SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, 19608

January 2, 2018

Mr. Domenic Rocco, P.E.
Regional Manager; Waterways and Wetlands
Pennsylvania Department of Environmental Protection
2 East Main Street
Norristown, Pennsylvania 19401

Response to DADEP Comments and Data Request
Updated Horizontal Directional Drill Analysis
Arch Bishop/South Chester Road Crossing (S3-0541)
PADEP Permit Nos.: E15-862 and E23-524
Westtown and Edgemont Townships; Chester and Delaware Counties, PA

Dear Mr. Rocco:

Sunoco Pipeline, L.P. (SPLP) provides the attached revised and updated version of the Horizontal Directional Drill Analysis for HDD No. S3-0541, as referenced above, in response to your letter of December 22, 2017, which commented on SPLP's original horizontal directional drill (HDD) re-evaluation.

Additional information regarding the verified presence of private water supplies, SPLP's analysis of risk to these supplies, and continued actions to protect these resources has been updated.

Supplemental information to further explain the potential for and handling of produced groundwater and actions to prevent inadvertent returns is included.

SPLP appreciates your continued time and effort to review this information. With the submittal of this information, we request that DEP approves the plans for the crossing of Arch Bishop and South Chester Roads (HDD No. S3-0541) as soon as possible.

Sincerely,

Matthew Gordon
Project Director

HORIZONTAL DIRECTIONAL DRILL ANALYSIS
ARCH BISHOP/SOUTH CHESTER ROAD CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0421.0000-RD & PA-CH-0421.0000-RD-16
(SPLP HDD No. S3-0541)

ARCH BISHOP/SOUTH CHESTER ROAD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0421.0000-RD & PA-CH-0421.0000-RD-16
(SPLP HDD No. S3-0541)

This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch and 20-inch diameter pipeline parallel to South Chester Road has been completed in accordance with Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 2 of the Stipulated Order. This HDD is number 19 on the list of HDDs included on Exhibit 2. This HDD was not initiated before the issuance of the Order.

PIPE INFORMATION

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

- Horizontal length: 6,346 foot (ft)
- Entry/Exit angle: 10-12 degrees
- Maximum Depth of cover: 176 ft
- Pipe design radius: 2,000 ft

ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 6,312 ft
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 170 ft
- Pipe design radius: 1,600 ft

These HDDs are planned as “intercept drills”. An intercept drill utilizes a drilling rig on each end of the HDD, drilling the pilot hole towards an “intercept point” near the middle of the planned profile. Once the two pilot holes meet up and are joined together, then one drilling rig chases the other rig’s drilling stem string out to maintain drilling stem within the pilot hole for the entire length of the profile. Reaming of the profile is completed by one drilling rig alone, typically pulling the reaming tool through the profile. The reasoning for establishing this HDD as an “intercept” drill is due to the “compound” nature of the of the profile design required to follow the Sunoco easement. In this instance, each HDD rig is required to both steer the pilot tool down to horizontal depth and steer left or right as required to stay within the easement limits. Use of two rigs during the pilot phase reduces the steering complications to complete the pilot hole.

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

This HDD is located within the Piedmont Uplands Section of the Piedmont Physiographic Province in southeastern Pennsylvania. The Piedmont Uplands Section is characterized by broad, rounded to flat-topped hills and shallow valleys with low to moderate topographic relief. The geologic structure of this section is complexly folded and faulted. Bedrock in the area of HDD S3-0541 is comprised of crystalline, Precambrian-aged weathered Baltimore Gneiss having quartzofeldspathic granulite facies and undifferentiated amphibolite facies. Regional fabric (relict bedding and structure) trends are to the northeast.

Karst geology is not present at this HDD location; therefore, the use of geophysics assessments was considered but not conducted because the results from these types of assessments would provide no data to assist in the redesign of these HDDs.

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

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

The Baltimore gneiss unit mapped beneath the HDD S3-0541 location is identified as a unit of poor groundwater production. A limited network of fractures with small apertures generally provides the secondary porosity needed to support low groundwater discharges from this rock formation. Based upon the well information reported to the Pennsylvania Groundwater Information System (PAGWIS), well depths vary from 70 to 300 ft below ground surface (bgs). Median well yields for this geologic setting are reported as variable but generally less than 10 gpm (Geyer and Wilshusen, 1982). Domestic well yields as reported by PAGWIS range from 1 to 40 gpm. The reported static water level in these wells varies from 15-60 ft bgs. The production zone for water wells within rock formations is from the well bottom to highest point of water inflow from the water bearing seams, joints, and fractures in the rock formation.

Due to the topographic rise and higher ground elevation near the middle of these HDD profiles, there is the potential for groundwater at the higher elevation to flow back through the pilot hole towards the entry points. As stated in the hydrogeology report, this difference in elevation is not extreme; therefore, the gentle hydraulic gradient and the potential water volumes are not anticipated to be significant, and will not adversely affect water table levels or require enhanced groundwater flow back management techniques. Water produced in both the pilot and reaming phases will be utilized in the HDD process, which reduces the amount of water imported to complete the HDD. If water flow at the exit points of the HDD persists post installation of the pipeline, then grout will be injected into the annulus space surrounding the pipe to seal and stop water flows.

Attachment 1 provides an extensive discussion on the geology, 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 HDD designs summarized above, and determined that that the design profiles for the 16 and 20-inch HDDs have no apparent faults given the setting and nature of the geologic strata. The single feature of concern from this HDD review is the shallow depth of passage under Highway 926 at the southeast end of the HDD, and revisions to the HDD profiles have been recommended to increase the depths below the roadway.

Based on recent experiences with HDDs in the same geology, the gneiss geology in this area of the project at profile depth is a porous yet hard substrate that tends towards a detectable loss of fluids during the pilot phase but is resistant to IR's where depth of cover is sufficient. IR's during the pilot phase have occurred at some nearby HDD's and not at others. IRs during entry of the pilot tool can be minimized by rotation drilling of the cutting head until good bedrock is entered, rather than use of the mud motor. Rotation drilling requires substantially less fluid pressures and is suitable for loose overburden and weathered rock. During the pilot phase while drilling in bedrock, the loss of fluids can be typically managed by the injection of loss control materials, or grouting. During the reaming phase, the maintenance of full returns back to the HDD entry points has not been problematic.

Two recent geotechnical cores at each end of the HDD reveal that the designed horizontal profile is below and within bedrock with recovery percentages varying from 30-60%, with RQD values of 60-80. These test results are indicative of bedrock having fair to good integrity and good to very good strength.

ADJACENT FEATURES ANALYSIS

This HDD location is 4.4 miles east of the city of West Chester in Chester and Delaware Counties, Pennsylvania. The pipeline alignments follow parallel to South Chester Road and cross under Highway 926 between Paoli Pike Road and East Boot Road, and will co-join other gas utilities lines along the roadway.

This HDD location is set within urban residential developments for the majority of its length as it proceeds parallel to South Chester Road. The HDD crosses under stream S-B35 which is not a high quality or exceptional value resource.

SPLP has identified all landowners with property located within 450 ft of the HDD alignment. There are two hundred-seventeen (217) individual landowners with properties located within 450 ft of the HDD alignment. SPLP sent each of these landowners a notice letter via both certified and first-class mail on October 30, 2017, that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the Right-of-Way agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office.

As of December 21, 2017, SPLP has received forty-two (42) responses from individual landowners. Of these, forty-one (41) have confirmed the use of a private water well, and the remaining landowner response verified the use of public water supply. All forty-one wells have been sampled for establishment of background water quality parameters. Thirty-two (32) of these respondents are within 450 ft of the HDD profiles. SPLP assumes that additional landowner water supply information will continue to be acquired prior to the initiation of these HDDs and throughout the drilling process. Attachment 2 presents a graphic view of the currently identified well locations in relation to the HDD profiles.

Based upon the understanding of the groundwater levels and movement through the overburden and subsurface bedrock fractures and fissures as described in the hydrogeology report, SPLP believes that HDD activities could affect individual well use during active drilling for wells located within 150 linear ft. The yield and quality of these wells is governed by their depth, construction and location within to the geologic structural horizon (porosity, fissures, and fractures) from where they draw groundwater. The HDD is an active "pressure event" in the aquifer that pushes upon the static ground water and at minimum could agitate settled sediments within the water bearing zones, or could result in transport of diluted drilling fluids towards the withdrawn zone for individual wells. As a result, active well use during HDD activities potentially could result in the uptake of turbid water. While this does not present a health hazard, it can be unsightly to users and could affect taste.

SPLP will engage in a second and final effort to encourage landowners to make advance arrangements for the supply of alternative water sources as necessary during the HDDs. Agents for SPLP will initiate direct contact by phone or in person, and SPLP will prepare a second communication specifically directed to all landowners with known wells, or unidentified water supplies within 150 ft of the HDD profiles. The letter will communicate our analysis regarding their water supply. It will clearly state the preference to

establishing communications in advance of the work; permission to perform monitoring during the HDDs, and landowners' preference to installing alternative water in advance of the HDDs.

During the active HDD process, any landowner contacting SPLP with concerns about their water supply will be responded to. If an impact from the HDD is verified, then SPLP will encourage the affected landowner to allow the installation of alternative water supply.

In accordance with the requirements of the Stipulated Order, SPLP has transmitted 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 S3-0541 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 (PADOT) cover requirements under public roadways is 60-inches of cover.

While an open cut installation of the pipeline is possible, the logistics associated with this method would significantly increase the length of time the affected properties would be subject to construction disturbance. To minimize impact to the public users of the primary and intersecting roadways, open cut construction would require obtaining a permit from PADOT to undertake night-time construction with a lane closure while "stove piping" the new pipeline installations. Under this construction scenario the pipeline construction proceeds in 80-170 ft segments; a trench is cut, pipe segments held in place and welded to the preceding segment end; the weld is inspected and approved and coated and then backfilled to within 20-30 ft of the segment end. Only 1 to 2 segments of pipe could be completed per night due to the time requirements to complete each welding and coating procedure to specification. Steel plates are laid over the backfilled segments and minimally permitted open end before the stop of construction to allow for daytime roadway use. This sequence of construction events is repeated until the entire lay segment is completed.

There are two minor stream crossings within the HDD profiles, neither of which are high quality or exceptional value. Open cut impacts to these resources would be minimal, but would require modification of the state and federal permits. Moreover, any produced groundwater in the open excavations would be pumped to a discharge filtration structure. The current feasible filtration ability, however, does not exceed 50 microns. Therefore, cloudy water (from suspended fine clay and silt particles) would be discharged

downstream regardless of all control methods employed for the entire duration of the use of open cut construction techniques.

As a construction method alternative, 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 at the location of these HDDs, there are no subset locations within this length of area to feasibly employ this type of installation method.

Re-Route Analysis

The pipeline route as currently permitted follows an existing SPLP easement under the public right-of-way of South Chester Road through urban development east-northeast of the City of West Goshen. This alignment bypasses or avoids directly impacting South Chester Road, seven (7) intersecting public roads, and thirty-seven intersecting (37) private driveways.

The general route of the Mariner II project in this area of the state is from northwest to the southeast.

Approximately 1.1 mile east, an existing pipeline utility corridor parallels the route of the Mariner II project, generally at a 1.0 to 1.5-mile offset. Use of this corridor as an alternative route to the replace the HDD proposed for this crossing would require deviating from the current route and proceeding east parallel to West Chester Pike to intersect the alternate utility corridor. Residential and commercial developments line both sides of the roadway and the general area offset from either side of the road, and these developments would be impacted under this alternative route. Furthermore, once the alternate corridor is accessed, the Mariner pipeline would need to be aligned to the outside, northeast or southwest, of the three existing pipelines. Although this alignment would not create a new corridor, the addition of two new pipelines to this corridor would significantly expand the area of pipeline use within the corridor. This corridor passes through numerous developments and there is significant encroachment on the easement edge by home sites and developments. Lastly, the alternate route would need to deviate and return to the continued direction of the existing Mariner II route because the alternate corridor proceeds to a different endpoint.

There are no existing utility corridors to the southwest that provide a practical alternative route. Any alternate route considered to the southwest would require the clearing of a new “greenfield” corridor through existing woodlands and croplands, increase the number of stream crossings, and possibly encroach on additional private residences before it could rejoin the current route.

Finally, the current route utilizes existing easements that were utilized for pipelines at the time development surrounding the existing pipeline commenced. Accordingly, development surrounding the existing easement took place with the knowledge of existing pipelines and a permanent encumbrance on the land. By contrast, using a “greenfield” corridor outside of the existing developments in any direction away from the existing easement would require additional landowners to accept the establishment of a new encumbrance for pipeline use that did not exist at the time of acquisition. 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. In summary, due to the urban setting surrounding the overall route of the Mariner II pipelines in this area, there is no alternative route that could avoid conflicts with existing developments.

This re-route analysis conducted for the South Chester Road HDD confirms the conclusions reached in the previously submitted alternatives analysis.

ARCH BISHOP/SOUTH CHESTER ROAD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0421.0000-RD & PA-CH-0421.0000-RD-16
(SPLP HDD No. S3-0541)

RECONSIDERATION OF THE HORIZONTAL DIRECTIONAL DRILL

HDD specialists and geologists employed by SPLP have investigated the HDD design and subsurface geologic conditions and concluded that the original HDD design for the 16 and 20 inch pipelines, as summarized in the introduction, have a minimal risk of inadvertent returns (IRs) if implemented. Minor adjustments to the profile design were made to increase the depth of cover at the crossing of Highway 926.

Upon the start of these HDDs, SPLP will employ the following site-specific HDD best management practices:

- These HDDs, in the pilot phase, will be performed as an “intercept drill” (two drills operating toward each other) which reduces the annulus pressure requirements from using a single drill to maintain return flows of drill cuttings and drilling mud to the point of entry and reduces the chances of IRs;

- SPLP will mandate rotational drilling of the pilot hole until competent bedrock is reached, such that the initial drilling at entry is performed at fluid pressures less than those required to operate the mud motor;

- 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, managing development 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;

- The HDD entry point southeast of Highway 926 will have the pilot hole cased to control drilling returns during drilling of the pilot hole and reaming phases;

- SPLP will mandate short-tripping of the reaming tools, as monitoring indicates is needed, 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;

- If LCMs prove ineffective to mitigate loss of returns or IRs, then grouting at those areas and re-drilling of the pilot hole may be implemented; and

- During the reaming phase, the use of Loss Control Materials can be implemented if indications of a potential IR are noted or an IR is observed.

CONCLUSION

Other than the implementation of the above described drilling practices and procedures, no significant changes to the HDD plans for the pipelines at this location are recommended or planned.

As there were no major alterations of these HDD designs, the final designs are attached as Figures 1 A & B, and Figures 2 A & B in Attachment 3.

ARCH BISHOP/SOUTH CHESTER ROAD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0421.0000-RD & PA-CH-0421.0000-RD-16
(SPLP HDD No. S3-0541)

ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

HDD HYDROGEOLOGIC REEVALUATION REPORT (Rev. 1)

Mariner East II
Spread 6
HDD S3-0541
Arch Bishop/South Chester Road
Westtown/Edgemont Townships, Chester/Delaware Counties, Pennsylvania

Prepared for:

Sunoco Pipeline, L.P.

Prepared by:

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

December 2017

HDD HYDROGEOLOGIC REEVALUTION REPORT (Rev. 1)

Mariner East II
Spread 6
HDD S3-0541
Westtown/Edgemont Townships, Chester/Delaware County, Pennsylvania

December 2017

Prepared for:

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

Prepared by:

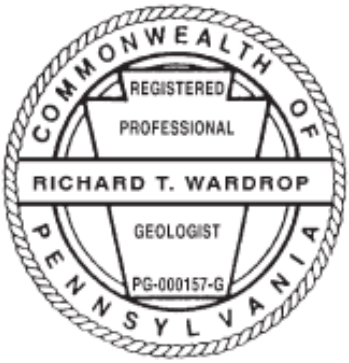
Samuel Baughman, P.G.
Senior Hydrogeologist

Reviewed by:

David J. Demko, P.G.
VP, Principal Hydrogeologist

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 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.



December 29, 2017

Richard T. Wardrop, P. G. date

Lic. No. PG000157G

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ATTACHMENTS

1.0 INTRODUCTION

Sunoco Pipeline, L.P., (SPLP) retained Groundwater & Environmental Services, Inc. (GES) to prepare HDD Hydrogeologic Reevaluation Reports for horizontal directional drills (HDDs) listed on Exhibit 2 of Stipulated Order EHB Docket No. 2017-009-L signed August 10, 2017. This report discusses the hydrogeologic reevaluation for HDD S3-0541, the 20-inch line, and HDD S3-0541-16 the 16-inch line, hereinafter referred collectively to as HDD S3-0541. HDD S3-0541 is aligned adjacent to South Chester Road in Westtown and Edgemont Townships, Chester and Delaware Counties, PA. A map depicting the location of the HDD with topographic information for the surrounding area is presented as **Figure 1**. The original profiles, revised May 10, 2016, were developed by Tetra Tech Rooney (Tetra Tech) and were presented in the risk assessment for HDD S3-0541, in the IR PPC Plan for Chester County. Proposed revisions to the profiles, revised November 27, 2017, were also developed by Tetra Tech and are considered in this reevaluation, as well. Both sets of profiles are provided in **Attachment A**. The elevation of the lowest, horizontal sections of the HDDs is shown 30 feet deeper for the 20-inch pipe and 5 feet deeper for the 16-inch pipe. Otherwise, both sets of revised profiles are similar between the 20-inch and the 16-inch borings therefore all references to distance and elevation hereinafter are referencing information associated with the 20-inch HDD. The revised profile has the same origin as the original profile with Station 0+00 at the northwest entry exit. The revised profile shows the southeastern entry/exit extended 164 feet southwest. The entrance angle for the revised boring on the northwest entry/exit is 6 degrees greater, and there the vertical curve radii was increased from 2,000 to 2,200 feet to provide more steering flexibility. The revised profile is up to 34 feet deeper than on the original profile in the first 700 feet of the northwestern part of the profile (Station 0+00 to 7+00) and is 30 feet deeper along the horizontal section, moving southeast from Station 7+00 to the southeast entry/exit at Station 63+46 on the original profile. These HDDs drills are designated as an "intercept drill" indicating that pilot advancement will occur at both the entry/exit locations of the drill profiles and the borings will intercept each other.

