HORIZONTAL DIRECTIONAL DRILL ANALYSIS
STRASBURG ROAD / BOW TREE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

STRASBURG ROAD / BOW TREE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

This reanalysis of the horizontal directional drill (HDD) installation of a 16-inch and 20-inch diameter pipeline crossing under Strasburg Rd. and Bow Tree Dr. in East Goshen Township, Chester County, Pennsylvania is in accordance with the Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 2 of the Stipulated Order. The 20-inch HDD is number 25 on the list of HDDs included on Exhibit 2. The 16-inch HDD is number 19 on the list of HDDs included on Exhibit 3. Collectively, these HDDs are referred to herein as HDD S3-0520. The 20-inch HDD pilot hole was initiated and then suspended for further evaluation 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.

HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 3,800 feet (ft)
- Entry angle: 10 - 12 degrees
- Maximum depth of cover: 80 ft
- Average depth of cover: 45 ft
- Pipe design radius: 2,000 ft

HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 3,807 ft
- Entry angle: 10 - 12 degrees
- Maximum depth of cover: 85 ft
- Average depth of cover: 45 ft
- Pipe design radius: 1,600 ft

GEOLOGIC AND HYDROGEOLOGIC ANALYSIS

HDD S3-0520 is located within the Piedmont Uplands Section of the Piedmont Physiographic Province in Southeast Pennsylvania. The Piedmont Uplands Section is characterized by broad, rounded to flat-topped hills and shallow valleys with low to moderate topographic relief. Bedrock in the area of HDD S3-0520 is composed of Precambrian- to early Paleozoic-aged weathered Baltimore Gneiss basement. The geology of this region is generally composed of meta-igneous and metasedimentary rocks of Proterozoic to Early- to Mid-Paleozoic age that have been severely folded and fractured. The rocks in the area of the HDD S3-0520 are strongly foliated, folded, fractured, and sheared.

No quarries or mines were identified within 1,000 ft of the HDD S3-0520 right-of-way (ROW) by the eMapPA database (PADEP 2017).

Based on published and documented geologic data, no karst features are anticipated within the region of HDD S3-0520; therefore, no geophysical studies were conducted for this reevaluation.

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

BOW TREE DRIVE / STRASBURG ROAD CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

The Baltimore gneiss unit mapped beneath the HDD S3-0520 location is identified as a unit of relatively poor groundwater production. Nonetheless, significant quantities of water can flow through discrete fracture or shear zones. Groundwater flow occurs through fractures, faults, and lithologic contacts in the metamorphic rocks and through pores and residual fractures in weathered rock and soils (Low et al. 2002).

This geologic unit serves as a source of potable water for many households in East Goshen Township. Review of the PaGWIS database (PA DCNR 2017) identified 562 wells in similar geology in East Goshen Township, Chester County. Median depth to water was reported at 26.8 feet, ranging between 1.7 and 165 ft bgs. Based on geotechnical borings conducted at this HDD, groundwater ranges from depths of 15 to 29.5 ft below ground surface (bgs). The production zone for waters wells in this formation is from the well bottom to highest point of water inflow from the water bearing overburden above competent bedrock, and seams, joints, and fractures in the upper bedrock of the formation.

As discussed below in the Adjacent Features section, most residences in the area of this HDD appear to be on public water.

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

INADVERTENT RETURNS DISCUSSION

No inadvertent returns (IRs) were reported along the alignment of the HDD S3-0520 drill on the list of IRs for Mariner East I documented in the IR Preparedness, Prevention and Contingency Plan (PPC) Plan for Chester County.

Minor fluid losses and IRs occurred during the initial pilot hole of phase of the 20-inch pipeline between May 15 and July 21, 2017. Two IRs of approximately 100 and 70 gallons were observed near the corner of Glenmont Lane and State Route 352, when the pilot drill bit was at approximately 1,776 ft from entry (on June 7, 2017) and 2,686 ft from entry (on July 11, 2017) respectively. Losses of returns (LORs) were observed in these same areas, during tripping-in operations. The fracture trace analysis indicates possible zones of fracture concentration intersecting at these locations along the HDD profile and the soil overburden above the original HDD profile in these locations area is relatively thin.

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 could be improved to lower the risk of IRs to the land surface and LORs.

Two recent geotechnical cores at each end of the HDD were utilized in the profile redesign. At the west core location bedrock starts at 60 ft bgs. Initial bedrock values are poor, the recovery value is 50 and rock quality designation (RQD) is 17. This quickly transitions and at 65 ft bgs the recovery value is 100 and RQD value is 60. Proceeding to profile depth, recovery values are 100, and the RQD value is 77. At the southeast entry point, bedrock commences at 40 ft bgs. Bedrock values are poor throughout the entire depth of core to 70 ft.

The best management practices in the Reconsideration of the Horizontal Directional Drill section below, lists the measures that will or may be employed to minimize or prevent IRs and Loss of Circulation during implementation of these HDDs.

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ADJACENT FEATURES ANALYSIS

The crossing of Strasburg Road / Bow Tree Dr. is located in East Goshen Township, Chester County, approximately 3.8 miles east of the community of West Chester, and 15 miles west of Philadelphia, Pennsylvania.

The pipeline route follows parallel to two existing SPLP pipelines and runs parallel to and on the west side of State Route 352 (North Chester Road) between Bow Tree Drive and Williams Way. At this HDD location, private residences, commercial buildings, sidewalks, driveways, and various utilities (e.g. overhead and underground electric lines, sewage lines, underground telephone line, and a gas lines) are immediately adjacent to the existing permanent utility easement, parallel to and crossing perpendicular to the easement. The presence of these structures necessitated the use of HDD construction techniques to avoid effects to pubic infrastructure, utilities, and residences at this location. Additionally, this HDD avoids impacts to Wetland H31, a palustrine emergent (PEM) wetland.

SPLP has identified all landowners with property located within 450 ft of the HDD alignment. There are 119 parcels 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 31, 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 Project 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, and Office of Programs at PADEP's Central Office.

The results of SPLP's public outreach has identified the presence of ten (10) water wells within 450 ft of the proposed HDD. Additionally, SPLP has confirmed the majority of the parcels within 450 ft of the HDD alignment are serviced by public water. A depiction of the identified private water well and those with public water service is provided in Attachment 2.

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, on either side of the profile, and wells out to 175 ft on either side of the profile set along potential identified fracture zones where water flow in the geology is less restrained. There are no unidentified water supplies out to 175 ft along suspected fracture lines. Use of the wells within this area draws upon the ground water reserves through underground porosity, fissures, and fractures. 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 final outreach 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 450 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.

ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of S3-0520 included an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Mariner East II Project (Mariner II), SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the Project, SPLP considered a number of different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. 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 and Conventional Bore Analysis

Considering the number and location of adjacent surface development, infrastructure and utilities, an excavation of sufficient size to accommodate any variation of open trench construction method would result in disturbances to residences, and damages or disruption of service on existing utility lines; therefore, the open trench alternative is not preferred.

A conventional auger bore is a practical means of pipeline installation where the topography is conducive, groundwater is manageable, and the length is ideally less than 200 ft, varying by substrate conditions at the location. The horizontal length of this crossing (greater than 3,800 ft) is beyond the technically practicable limits of an auger bore to complete regardless of substrate conditions; and the curvature of the alignment prevents use of auger bore since it is a “non-steerable” bore method.

Re-Route Analysis

In accordance with state and federal guidance, SPLP has routed this crossing to be co-located with existing pipelines and other utility corridors to avoid new “greenfield” routing alignments, to the maximum extent practicable. This avoids and minimizes new and permanent impacts on previously undisturbed land, land use encumbrance, and site-specific and cumulative impacts on land, environmental, and community resources.

The general orientation of the existing SPLP easement, and planned route of pipeline installation is from the northwest to the southeast.

Approximately 1-mile northeast, an existing pipeline utility corridor, containing three pipelines, parallels the route of the Mariner II project, generally at a 1.0 to 1.5-mile offset without intersecting the Mariner II route for miles to the northwest or southeast. 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 through residential developments in a new greenfield corridor until an intersect is achieved. Once the alternate corridor is accessed, the Mariner II 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.

No practicable re-route option lies to the southwest of the proposed route that would not transect the same infrastructure transected by the proposed route. Any reroute considered would be a new utility corridor requiring consent of newly-affected landowners or the use of eminent domain/condemnation, and would create a new utility encumbrance on every property crossed.

Lastly, the current route utilizes existing easements that were occupied by 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.

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 a redesign of the HDDs for the 16-inch and 20-inch diameter pipelines would reduce the risk of drilling fluid loss, IRs, and water supply impacts from HDD construction.

A summary of the redesign factors is provided below.

Revised Horizontal Directional Drill Design Summary: 20-inch

- Horizontal length: 3,842 foot (ft)
- Entry/Exit angle: 15 degrees
- Maximum Depth of cover: 111 ft
- Pipe design radius: 2,000 – 2,400 ft

Revised Horizontal Directional Drill Design Summary: 16-Inch

- Horizontal length: 3,890 ft
- Entry/Exit angle: 10 - 12 degrees
- Maximum Depth of cover: 85 ft
- Pipe design radius: 2,000 – 2,200 ft

Upon the restart of these HDDs, SPLP will employ the following HDD best management practices:

- SPLP will provide the drilling crew and company inspectors the location(s) data on potential zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path, so that monitoring can be enhanced when drilling through these locations;

- 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 drive;

- 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 the development of pressures that can induce an IR;

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

- SPLP will mandate short-tripping of the reaming tools to ensure an open annulus is maintained to manage the potential inducement of IRs;

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

- During 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;

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

- If necessary, the pilot hole and reaming phases at the point of entry for the HDD may utilize casing, hammered into the substrate down to structurally better rock, to prevent vertical or lateral movement of drilling fluids at shallow depths.

CONCLUSION

It is SPLP's intent to abandon the original profile designs and to pursue deeper and longer HDD profiles. Figures 1 and 3 in Attachment 2 presents the original HDD plan and profiles. Figure 2 and 4 present the revised HDD plan and profiles.

STRASBURG ROAD / BOW TREE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

ATTACHMENT 1

GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

HDD HYDROGEOLOGIC REEVALUATION REPORT

Mariner East II
Spread 6
HDD S3-0520
SR 352 / Strasburg Road / Bow Tree Drive
East Goshen Township, Chester County, Pennsylvania

Prepared for:

Sunoco Pipeline, L.P.

Prepared by:

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

January 2018

HDD HYDROGEOLOGIC REEVALUTION REPORT

Mariner East II
Spread 6
HDD S3-0520
SR 352 / Strasburg Road / Bow Tree Drive
East Goshen Township, Chester County, Pennsylvania

December 2017

Prepared for:

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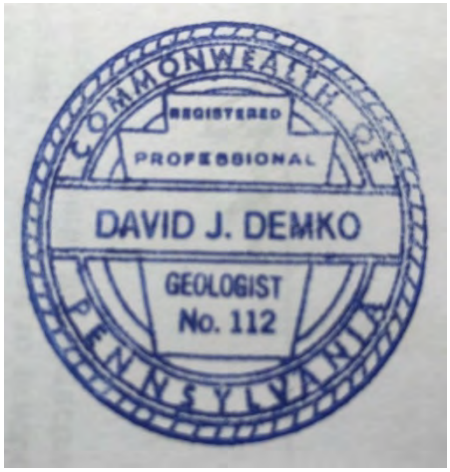
By affixing my seal to this document, I am certifying that the information is true and correct. I further certify I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information.



January 17, 2018

David J. Demko, P. G. Date

Lic. No. PG000112G

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1.0 INTRODUCTION

Sunoco Pipeline, L.P. (SPLP), retained Groundwater & Environmental Services, Inc. (GES) to prepare a horizontal directional drill (HDD) Hydrogeologic Reevaluation Report (HRR) for HDDs listed on Exhibit 2 of Stipulated Order EHB Docket No. 2017-009-L signed August 10, 2017. This HRR has been prepared for both the 20-inch and 16-inch pipe associated with the Mariner East II pipeline project at State Route (SR) 352 / Strasburg Road / Bow Tree Drive, PA-CH-0400.0000-RD (HDD S3-0520-20 and HDD S3-520-16), hereinafter collectively referred to as HDD S3-0520. HDD S3-0520 runs parallel to and on the west side of SR 352 (North Chester Road) between Bow Tree Drive / Anne Drive and White Chimney Road, crossing Strasburg Road, in East Goshen Township, Chester County, PA. A map depicting the location of the HDD with topographic information on the surrounding area is presented as **Figure 1**.

