HORIZONTAL DIRECTIONAL DRILL ANALYSIS
HIGHWAY 222 CROSSING
PADEP SECTION 105 PERMIT NO.: E06-701
PA-BR-0071.0000-RD-16
(SPLP HDD No. S3-0200-16)

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This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch diameter pipeline that traverses Highway 222 in Cumru Township, Berks 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 16 on the list of HDDs included on Exhibit 3 of the Order.

The installation of the 20-inch diameter pipeline using HDD was initiated before the temporary injunction issued by the Pennsylvania Department of Environmental Protection (PADEP) Environmental Hearing Board on July 25, 2017. This first pipeline HDD had two (2) inadvertent returns (IRs) which were remediated and the HDD installation for the 20-inch diameter pipeline was completed.

The 16-inch pipeline HDD is referred to herein as HDD S3-0200-16.

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: 1,106 foot (ft)
- Entry/Exit angle: 14-16 degrees
- Maximum Depth of cover: 100 ft
- Depth under Stream B-41: 20 ft
- Pipe design radius: 1,600 ft

ROOT CAUSE ANALYSIS FOR THE 20-INCH PIPELINE INSTALLATION INADVERDENT RETURNS

The occurrence of IRs reported during the drilling of the 20-inch line resulted from the shallow depth of the borehole profile, as well as the weathered nature of the bedrock in the area of the IRs. The IRs developed near the edge of the south bound lane of Highway 222 at HDD Stations 8+70 during the pilot phase and Station 9+00 during the reaming phase, when the drilling tools were within and/or above the weathered bedrock surface. The IRs ranged in depth of approximately 27 and 36 feet bgs. Based on the Rock Quality Designation (RQD) of the rock core (B-01) retrieved near the HDD Exit Location, the bedrock near the location of the IR was highly fractured to broken and significantly contributed to the occurrence of the IRs in this area.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS), the site is in the Gettysburg-Newark Lowland Section of the Piedmont hysiographic Province of Pennsylvania and is regionally underlain by red shale, siltstone, and sandstone, some conglomerate and diabase. Local topography is characterized by rolling lowlands, shallow valleys and isolated hills (Sevon, 2000). The regional structure of the Newark Group consists of a north-northwestward dipping homocline, with local folds plunging northward and reversed dips located adjacent to the northern border of the basin.

The site geology is mapped as the Hammer Creek Conglomerate of Triassic (Trhc) age. The Hammer Creek Conglomerate consists of very coarse quartz conglomerate with abundant pebbles, and cobbles of gray quartzite containing minor interbeds of coarse sandstone. The unit has a measured thickness of 2,580 feet. Beds are thick to massive and well bedded. Joints in this unit have a blocky pattern, are moderately developed and abundant, and occur regularly. There is a moderate distance between fractures which are open and steeply dipping. The unit is moderately resistant to weathering. Weathering of the Hammer Creek results in large blocks to individual pebbles, cobbles and sand grains. The overlying mantle tends to be thin. From an engineering standpoint, the slope stability is good to fair.

Karst geology is not present at this HDD location. At this HDD location the use of geophysics assessments was not conducted because the SPLP possess a complete geologic profile from the drilling of the 20-inch pipeline. This data in combination with vertical geotechnical data is sufficient for the needs for analysis of the 16-Inch HDD profile.

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 narrow secondary openings developed along bedding planes, joints, faults and fractures. The openings are best developed near the surface which allows water to move more easily near the ground surface. The degree to which openings have developed depends on the composition and texture of the rock, and on the direction and intensity of the forces that have acted upon the rock. The groundwater flow system at the S3-0200 site is described as a series of sedimentary beds with relatively high transmissivity separated by beds exhibiting lower transmissivities. This sequence of beds exhibits different hydraulic properties that collectively act as a series of alternating aquifers and confining or semi-confining units forming a leaky multi-aquifer system (LMAS). Groundwater flow direction within the Hammer Creek Conglomerate is controlled by hydraulic gradients and the variability of hydraulic conductivity.

The depths of 21 domestic and non-domestic water supply wells within 0.5 miles of this HDD range from 35 to 800 feet below ground surface (bgs), with yields ranging from 7 to 230 gallons per minute (gpm).

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

INADVERTENT RETURN (IR) DISCUSSION

HDD specialists for Sunoco Pipeline, L.P. (SPLP) reviewed the original 16-inch HDD design in combination with the data from the 20-inch pipeline installation and have concluded that that the design profile for the 16-inch HDD would likely produce an IR at the same location.

The profile for the 16-inch pipeline has been redesigned so that it is deeper than previously planned. By extending the HDD by 295 feet to the west and 50 feet to the east, the profile has been deepened to increase the maximum depth of the HDD by an additional 34 feet under the locations of the IRs that occurred during the 20-inch pipeline HDD. Proactive drilling Best Management Practices will be used to control Losses of Circulation to minimize the potential for IRs during drilling and installation of the 16-inch pipeline.

ADJACENT FEATURES ANALYSIS

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This HDD location is located 0.2 miles north of the Town of Gouglersville in Berks County, Pennsylvania, and crosses under Stream B-41, Highway 222, and Peach Tree Lane. The general route of the Mariner II pipeline is from west to east. The HDD location is set within an area of active agricultural lands with rural residential home sites, and light industry.

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

As a result of this communication effort eleven private wells were identified within the 450-foot radius. Additionally, six private wells were identified outside of the 450-foot radius. Reported total depths of the private wells ranged from 70 to 135 feet bgs. No complaints from the owners of private water wells were received during drilling and installation of the 20-inch pipeline.

To further avoid and mitigate any adverse effects from the HDD to private water wells, and in accordance with the requirements of the Stipulated Order, SPLP will transmit a copy of this HDD analysis to all landowners having a property line within 450 ft of any direction of this HDD location.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of HDD S3-0200-16 includes an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Mariner II East Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered several different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. The Alternatives Analysis submitted to PADEP conceptually analyzed the potential feasibility of any alternative to baseline route trenched resource crossings (e.g., reroute, conventional bore, HDD). The decision-making processes for selection of the HDD instead of an open cut crossing methodology is discussed thoroughly in the submitted alternatives analysis and was an important part of the overall PADEP approval of HDD plans as currently permitted. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

Open-cut Analysis

SPLP specifications require a minimum of 48-inches of cover over the installed pipelines. The Pennsylvania Department of Transportation (PennDOT) cover requirements under public roadways is 60-inches of cover.

Due to the need to cross under Highway 222, and in combination with differences in elevation on both sides of the highway, and the presence of immediately adjacent residential home sites east of Highway 222 an open cut construction plan is not feasible at this location.

Conventional auger bore is technically limited to less than 200 linear foot at a time varying by the underlying substrate. Due to the spacing constraints and elevation differences, there is no subset location within this length of area crossed by the HDD to feasibly employ this type of installation method, nor could a combination of conventional auger bore and open cut be employed to replace the HDD.

Re-Route Analysis

This alignment bypasses or avoids directly impacting Highway 222 and Peach Tree Lane.

There are no existing utility corridors to the north or south that provide a practical alternative route. Any alternate route considered to the north or south would require the clearing of a new "greenfield" corridor through existing agricultural lands, woodlands, and would likely encounter new stream and wetlands, and possibly encroach on additional private residences before it could rejoin the current route.

In summary there is no alternative route that could avoid conflicts with existing or similar resources and features as presented along the current pipeline route. Since SPLP possesses no prior rights for multiple utility lines in any nearby existing corridor, nor any new corridor that could be developed, SPLP anticipates significant legal action to acquire a new easement.

This re-route analysis conducted for the Highway 222 HDD confirms the conclusions reached in the previously submitted alternatives analysis.

REVISED HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

Additional geologic investigation has been completed, and the "as built" record for the 20-inch pipeline has been utilized in the redesign of the planned 16-inch HDD. The redesign adjusts the HDD profile deeper to minimize the risk of drilling fluid loss, drilling difficulties, and IRs. A summary of the redesign factors is provided below. The original and redesigned 16-inch HDD plan and profile drawings are provided in Attachment 2.

- Horizontal length: 1,432 ft
- Entry/Exit angle: 8-16 degrees
- Maximum Depth of cover: 100 ft
- Depth under Stream B-41: 55 ft
- Pipe design radius: 2,000 ft

CONCLUSION

As shown on Figure 2 in Attachment 2, the redesigned HDD profile for the 16-inch pipeline is 326 ft longer, with a depth of cover under the previous IR location increased by 35 ft from the permitted design.

Based on the original and revised profiles for HDD S2-0200-16, the revised profile for HDD S3-0200-16 goes deeper into bedrock than the original profile. As such, the revised profile represents a reduced risk of creating one or more IRs, similar to those occurring during installation of the 20-inch diameter pipeline. Procedures established and documented in SPLP's revised IR Assessment, Preparedness, Prevention, and Contingency (PPC) Plan (rev. February 7, 2018) across all ME II spreads have proven to be very

effective in eliminating IRs and minimizing the extent of IRs. Additionally SPLP is mandating proactive responses to Losses of Circulation, as explained below, that have successfully mitigated 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. 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 HDD Reevaluation Team, consisting of the Geotechnical Evaluation Leader, Professional Geologists, Professional Engineers, and HDD Specialists, it is the HDD Reevaluation Team's professional opinion that the proposed HDD design and implementation of the management measures contained within this re-revaluation 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

2-14-2019
Date

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

Pertaining to the practice of geology as set forth in the attached Hydrogeologic Reevaluation Report

2-14-19
Date

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

Pertaining to Pipe Stress and HDD Geometry

2/14/19
Date

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

HIGHWAY 222 CROSSING
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ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

RETTEW

We answer to you.

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Engineers
Environmental Consultants
Surveyors
Landscape Architects
Safety Consultants

February 12, 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
Highway 222 HDD (S3-0200), PA-BR-0075.0000-RD-16
Hydrogeologic Re-Evaluation Report for 16-Inch Pipeline
Cumru and Spring Townships, Berks County, PA
RETTEW Project No. 096302011

EXECUTIVE SUMMARY

1. The 20-inch and 16-inch S3-0200 Highway 222 horizontal directional drill (HDD) locations are included in the Corrected Stipulated Order of August 10, 2017, requiring re-evaluation, including a geologic report. This HDD is listed as No. 16 of the HDDs on Exhibit 3. This re-evaluation was also prepared as a result of an inadvertent return (IR) that occurred as the Highway 222 HDD was being completed for the 20-inch pipeline.
2. The site is underlain by sedimentary rocks of the Triassic-age Hammer Creek Conglomerate (Trhc). This unit consists of very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.
3. Water-bearing zones in the underlying geology generally occur in secondary openings along bedding planes, joints, and fractures. The openings are best developed near the surface which allows water to move more easily near the ground surface.
4. Reported median yields in non-domestic wells installed in shale, quartz conglomerate and sandstone within the Hammer Creek Conglomerate were 144, 120, and 90 gallons per minute (gpm), respectively.
5. The HDD profile for the proposed 16-inch drill has been redesigned to increase its depth beneath the identified roads and utilities.
6. Based on the hydro-structural characteristics of the underlying geology, information obtained from installation of the 20-inch pipe, and occurrence of inadvertent returns (IRs) during the installation of the 20-inch pipe, the Highway 222 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 Highway 222 S3-0200 HDD location on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner II East (PPP-ME2) Project. The Highway 222 HDD is located in Cumru and Spring Townships, Berks County, Pennsylvania as shown on **Figure 1**. The HDD is located approximately 0.25-mile north of Gouglersville

and passes under Highway 222. The HDD was designed to be drilled under an existing UGI pipeline, Highway 222, various utilities and Old Lancaster Pike Road as shown on **Figure 1**. This re-evaluation report is part of the response to the Corrected Stipulated Order dated August 10, 2017, related to the potential for the inadvertent return of drilling fluids during proposed drilling operations. This re-evaluation was also prepared as a result of an inadvertent return (IR) that occurred as the Highway 222 horizontal directional drill (HDD) was being completed for the 20-inch pipeline.

The 16-inch HDD profile was redesigned on November 30, 2018 in order to move the western and eastern entry/exit points to the north, increase the overall length of the HDD, and to increase the depth of the HDD bore profile that will underlie roadways and utilities. The redesigned west HDD entry/exit is at a surface elevation of approximately 730 feet above mean sea level (AMSL) and the redesigned east HDD entry/exit is at a surface elevation of approximately 761 feet AMSL. The redesigned profile allows for deepening of the profile under the existing UGI pipeline, Highway 222 and various identified subsurface utilities. The proposed 16-inch pipe will be approximately 55 feet deeper than the 20-inch pipe at the point of maximum separation. The HDD profile was extended approximately 290 feet to the west resulting in a new horizontal length and pipe length of 1,432 and 1,449 feet, respectively. The inclination of the entry and exit angles has remained unchanged, but the redesign of the bore profile will allow for approximately 10 feet of additional protective cover at the location of the IRs that occurred during the installation of the 20-inch pipe. The existing 20-inch and proposed 16-inch S3-0200 HDD locations are shown on **Figure 1,** and the redesigned 16-inch profile is included as **Attachment A.**

2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (PABTGS), the site is in the Gettysburg-Newark Lowland Section of the Piedmont Physiographic Province of Pennsylvania and is regionally underlain by red shale, siltstone, and sandstone, some conglomerate and diabase. Local topography is characterized by rolling lowlands, shallow valleys and isolated hills (Sevon, 2000). The regional structure of the Newark Group consists of a north-northwestward dipping homocline, with local folds plunging northward and reversed dips located adjacent to the northern border of the basin. These geologic structures are cross-cut by several faults occurring at large angles relative to the general strike of the bedrock. The overall dip direction is northwestward or northward ranging from 15 to 30 degrees and sometimes exceeding 40 degrees (MacLachlan et al., 1975). Outcrop patterns are broadly parallel to the Appalachian fold belt. These rocks generally have good surface drainage (Wood, 1980). Based on the United States Geologic Survey (USGS) 7.5-Minute Sinking Spring Topographic Quadrangle Map shown on **Figure 1**, the site is situated at an approximate elevation of 720 to 760 feet AMSL. Surface topography at the site slopes to the west along the HDD profile towards Little Muddy Creek. Little Muddy Creek flows primarily in a southwesterly direction before discharging into Muddy Creek and ultimately, the Conestoga River.

The site geology is mapped as the Hammer Creek Conglomerate of Triassic (Trhc) age. The Hammer Creek Conglomerate consists of very coarse quartz conglomerate with abundant pebbles, and cobbles of gray quartzite containing minor interbeds of coarse sandstone. The unit has a measured thickness of 2,580 feet. Beds are thick to massive and well bedded. Joints in this unit have a blocky pattern, are moderately developed and abundant, and occur regularly. There is a moderate distance between fractures which are open and steeply dipping. The unit is moderately resistant to weathering. Weathering of the Hammer Creek results in large blocks to individual pebbles, cobbles and sand grains. The overlying mantle tends to be thin. From an engineering standpoint, the slope stability is good to fair. Landslides may occur where the cut slopes are steep and the rocks dip towards the cut. Ease of excavation is classified as

difficult and drill rates tend to be slow due to the hardness of the quartz-pebble conglomerate. Foundation stability is good, but the excavation should be continued to sound material. Surface drainage is good with the unit having low primary porosity and low secondary porosity from joint and bedding plane openings. Permeability is also low in the Hammer Creek Conglomerate.

According to the United States Department of Agriculture (USDA) Soil Survey of Berks County, Pennsylvania, soils in the vicinity of the Highway 222 HDD consist of three 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 narrow secondary openings developed along bedding planes, joints, faults and fractures. The openings are best developed near the surface which allows water to move more easily near the ground surface. The degree to which openings have developed depends on the composition and texture of the rock, and on the direction and intensity of the forces that have acted upon the rock. The groundwater flow system at the S3-0200 site is described as a series of sedimentary beds with relatively high transmissivity separated by beds exhibiting lower transmissivities. This sequence of beds exhibits different hydraulic properties that collectively act as a series of alternating aquifers and confining or semi-confining units forming a leaky multi-aquifer system (LMAS). Groundwater flow direction within the Hammer Creek Conglomerate is controlled by hydraulic gradients and the variability of hydraulic conductivity. The predominant flow direction is parallel to bedding (Wood, 1980).

The yield of water wells is typically influenced by topographic position, with water-bearing zones located on the tops and slopes of high hills and ridges generally having low yields. Conversely, wells located in valleys typically have higher yields. Water wells completed in the Hammer Creek Conglomerate typically have higher yields when completed in valleys and lower yields when completed on hilltops. Industrial and public water-supply wells show little to no uniform correlation to well yield and topography largely because these wells are completed to greater depths; therefore, most of the yield in these wells is provided by the deeper zones, masking the influence of topography. Reported median yields from non-domestic wells installed in the quartz conglomerate within the Hammer Creek Conglomerate were 120 gallons per minute (Wood, 1980).

