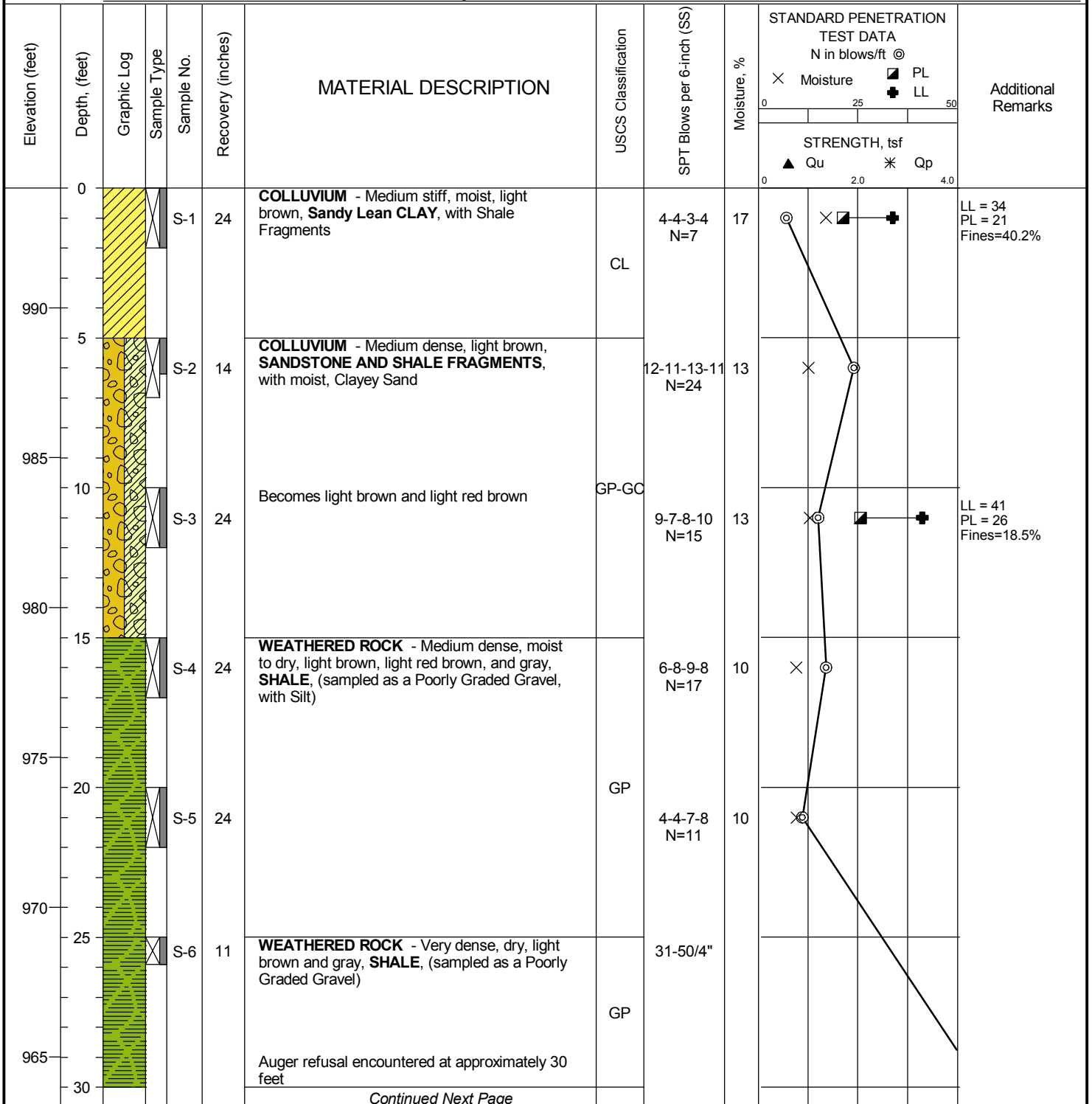
**DATE STARTED:** 12/4/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/15/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 131.5 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01

**Water**  
 ∇ During Drilling None Enc.  
 ▼ Upon Completion Dry  
 ∇

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

**REMARKS:** Ground elevation estimated based on information contained on Google Earth



Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/4/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/15/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 131.5 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01

**Water**  
 ▽ During Drilling None Enc.  
 ▼ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

**REMARKS:** Ground elevation estimated based on information contained on Google Earth

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
30				R-1	16	<b>BEDROCK</b> - Light brown and light gray, <b>SANDSTONE</b> , very fine to fine grained, very thin to thin bedded, weathered to highly weathered, very soft to soft (1-2) Extremely broken with Clay from 31 to 33.5 feet		RQD=0 Rec=87%			5 min. 5 min. 3 min.
960	35			R-2	60	Broken throughout run with Clay		RQD=18 Rec=100%			3 min. 3 min. 4 min. 3 min. 3 min. 4 min. 4 min.
955	40			R-3	60	<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to medium bedded, slightly weathered, moderately hard (6-7), interbedded with Claystone Broken from 41.5 to 42.2 feet		RQD=30 Rec=100%			4 min. 3 min. 4 min. 8 min. 5 min.
950	45			R-4	55			RQD=34 Rec=92%			5 min. 4 min. 4 min. 5 min. 4 min.
945	50			R-5	60			RQD=74 Rec=100%			5 min. 5 min. 4 min. 4 min. 4 min.
940	55			R-6	54			RQD=40 Rec=90%			4 min. 4 min. 4 min. 4 min.
935	60			R-7	60			RQD=82 Rec=100%			4 min. 4 min. 4 min.

Continued Next Page

Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/4/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/15/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 131.5 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01

**Water**  
 ▽ During Drilling None Enc.  
 ▽ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

**REMARKS:** Ground elevation estimated based on information contained on Google Earth

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ⊙ X Moisture    □ PL + LL  STRENGTH, tsf ▲ Qu            * Qp	Additional Remarks		
60						<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to medium bedded, slightly weathered, moderately hard (6-7), interbedded with Claystone  Broken and vertical fractures from 71.5 to 73.5 feet  Becomes medium to thick bedded at 76 feet  Vertical fracture from 85.9 to 86.9 feet  Lost core water at 89 feet					3 min.		
												3 min.	
												7 min.	
930	65			R-8	60			RQD=56 Rec=100%				7 min.	>> ⊙
												7 min.	
												7 min.	
												7 min.	
												5 min.	>> ▲ Q <sub>u</sub> = 215.5 tsf 171.2 pcf
925	70			R-9	60			RQD=90 Rec=100%				5 min.	>> ⊙
												5 min.	
												5 min.	
920	75			R-10	50			RQD=0 Rec=84%				5 min.	>> ⊙
												5 min.	
										5 min.			
										4 min.	>> ▲ Q <sub>u</sub> = 121.6 tsf 470.2 pcf		
915	80		R-11	60		RQD=86 Rec=100%				4 min.	>> ⊙		
										4 min.			
										4 min.			
										6 min.			
910	85		R-12	60		RQD=90 Rec=100%				6 min.	>> ⊙		
										6 min.			
										6 min.			
										5 min.	>> ▲ Q <sub>u</sub> = 114.1 tsf 167.5 pcf		
905			R-13	54		RQD=52 Rec=90%				5 min.	>> ⊙		
90										5 min.			

Continued Next Page

Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/4/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/15/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 131.5 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01

**Water**  
 ▽ During Drilling None Enc.  
 ▽ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

**REMARKS:** Ground elevation estimated based on information contained on Google Earth

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks		
										X Moisture    □ PL + LL STRENGTH, tsf ▲ Qu            * Qp			
90						<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to medium bedded, slightly weathered, moderately hard (6-7), interbedded with Claystone  Core water returned at 92.5 feet  Becomes thin to thick bedded at 96.5 feet  Clay seam from 113.8 to 114 feet					5 min.		
												5 min.	
												7 min.	
												7 min.	
900				R-14			60		RQD=64 Rec=100%				>> ⊙
													7 min.
													7 min.
													7 min.
													>> ▲ Q <sub>u</sub> = 166.6 tsf 167.3 pcf
													5 min.
895				R-15			60		RQD=86 Rec=100%				>> ⊙
													5 min.
													5 min.
													4 min.
													4 min.
890				R-16			60		RQD=90 Rec=100%				>> ⊙
													4 min.
													4 min.
													4 min.
											>> ▲ Q <sub>u</sub> = 208.9 tsf 169.8 pcf		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
885			R-17		60		RQD=60 Rec=100%				>> ⊙		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
											4 min.		
880			R-18		60		RQD=80 Rec=100%				>> ⊙		
											5 min.		
											4 min.		
											>> ▲ Q <sub>u</sub> = 82.0 tsf 47.7 pcf		
											4 min.		
											4 min.		
											4 min.		
875			R-19		60		RQD=84 Rec=100%				>> ⊙		
											4 min.		

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

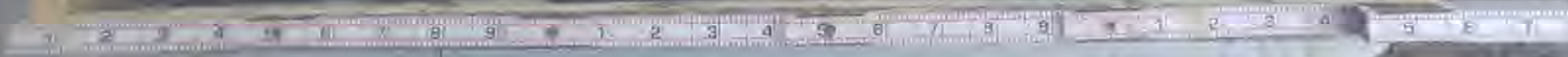
**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1  
PSI Project No. 08031101

Depth	Diag.	Mo.	Wt.
R-1	30.0-30.8	13	00
R-2	31.0-31.5	50	69
R-3	31.6-31.5	50	15



DEPTH	DESCRIPTION	LOG	TEST
0.00 - 0.10	CLAY	04	1.5
0.10 - 0.20	CLAY	46	1.7
0.20 - 0.30	CLAY	50	2.3

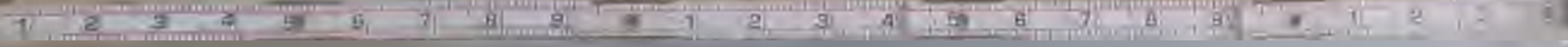


0.00  
 0.10  
 0.20  
 0.30  
 0.40  
 0.50  
 0.60  
 0.70  
 0.80  
 0.90  
 1.00



Depth	Soil	Moisture	Wt %
0-1	CL-5-5L-3	50	2.0
1-2	CL-5-5L-3	45	2.0
2-3	CL-5-5L-3	50	4.1

Top



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1  
PSI Project No. 08031101



DEPTH	LOG	WT	SPG
0-1	US-710	50	45
1-2	US-710	112	40
2-3	US-710	50	43

TOP

210

5.97



08031101  
Everett RR  
PPP3  
B-1  
Reservoir Road  
GPR

Interval	Depth	Grain	WGT
0.0 - 1.5	1.5	6.0	4.1
1.5 - 3.0	3.0	5.0	4.5
3.0 - 4.5	4.5	4.5	2.6

Top

81.5

86.5



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1  
PSI Project No. 08031101

Interval	Depth	Remarks
0.0 - 0.5	0.0 - 0.5	...
0.5 - 1.0	0.5 - 1.0	...
1.0 - 1.5	1.0 - 1.5	...



Depth	Interval	Length	Notes
10.0	101.5	5.0	11.3
15.0	101.5 - 106.5	5.0	11.3
20.0	106.5 - 111.5	5.0	30



2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

	Run	Depth	Dr	RL
106.5 - 111.5	106.5 - 111.5	5.0	8.0	
111.5 - 114.5	111.5 - 114.5	3.0	1.0	
114.5 - 121.5	114.5 - 121.5	7.0	4.2	

Top



111.5

116.5

Drill Log  
Boring B-1  
Reservoir Rd  
PPP3

Core Depth	Gr	RFD
0-12.5	5.0	4.5
12.5-25.0	5.0	4.5

TOP





**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette  
**REMARKS:**

# BORING B-01A

**Water**  During Drilling None Enc.  
 Upon Completion Dry

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
0	0					Auger probe to refusal at 40 feet					
990	5										
985	10										
980	15										
975	20										
970	25										
965	30										

**STANDARD PENETRATION TEST DATA**  
 N in blows/ft @  
 X Moisture  PL  
 LL  
 0 25 50  
**STRENGTH, tsf**  
 Qu  \* Qp  
 0 2.0 4.0

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette  
**REMARKS:**

# BORING B-01A

**Water**  
 ▽ During Drilling None Enc.  
 ▼ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STRENGTH, tsf	Additional Remarks
30						Auger probe to refusal at 40 feet					
960	35										
955	40			R-1	8	Auger refusal encountered at approximately 40 feet <b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, very thin bedded, highly weathered, soft (2-3) Becomes very thin to thin bedded at 42 feet		RQD=0 Rec=35%			>> 6 min.
950	45			R-2	6			RQD=10 Rec=10%			>> 7 min.
945	50			R-3	42			RQD=18 Rec=70%			>> 10 min.
940	55			R-4	41	Becomes very thin to medium bedded at 52 feet		RQD=60 Rec=68%			>> 3 min.
935	60			R-5	8			RQD=12			>> 6 min.