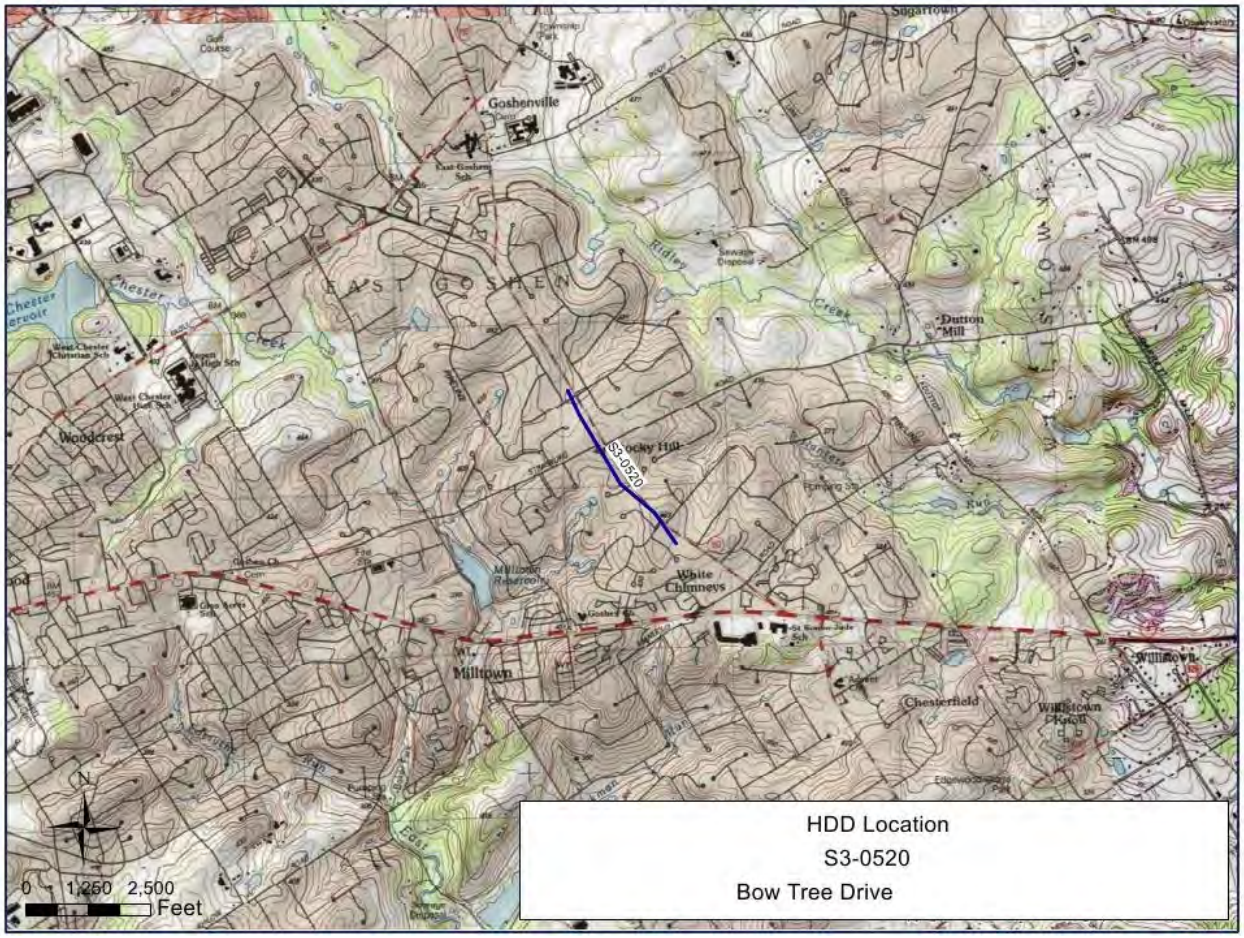

Figure 1. Site Location Map (modified from USGS West Chester, PA 1:24,000 Topo. Quad., rev. 1975)

As described in the Stipulated Order (pages 3 and 4), this HRR will provide information to eliminate, reduce, or control the release or inadvertent return (IR) of HDD drilling fluids to the surface of the ground or impact to water supplies at the location during HDD operations. This report presents the following information:

- Geologic and hydrogeologic characteristics in the area of HDD S3-0520;
- Summaries of studies performed pertinent to reevaluation, including fracture trace analysis and geotechnical borings;
- A site conceptual model; and

- A reevaluation summary with conclusions and recommendations.

The contents of this report were developed from interpretation of published information, field observations during initial HDD pilot hole drilling, and related field studies. Site geotechnical boring programs were conducted by Tetra Tech in June through December 2015, and more recently by Terracon Consultants, Inc. (Terracon) in August and September 2017 in support of the HDD S3-0520 reevaluation process. Please note that GES did not oversee or direct either geotechnical drilling program, including, but not limited to, the selection of number and location of borings; determination of surface elevations; target depths; observations of soil, rock cores, and water levels 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 the two SPLP contractors. GES relied on these reports and incorporated their data into the general geologic and hydrogeologic framework for this HRR.

2.0 HDD GEOLOGY / HYDROGEOLOGY

The discussion presented in this report is based on the alignment plan and profiles developed by Tetra Tech/Rooney for both the 20-inch and 16-inch pipe installation. This was originally submitted in the IR PPC Plan for Chester County (rev. 9/30/16 and 10/7/2016), then revised and provided in support of this reevaluation (rev. 1/5/18). The plans and profiles can be found in **Attachment A** of this report.

2.1 Physiography

HDD S3-0520 is located within the Piedmont Uplands Section of the Piedmont Physiographic Province in Southeast Pennsylvania. The Piedmont Uplands Section is characterized by broad, rounded to flat-topped hills and shallow valleys with low to moderate topographic relief. The geology of this region is generally comprised of meta-igneous and metasedimentary rocks of Proterozoic to Early- to Mid-Paleozoic age that have been severely folded and fractured.

2.1.1 Topography

The topography in the area of HDD S3-0520 has moderate relief, with a ground surface elevation at the northwestern entry/exit point of 450 feet above mean sea level (ft. amsl), and the entry/exit point 3,842 feet to the southeast at an elevation of 448 ft amsl (**Figure 1**). The revised plan and profile for the 20-inch line shows the northwest and southeast ends to be located between coordinates N39.979336 / W75.537796 and N39.970715 / W75.530144, respectively. The 16-inch line entry/exits are offset from these positions. The HDD profiles show topography gently undulating, with each entry/exit point located at topographic lows, separated by two topographic highs. Near the northwest entry/exit the elevation increases to a maximum elevation of approximately 485 ft amsl; from the southeast entry/exit the elevation increases to a maximum elevation of approximately 465 ft amsl. Between the two topographic rises, the elevation decreases to approximately 448 ft amsl, where the HDDs cross under Glenmont Lane. The HDD alignments are located in uplands, approximately 3,500 feet west of Ridley Creek, which has an elevation of approximately 320 ft amsl, and approximately 3,250 feet east of the East Branch Chester Creek, which also has an elevation of approximately 320 ft amsl. The difference in elevation between the northwestern and southeastern entry/exits for both pipes is 2 feet less to the southeast.

The original plan and profile for the 20-inch pipeline design, dated September 30, 2016, was modified slightly for the January 5, 2018 revision (**Attachment A**) by extending the northwest entry/exit point and southeast entry/exit points a total of 42 feet longer than the original plan length. The horizontal drill length is now 3,842 feet long. The angle of entry/exit was increased from 12 to 15 degrees at the northwest end and from 10 to 15 degrees at the southeast end, and the profile depth was increased approximately 31 feet, including the area beneath Glenmont Lane, where there was a previous IR during ME II drilling (see **Section 3.1.2**). The present 20-inch HDD alignment path was relocated to the original 16” pipeline alignment path.

The original plan and profile for the 16-inch pipeline design, dated October 7, 2016, was modified slightly for the January 5, 2018 revision (**Attachment A**) by extending the northwest entry/exit point and southeast entry/exit points a total of 83 feet longer than the original plan length. The horizontal drill length is now 3,890 feet long. The angle of entry/exit remains the same at both ends; however, the profile depth was increased approximately 16 feet, including the area beneath Glenmont Lane, where there was a previous IR during ME II drilling (see **Section 3.1.2**). The 16-inch HDD alignment path was relocated to the original 20-inch pipeline alignment path.

2.1.2 Hydrology

HDD S3-0520 lies within the Chester Creek Watershed (Sloto, 1994). The nearest surface water body to the HDD is a small tributary to Ridley Creek, approximately 1,000 feet northeast of the northwestern entry/exit location and veering away from the HDD path. Ridley Creek is located approximately 3,500 feet

east of the HDD. A small pond is located approximately 1,500 feet northwest of the northwestern entry/exit point of HDD S3-0520, which connects to Milltown Reservoir, approximately 3,250 feet to the southwest of HDD S3-0520, which flows to the south and empties into the East Branch Chester Creek. Hunters Run originates approximately 1,750 feet to the northeast of HDD S3-520, and flows generally east, away from the HDD.

2.2 Geology

2.2.1 Soils

Overburden materials along the drill paths in the area of HDD S3-0520 were characterized by four geotechnical borings installed by Tetra Tech (S3-0510-SB-02, S3-0520-SB-01, S3-0520-SB-02, and S3-0520-SB-03; **Attachment B**), the two more recent deep borings logged by Terracon (B6-7W and B6-7E; **Attachment B**), and the USDA NRCS Web Soil Survey for Chester and Delaware Counties (USDA NRCS, 2017).

Soil thickness along the drill paths range from 15 feet to 56 feet below ground surface (ft bgs) as defined in the geotechnical borings. The geotechnical boring logs describe the soils with textures ranging from sand and silt to lean clay with silt. Soil taxonomy includes Urban Land Udorthents (schist and gneiss complex, typically a silty clay loam overlaying schist and/or gneiss bedrock), Urban Land Gladstone Complex (typically a gravelly loam or gravelly clay loam overlaying granite or gneiss bedrock), and Gladstone gravelly loam (typically a gravelly or sandy clay loam over granite and gneiss bedrock [USDA NRCS, 2017]).

The geotechnical boring logs describe variegated and micaceous sands and silts with weathered rock overlaying competent bedrock, indicating the presence of saprolite. Saprolite inherits properties of the bedrock, including fractures that may act as preferential flow paths for drilling fluids.

Near the northwest entry/exit point, boring logs S3-0510-02 and B6-7W describe approximately 15 to 16.5 feet of silty clay and sand and silt, overlaying decomposed rock. Near the southeast entry/exit point, boring logs S3-0520-SB-03 and B6-7E describe approximately 30 to 40 feet of sandy clay and sandy silt, overlaying decomposed rock. Overall the clay content in these overburden soils relative to coarser grained material does not appear to be large enough to significantly reduce the risk of IRs upon entry and exit when compared to soils with higher clay content.

2.2.2 Bedrock Lithology

Bedrock in the area of HDD S3-0520 is comprised of Precambrian- to early Paleozoic-aged weathered Baltimore Gneiss basement, exposed in this area as part of the West Chester Massif (Blackmer, 2005). This unit is a quartzofeldspathic granulite facies consisting of a lineated, coarse-grained quartz-plagioclase-potassium feldspar-orthopyroxene-clinopyroxene-garnet-biotite gneiss. The lineation is defined by mafic (dark) minerals concentrated in narrow streaks. Regional fabric (relict bedding and structure) strikes northeast/southwest. **Figure 2** depicts the orientation of HDD S3-0520 within the quartzofeldspathic granulite facies gneiss.

2.2.3 Structure

The rocks in the area of the HDD S3-0520 site experienced multiple episodes of metamorphism. They are strongly foliated, folded, fractured, and sheared. The six geotechnical borings installed along the HDD S3-0520 alignment were advanced to depths between 30 and 105 feet. The borings recorded “very close” to “moderately close” fractures/joints in the competent gneiss. At least three sets of fracture patterns (striking Approximately N25-35°W, N65-80°W, and N10-40°E) are indicated by fracture trace analysis (**Section 2.2.4**). These appear to coincide with regional foliation and tectonic and neotectonic stress directions (Blackmer, 2005).

