

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS
OLD US 220 HIGHWAY CROSSING
PADEP SECTION 105 PERMIT NO.: E07-459
(SPLP HDD No. S2-0109-16)**

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This reevaluation of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses Old US Highway 220 Highway, Stream S-M69, and wetlands W-M49 and W-M79, 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 4 on the list of HDDs included on Exhibit 3 of the Order.

The first pipeline HDD had three inadvertent returns (IRs), which were remediated in conjunction with the installation of the 20-inch diameter pipeline.

The 16-inch pipeline HDD is referred to herein as HDD S2-0109-16.

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: 1,912 foot (ft)
- Entry/Exit angle: 8 - 20 degrees
- Maximum Depth of cover: 79 ft
- Depth of cover under streams: 51 ft
- Pipe design radius: 1,600 ft

ROOT CAUSE ANALYSIS FOR THE 20" PIPE INSTALLATION IR

Three (3) IR events occurred during completion of this HDD. One IR during the pilot drilling at 320 ft before exiting; a second IR event immediately before exiting (a "Punch Out" IR), and a third during exiting of the 30 inch reaming tool immediately at the exit point. Based upon a review of the drilling records the shallow profile depth and clogging of the annulus attributed to the occurrence of these events.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

The Old US 220 HDD 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 bedrock in the area is primarily in the middle and lower Devonian period aged Hamilton Group, with the eastern exit/entry point within the Devonian-aged Onondaga and Old Port Formations, undivided.

The Hamilton Group consists of the Mahantango Formation, a gray, dark gray, brown, and olive laminated shale; siltstone; and very fine-grained sandstone or claystone containing marine fossils. It overlies the Marcellus Shale, a fissile gray-black to black, thinly laminated, pyritic, carbonaceous thin shale with sparse marine fauna and siderite concretions. The total thickness of the Hamilton Group in Pennsylvania runs about 970 feet.

The Onondaga Formation component consists of gray calcareous, sandy shale. The Old Port Formation consists of varying lithologies including limestone, cherty limestone, shale, and sandstone components.

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Karst geology is not present at this location. SPLP possesses a complete geologic profile from the HDD of the 20-inch pipeline and no further geologic information is needed.

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

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Groundwater at the site occurs in a fractured carbonate and sedimentary bedrock aquifer system within the geologic units described above. In these rock types of Blair County, water-bearing zones generally occur in the secondary openings along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures that may be sufficiently enlarged by dissolution of the bedrock to provide pathways for the transport of water.

The depths of 243 domestic and non-domestic water supply wells completed in the Hamilton Group range from 10 to 695 feet below ground surface (bgs), with yields ranging from 1 to 380 gallons per minute (gpm). The median well depth for domestic wells is 173 feet bgs and 300 feet bgs for non-domestic wells. The median well yield for domestic wells is 12 gpm and 38 gpm for non-domestic wells.

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 with median well yields of 10 gpm for domestic wells and 66 gpm for non-domestic wells.

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

INADVERTENT RETURN (IR) DISCUSSION

Two IR events occurred during the pilot hole drilling with approximately 100 gallons of drilling fluids being released on the first event and approximately 300 gallons of drilling fluids were released during the second event as the pilot hole was being completed. As the 30-inch ream pass was being completed, an IR was observed near the limit of disturbance (LOD) with approximately 30 gallons of drilling fluids flowing outside of the LOD.

ADJACENT FEATURES ANALYSIS

The HDD location is 1.0 miles south-southwest of the city of Duncansville in Blair County and is set within a mixture of residential home sites, commercial/industrial businesses, deciduous woodlands, and pasture. The general route of the Mariner II pipeline in this area is from west to east.

The crossing of stream S-M69 extends north and south of the pipeline alignment. Wetland W-M49 extends to the north and south of the pipeline alignment and Wetland W-M79 extends to the north of the alignment. Near the crossing of Old US 220 Highway, Wetland BB47 and Stream S-L82 are located 130 ft south of the pipeline alignment, and Wetland W-L60 and Stream S-L81 are located 340 ft south of the pipeline alignment.

Individual home sites occur in the immediate vicinity of the HDD location along both sides of Old US 220 Highway with the nearest home site located 165 ft north of the alignment.

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During the original project planning by SPLP a survey of land owners within 150 feet of the ROW was performed. All land owners were contacted with an offer for SPLP to test their wells, one landowner requested that their well be tested.

SPLP has more recently identified all landowners with property located within 450 ft of the HDD alignment. There are 24 individual landowners with properties located within 450 ft of the HDD alignment. SPLP sent each of these landowners a notice letter via both certified and first-class mail on August 18, 2017, 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.

SPLP identified and tested four (4) water wells within 450 ft of the HDD profile. No new parcels are encumbered by the proposed 16-inch redesign.

No complaints from adjacent water well owners were received during installation of the 20-inch pipeline.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of HDD S2-0109-16 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 a number of 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 baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures.

As described below, several alternatives to the previously permitted HDD were evaluated.

Open-cut and Conventional Bore 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, construction through wetlands W-M49 and W-M79 and Stream S-M69 would require a minimum authorized open cut work space 75 ft in width to accommodate the 16-inch diameter pipeline and provide sufficient space for trench excavation and spoil storage. The assessed area of impact by this open cut plan would directly affect 0.03 acre of stream bed and 0.3 acre of floodway, and 0.94 acre of exceptional value wetlands, inclusive of 0.65 acre of forested wetlands. Stream S-M69 (Dry Run) is a 10 ft-wide perennial stream. To make this conventional crossing would require damming the stream using an upstream and downstream geotube, while simultaneously pumping around all stream flows, and pumping out of all produced groundwater discharge from the excavated shallow soil horizons and water seepage below the geotube dams installed in the channel for the entire duration of the open cut crossing event. Open cutting this area would result in temporary impacts to two (2) roads, residences, and commercial/industrial properties. Although the temporary impacts would be controlled and managed using these appropriate mitigation measures, the preferred method is to Direct Pipe Bore below these resources.

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The linear expanses of wetlands W-M49 and W-M79 within the pipeline route pathway prohibits use of a single conventional bore installation and would require utilizing several separate bores to complete installation. Equipment ingress and egress through portions of the wetland would be necessary to complete separate bores and would result in wetland impacts. The revised 16-inch HDD profile avoids surficial impacts to a stream and exceptional value wetlands, while reducing the chance of IRs.

Re-Route Analysis

The pipeline route as currently permitted follows an existing SPLP easement and this alignment bypasses or avoids direct impacts to forested wetlands and woodlands.

No practicable re-route option lies to the north or south of the proposed route that would not transect the same forested woodlands and wetlands transected by the proposed route. Shifting the pipeline route north would result in new utility corridor requiring consent of newly-affected landowners or the use of eminent domain/condemnation, and would create a new land encumbrance on every private property crossed. Shifting the line south parallel to an existing utility easement would transect the same forested woodlands and wetlands transected by the proposed route and result in impacts to additional wetlands (W-BB47 and W-L60) and streams (S-L82 and S-L81). 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 the woodlands and wetlands to the north and south of the proposed HDD installation, additional direct effects to infrastructure and creation of a new "greenfield" corridor for any shift north or south, there is no identifiable alternative route that would result in less impacts to forested woodland and wetland resources and associated infrastructure in the vicinity of HDD S2-0109-16.

In accordance with state and federal guidance, SPLP has routed the Project to be co-located with existing pipeline and other utility corridors to avoid new "greenfield" routing alignments, to the maximum extent practicable. This avoids and minimizes new and permanent impacts on previously undisturbed land, land use encumbrance, and site-specific and cumulative impacts on land, environmental, and community resources. The Direct Pipe Bore/open cut construction plan is co-located within the existing SPLP 20-inch diameter pipeline ROW and rerouting would cause new greenfield impacts. In addition, given the size, length, and general perpendicular direction of Stream S-M69 (Dry Run), no practicable re-route option lies to the north or south of the proposed route that would not ultimately cross Dry Run.

This re-route analysis conducted for the Old US 220 Highway HDD installation is consistent with the conclusions reached in the alternatives analysis previously submitted to PADEP.

REDESIGNED HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

The originally designed 16-inch HDD profile was relatively shallow at the entry and exit points and passed through both unconsolidated overburden and fractured bedrock. As a result, the proposed 16-inch HDD profile has been redesigned to be 53 ft longer and allow for a deeper crossings beneath streams and wetlands. The longer and deeper profile, in conjunction with the proposed engineering controls and drilling BMPs, will greatly reduce the risk of inadvertent returns.

A summary of the redesign factors is provided below. The original and redesigned HDD plan and profile drawings are provided in Attachment 2.

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Revised Horizontal Directional Drill Design Summary: 16-inch

- Horizontal length: 1,965 ft
- Entry/Exit angle: 12-20 degrees
- Maximum Depth of cover: 111 ft
- Pipe design radius: 2,400 ft

CONCLUSION

Based on the results of this reevaluation, the 16-inch HDD has been redesigned to allow for deeper crossings beneath S-M69 and wetlands M79 & M49. The deeper profile increases the depth of the proposed 16-inch HDD profile to 107 ft below the stream and increases the depth of protective cover where the previous IRs occurred during the installation of the 20-inch pipe.

Procedures established and documented in SPLP's revised IR Assessment, Preparedness, Prevention, and Contingency (PPC) Plan (April 2018 plan) across all ME II spreads have proven to be very effective in eliminating IRs and minimizing the extent of IRs. Additionally SPLP has engaged and requires proactive responses to Losses of Circulation which precede the occurrence of IRs.

The redesign of the HDD will not prevent all IRs. IR's 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 provide the drilling crew and company inspectors the location(s) data on potential zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis, so that monitoring can be enhanced when drilling through these locations.
- SPLP will require and enforce the use of annular pressure (AP) monitoring during the drilling of the pilot holes, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus to manage development of pressures that can induce an IR;
- SPLP inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipe, is used to ensure adequate "annulus spacing" around the drilling pipe exits to allow good return flows during the pilot drilling;
- SPLP will implement short-tripping of the reaming tools as return flow monitoring indicates 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. The AP below that depth can exceed the effective stabilization capability of LCMs. Accordingly, the preferred corrective action needed to address the presence of fractures or Losses of Circulation at greater depths below ground will require grouting of the HDD annulus. Two types of grouting will be utilized for corrective actions to seal fractures and stabilize zones of weak geology.

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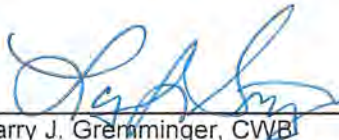
These are: 1) grouting using "neat cement"; and 2) grouting using a sand/cement mix. Neat cement grout is a slurry of Portland cement and water which is highly reactive to bentonite and induces solidification. The sand/cement grout mix is a slurry of mostly sand with a small percentage of Portland cement 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.

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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-evaluation report will minimize the risk of IRs and impacts to public and private water supplies during the construction phases of the HDD.

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

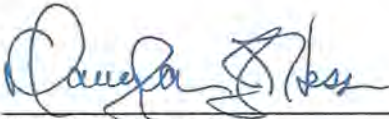


Larry J. Gremminger, CWB
Geotechnical Evaluation Leader
Mariner East 2 Pipeline Project

2-11-2019

Date

Pertaining to the practice of geology



Douglas J. Hess, P.G.
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Director of Groundwater
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Geo-Environmental Services

2-11-19

Date



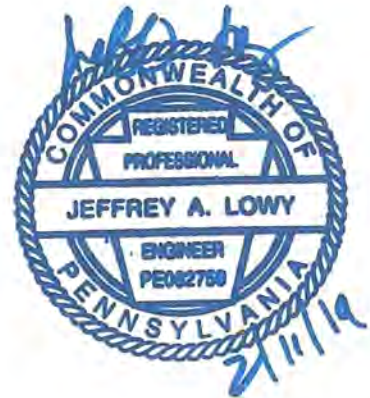
Pertaining to the pipeline stress and HDD geometry



Jeffrey A. Lowy, P.E.
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Rooney Engineering, Inc.
Civil Engineer

2/11/19

Date



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**ATTACHMENT 1
GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT**

February 8, 2019

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

RE: Sunoco Pipeline, L.P. Pipeline Project - Mariner East II
Palmer Lane (Old Route 220) HDD Location S2-0109
PA-BL-0001.0031-RD-16
Hydrogeological Re-Evaluation Report for 16-inch Pipeline
Blair Township, Blair County, Pennsylvania
RETTEW Project No. 096302011

EXECUTIVE SUMMARY

1. This hydrogeologic re-evaluation was prepared as a result of inadvertent returns (IRs) of drilling fluids that occurred at the Palmer Lane (AKA Old Route 220) horizontal directional drill (HDD) S2-0109 location as the 20-inch HDD was being completed.
2. The Palmer Lane HDD site is underlain by carbonate and sedimentary rocks of the Devonian age Hamilton Group (Dh) and Onondaga and Old Port Formations, undivided (Doo).
3. Water-bearing zones in the underlying geology generally occur in secondary openings along bedding planes, joints, faults, fractures, and solution openings. The permeability of these features can be enhanced by dissolution of the carbonate bedrock units.
4. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults, fractures, and solution openings. Water-bearing zones in the Hamilton Group occur most frequently within 350 feet of the ground surface, and within 300 feet of the ground surface in the Onondaga and Old Port Formations.
5. The HDD profile for the proposed 16-inch drill has been redesigned to increase its depth beneath the roads, utilities, stream and wetlands.
6. Based on the hydro-structural characteristics of the underlying geology, information obtained from installation of the 20-inch pipe, and the IR that occurred during the installation of the 20-inch pipe, the Palmer Lane HDD is susceptible to an IR of drilling fluids during HDD operations for the planned 16-inch drill. The redesigned 16-inch HDD profile and proactive HDD best management practices (BMPs) 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 Palmer Lane (S2-0109) HDD location (the site) on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project - Mariner East II (PPP-ME2) Project. The Palmer Lane HDD is located in Blair Township, Blair County, Pennsylvania (refer to **Figure 1**). The HDD was designed to be drilled under Dry Run (S-M69) and two



Palustrine Forested (PFO) wetlands (Wetlands M79PFO and M49PFO). This re-evaluation report was prepared as a result of IRs of drilling fluids that occurred during installation of the 20-inch pipe.