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01A

**Water**  
 ▽ During Drilling None Enc.  
 ▼ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ⊙ X Moisture    ⊠ PL ⊕ LL STRENGTH, tsf ▲ Qu            * Qp	Additional Remarks	
60						<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, very thin bedded, highly weathered, soft (2-3)		Rec=14%			6 min.	
											6 min.	
											6 min.	
											9 min.	
930	65			R-6	40				RQD=40 Rec=66%			9 min.
							Interbedded with Claystone at 67 feet					>> ⊙
												9 min.
												9 min.
												3 min.
925	70			R-7	56				RQD=60 Rec=94%			3 min.
												>> ⊙
											3 min.	
											3 min.	
											3 min.	
920	75		R-8	60		Vertical fractures and broken from 75.4 to 79.1 feet		RQD=64 Rec=100%			>> ⊙	
											3 min.	
											3 min.	
											3 min.	
											5 min.	
915	80		R-9	55				RQD=26 Rec=92%			6 min.	
											>> ⊙	
											6 min.	
											4 min.	
											4 min.	
											5 min.	
910	85		R-10	43		Broken and vertical fractures at 83.5 feet		RQD=16 Rec=72%			5 min.	
											>> ⊙	
											5 min.	
											5 min.	
											5 min.	
905			R-11	60		<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to thick bedded, highly weathered, medium hard (3-4), with quartz veining		RQD=96			>> ⊙	
											3 min.	
											3 min.	

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA  
 PA-BL-0001.0048-RR-16/PO#20171129-4

The stratification lines represent approximate boundaries. The transition may be gradual.

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01A

**Water**  During Drilling None Enc.  
 Upon Completion Dry

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks	
90						<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to thick bedded, highly weathered, medium hard (3-4), with quartz veining		Rec=100%		X Moisture <input checked="" type="checkbox"/> PL <input checked="" type="checkbox"/> LL STRENGTH, tsf ▲ Qu * Qp	3 min.	
						Vertical fracture from 93.2 to 94.1 feet					3 min.	
900				R-12	60			RQD=64 Rec=100%			>>⊕	3 min.
95						Extremely broken from 95.3 to 95.7 feet						4 min.
												4 min.
												4 min.
												4 min.
												3 min.
895				R-13	60			RQD=100 Rec=100%			>>⊕	3 min.
100												3 min.
												3 min.
												3 min.
												3 min.
890				R-14	60			RQD=74 Rec=100%			>>⊕	3 min.
105												3 min.
												3 min.
												3 min.
											3 min.	
885			R-15	52			RQD=56 Rec=86%			>>⊕	3 min.	
110						Becomes gray and red gray at 111.2 feet					3 min.	
											3 min.	
											3 min.	
											3 min.	
880			R-16	60			RQD=86 Rec=100%			>>⊕	3 min.	
115											3 min.	
											3 min.	
											3 min.	
											3 min.	
875			R-17	60		<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to thick bedded, highly weathered, medium to moderately hard (3-5)		RQD=88		>>⊕	2 min.	
120											2 min.	

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA  
 PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette

# BORING B-01A

**Water**  
 ▽ During Drilling None Enc.  
 ▽ Upon Completion Dry  
 ▽

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks	
120						<b>BEDROCK</b> - Gray, <b>SHALE</b> , very fine grained, thin to thick bedded, highly weathered, medium to moderately hard (3-5)		Rec=100%		X Moisture    □ PL + LL STRENGTH, tsf ▲ Qu    * Qp	2 min. 2 min. 2 min. 5 min. 5 min.	
870	125		R-18	60			RQD=74 Rec=100%				>>⊙ 5 min.	
865	130		R-19	60			RQD=88 Rec=100%				>>⊙ 3 min.	
860	135		R-20	60			RQD=94 Rec=100%				>>⊙ 5 min. 5 min.	
855	140		R-21	60			RQD=86 Rec=100%				>>⊙ 5 min. 3 min.	
850	145		R-22	60			RQD=38 Rec=100%				>>⊙ 5 min. 5 min.	
845	150		R-23	60			RQD=70				>>⊙ 5 min. 5 min.	
							Very thin clay seam from 136.7 to 136.8 feet					>>▲ 5 min. 3 min. 3 min.
							Broken and vertical fractures from 142 to 143.8 feet					>>▲ 5 min. 4 min.

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA  
 PA-BL-0001.0048-RR-16/PO#20171129-4

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED: 12/15/17 DRILL COMPANY: Terra Testing, Inc.  
 DATE COMPLETED: 12/22/17 DRILLER: T. Caton LOGGED BY: C. Lehman  
 COMPLETION DEPTH: 250.0 ft DRILL RIG: Diedrich D-50  
 BENCHMARK: N/A DRILLING METHOD: Hollow Stem Auger  
 ELEVATION: 994 ft SAMPLING METHOD: SS, 3' Centers  
 LATITUDE: \_\_\_\_\_ HAMMER TYPE: Automatic  
 LONGITUDE: \_\_\_\_\_ EFFICIENCY: N/A  
 STATION: N/A OFFSET: N/A REVIEWED BY: S. Simonette

# BORING B-01A

**Water** ∇ During Drilling None Enc.  
 ∇ Upon Completion Dry  
 ∇

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ⊙ × Moisture    ⊠ PL ⊕ LL  STRENGTH, tsf ▲ Qu        * Qp	Additional Remarks
150			R-24	60	60	BEDROCK - Gray, SHALE, very fine grained, thin to thick bedded, highly weathered, medium to moderately hard (3-5)	Rec=100%				4 min. 4 min. 4 min. 5 min. 5 min.
840	155							RQD=96 Rec=100%			
835			R-25	60	60	Broken from 158.5 to 159 feet BEDROCK - Red gray and gray, SHALE, thin to medium bedded, slightly weathered, medium to moderately hard (3-5), interbedded with Claystone	RQD=72 Rec=100%				4 min. 4 min. 4 min. 3 min. 3 min.
830	160							RQD=92 Rec=100%			
825			R-26	49	49		RQD=38 Rec=82%				3 min. 3 min. 4 min. 4 min.
820	165							RQD=62 Rec=100%			
815			R-27	60	60	Vertical fracture with Clay from 174.9 to 176.3 feet	RQD=62 Rec=100%				6 min. 7 min. ▲ Qu = 109.8 tsf 174.1 pcf 3 min.
810	170							RQD=30			
180	175		R-28	60	60	Vertical fractures and broken from 178.5 to 182 feet					>> ⊙ 6 min. 6 min.

Continued Next Page

Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

PROJECT NO.: 08031101  
 PROJECT: Energy Transfer HDD (DPS)  
 LOCATION: Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

DATE STARTED: 12/15/17  
 DATE COMPLETED: 12/22/17  
 COMPLETION DEPTH: 250.0 ft  
 BENCHMARK: N/A  
 ELEVATION: 994 ft  
 LATITUDE:  
 LONGITUDE:  
 STATION: N/A OFFSET: N/A  
 REMARKS:

DRILL COMPANY: Terra Testing, Inc.  
 DRILLER: T. Caton LOGGED BY: C. Lehman  
 DRILL RIG: Diedrich D-50  
 DRILLING METHOD: Hollow Stem Auger  
 SAMPLING METHOD: SS, 3' Centers  
 HAMMER TYPE: Automatic  
 EFFICIENCY: N/A  
 REVIEWED BY: S. Simonette

### BORING B-01A

<b>Water</b>	▽	During Drilling	None Enc.
	▼	Upon Completion	Dry
	▽		

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks	
										X Moisture      ◻ PL ◼ LL STRENGTH, tsf ▲ Qu              * Qp		
180						<b>BEDROCK</b> - Red gray and gray, <b>SHALE</b> , thin to medium bedded, slightly weathered, medium to moderately hard (3-5), interbedded with Claystone		Rec=100%			6 min. 6 min. 6 min. 5 min. 5 min.	
810			R-30	60	Broken from 184.5 to 185.5 feet		RQD=48 Rec=100%			>> ◉ >> ▲ Qu = 34.8 tsf * Qp = 36.8 pcf	5 min. 5 min.	
185												
805				R-31	60			RQD=100 Rec=100%			>> ◉ >> ◉	4 min. 4 min.
190												
800				R-32	60			RQD=86 Rec=100%			>> ◉ >> ▲ Qu = 46.1 tsf * Qp = 171.3 pcf	4 min. 3 min. 3 min.
195												
795				R-33	60	<b>BEDROCK</b> - Red gray and gray, <b>SHALE</b> , thin to thickly bedded, slightly weathered, medium to moderately hard (3-5), interbedded with Claystone		RQD=100 Rec=100%			>> ◉ >> ◉	5 min. 5 min.
200												
790				R-34	60	Vertical fracture and broken from 205.3 to 207 feet		RQD=66 Rec=100%			>> ◉ >> ◉	5 min. 4 min. 4 min.
205												
785			R-35	60			RQD=100			>> ◉ >> ▲ Qu = 96.0 tsf * Qp = 169.5 pcf	3 min. 5 min. 5 min.	
210										>> ◉	5 min.	

Continued Next Page

Professional Service Industries, Inc. 850 Poplar Street Pittsburgh, PA 15220 Telephone: (412) 922-4000	<b>PROJECT NO.:</b> 08031101 <b>PROJECT:</b> Energy Transfer HDD (DPS) <b>LOCATION:</b> Everett RR/Reservoir Rd (PPP3) Blair Co., PA PA-BL-0001.0048-RR-16/PO#20171129-4
---	--

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette  
**REMARKS:**

# BORING B-01A

**Water**  
 ∇ During Drilling None Enc.  
 ∇ Upon Completion Dry  
 ∇

**BORING LOCATION:**  
 Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks
210						<b>BEDROCK</b> - Red gray and gray, <b>SHALE</b> , thin to thickly bedded, slightly weathered, medium to moderately hard (3-5), interbedded with Claystone	Rec=100%			X Moisture    PL LL 0                    25                    50	
780			R-36	60			RQD=100 Rec=100%			STRENGTH, tsf ▲ Qu    * Qp 0                    2.0                    4.0	5 min. 5 min. 5 min. 4 min. 4 min. 4 min.    >>▲ Qu = 122.5 tsf 4 min.    >>▲ Qp = 173.1 pcf
215											
775			R-37	60			RQD=100 Rec=100%				4 min. 4 min. 6 min. 6 min. 6 min.    >>⊙
220											
770			R-38	60			RQD=100 Rec=100%				5 min. 5 min. 4 min. 4 min.    >>⊙
225											
765			R-39	60			RQD=100 Rec=100%				4 min.    >>▲ Qu = 158.6 tsf 4 min.    >>▲ Qp = 172.6 pcf 5 min. 5 min.    >>⊙
230											
760			R-40	60			RQD=76 Rec=100%				5 min. 5 min. 6 min. 6 min.    >>⊙ 6 min.    >>▲ Qu = 115.1 tsf 6 min.    >>▲ Qp = 172.6 pcf 6 min.
235											
755		R-41	60			RQD=64				5 min. 5 min.    >>⊙	
240											

Continued Next Page



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA


PA-BL-0001.0048-RR-16/PO#20171129-4

**DATE STARTED:** 12/15/17 **DRILL COMPANY:** Terra Testing, Inc.  
**DATE COMPLETED:** 12/22/17 **DRILLER:** T. Caton **LOGGED BY:** C. Lehman  
**COMPLETION DEPTH:** 250.0 ft **DRILL RIG:** Diedrich D-50  
**BENCHMARK:** N/A **DRILLING METHOD:** Hollow Stem Auger  
**ELEVATION:** 994 ft **SAMPLING METHOD:** SS, 3' Centers  
**LATITUDE:** **HAMMER TYPE:** Automatic  
**LONGITUDE:** **EFFICIENCY:** N/A  
**STATION:** N/A **OFFSET:** N/A **REVIEWED BY:** S. Simonette  
**REMARKS:**

## BORING B-01A

<b>Water</b>	▽	During Drilling	None Enc.
	▼	Upon Completion	Dry
	▽		

**BORING LOCATION:**  
Refer to Figure 2 - Boring Location Plan

Elevation (feet)	Depth (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft @	Additional Remarks
										X Moisture      □ PL + LL 0                    25                    50	
										STRENGTH, tsf ▲ Qu              * Qp 0                    2.0                    4.0	
240						<b>BEDROCK</b> - Gray, <b>SHALE</b> , thin to thickly bedded, slightly weathered, medium to moderately hard (3-5), interbedded with Claystone		Rec=100%			6 min.
750			R-42	60			RQD=98 Rec=100%				6 min.
245											5 min.
											5 min.
745			R-43	32				RQD=37 Rec=90%			5 min.
250						Boring terminated at approximately 250 feet					5 min.



Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000

**PROJECT NO.:** 08031101  
**PROJECT:** Energy Transfer HDD (DPS)  
**LOCATION:** Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA

PA-BL-0001.0048-RR-16/PO#20171129-4

The stratification lines represent approximate boundaries. The transition may be gradual.

Depth (ft)	Soil Description	Moisture (%)	Specific Gravity
0.0 - 0.5	Dark grey silty clay	62	2.70
0.5 - 1.0	Dark grey silty clay	65	2.70
1.0 - 1.5	Dark grey silty clay	68	2.70
1.5 - 2.0	Dark grey silty clay	70	2.70
2.0 - 2.5	Dark grey silty clay	72	2.70
2.5 - 3.0	Dark grey silty clay	75	2.70



10-10-16  
10-10-16 CR  
10-10-16  
10-10-16  
10-10-16  
10-10-16

Depth	Dist.	Temp	Temp
0.0	620-630	43	43
0.2	630-640	43	43
0.4	640-650	43	43

TOP



620

10-10-16



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1A  
PSI Project No. 08031101



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1A  
PSI Project No. 08031101

Core No.	Depth (ft)	Interval (ft)	Notes
1	0-11	0-11	
2	11-12	11-12	

Top

0-11

11-12

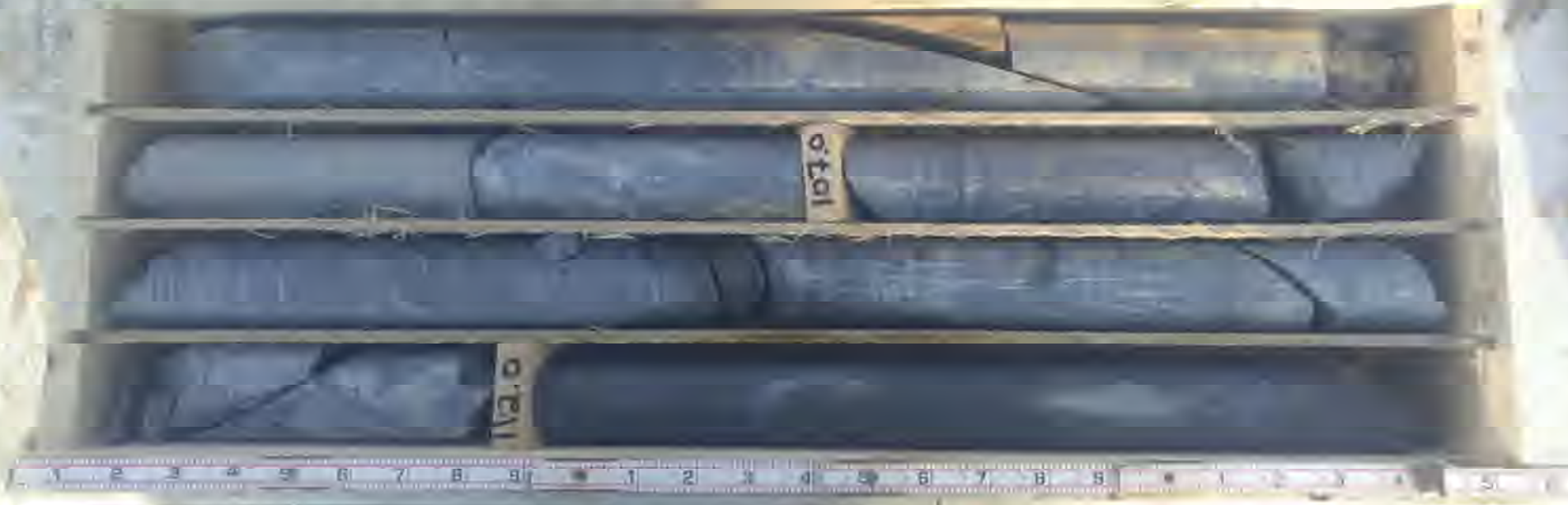


Case	Depth	Bl	Blk
B-12 (top)	920 - 930	50	32
B-13	930 - 1020	50	50
B-14	1020 - 1070	50	32



Depth	Interval	Length	Weight
1-10	107.0 - 107.0	5.0	3.2
2-5	107.0 - 112.0	4.8	3.8
6-11	112.0 - 119.0	5.0	4.7

TOP



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1A  
PSI Project No. 08031101

Core No.	Depth (ft)	Remarks	Length (ft)	Notes
1	0.0 - 0.5	...	0.5	...
2	0.5 - 1.0	...	0.5	...
3	1.0 - 1.5	...	0.5	...

TOP

117.0

122.0



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1A  
PSI Project No. 08031101

Core	Date	Q	R
1370	12/10-12/12	50	20
1370	12/10-12/12	150	40

TOP

1370

1370



Everett RR - Reservoir Road HDD  
BL-0001.0048-RR-16  
PPP3  
Boring B-1A  
PSI Project No. 08031101

Depth	Sample	Wt.	Moist.
0-10	137.0	50	4.7
10-20	137.0	50	4.3



Run	Depth	Est	Rqd
B-22	1420-1470	5.0	1.7
B-26	1470-1520	5.0	3.5

CR 1510  
Everett RR  
PPP3  
B-1A  
PSI Project No. 08031101



Station	Interval	Ref	Page
1520	1520-1530	50	48
1530	1530-1540	50	16





08031101  
Everett RR  
PPP3  
B-1A  
Box 12 of -  
12/11/17  
21

Core No.	Depth (ft)	Moisture (%)	Wt (%)
R-28	1720-1770	5.0	3.1
R-29	1770-1820	5.0	1.5



D580301  
Everett RR  
Bore  
B-1A  
12/15/11  
01

Run	Depth	R	R20
R-30	187.0-187.0	5.0	2.4
R-31	187.0-192.0	5.0	5.0



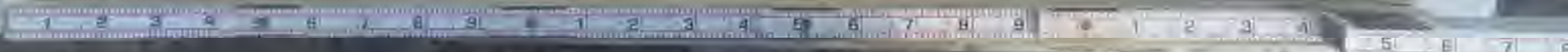
Run	Depth	Rc	RSD
R-32	192.0-197.0	5.0	4.3
R-33	197.0-202.0	5.0	5.0

Overall  
Boring  
12/18/18  
21

1920

1970

2020



Depth	Diag.	Mo.	PSH
2-31	2020-2070	50	2.3
2-35	2070-2120	50	5.0

TOP

2050

2060

2070



## GENERAL NOTES

### SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

### DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.	☒ SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.	■ ST: Shelby Tube - 3" O.D., except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry	▮ RC: Rock Core
R.C.: Diamond Bit Core Sampler	⬇ TC: Texas Cone
H.A.: Hand Auger	☞ BS: Bulk Sample
P.A.: Power Auger - Handheld motorized auger	☒ PM: Pressuremeter
	CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

### SOIL PROPERTY SYMBOLS

- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N<sub>60</sub>: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q<sub>u</sub>: Unconfined compressive strength, TSF
- Q<sub>p</sub>: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼, ▼, ▼ Apparent groundwater level at time noted

### RELATIVE DENSITY OF COARSE-GRAINED SOILS    ANGULARITY OF COARSE-GRAINED PARTICLES

<u>Relative Density</u>	<u>N - Blows/foot</u>
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

<u>Description</u>	<u>Criteria</u>
Angular:	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular:	Particles are similar to angular description, but have rounded edges
Subrounded:	Particles have nearly plane sides, but have well-rounded corners and edges
Rounded:	Particles have smoothly curved sides and no edges

### GRAIN-SIZE TERMINOLOGY

<u>Component</u>	<u>Size Range</u>
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

### PARTICLE SHAPE

<u>Description</u>	<u>Criteria</u>
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

### RELATIVE PROPORTIONS OF FINES

<u>Descriptive Term</u>	<u>% Dry Weight</u>
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%



## GENERAL NOTES

(Continued)

### CONSISTENCY OF FINE-GRAINED SOILS

<u>Q<sub>u</sub> - TSF</u>	<u>N - Blows/foot</u>	<u>Consistency</u>
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

### MOISTURE CONDITION DESCRIPTION

<u>Description</u>	<u>Criteria</u>
Dry:	Absence of moisture, dusty, dry to the touch
Moist:	Damp but no visible water
Wet:	Visible free water, usually soil is below water table

### RELATIVE PROPORTIONS OF SAND AND GRAVEL

<u>Descriptive Term</u>	<u>% Dry Weight</u>
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

### STRUCTURE DESCRIPTION

<u>Description</u>	<u>Criteria</u>	<u>Description</u>	<u>Criteria</u>
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick	Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick	Lensed:	Inclusion of small pockets of different soils
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing	Layer:	Inclusion greater than 3 inches thick (75 mm)
Slickensided:	Fracture planes appear polished or glossy, sometimes striated	Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
		Parting:	Inclusion less than 1/8-inch (3 mm) thick

### SCALE OF RELATIVE ROCK HARDNESS

<u>Q<sub>u</sub> - TSF</u>	<u>Consistency</u>
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

### ROCK BEDDING THICKNESSES

<u>Description</u>	<u>Criteria</u>
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

### ROCK VOIDS

<u>Voids</u>	<u>Void Diameter</u>
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

### GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

<u>Component</u>	<u>Size Range</u>
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

### ROCK QUALITY DESCRIPTION

<u>Rock Mass Description</u>	<u>RQD Value</u>
Excellent	90 - 100
Good	75 - 90
Fair	50 - 75
Poor	25 - 50
Very Poor	Less than 25

### DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

#### Degree of Brokenness

<u>Characteristic</u>	<u>Description</u>
Less than 1 inch	Very Broken
1 inch to 3 inches	Broken
3 inches to 6 inches	Slightly Broken
Greater than 6 inches	Massive

Highly Weathered:	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.
-------------------	---

**Table 4-3** Hardness and unconfined compressive strength of rock materials

Hardness category	Typical range in unconfined compressive strength (MPa)	Strength value selected (MPa)	Field test on sample	Field test on outcrop
Soil*	< 0.60		Use USCS classifications	
Very soft rock or hard, soil-like material	0.60–1.25		Scratched with fingernail. Slight indentation by light blow of point of geologic pick. Requires power tools for excavation. Peels with pocket knife.	
Soft rock	1.25–5.0		Permits denting by moderate pressure of the fingers. Handheld specimen crumbles under firm blows with point of geologic pick.	Easily deformable with finger pressure.
Moderately soft rock	5.0–12.5		Shallow indentations (1–3 mm) by firm blows with point of geologic pick. Peels with difficulty with pocket knife. Resists denting by the fingers, but can be abraded and pierced to a shallow depth by a pencil point. Crumbles by rubbing with fingers.	Crumbles by rubbing with fingers.
Moderately hard rock	12.5–50		Cannot be scraped or peeled with pocket knife. Intact handheld specimen breaks with single blow of geologic hammer. Can be distinctly scratched with 20d common steel nail. Resists a pencil point, but can be scratched and cut with a knife blade.	Unfractured outcrop crumbles under light hammer blows.
Hard rock	50–100		Handheld specimen requires more than one hammer blow to break it. Can be faintly scratched with 20d common steel nail. Resistant to abrasion or cutting by a knife blade, but can be easily dented or broken by light blows of a hammer.	Outcrop withstands a few firm blows before breaking.
Very hard rock	100–250		Specimen breaks only by repeated, heavy blows with geologic hammer. Cannot be scratched with 20d common steel nail.	Outcrop withstands a few heavy ringing hammer blows but will yield large fragments.
Extremely hard rock	> 250		Specimen can only be chipped, not broken by repeated, heavy blows of geologic hammer.	Outcrop resists heavy ringing hammer blows and yields, with difficulty, only dust and small fragments.