The contents of this report were developed from interpretation of published information, field observations, and related field studies. Site geotechnical boring programs were conducted by Tetra Tech in 2015 and by Terracon Consultants, Inc. (Terracon), in August and September 2017 in support of the HDD S3-0541 reevaluation. Please note that GES did not oversee or direct the geotechnical drilling programs, 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 two SPLP 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 from USGS, 1:24,000, West Chester topo. quad., rev. 1975)

2.0 HDD GEOLOGY / HYDROGEOLOGY

2.1 Physiography

HDD S3-0541 is located within the Piedmont Uplands Section of the Piedmont Physiographic Province in southeastern Pennsylvania. The Piedmont Uplands Section is characterized by broad, rounded to flat-topped hills and shallow valleys with low to moderate topographic relief. The geologic structure of this section is complexly folded and faulted.

2.1.1 Topography

The topography in the area of HDD is quite flat with the ground surface elevation at the northwestern entry point identified as 401 feet above mean sea level (ft amsl) and the exit point 6,346 feet to the southeast at an elevation of 360 ft amsl, on the original profile. The profile shows a rise between these points with an elevation of approximately 469 ft amsl. The area surrounding the HDD is comprised of residential communities throughout the alignment and commercial properties to the northwest. Agricultural land is located east of South Chester Road between West Lynn Drive and Street Road. The site location is depicted on **Figure 1**.

2.1.2 Hydrology

The nearest surface water bodies to the HDD location are tributaries East Branch Chester Creek, located approximately 1,000 feet to the west and flowing west and Hunters Run, located approximately 1,200 feet to the east and flowing northeast. Additional small ponds and related ephemeral streams are located in residential areas approximately 1,000 feet or more south of the HDD S3-0541 location. The lowest surface elevation along the drill is at a tributary stream (S-B35), crossing the boring at Station 57+41.

2.2 Geology

Bedrock in the area of HDD S3-0541 is comprised of crystalline, Precambrian-aged weathered Baltimore Gneiss – quartzofeldspathic granulite facies and undifferentiated amphibolite facies. Regional fabric (relict bedding and structure) trends are to the northeast as depicted in the geologic map below (Blackmer, 2005). **Figure 2** is a scaled map depicting site bedrock geology.

Information provided on drilling logs for eight (8) geotechnical borings was used in the development of this hydrogeologic reevaluation report (**Attachment B**). Please note that GES did not oversee or direct the geotechnical drilling programs associated with the HDD S3-0541, 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 core photographs that resulted from these programs were generated by other Sunoco Pipeline, L.P. contractors. GES relied on these reports and incorporated their data into the general geologic and hydrogeologic framework for this hydrogeologic reevaluation report.

Three (3) geotechnical borings placed along the northwestern portion of the HDD S3-0541 alignment were advanced to auger refusal depths ranging from 18.5 to 32 feet. Three (3) geotechnical borings placed along the southeastern portion of the HDD S3-0541 alignment were advanced to auger refusal depths ranging from 30 to 68.5 feet. Two (2) recent geotechnical borings were also placed proximal to the northwestern and southeastern entry/exit points (B6-1W and B6-1E), and had auger refusal depths of 22 feet and 40 feet below ground surface (bgs), respectively. Based on the geotechnical boring data, overburden in the area of HDD S3-0541 can range in thickness from 18.5 to 68.5 ft bgs. This material is primarily composed of weathered in-situ gneiss bedrock and has been logged according to USCS methods as SM (silty sands and sand/silt mixtures).

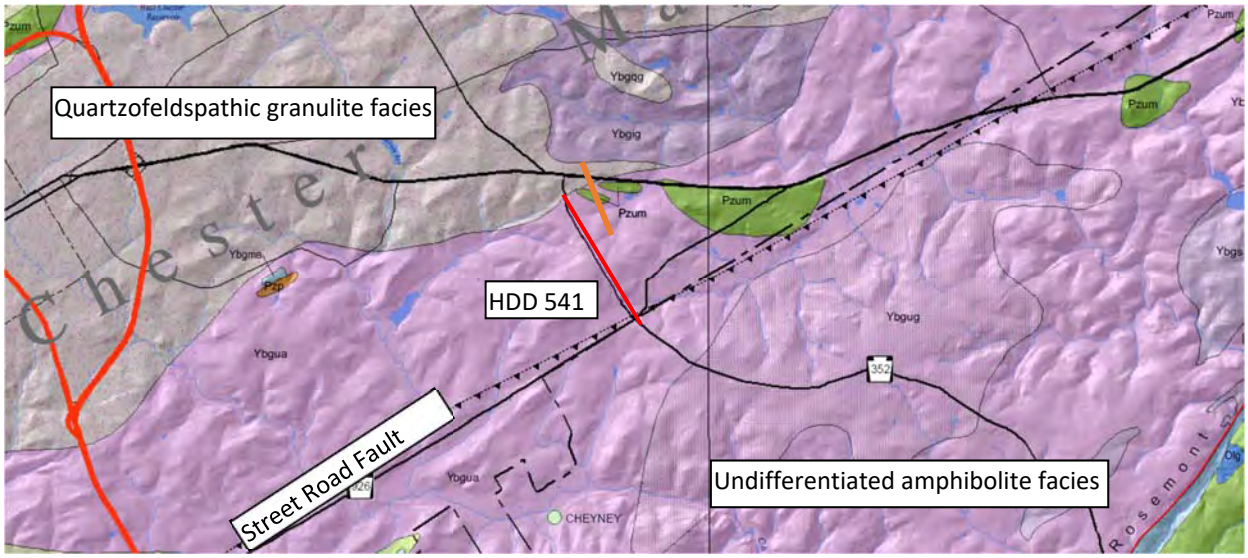


Figure 2. Regional Geologic Map (modified from Blackmer, 2005)

2.2.1 Soils

Soils across the profile are comprised of loam, silt loam, gravelly silt loam, and urban land (USDA NRCS). Southeastern and northwestern entry/exit points are likely to encounter bedrock at an approximate depth of 20 feet below grade. The soil horizon across the central area of the profile are likely to encounter bedrock at an approximate depth of 20 to 40 feet below grade.

2.2.2 Bedrock Lithology

As noted, the HDD S3-0541 bore lies in an area of the Piedmont Uplands Section of the Piedmont physiographic province of Pennsylvania. Mapped as Pre-Cambrian Baltimore Gneiss – quartzofeldspathic granulite facies and undifferentiated amphibolite facies. As stated by Blackmer (2005):

"Quartz-plagioclase-potassium feldspar-orthopyroxene-clinopyroxene-garnet-biotite gneiss."

"Heterogeneous felsic, intermediate, and mafic amphibolite facies gneiss. Predominant lithology is intermediate plagioclase-hornblende-quartz-biotite gneiss with local orthopyroxene, clinopyroxene, potassium feldspar, and garnet. Swirling magmatic leucosome and biotite-rich restite layers are common. Felsic gneiss consists of quartz, plagioclase, microcline, and biotite with local muscovite and garnet. Mafic gneiss hornblende-plagioclase-quartz amphibolite with garnet and subordinate biotite."

These rocks are metamorphosed crystalline units of unknown thickness and limited primary porosity.

2.2.3 Structure

As shown in the regional geologic map compiled by Blackmer (2005), the amphibolite gneiss is bisected by the Street Road Thrust Fault at the southern end of HDD S3-0541 that is oriented northeast-southwest. HDD S3-0541 also lies within the West Chester Massif to the north and the Avondale Anticline to the south. Gross structural trends for the HDD S3-0541 location include folding, faulting, and foliation patterns striking northeast to nearly east-west with additional nearly orthogonal (nearly north-south) brittle features interspersed. These regional features are mapped within close proximity (i.e., one mile) of HDD S3-0541. A fracture trace study completed via analysis of stereo air photo pairs is shown below as **Figure 3** and demonstrates these regional patterns and relationships. The primary lineament trends are approximately N10°E, N80°W, and N45°E.

As shown on **Figure 2**, the Street Road fault, extends along the West Chester Massif and the Avondale Anticline intersecting the HDD near the southeastern entry/exit point at approximately 90 degrees. In the vicinity of this thrust fault, the mid-Proterozoic gneiss becomes mylonitic. The fault is not a single plane but a zone of smaller, southeast dipping planes that may represent a planar zone of enhanced secondary porosity, permitting fluids to flow more easily and farther along these planes than other discontinuities.

2.2.4 Fracture Trace Analysis

Fracture trace analysis of 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) are the surficial expression on natural landscapes of 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 that was performed for HDD S3-0541. This mapping was performed on aerial stereographic pairs flown in the September 18, 1937. As such, much of the land surface appears undeveloped therefore; fracture traces are more easily seen. The path of the drill is shown in red on **Figure 3** and transects six of the mapped fracture traces. Theses intersections with the drill path indicate potential vertical zones of weakness in the bedrock.

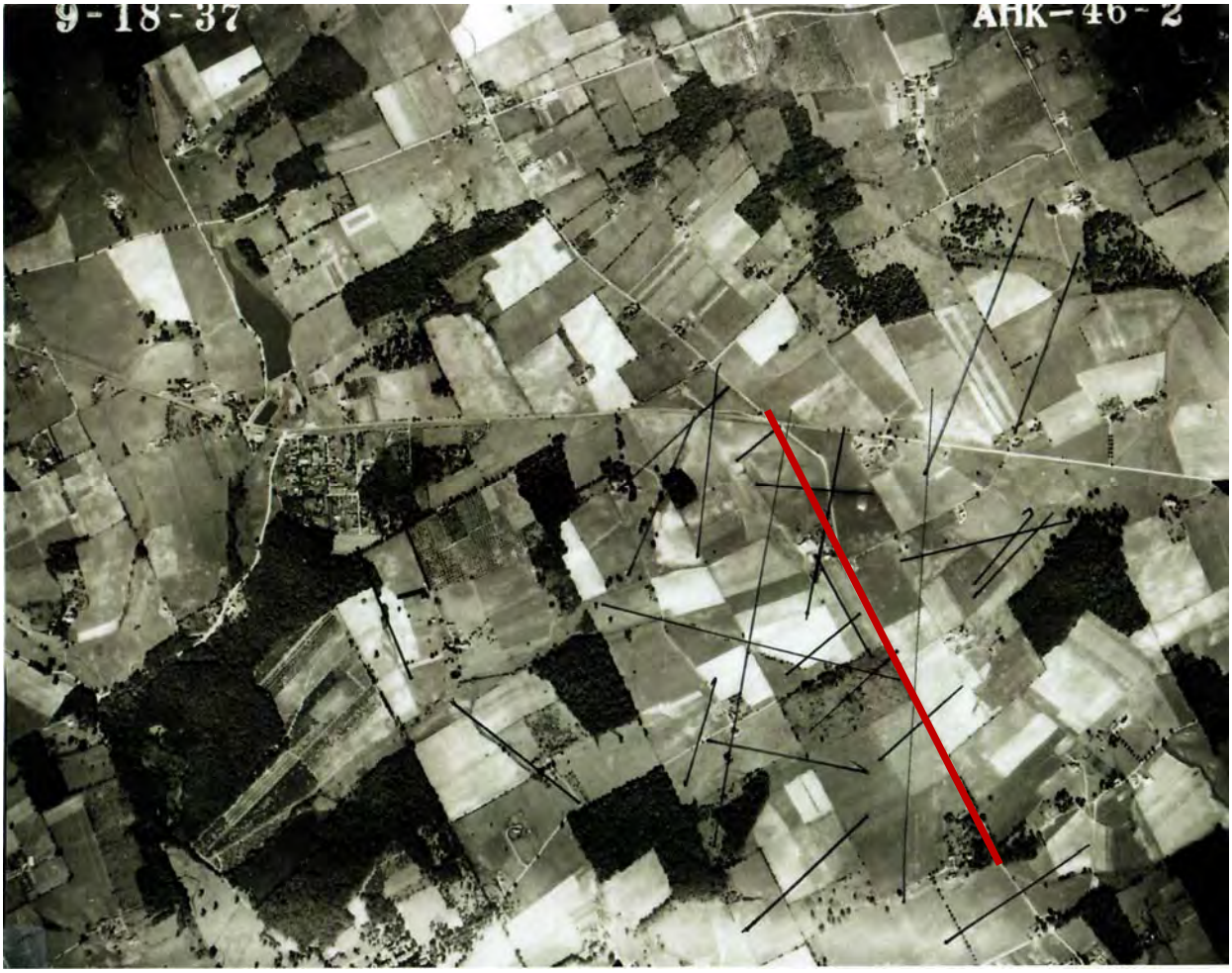


Figure 3. Fracture Trace Analysis (HDD S3-0541 approximate location shown as red line)

2.2.5 Karst

The alignment of HDD S3-0541 is underlain by the Baltimore Gneiss, a metamorphic rock, non-carbonate rock formation. Therefore, karst features are not found in the vicinity of HDD S3-0541.

2.2.6 Mining

No mining was identified within on mile of the HDD S3-0541 location.

2.2.7 Rock Engineering Properties

Granitic Gneiss (Baltimore Gneiss) rock engineering properties are provided in Geyer and Wilshusen (1982) and listed, as follows:

- Bedding – none.
- Fractures/Joints have a blocky pattern and are moderately developed. They are further described as moderately, abundant widely spaced, and moderately dipping.
- Surface drainage is good.
- Joints provide a very low secondary porosity and low permeability. Median well yields are up to 10 gallons per minute (gpm).
- Drilling rate is slow.

2.2.8 Results of Geotechnical Borings

As discussed in **Section 2.2**, drilling logs from eight geotechnical borings indicate weathered gneiss bedrock with a silty sand texture occurs at the surface in the area of HDD S3-0541 at a thickness ranging from 18.5 to 68.5 feet. Two (2) of the original set of geotechnical borings (SB-02 and SB-04) were advanced into bedrock by coring a maximum of 10 feet. The Rock Quality Determinations (RQDs) for these cores were low, ranging from 0 to 11%, as expected that close to the horizon of auger refusal. Rock cores were advanced to much deeper depths in the two more recent geotechnical borings (B6-1W and B6-1E). Bedrock in both borings was highly fractured with poor RQD values to a depth of about 55 ft bgs. Below that depth, RQDs averaged 63% but varied widely, ranging from 11 to 88 %, and displayed no trend with depth.

2.3 Hydrogeology

2.3.1 Occurrence of Groundwater

The Baltimore gneiss unit mapped beneath the HDD S3-0541 location is identified as a unit of poor groundwater production. A limited network of fractures with small apertures generally provides the secondary porosity needed to support low groundwater discharges from this rock formation.

2.3.2 Ground Elevation between HDD entry/exits

The topography in the area of HDD is relatively flat with the ground surface elevation at the northwestern entry/exit point identified as 403 ft amsl and the entry/exit point, 6,510 feet to the southeast at an elevation of 367 ft amsl on the revised plan and profile. The profile shows a rise between these points with an elevation of approximately 469 ft amsl, peaking at Station 35+50, moving southeast from Station 0+00 at the northwest entry/exit. The lowest surface elevation along the drill is at stream S-B35 at approximate 352 ft amsl,

2.3.3 Groundwater Levels

Groundwater was encountered at boring B6-1E near the southeast entry/exit points at a depth of 32.2 feet or approximately 328 ft amsl. Boring B6-1W was dry to it total depth of 158.3 feet at an approximate elevation of 323 ft amsl. Groundwater was encountered in the original borings farther from the entry/exit points.

Tetra Tech's revised profile sheets (**Attachment A**) indicate depths to groundwater of 18 and 39 ft bgs and groundwater elevations ranging between approximately 351 to 425 ft amsl across the HDD. Borings near the northwest entry/exit point had a groundwater elevation of approximately 351 ft amsl and near the central portion of the HDD at 404 ft amsl, near the peak of the topographic high (see **Attachments A** and **B**). These elevations generally reflect a water table surface that is a subdued reflection of topography.

Using the existing water level information, the difference in groundwater elevation between the borings near the entry/exit points is approximately 23 feet. The difference in surface elevations of the entry/exit points is approximately 36 feet on the revised profiles. A topographic high exits near the midpoint of the HDD S3-0541 with an approximate surface elevation of 469 ft amsl. This topographic high may act as a groundwater divide between the entry/exit points. The difference between the surface elevations of the entry/exit points and this topographic high is 102 feet (towards the southeast point) and 66 feet (towards the northwest point). The possibility of differing groundwater head pressures between the entry/exit points and the topographic high may exist which could cause excessive groundwater discharges at the entry/exit points during HDD construction and local water table lowering in the area of the topographic high.

2.3.4 Well Yields

Median well yields for this geologic setting are reported as variable but generally less than 10 gpm (Geyer and Wilshusen, 1982). A review of 12 nearby domestic wells recorded in the PaGWIS database revealed a median well yield of 8 gpm with a minimum of 4 gpm and maximum 60 gpm. The wells were completed in gneiss between 81 and 223 ft deep. These results are consistent with the median yield of 12 gpm (range 0.3 to 270 gpm) reported by a study of 509 domestic wells completed in gneissic rocks across Southeast Pennsylvania (Low et al., 2002).

2.3.5 Water Supply Wells within 450 ft. of the ROW

An initial pre-construction sampling program for domestic wells within 450 feet of the HDD alignment was performed and resulted in the identification and sampling of thirty-six (36) wells and additional 5 wells whose properties adjoin the 450-foot program boundary to establish a general water quality base line prior to HDD drilling.

2.4 Summary of Geophysical Studies

No geophysical studies were recommended or performed for the reevaluation of HDD S3-0541 as the alignment is not in a karst area.

3.0 OBSERVATIONS TO DATE

3.1 On This HDD Alignment

3.1.1 ME I

No IRs were observed during the installation of ME I at the location of HDD S3-0541.

3.1.2 ME II

No IRs have been observed as neither the 16-inch nor the 20-inch HDD has not been drilled at this time. This drill is designated as an "intercept drill" indicating that pilot advancement will occur at both the entry and exit locations of the drill profile.

3.2 On Other HDD Alignments in Similar Hydrogeologic Settings

3.2.1 ME I

An IR occurred approximately one mile southeast of the southeast entry/exit point for HDD S3-0541 during the installation of ME I. This IR is listed as HDD 24 on the list of MEI IRs provided in the IR PPC Plan for Delaware County.

3.2.2 ME II

IRs associated with ME II HDDs have been observed in similar geology (gneiss bedrock in Chester and Delaware Counties) at seven (7) HDD sites to date, recognizing however that there are variations of the mineralogical of the gneiss in differing lithologic units. Typically, IRs have occurred when the HDD intersects a zone of fracture concentration (indicated by a mapped fracture trace) or softer soils with increased bit pressure. An IR from HDD S3-0631 occurred when the HDD bore intersected fracture traces and highly fractured bedrock from installation of a sanitary sewer line that required blasting. An IR from HDD S3-0620 in the S-12 tributary to Chester Creek appears to be attributed to the intersection of a fracture trace by the HDD bore and increased groundwater head pressures resulting from elevation variations along the bore path.