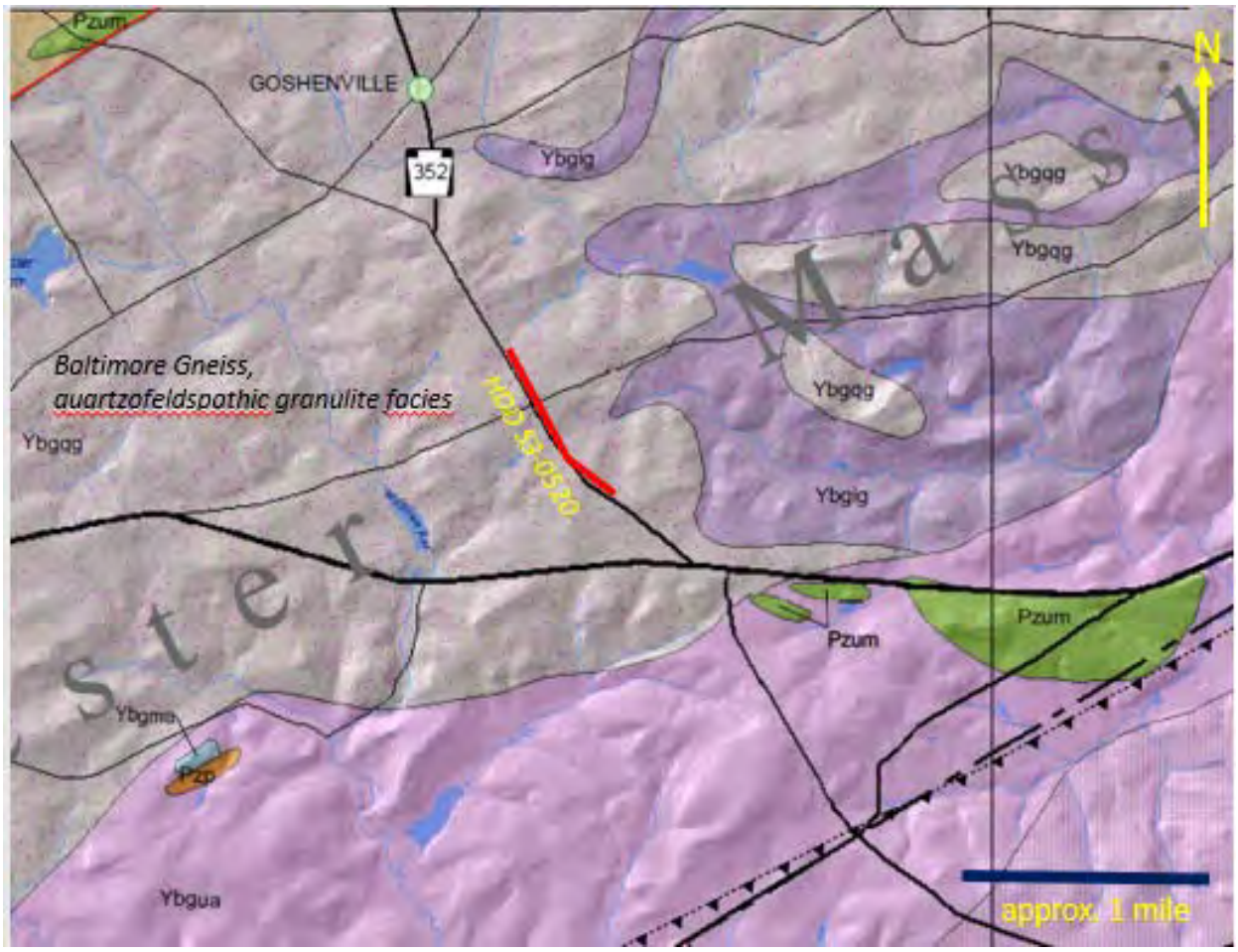

Figure 2. Site Geology (modified from Blackmer, 2005)

2.2.4 Fracture Trace Analysis

A fracture trace analysis using high altitude aerial photography was performed for the area of interest to identify potential zones of bedrock weakness along the drill path. 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.

Aerial photos were obtained through the Pennsylvania Imagery Navigator (PASDA, 2017). Fracture traces and lineaments were mapped using stereo pair images at the 1:20,000-scale recorded by USDA in 1937 (**Figure 3**). Four north-northeast trending possible fracture traces and one north-northeast-trending possible fracture zone were mapped crossing the HDD S3-0520 alignment: two possible fracture traces intersecting near the northwest entry/exit point, one possible fracture trace at approximately 30 percent, one possible fracture trace at approximately 50 percent, and one possible fracture zone at approximately 90 percent of the distance from the northwest entry/exit point toward the southeast entry/exit point. Two more sets of possible fracture traces oriented in an approximate range from west-northwest to northwest orientation were also mapped in the area, but do not appear to intersect the HDD S3-0520 alignment. The approximate locations of these fracture lineaments were also mapped on the most recent P&Ps (**Attachment A**).

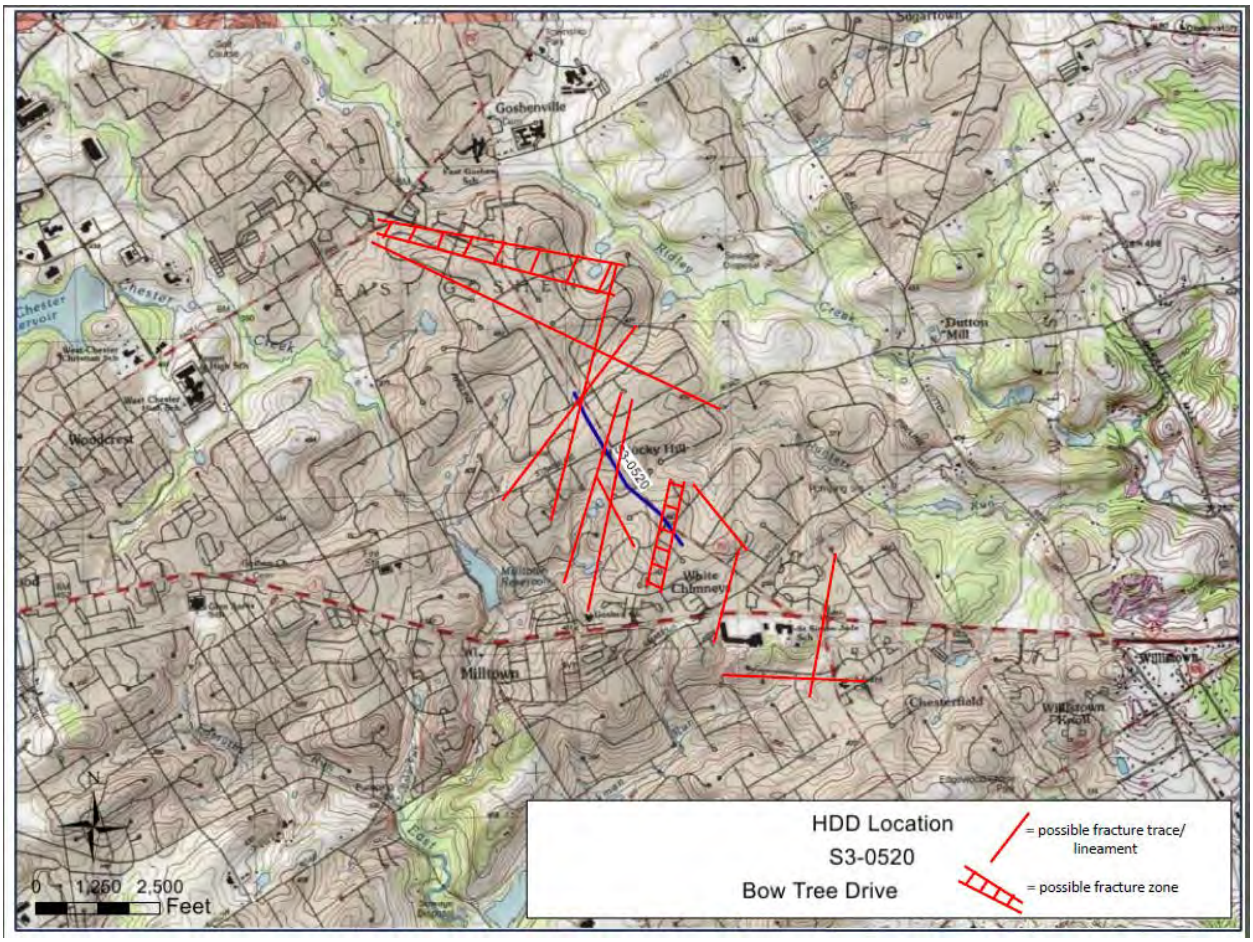

Figure 3. Fracture Trace Map (modified from USGS West Chester, PA 1:24,000 Topo. Quad., rev. 1975, and Pennsylvania Imagery Navigator (PASDA, 2017) USDA stereoimagery)

2.2.5 Karst

Based on published and documented geologic data, no karst features are anticipated within the region of HDD S3-0520. The area is underlain by gness facies and is void of carbonate formations.

2.2.6 Mining

No quarries or mines were identified within 1,000 feet of the HDD S3-0520 ROW by the eMapPA database (PADEP, 2017).

2.2.7 Rock Engineering Properties

Rock unconfined compressive strength was determined by Terracon for samples collected from boring B6-7W; Tetra Tech attempted to collect a rock core from boring S3-0520-SB-01, but could not retrieve a competent sample for testing (**Attachment B**). Mean unconfined compressive strength of a schist/gneiss sample from 70 ft bgs in B6-7W was 13,449 per square inch (psi). This value is similar to the compressive strength reported in the literature of 8,381 psi for schist and 25,230 psi for gneiss (Johnson and Degraff, 1988). Note, however, that the numerous weathered, fractured, and sheared zones encountered by these boreholes indicate that in-situ the compressive strength may be significantly lower than reported by the laboratory.

2.2.8 Results of Geotechnical Borings

Original Geotechnical Borings
Four geotechnical borings (Tetra Tech borings S3-0510-SB-02, S3-0520-SB-01, S3-0520-SB-02, and S3-0520-SB-03) were installed to support the original boring profile design. The locations for these borings are shown on the original plan and profile in **Attachment A** and the logs are provided in **Attachment B**. The boring logs report depths to bedrock at >30 feet, 64 feet, 56 feet, and >30 feet for S3-0510-SB-02, S3-0520-SB-01, S3-0520-SB-02, and S3-0520-SB-03, respectively. Groundwater was encountered at a depth of 15 to 22 feet for S3-0510-SB-02, 25 feet for S3-0520-SB-01, 29.5 feet for S3-0520-SB-02, and 28 feet for S3-0520-SB-03. Soils included silty clay, sand and silt, silty sand, silt, and traces of gravel. Rock core collected in boring S3-0520-SB-02 reported mostly decomposed rock with only slight recovery and too small a specimen to test for compressive strength.

Recent Geotechnical Borings
Two geotechnical borings were drilled by Terracon in August and September 2017 with the objective of collecting rock core from the maximum planned depth of the HDD. Boring B6-7W is located near the northwest entry point and B6-7E is located within the ROW near the southeast entry point. The locations for these borings are shown on the map included with the boring logs in the Terracon GeoReport provided in **Attachment B**. Boring B6-7W reported weathered and friable rock from 15 to 60 ft bgs, underlain by highly weathered and fractured schist from 60 to 65 ft bgs, and gneiss or schist/gneiss with moderately close to very close fracture spacing below 65 feet to the maximum cored depth of 105 feet. Boring B6-7E encountered highly weathered gneiss from 40 to 70 ft bgs, where the boring was terminated and no rock coring was performed.

Rock Quality Designation (RQD) of core collected from boring B6-7W showed a general increase in RQD from 17% at 60 to 65 ft bgs to 100% at 85 to 90 ft bgs. However, it decreased below this interval, to a value of 63% at 90 to 95 ft bgs. Thus, bedrock strength as indicated by RQD is variable at the location of the boring and is expected for bedrock in the area of the HDD site, in general. No bedrock coring was performed at boring B6-7E.

2.3 Hydrogeology

2.3.1 Occurrence of Groundwater
The Baltimore Gneiss unit mapped beneath the HDD S3-0520 location is identified as a unit of relatively poor groundwater production. Nonetheless, significant quantities of water can flow through discrete fracture or shear zones. This unit serves as an important source of potable water for many households in the area, although most residences in the area of HDD S3-0520 are on public water (**Figure 4**). The geotechnical borings reported depths to groundwater between 15 and 29.5 ft bgs. This area is in a groundwater recharge zone, and groundwater is expected to flow generally toward the south and southwest toward the tributary to East Branch Chester Creek and toward East Branch Chester Creek proper.

Groundwater flow at HDD S3-0520 occurs through fractures, faults, and lithologic contacts in the metamorphic rocks and through pores and residual fractures in weathered rock and soils (Low et al., 2002). Depth to groundwater ranges from 5 to 40 ft bgs with reported well yields ranging from 3 to 30 gallons per minute (gpm) (Hall, 1934). Fracture flow is likely to promote seasonal fluctuations in the water table (between 5 and 15 feet).

2.3.2 Ground Elevation Between HDD Entry/Exits
The slight difference in elevation of only 2 feet between the northwestern entry/exit (elevation 450 ft amsl) and the southeastern entry/exit (elevation 448 ft amsl) indicates that HDD activities at this location are not expected to produce excessive groundwater discharge at either entry/exit. The highest topographic point along the alignment is approximately 485 ft amsl, midway along the profile (**Attachment A**). During initial drilling activities at the northwest entry/exit point, excessive surface water was observed to collect and

flood the drill pad, due to its lower elevation with respect to surrounding areas that caused surface water to accumulate during rain events.

2.3.3 Water Level

Groundwater was encountered at depths of 15 to 22 feet for boring S3-0510-SB-02, 25 feet for boring S3-0520-SB-01, 29.5 feet for boring S3-0520-SB-02, and 28 feet for boring S3-0520-SB-03. Based on reported depths to water and topography from the plan and profile drawings, the water table appears to have a relatively low gradient, ranging in elevation between 416.5 and 431 ft amsl along the bore path. A review of the Pennsylvania Groundwater Information System (PaGWIS) database (PA DCNR, 2017) identified 562 wells in similar rocks in East Goshen Township, Chester County. Median depth to water was reported at 26.8 feet, ranging between 1.7 and 165 ft bgs.

2.3.4 Well Yields

Median yield reported for 562 wells completed in East Goshen Township, Chester County rocks was 15.3 gallons per minute (gpm), ranging from 0.5 to 100 gpm. This is consistent with the median well yield of 12 gpm reported in the literature for wells completed in gneiss throughout Southeast Pennsylvania (Low et al., 2002).

