SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

October 4, 2019

Mr. John F. Hohenstein P.E
Environmental Program Manager
Southeast Regional Office
Pennsylvania Department of Environmental Protection;
2 East Main Street
Norristown, Pennsylvania 19401-4915

Re: Response to DEP Comments for HDD Re-Evaluation Report
SPLP HDD No. S3-0331 Eagleview Boulevard Crossing
PADEP Section 105 Permit No.: E15-862
Uwchlan Township, Chester County

Dear Mr. Hohenstein,

On June 25, 2019, Sunoco Pipeline, L.P (SPLP) submitted for public review and comment a Re-Evaluation of the Eagleview Boulevard Crossing, S3-0331, as referenced above. SPLP received an emailed comment from the Department dated September 30, 2019, requesting enhancement of one item within the drilling best management practices. Please accept this letter as a response to your request. Below is the specific comment from the Department.

- Regarding the last bullet point in the Conclusion section of the HDD analysis: The discussion of how a determination is made as to whether a LOC is small vs. large to determine the next steps. DEP requests that a responsible professional be on site to monitor the LOCs and make a determination as to which LOCS will require remediation.

This comment has been addressed by an addition to the last bulleted item within the revised Best Management Practices in the attached Re-Evaluation report, which states "The monitoring PGs and Drilling Specialists will assess the LOCs and make a determination as to which LOCS will require remediation and the method employed".

SPLP submits that we have been, and are, in complete compliance with the agreed terms and analysis requirements of the Order, as agreed to by the Department, and that no further analysis is required for the Department to consent to SPLP's evaluation for this permitted horizontal directional drill. SPLP therefore requests that the Department approve the Reevaluation Report for the Eagleview Boulevard Horizontal Directional Drill (S3-0331) as soon as possible.

Sincerely,

Larry J. Gremminger, CWB
Vice-President – Environmental, Health & Safety
Energy Transfer Partners
Mariner East 2 Pipeline Project

HORIZONTAL DIRECTIONAL DRILL ANALYSIS
EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

This reanalysis of the horizontal directional drill (HDD) installation of a 20-inch diameter pipeline that traverses Eagleview Boulevard in Uwchlan Township, Chester County, Pennsylvania, has been completed in accordance with Condition No. 3 of the Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L. Condition No. 3 stipulates, for HDDs initiated after the temporary injunction issued by the Pennsylvania Department of Environmental Protection (PADEP) Environmental Hearing Board on July 25, 2017, a reevaluation must be performed on HDDs for which an inadvertent return (IR) occurs during the installation of one pipe (20-inch or 16-inch diameter) where a second pipe will thereafter be installed in the same right-of-way (ROW).

The installation of the 16-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 an inadvertent return (IR), and therefore, the installation of the second pipeline (20-inch diameter) requires reanalysis. The IRs for the 16-inch pipeline were remediated, and completion of the HDD is currently underway, with the final reaming phase at 74 percent complete with no additional incidents.

The 20-inch pipeline HDD is referred to herein as HDD S3-0331.

PIPE INFORMATION

20-Inch: 0.456 wall thickness; X-65.

Pipe stress allowances are an integral part of the design calculations performed for each HDD. For steel pipe the “pipe stress allowance” is the amount of curvature that a piece or length of pipeline can bend without resulting in damages such as a “kink” or “crimp” in the wall of the pipe. The innate curvature ability of pipe is termed the “free stress radius”. The stress allowances of the pipe is determined by the ductility of the steel, wall thickness, and the diameter of the pipe. An HDD design is limited by the horizontal distance between the points of entry and exit and the free stress radius of the pipe.

Ductility of the steel used for pipelines is determined by the percentage of carbon within the steel. Generally steel pipe is categorized as “low carbon” having less than 0.3% carbon content within the steel, and “high carbon” having greater than 3% carbon within the steel. As the carbon content within the steel used to make the pipe increases, the flexibility of the pipe is decreased. The X65 20-inch pipe utilized on the Mariner project is a low carbon steel pipe.

The design of an HDD profile accounts for the free stress radius of the pipeline segment to be pulled into the drilled entry, through the entry radius of curvature at maximum horizontal depth, out the exit radius leaving maximum depth, and out the drilled exit; therefore each HDD has a minimum of four (4) points of pipeline curvature to assess for pipeline stress. Additionally, a horizontally drilled profile is not a “perfect” pathway, especially when drilled through rock formations. The pilot tool cutting into the rock face has a larger cutting face than the drill stem pushing the tool forward, which results in flexibility of the tooling within the pilot hole, and as a result the pilot tool will drift in orientation as proceeding forward because the cutting tool will proceed easier into softer material while cutting due to natural variances in hardness of the materials being cut, whether they are soils or rock. Steering of the pilot tool is used to correct drifting as it occurs. As a result of this natural drifting during completion of the pilot hole, the entire length of the drilled pilot hole is assessed for stress allowances on three (3) joint intervals before reaming of the annulus is permitted. If errors during pilot drilling or reaming occur and a mid-point is identified that would breach the pipe stress allowance, then the use of an over-reamed annulus is assessed for breach of the stress allowance. In cases where an over-reamed annulus will not correct the stress problem, then the HDD has to be re-drilled.

All of the information and the stress assessment procedures discussed above are incorporated into the profile design and implemented in analysis of the drilling profile to ensure the integrity of the pipeline as installed.

Specifics for the original permitted 20-inch HDD plan and profile (P & P) are discussed in the original permitted HDD design summary below. Specifics for the revised 20-Inch HDD P & P are discussed in the Redesigned Horizontal Directional Drill Design Summary at the end of this report.

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 3,571 feet (ft)
- Entry/Exit angle: 6-8 degrees
- Maximum Depth of cover: 45 ft
- Pipe design radius: 1,600-2,000 ft

The original profile design factors are below the pipeline stress allowances for all points of analysis.

ROOT CAUSE ANALYSIS FOR THE 16-INCH PIPELINE INSTALLATION INADVERDENT RETURNS

Two IRs in upland areas occurred during the pilot phase drilling for the 16-inch pipe installation, while drilling was proceeding from northwest to southeast. The first IR was 75 gallons in volume and occurred at 122 ft before the southeast entry point when the pilot tool was at approximately 21 ft below ground surface (bgs). The second IR occurred at the completion of the pilot drill when 40 gallons of drilling fluid emerged from under the timber mats overlying the HDD workspace, at approximately 75 feet before the exit stake where the overburden was 11.7 feet thick.

Both of these IR event are called “punch out” IRs in the drilling industry. Both IR events occurred as the pilot tool was proceeding towards the exit point while overburden above the drilling tool is thinning and is comprised of relatively weak, highly weathered, fractured bedrock.

Due to the tool location of 3,449 ft distance, or more, from entry at the time of the IRs, it is obvious that the drilling fluid pressures required to maintain return flows to the entry pit exceeded the retention strength of the bedrock and overburden; therefore root cause of the IR is poor rock/overburden strength while operating at normal drilling fluid pressure to maintain return flows.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

Bedrock underlying the area of HDD S3-0331 is predominantly Pre-Cambrian age gneiss differentiated as felsic & intermediate gneiss (PA GEODE). The felsic & intermediate gneiss occurs along the entire extent of the HDD bore alignment. No major structural features have been mapped in proximity of the HDD S3-0331 alignment. The regional structural fabric and contacts between the felsic and intermediate gneiss and other units mapped to the northwest and south/southeast generally trend northeast.

Fracture trace analysis identified two fractures, one trending northeast and the other trending north-northeast, crossing the HDD bore alignment. These fractures cross both the permitted and proposed profile alignments at approximately Station 15+00 and Station 16+85 and are plotted on the proposed HDD profile in Attachment A of the Hydrogeologic Report provided in Attachment 1 of this report.

Based on published geologic data, no karst features are anticipated within the Limit of Disturbance (LOD) of HDD S3-0331. No geophysical studies were performed for the design of HDD S3-0331 as there is no

carbonate bedrock or associated karst terrane proximal to the HDD alignment and no carbonate rock was logged in the geotechnical borings.

Vertical geotech core data indicates highly weathered and fractured bedrock to a depth of approximately 30 ft bgs, after which the data indicates generally excellent recovery (100 %) and good to excellent RQD (57-100) to the final core depth. The rock strength at profile depth indicated by core B6-9W and the drilling experience for the 16-inch line to date, indicate rock strength is better at depth on HDD S3-0331 than at other HDD locations in the gneiss geology. Higher rock strength at profile depth at this HDD may be attributed to the density of quartz seams and suggests drilling conditions are better. There have been no IRs during the progress of the reaming phase; however, drilling rates have been relatively slow, which supports the geologic analysis.

Attachment 1 provides a discussion on the geology and results of the geotechnical investigations performed at this location.

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Groundwater in the gneissic units of Chester County is stored and moves within unconsolidated highly weathered and fractured bedrock materials (saprolite), near the land surface, and through the weathered bedrock zone down into an interconnected network of joints, fractures, and faults in more competent rock. Some saturated zones within the saprolite may be under perched conditions.

A Pennsylvania Groundwater Information System web site (PaGWIS) search identified 21 domestic wells within one mile of HDD S3-0331. All wells were drilled in gneiss units. The total depths of the wells ranged from 56 to 405 ft below ground surface (bgs) with only one depth greater than 288 ft bgs. Depth to bedrock ranged from 0 to 78 ft bgs and static water levels ranged from 0 to 40 ft bgs. The average yield was 13.5 gpm with a range from 1 to 75 gpm.

Groundwater was encountered in only one of the four geotechnical test borings described in the Hydrogeologic Report, Section 2.2.8, provided in Attachment 1. A water level of 15 ft bgs was recorded at Tetra Tech boring SB-03, located near the southeastern entry/exit.

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

ADJACENT FEATURE ANALYSIS

The crossing of Eagleview Blvd. is located in Chester County, and the City of Lionville, Pennsylvania and is set within an area of commercial development along public roadways with some peripheral and adjacent residential home sites. This HDD location occurs along a topographic apex and does not cross any stream or wetland resources. The alignment of the HDD generally parallels an existing SPLP pipeline for the majority of its length.

SPLP identified all landowners within 450 feet and greater from the HDD profile and sent each of these landowners a notice letter via both certified and first-class mail that included an offer to sample 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, if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Oder, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy – Executive Assistant, Office of Programs at the Department's Central Office.

As a result of these communications, one (1) private water supply well was identified within 450 feet of the original permitted HDD profile. With landowner permission, the one well within the 450-foot buffer was sampled pre-construction and during construction of the 16-inch pipeline. As per current ME II water supply protection protocols, this landowner will be re-offered temporary water service during the construction of the 20-inch line, and the sampling effort repeated after installation of the 20-inch pipeline.

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 feet in any direction of the revised HDD alignment.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of HDD S3-0331 includes an evaluation of construction alternatives and a re-route analysis.

The HDD as originally permitted was designed to avoid direct impacts to, or interference with, four public roadways, fifty-two (52) existing other utilities crossing the HDD alignment, and numerous surface developments while following generally parallel to an existing SPLP easement for the majority of the HDD length.

Open-cut Analysis

Sunoco Pipeline, LP (SPLP) specifications require a minimum of 48-inches of cover over the installed pipeline. The Pennsylvania Department of Transportation (PennDot) requires 60-inches of cover below public roadways. As introduced above, the HDD as originally permitted was designed to avoid direct impacts to, or interference with four public roadways, and fifty-two (52) existing utility crossings while following generally parallel to an existing SPLP easement for the majority of the HDD length.

The 52 existing utilities owned by other entities have various requirements for exposure and depth of separation. In some instances, specifically the public water and sewer line spacing requirements, make installation by an open cut, or open cut variations impossible given available open grounds above the alignment. Considering that an open-cut construction plan requires workspace within what is currently open accessible public or private areas for access and operations of commercial businesses, the conversion of the planned HDD to open cut for its entire length is not possible without significant and long duration affects, or restrictions, to these business and the public, even in combination with use of other construction techniques as discussed below.

The heavily developed characteristics of this area, and evidence that IRs occurred only during punch out of the pilot drilling phase, result in SPLP concluding that an HDD installation remains as the preferred construction method through this area.

Use of Conventional Auger Bore

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

Based on experience gained during construction of the Mariner II Pipeline project, conventional auger bores should be limited to approximately 200 linear ft at a time, or less, varying by the underlying substrate. Conventional auger bores for the 16-inch pipeline, attempted at longer distances, have at times had alignment drift and elevation deflections occur which have complicated installation.