Well records for 21 individual water supply wells within a 0.5 mile radius of the Highway 222 HDD were obtained from the Pennsylvania Groundwater Information System (PaGWIS). The well locations are shown on **Figures 2** and **3**. The information obtained from these well records is summarized in the following table:

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gallons per minute)
668790	INDUSTRIAL	39	800	UNKNOWN	15
668686	INDUSTRIAL	59	800	UNKNOWN	7.5
661835	DOMESTIC	57	140	UNKNOWN	20
658847	DOMESTIC	80	200	UNKNOWN	40
65406	IRRIGATION	108	200	80	UNKNOWN
65300	DOMESTIC	50	110	70	12

Well No.	Well Use	Casing Depth (feet)	Total Depth (feet)	Water Level (feet)	Yield (gallons per minute)
650360	DOMESTIC	40	120	UNKNOWN	50
646232	DOMESTIC	60	140	UNKNOWN	40
62049	DOMESTIC	UNKNOWN	138	93	7
62045	DOMESTIC	30	80	22	22
62044	DOMESTIC	27	108	52	10
62038	DOMESTIC	30	35	12	UNKNOWN
62032	DOMESTIC	53	68	17	30
61849	DOMESTIC	25.67	100	40	8
61832	DOMESTIC	43	160	42	15
61816	DOMESTIC	43	140	48	7
482278	DOMESTIC	100	180	60	75
415737	DOMESTIC	105	250	UNKNOWN	25
124	COMMERCIAL	60.3	231	30	237
122	IRRIGATION	108	200	80	30
121	DOMESTIC	UNKNOWN	125	UNKNOWN	20

As a condition of the Corrected Stipulated Order, other Sunoco subcontractors have researched private water supplies located within a 450-foot radius the Highway 222 HDD. RETTEW received a map depicting the results of these efforts identifying any private wells within the search radius on February 8, 2019. Eleven private wells were identified within the 450-foot radius. Additionally, six private wells were identified outside of the 450-foot radius. Reported total depths of the private wells ranged from 70 to 135 feet bgs. The location of all of the identified wells is shown on the figure in **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 fractures, joints, faults or bedding planes within the subsurface. Fracture traces may be observed on aerial photographs as linear topography, straight stream segments, vegetation or soil tonal alignments. These features can transmit groundwater through the fractured bedrock aquifer underlying the S3-0200 HDD site. Fracture traces underlying, or in close proximity to, the Highway 222 HDD were evaluated using historical aerial photographs from the years 1992 through 2018 (Google Earth Pro, 2018), the Sinking Springs, PA USGS 7.5 Minute Quadrangle Topographic Map, and the Geologic Map of the Sinking Spring Quadrangle (MacLachlan et al., 1975). The aerial photographs, publications and maps were reviewed to approximate locations of natural linear 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 and aerial base map, respectively. Four fracture traces were identified near the Highway 222 HDD site that are likely

related to the primary geologic structure of the area. Three of the fracture traces trend approximately northeast-southwest (NE-SW), generally parallel to geologic strike. One fracture trace trends northwest-southeast (NW-SE), generally at an angle to the strike of bedding, and may represent stress-related joint sets. General surface drainage patterns near the site are characterized by linear stream reaches trending NE-SW or NW-SE that reflect the general geologic structure.

5.0 GEOTECHNICAL EVALUATION

Two geotechnical drilling investigations were performed at the site. The initial investigation was performed between December 2014 and February 2015 during the preliminary investigation of the Highway 222 HDD and prior to initiating the 20-inch HDD operations. A second phase of geotechnical drilling was performed in September 2017. The 2014-2015 test borings were advanced by hollow-stem auger drilling and NQ-sized wireline rock coring methods. These borings are designated as SB-01, SB-02, and SB-03. The second phase test borings completed in 2017 were also advanced by hollow-stem auger drilling and NQ-sized wireline rock coring methods. These borings are designated as B-01 and B-02. Soil, residual soil, and weathered bedrock samples collected during the two phases of the geotechnical investigation were sampled using split-spoon samplers. Geotechnical boring logs are included in **Attachment 1**.

SB-01 was located approximately 25 feet west of the western 20-inch HDD entry/exit point and SB-02 was located to the east of Highway 222, approximately 650 feet northwest of the eastern 20-inch HDD entry/exit point. SB-03 was located approximately 75 feet southeast of the eastern 20-inch HDD entry/exit point. Boring B-01 was drilled approximately 75 feet northwest of the western 20-inch HDD entry/exit point, while boring B-02 was drilled approximately 75 feet east of the eastern 20-inch HDD entry/exit point. The locations of these borings are identified on **Figures 2** and **3**.

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

- Soil and residual soils vary from boring to boring; 30.0 feet at SB-01, 24.0 feet at SB-02, 30.0 feet at SB-03, 10.25 feet at B-01, and 20.25 feet at B-02. Residual soils are described as follows:
    - **Boring SB-01**: TOPSOIL, fine to coarse SAND (SM) with a little fine to coarse gravel/conglomerate matrix, some silt. The total depth of the soil boring was 30.0 feet below ground surface (bgs). Groundwater was not encountered.
    - **Boring SB-02**: TOPSOIL, fine to coarse SAND (SM) with a little silt and some conglomerate gravel, medium to coarse SAND with conglomerate gravel, a little silt and CONGLOMERATE GRAVEL (SM/GC). Auger refusal occurred at 24.0 feet bgs. Groundwater was not encountered.
    - **Boring SB-03:** TOPSOIL, fine to medium SAND (SM) with silt and a little fine to coarse gravel. The total depth of the soil boring was 30.0 feet bgs. Groundwater was not encountered.
    - **Boring B-01**: Medium dense silty SAND (SM), trace gravel, medium dense clayey SAND (SC) with gravel, medium dense to dense silty SAND (SM) with gravel, moist. Bedrock was encountered at a depth of 10.25 feet bgs. Groundwater was encountered at 9 feet bgs.
    - **Boring B-02**: Medium dense sandy lean CLAY (CL), trace gravel, dry/moist; dense silty GRAVEL (GM) with sand, dry/moist; medium dense silty SAND (SM) with gravel, moist; medium dense silty GRAVEL (GM) with sand, moist/wet; highly weathered to completely weathered SANDSTONE; very dense silty SAND with gravel, moist/wet. Bedrock was encountered at a depth of 20.25 feet bgs. Groundwater was encountered at 15 feet bgs.

- From the initiation of coring operations, to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and are described as follows:
  - **Boring SB-01**: Rock coring was not completed at this location.
  - **Boring SB-02**: SB-02 was completed to a total depth of 32.0 feet bgs. The top of bedrock was encountered at 24.0 feet bgs. The bedrock consisted of fractured CONGLOMERATE from 24.0 to 32.0 feet bgs. Total core recovery (TCR) ranged from 37% to 58% and rock quality designations (RQDs) were very poor (0).
  - **Boring SB-03:** Rock coring was not completed at this location.
  - **Boring B-01:** B-01 was completed to a total depth of 145 feet bgs. The top of bedrock was encountered at approximately 10.25 feet bgs. From 10.25 to 15 feet bgs, highly weathered to completely weathered SANDSTONE was observed. TCR was 12%, while RQDs were very poor (0%). From 15 to 25 feet bgs, light red-gray-brown to dark gray-brown, fine to very coarse grained, weathered to highly weathered, very broken to massive, moderately hard to hard CONGLOMERATE was observed with trace pits and vugs. TCR ranged from 92% to 100% and RQDs were very poor to poor (20 to 26). From 25 to 42 feet bgs light gray to dark brown, fine to very coarse grained, slightly weathered to highly weathered, slightly to very broken to massive, hard to very hard CONGLOMERATE was observed with trace pits and vugs. TCR ranged from 57% to 88% and RQDs were very poor to poor (8 to 38). From 42 to 43.8 feet bgs, red-brown, fine grained, weathered to slightly weathered, very broken to slightly broken, moderately hard SANDSTONE was observed. TCR was 100% and RQDs were poor (42). From 43.8 to 84.5 feet bgs, light gray-white to dark brown, fine to very coarse grained, slightly to highly weathered, very broken to massive, moderately hard to very hard CONGLOMERATE was observed with trace pits and vugs. TCR ranged from 83% to 100% and RQDs were poor to good (38 to 88). From 84.5 to 86 feet bgs, gray-brown to dark gray-brown, fine to very coarse grained, slightly weathered, slightly broken to massive, moderately hard conglomeritic SANDSTONE was observed. From 86 to 90.5 feet bgs, light gray-brown to dark gray-brown, fine to very coarse grained, weathered to slightly weathered, very broken to massive, hard to very hard CONGLOMERATE was observed. TCR was 100% and RQDs were fair (72). From 90.5 to 96 feet bgs, light gray-brown, fine to medium grained, slightly weathered, slightly broken to massive, hard to very hard SANDSTONE was observed. TCR was 100% and RQDs were good (78). From 96 to 98 feet bgs, gray-brown to dark gray-brown, fine to very coarse grained, slightly weathered, very broken to massive, hard conglomeritic SANDSTONE was observed. From 98 to 145 feet bgs, light gray-brown to dark brown, fine to very coarse grained, weathered to slightly weathered, very broken to massive, hard to very hard CONGLOMERATE was observed with trace pits and vugs. TCR ranged from 92 to 100% and RQDs ranged from fair (68) to excellent (98). Groundwater was observed at 20 feet bgs after the completion of coring operations.
  - **Boring B-02**: B-02 was completed to a total depth of 165.0 feet bgs. The top of bedrock was encountered at approximately 20.25 feet bgs. From 20.25 to 30 feet bgs, light gray-brown to dark brown, fine to coarse grained, weathered to highly weathered, very broken to massive, moderately hard SANDSTONE with multiple soil seams and layers was observed. TCR was 80% and RQDs were very poor (10 to 19). From 30 to 54.5 feet bgs, light gray-brown to gray-brown, fine to coarse grained, highly weathered, very broken to massive, moderately hard conglomeritic SANDSTONE was observed. TCR ranged from 22% to 53% and RQDs were very poor (0 to 12). From 54.5 to 56 feet bgs, light gray to dark brown, medium to coarse grained, weathered, very to slightly broken, moderately hard SANDSTONE was observed. From 56 to

78.5 feet bgs, light gray to dark brown, very fine to coarse grained, highly weathered, very broken to slightly broken, moderately hard SANDSTONE was observed. TCR ranged from 17% to 37% and RQDs were very poor (0-15). From 78.5 to 85.5 feet bgs, light gray-brown to dark brown, fine to very coarse grained, weathered to highly weathered, very broken to massive, moderately hard to very hard CONGLOMERATE was observed. TCR was 58% and RQDs was fair (58). From 85.5 to 93.6, feet bgs light gray-brown to gray-brown, fine to very coarse grained, slightly weathered, very broken to massive, moderately hard to hard SANDSTONE was observed. Trace pits were encountered between 87.5 to 93.6 feet bgs. TCR ranged from 87% to 97% and RQDs were fair (52 to 58). From 93.6 to 115 feet bgs brown to gray-brown, fine to very coarse grained, slightly weathered to highly weathered, very broken to massive, moderately hard to hard conglomeritic SANDSTONE with multiple soil seams and layers was observed. Pits and vugs were encountered between 93.6 and 100 feet bgs and a less than 3-inch thick soil layer was encountered at 96.9 feet bgs. TCR ranged from 37% to 83% and RQDs were very poor (0) to poor (48). From 115 to 116 feet bgs, brown, fine grained, slightly weathered, broken to massive, moderately hard SANDSTONE was observed. From 116 to 125 feet bgs, gray-brown to brown, medium to very coarse grained, weathered to highly weathered, very broken to massive, moderately hard to hard conglomeritic SANDSTONE with multiple soil seams and layers was observed. TCR ranged from 60% to 100% and RQDs were very poor to poor (8 to 47). From 125 to 135 feet bgs, red-brown to red-gray-brown, very fine grained, slightly weathered to weathered, very broken to massive, moderately hard SILTSTONE was observed. Multiple soil seams were encountered between 127.5 and 135 feet bgs. TCR was 100% and RQDs were very poor to poor (14 to 43). From 135 to 151.5 feet bgs, red-gray-brown to light gray, fine to coarse grained, weathered to slightly weathered, very broken to massive, moderately hard to very hard SANDSTONE was observed. Multiple soil seams were encountered between 135 and 140 feet bgs. An approximately 6.75-inch thick conglomerate layer, with trace pits and vugs, was encountered at 143.9 feet bgs. TCR was100% and RQDs ranged from poor (27) to excellent (98). From 151.5 to 155 feet bgs, light gray to gray-brown, fine to very coarse grained, weathered to slightly weathered, very broken to massive, hard, CONGLOMERATE was observed with trace pits and vugs. TCR was 100% and RQD was good (75). From 155 to 157.5 feet bgs, light gray to gray-brown, fine to very coarse grained, weathered to slightly weathered, very broken to massive, hard conglomeritic SANDSTONE (with trace pits) was observed. From 157.5 to 160 feet bgs, dark red-brown to gray-brown, fine grained, slightly weathered, massive, very hard SANDSTONE was observed. From 160 to 165 feet bgs, a sequence of SILTSTONE to SANDSTONE to COMGLOMERATE was encountered. Soil parting was observed at 160 feet bgs and highly weathered and weathered seams were encountered at 161.5 and 162.6 feet bgs. TCR was 100% and the RQD value was fair (63). Groundwater was observed at 28 feet bgs after the completion of coring operations.

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

Boring	Sample Depth (feet bgs)	Compressive Strength (tons per square foot)
B-01	26.5	391.44
B-01	45.3	547.02

Boring	Sample Depth (feet bgs)	Compressive Strength (tons per square foot)
B-01	55.6	274.09
B-01	72.5	771.01
B-01	81.6	257.95
B-01	85.2	170.70
B-01	92.9	529.64
B-01	104.5	659.42
B-01	114.2	443.35
B-01	120.8	209.99
B-01	128.3	420.91
B-01	135.2	618.03
B-02	21.5	71.75
B-02	28.8	162.75
B-02	49.4	238.34
B-02	85.5	251.61
B-02	91.8	304.92
B-02	102	149.76
B-02	115.5	180.29
B-02	126.5	140.75
B-02	130.5	355.11
B-02	148	776.19
B-02	152.5	381.73

Please note that Skelly and Loy or RETTEW did not oversee or direct the geotechnical drilling program associated with HDD S3-0200 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. Skelly and Loy and RETTEW relied on these reports and incorporated the data into the general geologic and hydrogeologic framework included in this report.

6.0 GEOPHYSICAL SURVEY

No karst geology was observed during the field reconnaissance, nor is any mapped as being present at this HDD location. In addition, no carbonate bedrock was observed in the geotechnical borings and no evidence of land subsidence was observed during the completion of the 20-inch boring. The use of

geophysical surveys during this hydrogeologic re-evaluation was considered for study purposes; however, was not used since the Hammer Creek Conglomerate is not deemed susceptible to the solution activity present in carbonate geologic formations in Pennsylvania. Geophysical survey data would not enhance the evaluation or reduce the risk of an IR.

7.0 FIELD OBSERVATIONS

RETTEW staff were on-site during 20-inch pipe HDD activities. Laney Directional Drilling (Laney) completed the drilling for the 20-inch pipeline. Laney initiated drilling on May 18, 2017. On May 31, 2017 a full loss of returns was observed and all drilling activities were stopped when the pilot bit was at a trajectory length of 1,021.2 and a depth of 59 feet from the entry point. An IR of approximately 500 gallons was observed in retention pond B7. Sand bags were used to construct a "ring dam" around the IR and cleanup efforts were initiated. Since the IR occurred in an upland area, and no water resources were impacted, advancement of the pilot bit resumed on June 1, 2017. The viscosity of the drilling fluid was increased to seal off the IR, but discharge from the IR overwhelmed the containment structure and advancement of the pilot hole was suspended. Drilling resumed on June 2, 2017 and was stopped periodically during the day to allow the containment structure within retention pond B7 to be expanded to encompass three new IRs that occurred throughout the day. The pilot hole was completed at 1654 on June 2, 2017.

On June 5, 2017, the 15-inch ream pass was started and on June 19, when the reamer was at a trajectory length of 989 feet, an IR originating from a culvert pipe beneath Highway 222 was observed. Approximately 10 gallons was released below retention pond B7, contained, and cleaned up. The 15-inch ream pass was resumed on June 20, 2017 until an IR was observed below the June 19, 2017 IR containment. All drilling activities were then suspended. An inspection of stream S-B40 identified drilling fluid within the stream channel that was likely deposited the previous day during a heavy precipitation event. The 15-inch ream pass resumed on June 26, 2017 and was completed with no additional IRs.

After receiving approval from the Pennsylvania Department of Environmental Protection (PA DEP) to resume drilling activities, the 24-inch ream pass was started on June 28, 2017. No new IRs, or re-activation of existing IRs, was observed when the ream pass was initiated. The 24-inch ream was completed on July 15, 2017. The 30-inch ream pass was started on July 15, 2017, and stopped on July 21, 2017, pending legal action. No new IRs, or re-activation of existing IRs, were observed during the 30-inch ream pass. Following restart approval from the PA DEP, the 30-inch ream pass was resumed on August 29, 2017 and completed on September 2, 2017. Laney completed the swab pass on September 5 and 6, 2017 and the 20-inch product pipe was pulled through the boring on September 8, 2017.

8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION

Based on published geologic and hydrogeologic information, geotechnical borings, and field observations during the completion of the 20-inch HDD, the Highway 222 HDD is underlain by sedimentary rocks of the Triassic-age Hammer Creek Conglomerate (Trhc). The geology consists of very coarse quartz conglomerate with abundant pebbles and cobbles of gray quartzite. The hydrogeologic setting is dominated by groundwater flow that occurs in secondary openings along bedding planes, joints, faults and fractures. The openings are best developed near the surface which allows water to move more easily near the ground surface. Reported median yields from non-domestic wells installed in the quartz conglomerate within the Hammer Creek Conglomerate were 120 gallons per minute.

The original 16-inch HDD profile was relatively shallow at the entry and exit points. In addition, the original profile passed through shallow unconsolidated overburden and weathered bedrock. Based on the hydro-structural characteristics of the underlying geology described in this report, and the previous occurrence of IRs during installation of the 20-inch pipe, the Highway 222 HDD site is susceptible to an IR of drilling fluid during HDD operations. As a result, the 16-inch HDD profile was redesigned to allow for a deeper crossing beneath the existing UGI pipeline, Highway 222, and the various subsurface utilities. The proposed 16-inch pipe will be approximately 55 feet deeper than the 20-inch pipe at the point of maximum separation. From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or proactive drilling best management practices, will be used to reduce the risk of an IR and/or a loss of drilling fluid. Drilling best management practices are described in the Horizontal Directional Drill Analysis component of the overall re-evaluation package.

9.0 REFERENCES

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C.R. Wood, 1980, *Groundwater Resources of the Gettysburg and Hammer Creek Formations, Southeastern Pennsylvania*, Pennsylvania Geological Survey, Water Resource Report 49, 95 pages.