The original 16-inch HDD profile was redesigned on January 8, 2018. The profile was lengthened to deepen the profile beneath the resources described above. The deeper profile increases the depth of the pipe to 107 feet below Dry Run and increases the depth of cover where two IRs occurred during installation of the 20-inch pipe. The redesigned western HDD entry/exit is at a surface elevation of approximately 1,095 feet above mean sea level (AMSL) and the redesigned eastern entry/exit is at an elevation of approximately 1,139 feet AMSL. The as-built 20-inch pipeline and proposed 16-inch HDD locations are shown on **Figure 1**, and the 20-inch as-built profile and redesigned 16-inch profile are included as **Attachment 1**.

2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS, 2001), 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 structures include both 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). Based on the United States Geologic Survey (USGS) 7.5-Minute Aughwick and Blairs Mills Topographic Quadrangle Maps shown on **Figure 1**, the site is situated at an approximate elevation range of 880 to 840 feet AMSL. Surface topography at the site slopes to the east along the proposed HDD bore path towards George Creek. The major surface water feature is George Creek which flows to the northeast and then southeast before discharging into Tuscarora Creek which, in turn, ultimately discharges to the Juniata River.

The site geology is mapped west to east as the Devonian age Hamilton Group and the Onondaga and Old Port Formations, undivided, as shown on **Figure 2** (Berg and Dodge, 1981). The Palmer Lane HDD is located on the west limb of an anticline that has a strike trending north-south and dipping to the west.

The Hamilton Group (Dh) includes the Mahantango Formation (Dmh) and the Marcellus Formation (Dmr). The Mahantango Formation consists of gray, brown and olive interbedded shales, siltstones, and very fine-grained sandstones and claystones containing marine fossils. Oolitic hematite occurs near the top of the Mahantango Formation, while the middle section contains medium to coarse grained sandstone and thin conglomerate layers. The Marcellus Formation consists of very dark to black, fissile, homogeneous carbonaceous shales. The group is well bedded with the shale units having thin to flaggy beds and the sandstone units having thin, flaggy to medium beds. Joints are well developed, closely spaced, mostly open, and steeply dipping. The joints produce smooth, even faced, sharp edged rectangular blocks in the sandstone units. Permeability is described as moderate with joint and bedding plane openings providing a secondary porosity of low to moderate magnitude. The Hamilton Group is poorly to moderately resistant to weathering, with the shale units being less resistant to weathering. The overlying mantle is thin. Slope stability is classified as good in the sandstone units but only fair in the shale. The ease of excavation is classified as moderately easy in the shale to difficult in the siltstone and sandstone. The drilling rates are reported to range from moderate to fast. Foundation stability is good

when material is excavated to sound bedrock. Surface drainage is considered to be good. (Geyer and Wilshusen, 1982).

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 good, provided the excavation is completed to sound material and identified solution cavities are investigated and mitigated (Geyer and Wilshusen, 1982).

According to the United States Department of Agriculture (USDA) Soil Surveys of Blair County, Pennsylvania, soils within approximately 450 feet of the proposed 16-inch drill path for the Palmer Lane HDD consist of six 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 carbonate and sedimentary bedrock aquifer system within the geologic units described in Section 2.0. In these rock types of Blair County, water-bearing zones generally occur in the secondary openings along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures that may be sufficiently enlarged by dissolution of the bedrock to provide pathways for the transport of water (Taylor, 1982). In central Pennsylvania, many of the water-bearing rocks, such as sandstone, alternate with less permeable rocks such as shale. In areas with tilted rock strata or on the flanks of anticlines, such as the Palmer Lane HDD, water flows downdip in the permeable formations (Lohman, 1938). At the S2-0109 location, the proposed HDD exit point is at a higher elevation and position on the limb of the anticline in contrast to the proposed HDD entry point which is at the base of the limb. Based on these geologic structural features, it is assumed that primary groundwater flow is downdip and to the west.

A summary of the review of published information on water wells completed in the Hamilton Group and Onondaga and Old Port Formations is provided below.

The depths of 243 domestic and non-domestic water supply wells completed in the Hamilton Group range from 10 to 695 feet below ground surface (bgs), with yields ranging from 1 to 380 gallons per minute (gpm). The median well depth for domestic wells is 173 feet bgs and 300 feet bgs for non-domestic wells. The median well yield for domestic wells is 12 gpm and 38 gpm for non-domestic wells. Water-bearing zones among 198 wells reviewed are most frequent from 50 to 350 feet bgs and are relatively common to a depth of 350 feet, with the deepest water-bearing zone being reported at 635 feet bgs (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 with median well yields of 10 gpm for domestic wells and 66 gpm for non-domestic wells. Water-bearing zones among 88 wells inventoried showed an even distribution to a depth of 300 feet. Approximately 25% of the wells drilled deeper than 300 feet penetrated water-bearing zones, with the deepest water-bearing zone being reported at 460 feet bgs (Taylor et al., 1982).

Well records reviewed within a 0.5-mile radius of the Palmer Lane HDD location were obtained from the Pennsylvania Groundwater Information System (PaGWIS, January 14, 2019). A total of three well records were available and are summarized below. The well locations are shown on **Figures 2 and 3**.

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gpm)
58581	Domestic	25	45	20	5
58522	Domestic	27	102	13	5
58513	Unknown	40	130	50	10

As a condition of the corrected Stipulated Order, other Sunoco subcontractors researched private water supplies with 450 feet of the Palmer Lane HDD in January 2019. Five water supply wells were identified within the 450-foot buffer of the HDD alignment. Two reported well depths ranged between 150 and 200 feet bgs. Information regarding depth to water was available for only one of the five wells, with a reported depth to water ranging between 40 and 50 feet bgs. The depth to the pump was reported as 75 feet bgs in one of the wells. A map of these locations is included as **Attachment 3**.

4.0 FRACTURE TRACE ANALYSIS

Fracture traces are natural linear features that are unaffected by local topographic relief and, as a result, are considered surface manifestations of concentrated high-angle bedrock fracturing. Fracture traces may be observed on aerial photographs as linear topography, straight stream segments, vegetation or soil tonal alignments. The linear features may be the surficial representation of deeper fractures, joints, faults or bedding planes within the subsurface which can transmit groundwater through the fractured bedrock aquifer underlying the Palmer Lane HDD. Fracture traces underlying, or in close proximity to, the site were evaluated using historical aerial photographs from the years 1984 through 2016 (Google Earth, 2018), the Frankstown Quadrangle Geologic Maps (Berg and Dodge, 1981), Plate 1 (Taylor, 1982) and the Hollidaysburg, PA USGS 7.5 Minute Quadrangle Topographic Map. These photographs, publications and maps were reviewed to approximate the locations of natural linear fracture trace features or lineaments expressed on the ground surface.

Figures 2 and 3 show the results of the fracture trace analysis overlain on the geologic map of the site and an aerial base map. Eight fracture traces were identified within close proximity to the Palmer Lane HDD that are likely related to the primary geologic structure. Six of the fracture traces trend approximately northeast-southwest (NE-SW), parallel to geologic strike. Two perpendicular fracture traces trend southeast-northwest (SE-NW) and may represent transverse joint sets.

5.0 GEOTECHNICAL EVALUATION

Two geotechnical drilling evaluations were performed at the site; one in September of 2015 and one in September of 2017. The 2015 evaluation consisted of three test borings, which were advanced by hollow-stem auger methods and split-spoon samplers to sample the soil, residual soil and weathered bedrock. An NQ-sized wireline rock coring technique was used to collect a core from one of the 2015 sampling locations. The more recent 2017 test boring was advanced using mud-rotary and NQ-sized wireline rock coring methods. Soil, residual soil and weathered bedrock were sampled using split-spoon samplers. The boring completed in 2017 is designated as B3-6W. Geotechnical boring logs from both investigation phases are included in **Attachment 4**.

Borings SB-01 and B3-6W were located near the western end of the Palmer Lane HDD boring profile. Boring SB-02 was located near the center of the profile. Boring SB-03 was located near the eastern end of the HDD profile. The locations of these borings are depicted on **Figures 2 and 3**.

In general, the subsurface profile at the site, as observed in the borings, is described as follows:

- Soil and residual soil depths vary from boring to boring; 30 feet at SB-01, 22 feet at SB-02, 18.5 feet at SB-03, and 51 feet at B3-6W. The residual soils are described as follows:
 - **Boring SB-01:** decomposed bedrock consisting of fine to medium SAND and CLAY (SC) with some silty clay, silty CLAY (CL) and variegated silty CLAY (CL) and fine SAND (SC) with partially weathered shale. Groundwater was observed at 15 feet bgs through the augers and the boring was terminated at 30 feet bgs.
 - **Boring SB-02:** silty CLAY (CL) and fine to medium sand with trace sandstone gravel. Groundwater was observed at 7.5 feet bgs through the augers. Auger refusal occurred at 22 feet bgs and the boring was terminated at 32 feet bgs.
 - **Boring SB-03:** decomposed bedrock consisting of SILT (ML) and fine sand with lens of sandstone gravel and partially weathered shale. Groundwater was not encountered in this boring location. The boring was terminated at 30 feet bgs.
 - **Boring B3-6W:** lean CLAY with sand (CL) and fat CLAY (CH) (possibly highly weathered shale), highly weathered SILTSTONE with interbedded sandstone, highly weathered SANDSTONE with clay and highly weathered SHALE with trace clay. Groundwater was observed at 20.0 feet bgs during the drilling process.
- At depths of auger or split-spoon refusal and to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and described as follows:
 - **Boring SB-02:** SB-02 was cored from 22 to a total depth of 32 feet bgs. Dark gray intensely to moderately fractured calcareous shale was encountered. Rock recovery ranged from 73% to 100% in the core runs. Rock quality designations (RQDs) ranged from very poor to fair (0% to 63%), and the RQD value generally increased with depth.
 - **Boring B3-6W:** B3-6W was completed to a total depth of 171 feet. From 51 feet to 81 feet moderately hard to hard, moderately to slightly weathered SHALE with occasional calcite veins was encountered. The primary joint sets were low angle to moderately dipping, very closely to closely spaced and tight to moderately open. From 81 to 86 feet moderately hard to hard slightly to highly weathered SHALE was observed. Because of the severity of fracturing, it was not possible to fully identify details pertaining to the joints present in this interval. From 86 to 131 feet moderately hard to hard, fresh to slightly weathered SHALE was observed. The primary joint sets were low angle to moderate dipping, very closely to

closely spaced and slightly to moderately open. A highly weathered zone was observed between 123.3 to 124.1 feet with a less fractured interval observed between 126 and 131 feet. From 131 to 86 feet moderately hard to hard, fresh to slightly weathered SHALE with occasional calcite veins was encountered. The primary joint set were low angle to moderate dipping, very closely to closely spaced and slightly open to open. RQDs in the SHALE ranged from very poor to excellent (16% to 100%). The lowest RQD was encountered in the severely fractured zone observed between 81 and 86 feet. The highest RQDs were encountered between 141 and 146 feet and 151 and 156 feet.

Unconfined compressive strength testing was performed on core samples collected from borings SB-02 and B3-6W and the results are summarized in the table below.

Boring	Sample Depth (feet bgs)	Compressive Strength (pounds per square inch)
SB-02	29-29.5	3,040
SB-02	30-30.5	3,430
B3-6W	90	4,126
B3-6W	108	3,583

Please note that RETTEW Associates, Inc. or Skelly and Loy, Inc. did not oversee or direct the geotechnical drilling program associated with the Palmer Lane HDD 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, L.P. 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 FIELD OBSERVATIONS

RETTEW geologists were onsite during 20-inch pipeline HDD drilling activities. The 20-inch pipeline boring was started on June 22, 2017 and the pilot hole was completed on July 1, 2017. Two IR events occurred during the pilot hole drilling with the first occurring on June 28, 2017 with approximately 100 gallons of drilling fluids being released. Drilling activities were suspended to address the June 28, 2017 IR and resumed on June 30, 2017. The second IR occurred on July 1, 2017 when approximately 300 gallons of drilling fluids were released as the pilot hole was being completed. Both IRs were contained and remediated and on July 6, 2017, the 30-inch ream pass was started and continued until July 25, 2017 when all PPP-ME2 Project HDD activities were suspended by order of the Pennsylvania Department of Environmental Protection (PA DEP). Following PA DEP's restart approval, the 30-inch ream pass was resumed on August 28, 2017 and completed on August 30, 2017. As the 30-inch ream pass was being completed, an IR was observed near the limit of disturbance (LOD) with approximately 30 gallons of drilling fluids having flowed outside of the LOD and into the wetlands. Consequently, HDD activities were suspended until restart approval was granted by the PA DEP. HDD activities resumed on September 25, 2017, with the completion of the swab pass. On

September 26, 2017, the 20-inch product pipe was pulled through to complete HDD activities at the Palmer Lane HDD site.