Method used to determine consistency or hardness (check one):

Field assessment: \_\_\_\_\_ Uniaxial lab test: \_\_\_\_\_ Other: \_\_\_\_\_ Rebound hammer (ASTM D5873): \_\_\_\_\_

\* See NEH631.03 for consistency and density of soil materials. For very stiff soil, SPT N values = 15 to 30. For very soft rock or hard, soil-like material, SPT N values exceed 30 blows per foot.

Bedding/ Discontinuity Dip (Abbrev.)	Description
Flat Dip ( <b>Fld</b> )	Beds/Discontinuities dipping < 5 degrees
Shallow Dip ( <b>Sld</b> )	Beds/Discontinuities dipping from 5 to 15 degrees
Moderate Dip ( <b>Mdd</b> )	Beds/Discontinuities dipping from 15 to 30 degrees
Steep Dip ( <b>Std</b> )	Beds/Discontinuities dipping from 30 to 45 degrees
Very Steep Dip ( <b>Vsd</b> )	Beds/Discontinuities dipping from 45 to 60 degrees
Sheer Dip ( <b>Srd</b> )	Beds/Discontinuities dipping > 60 degrees

Table 29 - Bedding/Discontinuity Dip Descriptors

From PADOT Publication 222 "Geotechnical Investigations Manual"

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS	
			GRAPH	LETTER		
COARSE GRAINED SOILS  MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS  MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS  (LITTLE OR NO FINES)		<b>GW</b>	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
				<b>GP</b>	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	
		GRAVELS WITH FINES  (APPRECIABLE AMOUNT OF FINES)		<b>GM</b>	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES	
				<b>GC</b>	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES	
	SAND AND SANDY SOILS  MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS  (LITTLE OR NO FINES)		<b>SW</b>	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
				<b>SP</b>	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES	
		SANDS WITH FINES  (APPRECIABLE AMOUNT OF FINES)		<b>SM</b>	SILTY SANDS, SAND - SILT MIXTURES	
				<b>SC</b>	CLAYEY SANDS, SAND - CLAY MIXTURES	
	FINE GRAINED SOILS  MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS  LIQUID LIMIT LESS THAN 50			<b>ML</b>	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
					<b>CL</b>	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				<b>OL</b>	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
SILTS AND CLAYS  LIQUID LIMIT GREATER THAN 50				<b>MH</b>	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS	
				<b>CH</b>	INORGANIC CLAYS OF HIGH PLASTICITY	
				<b>OH</b>	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
HIGHLY ORGANIC SOILS				<b>PT</b>	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	

# Laboratory Summary Sheet

Sheet 1 of 1

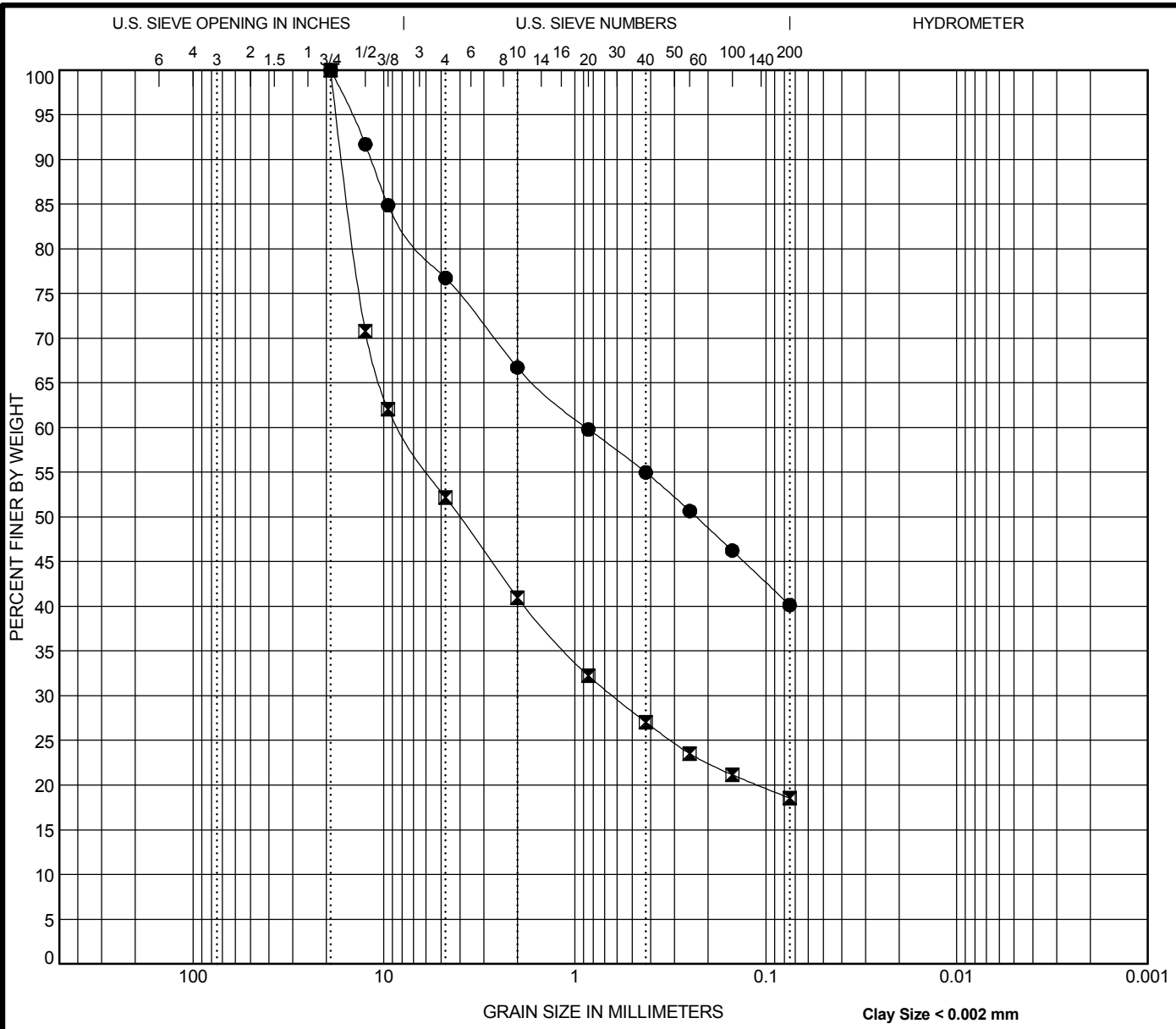
Borehole	Approx. Depth	Description	Liquid Limit	Plastic Limit	Plasticity Index	Qu (tsf)	%<#200 Sieve	Est. Specific Gravity	Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
B-01	1	Sandy Lean CLAY, with Shale Fragments	34	21	13		40.2%		17			
B-01	6								13			
B-01	11	SANDSTONE & SHALE FRGMNTS w/moist light brown Silty Clay & Sand	41	26	15		18.5%		13			
B-01	16								10			
B-01	21								10			

Professional Service Industries, Inc.  
 850 Poplar Street  
 Pittsburgh, PA 15220  
 Telephone: (412) 922-4000  
 Fax: (412) 922-4014

### Summary of Laboratory Results

PSI Job No.: 08031101  
 Project: Energy Transfer HDD (DPS)  
 Location: Everett RR/Reservoir Rd (PPP3)  
 Blair Co., PA  
 PA-BL-0001.0048-RR-16/PO#20171129-4





COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Classification	LL	PL	PI	Cc	Cu
● B-01     1.0	Sandy Lean CLAY, with Shale Fragments	34	21	13		
☒ B-01     11.0	SANDSTONE & SHALE FRAGMENTS w/moist light brown Silty Clay & Sand	41	26	15		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-01     1.0	19	0.872			23.3	36.6	40.2	
☒ B-01     11.0	19	8.223	0.63		47.8	33.7	18.5	

<p><b>Professional Service Industries, Inc.</b>          850 Poplar Street          Pittsburgh, PA 15220          Telephone: (412) 922-4000          Fax: (412) 922-4014</p>	<p style="text-align:center;"><b>GRAIN SIZE DISTRIBUTION</b></p> <p>Project: Energy Transfer HDD (DPS)          PSI Job No.: 08031101          Location: Everett RR/Reservoir Rd (PPP3)          Blair Co., PA</p>
--	--

Slake Test

08031101 B-1 R-2 35.1'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.01

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-5 46.9'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.12

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-7 56.8'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 6.75

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-9 68.0'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 6.86

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-10 75.5'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.02

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-13 86.2'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 5

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.21

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-15 96.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.36

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-17 106.5'



Start



2 Minute: Slake Index 5



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 5

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.45

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-19 116.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 6.65

Final Ph: 7.58

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1 R-20 122.7'



Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6

Test date: December 19, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.20

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1A R-20 136.0'

Start



2 Minute: Slake Index 6



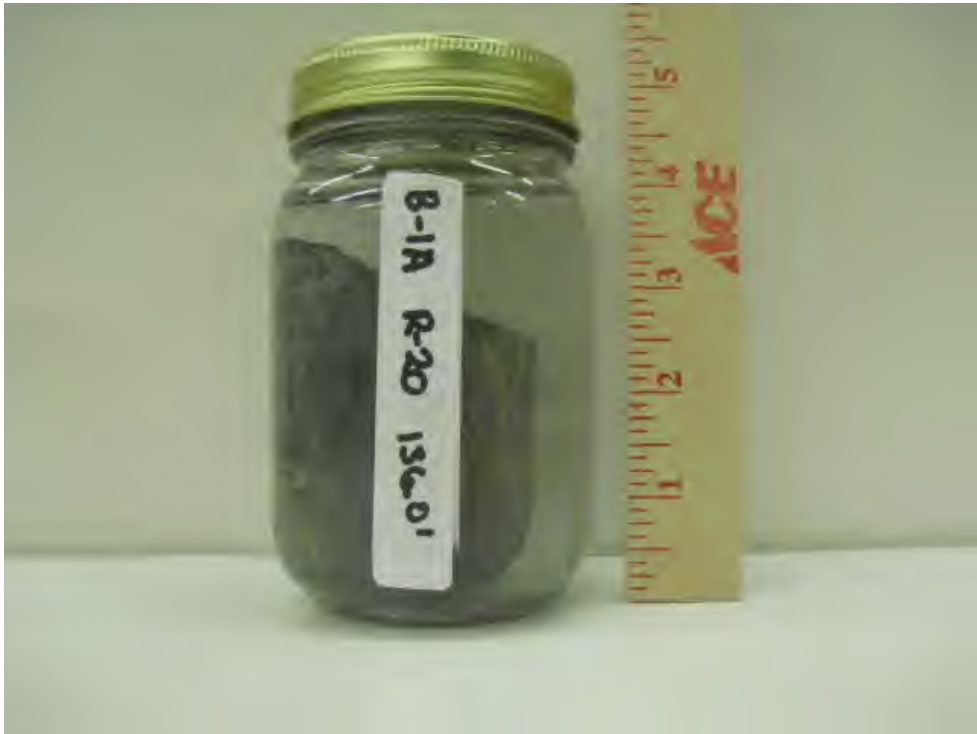
4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 7.87