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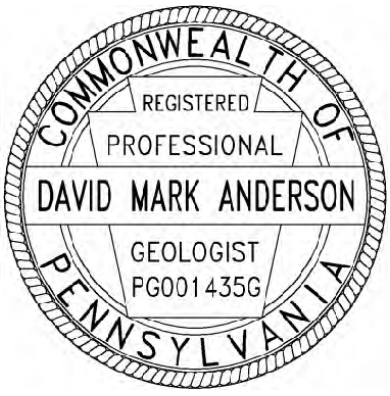
10.0 CERTIFICATION

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

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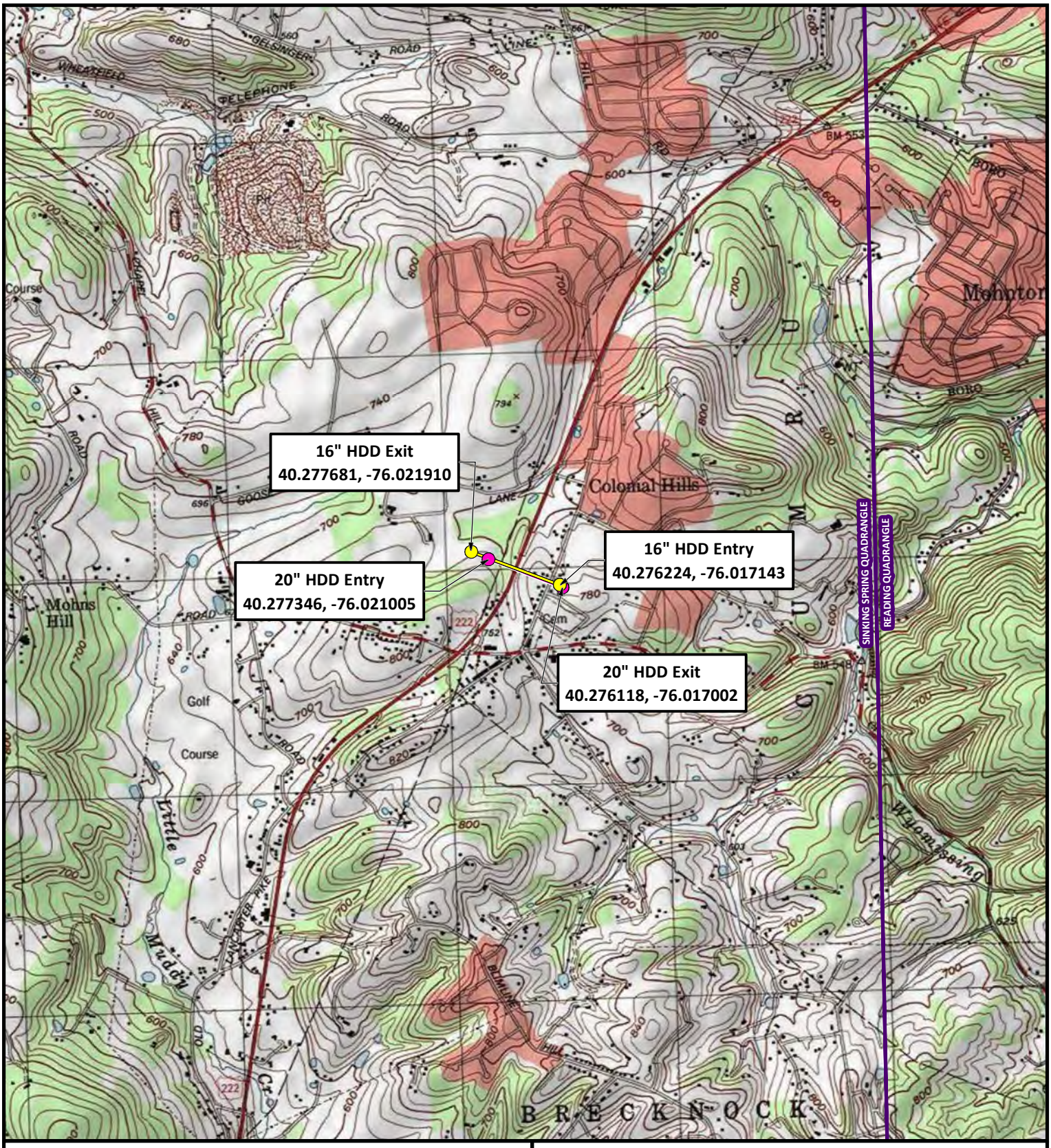
RETTEW

FIGURES



16" HDD Entry/Exit

20" HDD Entry/Exit

16" HDD Profile

20" HDD Profile

Sinking Spring, PA USGS 7.5' Topographic Quadrangle 2/8/2019

Sunoco Pipeline, L.P.

Highway 222 HDD Location

Figure 1 - Topographic Basemap

Cumru and Spring Townships, Berks County, PA

Project No. 096302011

N W E S

0 1,000 2,000 Feet

1 inch = 2,000 feet

Sunoco Logistics Partners L.P.

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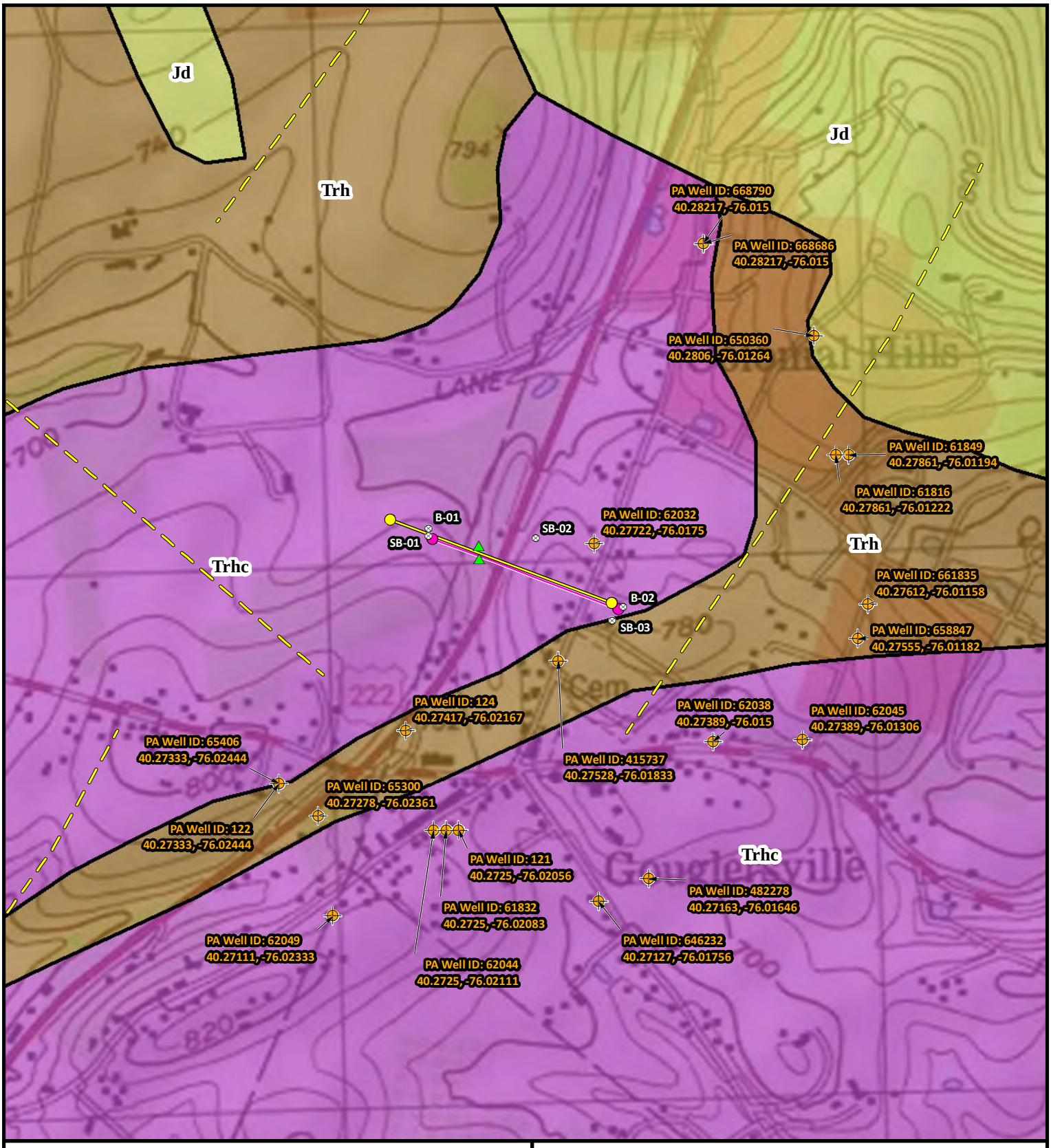

Inadvertent Return
Residential Well
Soil Boring
16" HDD Entry/Exit
20" HDD Entry/Exit
16" HDD Profile
20" HDD Profile
Inferred Fracture Trace

Geologic Formation

Jd - Diabase
Trh - Hammer Creek Formation
Trhc - Hammer Creek conglomerate

Sinking Spring, PA USGS 7.5' Topographic Quadrangle

2/8/2019

Sunoco Pipeline, L.P.

Highway 222 HDD Location

Figure 2 - Geologic Map

Cumru and Spring Townships, Berks County, PA

Project No. 096302011

N

W E

S

0 800 Feet

1 inch = 800 feet

Sunoco Logistics Partners L.P.

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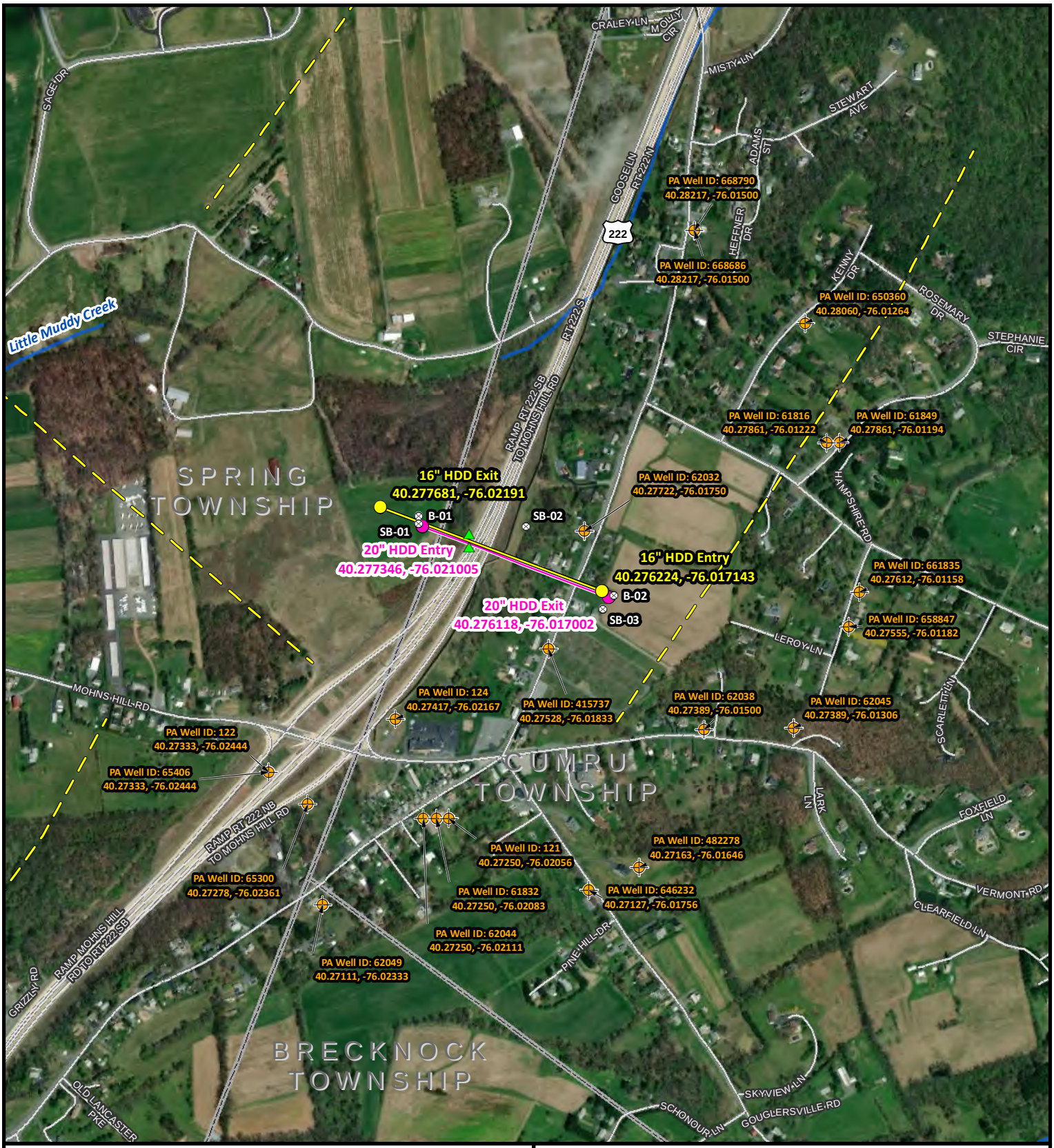

Inadvertent Return
Residential Well
Soil Boring
16" HDD Entry/Exit
20" HDD Entry/Exit
16" HDD Profile
20" HDD Profile
Inferred Fracture Trace
NHD Stream
Road
Municipal Boundary

2/8/2019

Sunoco Pipeline, L.P.

Highway 222 HDD Location

Figure 3 - Aerial Basemap

Cumru and Spring Townships, Berks County, PA

Project No. 096302011

N
W E
S

0 800 Feet

1 inch = 800 feet

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

Sunoco Logistics Partners L.P.

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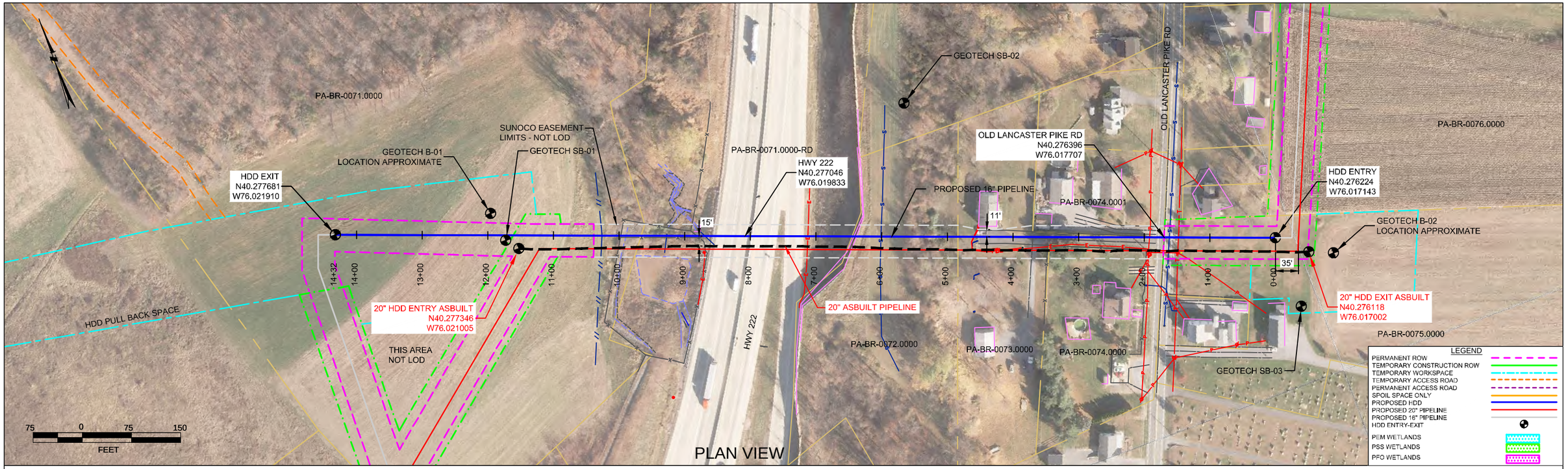
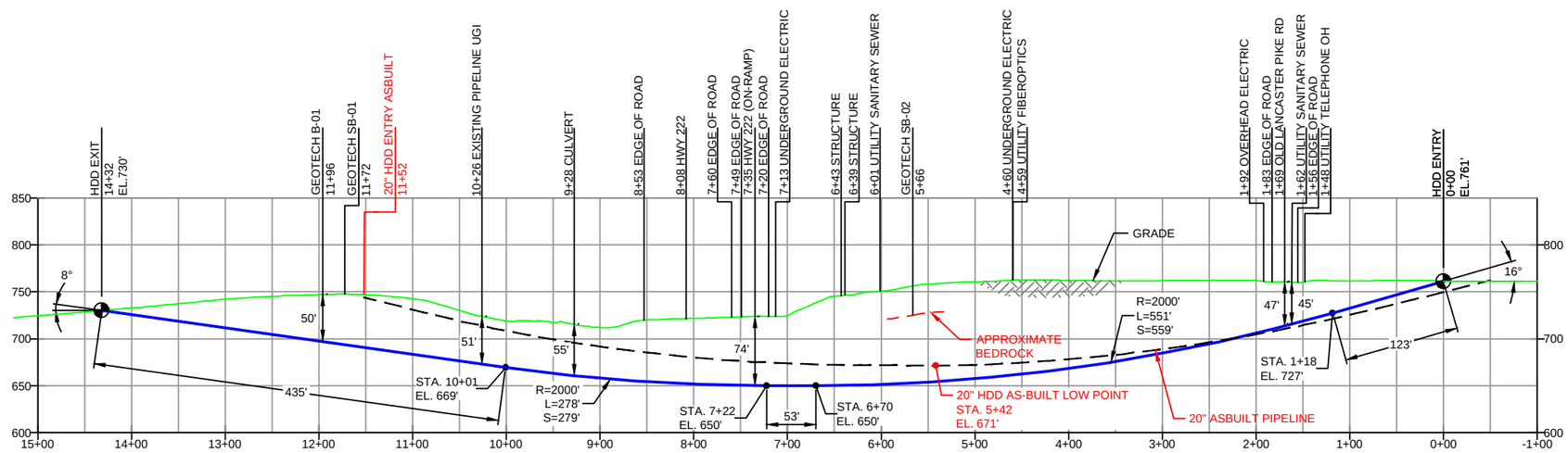
ATTACHMENT 1
HDD PROFILES AND GEOTECHNICAL BORING LOGS



PLAN VIEW

PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200-16



GEOTECH SB-01

-NG EL. 747'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 717'

GEOTECH SB-02

-NG EL. 750'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 11.0')
-SM/GM (11.0' - 24.0')
-FRACTURED CONGLOMERATE (24.0' - 32.0')
-COMPLETION DEPTH EL. 718'

GEOTECH SB-03

-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 737'

NOTE: REFER TO TEST BORING LOG S3-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-01

-NG EL. 745'
-RESIDUUM SILTY SAND SM (0.0' - 2.0')
-RESIDUUM CLAYEY SAND SC (2.0' - 4.0')
-RESIDUUM SILTY SAND SM (4.0' - 10.0')
-GROUNDWATER (20.0')
-CONGLOMERATE/SANDSTONE (10.0' - 145.0')
-BORING TERMINATED EL.600'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02

-NG EL. 763'
-RESIDUUM CLAY CL (0.0' - 2.0')
-RESIDUUM GRAVEL GM (2.0' - 4.0')
-RESIDUUM SAND SM (4.0' - 12.5')
-RESIDUUM GRAVEL GM (12.5' - 17.0')
-GROUNDWATER (28.0')
-CONGLOMERATE/SANDSTONE SILTSTONE (17.0' - 165.0')
-BORING TERMINATED EL.598'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1432'
   HDD PIPE LENGTH (S=):1449'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

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.