As presented above, the HDD alignment crosses four public roadways, and fifty-two (52) existing utilities. A conventional bore requires free ground surface workspace for setup of the entry and receiving pits to execute the bore and for pulling back of the product pipeline for the linear extent of the bore. The restrictions of working around and within the foreign utilities, in combination with public roadway crossings, make implementation of this construction method applicable to two out of four public roadways, leaving the remainder of the roadway crossings and foreign utility crossings prohibited by workspace and spacing requirements

The heavily developed characteristics of this area, and evidence that IRs occurred only during punch out of the pilot drilling phase, result in SPLP concluding that an HDD installation remains as the preferred construction method through this area.

FlexBor Analysis

SPLP contractors attempted three (3) FlexBors and partially completed two of these to replace HDDs on the Mariner Project. One FlexBor failed in the pilot phase and was replaced with a conventional bore under a highway and open cut construction. The two partially successful FlexBors completed the pilot phases, but both had difficulties completing the reaming phase. SPLP's analysis is that this technology is not perfected for larger diameter bore attempts regardless of length.

Direct Pipe Bore Analysis

The direct pipe bore method is also known as "microtunneling". This method of pipeline installation is a remote-controlled, continuously supported pipe jacking method. During the direct pipe installation, operations are managed by an operator in an above-ground control room alongside of the installation pit. Rock and soil cutting and removal occurs by drilling fluid injection through the cutting tool during rotation at the face of the bore, and the cuttings are forced into inlet holes in the crushing cone at the tool face for circulation to a recycling plant through a closed system. The entire operating system for this method of pipeline installation, including the cutting tool drive hydraulics, fluid injection, fluid return, and operating controls are enclosed inside the outside diameter bore pipe (or casing pipe) being installed. At the launching point/entry pit, the bore pipe is attached to a "jacking block" that hammers the bore pipe while the tool is cutting through the substrate or geology. The cutting tool face is marginally larger in diameter than the pipe it is attached to. As a result, there is minimal annulus space, which minimizes the potential for drilling fluid returns or the production of groundwater returning back to the point of entry. Unlike an HDD, this technology has no steering capability. Changes in direction are made by adjusting the cutting angle of the tool face which results in a maximum of 4 degrees radius between the point of entry and exit, varying by the length of the bore attempt. The shorter the bore, the less area for adjustment of depth or direction is available. The Direct Bore entry workspace requirements includes a 400 ft by 100 ft area for installation of the entry pit, hydraulic press, and casing assembly, plus approximately a 0.7 acre area for equipment power, fluids recycling, maintenance and supporting equipment.

SPLP's construction contractors have successfully completed one (1) Direct Pipe Bore approximately 925 ft on the Pennsylvania Pipeline Project at the crossing of the Frankston Branch of the Juniata River in Blair County. This Direct Pipe Bore was setup within a relatively flat area immediately outside the river floodplain and bored under the floodplain, wetlands, and river, exiting at the toe of a mountain slope.

There is one (1) sub-set within the HDD alignment where Direct Pipe bore could be considered. This is at the crossing of West Uwchlan Avenue. This construction method requires larger surface workspace area than a conventional auger bore for the entry pit operations area. This 500 ft extent of the HDD alignment could be completed by this method; however it leaves the remainder of the HDD alignment to be completed by other methods, which variations of have been discussed rejected.

The heavily developed characteristics of this area, and evidence that IRs occurred only during punch out of the pilot drilling phase, result in SPLP concluding that an HDD installation remains as the preferred construction method through this area.

Re-Route Analysis

As part of the PADEP Chapter 105 permit process for the Pennsylvania Pipeline 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 SPLP pipeline route as currently permitted, will parallel the 16-inch pipeline installation nearing completion, and follows an existing SPLP pipeline for a majority of the length. The HDD alignment is routed to minimize impacts to commercial businesses and residential home sites and minimize impacts across the area.

The general route of the Pennsylvania Pipeline Project in this area of the state is generally from northwest to southeast. A review of area maps and aerial photography does not reveal any other open utility corridors that could be considered as possible route alternatives. Existing commercial and residential development occurs for more than 1.0 mile to the southwest and northeast of the alignment. No practicable re-route option lies to the northeast or southwest of the proposed route that would not transect multiple roads, businesses and private property. Shifting the pipeline route northeast or southwest would still result in HDD crossings of N. Whitford Rd., W. Uwchlan Ave., Downlin Forge Rd., and Eagleview Blvd., require a new utility corridor, and affect similar residential and commercial buildings. A new utility corridor would require consent of newly-affected landowners or the use of eminent domain/condemnation and would create a new land encumbrance on every private/public property crossed. Given site conditions and features to the northeast and southwest of the proposed pipeline alignment, no practicable re-route exists that would result in less impacts to environmental resources.

The alteration of the current permitted route from HDD to open cut would require major modifications of the state Chapter 102 and Chapter 105 permits, and associated authorizations issued by the United States Army Corps of Engineers.

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

HORIZONTAL DIRECTIONAL DRILL REDESIGN

SPLP has considered all geologic data, and the IR events during drilling of the 16-inch pipeline, and has redesigned the 20-inch HDD profile accordingly. A summary of the redesign factors is provided below. The original and redesigned HDD plan and profile for the 20-inch pipeline are provided in Attachment 2.

Revised Horizontal Directional Drill Design Summary: 20-inch

- Horizontal length: 3,632 ft
- Entry/Exit angle: 12-16 degrees
- Maximum Depth of cover: 153 ft
- Pipe design radius: 1,800-5,000 ft

The redesigned HDD profile design factors are below the pipeline stress allowances for all points of analysis.

EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

CONCLUSION

Based on the original and revised profile for the 20-inch HDD, the revised HDD profile increases the depth in bedrock for a majority of the HDD profile; therefore, adjustments to the plan of construction for the 20-inch pipeline represent a reduced risk of IRs. Punch out IRs are common on entry and exit of the drilling tool and other measures are required to minimize this 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 mandate annular pressure monitoring during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus, to help manage development pressures that can induce an IR;

- SPLP inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipeline, is used to ensure adequate “annulus spacing” around the drilling pipeline exits to allow good return flows during the pilot drilling;

- SPLP will implement short-tripping of the reaming tools, as indicated by monitoring of return flows, to ensure an open annulus is maintained to manage the potential inducement of IRs;

- SPLP will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process;

- The drilling manager and SPLP drilling inspectors will monitor the tool face pressure while advancing towards exit to determine when mud pressures can be reduced to lower IR potential while completing the final footage for exiting of the pilot tool. During the reaming phase, the driller can implement both push and pull reaming to minimize IR potential at this HDDs southeast end to lower IR potential;

- During all drilling phases, the use of Loss Control Materials (LCMs) will be implemented upon detection of a LOC or indications of a potential IR are noted or an IR is observed. The use of LCMs, however, is less effective 70 ft-bgs. Accordingly, the preferred corrective action needed to address the presence of fractures or LOC at greater depths below ground will require grouting of the HDD annulus. Two types of grouting may be utilized for corrective actions to seal fractures. These are: 1) grouting using “neat cement”; and 2) grouting using a sand/cement mix. Neat cement grout is a slurry of Portland cement and water which is highly reactive to bentonite and induces solidification. The sand/cement grout mix is a slurry of mostly sand with a small percentage of Portland cement and activators that result in a material having the competency of a friable sandstone or mortar, after setup. Both grouting actions require tripping out the drilling tool, and then tripping in with an open-ended drill stem to apply or inject the grout mixes. Either of these grouting actions may be implemented upon the first detection of an LOC, with the selection of the treatment based upon the circumstances of the LOC, being small or large in magnitude. The monitoring PGs and Drilling Specialists will assess the LOCs and make a determination as to which LOCS will require remediation and the method employed.

EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

FEASIBILITY DETERMINATION

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

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

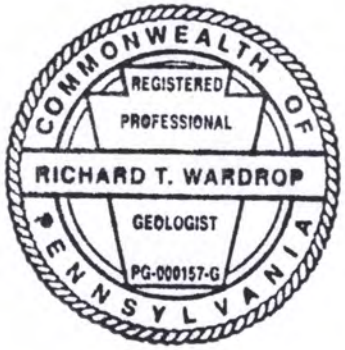
July 25, 2019

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

Pertaining to the practice of geology

6/25/19

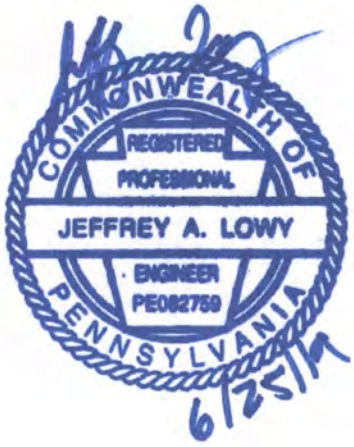
Richard T. Wardrop, P.G.
License No. PG-000157-G
Groundwater & Environmental Services, Inc.
Lead Hydrogeologist



Pertaining to the pipeline stress and HDD geometry

6/25/19

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



EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

HDD HYDROGEOLOGIC REEVALUATION REPORT

Mariner East II
Spread 6
HDD S3-0331
Dairy Queen Parking Lot/Eagleview Blvd.
Uwchlan Township, Chester County, Pennsylvania

Prepared for:

Sunoco Pipeline, L.P.

Prepared by:

Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, Pennsylvania 19341

June 2019

HDD HYDROGEOLOGIC REEVALUTION REPORT

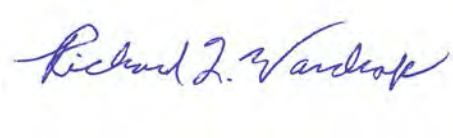
Mariner East II
Spread 6
HDD S3-0331
Dairy Queen Parking Lot/Eagleview Blvd.
Uwchlan Township, Chester County, Pennsylvania

June 2019

Prepared for:

Sunoco Pipeline, L.P.
535 Fritztown Road
Sinking Spring, Pennsylvania 19608

Prepared by:



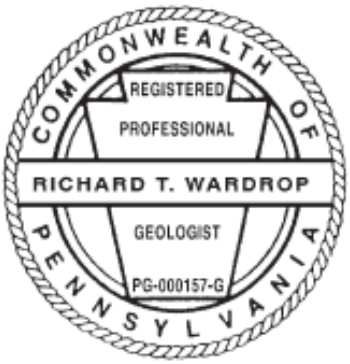
Richard T. Wardrop, P.G.
Principal Hydrogeologist

Reviewed by:

David J. Demko VP, P. G.
Program Manager

Groundwater & Environmental Services, Inc.
440 Creamery Way, Suite 500
Exton, Pennsylvania 19341
(610) 458-1077

By affixing my seal to this document, I am certifying that the geologic and hydrogeologic information is true and correct. I further certify 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.



June 25, 2019

Richard T. Wardrop, P. G. Date

Lic. No. PG000157G

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FIGURES

ATTACHMENTS

1.0 INTRODUCTION

Sunoco Pipeline, L.P., (SPLP) retained Groundwater & Environmental Services, Inc. (GES) to prepare HDD Hydrogeologic Reevaluation Reports (HRRs) for horizontal directional drills (HDDs) for the Mariner East II pipeline project. The project involves installation of a 20-inch and a 16-inch diameter natural gas liquid pipeline parallel to one another. This HRR is for the alignment referred to as HDD S3-0331 Dairy Queen Parking Lot/Eagleview Boulevard, which will be used for installation of the 20-inch pipeline. Installation of the 16-inch pipeline at this location is in progress and nearly complete. During the pilot phase of construction on the 16-inch line, two inadvertent returns (IRs) occurred. According to the requirements of Stipulated Order EHB Docket No. 2017-009-L signed August 10, 2017, HDD S3-0331 requires a HDD Reevaluation, which includes the preparation of an HRR, because an Inadvertent Return (IR) occurred during construction of the first of the two pipelines.

The discussion presented in this report is based on the plan and profile (P & P) for HDD S3-0331 developed by Tetra Tech/Rooney, revised September 30, 2016 (permitted profile) and a newly redesigned P & P (proposed profile), revised June 24, 2019, which is different than the permitted profile placing the HDD approximately 107 feet deeper along the central, deepest, portions of the profiles, with entry/exit angles increased from 8º to 12 º at the northwest entry/exits and from 6º to 16º at the southeast entry/exit. Both the 2016 and 2019 profiles are provided in **Attachment** A, along with the as-drilled profile for the 16-inch pilot bore, to date.