4.0 SUMMARY AND CONCLUSIONS OF HDD HYDROGEOLOGIC EVALUATIONS

4.1 HDD Site Conceptual Model

The horizontal portions of the pipeline profile for the revised borings for HDD S3-0541 are at an elevation of approximately 263 ft amsl for the 20-inch line and 288 ft amsl for the 16-inch line. Based on the geotechnical boring data, overburden in the area of HDD S3-0541 can range in thickness from 18.5 to 68.5 ft bgs (SB-03). At the lowest surface elevation along the drill, at stream S-B35, the surface elevation is at approximately 352 ft amsl, so the bore for the 20-inch line would be 89 ft bgs and the bore for the 16-inch line would be 64 ft bgs. Thus, highly weathered rock could exist along the 288 ft amsl elevation horizon. Entrance and exits will be passing through weathered gneiss overburden and this material lacks cohesive strength.

Rock cores were taken from two recent geotechnical borings below approximately 55 ft bgs had RQDs that averaged 63% but varied widely, ranging from 11 to 88 %, and displayed no trend with depth. As such, HDD construction in the coreable interval of bedrock surrounding the profile could encounter weak zones caused by bedrock fracturing. Note that the profile crosses six fracture traces mapped for this reevaluation.

The revised borings for the HDD S3-0541 drills are designated as an "intercept drills" indicating that pilot advancement will occur at both the entry and exit locations of the drill profile and the borings intercept at some point in between. Steering in the gneiss bedrock in Delaware County for MEII HDD drills advanced to date has been problematic due to variations in rock hardness and magnetic minerals within the formation. The metamorphic rocks found in Spread 6 are not homogenous but more heterogeneous due to a wide variety of minerals and rock types of differing degrees of hardness. These minerals and rocks can divert the drill bit from the intended alignment. Drilling along strike may be slowed by a mylonitic layer of harder rock until the harder section either pinches out or the HDD path moves out of the zone. Drilling perpendicular to strike has difficulties, as well. While a harder zone may be drilled through more quickly the variation in hardness tend to deflect the bit from the intended alignment, causing the drilling to be slowed due to extra location checks and additional steering back to the alignment.

Groundwater was encountered in geotechnical borings at elevations that generally reflect variations in surface topography. The topographic high likely represents a groundwater divide between both entry points. The difference between the surface elevations of this topographic high and the entry/exit points are 102 feet (moving southeast) and 66 feet (moving northwest) on the revised profile. The estimated differences in groundwater level from this topographic high to the entry/exit points is 76 feet moving southeast and 53 feet moving northwest. These elevation differences could cause produced groundwater discharge at the entry/exit points during construction and potentially lowering of the water table in the area of the high point, and several domestic water wells are known to be proximal to the HDD alignment. Monitoring of representative groundwater levels in the area of the topographic high, both pre-construction and during construction, could provide useful information relative to the potential for lowering water levels and whether the pipe installation actually affects water levels.

4.2 Recommendations

As discussed in **Section 4.1**, this hydrogeologic reevaluation for HDD S3-0541 has identified a few issues that need to be addressed to minimize the risk of IRs and potential adverse effect to the local bedrock aquifer. These issues are related to a drill that would be constructed according to the revised boring plan, dated November 27, 2017, which lower the horizontal sections of the 20-inch and 16-inch borings compared to the original profiles. Alternatives to HDD drilling, changes to the HDD design, and/or changes to drilling procedures should account for potential weakness in the overburden materials, weakness in the bedrock, and elevation differences in the water table between the high point and the entry/exit points.

Pre-construction and during construction monitoring of groundwater levels could be performed in the central, higher ground along the profile. Representative pre-construction water level data may be available as a result of the 450-foot well survey. Both pre-construction and during construction water level data could be collected from cooperative well owners in the area of interest, or by installing a couple of monitoring wells at strategic locations. In addition, monitoring of private domestic wells along the Street Road fault, northeast and southwest of the fault/alignment intersection, during HDD installation would be useful for minimizing potential water supply impacts. To date, steering within the Baltimore Gneiss has been problematic and drilling procedures for the HDD should take steering issues into consideration, especially if intercept drills are considered.

An intercept drill, using two drill rigs is being proposed as the planned profile is relatively long, at 6,510 feet, for the 20-inch line. Groundwater flow back to the entry point(s) may potentially be an issue due to the topographic high near the midpoint of the HDD drills, if groundwater elevations mirror topography. If the difference in water level elevation is slight, however, any produced water would be minimal and only occur during non-active drilling periods. Subsequently, any produced water could be managed and used as part of the drilling process, reducing or eliminating the need for imported water.

5.0 REFERENCES

Blackmer, G. C., 2005, Preliminary *Bedrock Geologic Map of a Portion of the Wilmington 30- by 60-Minute Quadrangle, Southeastern Pennsylvania*. Pennsylvania Geologic Survey.

Geyer, A. R. and J. P. Wilshusen, 1982, *Engineering Characteristics of the Rocks of Pennsylvania.* Pennsylvania Department of Environmental Resources, Office of Resource Management, Bureau of Topographic and Geologic Survey.

Low, D.J., D.J. Hippo, and D. Yannacci, 2002, Geohydrology of Southeastern Pennsylvania, United States Geological Survey, Water-Resources Investigations Report 00-4166.

Pennsylvania Geological Survey. Pennsylvania groundwater information system (PaGWIS). Pennsylvania Geological Survey, 4th series, SQL database, http://dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm.

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

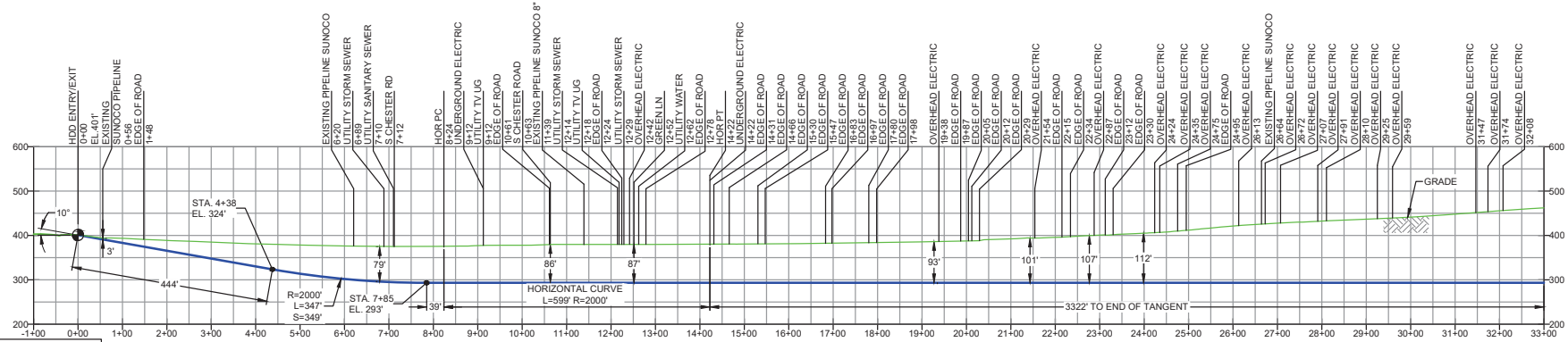
USGS, United States Geologic Survey, 1983, *7.5 Minute Topographic Quadrangle, Downingtown, Pennsylvania*.

Attachment A

Original and Revised Plan and Profile

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541A

PROFILE VIEW



GEOTECH SB-03

-NG EL. 430'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 18.5')
-WEATHERED ¨ UARTZ (18.5' - 18.9')
-COMPLETION DEPTH EL. 410'

NOTE: REFER TO TEST BORING LOG S3-0530 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=):6349'
   HDD PIPE LENGTH (S=):6349'
   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).
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11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
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REF. DRAWING

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ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

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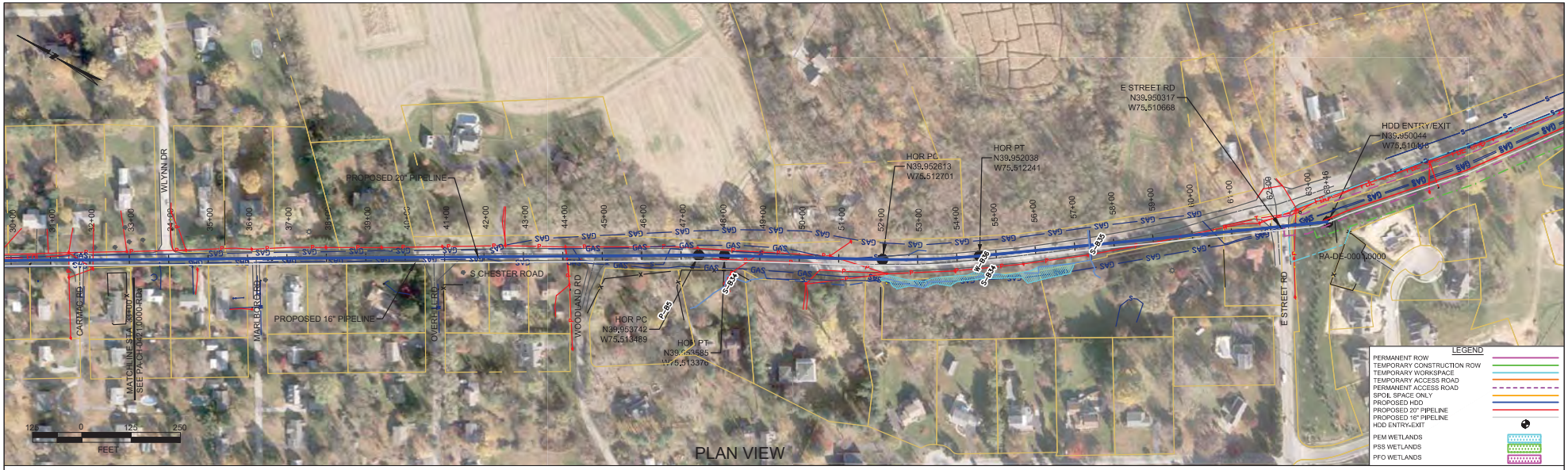
SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

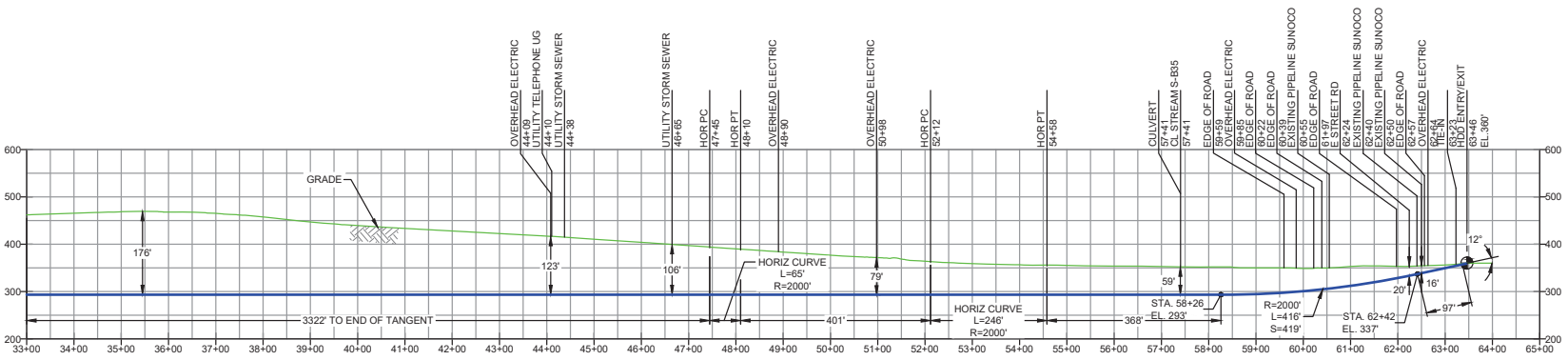
SCALE: 1"=250' | DWG. NO: PA-CH-0421.0000-RD-



PLAN VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541A

PROFILE VIEW



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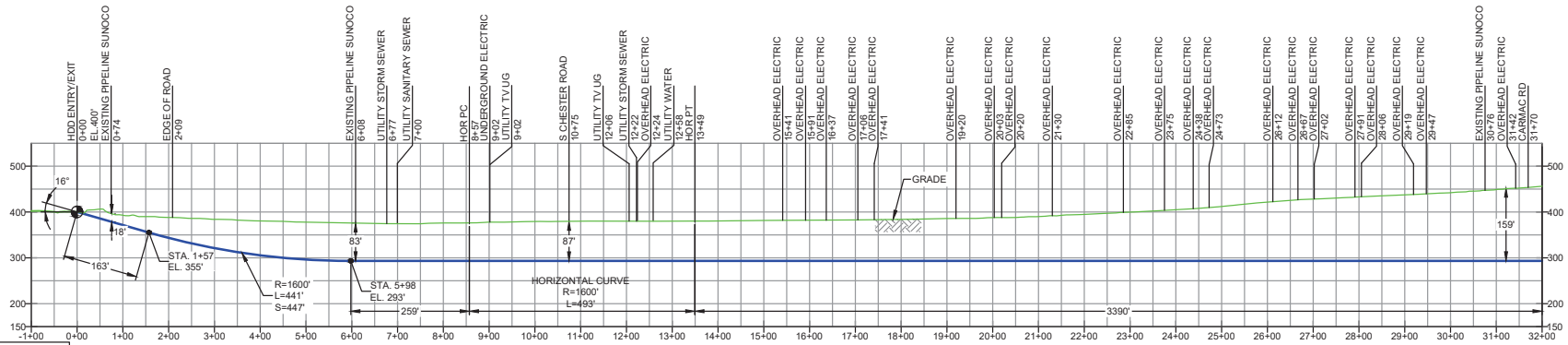
SCALE: 1"=250' | DWG. NO: PA-CH-0421.0000-RD

PLAN VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541A-16

PROFILE VIEW



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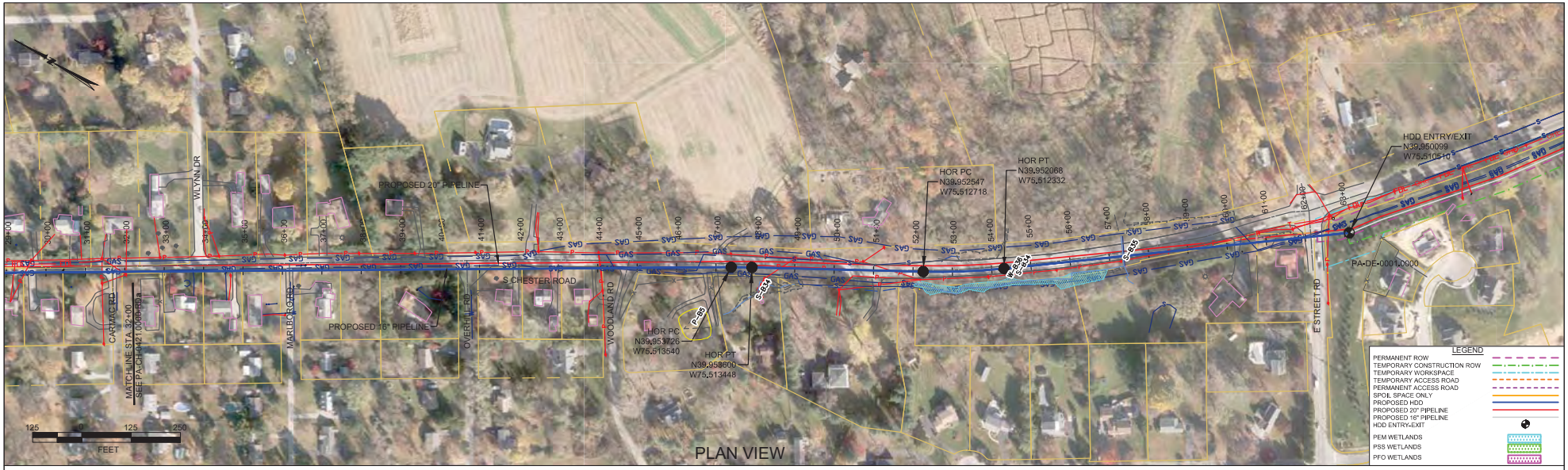

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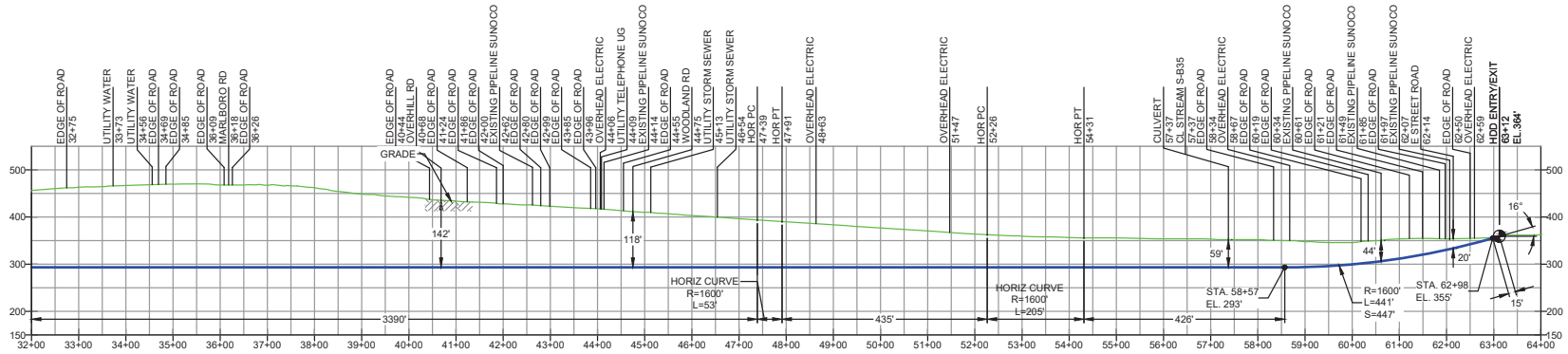
S3-0541B-16

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=):6312'
   HDD PIPE LENGTH (S=):6332'
   16" x 0.438" W.T., X-70, 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