A field investigation was performed by a RETTEW geologist on November 2, 2017 to identify rock outcrops for fracture fabric analysis, and to identify potential sensitive receptors to IRs. An outcrop was identified approximately 2.3 miles west of the 20-inch HDD entry point along geologic strike as shown on **Figure 2**. The outcrop consisted of thinly bedded soft shale interbeds of the Hamilton Group. The strike of bedding at this outcrop is 353° with a dip of 40° west-northwest (WNW). The field data is consistent with published geologic data, mapping, and fracture traces referenced in Section 4.0. No additional sensitive receptors to IRs beyond the previously mapped streams and wetlands were identified during the site reconnaissance.

7.0 GEOPHYSICAL SURVEY CONSIDERATIONS

No karst geology was observed during the field reconnaissance and none is mapped as being present at this HDD location. In addition, no carbonate bedrock was observed in the geotechnical borings, and no evidence of subsidence was observed during completion of the 20-inch HDD boring. Based on the lack of karst geologic features, and the lack of thick carbonate sequences at the depths anticipated for the proposed 16-inch HDD, the use of geophysical surveys during re-evaluation was considered but was ultimately not implemented at the Palmer Lane HDD location because the results of geophysical surveys would not likely provide additional information that would reduce the risk of an IR.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION

Based on published geologic and hydrogeologic information, and the evaluation of geotechnical borings from the site, the Palmer Lane HDD location is underlain by sedimentary rocks of the Hamilton Group and the Onondaga and Old Port Formations. The hydrogeologic setting is dominated by groundwater flow through secondary openings along geologic features including bedding planes, joints, faults, and fractures. These secondary openings may be enlarged or enhanced by dissolution of the constituent carbonate rocks. Observed weathering, fractures, and joints in the geotechnical cores may be indicative of the high yields reported from some domestic and non-domestic wells completed in the Onondaga Formation. In addition, field measurements of local geologic structure support the published information regarding the presence of vertical and near vertical joint sets. Well records indicate that water-bearing zones in water wells close to the site are common to depths of 350 feet bgs in the Hamilton Group and to depths of 300 feet bgs in the Onondaga and Old Port Formations.

The originally designed 16-inch HDD profile was relatively shallow at the entry and exit points and passed through both unconsolidated overburden and fractured bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report and geologic information obtained and utilized during installation of the 20-inch pipe, the Palmer Lane site is susceptible to the inadvertent return of drilling fluids during HDD operations. As a result, the proposed 16-inch HDD profile has been redesigned to allow for deeper crossings beneath Dry Run (S-M69) and Wetlands M79PFO and M49PFO. The deeper profile increases the depth of the proposed 16-inch pipe to 107 feet below Dry Run and increases the depth of protective cover where two previous IRs occurred during installation of the 20-inch pipe. From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling BMPs, will be used to reduce the risk of an IR and/or a loss of drilling

fluids. Drilling BMPs are described in the Horizontal Directional Drill Analysis component of the overall re-evaluation package.

9.0 REFERENCES

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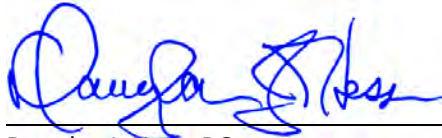
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10.0 CERTIFICATION

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.

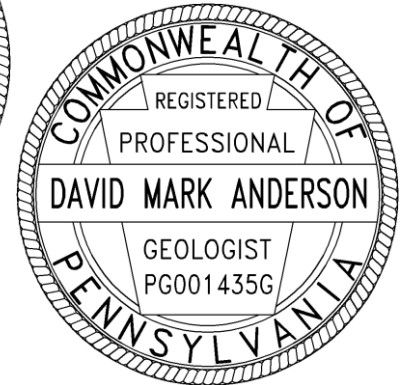
By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information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



Douglas J. Hess, PG
License No. PG000186G



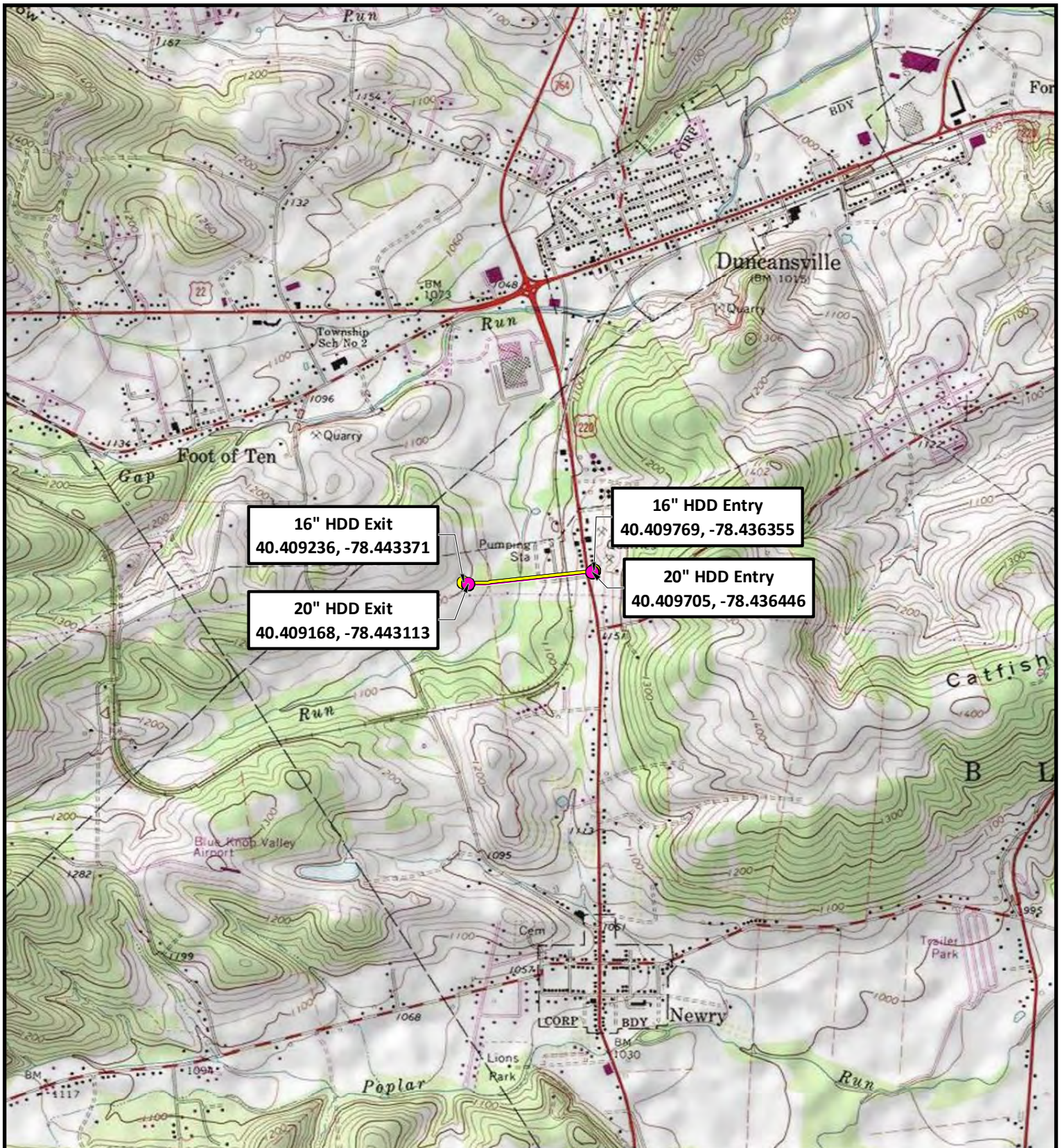
David M. Anderson, PG
License No. PG001435G



Enclosures

Z:\Shared\Projects\09630\096302011\GS\Hydrogeology Review\Old Route 220\Palmer Lane (Old Route 220) S2-0109 Hydro Report 2-8-19 FINAL.docx

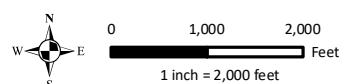
FIGURES

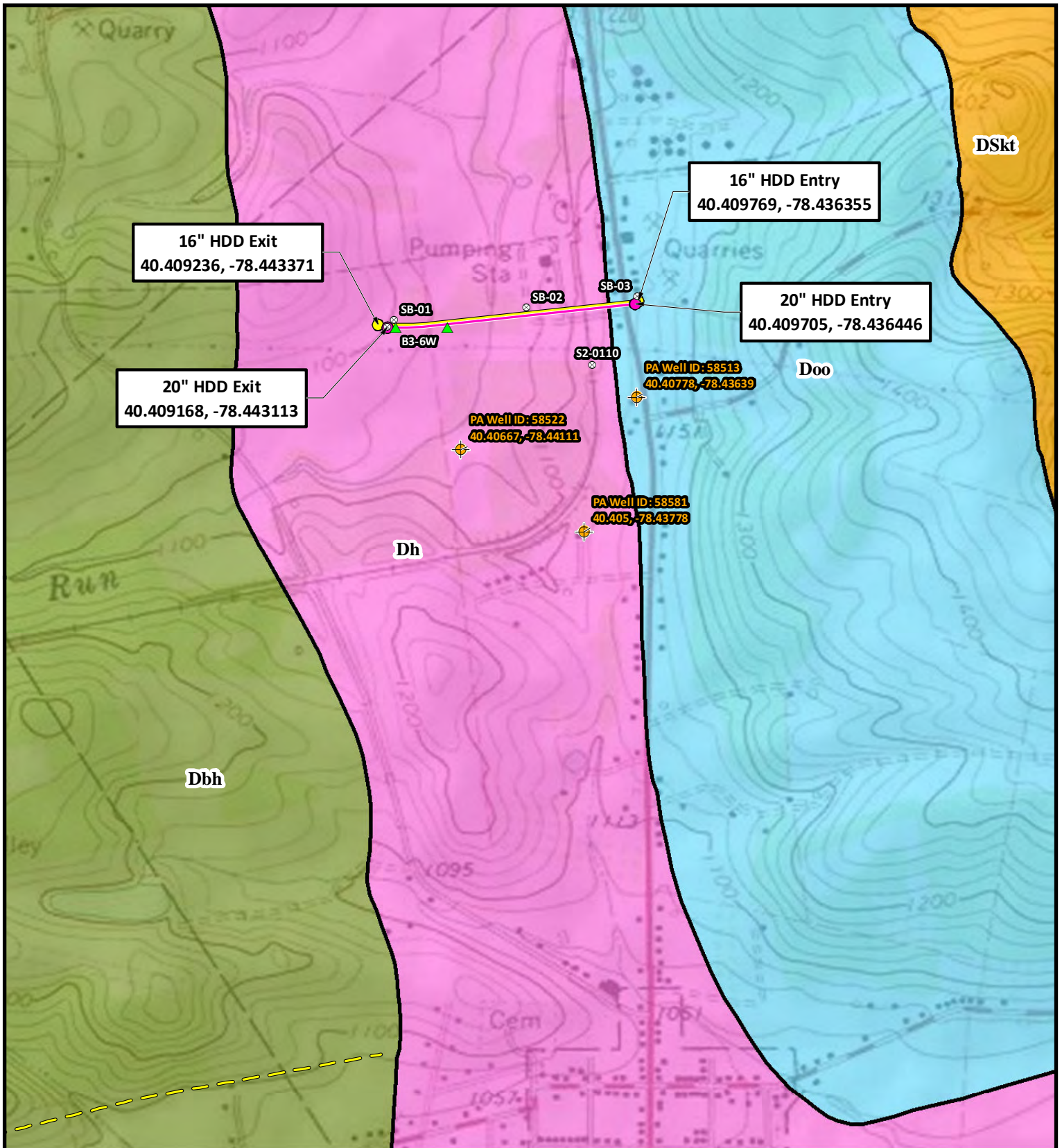


- 16" HDD Entry/Exit
- 20" HDD Entry/Exit
- 16" HDD Profile
- 20" HDD Profile

Sunoco Pipeline, L.P.
Old Route 220 HDD Location

Figure 1 - Topographic Basemap
 Blair Township, Blair County, PA
 Project No. 096302011





16" HDD Exit
40.409236, -78.443371

16" HDD Entry
40.409769, -78.436355

20" HDD Entry
40.409705, -78.436446

20" HDD Exit
40.409168, -78.443113

PA Well ID: 58513
40.40778, -78.43639

PA Well ID: 58522
40.40667, -78.44111

PA Well ID: 58581
40.405, -78.43778

Inadvertent Return	Inferred Fracture Trace
Residential Well	Geologic Formation
Soil Boring	DSkt - Keyser and Tonoloway Formations, undivided
16" HDD Entry/Exit	Dbh - Brallier and Harrell Formations, undivided
20" HDD Entry/Exit	Dh - Hamilton Group
16" HDD Profile	Doo - Onondaga and Old Port Formations, undivided
20" HDD Profile	