The alignment for HDD S3-0331 is in Uwchlan Township, Chester County, approximately one mile southwest of where East Uwchlan Avenue passes over Route I-76, 0.3 miles southwest of the intersection of West Uwchlan Avenue and State Route 100, and approximately 2.7 miles east/southeast of Marsh Creek Reservoir. A map depicting the location of the HDD with topographic information for the surrounding area is presented as **Figure 1**.

This report presents the following information:

- Geologic and hydrogeologic characteristics in the area of HDD S3-0331;
- Summaries of studies performed pertinent to reevaluation, including fracture trace analysis and geotechnical borings;
- A site conceptual model; and
- A reevaluation summary with conclusions.

The contents of this report were developed from interpretation of published information, field observations, and related field studies. In May 2015, Tetra Tech conducted a site geotechnical boring program. In August 2017 Terracon drilled additional geotechnical borings at nearby HDD S3-0350, one of which (the northwestern boring) is reviewed in the context of this evaluation since the HDD S3-331 southwest entry/exit is at the HDD S3-350 northwest entry/exit. The Tetra Tech boring logs and the Terracon boring log are provided in **Attachment B**. Please note that GES did not oversee or direct either geotechnical boring program, including, but not limited to, the selection of number and location of borings, determination of surface elevations, target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and any core photographs that resulted from these programs were generated by SPLP's contractors. GES relied on these reports and incorporated their data into the general geologic and hydrogeologic framework for this hydrogeologic reevaluation report.

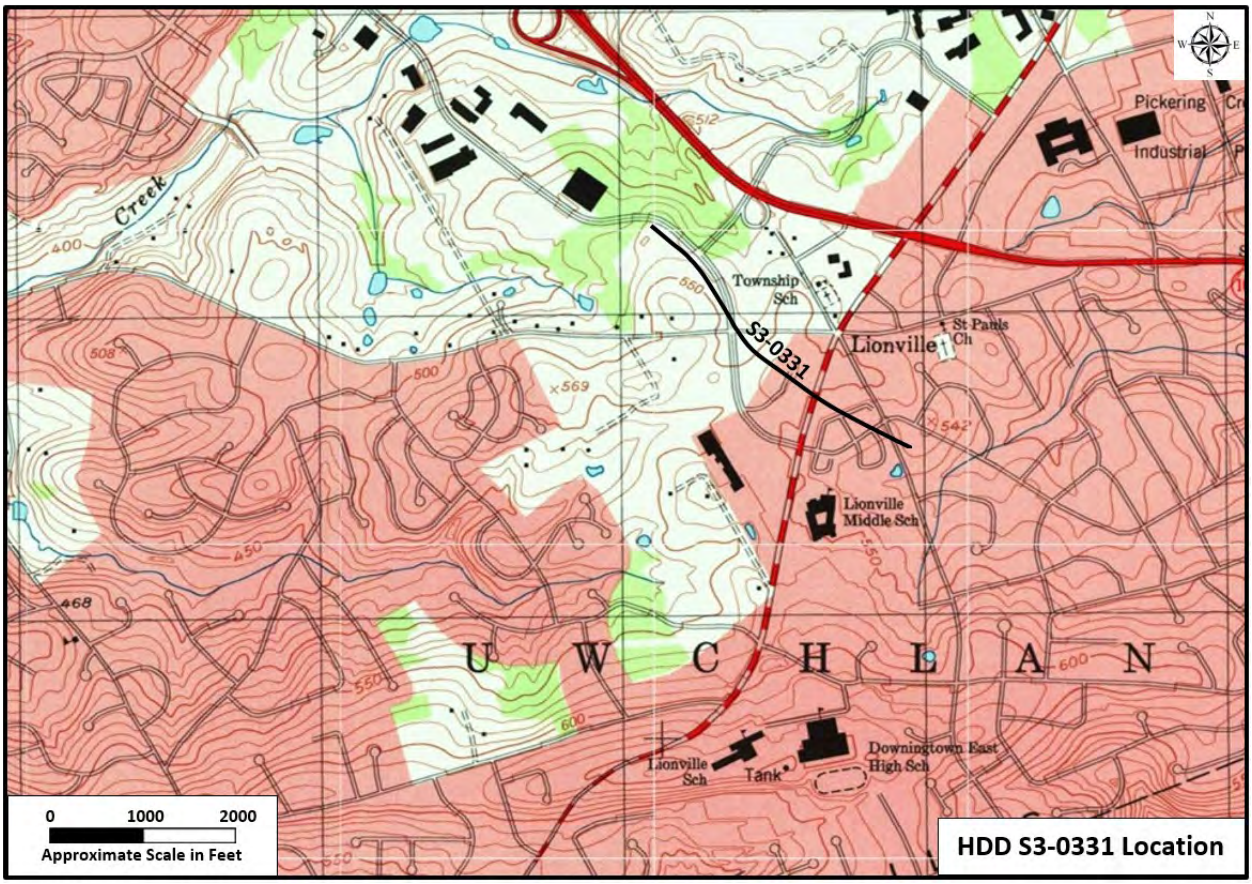

Figure 1. Site Location Map (modified USGS 7.5-Minute Series Quadrangle Map, 1999)

As described in the Stipulated Order (pages 3 and 4), the HRRs will provide information to eliminate, reduce, or control the release or inadvertent return (IR) of HDD drilling fluids to the surface of the ground or impact to water supplies at the location during HDD operations. The HRRs are not intended to evaluate the potential risks of adverse effects on man-made structures (ex. roadways, parking lots and buildings) proximal to the HDD alignment.

2.0 HDD GEOLOGY / HYDROGEOLOGY

2.1 Physiography

HDD S3-0331 is located within the Piedmont Upland Section of the Piedmont Province, which is characterized by broad, rounded to flat-topped hills and shallow valleys. The area surrounding the HDD is comprised of primarily commercial properties, with some light industrial properties.

2.1.1 Topography

The horizontal distance for the permitted profile is 3,571 feet and is 3,632 feet for the proposed profile, with slight additions to footage on either end. The northwestern entry/exit is at an elevation of 534 feet above mean sea level (ft amsl) on the permitted profile and at 533 ft amsl on the proposed profile. The southeastern entry/exit is at an elevation of 527 ft amsl on the permitted profile and at 526 ft amsl on the proposed profile. The land surface has a topographic high of approximately 557 ft amsl at Station 21+00 and there are relatively continuous gentle slopes from the topographic high to the entry/exits.

2.1.2 Hydrology

Groundwater flow gradients in the area of the HDD are assumed to be subdued reflections of the local topography. In the area of the northwestern half of HDD S3-0331, Shamona Creek is the closest surface water feature to the HDD bore as the stream meanders along topographic lows that occur east, north and northwest of the HDD S3-0331 alignment. The topography suggests that drainage along the southeast half of the profile is to the west and that drainage near the southeast entry/exit is to the south. The shallow groundwater flow paths proximal to the HDD are expected to take similar directions. Shamona Creek and its tributaries are considered local groundwater discharge points. In addition, there is a small unnamed stream that occurs approximately 640 feet to the southeast of the southeast entry/exit, which is also likely a shallow groundwater discharge point.

It is possible that deeper groundwater flow in the area of S3-0331 would be toward the west ultimately discharging into Marsh Creek and Marsh Creek Reservoir. Marsh Creek Lake was created by the damming of Marsh Creek to "address frequent flooding and to address water shortages and to provide local recreational opportunities" (PADCNR, Marsh Creek State Park web site).

There are no water resources (stream segments or wetlands) that intersect or run immediately adjacent to the HDD S3-0331 alignment. However, the HDD alignment passes below an approximate one-acre storm water basin between 15+00 and 17+50, situated in the southeast quadrant at the intersection of Eagleview Boulevard and Dowlin Forge Rd.

2.2 Geology

2.2.1 Soils

Based on information obtained from the National Resource Conservation Service Web Soil Survey database (NRCS WSS) for Chester County, soils underlying HDD S3-0331 include the Neshaminy silt loam on 3 to 8 percent and on 8 to 15 percent slopes, the Califon loam on 3 to 8 percent slopes; the Gladstone gravelly loam on 3 to 8 percent slopes, and Urban land on 0 to 8 and 8 to 25 percent slopes. All of these soil types are derived from weathering of the underlying gneissic bedrock, with varying amounts of clay, silt, sand and gravel. All of the soils are considered well drained except for the Califon loam, which is considered moderately well drained. NRCS WSS information indicates the depth of bedrock weathering to create these soils ranges from 5.5 to 8.25 feet and the depth to the water table ranges from 5.0 to greater than 6.7 feet. The soil present at the northwest entry/exit is the Neshaminy silt loam on a 3 to 8 percent slope that transitions to a gravelly clay at approximately 6.2 feet. The soil present at the southeast entry/exit is the Gladstone gravelly loam that transitions to sandy loam with depth.

2.2.2 Bedrock Lithology

Bedrock underlying the area of HDD S3-0331 is predominantly Pre-Cambrian age gneiss differentiated as felsic & intermediate gneiss (PaGEODE). The felsic & intermediate gneiss occurs along the entire extent of the HDD bore alignment (**see Figure 2**).

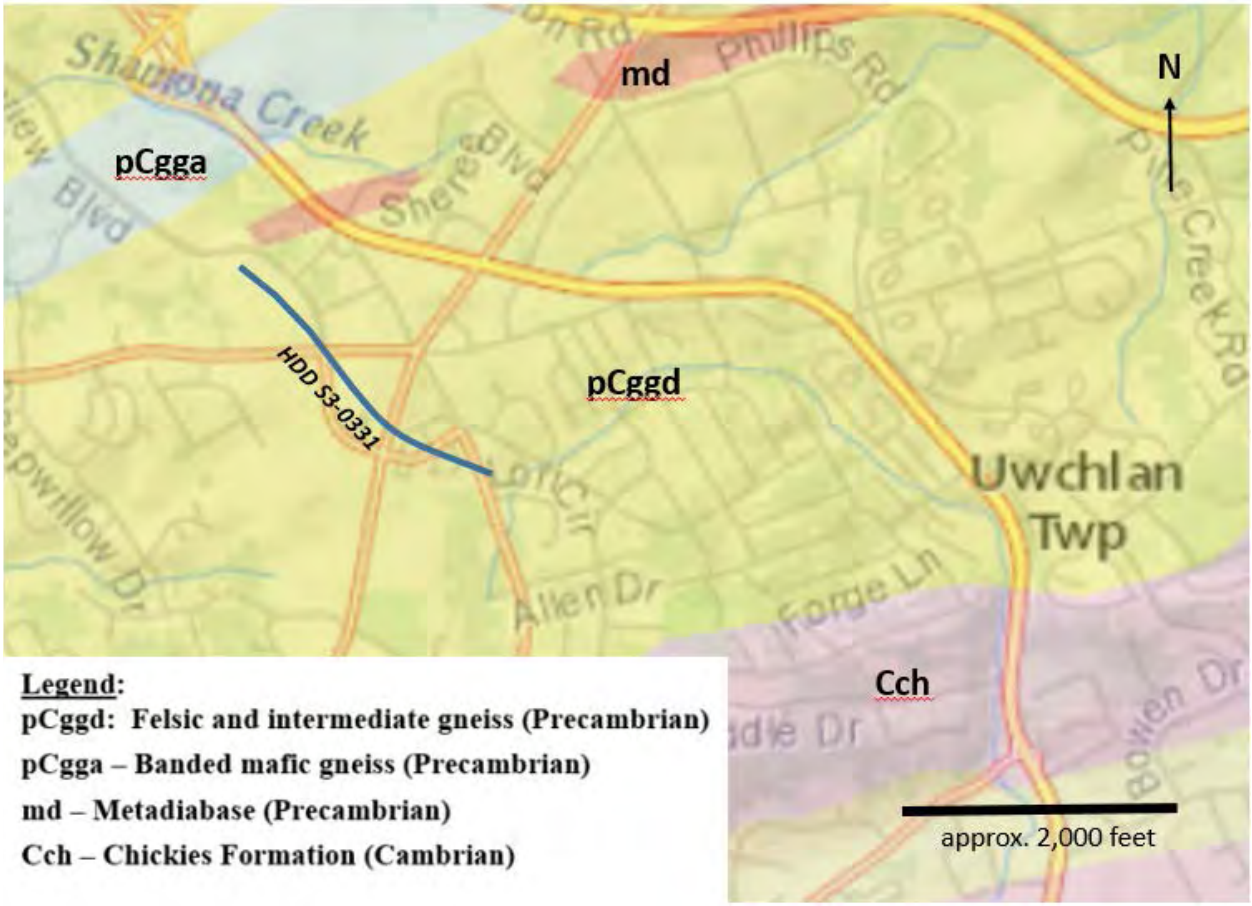

Figure 2. Local Bedrock Geology (modified from PaGEODE)

2.2.3 Structure

No major structural features have been mapped in proximity of the HDD S3-0331 alignment. The regional structural fabric and contacts between the felsic and intermediate gneiss and other units mapped to the northwest and south/southeast generally trend northeast. Cross-Section A-A' in Berg, et. al. (1980) shows the local gneiss bodies dipping steeply to the south. A metadiabase dike, trending northeast, is mapped approximately 355 feet north of the northeast entry/exit and a second metadiabase dike with similar trend is mapped approximately 0.6 miles northeast of the alignment.