DWG NO		DWG NO	DESCRIPTION
ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

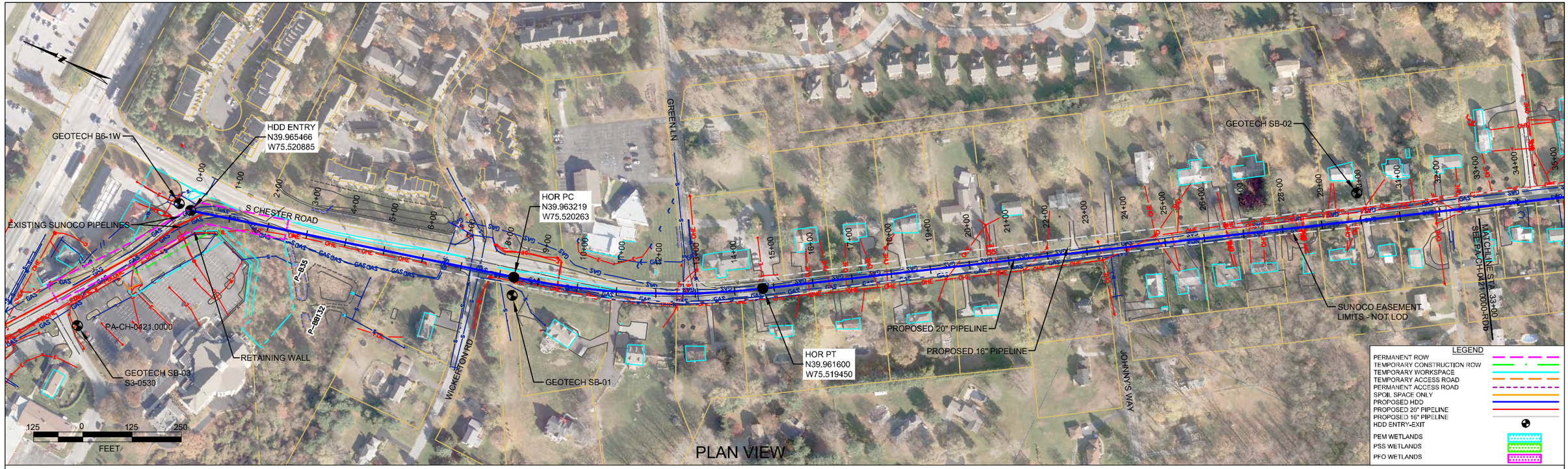
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' | DWG. NO: PA-CH-0421.0000-RD-16



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541

GEOTECH B6-1W

- NG EL. 405'
- -ASPHALT (0.0' - 0.3')
- -GRAVEL (0.3' - 1.5')
- -WEATHERED ROCK (1.5' - 22.0')
- -GNEISS (22.0' - 158.3')
- -BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

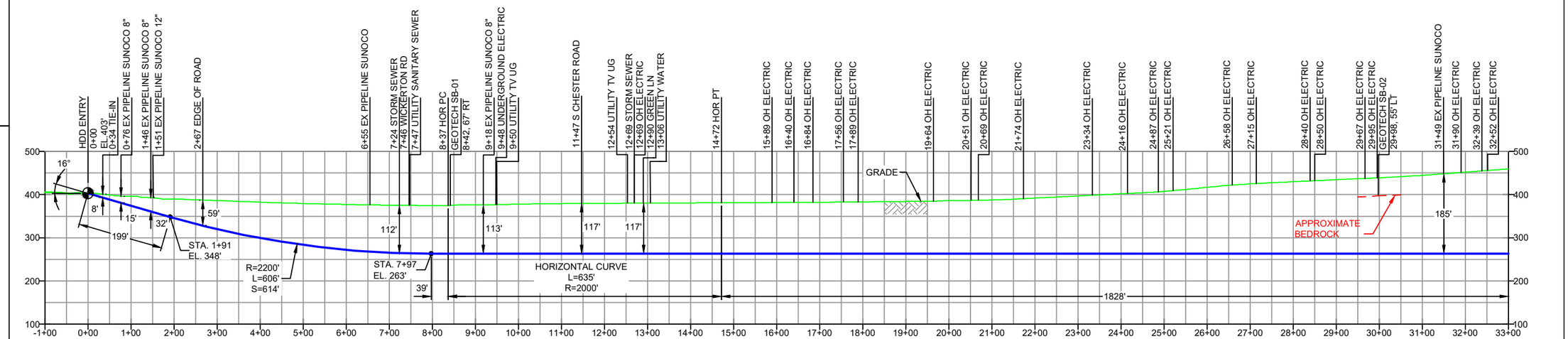
GEOTECH SB-01

- NG EL. 376'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 30.0')
- -GROUNDWATER (25.0')
- -COMPLETION DEPTH EL. 346'

GEOTECH SB-02

- NG EL. 439'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 11.5')
- -SM (11.5' - 23.5')
- -SM / GM (23.5' - 32.0')
- -FELSIC GNEISS (32.0' - 42.0')
- -COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION



DESIGN AND CONSTRUCTION:

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
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7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NO 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.

NOTES

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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-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
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	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

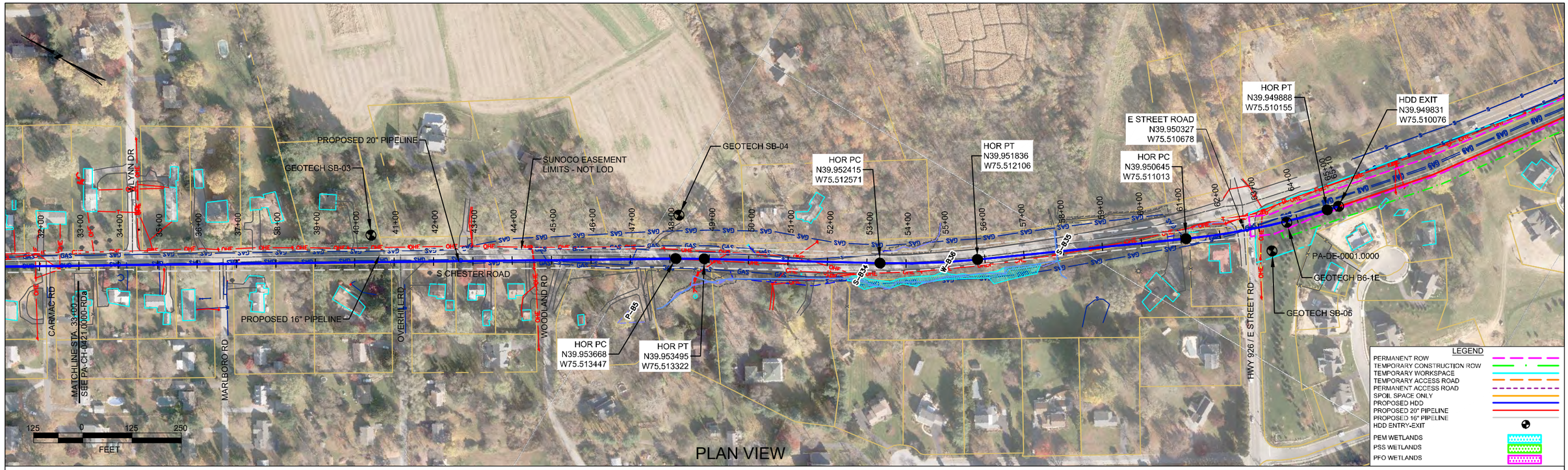
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

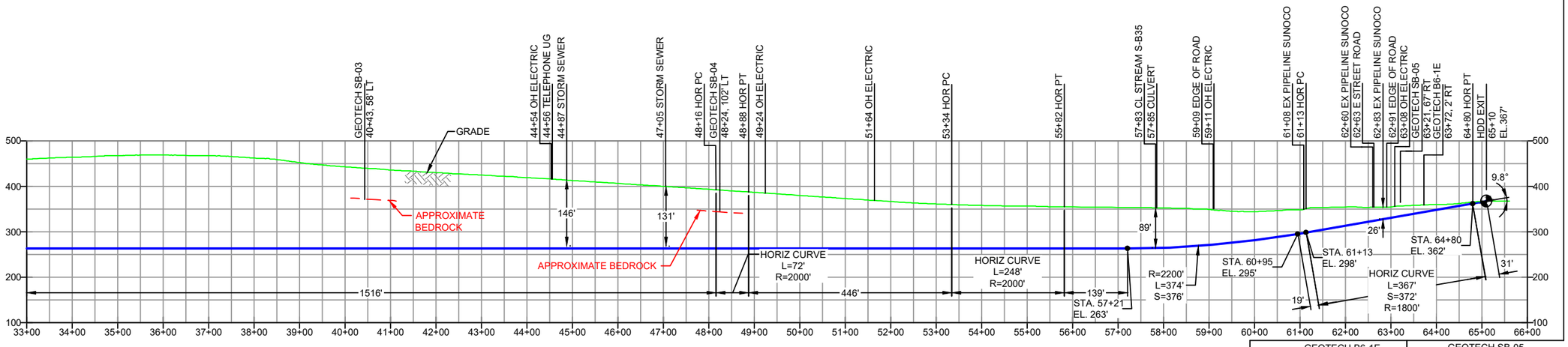
SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDa

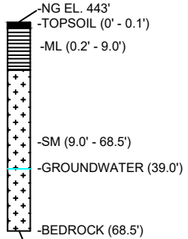


PLAN VIEW

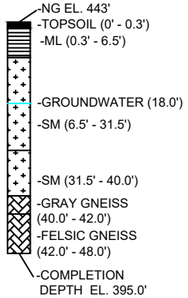
PROFILE VIEW



GEOTECH SB-03

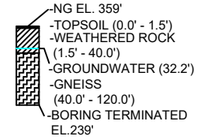


GEOTECH SB-04



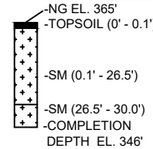
NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-1E



NOTE: REFER TO TEST BORING LOG B6-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-05



NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541

DESIGN AND CONSTRUCTION:

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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 NO 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.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
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	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

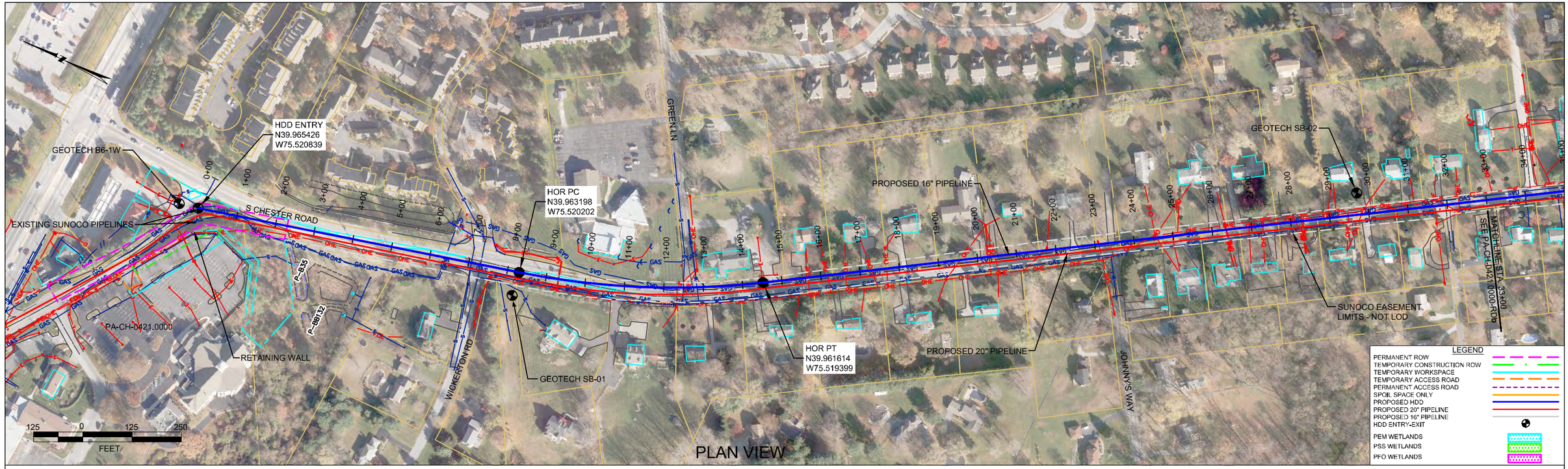
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDb



CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16

PROFILE VIEW

GEOTECH B6-1W

-NG EL. 405'
-ASPHALT (0.0' - 0.3')
-GRAVEL (0.3' - 1.5')
-WEATHERED ROCK (1.5' - 22.0')
-GNEISS (22.0' - 158.3')
-BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

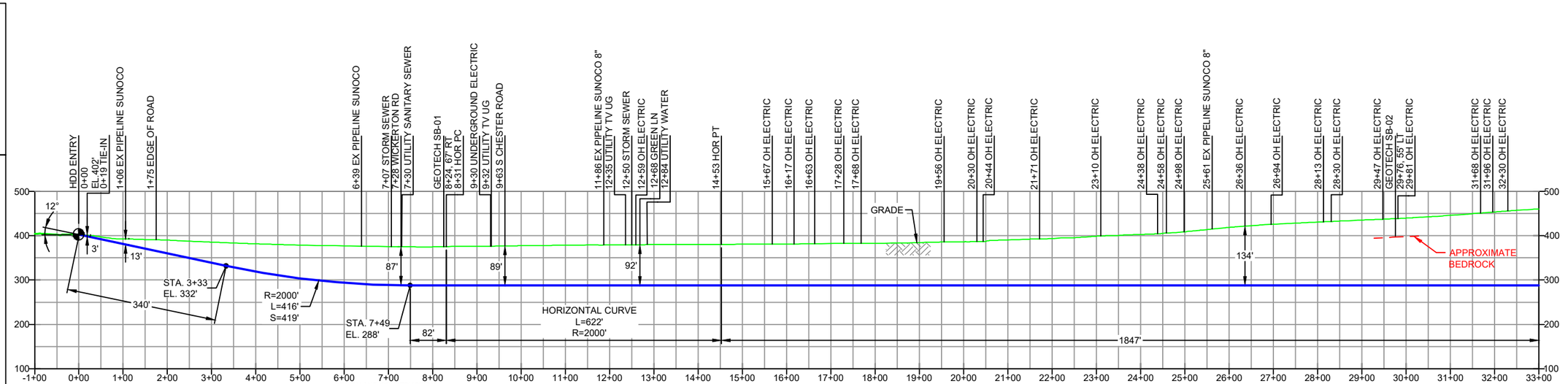
GEOTECH SB-01

-NG EL. 376'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 30.0')
-GROUNDWATER (25.0')
-COMPLETION DEPTH EL. 346'

GEOTECH SB-02

-NG EL. 439'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 11.5')
-SM (11.5' - 23.5')
-SM / GM (23.5' - 32.0')
-FELSIC GNEISS (32.0' - 42.0')
-COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION



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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6548'
   HDD PIPE LENGTH (S=):6562'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.

NOTES

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REF. DRAWING

ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN
DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
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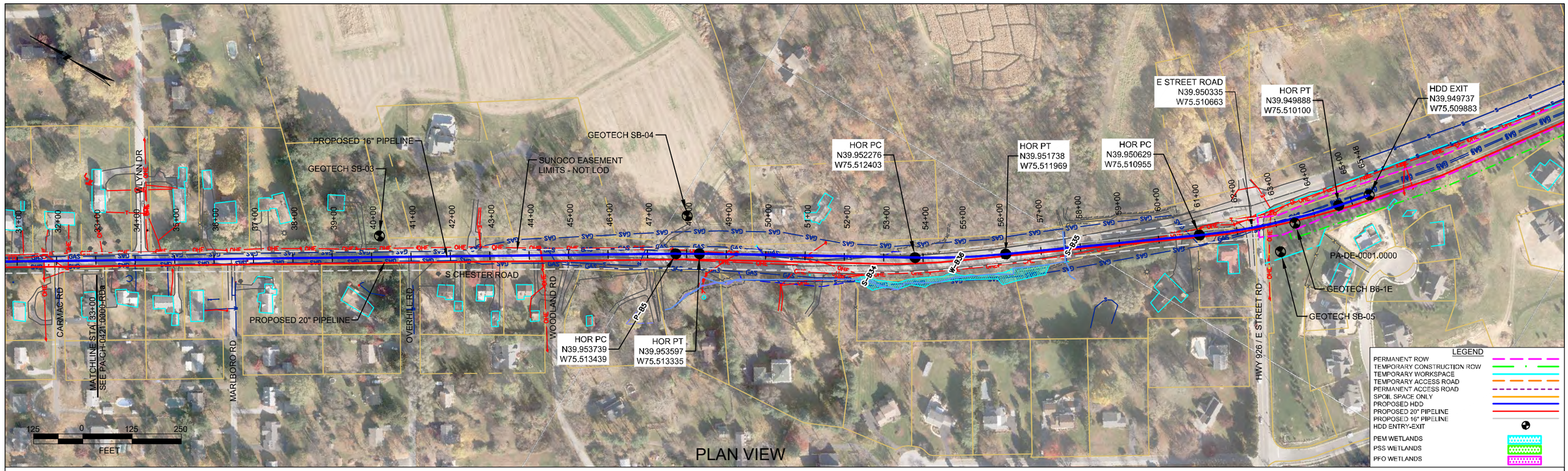
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

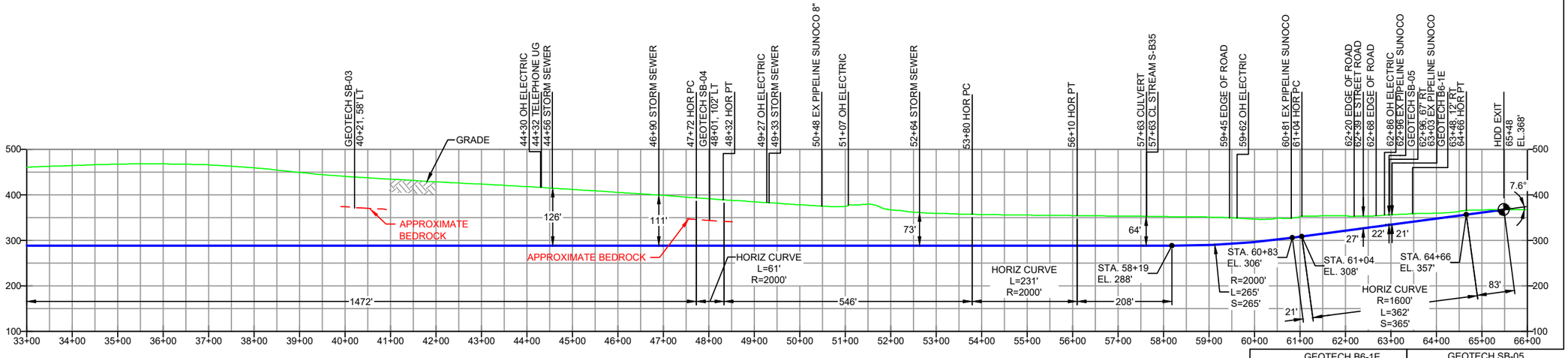
DWG. NUMBER: PA-CH-0421.0000-RDa-16



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16



GEOTECH SB-03
-NG EL. 443'
-TOPSOIL (0' - 0.1')
-ML (0.2' - 9.0')
-SM (9.0' - 68.5')
-GROUNDWATER (39.0')
-BEDROCK (68.5') AUGER REFUSAL
-COMPLETION DEPTH EL. 374.5'