REF. DRAWING

ES-5.27	TO	ES-5.28	EROSION & SEDIMENT PLAN	
SHEET 15	TO	SHEET 16	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	REDESIGNED DRILL EXIT SIDE PER CLIENT REQUEST AND ADDED GEOTECH INFORMATION	MRS	11/30/18	RMB	11/30/18	JAL	11/30/18
EP3	UPDATED TO MATCH 16" IFC DESIGN AND NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	05/10/18	RMB	05/10/18	AMC	05/10/18
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/21/16	RMB	10/21/16	AAW	10/21/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GOETECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15

Sunoco Logistics Partners L.P.

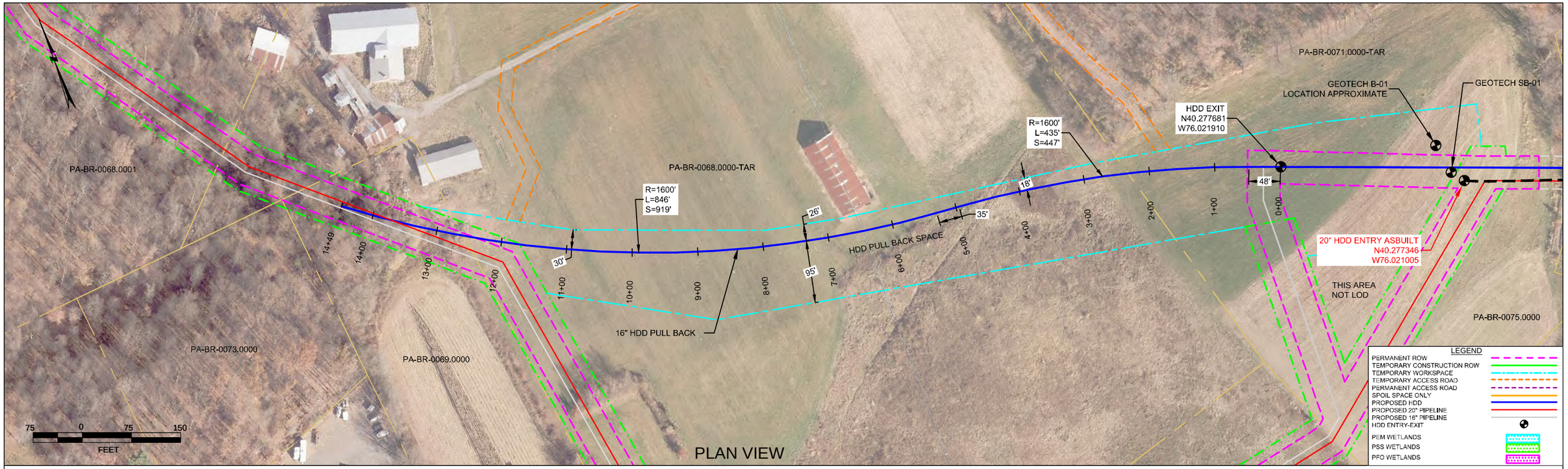
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

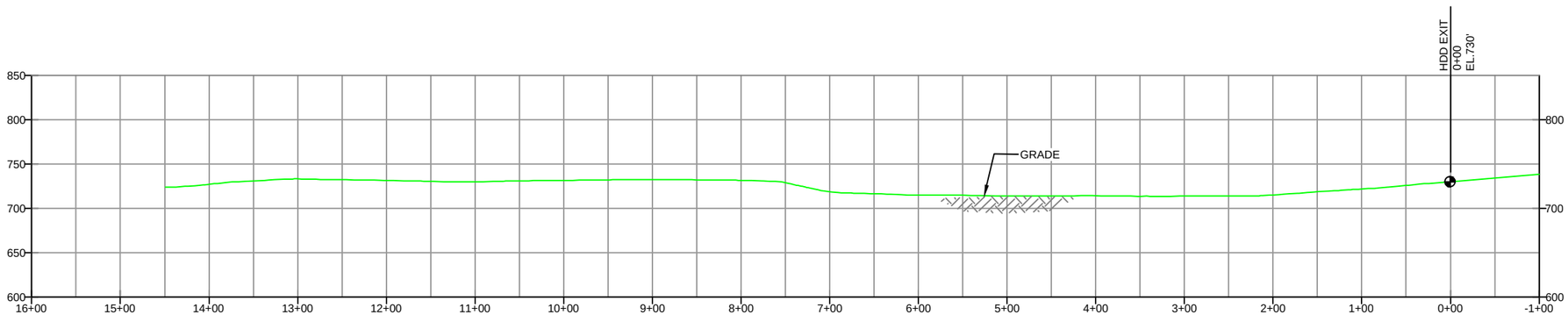
SCALE: 1"=150'

DWG. NO: PA-BR-0075.0000-RD-16



BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200-16

PROFILE VIEW



GEOTECH SB-01

-NG EL. 747'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 717'

GEOTECH SB-02

-NG EL. 750'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 11.0')
-SM/GM (11.0' - 24.0')
-FRACTURED CONGLOMERATE (24.0' - 32.0')
-COMPLETION DEPTH EL. 718'

GEOTECH SB-03

-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 737'

NOTE: REFER TO TEST BORING LOG S3-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-01

-NG EL. 745'
-RESIDUUM SILTY SAND SM (0.0' - 2.0')
-RESIDUUM CLAYEY SAND SC (2.0' - 4.0')
-RESIDUUM SILTY SAND SM (4.0' - 10.0')
-GROUNDWATER (20.0')
-CONGLOMERATE/SANDSTONE (10.0' - 145.0')
-BORING TERMINATED EL.600'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02

-NG EL. 763'
-RESIDUUM CLAY CL (0.0' - 2.0')
-RESIDUUM GRAVEL GM (2.0' - 4.0')
-RESIDUUM SAND SM (4.0' - 12.5')
-RESIDUUM GRAVEL GM (12.5' - 17.0')
-GROUNDWATER (28.0')
-CONGLOMERATE/SANDSTONE SILTSTONE (17.0' - 165.0')
-BORING TERMINATED EL.598'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD)
4. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
5. CARRIER PIPE NOT ENCASED
6. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.

NOTES

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.

REF. DRAWING

ES-5.27	TO	ES-5.28	EROSION & SEDIMENT PLAN	
SHEET 15	TO	SHEET 16	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	REDESIGNED DRILL EXIT SIDE PER CLIENT REQUEST	MRS	11/21/18	RMB	11/21/18	JAL	11/21/18
EP3	UPDATED TO MATCH 16" IFC DESIGN AND NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	05/10/18	RMB	05/10/18	AMC	05/10/18
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/21/16	RMB	10/21/16	AAW	10/21/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GOETECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15

Sunoco Logistics Partners L.P.

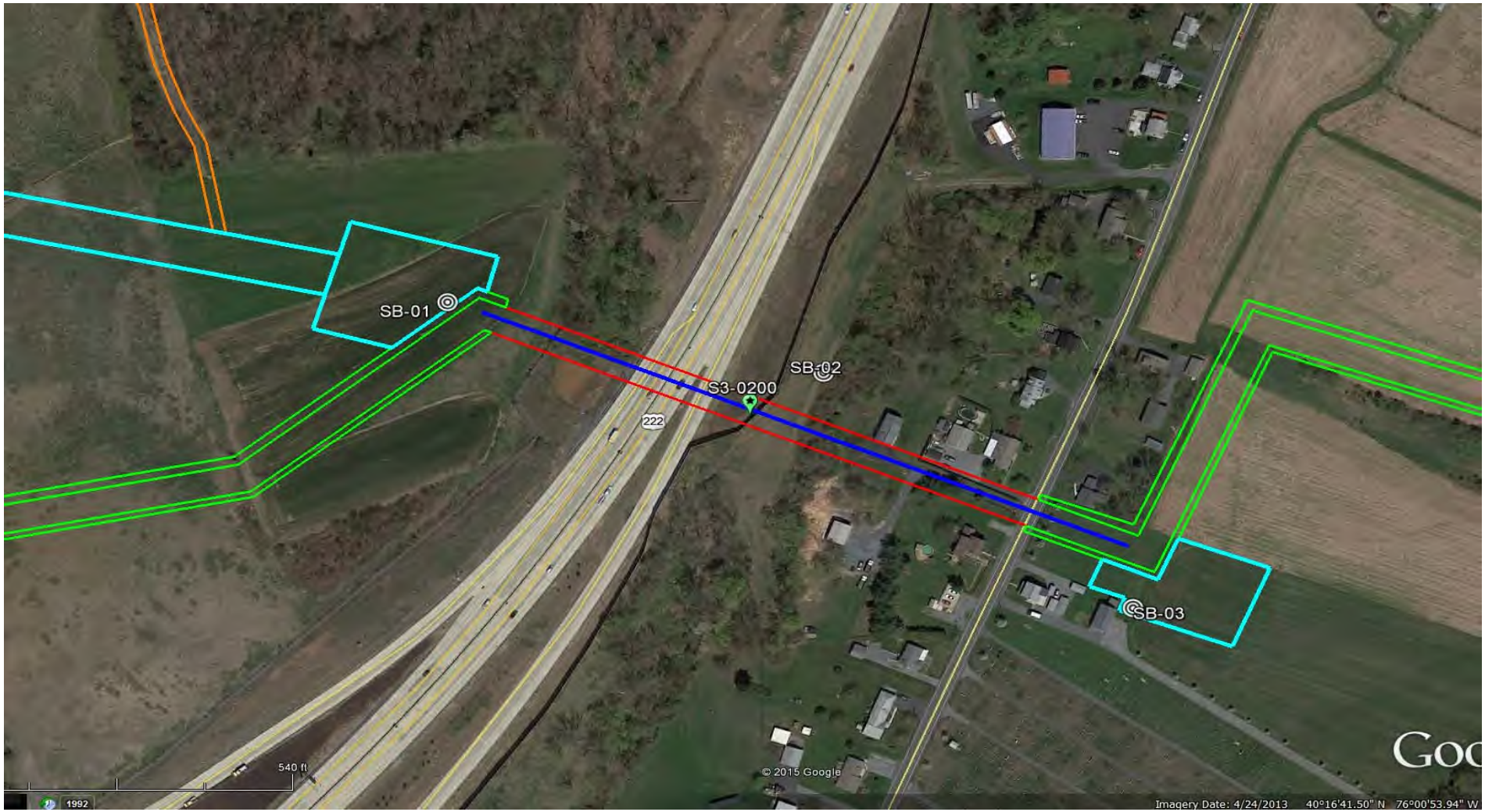
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
HWY 222 PULL BACK EXHIBIT
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

DWG. NO. PA-BR-0075.0000-RD-16EX



LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0200
BERKS COUNTY, CUMRU 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:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 12-11/12-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 16' 38.638" N	76° 1' 15.864" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	1.0			TOPSOIL (12")					
1	3.0	5.0	1.0		17		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	8	14	22	15	**36**
							GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
2	8.0	8.7			6		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50	50/2"			**>50**
							GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
3	13.0	13.9			8		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	16	50/5"			**>50**
						SM	GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
4	18.0	18.8			5		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50	50/3"			**>50**
							GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
5	23.0	25.0			24		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	3	31	48	25	**79**
							GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
6	28.0	28.4			6		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50/5"				**0**
				30.0			GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
							AUGERED TO 30'.					
							GRINDING BEGINS 5' TO 6', THEN OFF AND ON BETWEEN					
							10 TO 28'.					
							CAVED AND DRY AT 27'.					

Notes/Comments:
Pocket Pentrometer Testing

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:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 02-10-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 32.0
Boring Location Coordinates:		40° 16' 38.348" N	76° 1' 7.530" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		17	SM	MAROON FINE TO COARSE SAND WITH A LITTLE SILT, AND WITH	19	26	21	42	**47**
							SOME FINE TO COARSE GRAVEL.					
2	8.0	8.7			6		REDDISH BROWN MEDIUM COARSE SAND WITH SOME CONGLOMERAT	34	50/2"			**>50**
				11.0			GRAVEL, AND A LITTLE SILT.					
							AUGER REFUSAL AT 10'. OFFSET 8' NORTH AND CONTINUOUSLY					
							AUGERED TO NEXT SAMPLE INTERVAL.					
3	13.0	13.7	11.0		8	SM/ GM	REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME	10	50/3"			**>50**
							CONGLOMERATE GRAVEL, TRACE ROCK FRAGMENTS, LITTLE SILT.					
4	18.0	18.3			5		REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME	50/4"				**>50**
							CONGLOMERATE GRAVEL, TRACE ROCK FRAGMENTS, LITTLE SILT.					
5	23.0	23.1		24.0	24		REDDISH BROWN CONGLOMERATE GRAVEL.	50/1"				**>50**
							AUGER REFUSAL AT 24'.					
							ROCK CORING					
RUN 1	24.0	27.0	24.0	27.0	21	CONGLOM.	REDDISH BROWN INTENSELY FRACTURED CONGLOMERATE.	TCR: 58%, SCR: 8%, RQD: 0%				
RUN 1	27.0	32.0	27.0	32.0	22		REDDISH BROWN INTENSELY FRACTURED CONGLOMERATE.	TCR: 37%, SCR: 17%, RQD: 0%				
							CAVED AND DRY AT 23'.					

Notes/Comments:
Pocket Pentrometer Testing

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.

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fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 12-11-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 16' 33.303" N	76° 1' 1.736" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		10		MAROON FINE SAND AND SILT, TRACE CONGLOMERATE MATRIX.	2	9	9	12	**18**
2	8.0	10.0			11		MAROON FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE	1	5	15	20	**20**
							TO COARSE GRAVEL.					
3	13.0	14.5			15		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	312	35	35		**70**
						SM	TO COARSE GRAVEL. (USCS: SM).					
4	18.0	19.4			15		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	7	8	50/5"		**>50**
							TO COARSE GRAVEL.					
5	23.0	23.8			7		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	20	50/3"			**>50**
							TO COARSE GRAVEL.					
6	28.0	28.7			5		MAROON FINE TO MEDIUM SAND WITH SOME SILT, WITH A LITTLE FINE	30	50/2"			**>50**
				30.0			TO COARSE GRAVEL.					
							AUGERED TO 30'.					
							CAVED AND DRY AT 20'.					

Notes/Comments:
Pocket Pentrometer Testing

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.

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0200

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S3-0200	SB-01	2	8.0	8.7	8.5	24.0	-	-	-	-
		3	13.0	13.9	5.8	16.8	-	-	-	-
		5	23.0	25.0	7.3	19.3	-	-	-	-
		6	28.0	28.4	8.7	31.9	-	-	-	-
	SB-02	1	3.0	5.0	6.3	19.3	-	-	-	-
		2	8.0	8.7	5.7	12.6	-	-	-	-
		3	13.0	13.7	9.6	20.2	-	-	-	-
	SB-03	1	3.0	5.0	11.6	47.1	-	-	-	-
		2	8.0	10.0	8.4	28.2	-	-	-	-
		3	13.0	14.5	8.4	40.6	33	25	8	SM
		5	23.0	23.8	8.0	38.7	-	-	-	-
		6	28.0	28.7	4.5	26.8	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0200

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
S3-0200	Hwy 222 - Lancaster Pike	SB-01	**Hammer Creek Conglomerate** - very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.	level-rolling upland	Hammer Creek Conglomerate	quartz conglomerate; reddish brown cross-bedded sandstone	2,580	10-60	
		SB-02							
		SB-03							

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.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0200

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					
S3-0200	SB-2	1	24	27	58	8	0	24	27	Slight to moderate	Conglomerate	Massive	Light Red	Heavily fractured in bottom half of core; fractures ranging from 0° to 65°, Avg. 25°
		2	27	32	37	17	0	27	32	Slight to moderate	Conglomerate	Massive	Light Red	Fractures ranging from 0° to 30°, Avg. 9°

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

Description Term	*Percent*
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 (M)	No. 10 to No. 40 sieve (2.00mm – 0.425mm)
	Fine (F)	No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

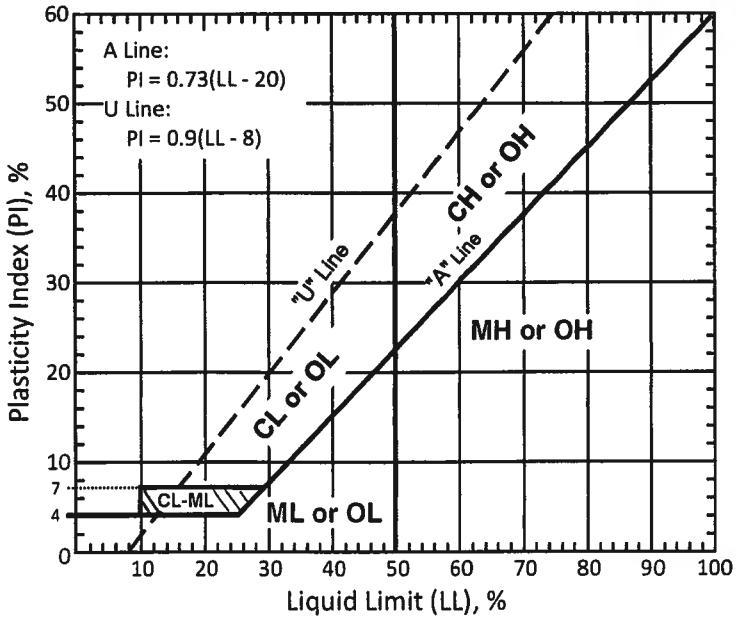
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	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]	$C_u=\frac{D_{60}}{D_{10}}$ greater than 4: $C_c=\frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW	
		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, gravely 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	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW	
		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	

Major Divisions		Group Symbols	Typical Descriptions
Fine–grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.