Discontinuities in the form of joints, fractures and faults are imprinted in the bedrock units across the region. These features can act as conduits for groundwater movement and/or represent areas of weakness in the rock.

2.2.4 Fracture Trace Analysis

Fracture trace analysis using high altitude aerial photography was performed for the area of interest to identify potential zones of bedrock weakness along drill paths. Fracture traces (one mile in length or less) and lineaments (greater than one mile in length) can be the surficial expression on natural landscapes of vertical to near vertical zones of bedrock fracture concentration. Fracture trace analysis is partly subjective;

therefore, every mapped fracture trace does not necessarily represent a zone of bedrock fracture concentration.

Figure 3 shows the fracture trace mapping conducted for this reevaluation. This mapping was performed using aerial stereographic pairs flown in the fall of 1937 obtained from the Pennsylvania Imagery Navigator web site. As such, much of the land surface appears undeveloped and fracture traces are more easily seen.

General orientations present in the fracture traces proximal to the alignment include the following: north-northeast trending, northwest trending and northeast trending. Two fractures, one trending northeast and the other trending north-northeast, cross the HDD bore alignment. These fractures cross the proposed profile alignment at approximately Station 15+00 and Station 16+85 and are shown in **Attachment A**. These traces come close to intersecting northeast of the alignment.

Figure 3. Fracture Trace Map (modified USGS 7.5-Minute Series Quadrangle Map, 1999)

2.2.5 Karst

Based on published geologic data, no karst features are anticipated within the Limit of Disturbance (LOD) of HDD S3-0331. The potential of karst conditions is not anticipated because carbonate rock is not mapped proximal to the HDD alignment and no carbonate rock was logged in the geotechnical borings (see Section 2.2.8). The contact between the gneissic units and carbonate valley of Chester County begins two miles southeast of the HDD alignment.

2.2.6 Mining

No historic or current, surface or deep, mineral mining operations have been identified in the area of the HDD in Uwchlan Township. (PADCNR Non-Fuel Mineral Resources and PADEP eMap). Many commercial attempts were made historically to mine graphite from the Pickering Gneiss in a band of small mines running west to east in a line approximately two miles northwest of the HDD. Bascom and Stose (1938) mapped over a dozen graphite mines along this line that are no longer operating. Given these locations, it is not anticipated that any historic mining operations will effect installation of the 20-inch pipe.

2.2.7 Rock Engineering Properties

The properties of the felsic & intermediate gneiss (granodiorite and granodioritic gneiss), as described in Geyer and Wilshusen (1982), are as follow:

- No bedding.
- Joints / fractures occur in a blocky pattern, moderately developed, moderately abundant, irregular, widely spaced, open and moderately dipping.
- Difficult to excavate, expect large surface and near-surface boulders, slow drilling rates.

Drilling rates for installation of the 16-inch line have been relatively slow. Currently, the final ream is progressing at approximately 80 feet per day of drilling.

2.2.8 Results of Geotechnical Borings

Tetra Tech advanced three geotechnical borings proximal at the HDD S3-0331 alignment in support of designing the original HDD profile. Boring SB-01 was located near the northwest entry/exit while SB-03 was located near the southeast entry/exit. Boring SB-02 was located along the alignment, between Sheree Boulevard and Dowlin Forge Road. Terracon advanced boring B6-9W, primarily for the HDD S3-0350; however, this boring was in close proximity to the southeast entry/exit for S3-0331, on the same drill pad as the S3-0350 northwest entry/exit. The logs for these borings are provided in **Attachment B**.

At each geotechnical boring location, split spoon samples were collected through a hollow stem auger. In general, the texture of the unconsolidated materials was silty fine to medium sand, with weathered to unweathered gravel sized gneiss fragments classified as decomposed rock. Auger refusal ranged from 11 feet below ground surface (ft bgs) at SB-02 to 28.8 ft bgs at SB-03. Split spoon blow counts generally increased with depth, with refusal (>50 blows/6-inches or less). Groundwater was not encountered in SB-01 (total depth of 16.5 feet) or in SB-02 (total depth of 13 feet with 2 feet of coring), but groundwater was encountered in SB-03 at a depth of 15 feet (total depth of 28.8 feet).

Tetra Tech advanced a core two feet into bedrock at SB-02, which was described as a fractured felsic gneiss. Recovery for the run was 100% but the Rock Quality Designation (RQD) was poor at 38 percent (ASTM, 1988). In 2017, deeper additional geotechnical borings and coring were performed. Terracon advanced boring B6-9W a total of 80 ft bgs. Rock coring commenced at 20 ft bgs and continued to total depth. Recoveries ranged from 30 to 48 percent for the top ten feet of core, then were consistently 100 percent to the total depth. The RQD for cored rock at this boring was very poor (<25-percent) for the top ten feet of core, described as highly weathered gneiss. After 30 ft bgs, RQD was good to excellent (75 to 90-percent and 90 to 100-percent, respectively) for the remainder of the bore, except for the run from 65 to 70 ft bgs

for which RQD was poor (57-percent). After 30 ft bgs the bedrock was described as being a hard to very hard, slightly weathered gray and white banded, coarse-grained granodiorite gneiss with numerous quartzite seams. Groundwater was not encountered in boring B6-9W.

2.3 Hydrogeology

2.3.1 Occurrence of Groundwater

Groundwater in the gneissic units of Chester County is stored and moves within unconsolidated highly weathered and fractured bedrock materials (saprolite), near the land surface, and within more competent fractured bedrock, at depth. Some saturated zones within the saprolite may be under perched conditions.

Groundwater in this hydrogeologic setting moves through the weathered bedrock zone down into an interconnected network of joints, fractures, and faults in more competent rock. Fracture traces represent potential zones of fracture concentration and preferred pathways for fluid movement, contributing to the interconnected network of discontinuities.

2.3.2 Well Yields and Water Levels

A Pennsylvania Groundwater Information System web site (PaGWIS) search identified 21 domestic wells within one mile of HDD S3-0331. All wells were drilled in gneiss units and the average yield was 13.5 gpm with a range from 1 to 75 gpm. The total depths of the wells ranged from 56 to 405 ft bgs with only one depth greater than 288 ft bgs. Depth to bedrock ranged from 0 to 78 ft bgs and static water levels ranged from 0 to 40 ft bgs.

Groundwater was only encountered in one of the four geotechnical test borings described in Section 2.2.8. A water level of 15 ft bgs was recorded at Tetra Tech boring SB-03, located near the southeastern entry/exit.

2.3.3 Ground Elevation between HDD entry/exits

The surface elevation for the proposed profile at the northwest entry/exit is 533 ft amsl and the surface elevation for the southeast entry/exit 526 ft amsl. Considering the water level data presented in Section 2.3.2, only one of four borings identified saturated material with a water level measurement of 15 ft amsl near the southeast entry/exit. If we conservatively assume that depth to water under the highest point on the land surface along the profile, the water table would be at approximately 542 ft amsl at approximately Station 21+00, and higher in elevation than both entry/exits, indicating some risk of a groundwater discharge. The water level beneath the high point of the profile is likely deeper which would reduce that risk.

2.3.4 Water Supply Wells within 450 feet of Alignment

HDD-S3-0331 was included in the implementation of SPLP's original 150-foot water supply survey and subsequent 450-foot water supply survey (see **Figure 4**). Certified letters were sent to land owners with parcels that intersect the 450-foot survey border. One water supply well was identified within the 450-foot survey area. This well is located between West Uwchlan Avenue and North Whitford Road, approximately 385 feet northeast of the HDD bore alignment. The water supply is part of the SPLP ME II water quality sampling program, which provide for a pre-construction, during construction and post-construction sampling. As per current ME II water supply protection protocols, this landowner will be offered temporary water service during the construction of the 20-inch line.

To date there have been no reported impacts to water supplies at HDD S3-0331 during drilling activities for the 16-inch line.

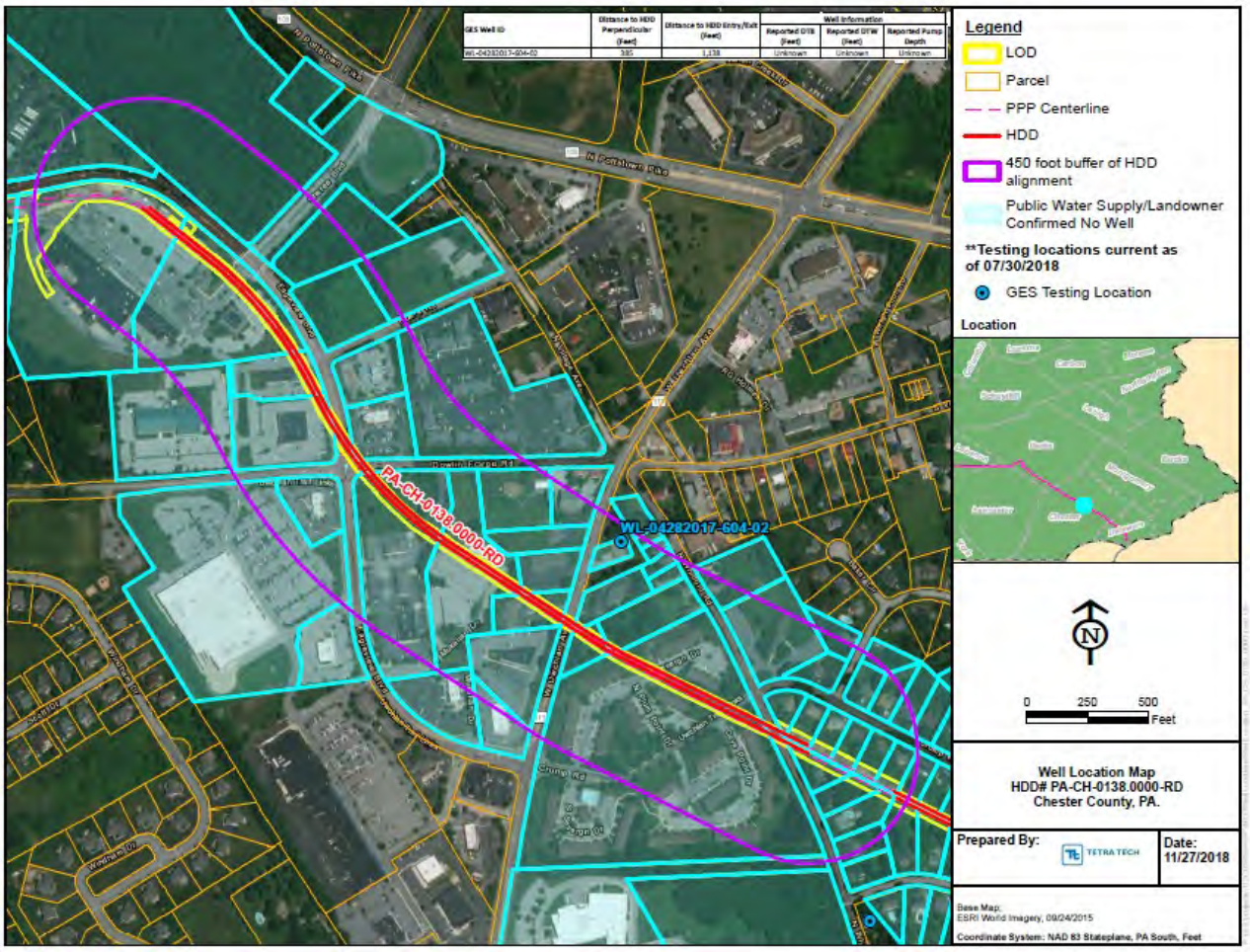

Figure 4. 450-foot Water Supply Survey

2.4 Summary of Geophysical Studies

No geophysical studies were performed for the design of HDD S3-0331, as there is no carbonate bedrock or associated karst terrane proximal to the alignment and this HDD was not the subject of additional geophysical studies being performed in Spread 6.