2.3.5 Water Supply Wells within 450 feet of ROW

Approximately 119 properties lie within 450 feet of the HDD S3-0520 ROW. Ten (10) residential wells within 450 feet of the ROW were identified and sampled during two phases of preconstruction surveying and sampling associated with the ME II project (**Figure 4**). Two (2) additional properties with residential wells are within 450 feet of the ROW and, although their supply wells are not within 450 feet, they were also sampled. Thirteen (13) properties have no available information, so the nature of their water supplies is unknown. Approximately 94 properties located within 450 feet of the ROW were confirmed to be connected to public water and have no supply well. Median well depth of the residential wells sampled within 450 feet of HDD S3-0520 is approximately 120 ft bgs (of the 12 sampled during preconstruction assessment, only six (6) were able to be measured). According to PaGWIS, median well depth in East Goshen Township, Chester County is 156 ft bgs, approximately 50 feet deeper than the HDD boring.

There are no municipal water supply wells or municipal surface intakes indicated on the PaGWIS database within 1,000 feet of HDD S3-0520; the closest surface water body is a tributary to Ridley Creek located approximately 1,000 feet east of the LOD.

The water utility for East Goshen Township has been identified as Aqua America, Inc. (Aqua Pennsylvania, Inc.).

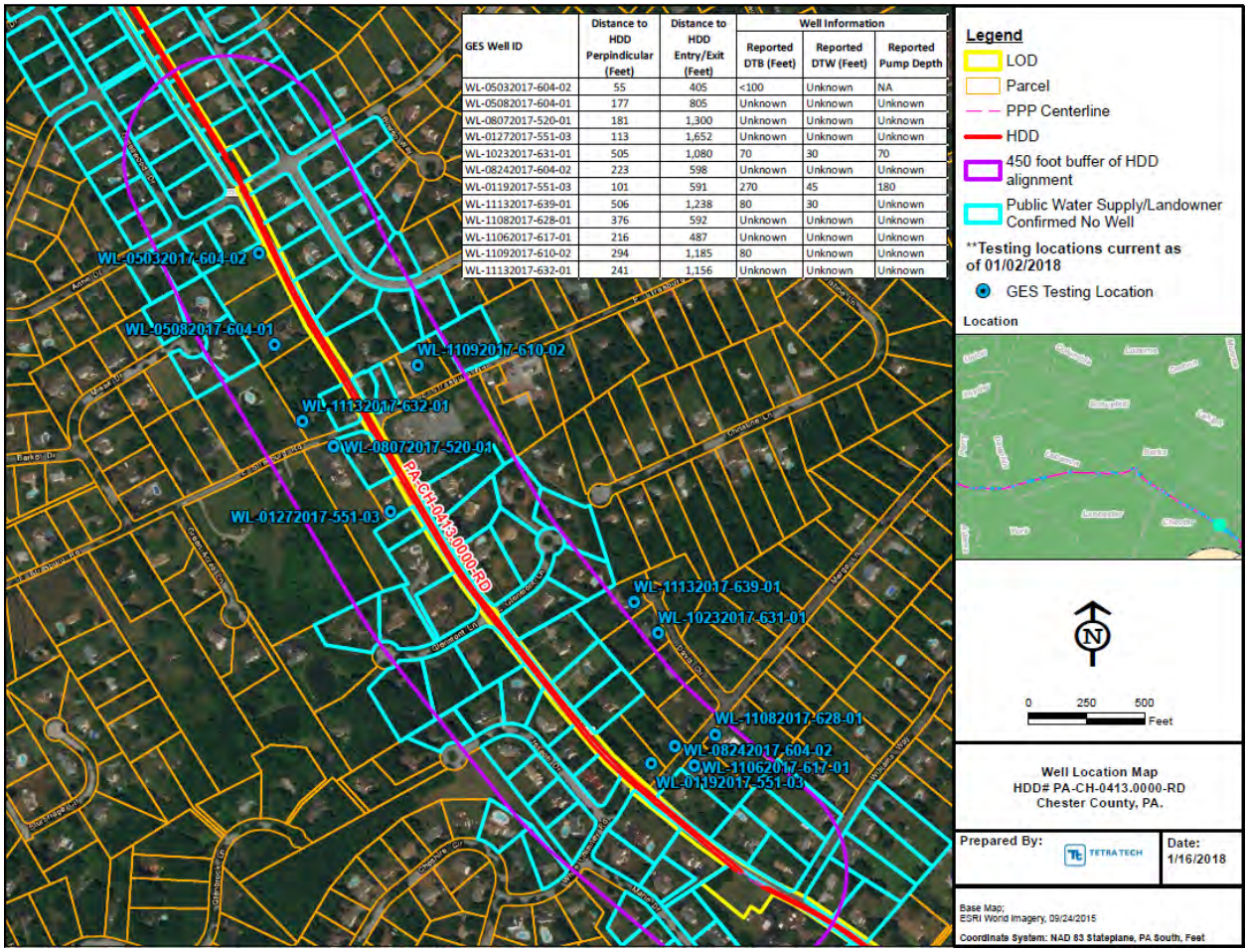

Figure 4. Sampled Residential Wells

2.4 Summary of Geophysical Studies

No geophysical studies were conducted for this reevaluation. There is no indication of karst development in the area and deep mining has not been identified beneath the HDD alignment.

3.0 OBSERVATIONS TO DATE

3.1 On This HDD Alignment

3.1.1 ME I

No IRs were reported along the alignment of the HDD S3-0520 drill on the list of IRs for ME I documented in the IR PPC Plan for Chester County (rev. August 2017). It appears that the segment of ME I pipeline in the area of HDD S3-0520 was installed by repurposing existing 12" pipeline; no new HDD activities occurred in this area.

3.1.2 ME II

Minor fluid losses and IRs have occurred at HDD S3-0520, during pilot drilling of the 20-inch pipeline (active between May 15, 2017 and July 21, 2017). Two IRs of approximately 100 and 70 gallons were observed near the corner of Glenmont Lane and SR 352, when the pilot drill bit was at approximately 1,776 feet (on June 7, 2017) and 2,686 feet (on July 11, 2017), respectively, from the northwest entry point. Losses of returns (LORs) were observed in the same area, during tripping-in operations. The fracture trace analysis (**Figure 3** and **Attachment A**) indicates possible zones of fracture concentration intersecting in that part of the profile and the soil overburden in that area is relatively thin.

3.2 On Other HDD Alignments in Similar Hydrogeologic Settings

3.2.1 ME I

One IR was reported on the list of IRs for ME I documented in the IR PPC Plan for sites underlain by the Baltimore Gneiss, near the location of HDD S3-0570 to the southeast (ME I Drill #24). This previous IR location is located approximately 2.8 miles to the southeast of the southeast entry/exit end of HDD S3-0520. As stated in **Section 3.1.1**, it appears that the segment of ME I pipeline in the area of HDD S3-0520 was installed by repurposing existing 12" pipeline; no new HDD activities occurred in this area.

3.2.2 ME II

Minor fluid losses and IRs have occurred at nearby HDDs S3-0500 and S3-0560 as the pilot drills were ascending towards the surface and exit at shallow depths. Experience has demonstrated HDD IRs in this geologic setting can be related to shallow overburden (especially under water bodies), large elevation changes between entries and exits, coarse grained unconsolidated materials near the surface (such as weathered/decomposed rock), and the interconnectivity of open bedrock structural features that is difficult to predict. IRs often occur at lithologic boundaries, at entry/exit points, and at fracture crossings identified by fracture trace analysis. As the geology at HDD S3-0520 is similar to that at HDDs S3-0500 and S3-0560, the fracture density at this location indicates a potential risk for fluid losses and IRs.

4.0 SUMMARY AND CONCLUSIONS OF HDD HYDROGEOLOGIC EVALUATION

4.1 HDD Site Conceptual Model

HDD S3-0520 is located in an upland area that likely serves as a local groundwater recharge zone. The hydrogeologic conceptual model for HDD S3-0520 has groundwater flowing generally along topography away from the boring, mostly southwest towards East Branch Chester Creek and its tributaries. The low-lying entry/exit points with respect to the immediate surroundings indicates the likelihood of surface water accumulation and flooding at these points.

The fracture trace analysis identified linear features crossing the drill path near the northwest entry-exit and at (approximately) one-third and one-half the distance from the northwestern entry/exit point, and near the southeast entry/exit point. These lineaments represent potential vertical zones of fracture concentration, and where they cross the alignment there is a potential risk of drilling fluid losses and IRs. Variability in RQD values for rock core logged at B6-7W are indicative of weaker bedrock fracture zones as well. Risk of fluid losses and IRs is also increased near the entry/exit points as the bore passes through relatively non-cohesive saprolite and soil.

Approximately 94 properties within 450 feet of the ROW were confirmed to be supplied by public water. For the domestic wells associated with the 12 residences requesting preconstruction water sampling, the open bedrock zones likely occur at the same depth, or deeper than, the revised HDD boring profiles, which increases the risk of HDD construction affecting these water supplies. Thirteen properties within the 450-foot radius have an unknown water source (do not appear to be connected to public water nor did they request sampling of a water supply well). No public supply well information is provided in the PaGWIS database.

According to the East Goshen Township website, approximately 93% of the 8,500 residential units (and all of the businesses) in the township are connected to public sewer; 526 households are served by an on-lot septic system. Where the HDD bore passes near to and at the same depth as any septic systems, or where fracture traces/zones connect the borehole to septic system locations, the risk of IR is increased.

4.2 Recommendations

The synthesis of regional and local geologic and hydrogeologic information for the HDD S3-0520 site, combined with a history of LORs and IRs, suggests potential risk of drilling fluid loss, drilling difficulties, inadvertent returns, and water supply impacts from HDD construction. The location of the HDD along a groundwater recharge zone, a complex structural geology including a high degree of fracturing, and close proximity of residential wells significantly increases the risk at this site. Recommendations to mitigate these risks include the following:

- The drill crew should be oriented to the location(s) of zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path. Other zones of elevated risk include the borehole entry/exit points where drilling fluids may migrate through shallow soils and saprolite.

- Given the potential increased risk for fluid losses and IRs, a fluid loss mitigation plan (i.e., grouting or sealing) should be readied for implementation during construction.

- The results of residential well survey performed, where notification letters were mailed to all property owners within the 450’ buffer of the HDD, by ETP Land agents, indicates 13 properties

where no information was available to confirm the presence, absence or connection to a public water supply. A follow up door-to-door survey should be conducted to confirm the status of these locations and the nature of their respective water supplies.

- A plan to connect at-risk residents to a temporary alternative water supply should be prepared in case this is deemed necessary from the verification of complaints of impacted water observed during HDD operations.

- Properties that lie beyond the 450-foot buffer and are in alignment with the mapped geologic structural features (fracture traces/zone, faults), intersecting water bodies, or other identified high-risk indicator for the incidence of IRs should be identified. The locations of these properties should be surveyed for information on water supply type

- Existing surface drainage control and storm runoff management infrastructure in the areas of the HDD entry/exit should be evaluated. Prior operation experienced significant surface water flooding at the drill entry point following large rain events and snow melts.

- An effective traffic control plan should be maintained to allow safe inspection of the LOD during drilling, as the drill path lies directly along SR 352 and provides no off-shoulder walkways. This will also allow efficient response to any potential IR event and will allow safe ingress/egress to the drill pad location.

5.0 REFERENCES

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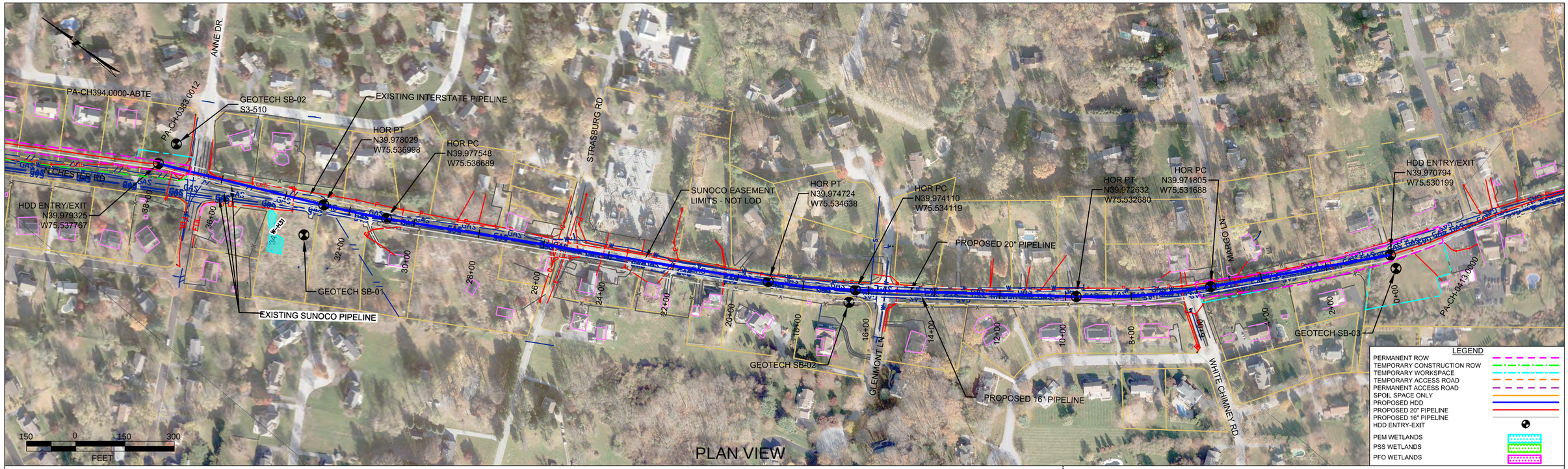
Attachment A