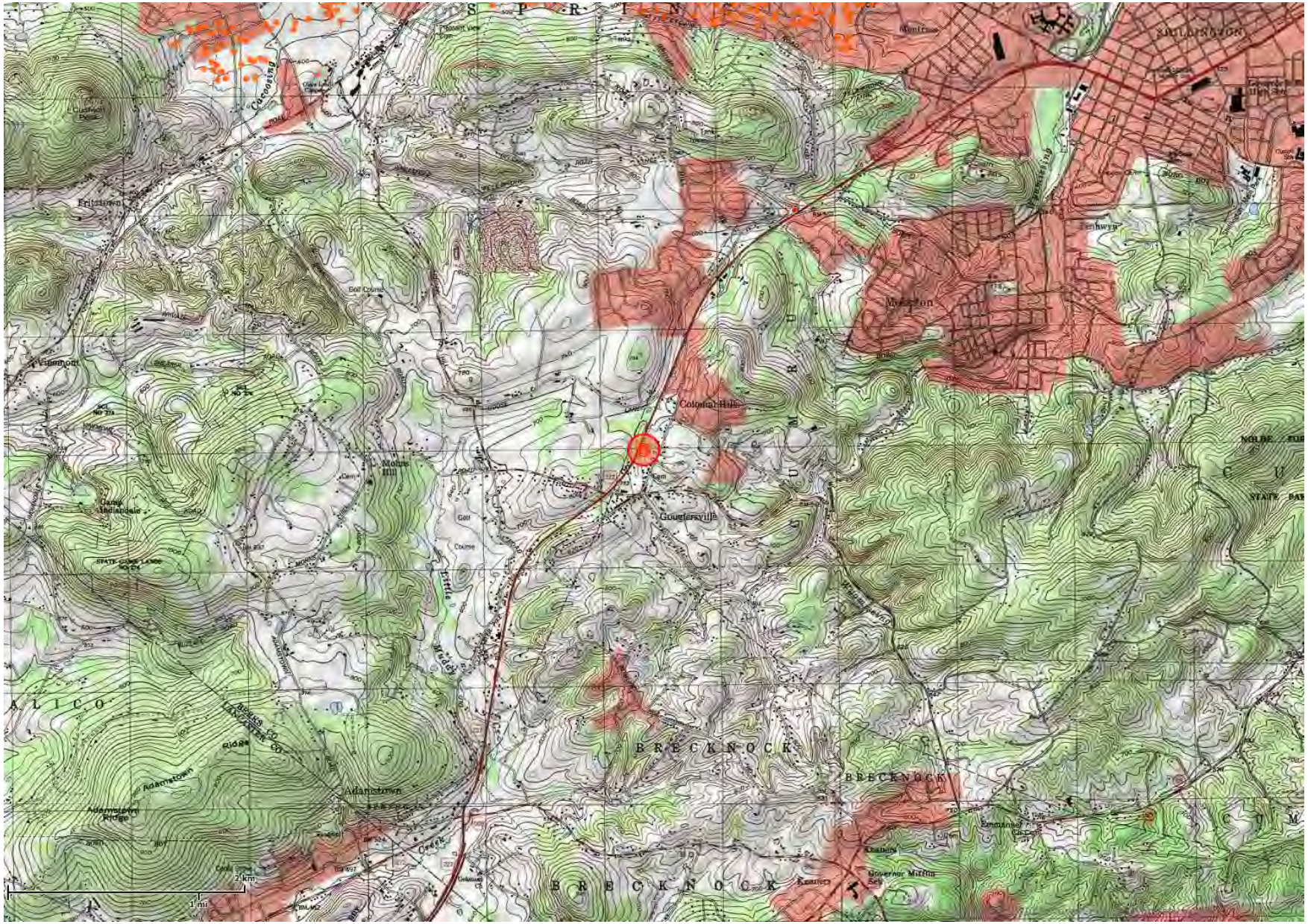
(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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

Figure 1: Site Vicinity Map

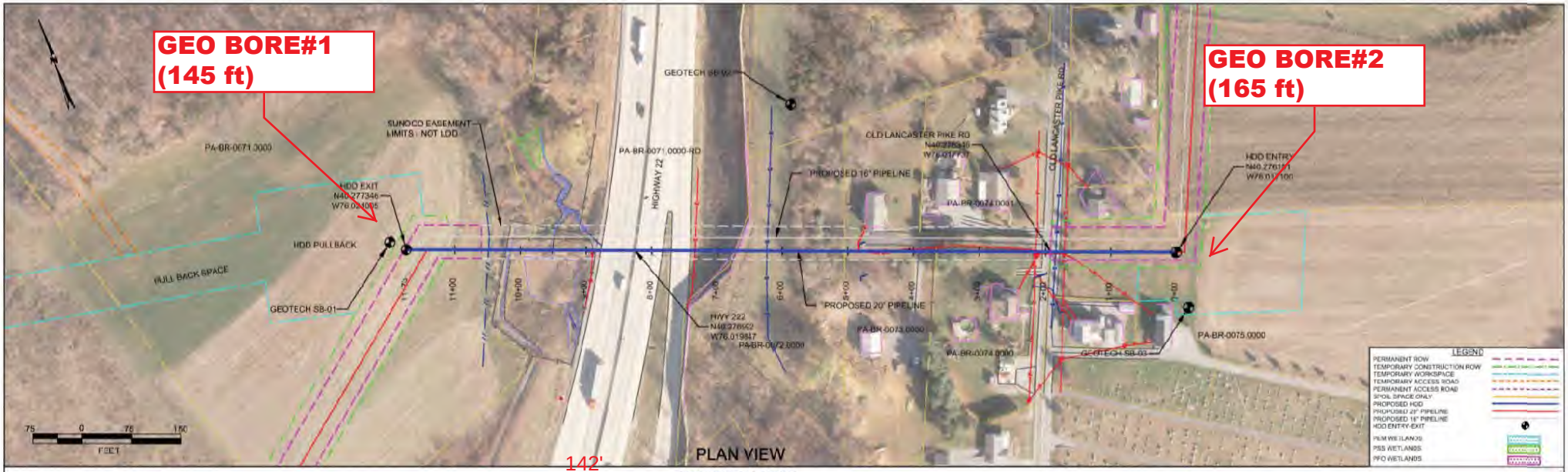
Make online reservations at
www.visitPAparks.com
or call toll-free 888-PA-PARKS



Created using PA DCNR Map Viewer

Map created on Mon Sep 25 2017

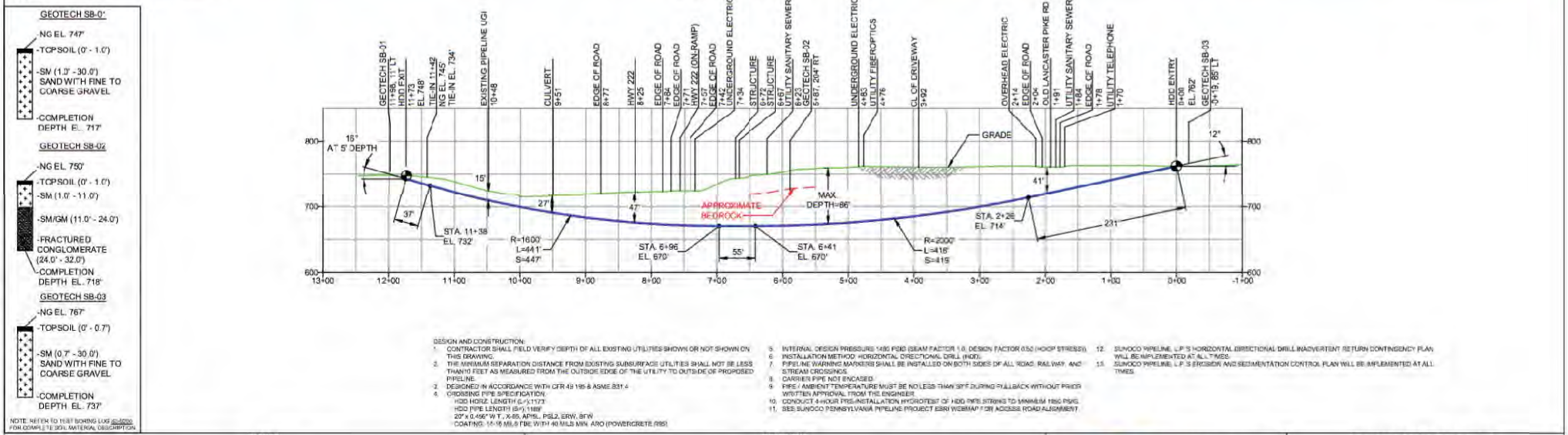
FIGURE 2: BORING LOCATION PLAN
HWY 222-PPP5
PSI Project No.: 04911461



142'

BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200

PROFILE VIEW



DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L+): 1173'
   HDD PIPE LENGTH (S+): 1189'
   20"x 0.456" W.T., X-65, API5L, PSL2, ERW, BEW
   COATING: 14-16 MIL 6 FBE WITH 40 MILS MIN. ARO (POWERCRETE 685)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.52 (HOOP STRESS))
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 50°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES
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, L.P. 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

REVISIONS

NO	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
5	DESIGN CHANGE - MOVED DRILL ENTRY / EXIT	MRS	03/03/17	RMB	03/03/17	AMC	03/03/17
4	REVISED PROFILE WITH 2017 LIDAR	MRS	02/15/17	RMB	02/15/17	AMC	02/15/17
3	UPDATED SUNOCO EASEMENT LIMITS - NOT LOD	MRS	10/24/16	RMB	10/24/16	AAW	10/24/16
2	REVISED PER ENGINEERING COMMENTS	MRS	08/18/16	RMB	08/18/16	AAW	08/18/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	01/21/16	RMB	01/21/16	AAW	01/21/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY (303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' DWG NUMBER: PA-BR-0071.0000-RD

pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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

Figure 3: Site Geology Map

Make online reservations at
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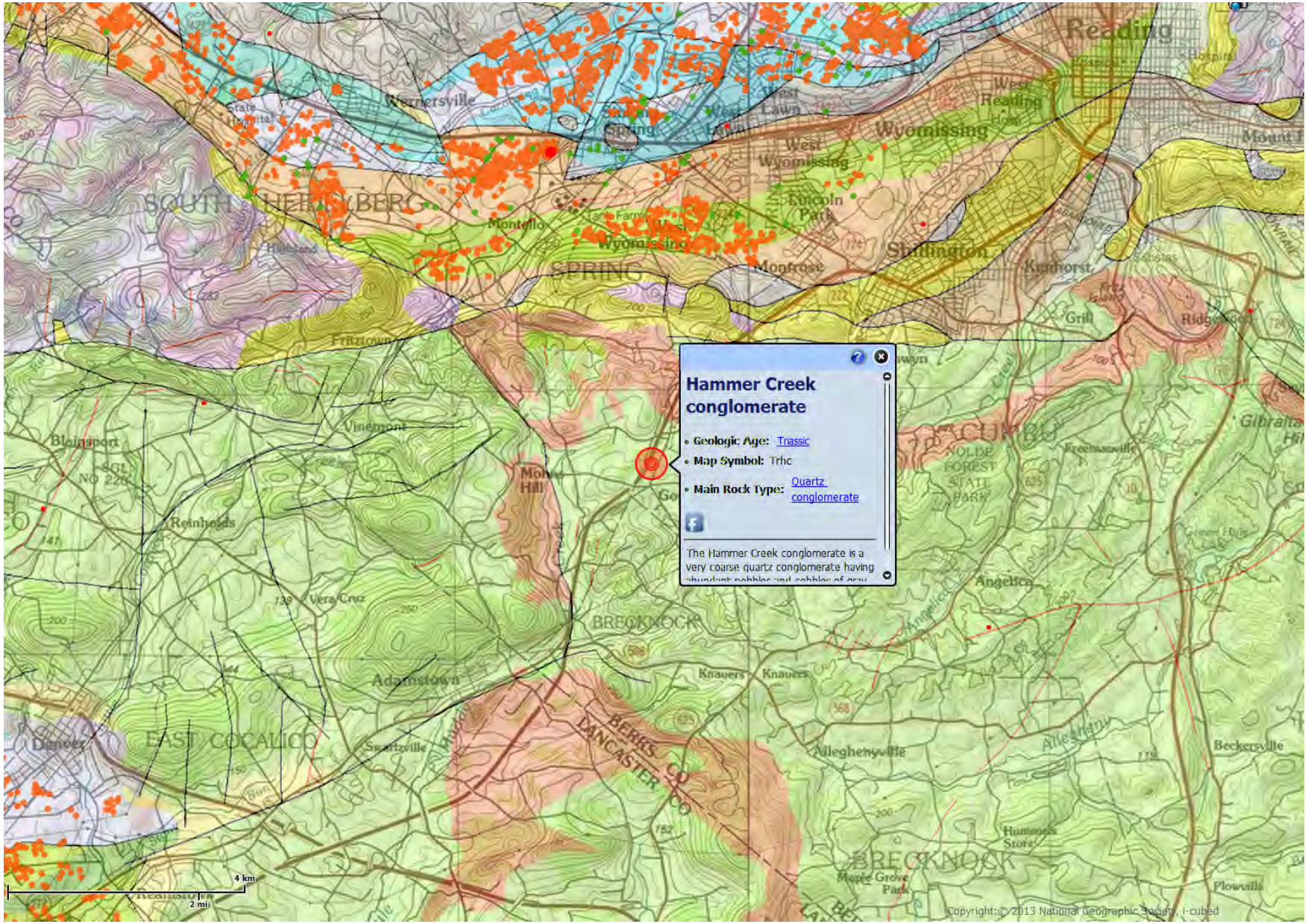

Created using PA DCNR Map Viewer

Map created on Mon Sep 25 2017

BORING B-01

DATE STARTED:	9/5/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/6/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	145.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 9 feet
- Post-Core 20 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	0			S-1	16	**RESIDUUM**-Medium Dense, Dark brown, Silty SAND, trace Gravel, moist	SM	4-6-6-4 N=12	11		
				S-2	12	**RESIDUUM**-Medium Dense, Dark brown, Clayey SAND with Gravel, moist	SC	3-4-8-7 N=12	9		Fines=15.6%
	5			S-3	18	**RESIDUUM**-Medium Dense to Dense, Light gray to dark brown, Silty SAND, trace Gravel, moist		9-12-15-19 N=27	12		Fines=14.5%
				S-4	17		SM	20-21-27-31 N=48	8		
				S-5	18	With Gravel from 5 to 10 feet.		15-21-17-11 N=38	8		
	10			R-1	7	**Highly Weathered to Completely Weathered SANDSTONE**-Low recovery consisted of gravel-sized rock fragments		RQD=0 Rec=12%			
	15			S-6	0			50/3"		>>	3 min.
				R-2	53	**CONGLOMERATE**-Light red-gray-brown to dark gray-brown, Fine to very coarse grained, Weathered to Highly Weathered, very broken to massive, moderately hard to hard, trace pits and vugs		RQD=26 Rec=92%			2 min. 2 min. 2 min. 2 min.
	20			R-3	60			RQD=20 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min.
	25			R-4	53	**CONGLOMERATE**-Light gray to dark brown, Fine to very coarse grained, Weathered to Slightly Weathered, very broken to massive, hard to very hard, trace pits and vugs		RQD=38 Rec=88%		>>	2 min. Q_u = 391.4 tsf 160.5 pcf 2 min. 2 min. 2 min.
	30					*Continued Next Page*					

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Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

DATE STARTED:	9/5/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/6/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	145.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

BORING B-01

Water

Pre-Core	9	feet
Post-Core	20	feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture ✕ / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	30			R-5	41	**CONGLOMERATE**-Gray-brown to dark brown, Fine to very coarse grained, Highly Weathered, very broken to slightly broken, hard to very hard, trace pits and vugs		RQD=10 Rec=68%			2 min. 2 min. 2 min. 2 min. 2 min. 2 min.
	35			R-6	34			RQD=8 Rec=57%			1 min. 1 min. 1 min. 2 min. 1 min.
	40			R-7	60	**SANDSTONE**-Red-brown, Fine grained, Weathered to Slightly Weathered, very broken to slightly broken, moderately hard		RQD=42 Rec=100%			
	45			R-8	60	**CONGLOMERATE**-Light red-gray-brown to gray-brown to light gray, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard Trace pits and vugs from 43.8 to 48.0 feet		RQD=88 Rec=100%		>> ▲ Q_u = 547.0 tsf 165.6 pcf	2 min. 2 min. 2 min. 2 min. 2 min.
	50			R-9	60			RQD=83 Rec=100%			2 min. 2 min. 2 min. 2 min. 2 min.
	55			R-10	54	**CONGLOMERATE**-Light gray-white to light gray, Fine to very coarse grained, Weathered, very broken to massive, very hard, trace pits and vugs		RQD=45 Rec=90%		>> ▲ Q_u = 274.1 tsf 151.9 pcf	2 min. 3 min. 4 min. 2 min.
	60					*Continued Next Page*					

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Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.:	04911461
PROJECT:	Energy Transfer HDD (DPS)
LOCATION:	HWY 222 (PPP5)
	Berks Co., PA
	PA-BR-0071.0000-RD/PO#20170830-2

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

DATE STARTED:	9/5/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/6/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	145.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

BORING B-01

Water

Pre-Core	9	feet
Post-Core	20	feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	60					**CONGLOMERATE**-Light gray-white to gray-brown, Fine to very coarse grained, Highly Weathered, very broken to massive, moderately hard to hard, trace pits and vugs					4 min.
				R-11	60			RQD=28 Rec=100%			2 min.
						CONGLOMERATE-Light gray to dark gray-brown, Fine to very coarse grained, Weathered to Highly Weathered, very broken to massive, very hard					3 min.
	65										2 min.
											3 min.
											4 min.
				R-12	60			RQD=38 Rec=100%			3 min.
											3 min.
						CONGLOMERATE-Light gray to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, moderately hard to very hard					5 min.
	70					Weathered layer @ 70.6 feet (~ 5-1/4 inches thick)					3 min.
											2 min.
											2 min.
				R-13	58			RQD=73 Rec=97%		>> Q_u = 771.0 tsf, 165.6 pcf	3 min.
											3 min.
	75										3 min.
											4 min.
											4 min.
				R-14	60			RQD=70 Rec=100%			4 min.
											4 min.
						CONGLOMERATE-Light gray-brown to dark brown, Fine to very coarse grained, Weathered to Slighty Weathered, very broken to massive, hard to very hard					3 min.
	80										3 min.
										>> Q_u = 257.9 tsf, 155.6 pcf	3 min.
				R-15	50			RQD=52 Rec=83%			3 min.
											3 min.
											3 min.
	85					**Conglomeratic SANDSTONE**-Gray-brown to dark gray-brown, Fine to very coarse grained, Slightly Weathered, slightly broken to massive, moderately hard				>> Q_u = 170.7 tsf, 141.4 pcf	3 min.
				R-16	60	**CONGLOMERATE**-Light gray-brown to dark gray-brown, Fine to very coarse grained, Weathered to Slightly Weathered, very broken to massive, hard to very hard		RQD=72 Rec=100%			2 min.
											2 min.
	90										3 min.