3.0 OBSERVATIONS TO DATE

3.1 On This HDD Alignment

The pilot phase drilling for the 16-inch pipe installation began in July 2017. Drilling continued without incident until November 2017 when two upland, punch out IRs occurred in the same general area. The first on November 20, 2017 and the second on November 30, 2017. The first IR was 75 gallons during the pilot phase and appeared approximately 144 feet northwest of the southeast entry/exit along a 3,622-foot drill (horizontal distance) just outside the LOD where the overburden was approximately 22 feet thick. The second IR occurred at the completion of the pilot drill when 40 gallons of drilling fluid emerged from under the timber mats, approximately 75 feet before the exit stake where the overburden was 14 feet thick. The two IRs occurred as the pilot tool was ascending to surface towards the exit location. In this section of the profile, the overburden is thinning and is comprised of relatively weak, highly weathered, fractured bedrock. Also, in this section of the profile of a relatively long HDD, an increase in annular pressure is often required to maintain circulation back to the drilling fluid pit at the entry, and this type of pressure increase may have contributed to the upland IRs.

3.2 On Other HDD Alignments in Similar Hydrogeologic Settings

Upland, punch out IRs have occurred during the drilling of other ME II HDDs in the metamorphic rocks of Chester and Delaware County. These IRs have typically occurred where bedrock is densely fractured (sometimes indicated by a fracture trace or fracture trace intersection) or where the profile approaches an entry/exit point, closer to the surface, where unconsolidated overburden material thins and there is less overburden strength to contain drilling fluid pressures. In some cases, overburden thickness is reduced where the deepest part of the profile passes under a stream occupying a section of the alignment with the lowest surface elevation along the profile. At the exit end of pilot bores for HDDs, especially relatively long HDDs, an increase in annular pressure is often required to maintain circulation back to the drilling fluid pit at the entry, and this type of pressure increase has contributed some of the IRs that have occurred to date.

4.0 SUMMARY AND CONCLUSIONS OF HDD HYDROGEOLOGIC EVALUATION

4.1 HDD Site Conceptual Model

This HDD hydrogeologic reevaluation was based on comparing permitted and proposed P&Ps for constructing the ME II 20-inch line at HDD S3-0331. Comparison of the profiles shows the entry/exit angles are increased (4 degrees at the northwest entry/exit and 10 degrees at the southeast entry/exit) and the lowest, central part of the profile is 107 feet deeper. The elevation of the low point on the permitted profile is 512 ft amsl and is 405 ft amsl on the proposed profile. Note, the low point on the as-built 16-inch profile is at 426 ft amsl, 21 feet above the proposed profile for the 20-inch line. Steepening the entry/exit angles and going deeper reduces the HDD footage in highly weathered and fractured material at each end of the profile, reducing the risk of punch out IRs.

Geologic conditions other than the weathered bedrock overburden that could affect HDD construction include loose blocks of competent bedrock in the lower portion of the weathered bedrock horizon and potential vertical to near-vertical zones of bedrock fracture concentration manifested as mapped fracture traces. Fracture traces cross the proposed alignment at approximately Station 15+00 and Station 16+85. The approximate positions of the fracture traces are shown on the proposed P&P in **Attachment A**. Zones of bedrock fracture concentration can represent preferred pathways for fluid migration contributing to Losses of Circulation (LOCs) and potentially IRs.

Rock core information from one geotechnical boring drilled near the southeast entry/exit of the proposed 20-inch P&P (B6-9W) indicated highly weathered and fractured bedrock to a depth of approximately 30 feet, below which rock cores generally showed excellent recovery and good to excellent RQD to the final depth of 80 feet or approximately elevation 439 ft amsl. In general, it is assumed that higher strength rock will persist at greater depths. This would include rock at the deepest part of the proposed profile at an elevation of 405 ft amsl, where the design provides for a maximum overburden thickness of 153 feet. The maximum overburden thickness for the permitted profile is approximately 45 feet.

The 30-foot depth of highly weathered and fractured bedrock is within the range of similar determinations derived from many other geotechnical borings and geophysical surveys conducted for the ME II project in the metamorphic rocks of Chester and Delaware County. Maximum depths of highly weathered and fractured rock determined at the other HDD locations exceed 100 feet; however, the rock strength at depth indicated by geotechnical boring B6-9W and the drilling experience for the 16-inch line to date, indicate rock strength is better at depth at S3-0331 than at other HDD locations in the gneiss units. Higher rock strength at depth at this HDD may be attributed to the density of quartz seams and suggests drilling conditions are better. In fact, there have been no IRs during the drilling for the 16-inch line at HDD S3-0331, except for the punch out IRs; however, drilling rates have been relatively slow.

Some risk of a groundwater discharge from construction of the proposed 20-inch line is present if it is assumed that the water table elevation is 15 feet below at the highest surface elevation along the alignment. The water level beneath the high point of the profile is likely deeper which would reduce this risk. Note that no groundwater discharge has occurred at this HDD location associated with drilling for 16-inch line.

SPLP's original 150-foot and subsequent 450-foot water supply surveys identified one water supply well that was 385 feet from the HDD bore alignment. There were no reported impacts to this or any other water supply during drilling activities associated with the 16-inch line installation, to date. Thus, there is a very small risk of a water supply impact from HDD construction using the proposed profile for the 20-inch line.

Drilling activities associated with the 16-inch line at HDD S3-0331 to date have had relatively few issues with LOCs and IRs. The two IRs occurred as the pilot bit was ascending to surface at the exit location

through the overburden. In this section of the profile, the overburden is thinning to less than 30 feet and is comprised of relatively weak soil and, highly weathered and fractured bedrock. At this location along the profile of a relatively long HDD, an increase in annular pressure is often required to maintain circulation back to the drilling fluid pit at the entry, and this type of pressure increase may have contributed to the upland IRs near exit.

4.2 Conclusions and Recommendations

Based on the site conceptual model for the 20-inch HDD at S3-0331, deepening of the profile as much as 107 feet will reduce the risk of IRs. However, due to certain factors, IR risk remains and drilling plans to complete the HDD should address these factors, including:

- Soil and, highly weathered and fractured bedrock overburden becomes thin near the entry/exit points.
- The approximate location of two fracture traces mapped on the proposed P&P (see **Attachment A**) represent the potential preferred pathways for fluid migration in the subsurface.
- Annular pressure tends to increase at the end of relatively long HDD pilot to maintain circulation.
- The rock strength at depth is high and drilling rates may be slow.

Given the location of the HDD, there is minimal risk of an impact to any water resource or water supply from construction using the proposed P&P, due to the distance of these resources from the HDD. Consistent with current ME II protocols, the landowner of the one water supply well identified by the 450-foot survey (located approximately 358 feet from the HDD alignment) should be offered a temporary water supply prior to the start of 20-inch line construction.

Although the risk of a groundwater discharge at either entry/exit is small, the drilling contractor should be prepared to manage this type of discharge.

Based on information provided by, and the expertise of, the HDD team, as well as our experience with the relevant hydrogeology and geology, GES believes that implementation of the proposed profile for the 20-inch line at S3-0331 and best management practices inherent to the ME II construction project, including specific references to areas of concern identified in this HRR, will minimize the risk of IRs and minimize the likelihood of an impact to the environment. Furthermore, based on such information, expertise and experience, GES believes that implementation of the proposed 20-inch P&P for S3-0331, especially in the context of the distance to water resources and water supplies, will minimize the risk of any impact to these resources.

5.0 REFERENCES

ASTM, 1988. *Rock Classification Systems for Engineering Purposes*, ASTM International, ASTM STP 984, West Conshohocken, PA. 1988

Bascom, F and G. W. Stose, 1938. *Geology and Mineral Resources of the Honeybrook and Phoenixville Quadrangles, Pennsylvania*, USGS Bull. 891.

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Geyer, Alan R. and J. Peter Wilshusen (1982*). Engineering Characteristics of the Rocks of Pennsylvania*. Department of Environmental Resources, Office of Resources Management, Bureau of Topographic and Geologic Survey. Harrisburg, PA, Environmental Geology Report 1, 1982.

United States Geological Survey (USGS), 1995. *Downingtown, PA*, 1:24,000 Topographic 7.5-minute series Quadrangle Map, 1999.

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Pennsylvania Department of Conservation & Natural Resources (PADCNR), NonFuel-Mineral Resources, http://maps.dcnr.pa.gov/topo/quarries/

Pennsylvania Department of Conservation & Natural Resources (PADCNR), Marsh Creek State Park, https://www.dcnr.pa.gov/StateParks/FindAPark/MarshCreekStatePark/Pages/History.aspx

Pennsylvania Department of Environmental Protection (PADEP) eMapPA, http://www.depgis.state.pa.us/emappa/

Pennsylvania Groundwater Information System (PAGWIS), http://www.docs.dcnr.pa.gov/topogeo/groundwater/pagwis/records/index.htm

Pennsylvania Imagery Navigator, http://maps.psiee.psu.edu/ImageryNavigator

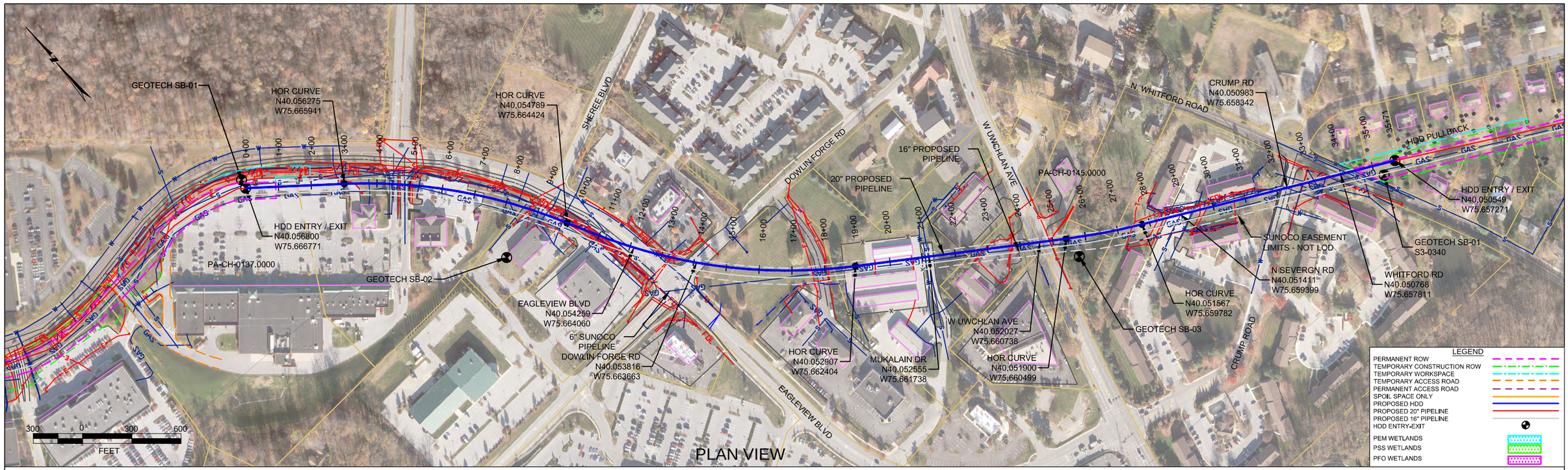
United State Department of Agriculture, Natural Resources Conservation Service Web Soil Survey (NRCS WSS), https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Attachment A

HDD S3-0331 Plan and Profiles

Permitted Plan and Profile, rev. 9/30/16

Proposed Plan and Profile, rev. 6/24/19, showing geology,
as-built 16-inch profile, and IRs



CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0331

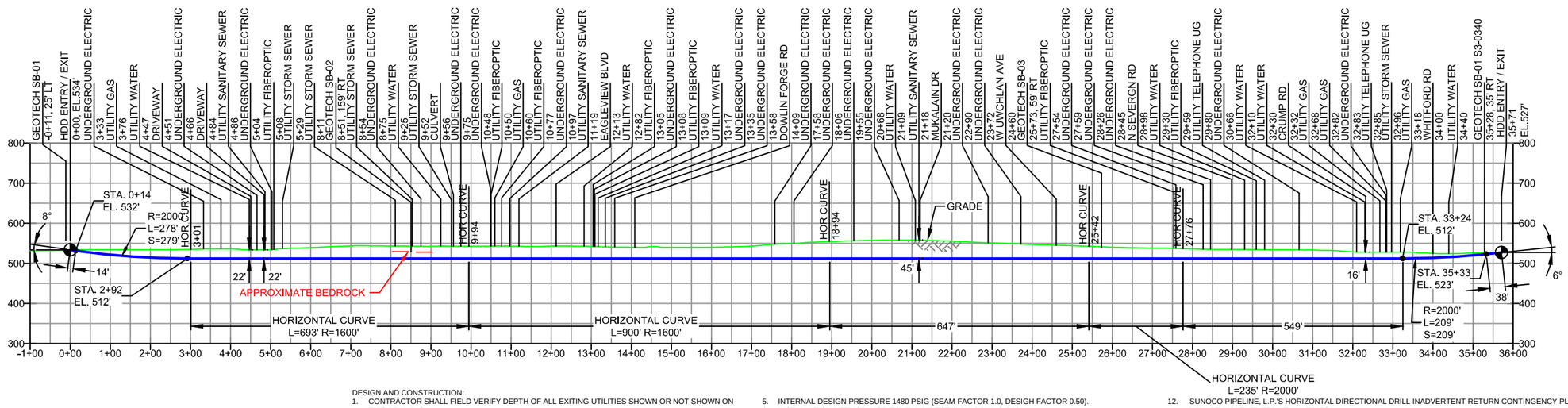
PROFILE VIEW

GEOTECH SB-01
-NG EL. 532.5'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 16.5')
-COMPLETION DEPTH EL. 516'

GEOTECH SB-02
-NG EL. 552'
-TOPSOIL (0' - 0.3')
-ML (0.3' - 3.5')
-SM (3.5' - 9.5')
-SM / GM (9.5' - 11.0')
-FRACTURED GNEISS (11.0' - 13.0')
-COMPLETION DEPTH EL. 539'

GEOTECH SB-03
-NG EL. 541'
-TOPSOIL (0' - 1.0')
-ML (1.0' - 11.5')
-GROUNDWATER (15.0')
-SM (11.5' - 26.5')
-ML (26.5' - 28.8')
-COMPLETION DEPTH EL. 512'

NOTE: REFER TO TEST BORING LOG S3-0330 FOR COMPLETE SOIL MATERIAL DESCRIPTION



GEOTECH SB-01
-NG EL. 541'
-TOPSOIL (0' - 0.5')
-CL (0.5' - 11.5')
-GROUNDWATER (16.0')
-SC (11.5' - 30.0')
-COMPLETION DEPTH EL. 512'

NOTE: REFER TO TEST BORING LOG S3-0340 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=):3571'
   HDD PIPE LENGTH (S=):3573'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
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.

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-6.38	TO	ES-6.40	EROSION & SEDIMENT PLAN	
SHEET 22	TO	SHEET 23	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
D	ADDED GEOTECH INFO	MRS	09/29/15	RMB	09/29/15	AAW	09/29/15
C	ISSUED FOR BID	DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15

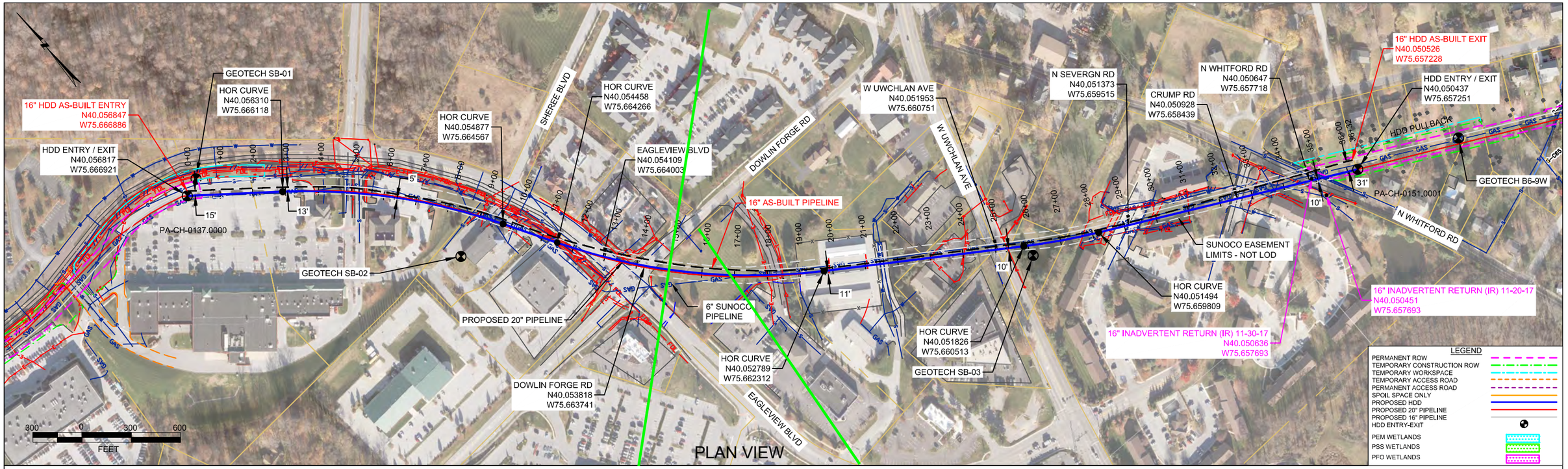
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
EAGLEVIEW BLVD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300' | DWG. NO: PA-CH-0138.0000-RD

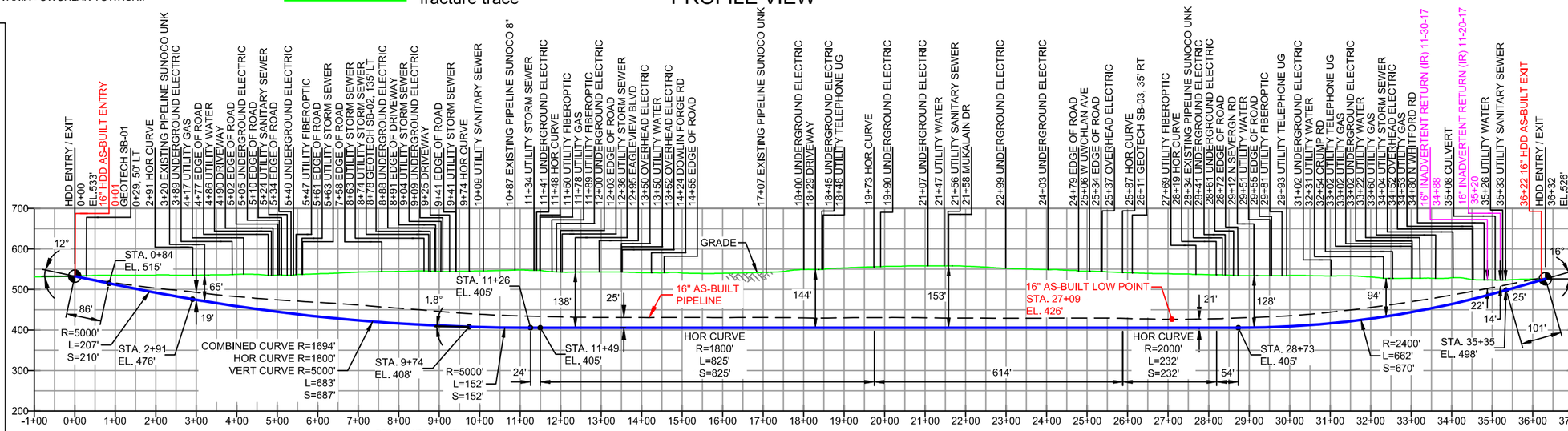


PLAN VIEW

fracture trace

PROFILE VIEW

CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0331



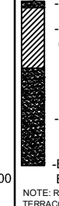
GEOTECH SB-01

GEOTECH SB-02

GEOTECH SB-03

NOTE: REFER TO TEST BORING LOG S3-0330 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-9W



NOTE: REFER TO TEST BORING LOG B6-9W TERRACON PROJECT #J217P078 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=):3632'
   HDD PIPE LENGTH (S=):3655'
   20" x 0.456" W.T., X-65, 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.

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-6.38	TO	ES-6.40	EROSION & SEDIMENT PLAN	
SHEET 22	TO	SHEET 23	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	ADDED B6-9W GEOTECH INFO	MRS	06/24/19	RMB	06/24/19	AMC	06/24/19
EP3	SWITCHED 20" CENTERLINE LOCATION AND INCREASED DEPTH OF DRILL	MRS	04/18/19	RMB	04/18/19	AMC	04/18/19
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
D	ADDED GEOTECH INFO	MRS	09/29/15	RMB	09/29/15	AAW	09/29/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
EAGLEVIEW BLVD
PENNSYLVANIA PIPELINE PROJECT

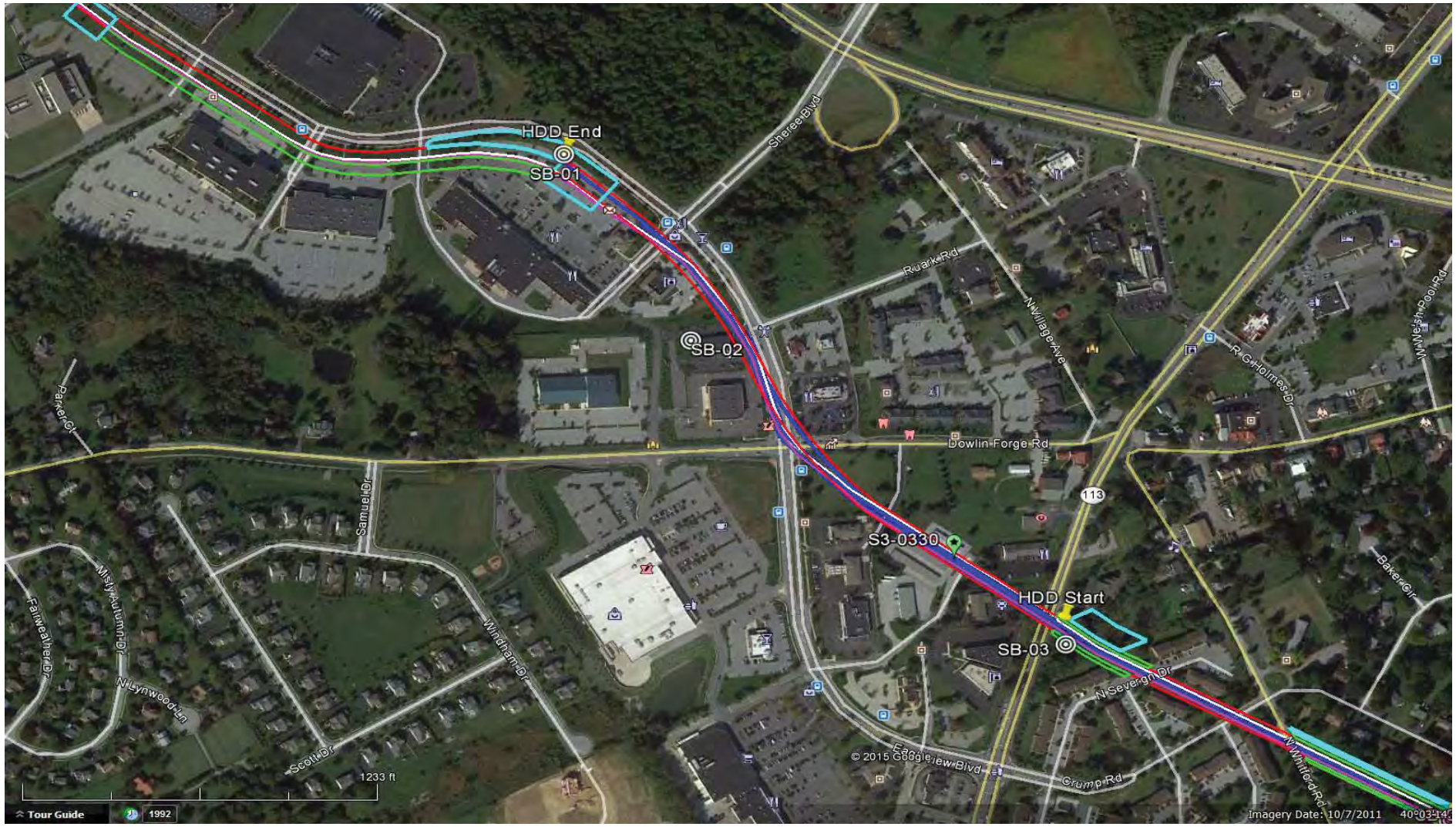
SCALE: 1"=300' | DWG. NO: PA-CH-0138.0000-RD

Attachment B

Geotechnical Reports

Tetra Tech – 2015

Terracon - 2017



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0330
CHESTER COUNTY, UWCHLAN 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:	278 EAGLEVIEW BLVD, EXTON, PA		Page 1 of 1
HDD No.:	S3-0330	Dates(s) Drilled: 05-27-15	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): 16.5
Boring Location Coordinates:		40° 3' 24.749" N	75° 40' 0.214" 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	0.4			TOPSOIL (5")					
1	3.0	5.0	0.4		18		DR WEATHERED TO A BROWN FINE TO MEDIUM SAND WITH SOME	9	11	16	18	**27**
							SILT, TRACE UNWEATHERED FINE GRAVEL.					
2	8.0	10.0			16		VARIEGATED WHITE, LIGHT BROWN, LIGHT GRAY, GRAY F-M SAND,	2	13	25	45	**38**
						SM	SOME SILT,TRACE UNWEATH. F-C GRAVEL. (USCS: SM)					
3	13.0	14.3			13		VARIEGATED WHITE, LIGHT BROWN, LIGHT GRAY, GRAY F-M SAND,	20	40	50/3"		**>50**
							A LITTLE SILT,TRACE UNWEATH. F-C GRAVEL.					
4	16.5	16.5		16.5			NO RECOVERY	50/0"				
							AUGER REFUSAL AT 16.5'. REFUSAL MATERIALS APPEARS TO BE					
							GRAY GNEISS.					