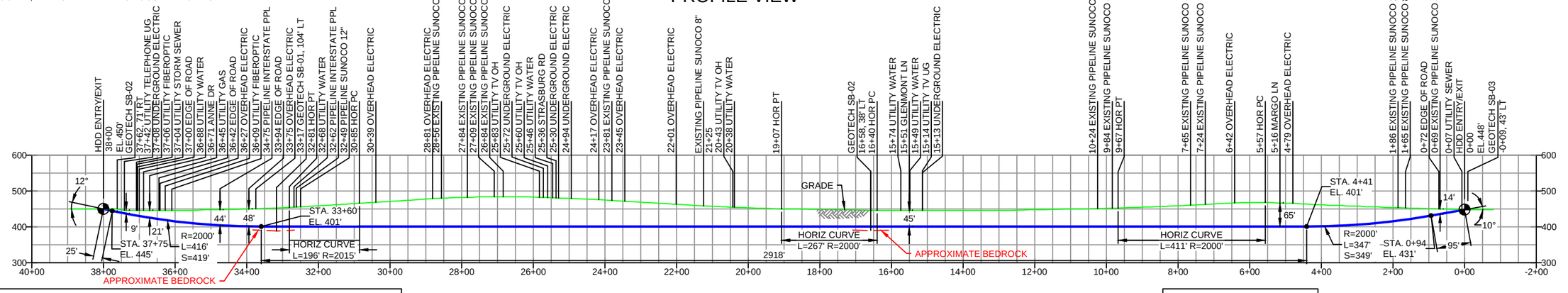
Original and Revised Plan and Profile



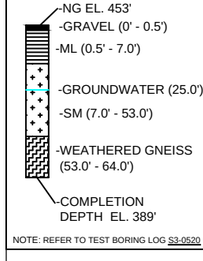
PLAN VIEW

PROFILE VIEW

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520



GEOTECH SB-01



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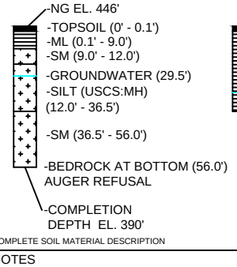

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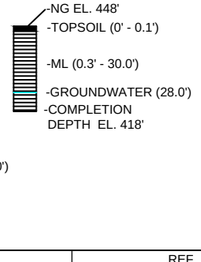
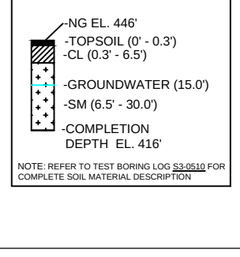


NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 3800'
   HDD PIPE LENGTH (S=): 3806
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

GEOTECH SB-02



NOTE: REFER TO TEST BORING LOG S3-0510 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTES

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

REF. DRAWING

ES-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN
SHEET 43	TO	SHEET 45	AERIAL SITE PLAN
DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/10/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	10/13/15	AAW	02/26/16
D	DESIGN CHANGE	MRS	10/13/15	RMB	10/13/15	AAW	10/13/15
C	ISSUED FOR BID/ADJUSTMENT TO ROW, NO DESIGN CHANGE	DLM	09/22/15	RMB	09/22/15	AAW	09/22/15
B	ISSUED FOR BID	MRS	08/21/15	RMB	08/21/15	AAW	08/21/15

Sunoco Logistics Partners L.P.

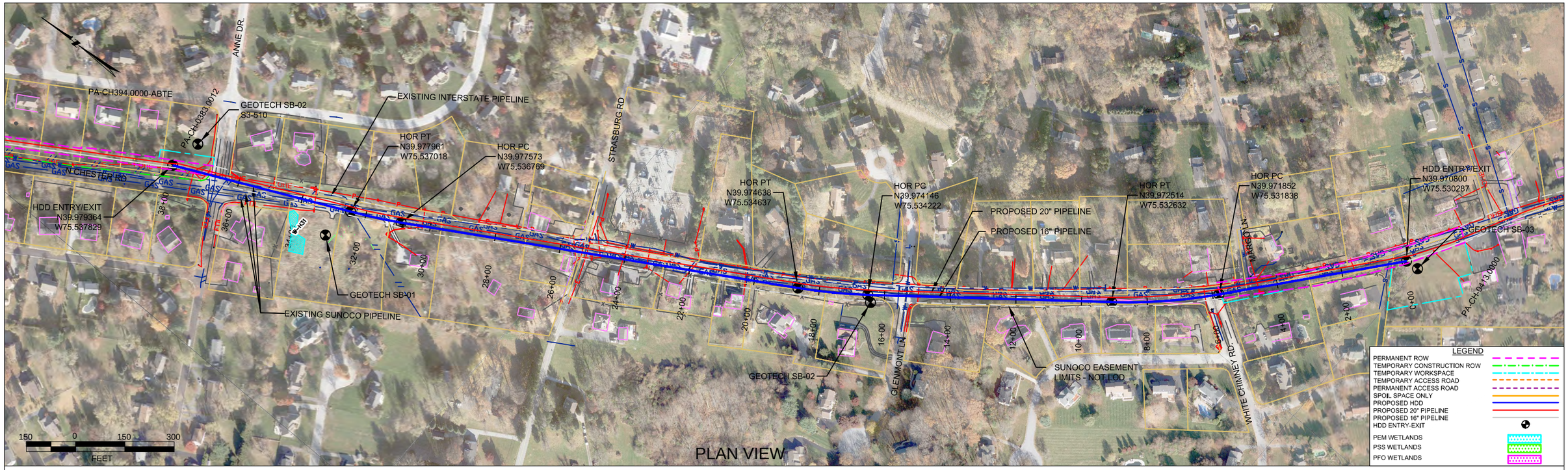
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

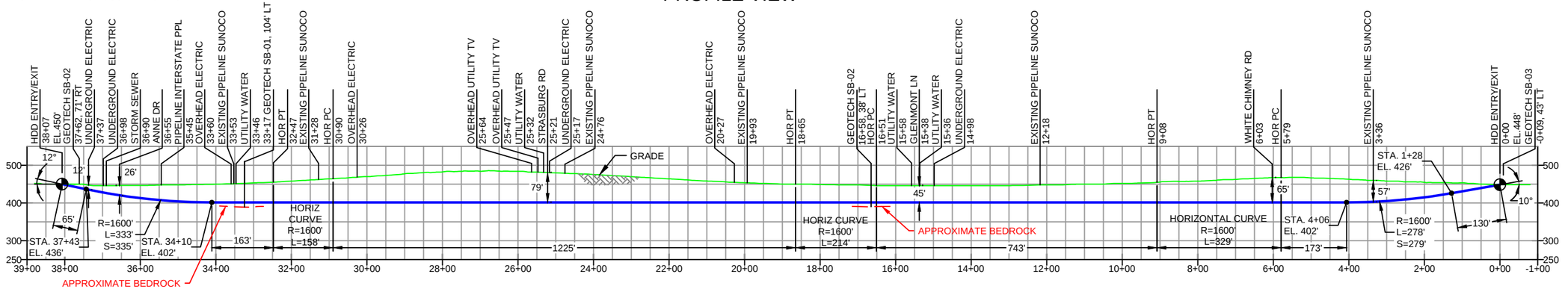
DWG. NO: PA-CH-0413.0000-RD



PLAN VIEW

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520-16

PROFILE VIEW



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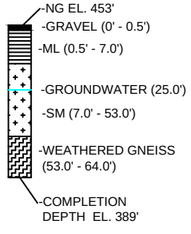

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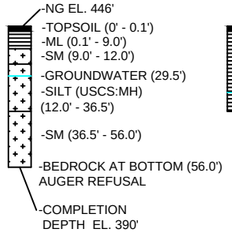

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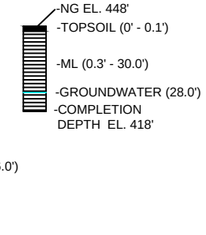

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3807'
   HDD PIPE LENGTH (S=):3814'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
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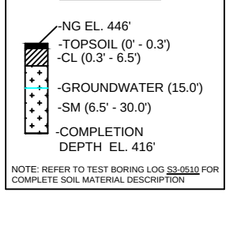
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS 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.

GEOTECH SB-02



NOTE: REFER TO TEST BORING LOG S3-0510 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN	
SHEET 43	TO	SHEET 45	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	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
C	DESIGN CHANGE	MRS	10/13/15	RMB	10/13/15	AAW	10/13/15
B	ISSUED FOR BID/ROW ADJUSTMENT, NO DESIGN CHANGE	DLM	09/22/15	RMB	09/22/15	AAW	09/22/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

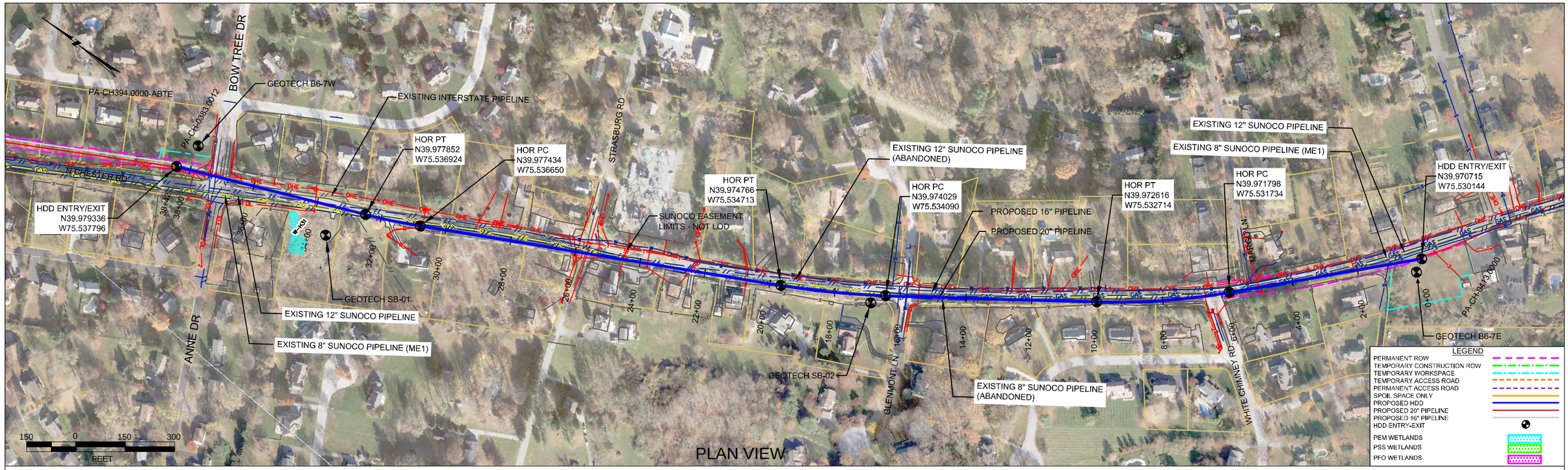
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

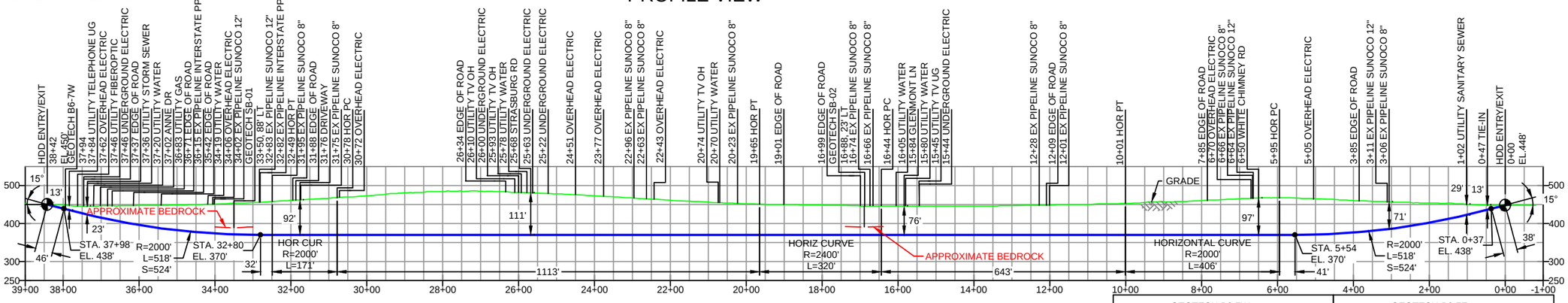
DWG. NO: PA-CH-0413.0000-RD-16



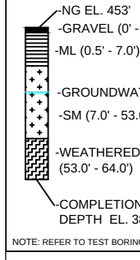
PLAN VIEW

PROFILE VIEW

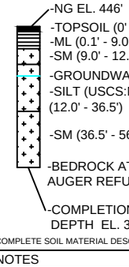
CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520



GEOTECH SB-01

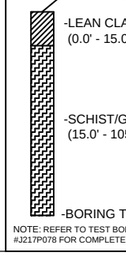


GEOTECH SB-02



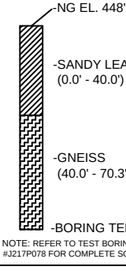
NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7W



NOTE: REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E



NOTE: REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3842'
   HDD PIPE LENGTH (S=):3858'
   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, DESIGN 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.