Continued Next Page

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PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

DATE STARTED:	9/5/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/6/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	145.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

BORING B-01

Water

Pre-Core	9	feet
Post-Core	20	feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	90					**SANDSTONE**-Light gray-brown, Fine to medium grained, Slightly Weathered, slightly broken to massive, hard to very hard					3 min.
				R-17	60	Broken/Weathered layer @ 90.5 feet (~ 6 inches thick)		RQD=78 Rec=100%			2 min.
											3 min.
											>> Q_u = 529.6 tsf 3 min. 153.9 pcf
											2 min.
	95										3 min.
						Conglomeratic SANDSTONE-Gray-brown to dark gray-brown, Fine to very coarse grained, Slightly Weathered, very broken to massive, hard					3 min.
				R-18	55	Weathered/Highly Weathered seam @ 97.9 feet (~1-1/2 inches thick)		RQD=68 Rec=92%			3 min.
						CONGLOMERATE-Light gray-brown to dark gray-brown, Fine to very coarse grained, Weathered to Slightly Weathered, very broken to massive, very hard, trace pits and vugs					3 min.
	100										3 min.
											2 min.
				R-19	60	**CONGLOMERATE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard		RQD=83 Rec=100%			3 min.
											3 min.
						Partial loss of water return @ 105 feet					>> Q_u = 659.4 tsf 3 min. 159.6 pcf
	105										3 min.
											3 min.
				R-20	60			RQD=78 Rec=100%			3 min.
											3 min.
	110										3 min.
											3 min.
											3 min.
				R-21	60			RQD=77 Rec=100%			3 min.
											>> Q_u = 443.4 tsf 3 min. 159.1 pcf
	115										3 min.
											3 min.
											3 min.
				R-22	60			RQD=98 Rec=100%			4 min.
											3 min.
	120					*Continued Next Page*					

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Telephone: (717) 230-8622

PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

BORING B-01

DATE STARTED:	9/5/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/6/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	145.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 9 feet
- Post-Core 20 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	120					**CONGLOMERATE**-Light gray-brown to dark brown, Fine to very coarse grained, Slightly Weathered, broken to massive, hard to very hard					3 min.
											>> Q_u = 210.0 tsf, 163.3 pcf
				R-23	60			RQD=95 Rec=100%			4 min.
											3 min.
											3 min.
	125										4 min.
											4 min.
											3 min.
				R-24	60			RQD=98 Rec=100%			4 min.
											>> Q_u = 420.9 tsf, 159.5 pcf
						Trace pits from 122 to 136 feet.					4 min.
	130										3 min.
						Broken/very broken seam @ 131 feet (~2-1/4 inches thick)					4 min.
											4 min.
				R-25	60			RQD=87 Rec=100%			4 min.
											4 min.
											4 min.
	135										4 min.
											>> Q_u = 618.0 tsf, 164.6 pcf
											4 min.
				R-26	60			RQD=77 Rec=100%			4 min.
											4 min.
											4 min.
	140										4 min.
											4 min.
											4 min.
				R-27	60			RQD=97 Rec=100%			5 min.
											5 min.
	145					Test boring terminated @ 145 feet					4 min.

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Telephone: (717) 230-8622

PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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


HDD Boring (GB#1)
09/05/17
Depth: 10.0ft - 30.0ft
Box: 1 of 9
HWY 222
Run | Depth | Recov | RQD
1 | 10.0-15.0 | 7" | 0"
2 | 15.2-20.0 | 53" | 15"
3 | 20.0-25.0 | 60" | 12"
4 | 25.0-30.0 | 53" | 23"
TOP
10.0
15.0
15.2
20.0
25.0
30.0


6491 1401
HDD Boring (GB#2)
08/09/05/17
Depth 30.0ft - 48.0ft
Box 2of
HWY 222 (Westside)
Run | Depth | Rec(in) | RQD
5 | 30-35 | 41" | 6"
6 | 35-40 | 34" | 5"
7 | 40-45 | 60" | 25"
8 | 45-50 | 60" | 53"
30.0
35.0
40.0
45.0
48.0


0491 1461
TPS # 20170830-2
HDD Boring (GB#1)
01/05/17
Depth 48.0 ft – 63.0 ft
Box 3 of 4
HWY 222 (West side)
Run | Depth | Rec | RQD
9 | 50-55 | 60" | 50"
10 | 55-60 | 54" | 27"
11 | 60-65 | 60" | 17"
48.0
50.0
55.0
55.0
60.0
63.0


MDD Boring (GB#1)
09/05/17
Box: 4 of
HWY 222 (West side)
Run | Depth | Rec | RQD
12 | 65-70 | 60" | 23"
13 | 70-75 | 58" | 44"
14 | 75-80 | 60" | 42"
63.0
65.6
70.0
75.0


201 7085c-2
HDD Boring (GB#1)
09/05/17
Depth: 77.5ft – 102.5ft
Box: 5 of 9
HWY 222 (West side)
Run | Depth | Rec | RQD
15 | 850 | 60' | 43'
17 | 905-925 | 60' | 47'
77.5
80.0
102.5


0491 1461
DPS # 20170850-2
HDD Boring 681
9/5/17
Depth: 925 ft-1076ft
Box 6 of 9
Hwy 222 (west side)
Run Depth
1-7 900-950 60" 47"
8 950-1000 55" 41"
9 1000-1050 60" 50"
925
1000
1050
1076


0491 1461
NPS# 20170830-2
HDD Boring 6B1
9/5/17
Depth: 107.6ft – 122.0ft
Box 7 of 9
Hwy 222 (west side)
Run | Depth | REC | RQD
20 | 105.0-110.0 | 60" | 47"
21 | 110.0-115.0 | 60" | 46"
22 | 115.0-120.0 | 60" | 57"
23 | 120.0-125.0 | 60" | 57"
110.0
115.0


0491 1461
DPS # 20170830-2
HDD Boring (GB#1)
9/6/17
Depth 122 oft – 136 oft
Box 8 of 9
HWY 222 (west side)
Run | Depth | Rec | RQD
24 | 125.0-130.0 | 60" | 59"
25 | 130.0-135.0 | 60" | 52"
26 | 135.0-140.0 | 60" | 46"
125.0
130.0
135.0


PS# 20170830-2
0491 1461
HDD Boring (GB#1)
09/05/17
Depth: 135.0 - 145.0ft
Box 9 of 9
HWY 222 (Outside)
Run | Depth | Rec | Rqd
27 | 140-145 | 60" | 58"
135.0
140.0
145.0

BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	Additional Remarks
	0			S-1	16	**RESIDUUM**-Medium Dense, Brown, Sandy Lean CLAY, trace Gravel, dry/moist	CL	7-12-11-15 N=23	11	Fines=63.7%
				S-2	4	**RESIDUUM**-Dense, Gray-brown, Silty GRAVEL withSand, dry/moist	GM	19-20-21-23 N=41	4	Fines=19.7%
	5			S-3	11	**RESIDUUM**-Medium Dense, Gray-brown to brown, Silty SAND with Gravel, moist		15-13-11-12 N=24	10	
				S-4	12			12-11-10-7 N=21	8	Fines=22.4%
				S-5	16	With Gravel from 8 to 10 feet.	SM	11-8-13-15 N=21	6	
	10									
						RESIDUUM-Medium Dense, Brown, Silty GRAVEL with Sand, moist/wet	GM			
	15			S-6	11			7-4-8-12 N=12	10	
						Highly Weathered to Completely Weathered SANDSTONE-Low recovery consisted of gravel-sized rock fragments				
				R-1	9			RQD=0 Rec=25%		
	20			S-7	2			50/3"	14	>>
						Highly Weathered SANDSTONE Sampled as Soil-Very Dense, Dark brown, Silty SAND with Gravel, moist/wet				1 min.
						SANDSTONE-Light gray-brown to dark brown, Fine to coarse grained, Weathered to Highly Weathered, very broken to massive, moderately hard, multiple soil seams and layers				>> Q_u = 71.6 tsf 142.5 pcf
				R-2	46			RQD=10 Rec=80%		2 min.
										2 min.
	25									2 min.
										2 min.
										2 min.
				R-3	48			RQD=19 Rec=80%		2 min.
										>> Q_u = 162.8 tsf 149.0 pcf
	30					*Continued Next Page*				

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
Moisture ✕ PL ◪ LL ✚
0 25 50
STRENGTH, tsf
Qu ▲ Qp ✳
0 2.0 4.0

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Professional Service Industries, Inc.
1707 S. Cameron Street, Suite B
Harrisburg, PA 17104
Telephone: (717) 230-8622

PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0 25 50) STRENGTH, tsf ▲ Qu ✳ Qp (0 2.0 4.0)	Additional Remarks
	30			R-4	32	**Conglomeratic SANDSTONE**-Light gray-brown to gray-brown, Fine to very coarse grained, Highly Weathered, very broken to massive, moderately hard		RQD=0 Rec=53%			2 min. 1 min. 1 min. 2 min. 3 min.
	35			R-5	13			RQD=0 Rec=22%			3 min. 2 min. 3 min. 2 min. 2 min.
	40			R-6	20			RQD=0 Rec=33%			3 min. 2 min. 2 min. 1 min. 2 min.
	45			R-7	23			RQD=12 Rec=38%			3 min. 1 min. 2 min. 2 min. 2 min. >> Q_u = 238.3 tsf 142.6 pcf
	50			R-8	17			RQD=0 Rec=28%			2 min. 2 min. 2 min. 2 min. 2 min.
	55					**SANDSTONE**-Gray-brown to brown, Medium to coarse grained, Weathered, very broken to slightly broken, moderately hard					2 min. 1 min.
				R-9	22	**Conglomeratic SANDSTONE**-Light gray to dark brown, Fine to very coarse grained, Highly Weathered, very broken to slightly broken, moderately hard		RQD=15 Rec=37%			2 min. 3 min. 2 min.
	60					*Continued Next Page*					

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PROJECT NO.: 04911461
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LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL (0, 25, 50) STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	60					**Conglomeratic SANDSTONE**-Light gray to dark brown, Fine to very coarse grained, Highly Weathered, very broken to slightly broken, moderately hard					2 min.
											2 min.
											2 min.
				R-10	18			RQD=7 Rec=30%			2 min.
											4 min.
	65										1 min.
											1 min.
											2 min.
				R-11	11			RQD=0 Rec=18%			2 min.
											2 min.
	70										2 min.
											1 min.
											2 min.
				R-12	10			RQD=0 Rec=17%			3 min.
											2 min.
	75										2 min.
											2 min.
											2 min.
				R-13	21			RQD=0 Rec=35%			2 min.
						CONGLOMERATE- Gray-brown to dark brown, Fine to very coarse grained, Weathered to Highly Weathered, very broken to massive, moderately hard to hard					2 min.
	80										4 min.
											1 min.
											2 min.
				R-14	35			RQD=18 Rec=58%			2 min.
											2 min.
	85										2 min.
						SANDSTONE-Light gray-brown to gray-brown, Fine to very coarse grained, Slightly Weathered, very broken to massive, moderately hard to hard				>> ▲ Q_u = 251.6 tsf	2 min.
										146.7 pcf	1 min.
				R-15	52			RQD=58 Rec=87%			2 min.
											2 min.
	90					*Continued Next Page*					

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PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0 25 50) STRENGTH, tsf Qu ▲ Qp ✳ (0 2.0 4.0)	Additional Remarks
	90			R-16	58	**SANDSTONE**-Light gray-brown to gray-brown, Fine to very coarse grained, Slightly Weathered, very broken to massive, moderately hard to hard Trace pits from 87.5 to 93.6 feet.		RQD=52 Rec=97%			2 min. 2 min. >> Q_u = 304.9 tsf 145.5 pcf 2 min.
	95			R-17	33	**Conglomeratic SANDSTONE**-Brown to gray-brown, Medium to very coarse grained, Weathered to Highly Weathered, very broken to slightly broken, moderately hard to hard, trace pits and vugs, multiple soil seams and layers Soil layer @ 96.9 feet (> 3 inches thick)		RQD=15 Rec=55%			1 min. 1 min. 2 min. 1 min. 1 min. 6 min.
	100			R-18	50	**Conglomeratic SANDSTONE**-Brown to gray-brown, Fine to very coarse grained, Weathered to Slightly Weathered, broken to massive, moderately hard to hard		RQD=48 Rec=83%			3 min. 1 min. >> Q_u = 149.8 tsf 138.8 pcf 1 min.
	105			R-19	22	**Conglomeratic SANDSTONE**-Light gray-brown to brown, Medium to very coarse grained, Highly Weathered, very broken to slightly broken, moderately hard to hard, multiple soil seams and layers		RQD=0 Rec=37%			1 min. 2 min. 2 min. 2 min. 2 min.
	110			R-20	37			RQD=15 Rec=62%			2 min. 2 min. 4 min. 4 min. 3 min.
	115			R-21	60	**SANDSTONE**-Brown, Fine grained, Slightly Weathered, broken to massive, moderately hard **Conglomeratic SANDSTONE**-Gray-brown to brown, Medium to very coarse grained, Weathered to Highly Weathered, very broken to massive, moderately hard to hard, multiple soil seams and layers		RQD=47 Rec=100%			>> Q_u = 180.3 tsf 147.6 pcf 2 min. 2 min. 2 min.
	120					*Continued Next Page*					

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PROJECT NO.: 04911461
PROJECT: Energy Transfer HDD (DPS)
LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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

BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ Moisture × PL ◪ LL ✚ (0 25 50) STRENGTH, tsf Qu ▲ Qp ✳ (0 2.0 4.0)	Additional Remarks
	120					**Conglomeratic SANDSTONE**-Gray-brown to brown, Medium to very coarse grained, Weathered to Highly Weathered, very broken to massive, moderately hard to hard, multiple soil seams and layers					2 min.
											2 min.
				R-22	36			RQD=8 Rec=60%			2 min.
											2 min.
											3 min.
	125										8 min.
						SILTSTONE-Red-brown, Very fine grained, Slightly Weathered, slightly broken to massive, moderately hard					4 min.
										>> ▲ Q_u = 140.7 tsf	3 min.
				R-23	60			RQD=43 Rec=100%			159.5 pcf
						SILTSTONE-Red-brown to red-gray-brown, Very fine grained, Weathered, very broken to massive, moderately hard, multiple soil seams					4 min.
											4 min.
	130										4 min.
										>> ▲ Q_u = 355.1 tsf	3 min.
											157.9 pcf
				R-24	60			RQD=14 Rec=100%			3 min.
											3 min.
											2 min.
	135					**SANDSTONE**-Red-gray-brown, Fine grained, Weathered to Slightly Weathered, very broken to massive, moderately hard, multiple soil seams					3 min.
											2 min.
				R-25	60			RQD=27 Rec=100%			2 min.
											2 min.
											3 min.
	140					**SANDSTONE**-Red-gray-brown to light gray, Fine to coarse grained, Slightly Weathered, very broken to massive, very hard					3 min.
											2 min.
				R-26	60			RQD=92 Rec=100%			2 min.
											2 min.
						Conglomerate layer @ 143.9 feet (~ 6-3/4 inches thick), trace pits and vugs					2 min.
	145										3 min.
											2 min.
											2 min.
				R-27	60			RQD=98 Rec=100%			3 min.
										>> ▲ Q_u = 776.2 tsf	3 min.
											153.6 pcf
	150										3 min.