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:	200 EAGLEVIEW BLVD, EXTON, PA (BEHIND CJs TIRE)		Page 1 of 1
HDD No.:	S3-0330	Dates(s) Drilled: 05-28-15	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): 13.0
Boring Location Coordinates:		40° 3' 17.676" N	75° 39' 54.522" 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	0.3			TOPSOIL (4")					
			0.3	3.5		ML	BROWN SILT WITH SOME FINE SAND, TRACE FINE GRAVEL.					
1	3.0	5.0	3.5		16	SM	DR WEATHERED T0 A BROWN, GRAY, WHITE FINE TO MEDIUM SAND	7	14	16	25	**30**
				9.5			WITH A LITTLE SILT (MICACEOUS), TRACE FINE GNEISS GRAVEL.					
2	8.0	9.9	9.5		12	GM/ SM	LIGHT GRAY AND WHITE GNEISS F-C GRAVEL AND FINE TO MEDIUM	5	18	40	50/5"	**58**
				11.0			SAND, TRACE SILT. (PARTIALLY WEATHERED GNEISS).					
							AUGER REFUSAL AT 11'.					
							ROCK CORING					
RUN 1	11.0	13.0	11.0	11.8	24	ROCK	INTENSELY FACTURED LIGHT GRAY GNEISS.	TCR: 100%, SCR: 52%, RQD: 38%				
			11.8	12.4			MODERATELY FRACTURED LIGHT GRAY GNEISS.					
			12.4	13.0			INTENSELY FACTURED LIGHT GRAY GNEISS.					
							ROCK CORE BORING COLLAPSED, COULD NOT ADVANCE					
							ANOTHER ROCK CORE RUN.					
							CORE TESTING RESULTS (RUN 1, DEPTH 12.3'):					
							COMPRESSIVE STRENGTH: 6,660 PSI					
							UNIT WEIGHT: 170.7 PCF					

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:	CH-0146, EXTON, PA		Page 1 of 1
HDD No.:	S3-0330	Dates(s) Drilled: 05-28-15	Inspector: J. COSTELLO
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: GREGG
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 15.0	Total Depth (ft): 28.8
Boring Location Coordinates:		40° 3' 6.180" N	75° 39' 37.819" 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		22	ML	YELLOWISH BROWN WITH LIGHT GRAY NODULES SILT AND FINE	3	5	9	9	**14**
							SAND, TRACE FINE GRAVEL.					
2	8.0	10.0			18		BROWN, WITH WHITE NODULES, SILT AND FINE TO MEDIUM SAND,	1	3	5	8	**8**
				11.5			TRACE FINE GRAVEL. (USCS: ML).					
3	13.0	15.0	11.5		24	SM	DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT,	1	2	10	50/3"	**12**
							TRACE UNWEATHERED FINE GRAVEL. (USCS: SM).					
4	18.0	20.0			14		DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT,	1	14	16	22	**30**
							TRACE FINE GRAVEL.					
5	23.0	24.3			12		DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT,	1	29	50/3"		**>50**
				26.5			WITH A LITTLE FINE GRAVEL.					
6	28.0	28.8	26.5		6	ML	BROWN SILTY CLAY AND FINE SAND, WITH A LITTLE F-C	5	50/3"			**>50**
				28.8			GNEISS GRAVEL.					
							WET ON SPOON AT 15',					
							WATER LEVEL THROUGH AUGERS AT 15'.					
							CAVED AT 21', WATER LEVEL ON CAVE AT 10'.					

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 S3-0330

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S3-0330	SB-01	1	3.0	5.0	11.2	24.8	-	-	-	-
		2	8.0	10.0	13.0	29.6	28	23	5	SM
		3	13.0	14.3	9.7	18.2	-	-	-	-
	SB-02	1	3.0	5.0	5.9	19.3	-	-	-	-
		2	8.0	9.9	1.4	9.3	-	-	-	-
	SB-03	1	3.0	5.0	19.2	61.7	-	-	-	-
		2	8.0	10.0	33.4	63.7	43	29	14	ML
		3	13.0	15.0	17.8	37.7	38	31	7	SM
		4	18.0	20.0	15.2	40.6	-	-	-	-
		6	28.0	28.8	19.3	59.1	39	28	11	ML

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	1	12.3	6,660	170.7

Notes:

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

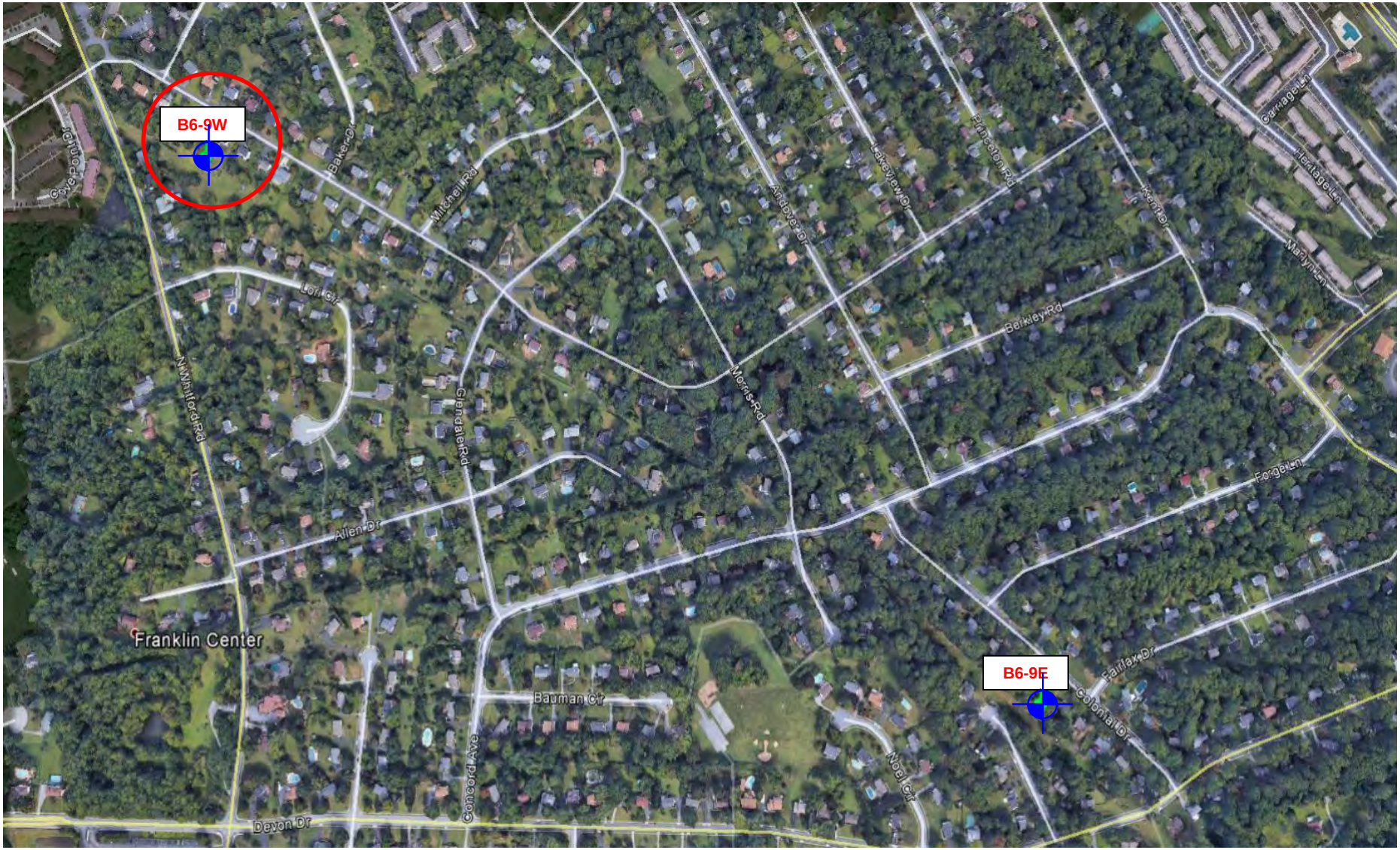
ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0330

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					
S3-330	SB-2	1	11	13	100	52	38	11	13	Slight	Felsic gneiss	Massive	Light gray	Fractures ranging from 0° to 40°, Avg. 17°

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0330

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
S3-0330		SB-01	Felsic and intermediate gneiss - Medium grained, light pink to greenish gray; largely quartz, feldspar, and mica; commonly gneissic, containing alteration minerals; interfingers with gabbroic gneiss.	Generally level	Felsic and intermediate gneiss (PreCambrian)	Felsic gneiss	Unknown	Ranges from 20 to 50 ft bgs, Avg. 40 ft bgs (.5 mile radius)	
		SB-02				Felsic gneiss	Unknown	Ranges from 10 to 65 ft bgs, Avg. 39 ft bgs (.25 mile radius)	
		SB-03				Felsic gneiss	Unknown	Ranges from 10 to 65 ft bgs, Avg. 32 ft bgs (.25 mile radius)	

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.



N

APPROXIMATE BORING LOCATION

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

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

Terracon
Consulting Engineers & Scientists
201 Hammer Mill Road Rocky Hill, Ct 06067
PH. (860) 721-1900 FAX. (860) 721-1939

TEST BORING LOCATION PLAN

Glendale Road/ Concord Ave HDD Cores B6-9W and B6-9E
PA-CH-0167.0000-RD
Chester County, Pennsylvania

Exhibit
A-2

EXPLORATION RESULTS

BORING LOG NO. B6-9W Glendale Road/Concord Ave West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0167.0000-RD
20170818-1
Latitude: 40.050069° Longitude: -75.656206°

Approximate Surface Elev: 519 (Ft.) +/-

DEPTH	ELEVATION (Ft.)
0.3 Gravel	518.5+/-
SANDY LEAN CLAY (CL), trace gravel, brown, very stiff to hard, (completely weathered rock)	
20.0	499+/-
Run 1, Soft to hard, severely to completely weathered, gray to black, medium to coarse-grained, GNEISS	
25.0	494+/-
Run 2, Similar	
30.0	489+/-

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
5		18	6-7-10 N=17			
10		12	18-21-27 N=48			
15		10	32-50/6"			
20		0	50/0"			
		18		7	1 1 3.5 2.5 1.5	
25		26		8	1 1.5 1 3 4	
30						

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-28-2017 | Boring Completed: 08-29-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Clayton J.