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-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN
SHEET 43	TO	SHEET 45	AERIAL SITE PLAN
DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP5	UPDATED EXISTING PIPELINES LABELS	MRS	01/05/18	RMB	01/05/18	AMC	01/05/18
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/15/17	RMB	11/15/17	AMC	11/15/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/09/17	RMB	11/09/17	AMC	11/09/17
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	10/13/15	AAW	02/26/16

Sunoco Logistics Partners L.P.

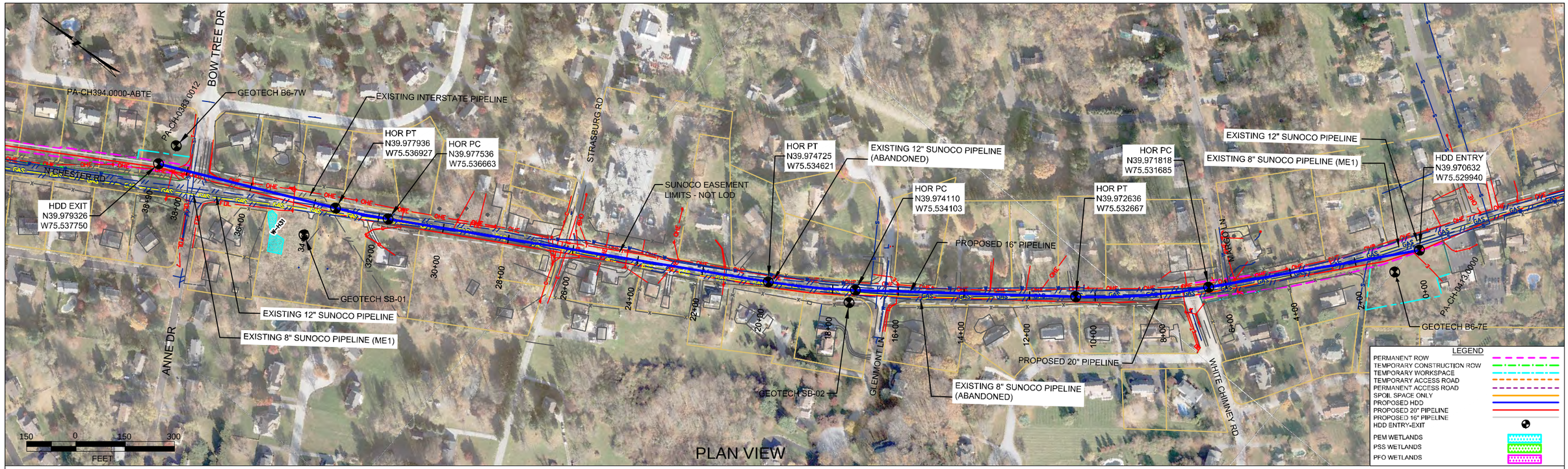
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

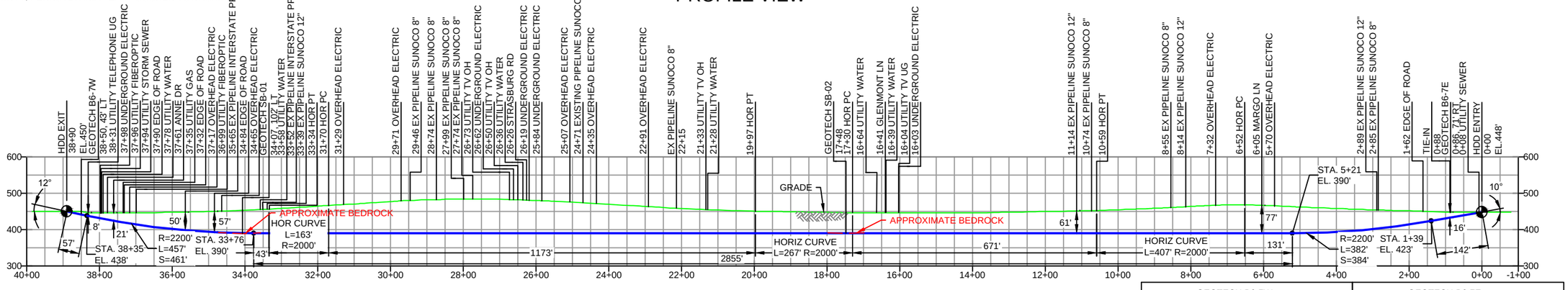
SCALE: 1"=300'

DWG. NO: PA-CH-0413.0000-RD

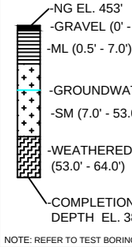


PLAN VIEW

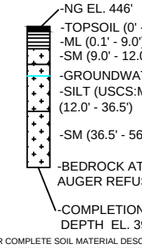
PROFILE VIEW



GEOTECH SB-01

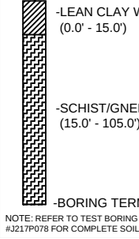


GEOTECH SB-02



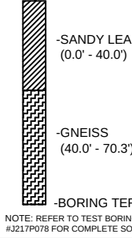
NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7W



NOTE: REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E



NOTE: REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3890'
   HDD PIPE LENGTH (S=):3899'
   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, DESIGN 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.

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520-16

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-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN
SHEET 43	TO	SHEET 45	AERIAL SITE PLAN
DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP5	UPDATED EXISTING PIPELINES LABELS	MRS	01/05/18	RMB	01/05/18	AMC	01/05/18
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/15/17	RMB	11/15/17	AMC	11/15/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/09/17	RMB	11/09/17	AMC	11/09/17
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

Sunoco Logistics Partners L.P.

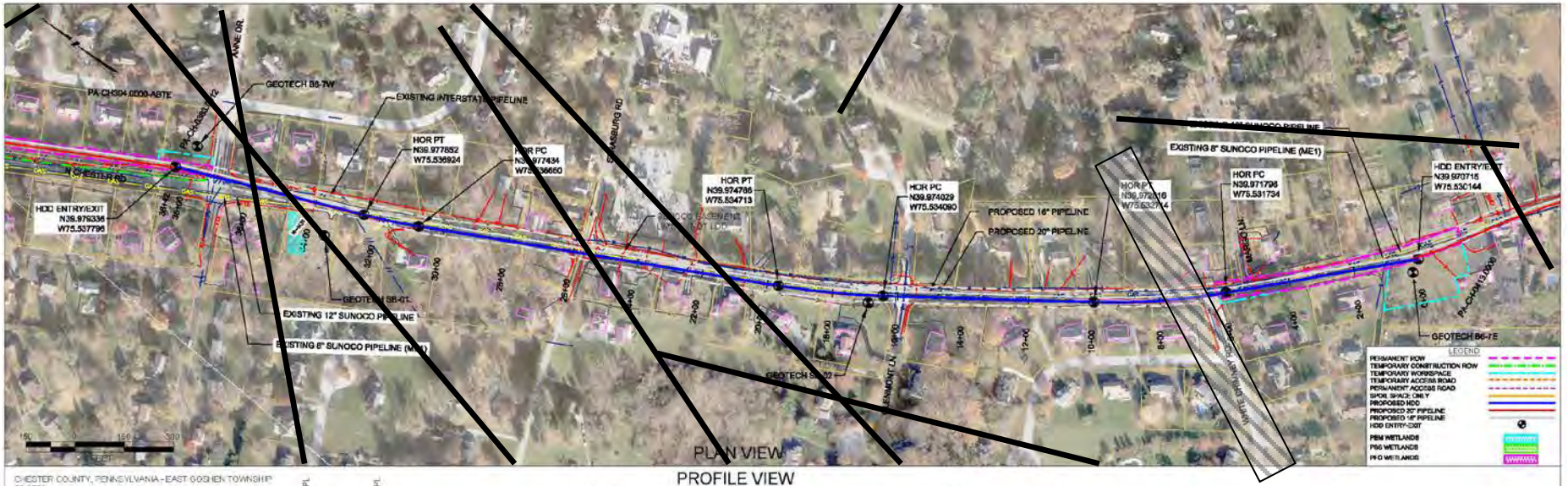
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

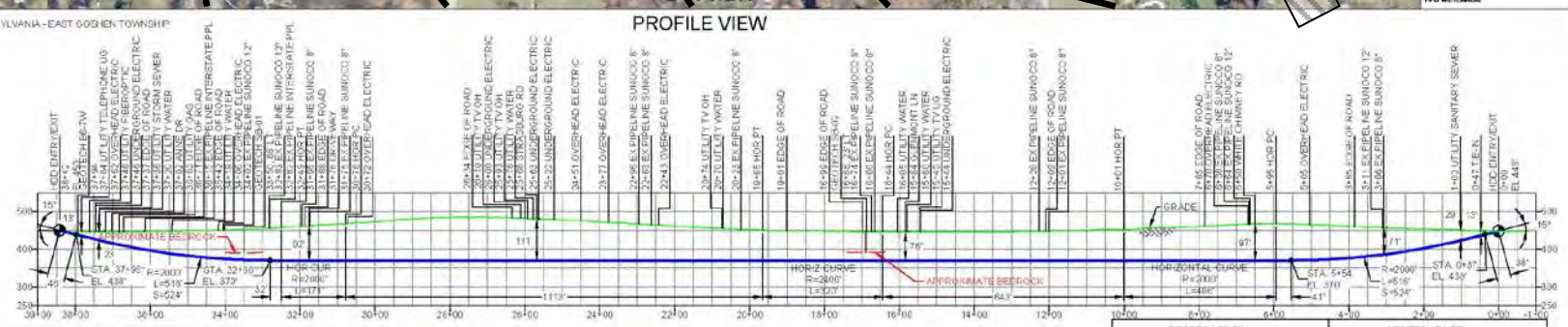
SCALE: 1"=300'

DWG. NO: PA-CH-0413.0000-RD-16



CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520

PROFILE VIEW



GEOTECH SB-01
NS EL 453'
-GRAVEL (0' - 0.5')
-MI (0.5' - 7.0')
-GROUNDWATER (25.0')
-SM (7.0' - 53.0')
-WEATHERED GNEISS (53.0' - 84.9')
-COMPLETION DEPTH EL 383'

GEOTECH SB-02
NG EL 448'
TOPSOIL (0' - 0.1')
-MI (0.1' - 9.0')
-SM (9.0' - 12.0')
-GROUNDWATER (29.5')
-SILT (USCS MH) (12.0' - 36.5')
-SM (36.5' - 56.0')
-BEDROCK AT BOTTOM (58.0')
AUGER REFUSAL
-COMPLETION DEPTH EL 390'

NOTE: REFER TO TEST BORING LOG S3-0529 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 TO REST 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 HORIZ. LENGTH (+/-) 3042'
HDD PIPE LENGTH (+/-) 3059'
20" x 0.468" WT., X-65, API 5L, PSL2, ERW, BFW
COATING: 14-15 MILS TBE WITH 30-35 MILS ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.80).
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 20°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. DOWN HOLE 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1560 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

GEOTECH B6-7W
NG EL 439'
-LEAN CLAY W/ SILT CL (0.0' - 15.0')
-SCHIST/GNEISS (15.0' - 105.0')
-BORING TERMINATED EL 334'
NOTE: REFER TO TEST BORING LOG FOR TERRACON PROJECT #2019155 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E
NG EL 448'
-SANDY LEAN CLAY CL (0.0' - 40.0')
-GNEISS (40.0' - 70.3')
-BORING TERMINATED EL 377.7'
NOTE: REFER TO TEST BORING LOG FOR TERRACON PROJECT #2019155 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTES
1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE, ALL MSL ELEVATIONS ARE NAD83
2. STATIONINGS 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 (800-786-7440).