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-22 145.0'

Start



2 Minute: Slake Index 5



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.05

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-24 155.5'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.18

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-26 165.9'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.11

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-28 174.8'

Start



2 Minute: Slake Index 5



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 5



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 7.95

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1A R-30 186.7'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.54

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-32 196.4'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 5



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.24

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1A R-34 204.5'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 5



8 Hour: Slake Index 5



24 Hour: Slake Index 5



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 7.96

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-36 216.8'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.26

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-38 226.0'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.05

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions

Slake Test

08031101 B-1A R-40 236.7'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 6



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.35

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

**Jar Slake Index Descriptions**

Slake Test

08031101 B-1A R-42 246.0'

Start



2 Minute: Slake Index 6



4 Hour: Slake Index 6



8 Hour: Slake Index 6



24 Hour: Slake Index 5



Test date: December 28, 2017

Test Fluid: Distilled Water

Initial Ph: 5.63

Final Ph: 8.25

Slake Index Table

Jar Slake Index, Ij	General behavior during test
1	Degrades rapidly into a pile of flakes or mud
2	Breaks readily and/or forms many chips
3	Breaks slowly and/or forms few chips
4	Breaks rapidly and/or develops several fractures
5	Breaks slowly and/or develops few fractures
6	Very little or no change

### Jar Slake Index Descriptions



**ATTACHMENT 2**  
**SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS**



United States  
Department of  
Agriculture



Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for Blair County, Pennsylvania

## Everett Railroad 16-inch HDD



# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

---

<b>Preface</b> .....	2
<b>How Soil Surveys Are Made</b> .....	5
<b>Soil Map</b> .....	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	11
Map Unit Descriptions.....	11
Blair County, Pennsylvania.....	14
Ba—Basher soils.....	14
BrB—Brinkerton silt loam, 3 to 8 percent slopes.....	15
CbB—Clarksburg silt loam, 3 to 8 percent slopes.....	16
EdD—Edom silty clay loam, 15 to 25 percent slopes.....	18
HeD—Hagerstown-Rock outcrop complex, 8 to 25 percent slopes.....	19
MnC—Mertz channery silt loam, 8 to 15 percent slopes.....	20
MsD—Morrison very stony sandy loam, 8 to 25 percent slopes.....	21
OuC—Opequon silty clay loam, 8 to 15 percent slopes.....	22
OxF—Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes.....	24
W—Water.....	26
<b>References</b> .....	27

# How Soil Surveys Are Made

---

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

## Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

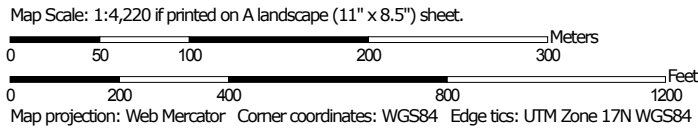
---

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.





































# Custom Soil Resource Report Soil Map



Soil Map may not be valid at this scale.



### MAP LEGEND

- Area of Interest (AOI)**
-  Area of Interest (AOI)
- Soils**
-  Soil Map Unit Polygons
-  Soil Map Unit Lines
-  Soil Map Unit Points
- Special Point Features**
-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot
-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features
- Water Features**
-  Streams and Canals
- Transportation**
-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads
- Background**
-  Aerial Photography

### MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
 Web Soil Survey URL:  
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Blair County, Pennsylvania  
 Survey Area Data: Version 14, Sep 18, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 23, 2010—Feb 22, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ba	Basher soils	6.2	25.0%
BrB	Brinkerton silt loam, 3 to 8 percent slopes	2.0	8.3%
CbB	Clarksburg silt loam, 3 to 8 percent slopes	0.0	0.0%
EdD	Edom silty clay loam, 15 to 25 percent slopes	2.8	11.5%
HeD	Hagerstown-Rock outcrop complex, 8 to 25 percent slopes	1.7	6.8%
MnC	Mertz channery silt loam, 8 to 15 percent slopes	3.2	12.9%
MsD	Morrison very stony sandy loam, 8 to 25 percent slopes	2.0	8.0%
OuC	Opequon silty clay loam, 8 to 15 percent slopes	4.6	18.8%
OxF	Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes	1.3	5.3%
W	Water	0.9	3.5%
<b>Totals for Area of Interest</b>		<b>24.7</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties

## Custom Soil Resource Report

and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

## Custom Soil Resource Report

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## Blair County, Pennsylvania

### Ba—Basher soils

#### Map Unit Setting

*National map unit symbol:* 16b3

*Elevation:* 400 to 840 feet

*Mean annual precipitation:* 30 to 45 inches

*Mean annual air temperature:* 45 to 54 degrees F

*Frost-free period:* 120 to 187 days

*Farmland classification:* Farmland of statewide importance

#### Map Unit Composition

*Basher and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Basher

##### Setting

*Landform:* Flood plains

*Landform position (two-dimensional):* Toeslope

*Landform position (three-dimensional):* Tread

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Reddish alluvium derived from sedimentary rock

##### Typical profile

*H1 - 0 to 5 inches:* silt loam

*H2 - 5 to 24 inches:* silt loam

*H3 - 24 to 56 inches:* loam

*H4 - 56 to 65 inches:* very gravelly sand

##### Properties and qualities

*Slope:* 0 to 3 percent

*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock

*Natural drainage class:* Moderately well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)

*Depth to water table:* About 12 to 36 inches

*Frequency of flooding:* Frequent

*Frequency of ponding:* None

*Available water storage in profile:* Moderate (about 8.7 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3w

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

#### Minor Components

##### Barbour

*Percent of map unit:* 10 percent

*Hydric soil rating:* No

**Holly**

*Percent of map unit:* 5 percent  
*Landform:* Flood plains  
*Landform position (two-dimensional):* Toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Concave  
*Hydric soil rating:* Yes

**BrB—Brinkerton silt loam, 3 to 8 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 16bh  
*Elevation:* 300 to 3,000 feet  
*Mean annual precipitation:* 30 to 65 inches  
*Mean annual air temperature:* 46 to 59 degrees F  
*Frost-free period:* 120 to 217 days  
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Brinkerton and similar soils:* 75 percent  
*Minor components:* 25 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Brinkerton**

**Setting**

*Landform:* Depressions  
*Landform position (two-dimensional):* Toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Concave  
*Parent material:* Local fine-silty colluvium derived from sedimentary rock

**Typical profile**

*H1 - 0 to 9 inches:* silt loam  
*H2 - 9 to 18 inches:* silty clay loam  
*H3 - 18 to 46 inches:* silty clay loam  
*H4 - 46 to 65 inches:* channery silt loam

**Properties and qualities**

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* 15 to 34 inches to fragipan  
*Natural drainage class:* Poorly drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* About 0 to 6 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None

## Custom Soil Resource Report

*Available water storage in profile:* Low (about 3.4 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4w

*Hydrologic Soil Group:* D

*Hydric soil rating:* Yes

### Minor Components

#### Ernest

*Percent of map unit:* 10 percent

*Hydric soil rating:* No

#### Laidig

*Percent of map unit:* 5 percent

*Landform:* Mountains

*Landform position (two-dimensional):* Footslope

*Landform position (three-dimensional):* Lower third of mountainflank

*Down-slope shape:* Concave

*Across-slope shape:* Concave

*Hydric soil rating:* No

#### Berks

*Percent of map unit:* 5 percent

*Landform:* Ridges, valleys

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Convex, linear

*Across-slope shape:* Convex, linear

*Hydric soil rating:* No

#### Atkins

*Percent of map unit:* 3 percent

*Landform:* Flood plains

*Down-slope shape:* Concave

*Across-slope shape:* Concave

*Hydric soil rating:* Yes

#### Philo

*Percent of map unit:* 2 percent

*Hydric soil rating:* No

## CbB—Clarksburg silt loam, 3 to 8 percent slopes

### Map Unit Setting

*National map unit symbol:* 16bq

*Elevation:* 200 to 1,500 feet

*Mean annual precipitation:* 32 to 48 inches

*Mean annual air temperature:* 48 to 57 degrees F

*Frost-free period:* 120 to 200 days

*Farmland classification:* All areas are prime farmland

**Map Unit Composition**

*Clarksburg and similar soils:* 90 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Clarksburg**

**Setting**

*Landform:* Valley flats

*Landform position (two-dimensional):* Toeslope, footslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear, concave

*Across-slope shape:* Concave, linear

*Parent material:* Residuum weathered from limestone

**Typical profile**

*Ap - 0 to 8 inches:* silt loam

*Bt - 8 to 27 inches:* silt loam

*Btx - 27 to 51 inches:* silt loam

*C - 51 to 84 inches:* silt loam

**Properties and qualities**

*Slope:* 3 to 8 percent

*Depth to restrictive feature:* 20 to 36 inches to fragipan; 60 to 99 inches to

*Natural drainage class:* Moderately well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.60 in/hr)

*Depth to water table:* About 18 to 36 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Low (about 4.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

**Minor Components**

**Thorndale**

*Percent of map unit:* 5 percent

*Landform:* Depressions

*Landform position (two-dimensional):* Footslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Concave

*Across-slope shape:* Linear, concave

*Hydric soil rating:* Yes

## **EdD—Edom silty clay loam, 15 to 25 percent slopes**

### **Map Unit Setting**

*National map unit symbol:* 16bz  
*Elevation:* 480 to 1,100 feet  
*Mean annual precipitation:* 36 to 46 inches  
*Mean annual air temperature:* 48 to 55 degrees F  
*Frost-free period:* 150 to 210 days  
*Farmland classification:* Not prime farmland

### **Map Unit Composition**

*Edom and similar soils:* 100 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Edom**

#### **Setting**

*Landform:* Hillslopes, valleys  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Clayey residuum weathered from limestone and shale

#### **Typical profile**

*H1 - 0 to 8 inches:* silty clay loam  
*H2 - 8 to 35 inches:* channery clay  
*H3 - 35 to 67 inches:* channery clay  
*H4 - 67 to 71 inches:* bedrock

#### **Properties and qualities**

*Slope:* 15 to 25 percent  
*Depth to restrictive feature:* 40 to 72 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Moderate (about 6.1 inches)

#### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* B  
*Hydric soil rating:* No

## HeD—Hagerstown-Rock outcrop complex, 8 to 25 percent slopes

### Map Unit Setting

*National map unit symbol:* 16c9  
*Elevation:* 400 to 3,000 feet  
*Mean annual precipitation:* 30 to 46 inches  
*Mean annual air temperature:* 44 to 57 degrees F  
*Frost-free period:* 130 to 200 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Hagerstown and similar soils:* 50 percent  
*Rock outcrop:* 30 percent  
*Minor components:* 5 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Hagerstown

#### Setting

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Residuum weathered from limestone

#### Typical profile

*H1 - 0 to 14 inches:* silty clay loam  
*H2 - 14 to 40 inches:* clay  
*H3 - 40 to 60 inches:* silty clay loam

#### Properties and qualities

*Slope:* 8 to 25 percent  
*Depth to restrictive feature:* 40 to 84 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* High (about 10.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 6s  
*Hydrologic Soil Group:* B  
*Hydric soil rating:* No

**Description of Rock Outcrop**

**Setting**

*Landform:* Valley sides

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Mountainflank

*Down-slope shape:* Linear, convex

*Across-slope shape:* Linear, convex

*Parent material:* Bedrock exposures

**Properties and qualities**

*Depth to restrictive feature:* 0 to 4 inches to lithic bedrock

**Minor Components**

**Opequon**

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

**MnC—Mertz channery silt loam, 8 to 15 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 16db

*Mean annual precipitation:* 36 to 50 inches

*Mean annual air temperature:* 46 to 59 degrees F

*Frost-free period:* 120 to 214 days

*Farmland classification:* Farmland of statewide importance

**Map Unit Composition**

*Mertz and similar soils:* 90 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Mertz**