Project No.: J217P078 | Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J217P078 - SPREAD 6.GPJ TERRACON_DATATEMPLATE.GDT 10/13/17

BORING LOG NO. B6-9W Glendale Road/Concord Ave West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0167.0000-RD
20170818-1
Latitude: 40.050069° Longitude: -75.656206°
Approximate Surface Elev: 519 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
35.0	484+/-	Run 3, Hard to very hard, slightly weathered to fresh, gray and white banded, medium to coarse-grained, granodiorite GNEISS with numerous quartzite seams, foliation is low angle to moderately dipping, low angle to horizontal primary joints, close to moderately close, smooth to rough, fresh, tight to open	35			60		87	2 4 4.5 3.5 4	
40.0	479+/-	Run 4, Similar, occasional secondary joints along foliation, wide spacing, smooth, planar to slightly undulating, fresh, open to tight	40			60		93	3.5 4 4.5 4.5 4	
45.0	474+/-	Run 5, Similar, quartzite seams with thicknesses varying from 0.2 to 1.6 feet	45			60		97	5 4 4 4 3	
50.0	469+/-	Run 6, Similar	50			59		84	4.5 2.5 3 4 4	
55.0	464+/-	Run 7, Similar	55			60		77	3.5 3.5 4.5 4 4	
60.0	459+/-	Run 8, Similar	60			60		92	4 4 3.5 4 4	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-28-2017 | Boring Completed: 08-29-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Clayton J.

Project No.: J217P078 | Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J217P078 - SPREAD 6.GPJ TERRACON_DATATEMPLATE.GDT 10/13/17

BORING LOG NO. B6-9W Glendale Road/Concord Ave West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0167.0000-RD
20170818-1
Latitude: 40.050069° Longitude: -75.656206°
Approximate Surface Elev: 519 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Run 9, Similar to 62.1 feet, transitions to predominately quartzite from 62.1 to 66.0 feet								
65.0	454+/-	65			60		100	4.5 3 4.5 4 4	
	Run 10, Similar, high angle to vertical joint from 67.2 to 68.9 feet, rough, undulating, fresh, open to tight								
70.0	449+/-	70			55		57	3 4.5 4.5 3 4	
	Run 11, Similar, moderately dipping joints along foliation between 72.7 and 73.3 feet, rough, undulating, fresh, open to tight								
75.0	444+/-	75			60		83	3 3 3.5 3 3	
	Run 12, Similar, no moderately dipping or high angle joints encountered								
80.0	439+/-	80			60		100	3 3 4 4 4.5	
	Boring Terminated at 80 Feet								

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-28-2017 | Boring Completed: 08-29-2017

Drill Rig: Diedrich D-50 | Driller: Terracon/Clayton J.

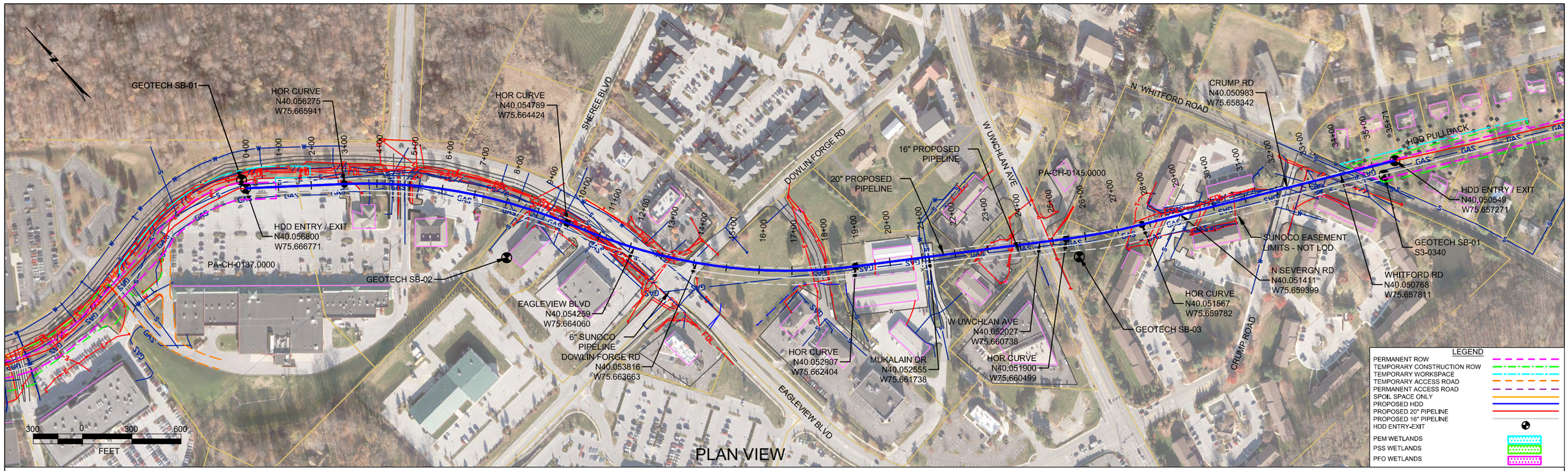
Project No.: J217P078 | Exhibit: A-1

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J217P078 - SPREAD 6.GPJ TERRACON_DATATEMPLATE.GDT 10/13/17

EAGLEVIEW BOULEVARD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0138.0000-RD
(SPLP HDD No. S3-0331)

ATTACHMENT 2

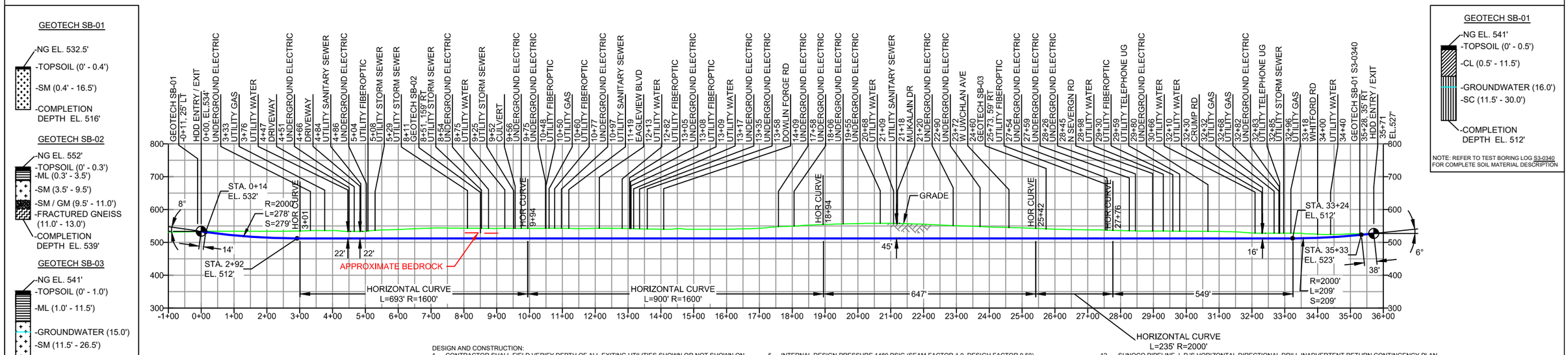
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0331

PROFILE VIEW



DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING 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=):3571'
   HDD PIPE LENGTH (S=):3573'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
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. Original 20-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-6.38	TO	ES-6.40	EROSION & SEDIMENT PLAN	
SHEET 22	TO	SHEET 23	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
D	ADDED GEOTECH INFO	MRS	09/29/15	RMB	09/29/15	AAW	09/29/15
C	ISSUED FOR BID	DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15

Sunoco Logistics Partners L.P.

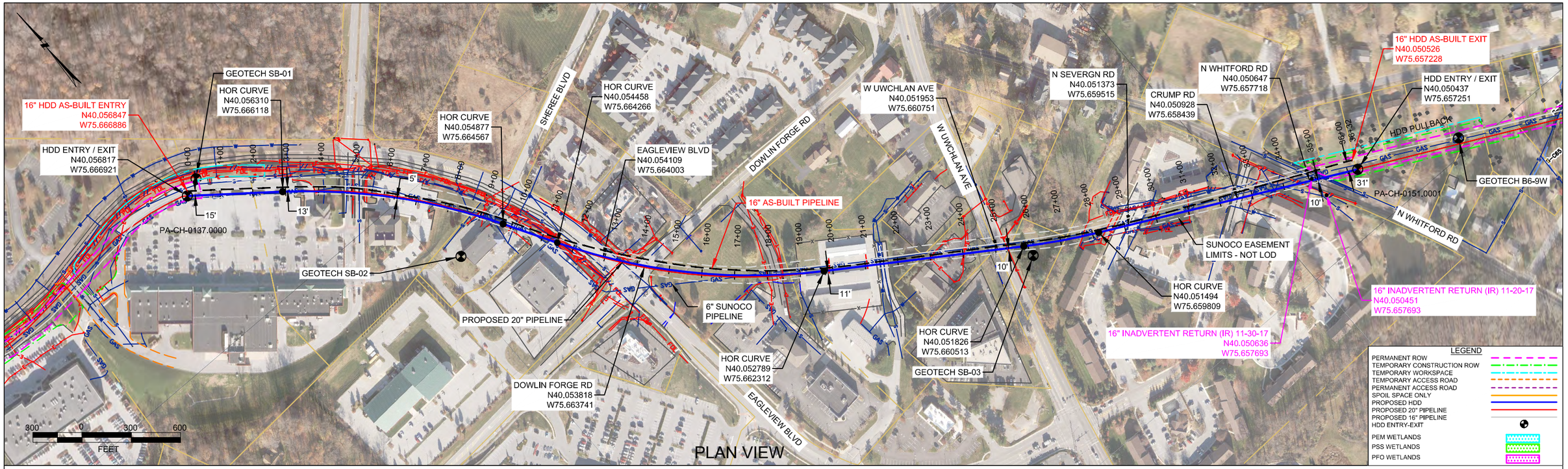
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
EAGLEVIEW BLVD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

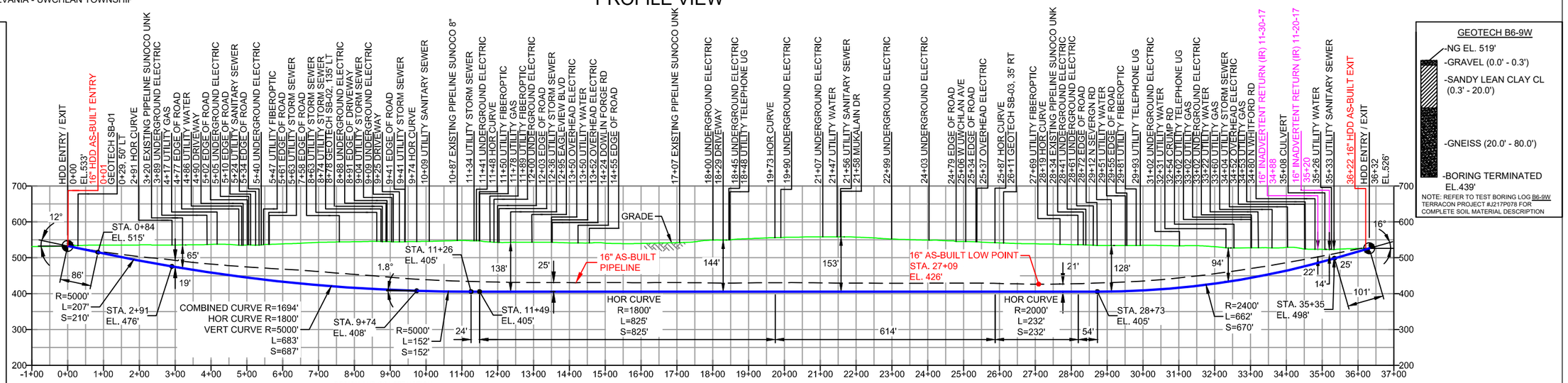
DWG. NO: PA-CH-0138.0000-RD



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-0331

PROFILE VIEW



GEOTECH SB-01

GEOTECH SB-02

GEOTECH SB-03

NOTE: REFER TO TEST BORING LOG S3-0330 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-9W

NOTE: REFER TO TEST BORING LOG B6-9W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
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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=):3632'
   HDD PIPE LENGTH (S=):3655'
   20" x 0.456" W.T., X-65, 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.

Figure 2. Revised 20-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-6.38	TO	ES-6.40	EROSION & SEDIMENT PLAN	
SHEET 22	TO	SHEET 23	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	ADDED B6-9W GEOTECH INFO	MRS	06/24/19	RMB	06/24/19	AMC	06/24/19
EP3	SWITCHED 20" CENTERLINE LOCATION AND INCREASED DEPTH OF DRILL	MRS	04/18/19	RMB	04/18/19	AMC	04/18/19
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
EP		MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
D	ADDED GEOTECH INFO	MRS	09/29/15	RMB	09/29/15	AAW	09/29/15

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SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
EAGLEVIEW BLVD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300' | DWG. NO: PA-CH-0138.0000-RD