Continued Next Page

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BORING B-02

DATE STARTED:	9/7/17	**DRILL COMPANY:**	Allied Well Drilling
DATE COMPLETED:	9/8/17	**DRILLER:** R. Miller	**LOGGED BY:** H. Patel
COMPLETION DEPTH	165.0 ft	**DRILL RIG:**	Dietrich D-50
BENCHMARK:	N/A	**DRILLING METHOD:**	Casing/Rock Coring
ELEVATION:	N/A	**SAMPLING METHOD:**	2-in SS1.874-in Core
LATITUDE:	n/a°	**HAMMER TYPE:**	Automatic
LONGITUDE:	n/a°	**EFFICIENCY**	N/A
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	F. Hoffman

REMARKS:

Water
- Pre-Core 15 feet
- Post-Core 28 feet

BORING LOCATION:
See Boring Location Plan

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS) RQD & Recovery % (NX)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ / Moisture × / PL ◪ / LL ✚ (0, 25, 50) / STRENGTH, tsf ▲ Qu ✳ Qp (0, 2.0, 4.0)	Additional Remarks
	150										4 min.
											2 min.
				R-28	60	**CONGLOMERATE**-Light gray to gray-brown, Fine to very coarse grained, Weathered to Slightly Weathered, very broken to massive, hard, trace pits and vugs		RQD=75 Rec=100%		>> ▲ Q_u = 381.7 tsf	2 min. γ_d = 142.5 pcf
											2 min.
	155										2 min.
						Conglomeratic SANDSTONE-Light gray to gray-brown, Fine to very coarse grained, Weathered to Slightly Weathered, very broken to massive, hard, trace pits					2 min.
				R-29	60	**SANDSTONE**-Dark red-brown to gray-brown, Fine grained, Slightly Weathered, massive, very hard		RQD=73 Rec=100%			2 min.
											3 min.
											3 min.
	160					**SILTSTONE**-Dark red-brown, Very fine grained, Slightly Weathered, broken to massive, moderately hard					3 min.
						Soil parting @ 160 feet (< 1/8 inch thick)					3 min.
				R-30	60	**SILTSTONE**-Red-brown, Very fine grained, Weathered, very broken to broken, moderately hard		RQD=63 Rec=100%			3 min.
						Highly Weathered seam @ 161.5 feet (~ 3/8 inch thick)					3 min.
											3 min.
	165					**SANDSTONE**- Gray, Fine grained, Slightly Weathered, broken to slightly broken, very hard					3 min.
						CONGLOMERATE-Light gray to dark gray-brown, Fine to very coarse grained, Slightly Weathered, very broken to massive, very hard					
						Weathered layer @ 162.6 feet (~ 4-1/4 inches thick)					
						Test boring terminated @ 165 feet					

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PROJECT NO.: 04911461
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LOCATION: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

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DPS # 20170830-2
0491 1461
HDD Boring (GB#2)
09/07/17
Depth: 15.0ft - 45.6ft
Box: 1 of
HWY 222 (East side)

Run	Depth(ft)	Rec(in)	RQD(in)
1	17.0-20.0	9"	0"
2	20.0-25.0	46"	6"
3	25.0-30.0	48"	11.5"
4	30.0-35.0	32"	0"
5	35.0-40.0	13"	0"
6	40.0-45.0	19.5"	0"
7	45.0-50.0	23.0"	7"


DPS # 20170830-2
0491 1461
HDD Boring (GB#2)
09/07/17
Depth: 45.6 ft - 87.5 ft
Box: 2 of
HWY 222 (East side)
Run
Depth (ft)
Rec (in)
Rqd (in)
8 50.0-55.0 17" 0"
9 55.0-60.0 22" 9"
10 60.0-65.0 18" 4"
11 65.0-70.0 11" 0"
12 70.0-75.0 10" 0"
13 75.0-80.0 21" 0"
14 80.0-85.0 35" 11"
45.6
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
87.5

DPS# 20170830-2
0491 1461
HDD Boring (GB#2)
09/07/17
~~HDD Boring~~
Depth: 87.5ft - 105.5ft
Box: 3 of
HWY 222 (East side)

Run	Depth (ft)	Rec (in)	RQD (in)
15	85.0 - 90.0	52"	35"
16	90.0 - 95.0	58"	31"
17	95.0 - 100.0	33"	9"
18	100.0 - 105.0	50"	29"

DPS # 20170830-2
0491 1461
HDD Boring (GB#2)
09/07/17
Depth: 105.5ft – 127.0ft
Box: 4 of
HWY 222 (East side)

Run	Depth (ft)	Rec (in)	RQD (in)
19	105.0 - 110.0	22"	0"
20	110.0 - 115.0	37"	9"
21	115.0 - 120.0	60"	28"
22	120.0 - 125.0	36"	5"
23	125.0-130.0	60"	26"


DPS # 20170830-2
0491 1461
MDD Boring (GB#2)
09/07/17
Depth: 127.0ft -
Box: 5 of
Hwy 222 (East side)
Run | Depth(ft) | Rec(in) | RQD(in)
24 | 130.0-135.0 | 60" | 8.5"
25 | 135.0-140.0 | 60" | 16"
26 | 140.0-145.0 | 60" | 55"
127.0
130.0
135.0
140.0
140.5


DPS #20170830-2
0491 1461
HDD Boring (GB#2)
09/07/17
Depth: 140.5 – 155.0ft
Box: 6 of 7
HWY 222 (East side)
Run | Depth(ft) | Rec(in) | RQD(in)
27 | 145.0-150.0 | 60" | 59"
28 | 150.0-155.0 | 60" | 45"
140.5
145.0
150.0
155.0

DPS # 20170830-2
0491 1461
HDD Boring (GB#2)
Depth: 155 - 165 ft
Box: 7 of 7
09/07/17
HWY 222 (East side)

Run	Depth (ft)	Rec (in)	RQD (in)
29	155.0 - 160.0	60"	44"
30	160.0 - 165.0	60"	38"

GENERAL NOTES

SAMPLE IDENTIFICATION

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

DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

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

RELATIVE DENSITY OF COARSE-GRAINED SOILS

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

ANGULARITY OF COARSE-GRAINED PARTICLES

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

GRAIN-SIZE TERMINOLOGY

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

PARTICLE SHAPE

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

RELATIVE PROPORTIONS OF FINES

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

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

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

MOISTURE CONDITION DESCRIPTION

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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

STRUCTURE DESCRIPTION

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

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

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

ROCK VOIDS

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

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

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

ROCK QUALITY DESCRIPTION

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

Degree of Brokeness

Characteristic	Description
Less than 1 inch	Very Broken
1 inch to 3 inches	Broken
3 inches to 6 inches	Slightly Broken
Greater than 6 inches	Massive

DEGREE OF WEATHERING

Slightly Weathered: Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.

Weathered: Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.

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

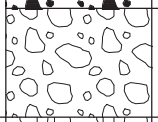
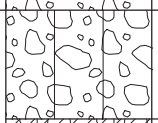
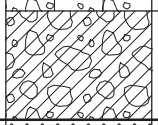
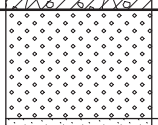
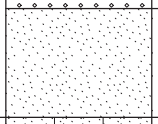
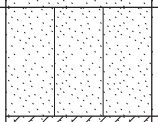
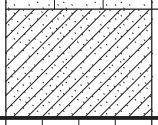
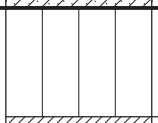
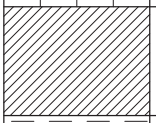
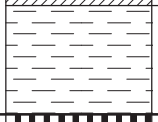
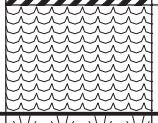
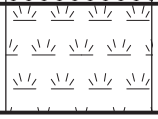
Table 4–3 Hardness and unconfined compressive strength of rock materials

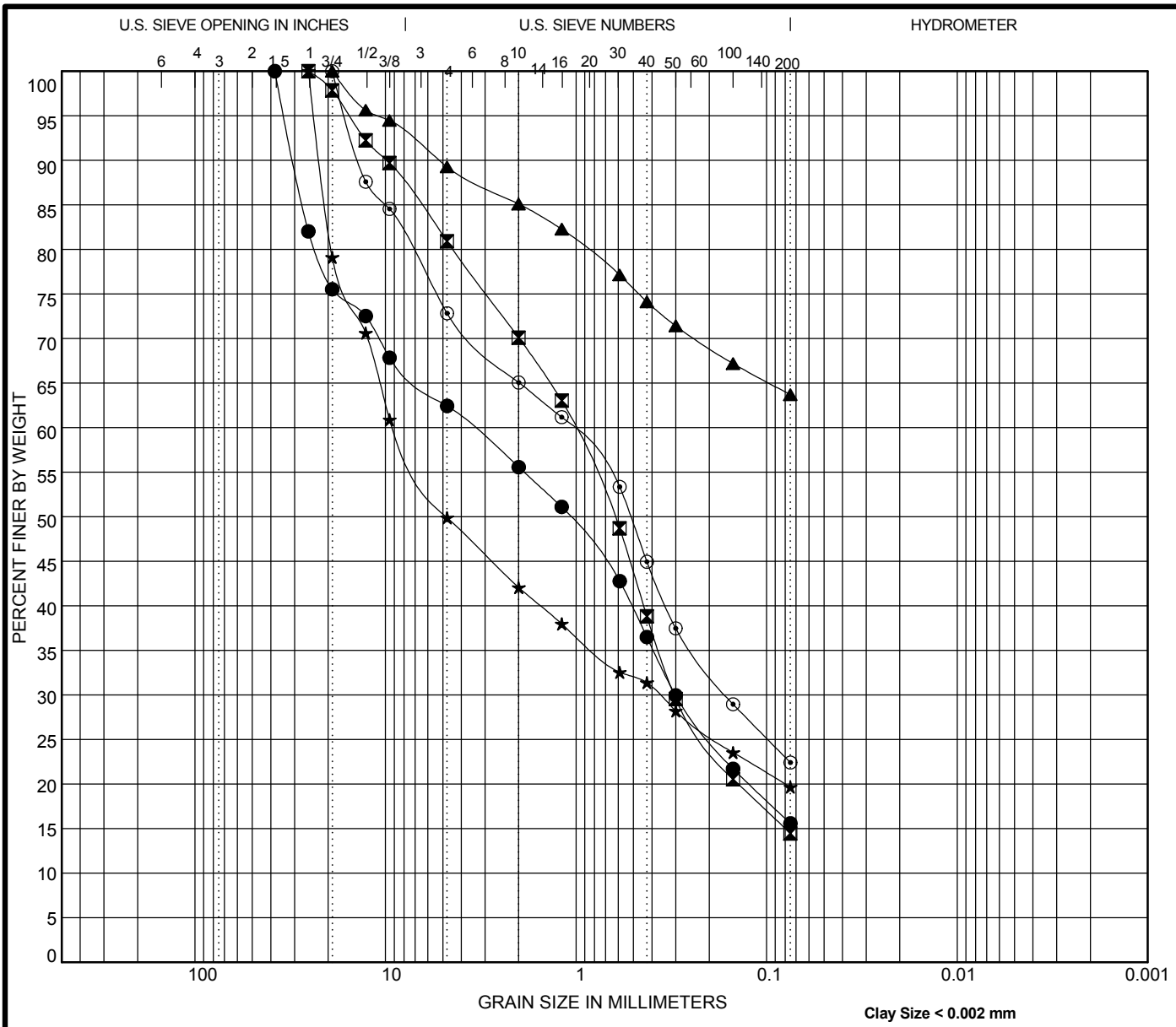
Hardness category	Typical range in unconfined compressive strength (MPa)	Strength value selected (MPa)	Field test on sample	Field test on outcrop
Soil*	< 0.60		Use USCS classifications	
Very soft rock or hard, soil-like material	0.60–1.25		Scratched with fingernail. Slight indentation by light blow of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

Method used to determine consistency or hardness (check one):
Field assessment: _____ Uniaxial lab test: _____ Other: _____ Rebound hammer (ASTM D5873): _____
* See NEH631.03 for consistency and density of soil materials. For very stiff soil, SPT N values = 15 to 30. For very soft rock or hard, soil-like material, SPT N values exceed 30 blows per foot.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-01	3.0	Clayey SAND with Gravel (SC)					
⊠	B-01	5.0	Silty SAND with Gravel (SM)					
▲	B-02	1.0	Sandy Lean CLAY (CL)					
★	B-02	3.0	Silty GRAVEL with Sand (GM)					
⊙	B-02	7.0	Silty SAND with Gravel (SM)					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-01	3.0	38.1	3.498	0.301		37.6	46.8	15.6	
⊠	B-01	5.0	25.4	1.026	0.305		19.1	66.4	14.5	
▲	B-02	1.0	19.05				10.7	25.6	63.7	
★	B-02	3.0	25.4	9.008	0.365		50.1	30.2	19.7	
⊙	B-02	7.0	19.05	1.071	0.163		27.2	50.4	22.4	

Professional Service Industries, Inc.
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GRAIN SIZE DISTRIBUTION

Project: Energy Transfer HDD (DPS)
PSI Job No.: 04911461
Location: HWY 222 (PPP5)
Berks Co., PA

Laboratory Summary Sheet

Borehole	Approx. Depth	Liquid Limit	Plastic Limit	Plasticity Index	Qu (tsf)	%<#200 Sieve	Est. Specific Gravity	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-01	1							11			
B-01	3					15.6%		9			
B-01	5					14.5%		12			
B-01	7							8			
B-01	9							8			
B-01	26.5				391.44						
B-01	45.3				547.02						
B-01	55.6				274.09						
B-01	72.5				771.01						
B-01	81.6				257.95						
B-01	85.2				170.70						
B-01	92.9				529.64						
B-01	104.5				659.42						
B-01	114.2				443.35						
B-01	120.8				209.99						
B-01	128.3				420.91						
B-01	135.2				618.03						
B-02	1					63.7%		11			
B-02	3					19.7%		4			
B-02	5							10			
B-02	7					22.4%		8			
B-02	9							6			
B-02	16							10			
B-02	20.1							14			
B-02	21.5				71.57						
B-02	28.8				162.75						
B-02	49.4				238.34						
B-02	85.5				251.61						
B-02	91.8				304.92						
B-02	102				149.76						
B-02	115.5				180.29						
B-02	126.5				140.75						
B-02	130.5				355.11						
B-02	148				776.19						
B-02	152.5				381.73						

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Summary of Laboratory Results

PSI Job No.: 04911461
Project: Energy Transfer HDD (DPS)
Location: HWY 222 (PPP5)
Berks Co., PA
PA-BR-0071.0000-RD/PO#20170830-2

RETTEW

ATTACHMENT 2
SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS

United States Department of Agriculture

Natural Resources Conservation Service

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

Custom Soil Resource Report for Berks County, Pennsylvania

Highway 222 HDD - 16-inch

February 4, 2019

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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Contents

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

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

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: 1:2,140 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N 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 1:24,000.

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: Berks County, Pennsylvania
Survey Area Data: Version 16, Sep 18, 2018

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

Date(s) aerial images were photographed: Jun 29, 2011—Mar 16, 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
JnB	Joanna loam, 3 to 8 percent slopes	1.3	18.9%
JnC	Joanna loam, 8 to 15 percent slopes	4.8	70.1%
JnD	Joanna loam, 15 to 25 percent slopes	0.8	10.9%
Totals for Area of Interest		**6.9**	**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 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.