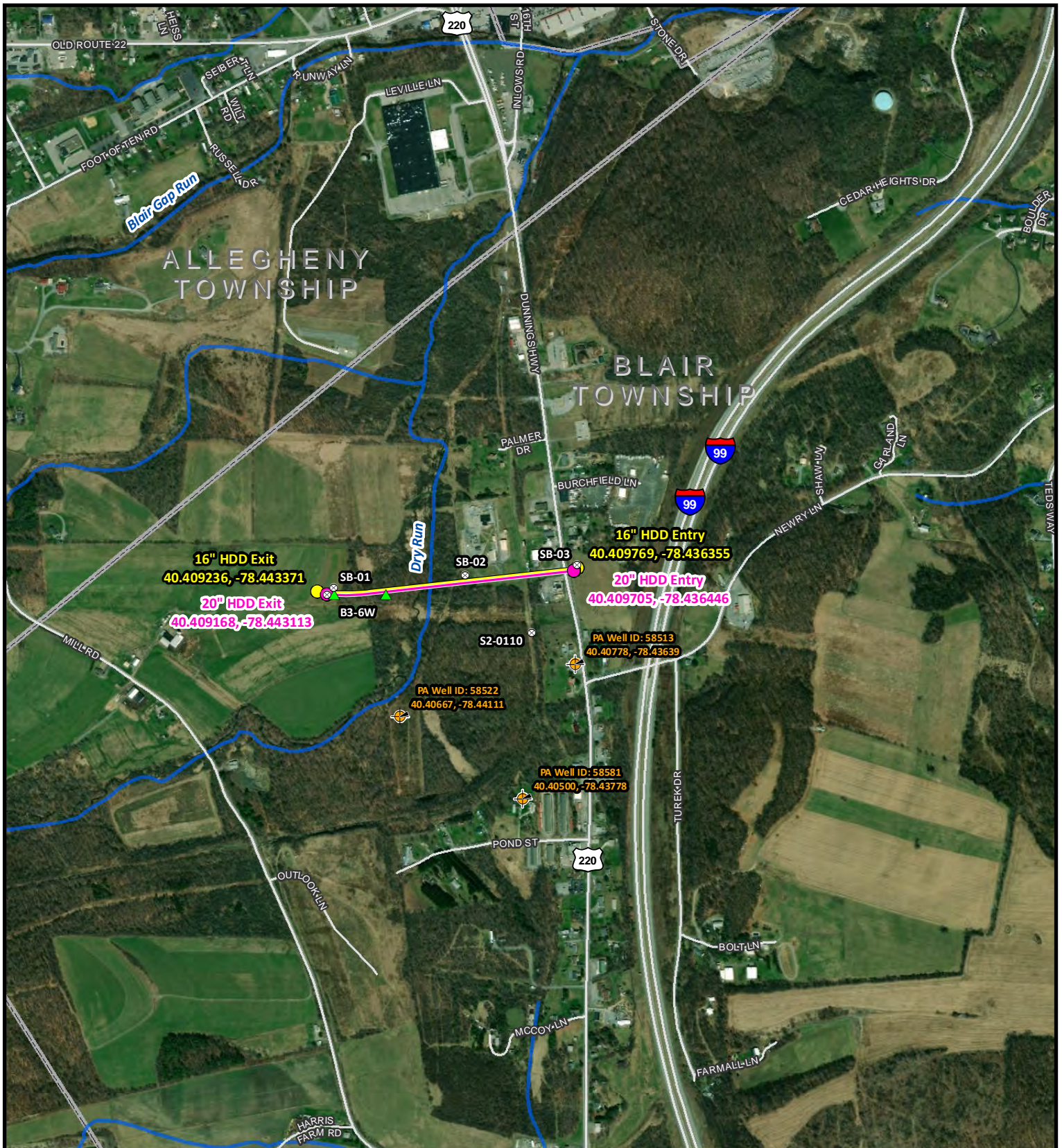
Hollidaysburg, PA USGS 7.5' Topographic Quadrangle 2/8/2019

Sunoco Pipeline, L.P.
Old Route 220 HDD Location
Figure 2 - Geologic Map
 Blair Township, Blair County, PA
 Project No. 096302011

0 1,000
Feet
1 inch = 1,000 feet

Sunoco Logistics Partners L.P.

Service Layer Credits: Copyright: © 2013 National Geographic Society, I-cubed

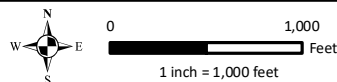


- ▲ Inadvertent Return
- ◆ 16" HDD Profile
- ⊕ Residential Well
- ◆ 20" HDD Profile
- ⊗ Soil Boring
- NHD Stream
- 16" HDD Entry/Exit
- Road
- 20" HDD Entry/Exit
- Municipal Boundary

2/8/2019

Sunoco Pipeline, L.P. Old Route 220 HDD Location

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

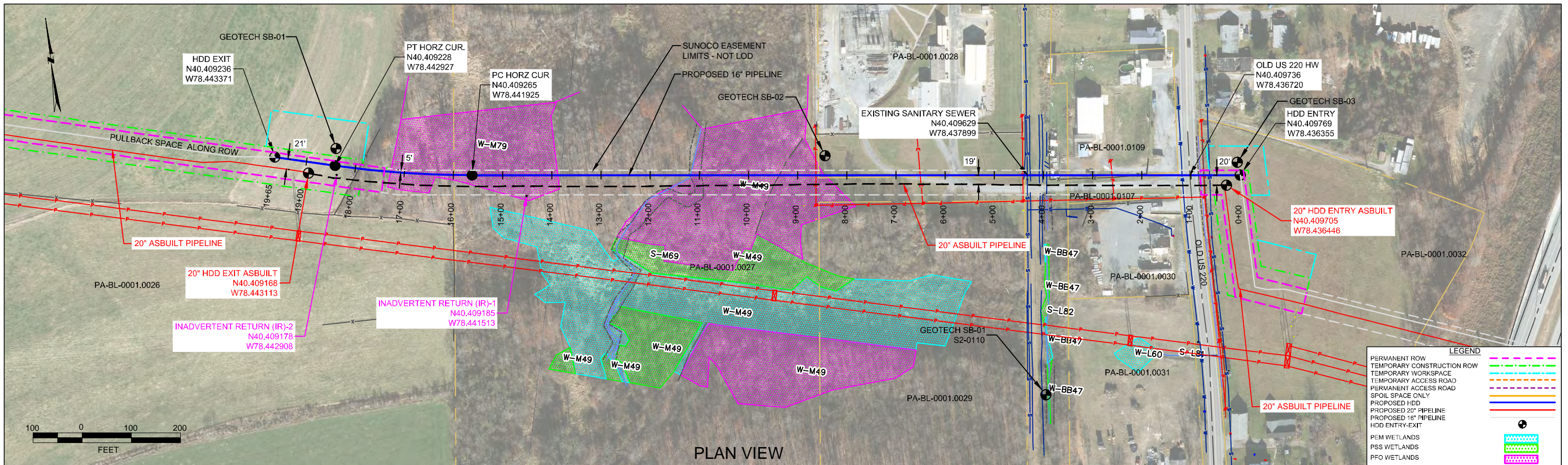


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





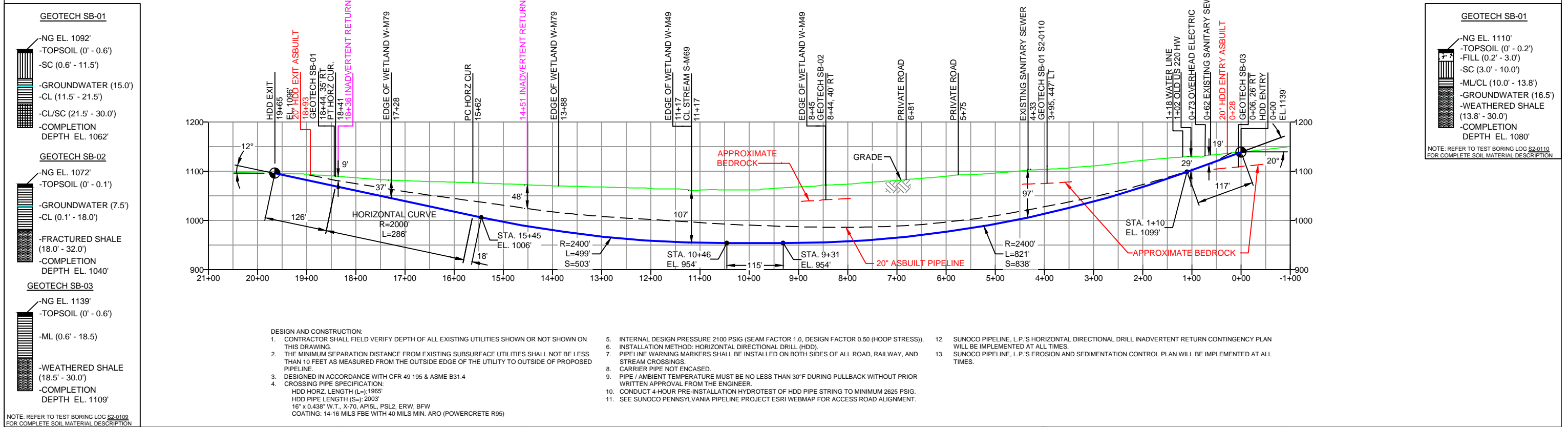
ATTACHMENT 1
HDD PROFILE AND GEOTECHNICAL BORING LOGS



PLAN VIEW

BLAIR COUNTY PENNSYLVANIA, BLAIR TOWNSHIP
S2-0109-16

PROFILE VIEW



NOTE: REFER TO TEST BORING LOG S2-0109 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- GEOTECH SB-01**
- NG EL. 1092'
 - TOPSOIL (0' - 0.6')
 - SC (0.6' - 11.5')
 - GROUNDWATER (15.0')
 - CL (11.5' - 21.5')
 - CL/SC (21.5' - 30.0')
 - COMPLETION DEPTH EL. 1062'
- GEOTECH SB-02**
- NG EL. 1072'
 - TOPSOIL (0' - 0.1')
 - GROUNDWATER (7.5')
 - CL (0.1' - 18.0')
 - FRACTURED SHALE (18.0' - 32.0')
 - COMPLETION DEPTH EL. 1040'
- GEOTECH SB-03**
- NG EL. 1139'
 - TOPSOIL (0' - 0.6')
 - ML (0.6' - 18.5')
 - WEATHERED SHALE (18.5' - 30.0')
 - COMPLETION DEPTH EL. 1109'

- 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_H): 1965'
HDD PIPE LENGTH (S_H): 2003'
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 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.
 - 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

ES-3.21	TO	ES-3.22	EROSION & SEDIMENT PLAN
SHEET 13	TO	SHEET 14	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	DATE	CHK	DATE	APP	DATE
EP3	DESIGN CHANGE PER DPS	01/08/18	RMB	01/08/18	CAG	01/08/18
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		11/13/15	RMB	11/13/15	AAW	11/13/15
B	ADDED GEOTECH INFO	10/05/15	RMB	10/05/15	AAW	10/05/15
A	ISSUED FOR BID	08/31/15	RMB	08/31/15	AAW	08/31/15

NOTES

DWG NO	DWG NO	DESCRIPTION	NO.	DESCRIPTION

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
OLD US 220 HWY
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'
DWG. NO. PA-BL-0001.0031-RD-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
HDD S2-0109
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: MILL ROAD, DUNCANSVILLE, PA			Page 1 of 1		
HDD No.: S2-0109		Dates(s) Drilled: 09-10-15		Inspector: E. WATT	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: M. HYNES	
Drilling Contractor: HYNES		Groundwater Depth (ft): 15.0		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 24' 33.565" N		78° 26' 34.559" 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	0.6			TOPSOIL (7")						
1	3.0	5.0	0.6		14	SC	DR WEATHERED TO A BROWN AND GRAY FINE TO MEDIUM SAND AND CLAY, TRACE UNWEATHERED SHALE FRAGS.	5	5	7	7	12	
2	8.0	10.0		11.5	24		DR WEATHERED TO A BROWN AND GRAY FINE TO MEDIUM SAND, WITH SOME SILTY CLAY, TRACE UNWEATHERED SHALE FRAGS.	4	7	7	8	14	
3	13.0	15.0	11.5		20	CL	DR, MOTTLED GRAY, BROWN, ORANGE BRWN. SILTY CLAY, SOFT AT 15'. (USCS: CL)	4	5	6	6	11	
4	18.0	20.0		21.5	15		GRAY CLAY.	4	5	5	6	10	
5	23.0	25.0	21.5		14	CL/SC	DR, VARIEGATED (REDDISH BRWN, YELLOWISH BRWN, GRAY) SILTY CLAY & F-SAND, WITH UNWEATHERED SHALE FRAGS. (USCS: CL/SC)	9	22	36	50	58	
6	28.0	29.3		30.0	14		DR, VARIEGATED (REDDISH BROWN, YELLOWISH BROWN, GRAY)	25	15	50/3"		>50	
							AUGER STARTED GRINDING AT 25'.						
							WET ON SPOON AT 15'.						
							WATER LEVEL THROUGH AUGERS AT 15'						
							CAVED AT 14', WATER LEVEL ON CAVE AT 14'.						