GEOTECH SB-04
-NG EL. 443'
-TOPSOIL (0' - 0.3')
-ML (0.3' - 6.5')
-GROUNDWATER (18.0')
-SM (6.5' - 31.5')
-SM (31.5' - 40.0')
-GRAY GNEISS (40.0' - 42.0')
-FELSIC GNEISS (42.0' - 48.0')
-COMPLETION DEPTH EL. 395.0'
NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-1E
-NG EL. 359'
-TOPSOIL (0.0' - 1.5')
-WEATHERED ROCK (1.5' - 40.0')
-GROUNDWATER (32.2')
-GNEISS (40.0' - 120.0')
-BORING TERMINATED EL.239'
NOTE: REFER TO TEST BORING LOG B6-1E TERRACON PROJECT #J2117P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-05
-NG EL. 365'
-TOPSOIL (0' - 0.1')
-SM (0.1' - 26.5')
-SM (26.5' - 30.0')
-COMPLETION DEPTH EL. 346'
NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
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   HDD HORZ. LENGTH (L=):6548'
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   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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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-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RBM	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

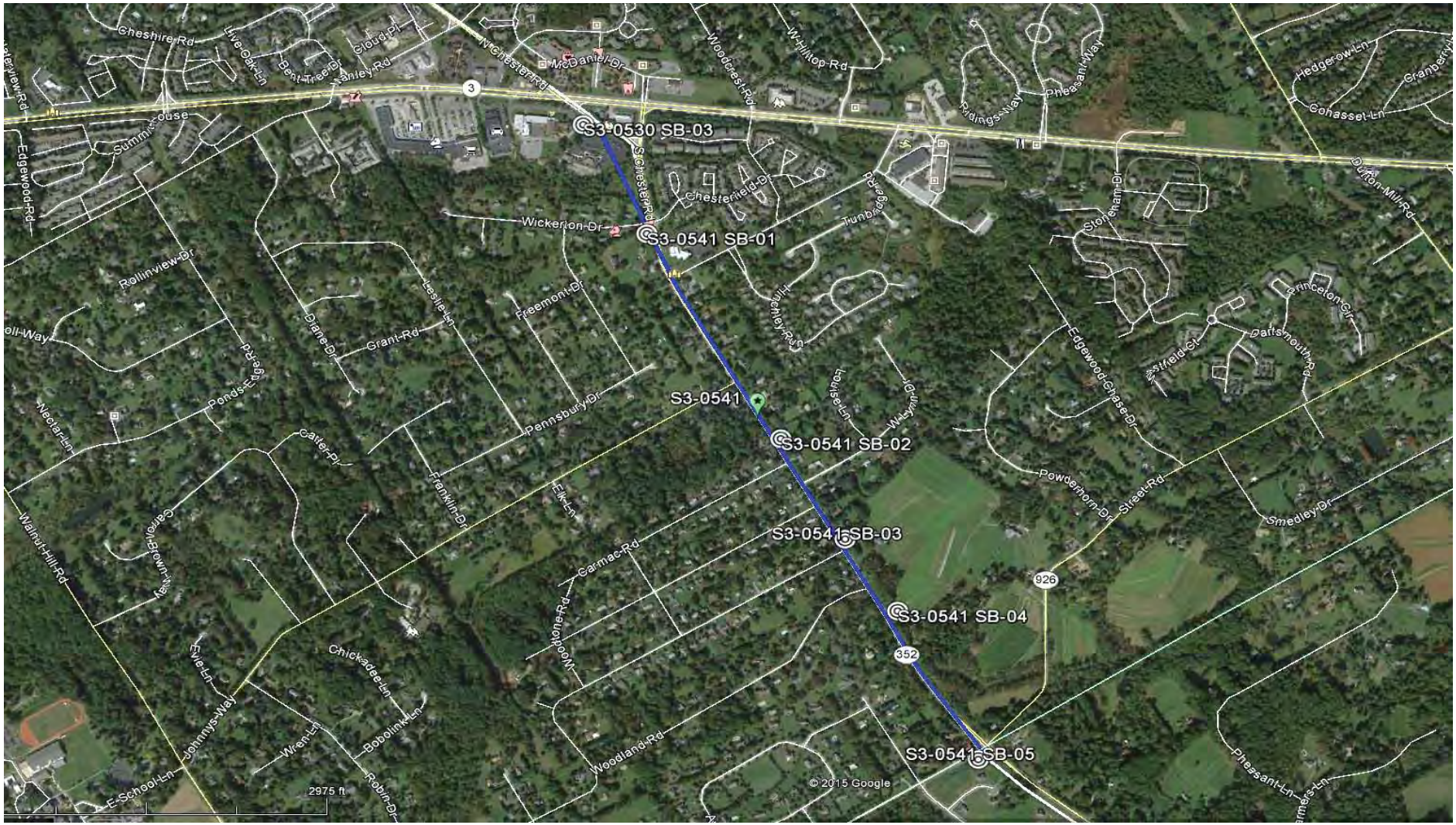
HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDb-16

Attachment B

Geotechnical Information



LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0541
CHESTER COUNTY, WESTTOWN TWP, AND
DELAWARE COUNTY, THORNBURY TWP, 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:	6 CAVANAUGH COURT, ST. SIMON & JUDE CHURCH, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0530	Dates(s) Drilled: 06-27-15	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): 18.9
Boring Location Coordinates:		39° 57' 57.12" N	75° 31' 20.11" 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 (3")					
1	3.0	5.0	0.3		11		DR, BROWN AND ORANGE BROWN FINE TO MEDIUM MICACEOUS	1	4	5	4	**9**
							SAND WITH SOME SILT.					
2	8.0	10.0			24	SM	DR, BROWN AND ORANGE BROWN FINE TO MEDIUM MICACEOUS	1	5	7	8	**12**
							SAND WITH A LITTLE SILT.					
3	13.0	15.0			22		DR, VARIEGATED BROWN, ORANGE BROWN, WHITE FINE TO MEDIUM	2	5	6	8	**11**
				18.5			MICACEOUS SAND WITH SOME SILT, TRACE FINE ROCK FRAGS.					
4	18.0	18.9	18.5		6		PARTIALLY WEATHERED QUARTZ, F-C SAND AND F-C GRAVEL,	20	50/5"			**>50**
				18.9			TRACE SILT.					
							AUGER REFUSAL AT 18.5'.					
							GRINDING VERY HARD AT 17.5'.					

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:	6 CAVANAUGH COURT, ST. SIMON & JUDE CHURCH, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0541	Dates(s) Drilled: 06-30-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 25.0	Total Depth (ft): 30.0
Boring Location Coordinates:		39° 57' 47.444" N	75° 31' 13.514" 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")					
1	3.0	5.0	0.3		18	SM	DR, VARIEGATED BROWN, ORANGE BROWN AND GRAY FINE TO	4	5	8	10	**13**
							MEDIUM SAND AND SILT, WITH A LITTLE F-C GNEISS GRAVEL.					
2	8.0	10.0			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS	3	14	12	20	**26**
							SAND AND SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.					
3	13.0	15.0			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS	3	16	23	17	**39**
							SAND AND SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.					
4	18.0	19.9			24		SAME. (USCS: SM).	4	15	34	50/5"	**49**
5	23.0	25.0			24		SAME.	13	20	25	34	**45**
6	28.0	29.9			24		DR, VARIEGATED GRAY, LIGHT GRAY FINE TO MEDIUM MICACEOUS	6	31	35	50/5"	**66**
				30.0			SAND , A LITTLE SILT, TRACE UNWEATHERED FINE GNEISS GRAVEL.					
							AUGERED TO 30'.					
							WET ON SPOON AT 27'.					
							WATER LEVEL THROUGH AUGERS AT 25'.					
							CAVED AT 28', WATER LEVEL ON CAVE AT 25'.					

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:	913 S. CHESTER ROAD, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0541	Dates(s) Drilled: 12-21-15	Inspector: J. COSTELLO
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft):
Boring Location Coordinates:		39°57'29.08"N	75°30'59.38"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")					
1	3.0	5.0	0.3		16	SM	DR, BROWN WITH BLACK NODULES FINE SAND AND SILT, TRACE	1	4	4	3	**8**
							MICA.					
2	8.0	10.0			17		DR, BROWN WITH BLACK NODULES, FINE SAND AND SILT, TRACE	4	5	7	8	**12**
				11.5			FINE GNEISS ROCK FRAGS., MICACEOUS.					
3	13.0	14.3	11.5		11	SM	DR, BROWN WITH BLACK NODULES, FINE SAND AND SILT, A LITTLE	17	50	50/4"		**>50**
							F-C GNEISS ROCK FRAGS., MICACEOUS. (USCS: SM).					
4	18.0	18.6			2		SAME	22	50/1"			**>50**
				23.5								
5	23.0	24.3	23.5		10	SM/ GM	DR, REDDISH BROWN AND BLACK LAYERING OF F-M SAND AND	1	27	50/4"		**>50**
							PARTIALLY WEATHERED GNEISS ROCK.					
6	28.0	30.0		32.0	18		SAME.	1	27	21	11	**48**
							AUGER REFUSAL AT 32'.					
							ROCK CORING					
RUN 1	32.0	37.0	32.0		49	GNEISS ROCK	INTENSELY TO VERY INTENSELY FRACTURED LIGHT GRAY TO GRAY	TCR: 82%, SCR: 33%, RQD: 9%				
							FELSIC GNIESS.					
RUN 2	37.0	42.0		42.0	55		SAME	TCR: 92%, SCR: 30%, RQD: 11%				
							CORE TESTING RESULTS (DEPTH 39-39.5 '):					
							COMPRESSIVE STRENGTH: 13,333 PSI					
							UNIT WEIGHT: 162.8 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:	1009 MIDDLETOWN RD, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0541	Dates(s) Drilled: 09-13-15	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): SEE NOTES	Total Depth (ft): 68.5
Boring Location Coordinates:		39° 57' 20.144" N	75° 30' 52.646" 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	0.1			TOPSOIL (2")					
1	3.0	5.0	0.1		10	ML	YELLOWISH BROWN TO BROWN SILT WITH SOME FINE SAND, TRACE	5	7	8	11	**15**
				9.0			FINE GRAVEL.					
2	8.0	10.0	9.0		17		DR, VARIEGATED BROWN, TAN, GRAY FINE TO MEDIUM SAND AND	3	6	7	9	**13**
							SILT, TRACE UNWEATEHRED FINE ROCK FRAGS.					
3	13.0	15.0			15		SAME	1	4	6	7	**10**
4	18.0	20.0			21		DR, VARIEGATED GRAY, ORANGE BROWN, TAN, WHITE F-M SAND	2	21	41	50	**62**
							AND SILT, WITH A LITTLE F-C UNWEATHERED ROCK FRAGS.					
5	23.0	25.0			13		DR, VARIEGATED REDDISH BROWN, GRAY, BLACK MICACEOUS FINE	1	2	4	5	**6**
							SAND AND SILT. (USCS: SM).					
6	28.0	29.9			16		DR, VARIEGATED REDDISH BROWN, GRAY, BLACK MICACEOUS F-C	1	4	12	50/5"	**16**
							SAND WITH SOME SILT, TRACE UNWEATHERED F-C ROCK FRAGS.					
7	33.0	35.0			17		DR, VARIEGATED GRAY, BROWN, ORANGE BROWN MICACEOUS F-M	13	12	32	44	**44**
							SAND WITH SOME SILT.					
8	38.0	39.8			14	SM	SAME, WITH A LITTLE F-C UNWEATHERED ROCK FRAGS.	2	19	32	50/3"	**51**
9	43.0	45.0			13		DR, VARIEGATED GRAY, BROWN, WHITE MICACEOUS FINE TO MEDUM	9	9	22	39	**31**
							SAND AND SILT, TRACE UNWEATHERED ROCK FRAGS.					
10	48.0	50.0			12		SAME	2	8	10	18	**18**
11	53.0	54.3			19		SAME (USCS: SM).	2	22	50/4"		**>50**
12	58.0	59.4			16		DR, VARIEGATED GRAY, BROWN, WHITE MICACEOUS FINE TO MEDUM	3	25	50/5"		**>50**
							SAND AND SILT, WITH A LITTLE UNWEATHERED ROCK FRAGS.					
13	63.0	64.0			8		SAME	13	50/6"			**>50**
14	68.0	68.3		68.5	4		SAME	50/3"				**>50**
							AUGER REFUSAL AT 68.5'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 2.75 TSF

DR: DECOMPOSED ROCK (FELSIC GNEISS ORGIN)

PERCHED WATER AT 8'.
WATER LEVEL THROUGH AUGERS AT 39'.
CAVED AND WET AT 40'.

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:	1121 S. CHESTER ROAD, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0541	Dates(s) Drilled: 07-09-15	Inspector: E. WATT
Boring No.:	SB-04	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 18.0	Total Depth (ft): 48.0
Boring Location Coordinates:		39° 57' 13.675" N	75° 30' 47.131" 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")					
1	3.0	5.0	0.3		20	ML	REDDISH TO ORANGE BROWN SILT WITH A LITTLE FINE SAND,	1	5	4	5	**9**
				6.5			MICACEOUS. (USCS: ML).					
2	8.0	10.0	6.5		16	SM	DR, VARIEGATED BROWN AND GRAY FINE TO MEDIUM SAND WITH	5	7	9	7	**16**
							SOME SILT, TRACE FINE ROCK FRAGS.					
3	13.0	15.0			24		DR, VARIEGATED BROWN, ORANGE BROWN AND LIGHT GRAY FINE	2	3	4	4	**7**
							TO MEDIUM SAND, SOME SILT.					
4	18.0	20.0			24		DR, VARIEGATED BROWN, ORANGE BROWN AND LIGHT GRAY FINE	2	3	4	8	**7**
							TO MEDIUM SAND AND SILT.					
5	23.0	25.0			24		DR, VARIEGATED BROWN AND ORANGE BROWN FINE MICACEOUS	1	6	10	15	**16**
							SAND AND SILT.					
6	28.0	30.0			24		DR, VARIEGATED BROWN FINE TO MEDIUM SAND AND SILT.	3	18	25	36	**43**
				31.5			(USCS: SM).					
7	33.0	33.9	31.5		11	SM	DR, VARIEGATED LIGHT BROWN AND BROWN MICACEOUS FINE TO	6	50/5"			**>50**
							MEDIUM SAND AND SILT, TRACE FINE GNEISS ROCK FRAGS.					
8	38.0	38.8			7		DR, VARIEGATED LIGHT BROWN AND BROWN MICACEOUS FINE TO	32	50/3"			**>50**
				40.0			MEDIUM SAND AND SILT, TRACE FINE GNEISS ROCK FRAGS.					
9	42.0	42.0	40.0	42.0	1		PARTIALLY WEATHERED GRAY GNEISS.	50/0"				**>50**
							AUGER REFUSAL AT 42'.					
							<u>ROCK CORING</u>					
RUN 1	42.0	46.0	42.0		41	GNEISS ROCK	INTENSELY TO VERY INTENSELY FRACTURED LIGHT GRAY TO GRAY	TCR: 85%, SCR: 21%, RQD: 8%				
							FELSIC GNIESS.					
RUN 2	46.0	48.0		48.0	24		SAME	TCR: 100%, SCR: 21%, RQD: 0%				
							COULD NOT TEST CORE SAMPLE FOR COMPRESSIVE STRENGTH.					
							DUE TO FRACTURE PLANES (WOULD BREAK DURING CORE PREP.)					

Notes/Comments:

<u>Pocket Pentrometer Testing</u>
S1: 3.5 TSF

DR: DECOMPOSED ROCK

AUGER GRINDING AT 40'.
WET ON SPOON AT 18'.
WATER LEVEL THROUGH AUGERS AT 21'.
CAVED AT 37.5', WATER LEVEL ON CAVE AT 16'.

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:	MIDDLETOWN ROAD AND RT. 926, GLEN MILLS, PA		Page 1 of 1
HDD No.:	S3-0541	Dates(s) Drilled: 11-12-15	Inspector: J. COSTELLO
Boring No.:	SB-05	Drilling Method: SPT - ASTM D1586	Driller: E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 30.0
Boring Location Coordinates:		39°57'0.29"N	75°30'38.61"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	0.1			TOPSOIL (2")					
1	3.0	5.0	0.1		18		DR, VARIEGATED DARK GRAYISH BROWN FINE TO MEDIUM SAND AND	2	4	4	5	**8**
							SILT, TRACE FINE GRAVEL.					
2	8.0	10.0			18		DR, VARIEGATED GRAY AND BROWN FINE SAND AND SILT, TRACE	2	6	7	8	**13**
							FINE GRAVEL.					
3	13.0	15.0			20	SM	SAME. (USCS: SM).	3	12	16	18	**28**
4	18.0	20.0			21		SAME.	1	4	10	11	**14**
5	23.0	25.0			24		SAME. (USCS: SM).	1	8	17	22	**25**
				26.5								
6	28.0	29.3	26.5		16	SM	DR, VARIEGATED GRAY AND BROWN FINE SAND AND SILT, A LITTLE	4	37	50/4"		**>50**
				30.0			FINE GRAVEL (UNWEATHERED ROCK FRAGS.).					
							AUGERED TO 30'.					
							CAVED AND DRY AT 26'.					

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.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0541

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					
S3-0541	SB-02	1	32	37	82	33	9	32	37	Moderate	Gneiss	Massive	Gray and White	Nearly rubble, fracturing ranging from 25 to 60 degrees
		2	37	42	92	30	11	37	42	Moderate	Gneiss	Massive	Gray and White	Nearly rubble, no bedding visible.
	SB-4	1	42	46	85	21	8	42	46	Slight	Paragneiss	Massive	Gray	Fractures ranging from 30° to 65°, Avg. 60°
		2	46	48	100	21	0	46	48	Moderate	Gneiss	Thin (foliation)	Gray and White	Fractures average 45°; fractures parallel to foliation, no bedding visible

October 11, 2017

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

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

Re: Geotechnical Site Characterization
Mariner East 2 Pipeline Project
Spread 6 – South Chester Road
Commonwealth of Pennsylvania
Drawing #PA-CH-0459.000-RDa_RDb
PO #20170804-16
Terracon Project No. J217P078

Dear Mr. Sessions:

This letter provides a summary of the bedrock characterization for the Mariner East 2 Pipeline Project crossing to be located at South Chester Road (Drawing # PA-CH-0459.000-RDa_RDb) in the Commonwealth of Pennsylvania. Our services were performed in general accordance with our proposal number PJ2175108 dated July 28, 2017. Our scope of services included advancing two borings, designated as B6-1W and B6-1E, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test borings, B6-1W and B6-1E were drilled between August 3 and September 8, 2017 to depths of 158.3 and 120.0 feet, respectively as shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of metamorphic rock comprised of gneiss. Final test boring logs documenting overburden soil and bedrock conditions as well as photographs of the rock core samples are attached.