Berks County, Pennsylvania

JnB—Joanna loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: l722
Elevation: 200 to 1,000 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 150 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Joanna

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

Ap - 0 to 8 inches: loam
Bt - 8 to 39 inches: clay loam
C - 39 to 85 inches: sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 72 to 100 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Croton

Percent of map unit: 5 percent
Landform: Depressions

Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Hydric soil rating: Yes

Readington

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

JnC—Joanna loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: l723
Elevation: 200 to 1,000 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Joanna

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from conglomerate and/or residuum weathered from sandstone

Typical profile

Ap - 0 to 8 inches: loam
Bt - 8 to 39 inches: clay loam
C - 39 to 85 inches: sandy loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 72 to 100 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

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

Minor Components

Croton

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

Readington

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

JnD—Joanna loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: l724
Elevation: 200 to 1,000 feet
Mean annual precipitation: 36 to 50 inches
Mean annual air temperature: 46 to 57 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Joanna

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope, nose slope
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Residuum weathered from sandstone and/or residuum weathered from conglomerate

Typical profile

Ap - 0 to 8 inches: loam
Bt - 8 to 39 inches: clay loam
C - 39 to 85 inches: sandy loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 72 to 100 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

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

Minor Components

Croton

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

Readington

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Base slope, head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: No

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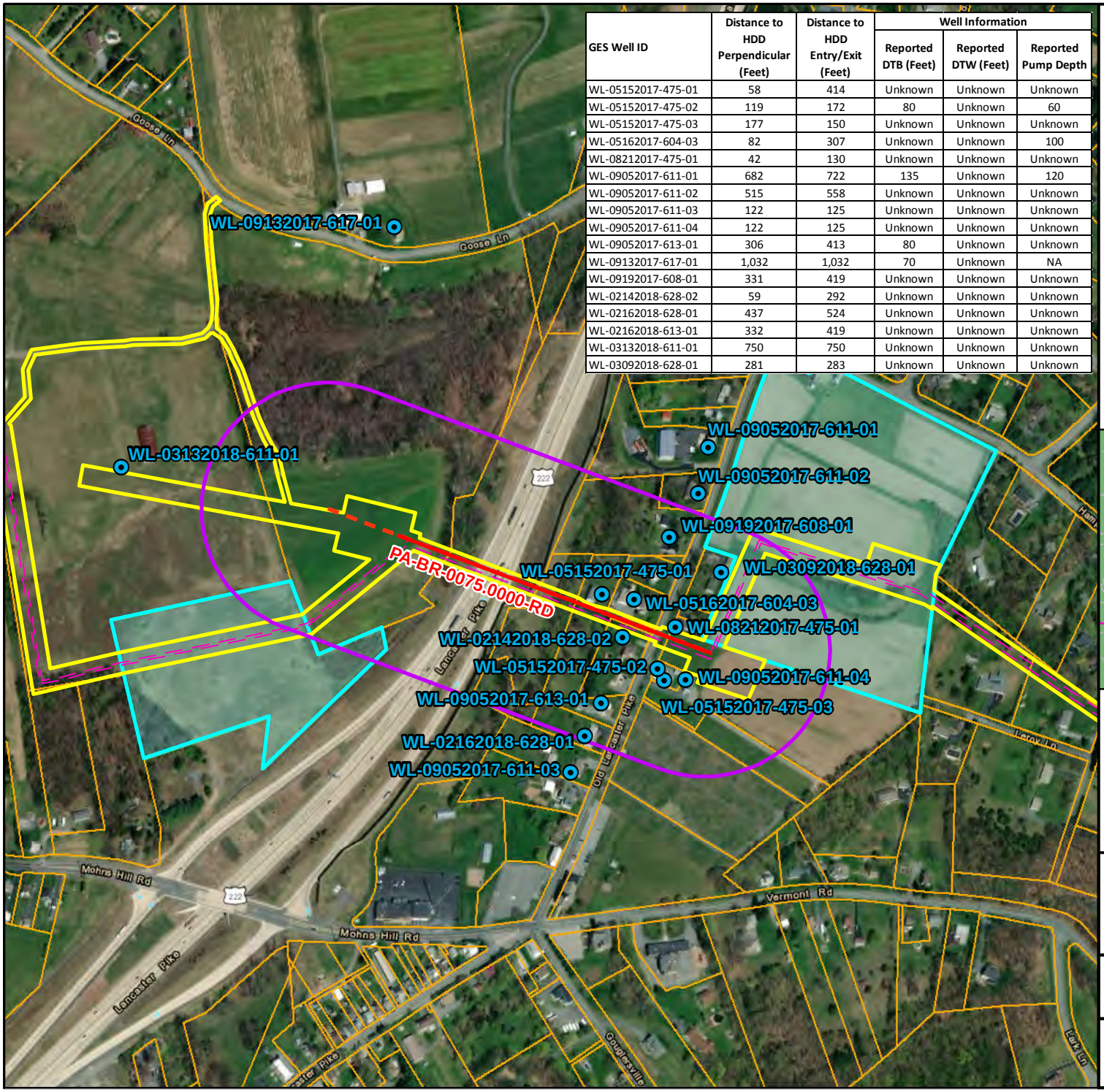
RETTEW

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-05152017-475-01	58	414	Unknown	Unknown	Unknown
WL-05152017-475-02	119	172	80	Unknown	60
WL-05152017-475-03	177	150	Unknown	Unknown	Unknown
WL-05162017-604-03	82	307	Unknown	Unknown	100
WL-08212017-475-01	42	130	Unknown	Unknown	Unknown
WL-09052017-611-01	682	722	135	Unknown	120
WL-09052017-611-02	515	558	Unknown	Unknown	Unknown
WL-09052017-611-03	122	125	Unknown	Unknown	Unknown
WL-09052017-611-04	122	125	Unknown	Unknown	Unknown
WL-09052017-613-01	306	413	80	Unknown	Unknown
WL-09132017-617-01	1,032	1,032	70	Unknown	NA
WL-09192017-608-01	331	419	Unknown	Unknown	Unknown
WL-02142018-628-02	59	292	Unknown	Unknown	Unknown
WL-02162018-628-01	437	524	Unknown	Unknown	Unknown
WL-02162018-613-01	332	419	Unknown	Unknown	Unknown
WL-03132018-611-01	750	750	Unknown	Unknown	Unknown
WL-03092018-628-01	281	283	Unknown	Unknown	Unknown



Legend

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

****Testing locations current as of 02/07/2019**

- GES Testing Location

Location

N

0 250 500

Feet

Well Location Map
HDD# PA-BR-0075.0000-RD
Berks County, PA.

Prepared By: TETRA TECH

Date: 2/7/2019

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

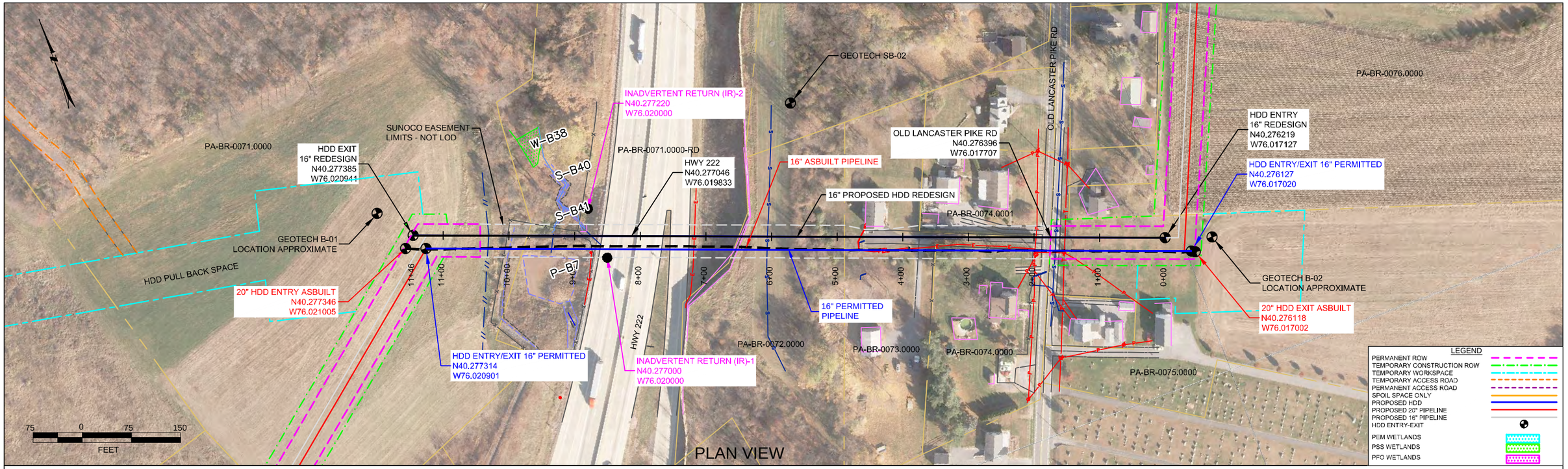
Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\0\0358-PPP\MXD\WellLocations\WellLocation_PA_BR_0075_0000.mxd LN

HIGHWAY 222 CROSSING
PADEP SECTION 105 PERMIT NO. E06-701
PA-BR-0071.0000-RD-16
(SPLP HDD No. S3-0200-16)

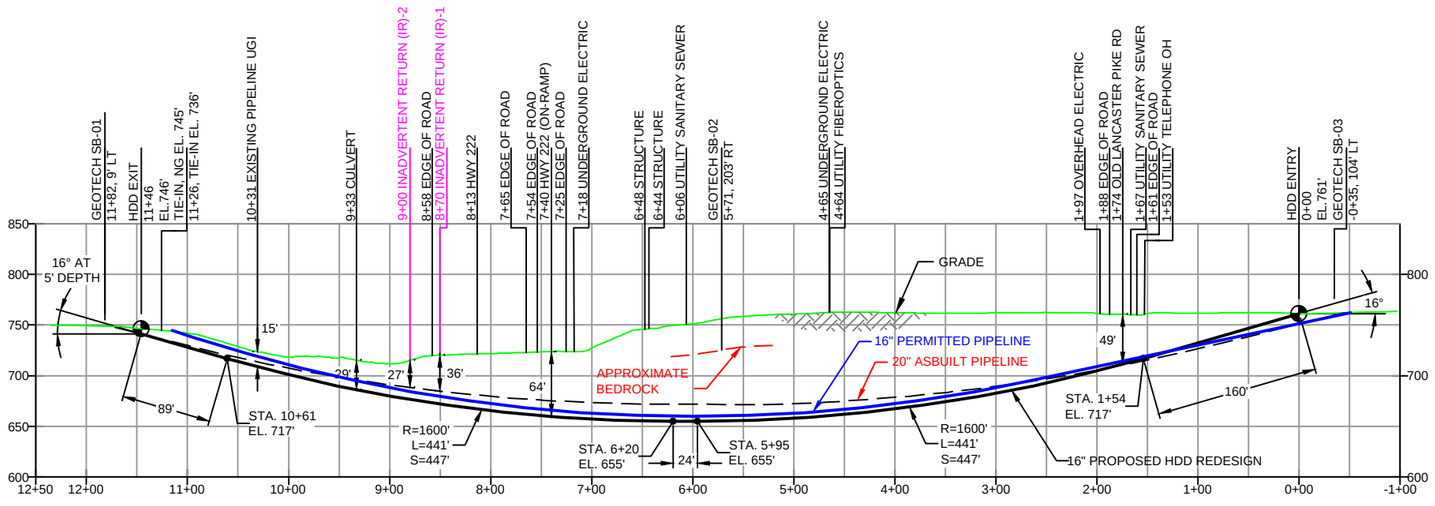
ATTACHMENT 2

HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

PROFILE VIEW



BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200-16

GEOTECH B-01

- NG EL. 745'
- -RESIDIUM-SILTY SAND SM (0.0' - 2.0')
- RESIDIUM-CLAYEY SAND SC (2.0' - 4.0')
- RESIDIUM-SILTY SAND SM (4.0' - 10.0')
- WEATHERED SANDSTONE (10.0' - 15.0')
- -GROUNDWATER (20.0')
- -CONGLOMERATE/SANDSTONE (15.0' - 145.0')
- -BORING TERMINATED EL.600'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02

- NG EL. 767'
- -RESIDIUM SANDY LEAN CLAY CL (0.0' - 2.0')
- RESIDIUM-SILTY GRAVEL GM (2.0' - 4.0')
- RESIDIUM-SILTY SAND SM (4.0' - 12.5')
- RESIDIUM-SILTY GRAVEL GM (12.5' - 17.0')
- WEATHERED SANDSTONE (17.0' - 30.0')
- GROUNDWATER (28.0')
- -SANDSTONE (30.0' - 165.0')
- -BORING TERMINATED EL.602'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1146'
   HDD PIPE LENGTH (S=):1167'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 1. Permitted 16-Inch HDD Plan and Profile with 20-Inch IR Data

NOTES

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.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
5	DESIGN CHANGE - MOVED DRILL ENTRY / EXIT	MRS	02/23/17	RMB	02/23/17	AMC	02/23/17
4	REVISED PROFILE WITH 2017 LIDAR	MRS	02/15/17	RMB	02/15/17	AMC	02/15/17
3	UPDATED SUNOCO EASEMENT LIMITS - NOT LOD	MRS	10/24/16	RMB	10/24/16	AAW	10/24/16
2	REVISED PER ENGINEERING COMMENTS	MRS	08/19/16	RMB	08/19/16	AAW	08/19/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	01/21/16	RMB	01/21/16	AAW	01/21/16

Sunoco Logistics Partners L.P.

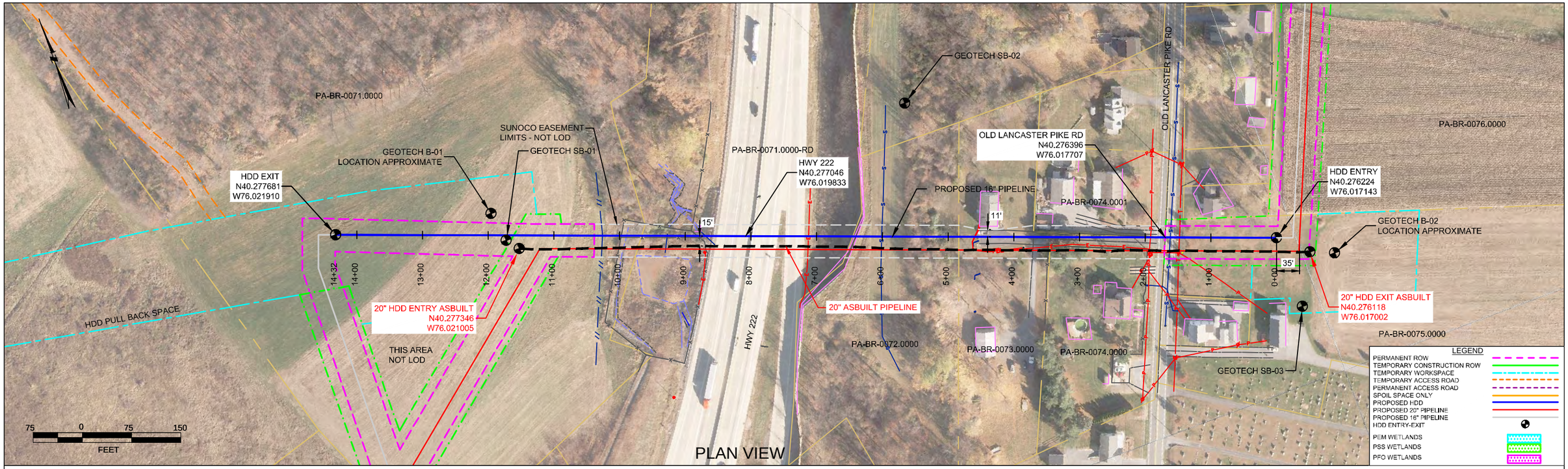
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

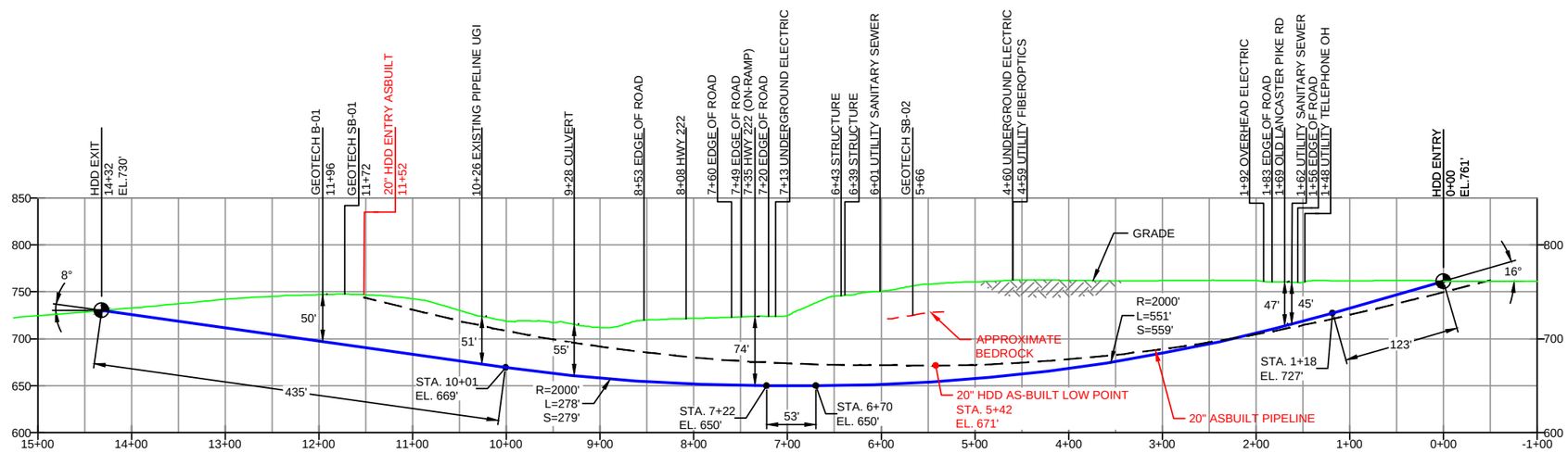
DWG. NO: PA-BR-0071.0000-RD-16 IR EXHIB



PLAN VIEW

PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200-16



GEOTECH SB-01

-NG EL. 747'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 717'

GEOTECH SB-02

-NG EL. 750'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 11.0')
-SM/GM (11.0' - 24.0')
-FRACTURED CONGLOMERATE (24.0' - 32.0')
-COMPLETION DEPTH EL. 718'

GEOTECH SB-03

-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0') SAND WITH FINE TO COARSE GRAVEL
-COMPLETION DEPTH EL. 737'

NOTE: REFER TO TEST BORING LOG S3-0200 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-01

-NG EL. 745'
-RESIDUUM SILTY SAND SM (0.0' - 2.0')
-RESIDUUM CLAYEY SAND SC (2.0' - 4.0')
-RESIDUUM SILTY SAND SM (4.0' - 10.0')
-GROUNDWATER (20.0')
-CONGLOMERATE/SANDSTONE (10.0' - 145.0')
-BORING TERMINATED EL.600'

NOTE: REFER TO TEST BORING LOG B-01 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B-02

-NG EL. 763'
-RESIDUUM CLAY CL (0.0' - 2.0')
-RESIDUUM GRAVEL GM (2.0' - 4.0')
-RESIDUUM SAND SM (4.0' - 12.5')
-RESIDUUM GRAVEL GM (12.5' - 17.0')
-GROUNDWATER (28.0')
-CONGLOMERATE/SANDSTONE SILTSTONE (17.0' - 165.0')
-BORING TERMINATED EL.598'

NOTE: REFER TO TEST BORING LOG B-02 INTERTEK PROJECT #04911461 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. 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.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1432'
   HDD PIPE LENGTH (S=):1449'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 2100 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 2625 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 2. Redesigned 16-Inch HDD Plan and Profile

NOTES

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.

REF. DRAWING

ES-5.27	TO	ES-5.28	EROSION & SEDIMENT PLAN	
SHEET 15	TO	SHEET 16	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	REDESIGNED DRILL EXIT SIDE PER CLIENT REQUEST AND ADDED GEOTECH INFORMATION	MRS	11/30/18	RMB	11/30/18	JAL	11/30/18
EP3	UPDATED TO MATCH 16" IFC DESIGN AND NOTE 5 AND 10 PER INCREASED 16" MOP	MRS	05/10/18	RMB	05/10/18	AMC	05/10/18
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/21/16	RMB	10/21/16	AAW	10/21/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GOETECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG. NO: PA-BR-0075.0000-RD-16