Notes/Comments:
Pocket Pentrometer Testing
 S2: > 4 TSF
 S3: 1.75 TSF
 S4: 1.5 TSF

DR: DECOMPOSED ROCK

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: PALMER LAND, DUNCANSVILLE, PA			Page 1 of 1		
HDD No.: S2-0109		Dates(s) Drilled: 09-10/11-15		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: M. HYNES	
Drilling Contractor: HYNES		Groundwater Depth (ft): 7.5		Total Depth (ft): 32.0	
Boring Location Coordinates:			40° 24' 34.575" N		78° 26' 21.778" 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	0.1			TOPSOIL (2")						
1	3.0	5.0	0.1		20	CL	MOTTLED (GRAY AND BROWN) SILTY CLAY AND FINE TO MEDIUM SAND, TRACR F-ROCK FRAGS.	3	3	4	6	7	
2	8.0	10.0			12		MOTTLED (BROWN AND ORANGE BROWN) SILTY CLAY AND FINE TO MEDIUM SAND, TRACT FINE SANDSTONE GRAVEL. (USCS: CL)	6	10	8	8	18	
3	13.0	15.0			23		GRAY AND DARK GRAY SILTY CLAY AND FINE TO MEDIUM SAND, TRACE FINE SANDSTONE GRAVEL.	1	1	1	1	2	
				18.0									
4	18.0	20.0	18.0	22.0	5		DARK GRAY PARTIALLY WEATHERED SHALE.	50/5"					>50
							AUGER REFUSAL AT 22'.						
							<u>ROCK CORING</u>						
RUN 1	22.0	24.5	22.0		22	SHALE	DARK GRAY INTENSELY FRACTURED DARK GRAY SHALE.	TCR: 73%, SCR: 28%, RQD: 0%					
RUN 2	24.5	29.5			44		DARK GRAY INTENSELY FRACTURED CALCEROUS SHALE.	TCR: 73%, SCR: 38%, RQD: 18%					
RUN 3	29.5	32.0		32.0	30		DARK GRAY MODERATELY FRACTURED CALCEROUS SHALE.	TCR: 100%, SCR: 83%, RQD: 63%					
							WET ON SPOON AT 8'.						
							WATER LEVEL THROUGH AUGERS AT 7.5'.						
							<u>CORE TESTING RESULTS (DEPTH 29-29.5'):</u>						
							COMPRESSIVE STRENGTH: 3,040 PSI						
							UNIT WEIGHT: 166.6 PCF						
							<u>CORE TESTING RESULTS (DEPTH 30-30.5'):</u>						
							COMPRESSIVE STRENGTH: 3,430 PSI						
							UNIT WEIGHT: 179.4 PCF						

Notes/Comments:
Pocket Pentrometer Testing
 4': 3.5 TSF DR: DECOMPOSED ROCK

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.

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0109 PALMER LANE**

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S2-0109	SB-2	1	22	24.5	73	28	0	22	32	Moderate	Shale (Potential limestone)	Massive	Dark Gray	Fractures ranging from 0° to 20°, Avg. 12°
		2	24.5	29.5	73	38	17.5							
		3	29.5	32	100	83	63							

**GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0109 PALMER LAND**

HDD No.	Boring No.	Sample No.	Depth of Sample (ft.)		Water	Percent	Atterburg Limits (ASTM D4318)			USCS
			From	To	Content, % (ASTM D2216)	Silts/Clays, % (ASTM D1140)	Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	Classif. (ASTM D2487)
S2-0109	SB-01	1	3.0	5.0	10.2	41.5	-	-	-	-
		2	8.0	10.0	11.9	34.3	-	-	-	-
		3	13.0	15.0	24.9	98.7	36	23	13	CL
		5	23.0	25.0	16.0	51.2	33	21	12	CL/SC
		6	28.0	29.3	17.2	51.0	-	-	-	-
	SB-02	1	3.0	5.0	20.5	69.2	-	-	-	-
		2	8.0	10.0	26.5	75.2	43	25	18	CL
		3	13.0	15.0	29.4	57.5	-	-	-	-
		4	18.0	20.0	12.8	13.6	-	-	-	-
	SB-03	1	3.0	5.0	14.2	67.0	-	-	-	-
		2	8.0	10.0	14.8	63.3	33	25	18	ML
		3	13.0	15.0	13.6	79.6	35	26	9	ML
		4	18.0	20.0	13.2	60.0	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	29 - 29.5	3,040	166.6
SB-02	3	30 - 30.5	3,430	179.4

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0109 PALMER LANE**

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
S2-109	Palmer Lane	SB-01	Hamilton Group - The Mahantango Formation and the underlying Marcellus Formation make up the Hamilton Group.	Gentle slope upwards to the east, mix of farmland and woods	Mahatango (aka Hamilton Group)	Shale-siltstone, laminated, fossiliferous			
		SB-02							
		SB-03	Onondaga and Old Port Formation (undivided) consists of two members - the upper Selinsgrove Limestone and the lower calcereous Needmore Shale.		Onadaga-Old Port	Limestone and calcareous shale with occasional chert	100-200	4-32	

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.

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

Relative Proportions

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

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 No. 10 to No. 40 sieve (M) (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)

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		
			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	Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line with I_p greater than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures	Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above A line with I_p greater than 7		
		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 ⁽¹⁾					
		Major Divisions		Group Symbols	Typical Descriptions	For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.	
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 – Old US 220 Hwy
Commonwealth of Pennsylvania
Drawing # PA-BL-0001.0031-RD
PO # 20170912-2
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 Old US 220 Hwy (Drawing # PA-BL-0001.0031-RD) 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 one boring, designated as B3-6W, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test boring, B3-6W was drilled between September 17 and 18, 2017 to a depth of 171.0 feet, as shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of sedimentary rock comprised of shale. The final test boring log 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 the boring location. As an exception to the planned 20-foot intervals, rock samples from 53 feet to 83 feet were not tested due to highly fractured conditions. Unconfined compressive strength test results are shown on the attached reports.

Geotechnical Site Characterization

Mariner East 2 Pipeline – Spread 3 Old US 220 Hwy ■ Pennsylvania
Drawing #PA-BL-0001.0031-RD / PO #20170912-2
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 positioned above the printed name and title.

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

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

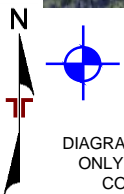
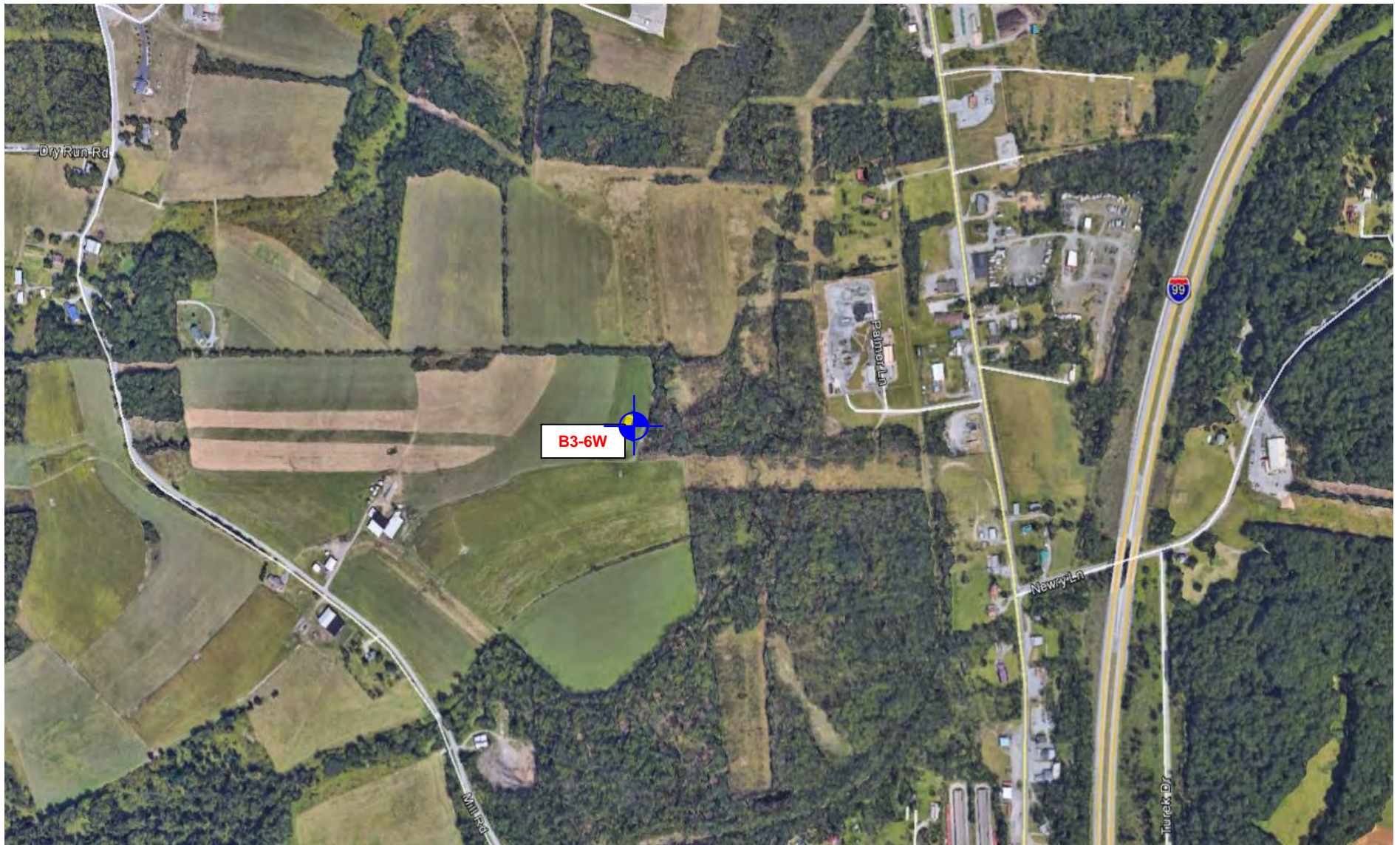
Attch:

TEST BORING LOCATION PLAN

EXPLORATION RESULTS (Boring Log, 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

Old US 220 Highway HDD Cores B3-6W
PA-BL-0001.0031-RD
Blair County, Pennsylvania

Exhibit

A-2

EXPLORATION RESULTS

BORING LOG NO. B3-6W Old US 220 Hwy West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0031-RD 20170912-2 Latitude: 40.409177° Longitude: -78.443108° Approximate Surface Elev: 1095 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	DEPTH								

	Highly weathered, dark gray to black SHALE, trace clay	35		13	23-18-24 N=42				
		51.0		3	100/3"				
		56.0		6	55-25/0"				
		56.0		1	100/1"				
	Run 1, Moderately hard to hard, moderately to slightly weathered, dark gray to black SHALE with occasional calcite veins, primary joint set, low angle to moderately dipping, very close to close spacing, smooth, fresh to discolored, tight to moderately open	55	1044+/-	56		46	2.5 2 2.2 2.5 1.5		
	Run 2, Similar	60	1039+/-	60		28	3.5 2.5 4 2 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
20' on 9/19/17



Boring Started: 09-17-2017	Boring Completed: 09-18-2017
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. B3-6W Old US 220 Hwy West

PROJECT: Mariner East Pipeline Borings

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

SITE: Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0031-RD 20170912-2 Latitude: 40.409177° Longitude: -78.443108° Approximate Surface Elev: 1095 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
61.0	Run 2, Similar <i>(continued)</i>	1034+/-			60				
	Run 3, Similar				57		55	2.5 2 1.5 2.5 2	
66.0	Run 4, Similar	1029+/-			60		88	3 2 2.5 2.5 1.5	
71.0	Run 5, Similar	1024+/-			60		62	2.5 2 2 3 3	
76.0	Run 6, Similar	1019+/-			57		57	2 2.5 3 3 3	
81.0	Run 7, Moderately hard to hard, slightly to highly weathered, dark gray to black SHALE, unable to properly identify joints due to severity of fractures	1014+/-			24		16	3 3 2.5 3 3	
86.0	Run 8, Moderately hard to hard, fresh to slightly weathered, dark gray to black SHALE, primary joint set, low angle to moderately dipping, close spacing, smooth, fresh to discolored, slightly to moderately open	1009+/-			60		37	4 3 3 2.5 2	
		90							

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

WATER LEVEL OBSERVATIONS

20' on 9/19/17

Notes:



Boring Started: 09-17-2017

Boring Completed: 09-18-2017

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. B3-6W Old US 220 Hwy West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0031-RD 20170912-2 Latitude: 40.409177° Longitude: -78.443108° Approximate Surface Elev: 1095 (Ft.) +/-	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
DEPTH	ELEVATION (Ft.)								
91.0	1004+/-				60				
Run 9, Similar					60		35	2.5 2.5 3.5 2.5 2	
96.0	999+/-	95			52		48	2 2.5 2 3 4	
Run 10, Similar					47		52	3 3.5 3.5 3 2.5	
101.0	994+/-	100			60		91	2 2 2.5 2 2	
Run 11, Similar					60		70	2 1.5 1.5 2 3	
106.0	989+/-	105			60		88	1.5 2 2 2 2.5	
Run 12, Similar					60				
111.0	984+/-	110							
Run 13, Similar									
116.0	979+/-	115							
Run 14, Similar									
		120							

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

20' on 9/19/17



Boring Started: 09-17-2017

Boring Completed: 09-18-2017

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. B3-6W Old US 220 Hwy West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 3

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

GRAPHIC LOG	LOCATION PA-BL-0001.0031-RD 20170912-2 Latitude: 40.409177° Longitude: -78.443108° Approximate Surface Elev: 1095 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Run 14, Similar <i>(continued)</i>	121.0			60				
	Run 15, Similar, highly weathered from 123.3 to 124.1 feet				60		75	2.5 2.5 2.5 3	
	Run 16, Similar, less fractured	126.0			60		91	2.5 2 2 2 2	
	Run 17, Moderately hard to hard, fresh to slightly weathered, dark gray to black SHALE with occasional calcite veins, primary joint set, low angle to moderately dipping, close spacing, smooth, fresh to discolored, slightly open to open	131.0			60		86	2 2 2 2 2	
	Run 18, Similar	136.0			60		95	3 2 2 2 2	
	Run 19, Similar	141.0			60		100	2 2 2.5 2.5 2	
	Run 20, Similar	146.0			60		76	2.5 2.5 1.5 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

20' on 9/19/17



Boring Started: 09-17-2017

Boring Completed: 09-18-2017

Drill Rig: CME-850

Driller: Terracon/Peter M.