REF. DRAWING

DWG NO	TC	DWG NO	DESCRIPTION
E5-0.0.0.0	TC	E5-0.0.0.0	EROSION & SEDIMENT PLAN
SHEET 1 of 1	TC	SHEET 45	AERIAL SITE PLAN

REVISIONS

NO	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/15/17	RMB	11/15/17	AMC	11/15/17
EP3	UPDATED 1.0.20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/08/17	RMB	11/09/17	AMC	11/09/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09.08.16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/13/16	RMB	05/10/16	AAW	05/10/16
EP		MRS	02/26/16	RMB	10/15/15	AAW	02/26/16
0	DESIGN CHANGE	MRS	10/13/15	MMB	10/13/15	AAW	10/13/15

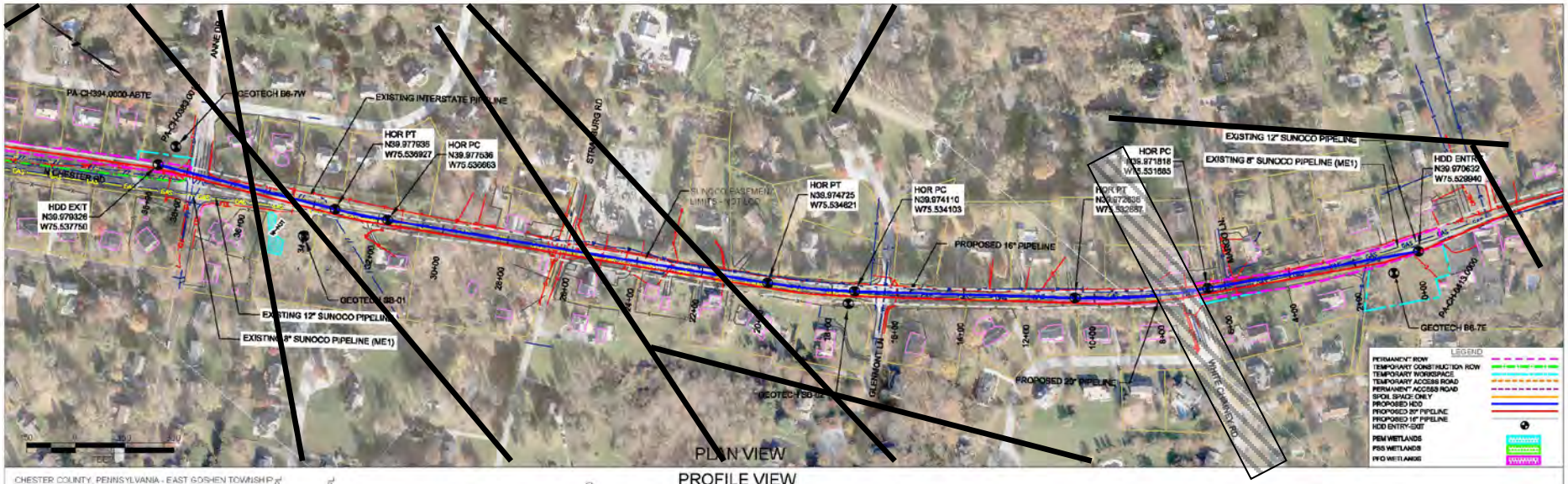
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

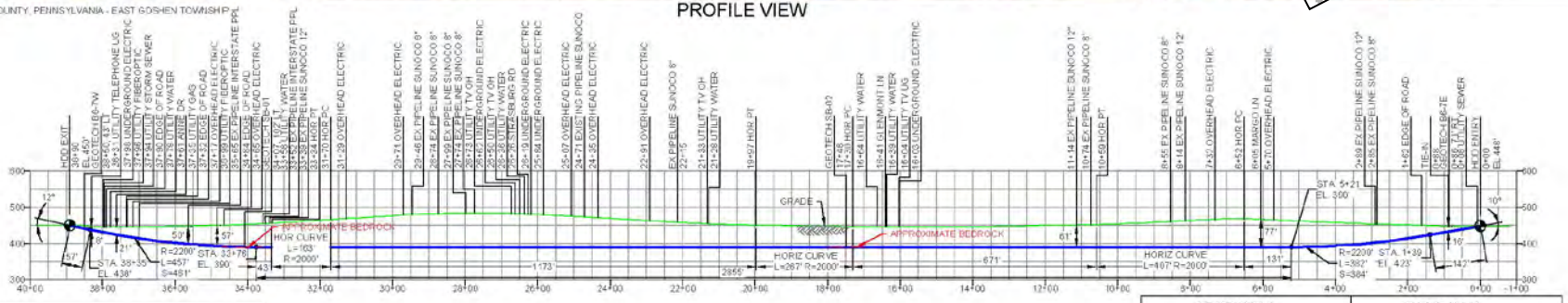
SCALE: 1"=300' DWG. NO: PA-CH-0413.0000-RD

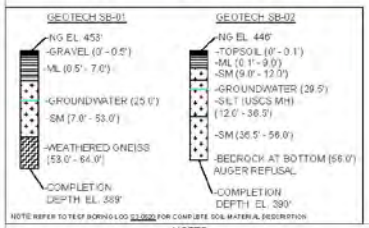


PLAN VIEW

PROFILE VIEW

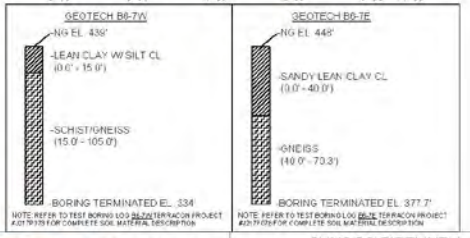
CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP PL
S3-0520-16





NOTE REFER TO TEST BORING LOG S1-0520 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 (+): 3990'
   - HDD PIPE LENGTH (S+): 3999'
   - 16" ø 0.438" WT, X-70, API 5L, PSL2, ERW, DFW
   - COATING: 14-16 MILS FBE WITH 30-35 MILARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
5. INTERNAL DESIGN PRESSURE 1,488 PSIG (BEAM FACTOR 1.0, DESIGN FACTOR 0.80).
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 20°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1888 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.



NOTE REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #2017175 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTE REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #2017175 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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 HEREIN.
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-646	TC	ES-646	EROSION & SEDIMENT PLAN
SHEET 43	TC	SHEET 45	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP.	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/15/17	RMB	11/15/17	AMC	11/15/17
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
C	DESIGN CHANGE	MRS	10/13/15	RMB	10/13/15	AAW	10/13/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300' | DWG. NO: PA-CH-0413.0000-RD-16

Attachment B

Geotechnical Reports

LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0520
CHESTER COUNTY, EAST GOSHEN 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:	544 BEAUMONT CIRCLE, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0510	Dates(s) Drilled: 12-17-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): SEE BELOW	Total Depth (ft): 30.0
Boring Location Coordinates:		39°58'26.72"N	75°32'3.30"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		24	CL	BROWN WITH GRAY NODULES, SILTY CLAY, TRACE FINE	1	3	7	9	**10**
				6.5			SAND. (USCS: CL).					
2	8.0	10.0	6.5		24	SM	REDDISH BROWN FINE SAND AND SILT. (USCS: SM).	4	3	4	5	**7**
3	13.0	15.0			5		SAME	3	4	4	6	**8**
				16.5								
4	18.0	20.0	16.5		24	SM	DR, VARIEGATED BROWN, WHITE, RED, BLACK FINE TO MEDIUM	1	2	3	6	**5**
							SAND AND SILT, TRACE FINE ROCK FRAGS.					
5	23.0	25.0			20		SAME.	4	12	22	23	**34**
6	28.0	28.8			8		DR, VARIEGATED BROWN, WHITE, RED, BLACK FINE TO MEDIUM	15	50/4"			**>50**
				30.0			SAND WITH A LITTLE SILT, TRACE FINE ROCK FRAGS.					
							AUGERED TO 30'.					
							WATER LEVEL THROUGH AUGERS AT 15', MAY BE PERCHED.					
							CAVED AND MOIST AT 22'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 2.5 TSF

DR: DECOMPOSED ROCK

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

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

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	N. CHESTER ROAD, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0520	Dates(s) Drilled: 10-29/30-15	Inspector: J. COSTELLO
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 25.0	Total Depth (ft): 70.0
Boring Location Coordinates:		39°58'40.81"N	75°32'14.53"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	0.5			GRAVEL					
1	3.0	5.0	0.5		23	ML	BROWN SILT WITH A LITTLE FINE SAND, TRACE FINE GRAVEL.	2	2	5	6	**7**
				7.0								
2	8.0	10.0	7.0		13		DR, VARIEGATED BROWN, WHITE, RED FINE SAND AND SILT, TRACE	4	2	2	5	**4**
							FINE GRAVEL (DECOMPOSED SCHIST).					
3	13.0	15.0			24		SAME	1	1	3	5	**4**
4	18.0	20.0			24		DR, GRAY AND WHITE FINE SAND AND SILT, TRACE FINE GRAVEL	2	2	3	5	**5**
							(DECOMPOSED GNEISS?)					
5	23.0	25.0			24		SAME	1	2	5	12	**7**
6	28.0	30.0			19	SM	SAME	1	1	4	10	**5**
7	33.0	35.0			20		DR, GRAYISH BROWN AND WHITE FINE TO MEDIUM SAND AND	1	2	6	11	**8**
							SILT, TRACE FINE GRAVEL.					
8	38.0	40.0			19		SAME (USCS: SM)	3	6	18	21	**24**
9	43.0	44.3			14		DR, VARIEGATED BLACK, WHITE, BROWN, GRAY FINE TO MEDIUM	11	50	50/4"		**>50**
							SAND AND SILT, TRACE FINE GRAVEL.					
10	48.0	50.0			18		DR, VARIEGATED BROWN, WHITE, GRAY, TAND FINE SAND WITH	2	8	13	21	**21**
				53.0			SOME SILT, TRACE FINE GRAVEL.					
11	53.0	53.8	53.0		7	PARTIALLY WEATHERED GNEISS	BROWN, WHITE, GRAY, AND TAN PARTIALLY WEATHERED GNEISS.	4	50/4"			**>50**
12	58.0	58.3			4		SAME	50/4"				**>50**
13	63.0	63.4		64.0	2		SAME	50/5"				**>50**
							AUGER REFUSAL AT 64'.					
							ROCK CORING					
RUN 1	64.0	67.0	64.0		0		NO RECOVERY	TCR: 0%, SCR: 0%, RQD: 0%				
RUN 2	67.0	70.0		70.0	5		FRAGMENTS OF WHITE AND GRAY GNEISS	TCR: 7%, SCR: 0%, RQD: 0%				

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

WATER LEVEL THROUGH AUGERS AT 25'
CAVED AT 60'.

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:	GLENMONT LANE, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0520	Dates(s) Drilled: 10-28-15	Inspector: J. COSTELLO
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 29.5	Total Depth (ft): 56.0
Boring Location Coordinates:		39°58'26.72"N	75°32'3.30"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 (<1")					
1	3.0	5.0	0.1		18	ML	ORANGE BROWN CLAYEY SILT WITH A LITTLE FINE SAND, TRACE	1	3	5	5	**8**
				9.0			FINE GRAVEL.					
2	8.0	10.0	9.0		24	SM	DR, BROWN TO ORANGE BROWN FINE TO MEDIUM SAND WITH A	1	8	12	4	**20**
				12.0			LITTLE SILT, TRACE F-C ROCK FRAGS.					
3	13.0	15.0	12.0		24	MH	DR, ORANGE BROWN SILT AND FINE SAND. (USCS: MH)	1	2	2	3	**4**
4	18.0	20.0			24		DR, ORANGE BROWN SILT AND FINE SAND.	1	1	2	4	**3**
5	23.0	25.0			24		DR, ORANGE BROWN SILT AND FINE SAND.	1	1	4	7	**5**
6	28.0	30.0			24		DR, VARIEGATED GRAY TO YELLOWISH BROWN SILT AND FINE	1	4	8	13	**12**
							SAND. (USCS: MH)					
7	33.0	35.0			24		DR, VARIEGATED GRAY TO YELLOWISH BROWN SILT AND FINE	1	4	8	8	**12**
				36.5			SAND, SECTION OF FELDSPAR AT 35'.					
8	38.0	40.0	36.5		24	SM	DR, VARIEGATED BROWN AND WHITE FINE SAND AND SILT, WITH	1	3	8	13	**11**
							BLACK NODULES.					
9	43.0	44.4			15		DR, VARIEGATED BROWN, BLACK, YELLOW, RED FINE TO COARSE	4	28	50/5"		**>50**
							SAND WITH SOME SILT, TRACE FINE ROCK FRAGS.					
10	48.0	49.4			14		SAME	4	28	50/5"		**>50**
11	53.0	53.9			8		SAME	11	50/5"			**>50**
				56.0								
							AUGER REFUSAL AT 56'.					
							WET ON SPOON AT 29.5'.					
							WATER LEVEL THROUGH AUGERS AT 29.5'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 1.5 TSF

DR: DECOMPOSED ROCK

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

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

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	MATLOCK FLORIST, WEST CHESTER, PA		Page 1 of 1
HDD No.:	S3-0520	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): 28.0	Total Depth (ft): 30.0
Boring Location Coordinates:		39° 58' 14.479" N	75° 31' 48.928" 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		19		LIGHT BROWN AND ORANGE BROWN SILT, TRACE FINE SAND.	1	5	5	9	**10**
2	8.0	10.0			22		BROWN, ORANGE BROWN AND LIGHT GRAY MICACEOUS SILT, TRACE	2	2	4	4	**6**
							FINE SAND.					
3	13.0	15.0			24		BROWN, ORANGE BROWN, GRAY, AND WHITE SILT, TRACE FINE	2	3	4	4	**7**
						ML	SAND. (USCS: ML).					
4	18.0	20.0			24		DR, VARIEGATED BROWN AND ORANGE BROWN MICACEOUS SILT,	4	5	11	11	**16**
							TRACE FINE SAND.					
5	23.0	25.0			24		DR, VARIEGATED BROWN ,ORANGE BROWN AND WHITE,	2	4	8	13	**12**
							MICACEOUS SILT, TRACE FINE SAND.					
6	28.0	30.0			24		DR, VARIEGATED BROWN ,ORANGE BROWN AND WHITE,	2	5	9	15	**14**
				30.0			MICACEOUS SILT, TRACE FINE SAND. (USCS: ML).					
							CAVED AT 29', WATER LEVEL ON CAVE AT 28'.					