**Setting**

*Landform:* Ridges

*Landform position (two-dimensional):* Summit

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Cherty residuum weathered from cherty limestone

**Typical profile**

*H1 - 0 to 21 inches:* channery silt loam

*H2 - 21 to 60 inches:* gravelly clay loam

*H3 - 60 to 80 inches:* very gravelly silty clay loam

**Properties and qualities**

*Slope:* 8 to 15 percent

## Custom Soil Resource Report

*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Moderate (about 8.4 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 3e  
*Hydrologic Soil Group:* C  
*Hydric soil rating:* No

### Minor Components

#### Hublersburg

*Percent of map unit:* 5 percent  
*Landform:* Ridges on valleys  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Hydric soil rating:* No

## MsD—Morrison very stony sandy loam, 8 to 25 percent slopes

### Map Unit Setting

*National map unit symbol:* 16dk  
*Elevation:* 600 to 1,800 feet  
*Mean annual precipitation:* 35 to 50 inches  
*Mean annual air temperature:* 46 to 55 degrees F  
*Frost-free period:* 120 to 180 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Morrison and similar soils:* 90 percent  
*Minor components:* 10 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Morrison

#### Setting

*Landform:* Ridges  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Crest, side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear

## Custom Soil Resource Report

*Parent material:* Residuum weathered from limestone and sandstone

### Typical profile

*H1 - 0 to 14 inches:* sandy loam

*H2 - 14 to 53 inches:* sandy loam

*H3 - 53 to 74 inches:* channery sandy loam

### Properties and qualities

*Slope:* 8 to 25 percent

*Percent of area covered with surface fragments:* 1.6 percent

*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock

*Natural drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Moderate (about 6.3 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 6s

*Hydrologic Soil Group:* A

*Hydric soil rating:* No

### Minor Components

#### Murrill

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

#### Vanderlip

*Percent of map unit:* 5 percent

*Landform:* Ridges

*Landform position (two-dimensional):* Summit, shoulder

*Landform position (three-dimensional):* Mountaintop, side slope

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Hydric soil rating:* No

## OuC—Opequon silty clay loam, 8 to 15 percent slopes

### Map Unit Setting

*National map unit symbol:* 2sg9v

*Elevation:* 300 to 3,000 feet

*Mean annual precipitation:* 37 to 50 inches

*Mean annual air temperature:* 46 to 56 degrees F

*Frost-free period:* 155 to 192 days

*Farmland classification:* Farmland of statewide importance

**Map Unit Composition**

*Opequon and similar soils:* 90 percent

*Minor components:* 10 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Opequon**

**Setting**

*Landform:* Hills

*Landform position (two-dimensional):* Shoulder, summit, backslope

*Landform position (three-dimensional):* Nose slope, side slope, crest

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Clayey residuum weathered from limestone and dolomite

**Typical profile**

*Ap - 0 to 5 inches:* silty clay loam

*Bt1 - 5 to 13 inches:* silty clay

*Bt2 - 13 to 16 inches:* silty clay

*R - 16 to 26 inches:* bedrock

**Properties and qualities**

*Slope:* 8 to 15 percent

*Depth to restrictive feature:* 12 to 20 inches to lithic bedrock

*Natural drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Salinity, maximum in profile:* Nonsaline (0.0 to 0.2 mmhos/cm)

*Available water storage in profile:* Very low (about 1.3 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4s

*Hydrologic Soil Group:* D

*Hydric soil rating:* No

**Minor Components**

**Hagerstown**

*Percent of map unit:* 5 percent

*Landform:* Ridges

*Landform position (two-dimensional):* Backslope, footslope

*Landform position (three-dimensional):* Side slope, base slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Hydric soil rating:* No

**Rock outcrop**

*Percent of map unit:* 5 percent

*Landform:* Hills

*Landform position (two-dimensional):* Shoulder, summit, backslope

*Landform position (three-dimensional):* Nose slope, side slope, crest

## Custom Soil Resource Report

*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Hydric soil rating:* No

### **OxF—Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes**

#### **Map Unit Setting**

*National map unit symbol:* 16dv  
*Elevation:* 300 to 3,000 feet  
*Mean annual precipitation:* 30 to 46 inches  
*Mean annual air temperature:* 44 to 59 degrees F  
*Frost-free period:* 130 to 200 days  
*Farmland classification:* Not prime farmland

#### **Map Unit Composition**

*Opequon and similar soils:* 40 percent  
*Hagerstown and similar soils:* 30 percent  
*Rock outcrop:* 20 percent  
*Minor components:* 8 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### **Description of Opequon**

##### **Setting**

*Landform:* Hills  
*Landform position (two-dimensional):* Backslope, shoulder, summit  
*Landform position (three-dimensional):* Side slope, crest  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from limestone

##### **Typical profile**

*H1 - 0 to 8 inches:* silty clay loam  
*H2 - 8 to 16 inches:* silty clay  
*H3 - 16 to 20 inches:* bedrock

##### **Properties and qualities**

*Slope:* 35 to 50 percent  
*Depth to restrictive feature:* 12 to 20 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Very low (about 2.7 inches)

##### **Interpretive groups**

*Land capability classification (irrigated):* None specified

## Custom Soil Resource Report

*Land capability classification (nonirrigated):* 7e  
*Hydrologic Soil Group:* D  
*Hydric soil rating:* No

### Description of Hagerstown

#### Setting

*Landform:* Valley floors, ridges  
*Landform position (two-dimensional):* Shoulder, backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear, convex  
*Across-slope shape:* Linear, convex  
*Parent material:* Residuum weathered from limestone

#### Typical profile

*H1 - 0 to 8 inches:* silty clay loam  
*H2 - 8 to 41 inches:* clay  
*H3 - 41 to 60 inches:* clay

#### Properties and qualities

*Slope:* 35 to 45 percent  
*Depth to restrictive feature:* 40 to 84 inches to lithic bedrock  
*Natural drainage class:* Well drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* High (about 10.4 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* B  
*Hydric soil rating:* No

### Description of Rock Outcrop

#### Setting

*Landform:* Valley sides  
*Landform position (two-dimensional):* Backslope, shoulder  
*Down-slope shape:* Convex, linear  
*Across-slope shape:* Convex, linear  
*Parent material:* Bedrock exposures

### Minor Components

#### Hublersburg

*Percent of map unit:* 5 percent  
*Landform:* Ridges on valleys  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Hydric soil rating:* No

## Custom Soil Resource Report

### **Clarksburg**

*Percent of map unit:* 2 percent  
*Hydric soil rating:* No

### **Holly**

*Percent of map unit:* 1 percent  
*Landform:* Flood plains  
*Landform position (two-dimensional):* Toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Concave  
*Across-slope shape:* Concave  
*Hydric soil rating:* Yes

## **W—Water**

### **Map Unit Setting**

*National map unit symbol:* 16f9  
*Mean annual precipitation:* 36 to 50 inches  
*Mean annual air temperature:* 46 to 59 degrees F  
*Frost-free period:* 120 to 214 days  
*Farmland classification:* Not prime farmland

### **Map Unit Composition**

*Water:* 100 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Water**

#### **Setting**

*Parent material:* Rivers streams ponds

#### **Properties and qualities**

*Runoff class:* Negligible  
*Frequency of ponding:* Frequent

# References

---

- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_054262](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262)
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053577](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577)
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053580](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580)
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2\\_053374](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374)
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

## Custom Soil Resource Report

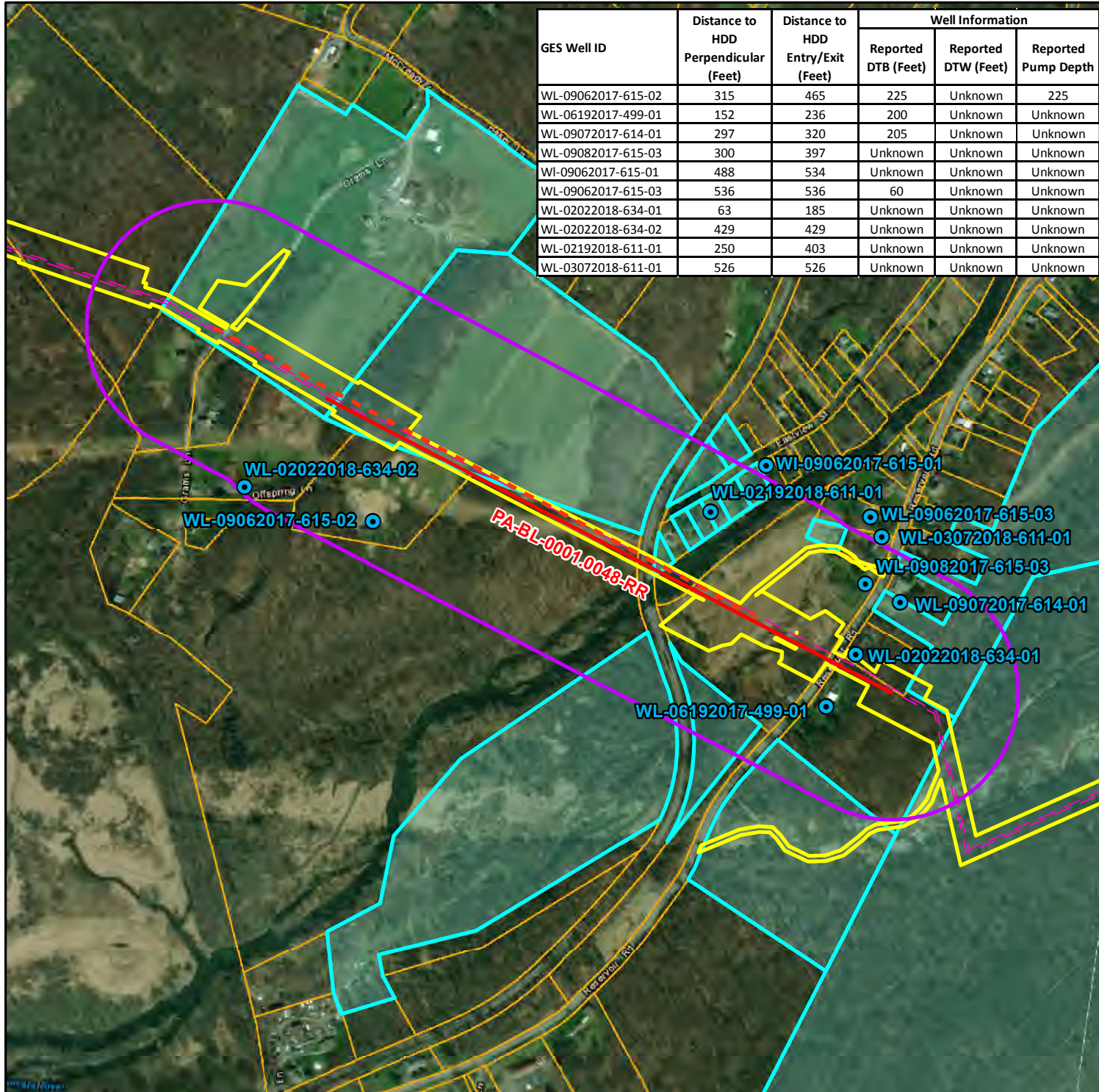
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242)

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053624](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624)

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_052290.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf)



**ATTACHMENT 3  
450-FOOT WELL SURVEY**



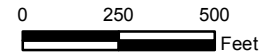
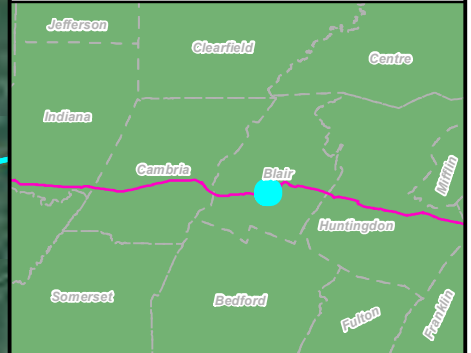
**Legend**