Project No.: J217P078

Exhibit: A-1

BORING LOG NO. B3-6W Old US 220 Hwy West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 3

GRAPHIC LOG	LOCATION PA-BL-0001.0031-RD 20170912-2 Latitude: 40.409177° Longitude: -78.443108° Approximate Surface Elev: 1095 (Ft.) +/- ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (in.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
151.0	Run 20, Similar <i>(continued)</i>	944+/-			60				
	Run 21, Similar				60		100	2.5 2.5 3 2.5	
156.0	Run 22, Similar	939+/-			60		96	2.5 2 2 2 2	
161.0	Run 23, Similar	934+/-			60		91	2.5 2 2.5 2 2	
166.0	Run 24, Similar	929+/-			58		58	3 2 2 2.5 2	
171.0	Boring Terminated at 171 Feet								

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

Hammer Type: Automatic

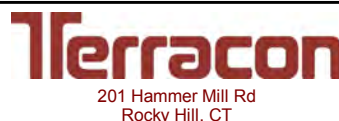
Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

20' on 9/19/17



Boring Started: 09-17-2017

Boring Completed: 09-18-2017

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

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

Boring No.: B3-6W
 Sample No.: 2
 Sample Depth: 90 feet
 Sampling Date: 9/17/17

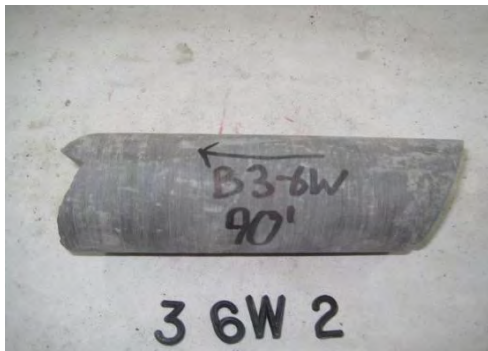
Lithology : Shale
 Moisture Content : As received
 Lab Temperature : 70° F
 Loading Rate: 55 psi/s
 Time to Failure: 4 min

Diameter: 1.96 in
 Length: 3.27 in
 L/D: 1.67
 End Area: 3.02 in²

Maximum Axial Load at Failure: 12,450 lb
 Compressive Strength: 4,126 psi
 Compressive Strength: 28.45 Mpa
 Unit Weight 168 pcf

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.

Before the Test



After the Test



Drawing # : PA-BL-0001.0031-RD
 PO # : 20170912-2
 Crossing : Old US 220 Hwy
 Spread : Spread 3

Project:	Mariner East Pipeline
Project No.	J217P078
Location:	Spread 3
Client :	Directional Project Support Inc.

Terracon
 77 Sundial Ave., Suite 401 W
 Manchester, New Hampshire

Performed by:	C. Santana
Test Date:	10/16/2017
Reviewed By :	L. Dwyer
Review Date :	10/16/2017

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

Boring No.: B3-6W
 Sample No.: 1
 Sample Depth: 108 feet
 Sampling Date: 9/17/17

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

Diameter: 1.96 in
 Length: 3.55 in
 L/D: 1.81
 End Area: 3.02 in²

Maximum Axial Load at Failure: 10,810 lb
 Compressive Strength: 3,583 psi
 Compressive Strength: 24.70 Mpa
 Unit Weight 167 pcf

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.


Before the Test



After the Test



Drawing # : PA-BL-0001.0031-RD
 PO # : 20170912-2
 Crossing : Old US 220 Hwy
 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

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Photograph 1: B3-6W, Samples C-1 to C-4 (51 to 71 feet)



Photograph 2: B3-6W, Samples C-5 to C-8 (71 to 91 feet)



Photograph 3: B3-6W, Samples C-9 to C-12 (91 to 111 feet)



Photograph 4: B3-6W, Samples C-13 to C-16 (111 to 131 feet)



Photograph 5: B3-6W, C-17 to C-20 (131 to 151 feet)



Photograph 6: B3-6W, C-21 to C-24 (151 to 171 feet)

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification		
				Group Symbol	Group Name ^B	
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^F	
		Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}
			Sands with Fines: More than 12% fines ^D	Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}
			Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I
	Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Clean Sands: Less than 5% fines ^D	$Cu < 6$ and/or $1 > Cc > 3$ ^E	SP	Poorly graded sand ^I
			Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G,H,I}
			Sands with Fines: More than 12% fines ^D	Fines classify as CL or CH	SC	Clayey sand ^{G,H,I}
			Inorganic:	$PI > 7$ and plots on or above "A"	CL	Lean clay ^{K,L,M}
				$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}
Silts and Clays: Liquid limit 50 or more		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried			Organic silt ^{K,L,M,O}
		Inorganic:	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}	
			PI plots below "A" line	MH	Elastic Silt ^{K,L,M}	
			Organic:	Liquid limit - oven dried	< 0.75	OH
Liquid limit - not dried	Organic silt ^{K,L,M,Q}					
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat	

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C 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.

^D 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

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

^F If soil contains ³ 15% sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains ³ 15% gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

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

^L If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

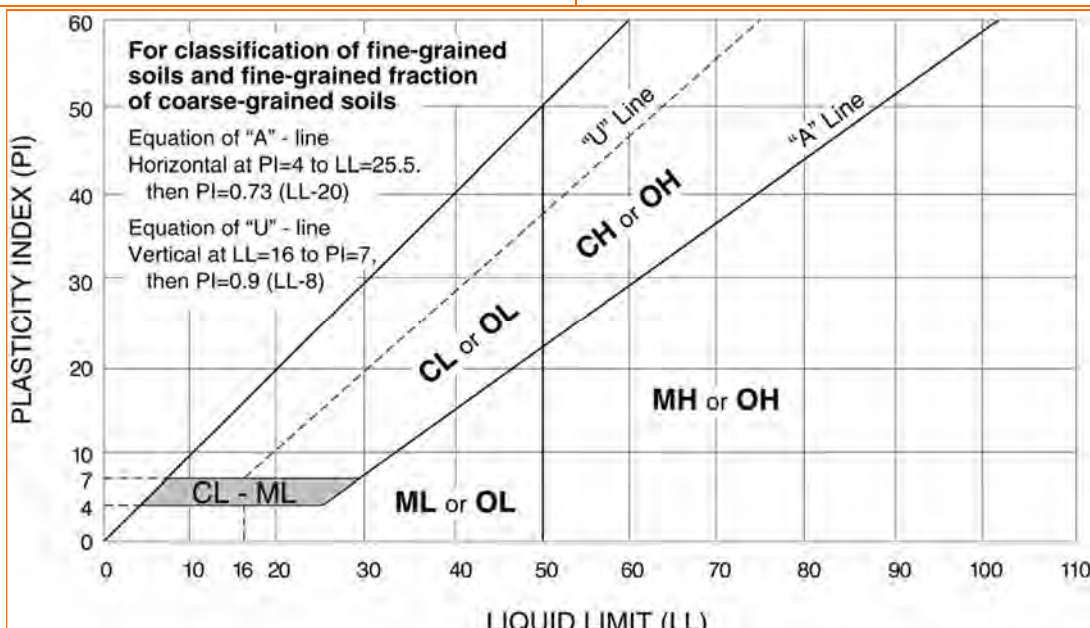
^M If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very Slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	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.
Moderate	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.
Moderately Severe	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.
Severe	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.
Very Severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	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)	
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	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.
Medium	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.
Soft	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.
Very Soft	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 ¹		
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) ¹		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.



ATTACHMENT 2
SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS



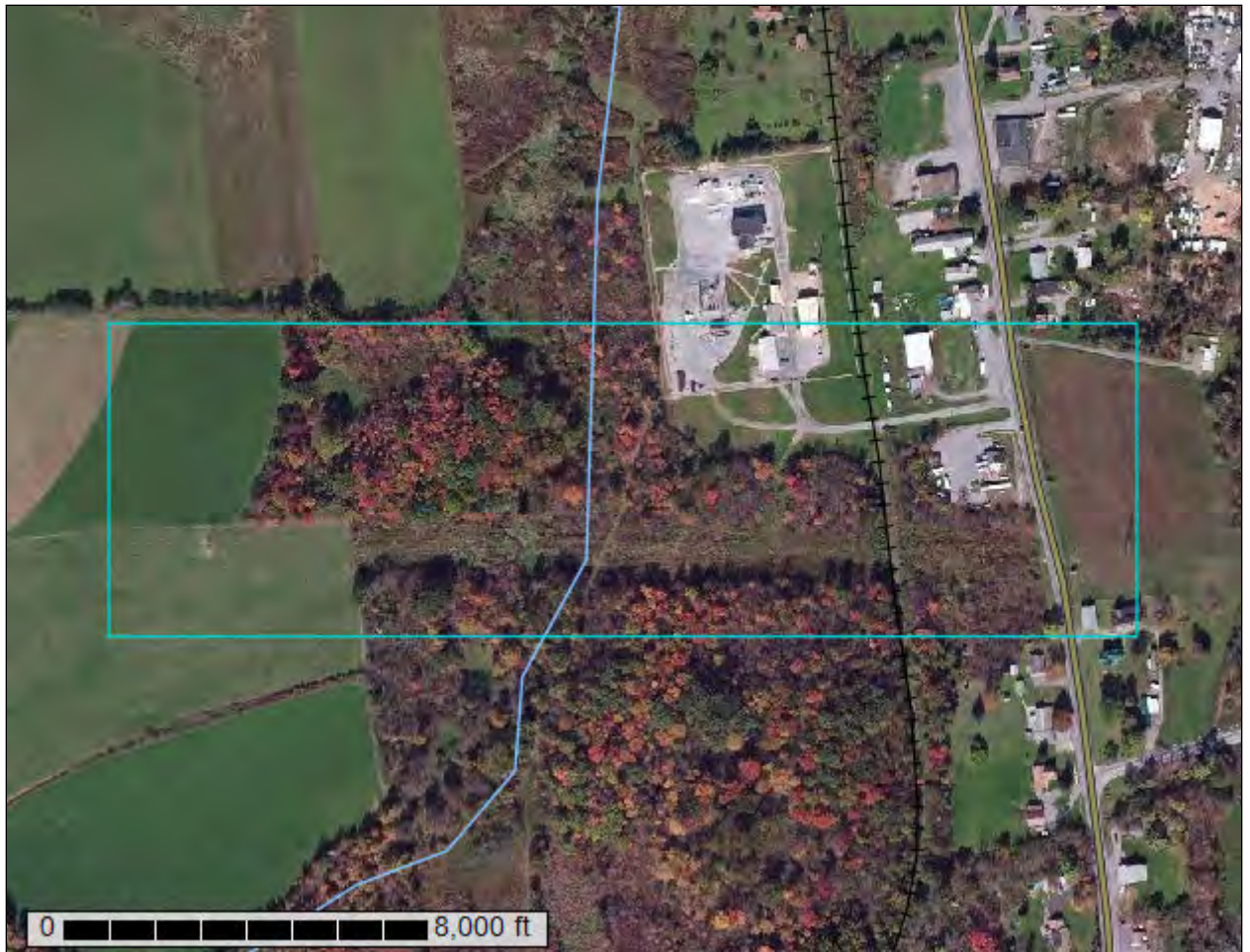
United States
Department of
Agriculture

NRCS

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**



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).

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.

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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

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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

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

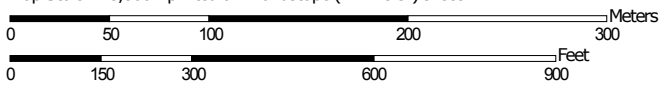
Soil Map

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




Map Scale: 1:3,800 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84


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 12, Oct 27, 2017

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
BmC	Berks-Weikert channery silt loams, 8 to 15 percent slopes	3.0	8.4%
BoB	Blairton silt loam, 3 to 8 percent slopes	12.7	35.2%
BxD	Buchanan extremely stony silt loam, 8 to 25 percent slopes	1.5	4.2%
LaC	Laidig channery loam, 8 to 15 percent slopes	13.0	36.2%
Ty	Tyler silt loam	1.9	5.4%
UD	Udifluvents-Dystrochrepts complex	3.8	10.6%
Totals for Area of Interest		35.9	100.0%

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 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

Custom Soil Resource Report

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.