Rock compressive strength testing was performed on samples from approximately 20-foot intervals within the bedrock strata at each boring location. As an exception to the planned 20-foot intervals, a rock sample from B6-1W near 62 feet was not tested due to highly weathered conditions. Unconfined compressive strength test results are shown on the attached reports.

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

Sincerely,
Terracon Consultants, Inc.

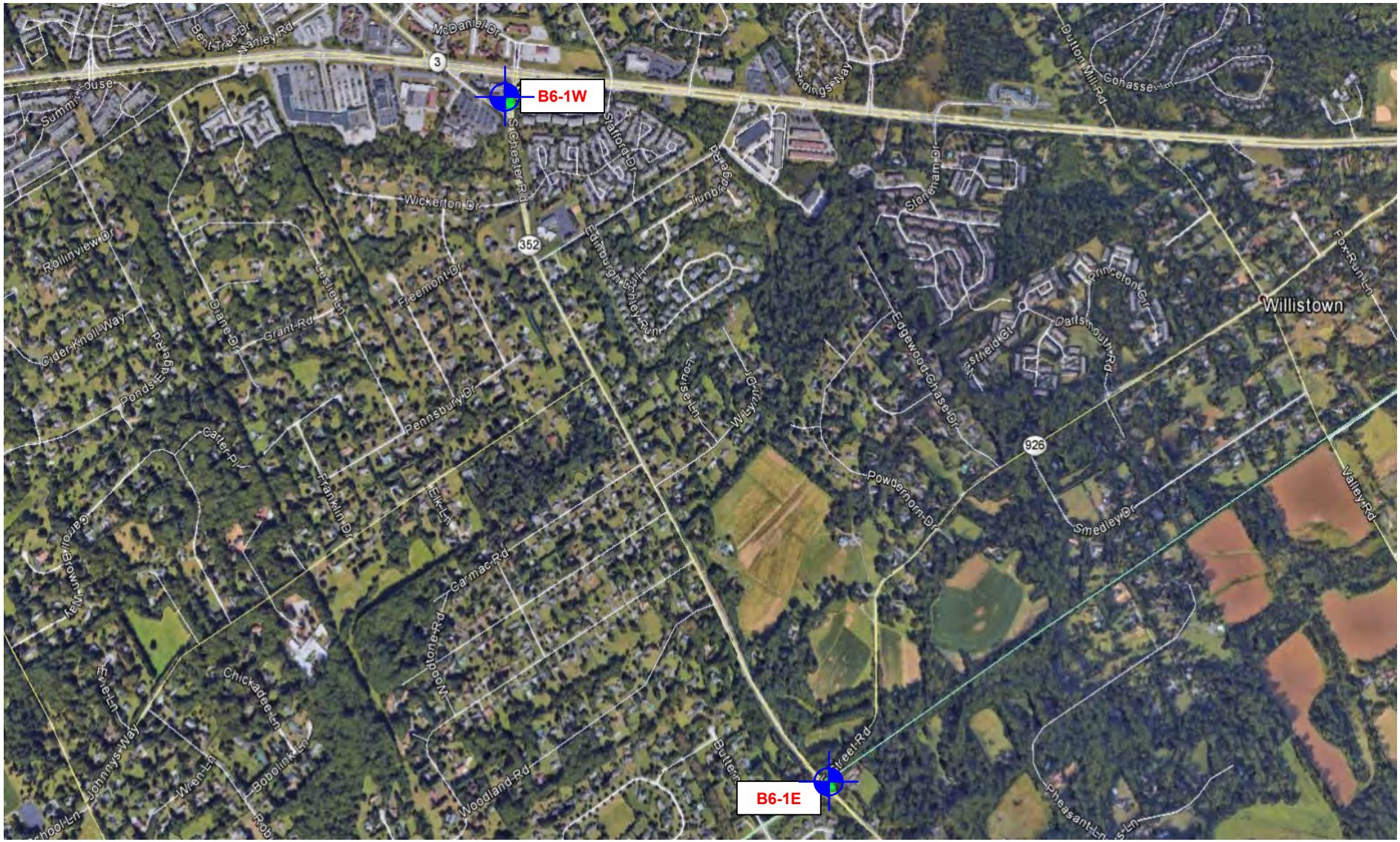
Marc A. Gullison, E.I.T.
Staff Geotechnical Engineer

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

Attch:

TEST BORING LOCATION PLAN
EXPLORATION RESULTS (Boring Logs, Laboratory Data, Rock Core Photographs)
SUPPORTING INFORMATION (Unified Soil Classification System, Description of Rock Properties)

TEST BORING LOCATION PLAN



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

South Chester Road HDD Cores B6-1W and B6-1E
PA-CH-0459.0000-RDa_RDb
Chester County, Pennsylvania

Exhibit

A-2

EXPLORATION RESULTS

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.96556° Longitude: -75.52087°

Approximate Surface Elev: 365 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0.3	364.5+/-	Asphalt
1.5	363.5+/-	Road base material: Gravel, sand, silt, brown , medium dense
		Completely weathered rock, with sand, gravel, trace silt, dense to very dense
22.0	343+/-	
		Run 1, Soft, severely weathered, white/light brown, coarse-grained GNEISS, highly fractured, no joints could be measured
27.0	338+/-	
		Run 2, Similar

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)
		13	13-8-10 N=18		
5					
		13	13-20-26 N=46		
10					
		14	10-16-21 N=37		
15					
		14	17-11-50 N=61		
20					
25		44		0	1 1 1 2 2
30		44		13	1 1 2

WATER LEVEL OBSERVATIONS: Not encountered

Penetrometer Test (tsf)

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

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.96556° Longitude: -75.52087°

Approximate Surface Elev: 365 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
		Run 2, Similar *(continued)*							1 2	
	32.0	333+/-				44				
		Run 3, Very soft, very severely weathered, gray brown, medium-grained GNEISS, highly fractured, could not measure joints	35			46.5		0	1 1 2 1 1	
	37.0	328+/-								
		Run 4, Similar	40			52.5		13	1 1 1 1 1	
	42.0	323+/-								
		Run 5, Similar 42 to 48 feet, microcline GNEISS	45			41		0	1 1 1 1 1	
	47.0	318+/-								
		Run 6, Soft, severely weathered, gray/light brown, medium-grained GNEISS, primary joint set low angle, very close, rough, open; secondary joint set high angle, moderately close, rough, open	50			55		0	1 1 2 1 1	
	52.0	313+/-								
		Run 7, Moderately hard, moderately to severely weathered, light brown, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set vertical, very close, rough, wide	55			50.5		32	1 2 2 1 2	
	57.0	308+/-								
		Run 8, Moderately hard, moderately to severely weathered, light brown, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set vertical, moderately close, rough, open	60			60		78	1 1 2	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.96556° Longitude: -75.52087°

Approximate Surface Elev: 365 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	RECOVERY (In.)	RQD (%)	Core rate (min/ft)
62.0	303+/-	Run 8, Moderately hard, moderately to severely weathered, light brown, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set vertical, moderately close, rough, open *(continued)*		60		2 1
67.0	298+/-	Run 9, Moderately hard, moderately weathered, light brown/gray, medium-grained GNEISS, primary joint set low angle, very close, rough, open; secondary joint set high angle, very close, rough, open	65	60	37	1 2 2 2 2
72.0	293+/-	Run 10, Similar	70	60	30	2 2 2 2 3
77.0	288+/-	Run 11, Moderately hard, moderately weathered, dark gray, medium-grained GNEISS, primary joint set moderately dipping, very close, rough, open; secondary joint set high angle, close, rough, open	75	60	48	2 2 3 3 2
82.0	283+/-	Run 12, Similar	80	60	64	2 2 2 3 3
87.0	278+/-	Run 13, Hard, slightly weathered, gray/dark gray/white, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set vertical, moderately close, rough, open	85	60	88	2 2 3 2 2
		Run 14, Similar, vertical fractures at 91.5 to 92 feet	90	60	62	2 3 3

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.96556° Longitude: -75.52087°

Approximate Surface Elev: 365 (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)
		Run 14, Similar, vertical fractures at 91.5 to 92 feet *(continued)*				60			3 3	
92.0	273+/-									
		Run 15, Hard, slightly weathered to fresh, gray/brown, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set moderately dipping, moderately close, rough, open	95			60		67	3 3 3 3 3	
97.0	268+/-									
		Run 16, Hard, moderately weathered to fresh, brown/gray, medium-grained GNEISS, primary joint set moderately dipping, close, rough, open; secondary joint set low angle, moderately close, rough, open	100			60		38	3 3 3 3 3	
102.0	263+/-									
		Run 17, Similar	105			60		56	3 3 3 3 4	
107.0	258+/-									
		Run 18, Moderately hard, moderately to severely weathered, gray/brown, medium-grained GNEISS, primary joint set low angle, very close, rough, wide; secondary joint set medium angle, moderately close, rough, open	110			60		11	3 3 3 2 2	
112.0	253+/-									
		Run 19, Moderately hard, moderately weathered, gray/brown, medium-grained GNEISS, primary joint set low angle, close, rough, open; secondary joint set high angle, moderately close, rough, open	115			60		49	2 3 3 2 3	
117.0	248+/-									
		Run 20, Similar	120			60		22	3 2 3	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.96556° Longitude: -75.52087°

Approximate Surface Elev: 365 (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)
		Run 20, Similar *(continued)*				60			3 2	
122.0	243+/-									
		Run 21, Hard, slightly weathered, gray/brown, medium-grained GNEISS, primary joint set medium angle, close, rough, open; secondary joint set high angle, close, rough, open	125			60		41	2 2 3 3 2	
127.0	238+/-									
		Run 22, Similar, becoming less weathered	130			60		73	2 2 3 2 2	
132.0	233+/-									
		Run 23, Very hard, fresh, gray, medium-grained GNEISS, primary joint set low angle, close to moderately close, rough, open	135			60		85	3 3 3 4 3	
137.0	228+/-									
		Run 24, Very hard, fresh, gray, coarse to medium-grained GNEISS, primary joint set low angle, close, rough, open	140			60		76	5 5 5 6 5	
142.0	223+/-									
		Run 25, Very hard, very slightly weathered, gray, medium-grained GNEISS, primary joint set low angle, moderately close, rough, open; secondary joint set high angle/vertical, close rough, wide	145			60		55	4 5 5 5 6	
147.0	218+/-									
		Run 26, Similar	150			60		81	5 5 5	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1W South Chester Road West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

GRAPHIC LOG	LOCATION Latitude: 39.96556° Longitude: -75.52087° Approximate Surface Elev: 365 (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 26, Similar *(continued)*				60			4 4	
	152.0 213+/-								
	Run 27, Similar				60		75	3 3 3 3 3	
	157.0 208+/-	155							
	Boring Terminated at 158.3 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

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 9/7/2017 Boring Completed: 9/8/2017

Drill Rig: Mobile B-57 Driller: Terracon/S. Bray

Project No.: J217P078

BORING LOG NO. B6-1E South Chester Road East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.95009° Longitude: -75.510435°

Approximate Surface Elev: 360 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0.0	360+/-	Topsoil, silty sand, brown
1.5	358.5+/-	Highly weathered rock, medium dense
15.0	345+/-	Weathered rock, medium dense to very dense

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
0	X	10	3-3-4 N=7			
5	X	15	3-4-5 N=9			
10	X	17	9-10-13 N=23			
15	X	14	6-8-9 N=17			
20	X	13	5-10-13 N=23			
25	X	14	9-21-49 N=70			
30	X	15	16-21-23 N=44			
35						

WATER LEVEL OBSERVATIONS: ▽ at 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

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *32.2' on 8/8/17*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/3/2017 Boring Completed: 8/8/2017

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

Project No.: J217P078

BORING LOG NO. B6-1E South Chester Road East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION
Latitude: 39.95009° Longitude: -75.510435°
Approximate Surface Elev: 360 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Weathered rock, medium dense to very dense *(continued)*					15	20-27-30 N=57			
	40.0	320+/-	40							
	Run 1, Moderately hard, moderately severe weathering, gray, fine-grained, GNEISS, very thin, moderately dipping foliation; primary joint set, moderately dipping, very close spacing, rough, tight to moderately open, oxidation along joints					32		7	1 1 1.5 1 1	
	45.0	315+/-	45							
	Run 2, Similar to 49 feet At 49 feet: Hard, very slight weathering, gray to white, fine-grained, GNEISS, very thin, moderately dipping foliation; primary joint set, moderately dipping, very close to close spacing, rough, tight to moderately open, frequent quartz intrusions					40		10	1 1.5 2 1 2.5	
	50.0	310+/-	50							
	Run 3, Similar					52		35	1.5 1.5 1.5 1.5 1.5	
	55.0	305+/-	55							
	Run 4, Similar, very close to moderately close spacing					60		63	2 2 2 2 2	
	60.0	300+/-	60							
	Run 5, Similar, close to moderately close spacing					57		65	2 2 2 2 2.5	
	65.0	295+/-	65							
	Run 6, Similar, very close to close spacing, high angle joint from 67.5 to 68 feet					60		63	2 3 3.5 5.5 3	
	70.0	290+/-	70							

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

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *32.2' on 8/8/17*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/3/2017 | Boring Completed: 8/8/2017
Drill Rig: Diedrich D-50 | Driller: Terracon/Clayton J.
Project No.: J217P078

BORING LOG NO. B6-1E South Chester Road East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.95009° Longitude: -75.510435°

Approximate Surface Elev: 360 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Run 7, Similar, close to wide spacing									
	75.0	285+/-	75			60		88	2.5 3.5 5 4.5 3	
	Run 8, Similar, close to moderately close spacing, high angle joint from 79 to 80 feet									
	80.0	280+/-	80			60		65	3.5 2.5 3 3 3.5 4	
	Run 9, Similar, high angle joint from 84 to 84.5 feet									
	85.0	275+/-	85			60		78	3.5 5 6 5 4.5	
	Run 10, Similar, very close to close spacing									
	90.0	270+/-	90			57		75	2 2.5 3 2.5 3	
	Run 11, Similar, close to moderately close spacing, vertical joint from 94.5 to 95 feet									
	95.0	265+/-	95			60		76	2.5 6.5 6 8.5 12	
	Run 12, Similar, increased quartz content from 95 to 96 feet, high angle joint from 96 to 96.5 feet									
	100.0	260+/-	100			51		73	17 22 32 4 3.5	
	Run 13, Similar, high angle joint at 102 feet									
	105.0	255+/-	105			60		82	3.5 3.5 3 3 3.5	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *32.2' on 8/8/17*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/3/2017 Boring Completed: 8/8/2017

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

Project No.: J217P078

BORING LOG NO. B6-1E South Chester Road East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION

Latitude: 39.95009° Longitude: -75.510435°

Approximate Surface Elev: 360 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
	Run 14, Similar, high angle joints at 106, 107, and 109 feet									
	110.0	250+/-	110			60		63	3 3.5 3.5 3 3.5	
	Run 15, Similar, high angle joint at 112 feet									
	115.0	245+/-	115			58		73	2 3 4 5 4	
	Run 16, Similar, high angle joint at 119 feet									
	120.0	240+/-	120			57		81	3 2.5 3 3.5 3	
	Boring Terminated at 120 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

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
Artesian pressure observed while coring from 115 to 120 feet

WATER LEVEL OBSERVATIONS

▽ *32.2' on 8/8/17*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/3/2017 Boring Completed: 8/8/2017

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

Project No.: J217P078

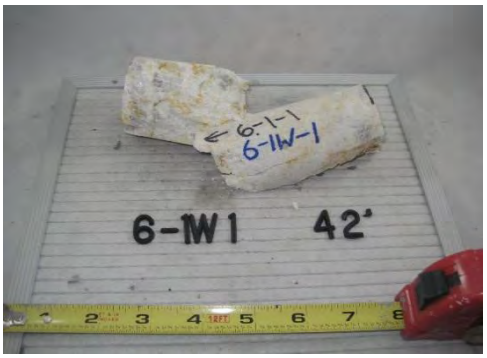
ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B6-1W	Lithology :	Gneiss
Sample No.:	1	Moisture Content :	As received
Sample Depth:	42 feet	Lab Temperature :	70° F
Sampling Date:	9/7/17	Loading Rate:	55 psi/s
		Time to Failure:	4 min

Diameter:	1.97 in	Maximum Axial Load at Failure:	12,240 lb
Length:	4.54 in	Compressive Strength:	4,016 psi
L/D:	2.30	Compressive Strength:	27.69 Mpa
End Area:	3.05 in^2	Unit Weight	158 pcf

Before the Test

After the Test



Drawing # : PA-CH-0459.0000-RDa_RDb
PO # : 20170804-16
Crossing : South Chester Road
Spread : Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/9/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/10/2017

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

Boring No.:	B6-1W	Lithology :	Gneiss
Sample No.:	3	Moisture Content :	As received
Sample Depth:	81.5 feet	Lab Temperature :	70° F
Sampling Date:	9/7/17	Loading Rate:	55 psi/s
		Time to Failure:	2 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	7,340 lb
Length:	4.48 in	Compressive Strength:	2,384 psi
L/D:	2.26	Compressive Strength:	16.44 Mpa
End Area:	3.08 in^2	Unit Weight	133 pcf

Before the Test

After the Test

Drawing # :	PA-CH-0459.0000-RDa_RDb
PO # :	20170804-16
Crossing :	South Chester Road
Spread :	Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	A. Suprunenko
Project No.	J217P078		Test Date:	9/13/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/10/2017

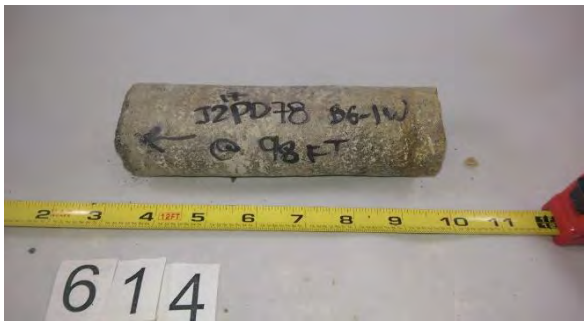
ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Boring No.:	B6-1W	Lithology :	Gneiss
Sample No.:	4	Moisture Content :	As received
Sample Depth:	98 feet	Lab Temperature :	70° F
Sampling Date:	9/7/17	Loading Rate:	55 psi/s
		Time to Failure:	2 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	5,830 lb
Length:	3.57 in	Compressive Strength:	1,893 psi
L/D:	1.80	Compressive Strength:	13.05 Mpa
End Area:	3.08 in^2	Unit Weight	168 pcf