- LOD
- Parcel
- PPP Centerline
- PPP 1 HDD
- Proposed PPP 2 HDD Redesign
- 450 foot buffer of HDD alignment
- Public Water Supply/Landowner Confirmed No Well

**\*\*Testing locations current as of 02/28/2019**

- GES Testing Location

**Location**



**Well Location Map**  
 HDD# PA-BL-0001.0048-RR  
 Blair County, PA.

Prepared By:



Date:  
 2/28/2019

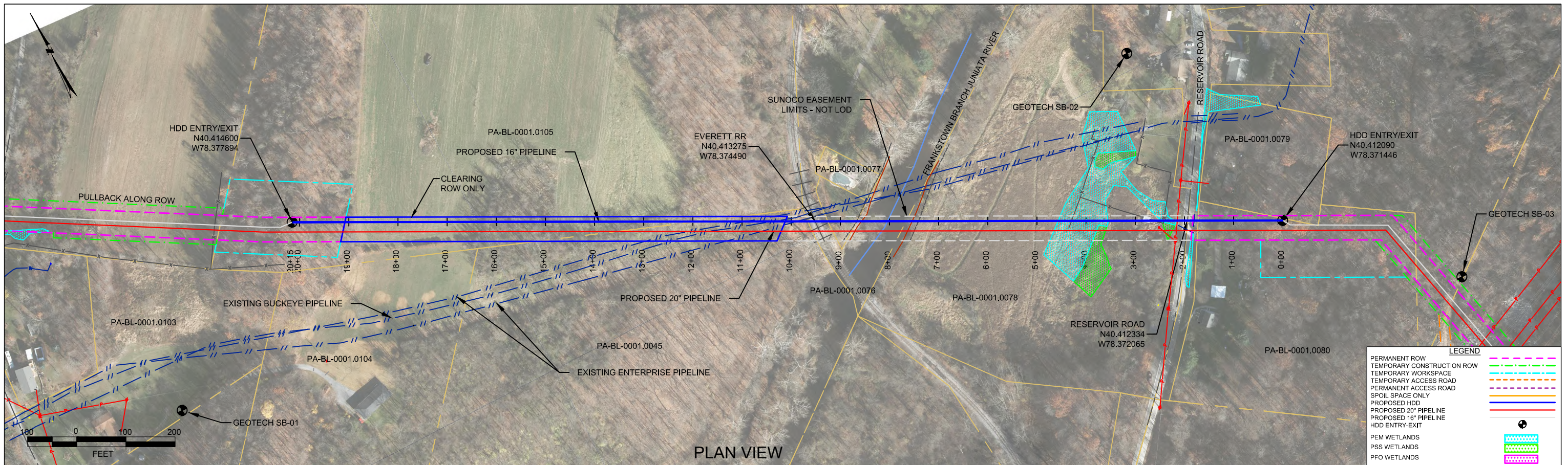
Base Map:  
 ESRI World Imagery, 09/24/2015

Coordinate System: NAD 83 Stateplane, PA South, Feet

C:\GIS\workspace\12\02\05\PA-BL-0001\WellLocations\WellLocations\_PA\_BL\_0001\_0048.mxd

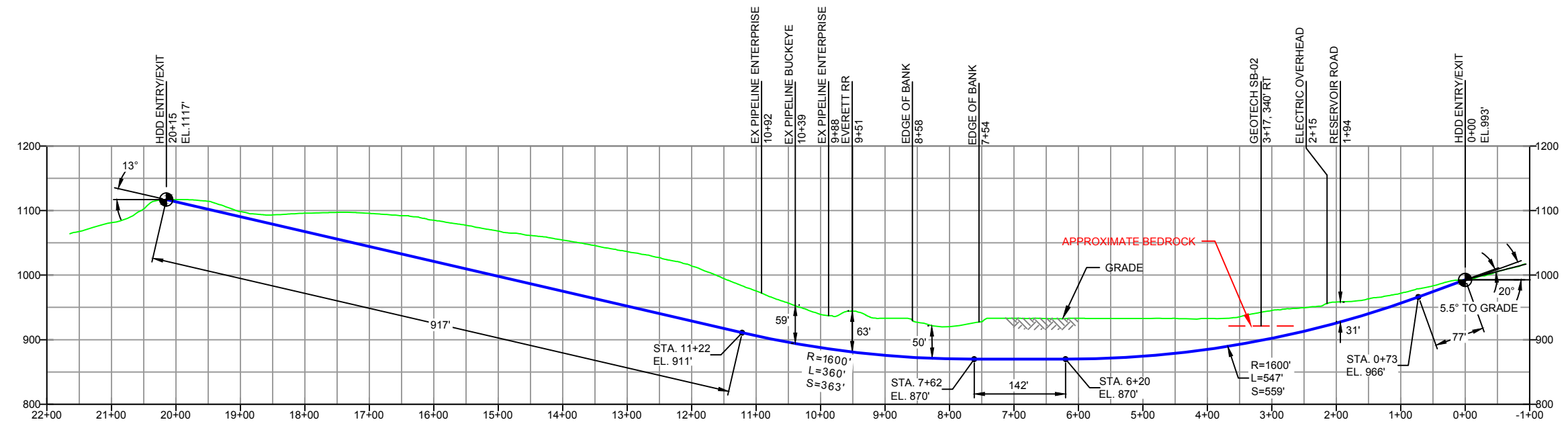
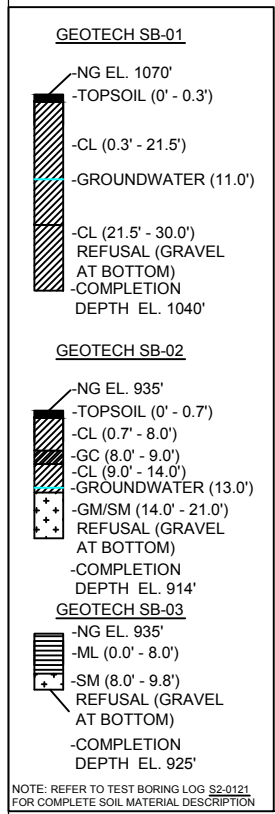
**HORIZONTAL DIRECTIONAL DRILL ANALYSIS  
EVERETT RAILROAD CROSSING  
PADEP SECTION 105 PERMIT NO.: E07-459  
PA-BL-0001.0048-RR  
(SPLP HDD# S2-0121-16)**

**ATTACHMENT 2  
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES  
CONVENTIONAL AUGER BORE PROFILE**



BLAIR COUNTY, PENNSYLVANIA - BLAIR TOWNSHIP  
S2-0121-16

PLAN VIEW  
PROFILE VIEW



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
  - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
  - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
  - CROSSING PIPE SPECIFICATION:  
HDD HORZ. LENGTH (L=): 2015'  
HDD PIPE LENGTH (S=): 2058'  
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW  
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
  - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
  - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
  - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
  - CARRIER PIPE NOT ENCASED.
  - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
  - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
  - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
  - BLASTING NOT PERMITTED.
  - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
  - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
  - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 1. Permitted 16-Inch HDD Plan and Profile

NOTES

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	REVISED PROFILE WITH 2017 LIDAR	MRS	03/20/17	RMB	03/20/17	CAG	03/20/17
3	DESIGN CHANGE	DLM	09/08/16	RMB	09/08/16	AAW	09/08/16
2	REVISED PER ENGINEERING COMMENTS	DLM	08/26/16	RMB	08/26/16	AAW	08/26/16
1	ADDED "CLEARING ROW ONLY" ANNOTATION	MRS	03/28/16	RMB	03/28/16	AAW	03/28/16
0	ISSUED FOR CONSTRUCTION	MRS	12/22/15	RMB	12/22/15	AAW	12/22/15

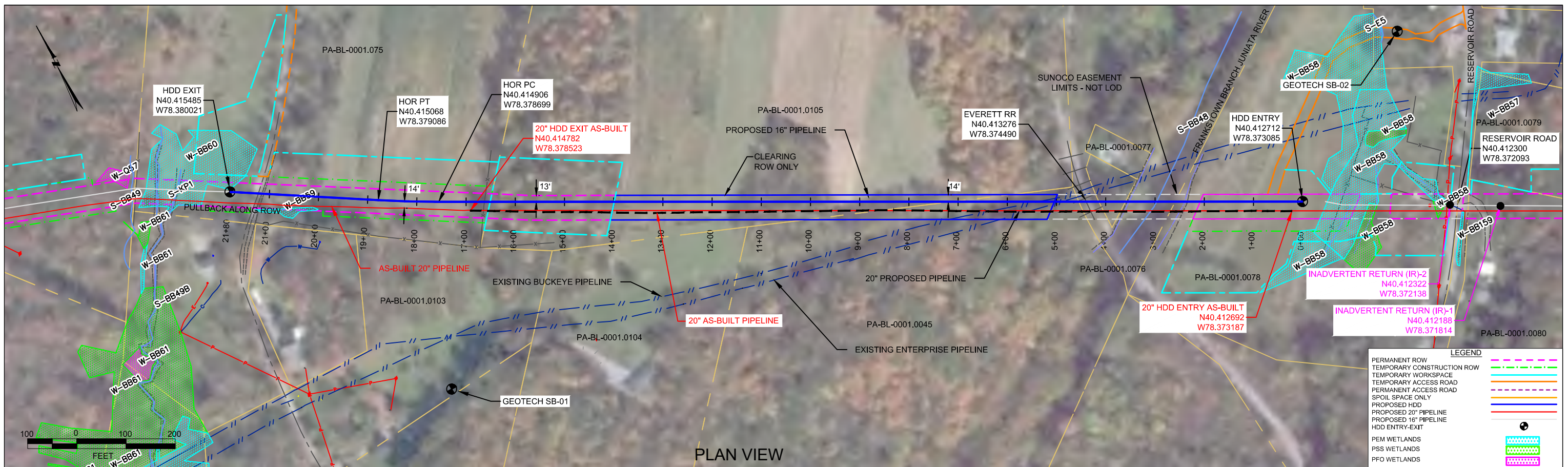
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL  
EVERETT RR/ RESERVOIR RD  
PENNSYLVANIA PIPELINE PROJECT

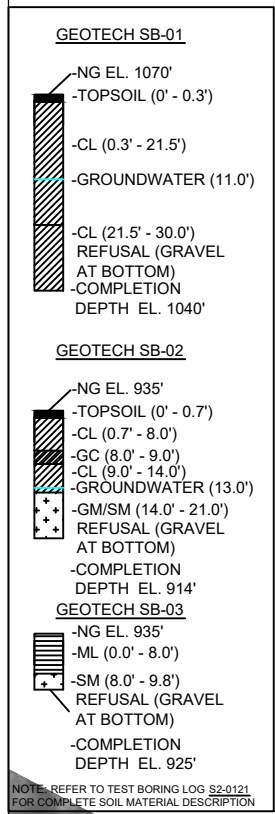
TETRA TECH ROONEY  
(303) 792-5911

SCALE: 1"=200'

DWG. NO. PA-BL-0001.0048-RR-16



BLAIR COUNTY, PENNSYLVANIA - BLAIR TOWNSHIP  
S2-0121-16



- DESIGN AND CONSTRUCTION:**
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
  - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
  - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
  - CROSSING PIPE SPECIFICATION:  
 HDD HORZ. LENGTH (L-): 2180'  
 HDD PIPE LENGTH (S-): 2205'  
 16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW  
 COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWDERCOATE R95)
  - INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
  - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
  - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
  - CARRIER PIPE NOT ENCASED.
  - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
  - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.

- PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
- BLASTING NOT PERMITTED.
- SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
- SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
- SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 2. Revised 16-Inch HDD Plan and Profile

**NOTES**

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES.
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP. FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
ES-3.32	TO	ES-3.34	DESCRIPTION
SHEET 20	TO	SHEET 20	AERIAL SITE PLAN
		EP9	RELOCATED DRILL ENTRY
		EP8	DESIGN CHANGE PER DPS
		EP7	RELOCATED DRILL ENTRY/EXIT - DESIGN CHANGE PER ENVIRONMENTAL
		EP6	UPDATED NOTE 5 AND 10 PER INCREASED 16" MOP
		EP5	ATWS USE RESTRICTION NOTE ADDED ON EAST SIDE OF DRILL
		EP4	ATWS ADDED ON EAST SIDE OF DRILL
DWG NO	DWG NO	NO.	DESCRIPTION

**Sunoco Logistics Partners L.P.**

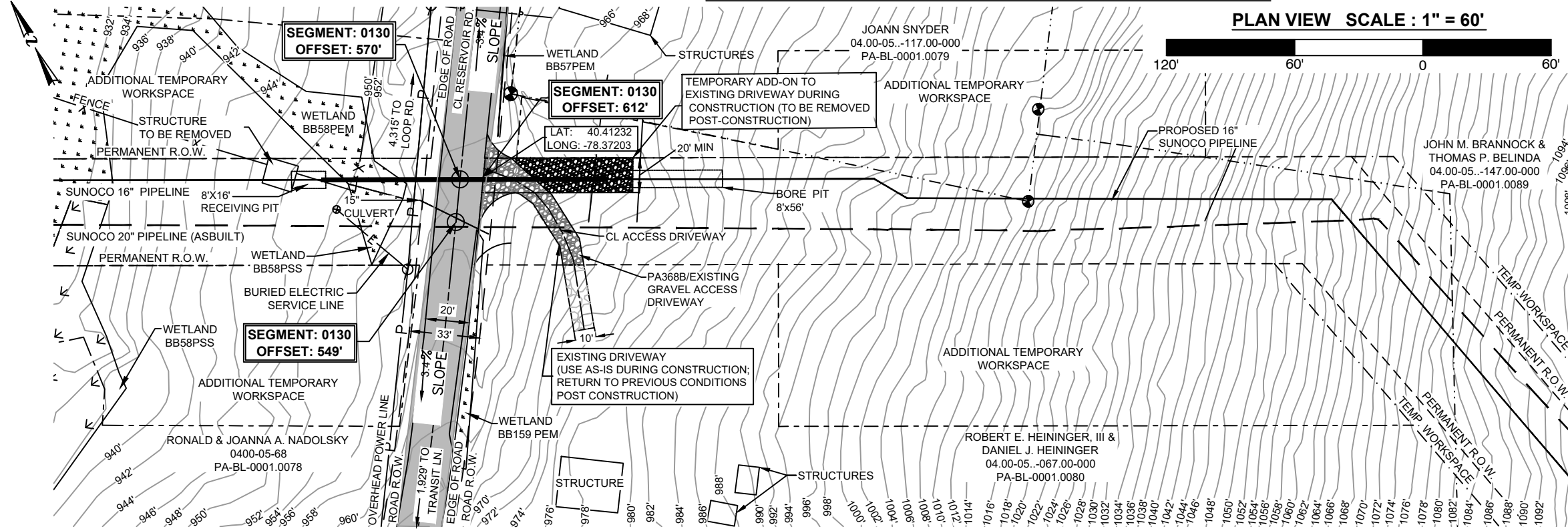
**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

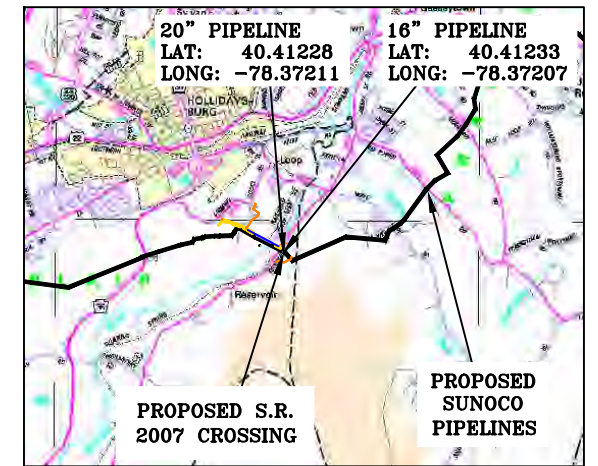
HORIZONTAL DIRECTIONAL DRILL  
EVERETT RR/ RESERVOIR RD  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-BL-0001.0048-RR-16

**BLAIR TOWNSHIP, BLAIR COUNTY, PENNSYLVANIA**



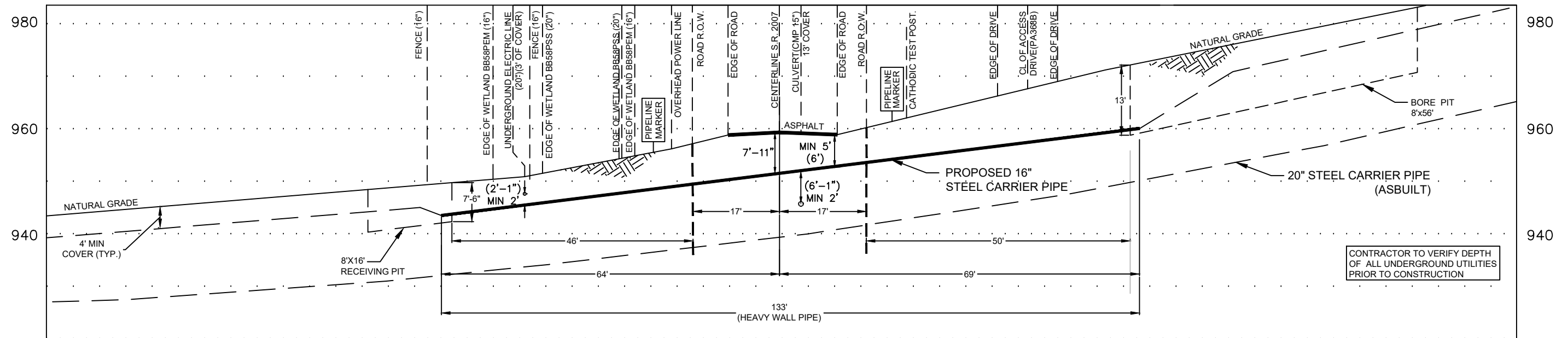
PLAN VIEW SCALE : 1" = 60'



AERIAL VIEW SCALE : 1" = 2MI

DRAWING LEGEND	
	PERMANENT R.O.W.
	TEMPORARY WORKSPACE
	ROAD R.O.W.
	POWER POLE
	OVERHEAD POWER LINE
	ADDITIONAL TEMPORARY WORKSPACE
	PROPERTY LINE
	MONUMENT/HDD EXIT
	ELECTRIC LINE
	LIGHT POLE
	PIPELINE
	GRAVEL COVER

**RESERVOIR ROAD / S.R. 2007**



**ROAD NOTES**  
(APPLIES TO BOTH 16" & 20" PIPELINES)

- 20" WELDED STEEL PIPE 20" OD x .456 WT., X-65, API 5L, PSL2, ERW, DRL
- 16" WELDED STEEL PIPE 16" OD x .438 WT., X-70, API 5L, PSL2, ERW, BFW
- COATING: 14-16 MILS OF 3M SCOTCHKOTE TM 6233 FBE WITH 40 MILS MIN. DFT POWERCRETE R95
- DESIGN FACTOR: 0.50 (HOOP STRESS)
- DESIGN PSI: 1480 PSIG TEST PSI: 1850
- WELDING PROCESS(ES): ALL WELDING IS DONE IN ACCORDANCE TO PENNDOT AND APPROVED SUNOCO PROCEDURES.
- THE COATING ON THE CARRIER PIPE SHALL BE INSPECTED IMMEDIATELY PRIOR TO ITS INSTALLATION AND ALL DAMAGED COATING SHALL BE REPAIRED IN ACCORDANCE WITH SUNOCO PIPELINE SPECIFICATIONS
- PIPELINE CROSSING SHALL BE AS NEAR TO PERPENDICULAR TO THE ROADWAY CENTERLINE AS PRACTICAL
- INSTALL CATHODIC PROTECTION TEST LEADS AS SPECIFIED ON THE ALIGNMENT SHEETS OR SUNOCO CORROSION TECHNICIAN
- WELDED JOINTS INSIDE R.O.W. SHALL BE 100% X-RAYED
- PENNDOT LEGAL RIGHT OF WAY WIDTH 33'
- BORE LENGTH: +/- 102'-10" (16") (APPROX).

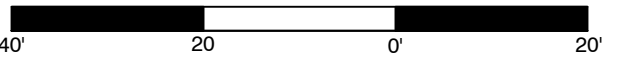
**CONSTRUCTION NOTES**

- CONTRACTOR WILL MAINTAIN 4' OF COVER TO THE TOP OF PIPE OUTSIDE OF ROAD R.O.W. USING FIELD BENDS
- CONTRACTOR SHALL USE THE "ONE CALL" SYSTEM PRIOR TO BEGINNING WORK. CONTRACTOR SHALL BE RESPONSIBLE TO LOCATE AND VERIFY ALL PARALLEL AND CROSSED UTILITIES PRIOR TO EXCAVATION OR CONSTRUCTION (AND MONITOR DURING EXCAVATION OR CONSTRUCTION). THIS DRAWING SHALL NOT CONSTITUTE VERIFICATION OF LOCATION, QUANTITY, SIZE, DEPTH, OR TYPES OF EXISTING UTILITIES.
- EMERGENCY CONTACT INFORMATION: SEE INCLUDED COMPANY INFORMATION
- UPON COMPLETION, UTILITY WILL BE REGISTERED WITH PENNSYLVANIA ONE-CALL SYSTEM
- ALL WORK AND MATERIALS SHALL CONFORM WITH PENNDOT AND ALL FEDERAL REGULATIONS AND STANDARDS
- SUNOCO PIPELINE, L.P. WILL BE AVAILABLE 24/7 FOR EMERGENCY AT 800-786-7440 IF SUCH A PROBLEM SHOULD ARISE.
- THIS PLAN IS FOR PERMITTING PURPOSES ONLY

**PER PUBLICATION 16M; DESIGN MANUAL PART 5, CHAPTER 1.3.D FOR UNCASD PIPELINE:**

- CATHODIC PROTECTION TEST LEADS ARE INSTALLED AS SPECIFIED ON THE ALIGNMENT SHEETS PER SUNOCO'S CORROSION PROGRAM.
- PLASTIC PIPE WILL NOT BE USED; ONLY WELDED STEEL.
- DUCTILE IRON OR REINFORCED CONCRETE WILL NOT BE USED; ONLY WELDED STEEL.
- THE WALL THICKNESS SHOWN ON THE DRAWINGS MEET OR EXCEED ALL APPLICABLE FEDERAL AND INDUSTRY STANDARDS.
- THE OPERATING STRESS LEVELS INDICATED ON THE DRAWINGS ARE IN ACCORDANCE WITH THE FEDERAL PIPELINE SAFETY REGULATIONS.

**PROFILE**  
HORIZ. SCALE : 1" = 20'  
VERT. SCALE : 1" = 20'



**COORDINATE SYSTEM**  
PENNSYLVANIA STATE PLANE SOUTH NAD 83 US FEET

R.O.W. INGRESS  
X=1795255.37  
Y=393665.87  
  
R.O.W. EGRESS  
X=1795284.82  
Y=393650.60

**24/7 CONTACT INFO & PIPE MARKER INFO:**

**SUNOCO PIPELINE L.P.**  
525 FRITZTOWN ROAD  
SINKING SPRING, PA 19608  
PHONE NUMBER: 800-786-7440  
NATURAL GAS PIPELINE

CENTERLINE REV DATE: 05-04-2016

Figure 3. Conventional Bore Plan and Profile of Reservoir Road

PA368B DRIVEWAY EPS APP#: 106403  
ROAD CROSSING EPS APP#: 103204

<b>SUNOCO</b>		
RESERVOIR ROAD / S.R. 2007		
BLAIR TOWNSHIP, BLAIR CO., PA		
03/31/15	SCALE	AS SHOWN
REVISED	AS NOTED	DWG #: PPP-PA-BL-0001.0078-RD
02/04/19		
Prepared by		
		<b>A</b>