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

BmC—Berks-Weikert channery silt loams, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2sgbn
Elevation: 1,120 to 3,600 feet
Mean annual precipitation: 37 to 50 inches
Mean annual air temperature: 47 to 56 degrees F
Frost-free period: 148 to 192 days
Farmland classification: Not prime farmland

Map Unit Composition

Berks and similar soils: 55 percent
Weikert and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Berks

Setting

Landform: Mountain slopes, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Upper third of mountainflank, side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

Ap - 0 to 8 inches: channery silt loam
Bw1 - 8 to 14 inches: very channery silt loam
Bw2 - 14 to 26 inches: very channery silt loam
C - 26 to 36 inches: extremely channery silt loam
R - 36 to 46 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 40 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 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 1 percent
Gypsum, maximum in profile: 1 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e

Custom Soil Resource Report

Hydrologic Soil Group: B

Other vegetative classification: Dry Uplands (DU2), Dry Uplands (DU3)

Hydric soil rating: No

Description of Weikert

Setting

Landform: Mountain slopes, ridges

Landform position (two-dimensional): Backslope, summit, shoulder

Landform position (three-dimensional): Upper third of mountainflank, side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Parent material: Gray and brown acid residuum weathered from shale and siltstone and/or fine grained sandstone

Typical profile

Ap - 0 to 7 inches: channery silt loam

Bw - 7 to 10 inches: extremely channery silt loam

C - 10 to 15 inches: extremely channery silt loam

R - 15 to 25 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: 10 to 20 inches to lithic bedrock

Natural drainage class: Somewhat excessively drained

Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 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 1.0 mmhos/cm)

Available water storage in profile: Very low (about 1.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: D

Other vegetative classification: Droughty Shales (SD2)

Hydric soil rating: No

Minor Components

Shelocta

Percent of map unit: 2 percent

Landform: Mountain slopes, ridges

Landform position (two-dimensional): Backslope, summit, shoulder

Landform position (three-dimensional): Lower third of mountainflank, side slope

Down-slope shape: Convex

Across-slope shape: Convex, linear

Hydric soil rating: No

Rough

Percent of map unit: 2 percent

Landform: Mountain slopes, ridges

Landform position (two-dimensional): Backslope, summit, shoulder

Landform position (three-dimensional): Upper third of mountainflank, side slope

Custom Soil Resource Report

Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Gilpin

Percent of map unit: 2 percent
Landform: Mountain slopes, ridges
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Upper third of mountainflank, side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Macove

Percent of map unit: 2 percent
Landform: Mountain slopes, ridges
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Lower third of mountainflank, side slope
Down-slope shape: Convex
Across-slope shape: Convex, linear
Other vegetative classification: Acid Loams (AL3)
Hydric soil rating: No

Blairton

Percent of map unit: 2 percent
Landform: Mountain slopes, ridges
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Upper third of mountainflank, head slope
Down-slope shape: Convex, concave
Across-slope shape: Convex, concave
Hydric soil rating: No

BoB—Blairton silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 16bf
Elevation: 300 to 1,300 feet
Mean annual precipitation: 35 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Blairton and similar soils: 90 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blairton

Setting

Landform: Depressions

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Head slope

Down-slope shape: Concave

Across-slope shape: Concave

Parent material: Local silty colluvium derived from shale and siltstone over acid silty residuum weathered from shale and siltstone

Typical profile

H1 - 0 to 9 inches: silt loam

H2 - 9 to 22 inches: channery silty clay loam

H3 - 22 to 26 inches: very channery loam

H4 - 26 to 30 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: 20 to 40 inches to lithic bedrock

Natural drainage class: Somewhat poorly drained

Runoff class: High

Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)

Depth to water table: About 6 to 36 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: C/D

Hydric soil rating: No

Minor Components

Brinkerton

Percent of map unit: 5 percent

Landform: Hills

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Base slope

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

BxD—Buchanan extremely stony silt loam, 8 to 25 percent slopes

Map Unit Setting

National map unit symbol: 16bn

Custom Soil Resource Report

Elevation: 300 to 3,000 feet
Mean annual precipitation: 35 to 55 inches
Mean annual air temperature: 45 to 59 degrees F
Frost-free period: 110 to 217 days
Farmland classification: Not prime farmland

Map Unit Composition

Buchanan and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Buchanan

Setting

Landform: Mountain slopes, valley sides
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank, base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Mountain slope colluvium derived from sedimentary rock

Typical profile

H1 - 0 to 4 inches: cobbly loam
H2 - 4 to 30 inches: gravelly clay loam
H3 - 30 to 65 inches: channery clay loam

Properties and qualities

Slope: 8 to 25 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 20 to 36 inches to fragipan
Natural drainage class: Moderately well drained
Runoff class: 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 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Hazleton

Percent of map unit: 5 percent
Hydric soil rating: No

Andover

Percent of map unit: 4 percent
Landform: Depressions
Landform position (three-dimensional): Mountainbase
Down-slope shape: Concave
Across-slope shape: Concave

Custom Soil Resource Report

Hydric soil rating: Yes

Berks

Percent of map unit: 2 percent

Hydric soil rating: No

Bedington

Percent of map unit: 2 percent

Hydric soil rating: No

Philo

Percent of map unit: 2 percent

Hydric soil rating: No

LaC—Laidig channery loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 16cr

Elevation: 400 to 3,800 feet

Mean annual precipitation: 34 to 60 inches

Mean annual air temperature: 50 to 57 degrees F

Frost-free period: 120 to 175 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Laidig and similar soils: 100 percent

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

Description of Laidig

Setting

Landform: Ridges

Landform position (two-dimensional): Footslope

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

Down-slope shape: Concave

Across-slope shape: Convex

Parent material: Loamy colluvium derived from sandstone and siltstone

Typical profile

H1 - 0 to 8 inches: channery loam

H2 - 8 to 32 inches: very channery loam

H3 - 32 to 60 inches: very channery sandy clay loam

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: 28 to 35 inches to fragipan

Natural drainage class: 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 30 to 48 inches

Frequency of flooding: None

Custom Soil Resource Report

Frequency of ponding: None

Available water storage in profile: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B

Hydric soil rating: No

Ty—Tyler silt loam

Map Unit Setting

National map unit symbol: 16dz

Elevation: 300 to 2,000 feet

Mean annual precipitation: 35 to 55 inches

Mean annual air temperature: 45 to 59 degrees F

Frost-free period: 120 to 180 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Tyler and similar soils: 90 percent

Minor components: 10 percent

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

Description of Tyler

Setting

Landform: Terraces

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Old alluvium derived from sedimentary rock

Typical profile

H1 - 0 to 9 inches: silt loam

H2 - 9 to 19 inches: silty clay loam

H3 - 19 to 50 inches: silty clay loam

H4 - 50 to 60 inches: stratified gravelly loam to silty clay loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: 15 to 36 inches to fragipan

Natural drainage class: Somewhat poorly drained

Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Depth to water table: About 6 to 18 inches

Frequency of flooding: None

Frequency of ponding: None

Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Purdy

Percent of map unit: 5 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Monongahela

Percent of map unit: 5 percent
Hydric soil rating: No

UD—Udifluvents-Dystrochrepts complex

Map Unit Setting

National map unit symbol: 16f0
Elevation: 200 to 1,300 feet
Mean annual precipitation: 30 to 50 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 120 to 214 days
Farmland classification: Not prime farmland

Map Unit Composition

Udifluvents and similar soils: 50 percent
Dystrochrepts and similar soils: 30 percent
Minor components: 4 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udifluvents

Setting

Landform: Flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 6 inches: channery silt loam
H2 - 6 to 42 inches: gravelly loam
H3 - 42 to 60 inches: silt loam

Custom Soil Resource Report

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
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: About 36 inches
Frequency of flooding: Frequent
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): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Description of Dystrochrepts

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Residuum weathered from sandstone and shale

Typical profile

H1 - 0 to 6 inches: loam, flagstones
H2 - 6 to 42 inches: gravelly loam
H3 - 42 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
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: About 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Brinkerton

Percent of map unit: 2 percent
Landform: Hills
Landform position (two-dimensional): Footslope

Custom Soil Resource Report

Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Holly

Percent of map unit: 2 percent
Landform: Backswamps, depressions on flood plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

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Custom Soil Resource Report

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**ATTACHMENT 3
450-FOOT WELL SURVEY**

GES Well ID	Distance to HDD Perpendicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-05162017-475-01	85	142	Unknown	Unknown	75
WL-09272017-614-02	310	315	150-200	40-50	Unknown
WL-09072017-614-02	251	320	Unknown	Unknown	Unknown
WL-09272017-614-01	326	329	150-200	Unknown	Unknown
WL-11012016-499-01	285	537	Unknown	Unknown	Unknown

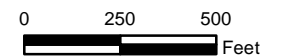
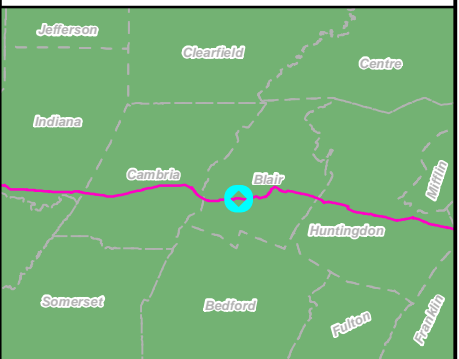
Legend

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

****Testing locations current as of 07/30/2018**

-  GES Testing Location

Location



**Well Location Map
HDD# PA-BL-0001.0027-RD
Blair County, PA.**

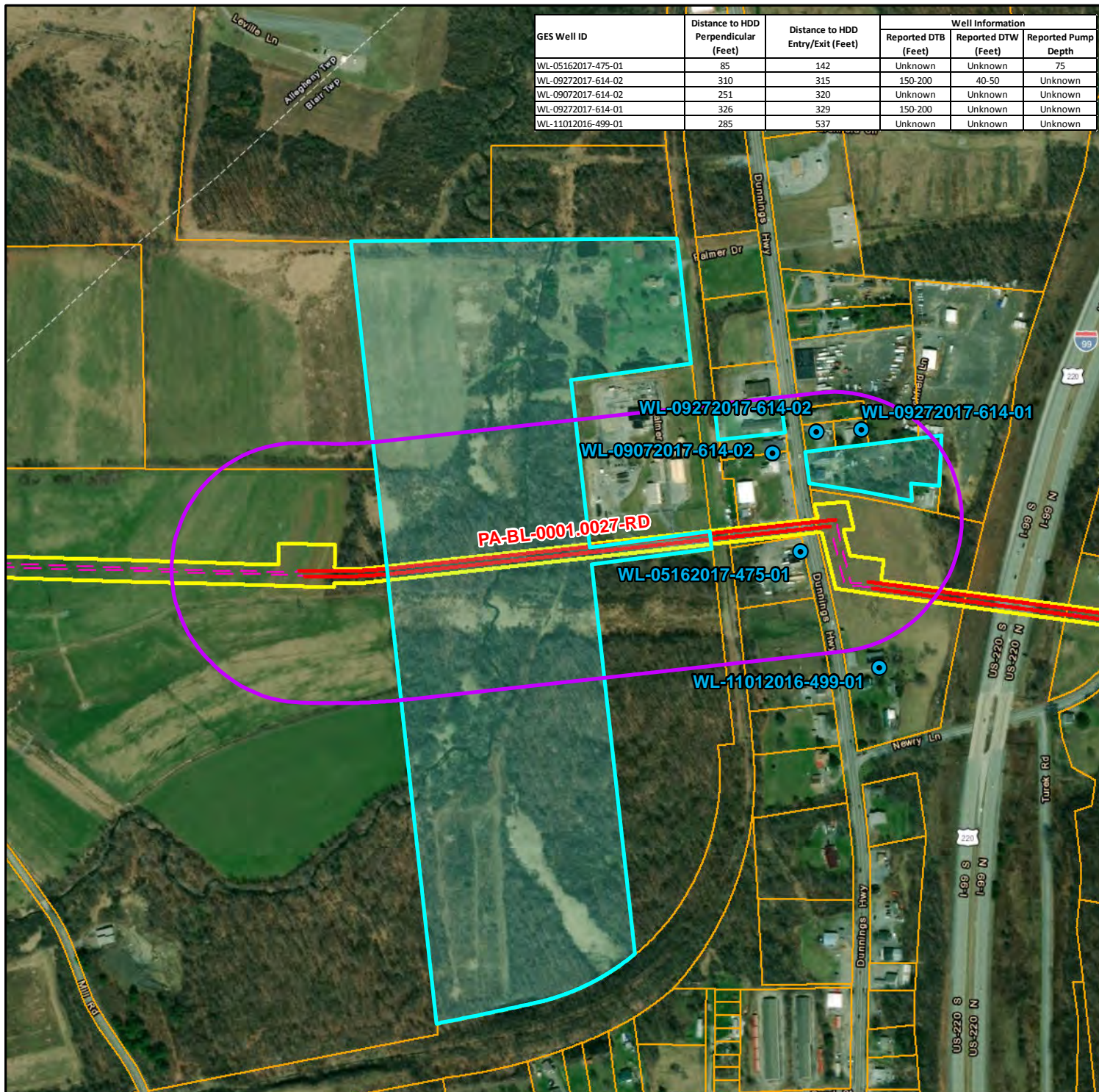
Prepared By:



Date:
1/10/2019

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

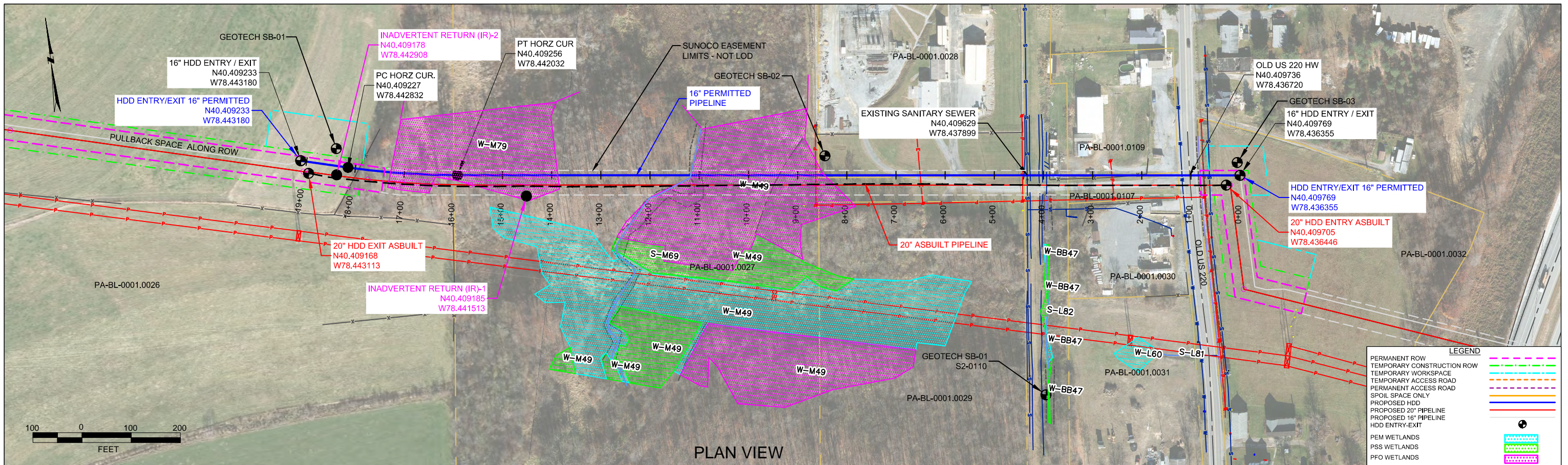
Coordinate System: NAD 83 Stateplane, PA South, Feet



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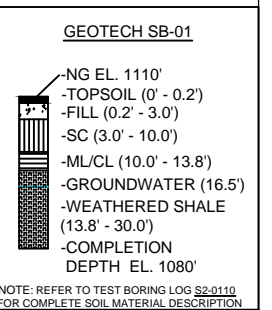
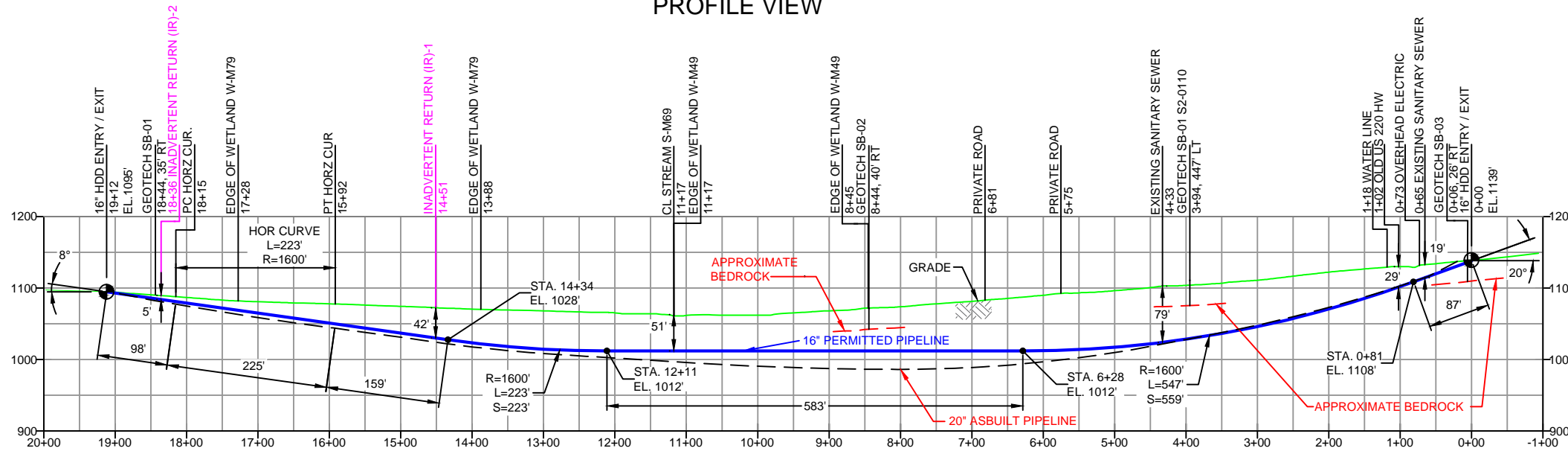
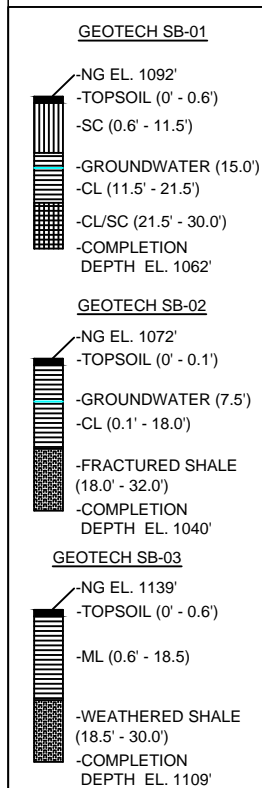
**OLD US 220 HIGHWAY CROSSING
PADEP SECTION 105 PERMIT NO.: E07-459
(SPLP HDD No. S2-0109-16)**

**ATTACHMENT 2
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES**



BLAIR COUNTY PENNSYLVANIA, BLAIR TOWNSHIP
S2-0109-16

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_H): 1912'
HDD PIPE LENGTH (S_H): 1935'
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.
 - 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. Original Permitted 16-Inch HDD Plan and Profile with 20-Inch IR Data

- 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		BY	DATE	CHK	DATE	APP	DATE
2	REVISED PROFILE WITH 2017 LIDAR	MRS	03/20/17	RMB	03/20/17	CAG	03/20/17
1	REVISED PER ENGINEERING COMMENTS	MRS	08/26/16	RMB	08/26/16	AAW	08/26/16
0	ISSUED FOR CONSTRUCTION	MRS	12/22/15	RMB	12/22/15	AAW	12/22/15
NO.	DESCRIPTION						

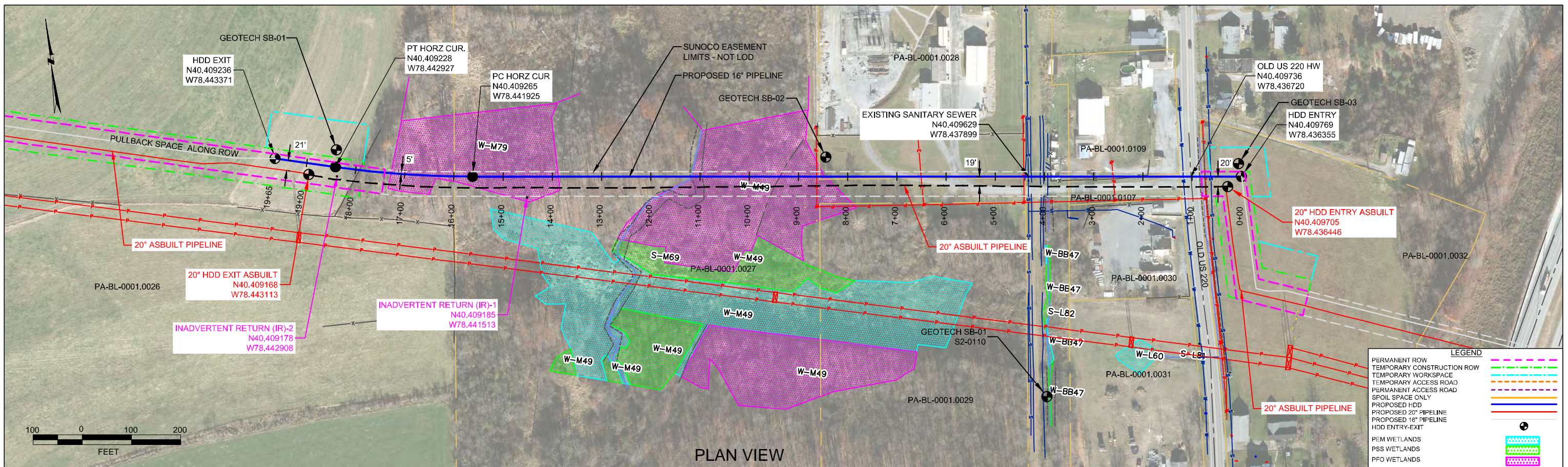
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
OLD US 220 HWY
PENNSYLVANIA PIPELINE PROJECT

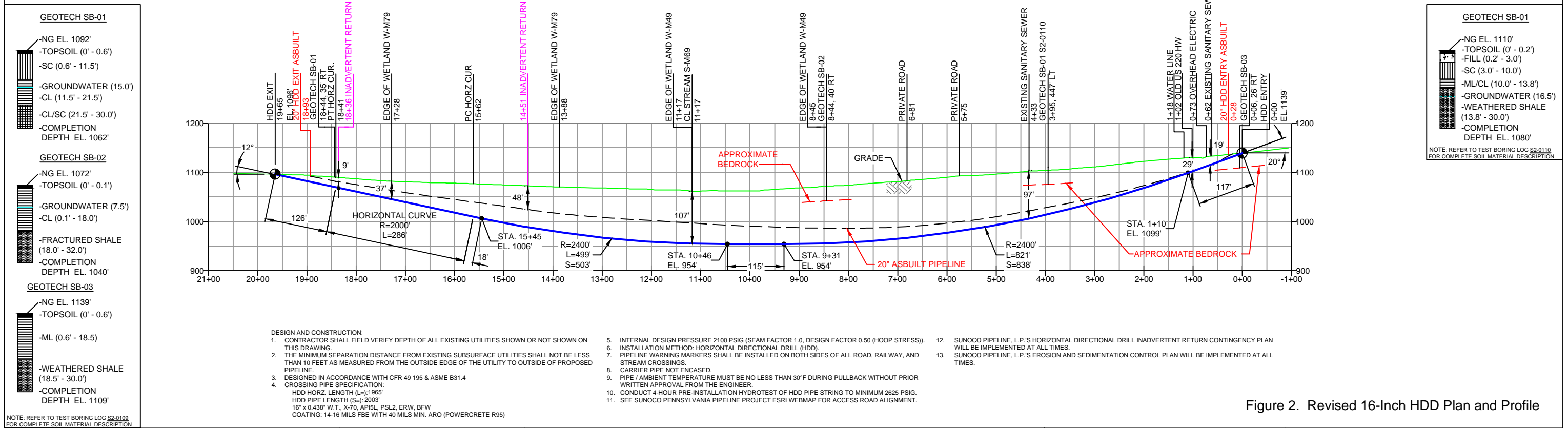
SCALE: 1"=200' DWG. NO. PA-BL-0001.0031-RD-16



PLAN VIEW

BLAIR COUNTY PENNSYLVANIA, BLAIR TOWNSHIP
S2-0109-16

PROFILE VIEW



NOTE: REFER TO TEST BORING LOG S2-0109 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTE: REFER TO TEST BORING LOG S2-0110 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_H): 1965'
HDD PIPE LENGTH (L_P): 2003'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCONCRETE 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.
 - 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		REF. DRAWING		REVISIONS						SUNOCO PIPELINE, L.P.				
1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83 2. STATIONING IS BASED ON HORIZONTAL DISTANCES. 3. 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. 4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING. 5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.		ES-3.21	TO	ES-3.22	EROSION & SEDIMENT PLAN	EP3	DESIGN CHANGE PER DPS	MRS	01/08/18	RMB	01/08/18	CAG	01/08/18	SUNOCO PIPELINE, L.P. HORIZONTAL DIRECTIONAL DRILL OLD US 220 HWY PENNSYLVANIA PIPELINE PROJECT
		SHEET 13	TO	SHEET 14	AERIAL SITE PLAN	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16	
						EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16	
						EP		MRS	11/13/15	RMB	11/13/15	AAW	11/13/15	
						B	ADDED GEOTECH INFO	MRS	10/05/15	RMB	10/05/15	AAW	10/05/15	
						A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15	
		DWG NO		DWG NO	DESCRIPTION	NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE	

Sunoco Logistics Partners L.P.

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(303) 792-5911