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

Before the Test



After the Test

Photograph after the test is not available

Drawing # : PA-CH-0459.0000-RDa_RDb
PO # : 20170804-16
Crossing : South Chester Road
Spread : Spread 6

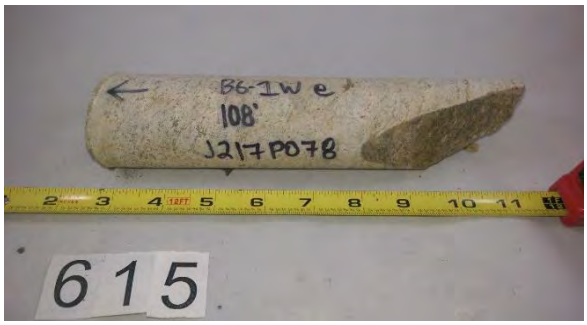
Project:	Mariner East Pipeline	Terracon	Performed by:	A. Suprunenko
Project No.	J217P078		Test Date:	9/13/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/10/2017

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

Boring No.:	B6-1W	Lithology :	Gneiss
Sample No.:	5	Moisture Content :	As received
Sample Depth:	108 feet	Lab Temperature :	70° F
Sampling Date:	9/7/17	Loading Rate:	55 psi/s
		Time to Failure:	6 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	18,240 lb
Length:	4.57 in	Compressive Strength:	5,924 psi
L/D:	2.31	Compressive Strength:	40.84 Mpa
End Area:	3.08 in^2	Unit Weight	162 pcf

Before the Test



After the Test

Drawing # : PA-CH-0459.0000-RDa_RDb
PO # : 20170804-16
Crossing : South Chester Road
Spread : Spread 6

Project:	Mariner East Pipeline	Terracon		Performed by:	A. Suprunenko
Project No.	J217P078			Test Date:	9/13/2017
Location:	Spread 6			Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire		Review Date :	10/10/2017

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

Boring No.:	B6-1W	Lithology :	Gneiss
Sample No.:	6	Moisture Content :	As received
Sample Depth:	118 feet	Lab Temperature :	70° F
Sampling Date:	9/7/17	Loading Rate:	55 psi/s
		Time to Failure:	2 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	6,610 lb
Length:	4.62 in	Compressive Strength:	2,147 psi
L/D:	2.33	Compressive Strength:	14.80 Mpa
End Area:	3.08 in^2	Unit Weight	171 pcf

Before the Test

After the Test

Drawing # :	PA-CH-0459.0000-RDa_RDb
PO # :	20170804-16
Crossing :	South Chester Road
Spread :	Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	A. Suprunenko
Project No.	J217P078		Test Date:	9/13/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/10/2017

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

Boring No.:	B6-1E	Lithology :	Gneiss
Sample No.:	1	Moisture Content :	As received
Sample Depth:	57 feet	Lab Temperature :	70° F
Sampling Date:	8/3/17	Loading Rate:	55 psi/s
		Time to Failure:	5 min

Diameter:	1.98 in	Maximum Axial Load at Failure:	14,980 lb
Length:	4.48 in	Compressive Strength:	4,865 psi
L/D:	2.26	Compressive Strength:	33.54 Mpa
End Area:	3.08 in^2	Unit Weight	167 pcf

Before the Test

After the Test

Drawing # :	PA-CH-0459.0000-RDa_RDb
PO # :	20170804-16
Crossing :	South Chester Road
Spread :	Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/11/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/11/2017

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

Boring No.:	B6-1E	Lithology :	Gneiss
Sample No.:	2	Moisture Content :	As received
Sample Depth:	65 feet	Lab Temperature :	70° F
Sampling Date:	8/3/17	Loading Rate:	55 psi/s
		Time to Failure:	10 min

Diameter:	1.99 in	Maximum Axial Load at Failure:	32,620 lb
Length:	4.52 in	Compressive Strength:	10,488 psi
L/D:	2.27	Compressive Strength:	72.31 Mpa
End Area:	3.11 in^2	Unit Weight	166 pcf

Before the Test

After the Test

Drawing # : PA-CH-0459.0000-RDa_RDb
PO # : 20170804-16
Crossing : South Chester Road
Spread : Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/11/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/11/2017

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

Boring No.:	B6-1E	Lithology :	Gneiss
Sample No.:	3	Moisture Content :	As received
Sample Depth:	77 feet	Lab Temperature :	70° F
Sampling Date:	8/3/17	Loading Rate:	55 psi/s
		Time to Failure:	0 min

Diameter:	N/A in	Maximum Axial Load at Failure:	N/A lb
Length:	N/A in	Compressive Strength:	N/A psi
L/D:	N/A	Compressive Strength:	N/A Mpa
End Area:	N/A in^2	Unit Weight	N/A pcf

Specimen broke during preparation

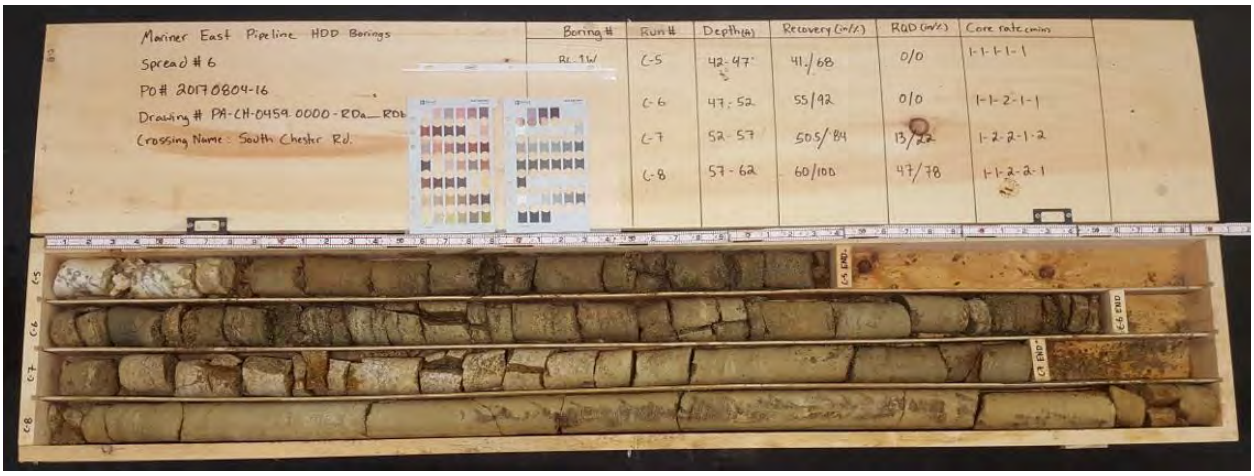
Before the Test

After the Test

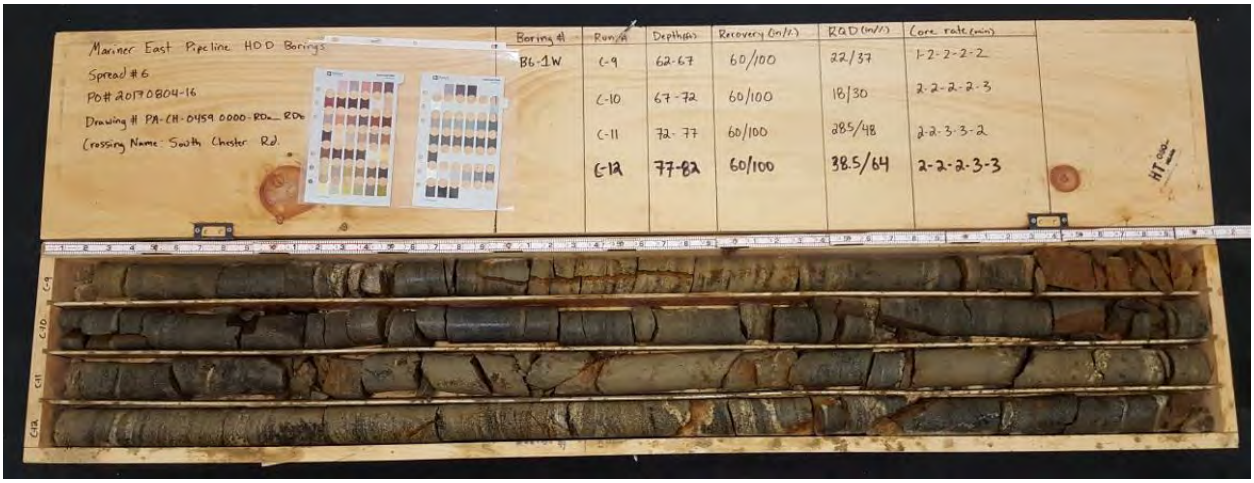
Drawing # : PA-CH-0459.0000-RDa_RDb
PO # : 20170804-16
Crossing : South Chester Road
Spread : Spread 6

Project:	Mariner East Pipeline	Terracon	Performed by:	H. Whitford
Project No.	J217P078		Test Date:	10/11/2017
Location:	Spread 6		Reviewed By :	L.Dwyer
Client :	Directional Project Support Inc.	77 Sundial Ave., Suite 401 W Manchester, New Hampshire	Review Date :	10/11/2017

Photograph 1: B6-1W, Samples C-1 to C-4 (22 to 42 feet)



Photograph 2: B6-1W, Samples C-5 to C-8 (42 to 62 feet)



Photograph 3: B6-1W, Samples C-9 to C-12 (62 to 82 feet)

Photograph 4: B6-1W, Samples C-13 to C-16 (82 to 102 feet)

Photograph 5: B6-1W, Samples C-17 to C-20 (102 to 122 feet)

Photograph 6: B6-1W, Samples C-21 to C-24 (122 to 142 feet)

Photograph 7: B6-1W, Samples C-25 to C28 (142 to 158.3 feet)

Photograph 1: B6-1E, Samples C-1 to C-4 (40 to 60 feet)

Photograph 2: B6-1E, Samples C-5 to C-8 (60 to 80 feet)

Photograph 3: B6-1E, Samples C-9 to C-12 (80 to 100 feet)

Photograph 4: B6-1E, Samples C-13 to C-16 (100 to 120 feet)

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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

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

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

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

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

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

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

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

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

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

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

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

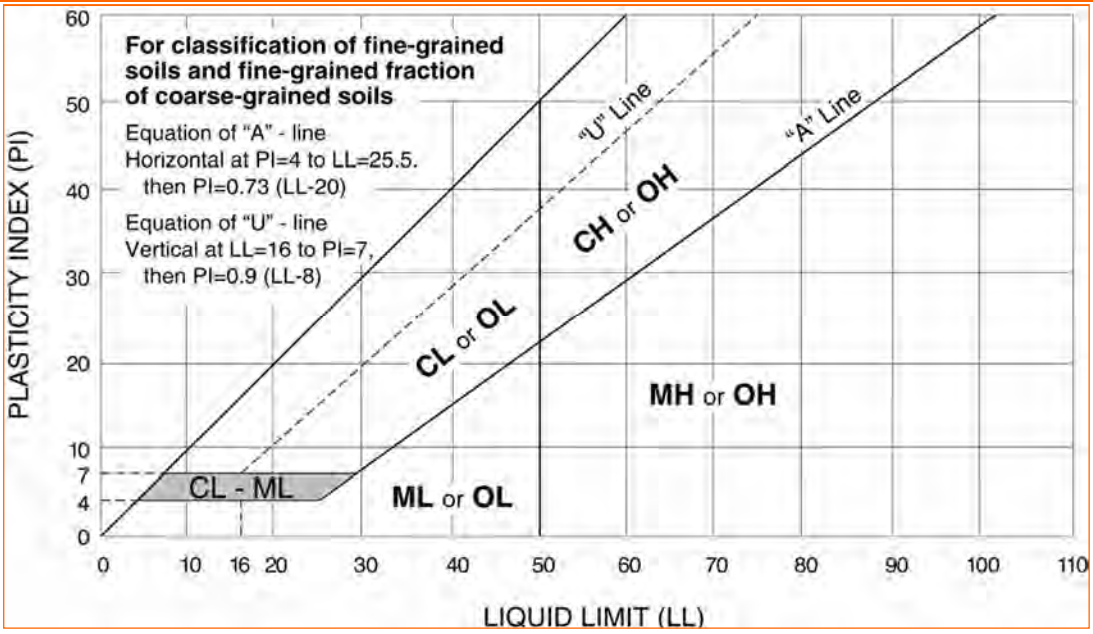
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very Slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately Severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very Severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.
HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

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

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

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

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

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

ATTACHMENT 2

WATER SUPPLY ILLUSTRATION

Map Locator ID	GES Well ID	Distance to HDD Perpindicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
				Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
1	WL-08112017-606-01	173	1,292	83	Unknown	Unknown
2	WL-01202017-551-01	54	1,808	100	Unknown	75
3	WL-11072017-634-01	84	2,494	Unknown	Unknown	Unknown
4	WL-11142017-610-01	102	2,648	Unknown	Unknown	Unknown
5	WL-11072017-639-01	74	2,606	Unknown	Unknown	Unknown
6	WL-11062017-631-01	470	2,506	75	Unknown	65
7	WL-08112017-606-02	110	2,703	Unknown	Unknown	40
8	WL-08112017-606-03	66	2,785	Unknown	Unknown	Unknown
9	WL-03082017-551-01	54	2,891	Unknown	Unknown	Unknown
10	WL-01242017-551-04	103	2,896	85	Unknown	NA
11	WL-03102017-551-02	108	2,960	200	Unknown	Unknown
12	WL-11092017-611-02	552	2,828	75	Unknown	Unknown
13	WL-11062017-618-01	383	2,867	Unknown	Unknown	Unknown
14	WL-03102017-551-03	121	2,805	Unknown	Unknown	Unknown
15	WL-01232017-551-03	83	2,726	170	30	160
16	WL-01232017-551-01	68	2,553	195	1	185
17	WL-11062017-612-01	258	2,417	~200	Unknown	~100
18	WL-11102017-630-02	331	2,595	Unknown	Unknown	Unknown
19	WL-03242017-477-02	301	2,094	LO Unavailable	LO Unavailable	LO Unavailable
20	WL-11152017-619-01	326	2,424	~150	Unknown	120
21	WL-03152017-477-03	292	2,007	Unknown	Unknown	Unknown
22	WL-02212017-551-02	47	2,158	60	Unknown	40
23	WL-03152017-477-02	1,225	1,809	500	5-10	300
24	WL-11132017-611-01	47	2,054	65	15	Unknown
25	WL-11072017-638-01	61	1,962	40	Unknown	Unknown
26	SP-08152017-604-02	192	1,776	NA	NA	NA
27	WL-08152017-604-03	184	1,755	Unknown	Unknown	Unknown
28	WL-11142017-634-01	590	1,375	~350	~50	320
29	WL-11142017-613-01	372	1,864	Unknown	Unknown	Unknown
42	WL-12082017-634-01	779	485	Unknown	Unknown	Unknown
31	WL-03152017-477-01	545	1,362	400	50-60	300
32	WL-11072017-638-02	636	1,968	230	~40	210
33	WL-11132017-638-01	283	1,501	Unknown	Unknown	Unknown
34	WL-07132017-606-01	205	1,171	283	70	Unknown
35	WL-05102017-604-03	292	1,312	Unknown	Unknown	Unknown
36	WL-11102017-630-01	506	1,485	105	Unknown	Unknown
37	WL-06012017-475-01	459	945	300	Unknown	Unknown
38	WL-03242017-477-01	127	277	Unknown	Unknown	Unknown
39	WL-01232017-551-02	83	389	LO Unavailable	LO Unavailable	LO Unavailable
40	WL-08152017-604-01	228	228	50	Unknown	Unknown
41	WL-03272017-551-02	171	233	Unknown	Unknown	Unknown

Legend

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

****Testing locations current as of 12/11/2017**

- GES Testing Location
- GES Spring Testing Location

Location

Well Location Map
HDD# PA-CH-0421.0000-RD
Chester County, PA.

Prepared By: TETRA TECH

Date: 12/12/2017

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

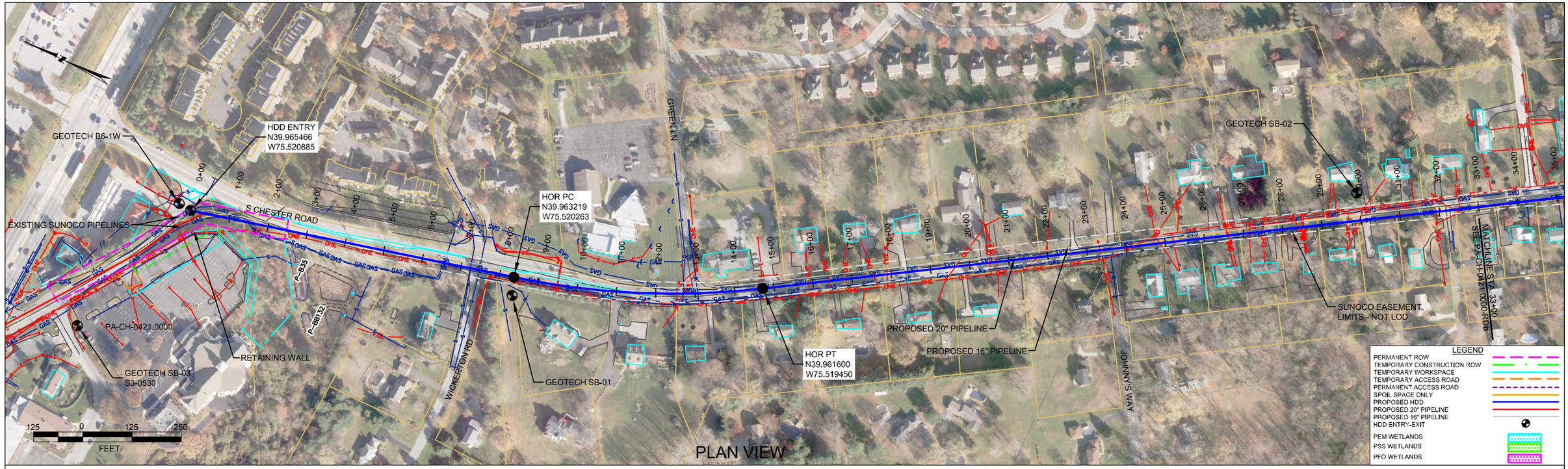
Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\0938-PPP\MXD\WellLocations\WellLocation_PA_CH_0421_0000.mxd LN

ARCH BISHOP/SOUTH CHESTER ROAD CROSSING
PADEP SECTION 105 PERMIT NO. E15-862
PA-CH-0421.0000-RD & PA-CH-0421.0000-RD-16
(SPLP HDD No. S3-0541)

ATTACHMENT 3

HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541

GEOTECH B6-1W

- NG EL. 405'
- -ASPHALT (0.0' - 0.3')
- -GRAVEL (0.3' - 1.5')
- -WEATHERED ROCK (1.5' - 22.0')
- -GNEISS (22.0' - 158.3')
- -BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

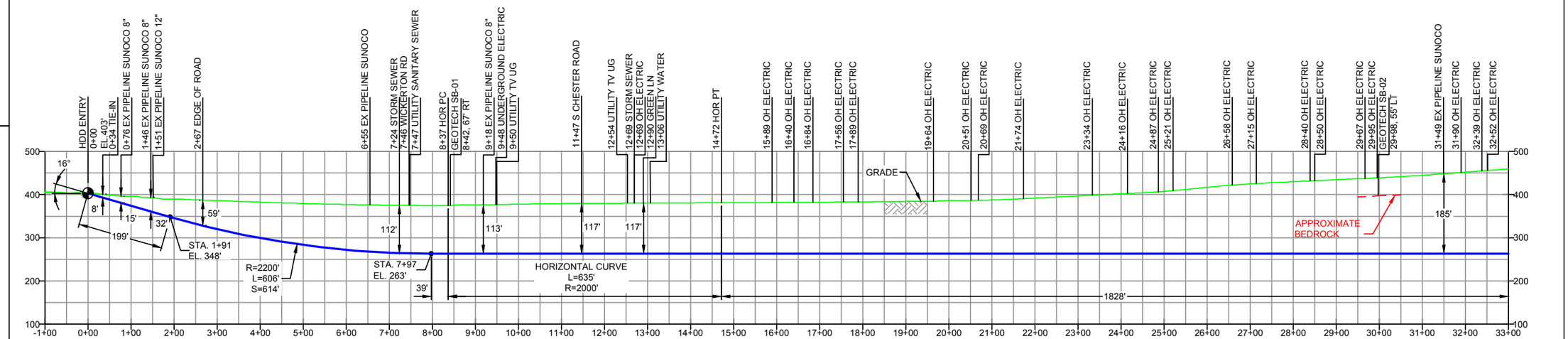
GEOTECH SB-01

- NG EL. 376'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 30.0')
- -GROUNDWATER (25.0')
- -COMPLETION DEPTH EL. 346'

GEOTECH SB-02

- NG EL. 439'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 11.5')
- -SM (11.5' - 23.5')
- -SM / GM (23.5' - 32.0')
- -FELSIC GNEISS (32.0' - 42.0')
- -COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 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=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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 NO 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.

Figure 1-A. 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-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
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	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

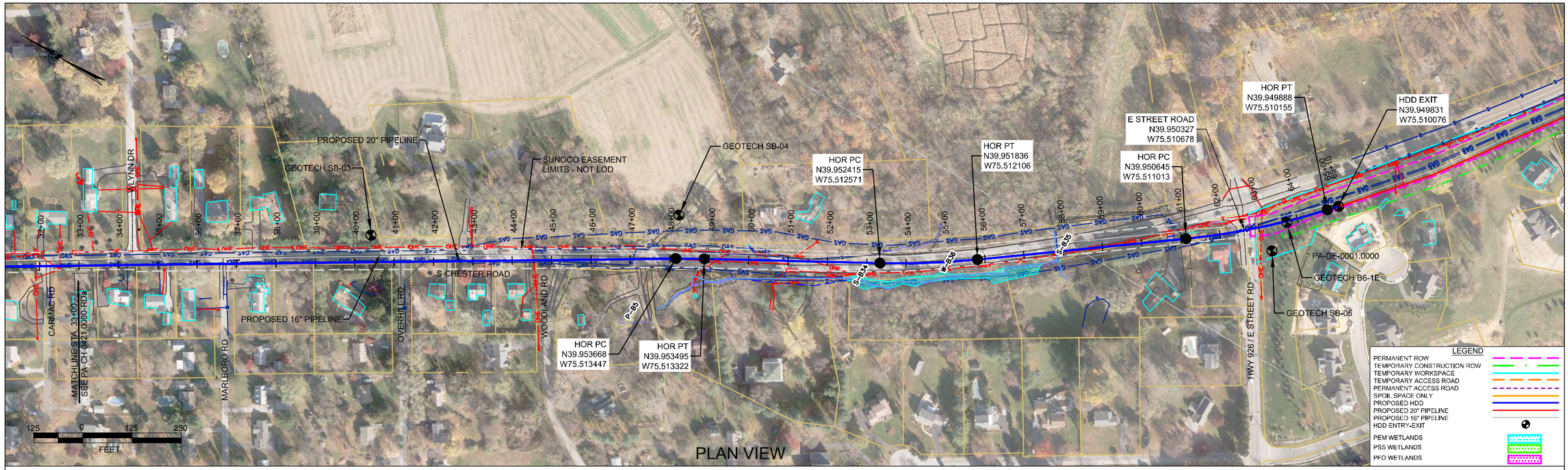
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDa



PLAN VIEW

PROFILE VIEW

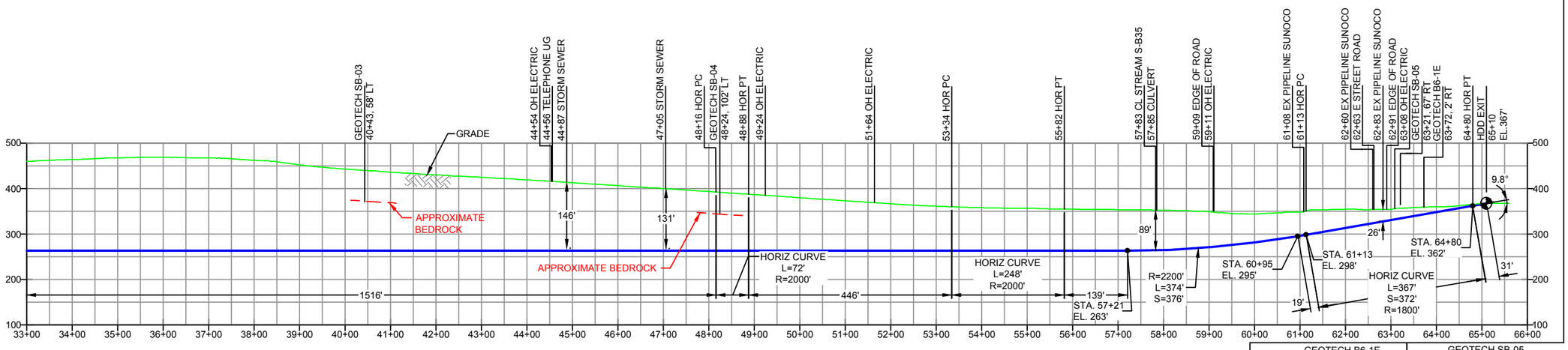
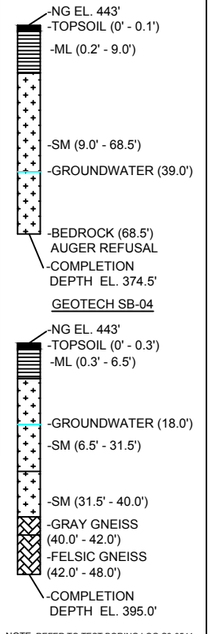


Figure 1B. 20-Inch HDD Plan and Profile



CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541

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=):6510'
   HDD PIPE LENGTH (S=):6534'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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 NO 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.

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-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN	
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
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	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

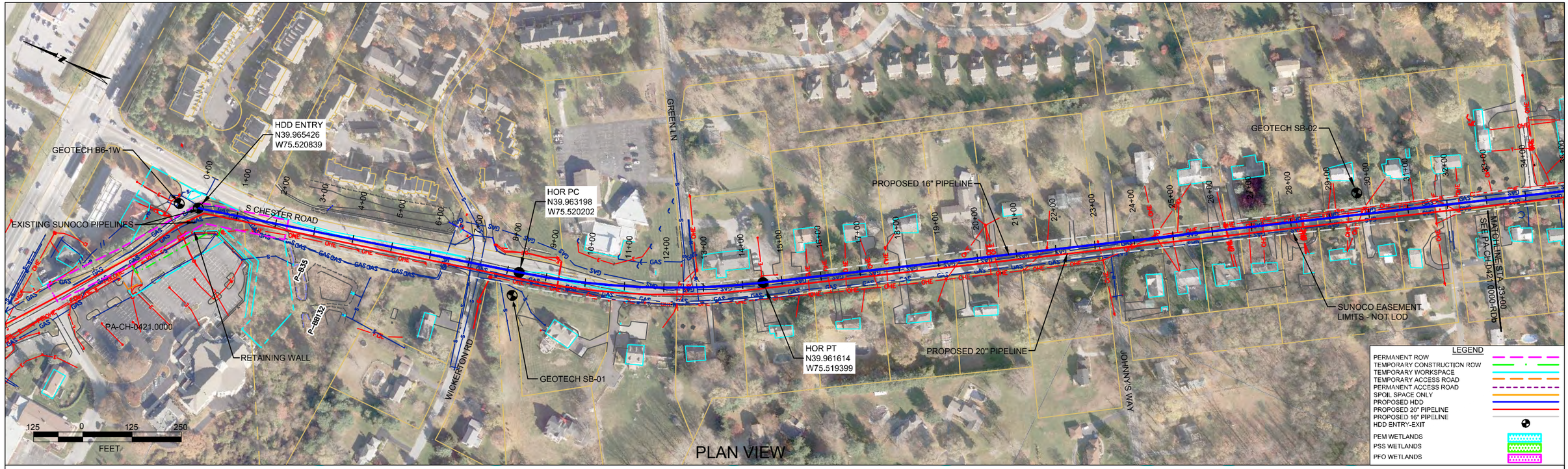
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250'

DWG. NUMBER: PA-CH-0421.0000-RDb



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16

GEOTECH B6-1W

- NG EL. 405'
- -ASPHALT (0.0' - 0.3')
- -GRAVEL (0.3' - 1.5')
- -WEATHERED ROCK (1.5' - 22.0')
- -GNEISS (22.0' - 158.3')
- -BORING TERMINATED EL.246.7'

NOTE: REFER TO TEST BORING LOG B6-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

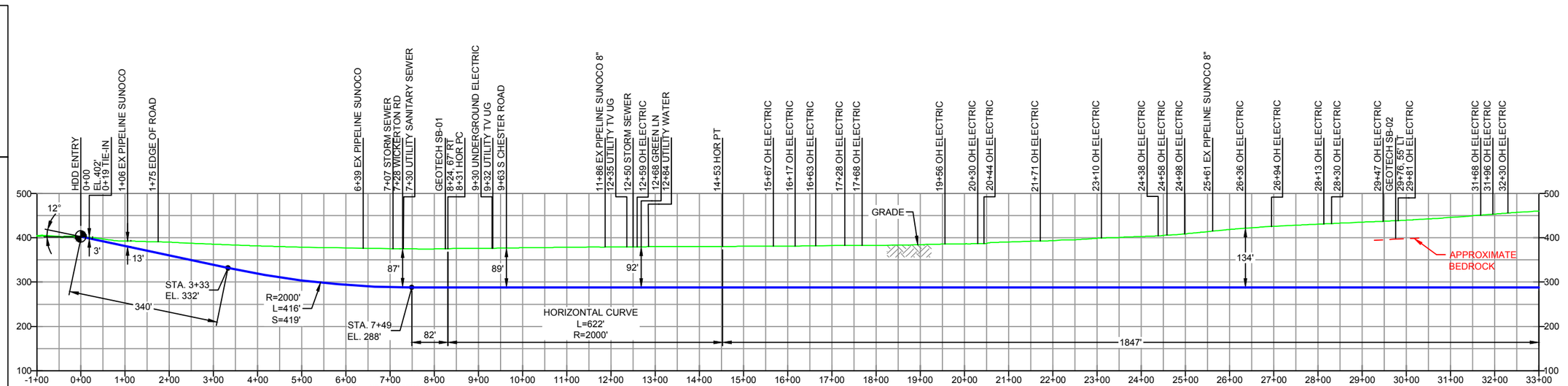
GEOTECH SB-01

- NG EL. 376'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 30.0')
- -GROUNDWATER (25.0')
- -COMPLETION DEPTH EL. 346'

GEOTECH SB-02

- NG EL. 439'
- -TOPSOIL (0' - 0.3')
- -SM (0.3' - 11.5')
- -SM (11.5' - 23.5')
- -SM / GM (23.5' - 32.0')
- -FELSIC GNEISS (32.0' - 42.0')
- -COMPLETION DEPTH EL. 397'

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION



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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):6548'
   HDD PIPE LENGTH (S=):6562'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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 NO 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.

Figure 2A: 16-Inch HDD Plan and Profile

NOTES

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REF. DRAWING

ES-6.70	TO	ES-6.01	EROSION & SEDIMENT PLAN
SHEET 46	TO	SHEET 1	AERIAL SITE PLAN
DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/27/17	RMB	11/27/17	AMC	11/27/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/08/17	AMC	11/08/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

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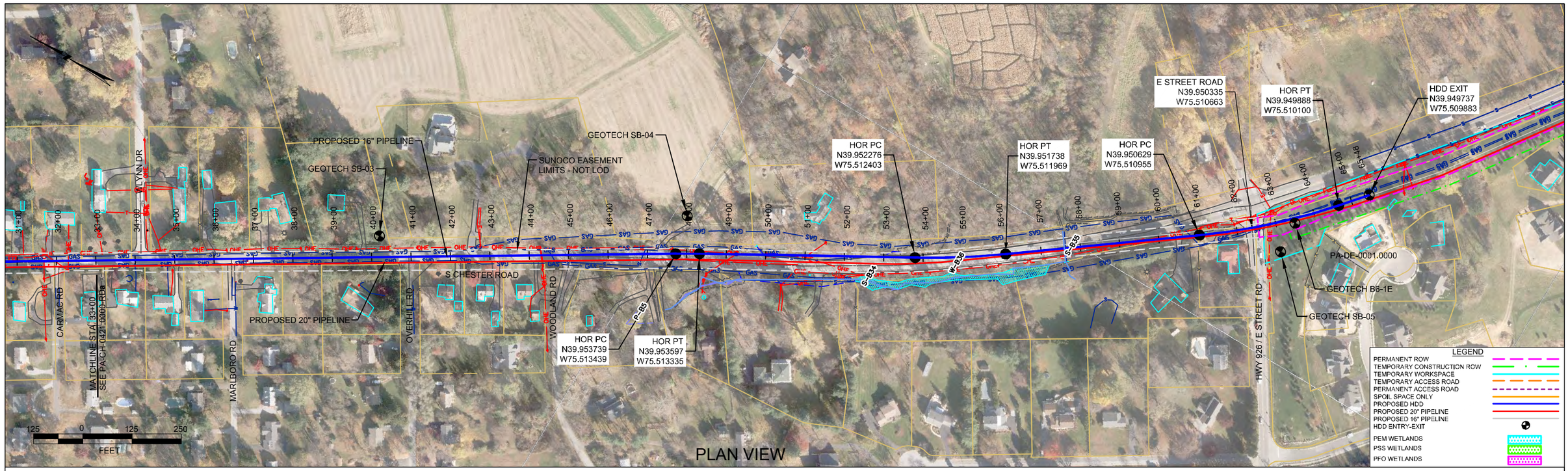
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
S CHESTER ROAD / HWY 926
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' | DWG. NUMBER: PA-CH-0421.0000-RDa-16



PLAN VIEW

PROFILE VIEW

CHESTER/DELAWARE COUNTY PENNSYLVANIA, WESTTOWN/EDGMONT TOWNSHIP
S3-0541-16

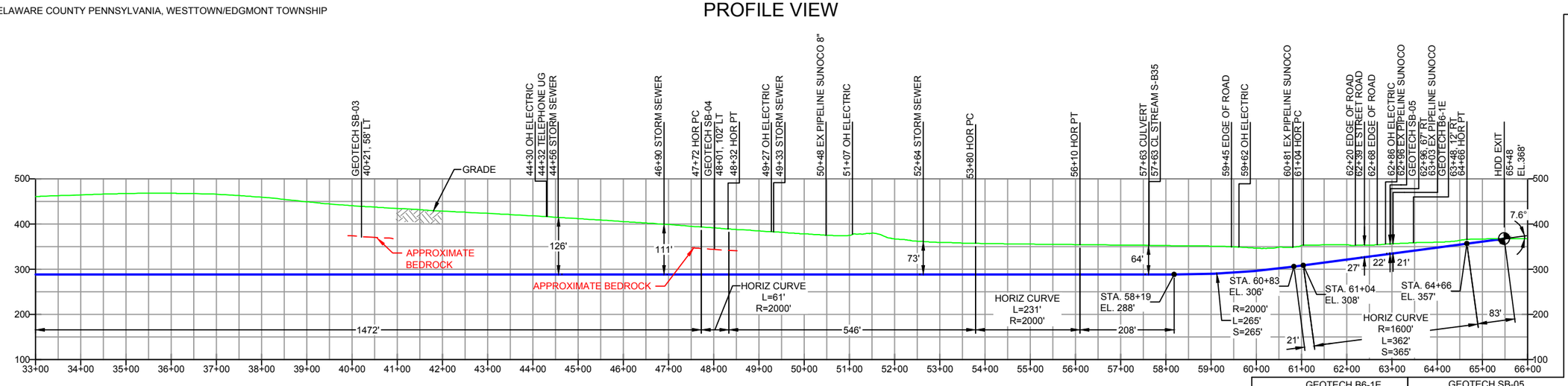
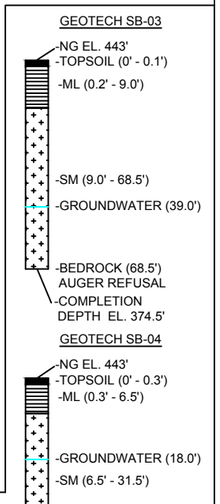


Figure 2B: 16-Inch HDD Plan and Profile



NOTE: REFER TO TEST BORING LOG B6-1E TERRACON PROJECT #J2177P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTE: REFER TO TEST BORING LOG S3-0541 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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SHEET 46	TO	SHEET 1	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

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