Notes/Comments:

Pocket Pentrometer Testing
10': 1.25 TSF
15': 1.5 TSF

DR: DECOMPOSED ROCK

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0520

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S3-0510	SB-02	1	3.0	5.0	23.3	96.1	43	24	19	CL
		2	8.0	10.0	30.1	47.2	NV	NP	NP	SM
		4	18.0	20.0	35.8	38.9	-	-	-	-
		5	23.0	25.0	24.4	36.6	-	-	-	-
		6	28.0	28.8	9.7	11.2	-	-	-	-
S3-520	SB-01	2	8.0	10.0	29.7	46.2	-	-	-	-
		4	18.0	20.0	25.1	37.2	-	-	-	-
		6	28.0	30.0	25.0	36.7	-	-	-	-
		8	38.0	40.0	22.0	46.4	NV	NP	NP	SM
		10	48.0	50.0	14.9	34.9	-	-	-	-
		12	58.0	58.3	15.4	40.7	NV	NP	NP	SM
	SB-02	1	3.0	5.0	34.7	85.1	-	-	-	-
		2	8.0	10.0	17.6	16.4	-	-	-	-
		3	13.0	15.0	47.1	69.1	65	46	19	MH
		6	28.0	30.0	33.9	60.3	55	37	18	MH
		8	38.0	40.0	28.6	47.0	-	-	-	-
		10	48.0	49.4	11.4	26.4	-	-	-	-
	SB-03	2	8.0	10.0	33.2	93.4	-	-	-	-
		3	13.0	15.0	40.9	98.8	48	35	13	ML
		4	18.0	20.0	35.2	99.0	-	-	-	-
		5	23.0	25.0	25.2	61.3	-	-	-	-
		6	28.0	30.0	35.6	89.3	47	33	14	ML

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
S3-0520, SB-02	1&2	SLIGHT RETRIEVAL IN CORE, MOSTLY DECOMPOSED ROCK SOIL. CORE DID NOT YIELD ROCK THAT COULD BE TESTED FOR COMPRESSIVE STRENGTH		

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0520

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S3-0510		SB-02	Felsic gneiss - Light, medium grained; includes rocks of probable sedimentary origin.	Generally level, slightly sloping to the south	Felsic gneiss (Precambrian age)	Felsic gneiss; Secondary - paragneiss	No information found during literature review	Bedrock depth information not available within .5 mile radius, likely similar to other formation wells, avg. from approx. 30 to 50 ft bgs	All part of Glenarm Supergroup a name given to provincial series of pre-Cambrian metamorphosed sedimentary rocks present in northern VA, MD, southeastern PA, western NJ, and possibly southeastern NY. Rocks from this assemblage consists of a thick sequence of metasedimentary rock and include the following formations; Setters metaquartzite, Cockeysville marble, Wissahickon Schist (along with subset of the Octoraro schist), Peters Creek metaquartzite and meta siltstones and the Peach Bottom Clate (Geology of Pennsylvania SP-1, 1999) . Drilling in these formations generally difficult to very difficult except where fractures and weathered exposed zones present.
S3-0520		SB-01		Generally level, slightly sloping to the north					
		SB-02		Generally level					
		SB-03		Generally level, slightly sloping to the south					

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

October 13, 2017 (Revised November 30, 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 – SR 352/Strasburg Rd.
Commonwealth of Pennsylvania
Drawing # PA-CH-0400.0000-RD
PO # 20170818-2
Terracon Project No. J217P078

Dear Mr. Sessions:

This letter provides a summary of the bedrock characterization for the Mariner East 2 Pipeline Project crossing to be located at SR 352/Strasburg Rd. (Drawing # PA-CH-0400.0000-RD) in the Commonwealth of Pennsylvania. Our services were performed in general accordance with our proposal number PJ2175108 dated July 28, 2017. Our scope of services included advancing two borings, designated as B6-7W and B6-7E, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test borings, B6-7W and B6-7E were drilled between August 30 and September 9, 2017 to depths of 105.0 and 70.3 feet, respectively as shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of metamorphic rock comprised of gneiss and schist at B6-7W. Competent bedrock was not encountered at B6-7E. 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 a sample from 70 feet at B6-7W. Unconfined compressive strength test results are shown on the attached report.

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.

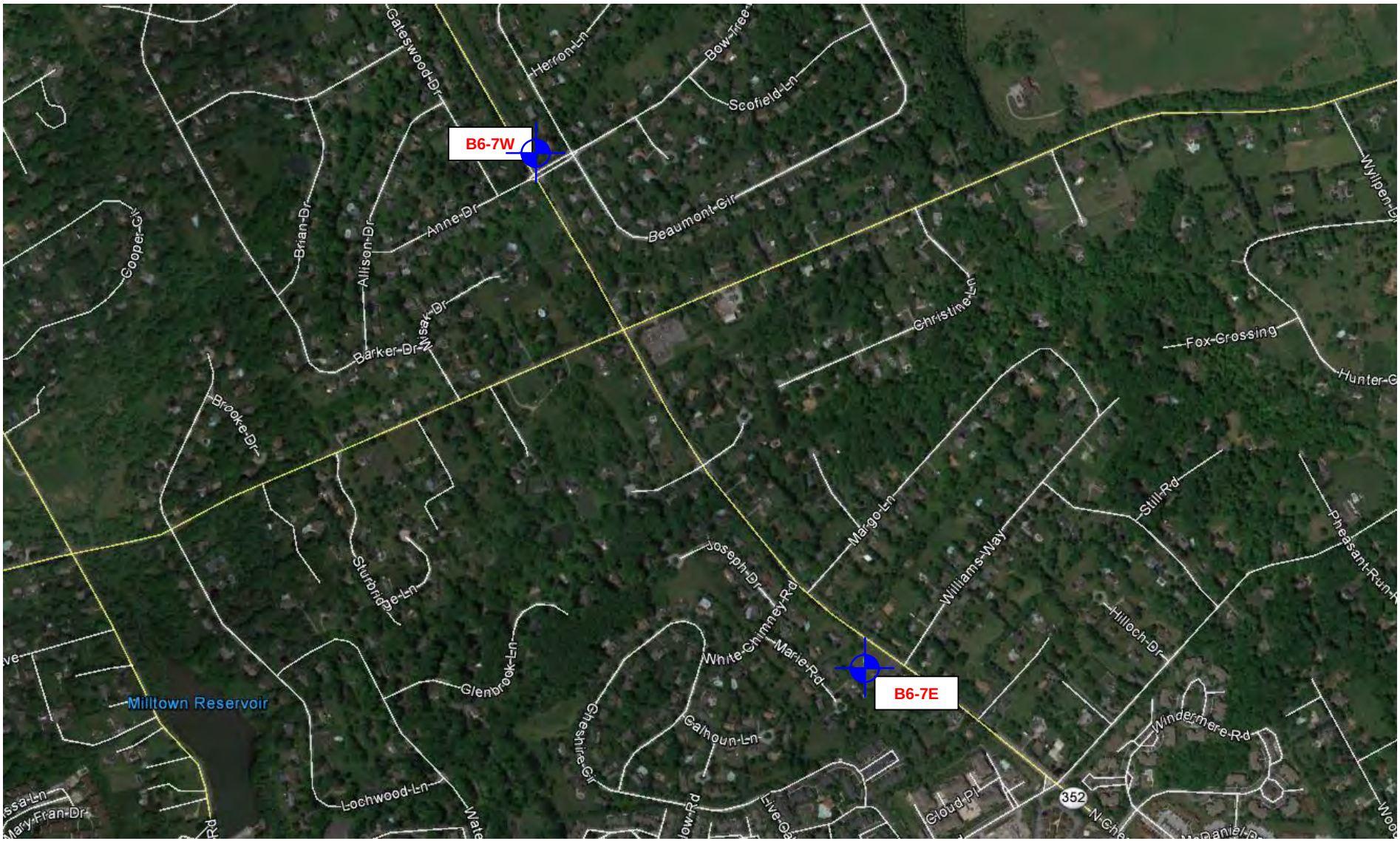
Marc A. Gullison, E.I.T.
Staff Geotechnical Engineer

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



Project Manager:	JGS
Drawn by:	SBL
Checked by:	LJD
Approved by:	LJD

Project No.	J217P078
Scale:	N.T.S.
File Name:	J217P078 BLP
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

SR 352/Strasburg Road HDD Cores B6-7W and B6-7E
PA-CH-0400.0000-RD
Chester County, Pennsylvania

Exhibit
A-2

EXPLORATION RESULTS

BORING LOG NO. B6-7W SR 352/Strasburg Rd. West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.979258° Longitude: -75.537638°

Approximate Surface Elev: 449 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
LEAN CLAY WITH SILT (CL), orange-brown, stiff									
		5		X	21	5-6-7 N=13			
		10		X	24	4-5-8 N=13			
15.0	434+/-	15		X	16	3-4-6 N=10			
Sand, gravel, clay, silt with weathered rock, friable Weathered rock to 60 feet, begin rock core at 60 feet		20		X	15	3-5-8 N=13			
		25		X	15	5-5-9 N=14			
		30							

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-08-2017 | Boring Completed: 09-09-2017

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

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B6-7W SR 352/Strasburg Rd. West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.979258° Longitude: -75.537638°

Approximate Surface Elev: 449 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	RECOVERY (In.)	FIELD TEST RESULTS
		13	9-11-15 N=26
35		14	12-24-38 N=62
40		6	50/6"
45		0	50/1"
50		9	47-50/3"
55		3	50/4"
60.0	389+/-		

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RQD (%) | Core rate (min/ft) | 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

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-08-2017 | Boring Completed: 09-09-2017

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

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B6-7W SR 352/Strasburg Rd. West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.979258° Longitude: -75.537638°
Approximate Surface Elev: 449 (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)
65.0	384+/-	Run 1, Medium hard, highly weathered, SCHIST, very close fracture spacing	65			30		17	6 5 7 12 7	
70.0	379+/-	Run 2, Hard, moderately to slightly weathered, blue-gray GNEISS, very close to close joint spacing	70			60		60	4 3 3 2 2	
75.0	374+/-	Run 3, Hard, fresh, SCHIST/GNEISS, moderately close joint spacing	75			60		77	3 3 3 3 3	
80.0	369+/-	Run 4, Similar, close to moderately close joint spacing	80			58		81	9 3 6 5 5	
85.0	364+/-	Run 5, Hard, fresh, black/gray, granitic GNEISS, close to moderately close joint spacing	85			60		90	4 17 3 3 3	
90.0	359+/-	Run 6, Similar	90			59		100	3 2 5 4 3	

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-08-2017 | Boring Completed: 09-09-2017

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

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B6-7W SR 352/Strasburg Rd. West

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.979258° Longitude: -75.537638°

Approximate Surface Elev: 449 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (In.)	RQD (%)	Core rate (min/ft)
Run 7, Similar					
95.0	354+/-	95	60	63	3 4 5 4 5
Run 8, Similar					
100.0	349+/-	100	0		5 5 4 4 4
Run 9, Similar					
105.0	344+/-	105	0		NR
Boring Terminated at 105 Feet					

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 09-08-2017 | Boring Completed: 09-09-2017

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

Project No.: J217P078 | Exhibit: A-1

BORING LOG NO. B6-7E SR 352/Strasburg Rd. East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.970342° Longitude: -75.530217°
Approximate Surface Elev: 453 (Ft.) +/-
DEPTH ELEVATION (Ft.)

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
				SANDY LEAN CLAY (CL), trace gravel (degraded mica schist), brown, medium dense, degraded gneiss, black and white below 15 feet			
5		X	18	3-5-7 N=12			
10		X	18	4-4-6 N=10			
15		X	14	2-4-7 N=11			
20		X	18	3-4-6 N=10			
25		X	16	3-5-6 N=11			
30							

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-30-2017 | Boring Completed: 08-30-2017

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

Project No.: J217P078 | Exhibit: A-2

BORING LOG NO. B6-7E SR 352/Strasburg Rd. East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.970342° Longitude: -75.530217°
Approximate Surface Elev: 453 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
SANDY LEAN CLAY (CL), trace gravel (degraded mica schist), brown, medium dense, degraded gneiss, black and white below 15 feet *(continued)*									
				X	17	2-4-6 N=10			
		35		X	18	2-4-7 N=11			
40.0	413+/-	40							
Highly degraded GNIESS , brown with black and white				X	18	5-8-14 N=22			
		45		X	16	8-14-21 N=35			
		50		X	17	4-13-23 N=36			
		55		X	15	7-14-26 N=40			
60.0	393+/-	60							

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

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-30-2017 | Boring Completed: 08-30-2017

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

Project No.: J217P078 | Exhibit: A-2

BORING LOG NO. B6-7E SR 352/Strasburg Rd. East

PROJECT: Mariner East Pipeline Borings

CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354

SITE: Spread 6

LOCATION PA-CH-0400.0000-RD
20170818-2
Latitude: 39.970342° Longitude: -75.530217°

Approximate Surface Elev: 453 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	RQD (%)	Core rate (min/ft)	Penetrometer Test (tsf)
Highly weathered, highly degraded GNEISS, black and white									
				X	4	50/4"			
		65		X	14	11-29-50/6"			
70.3	382.5+/-	70		X	0	50/3"			
Boring Terminated at 70.3 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

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 08-30-2017 | Boring Completed: 08-30-2017

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

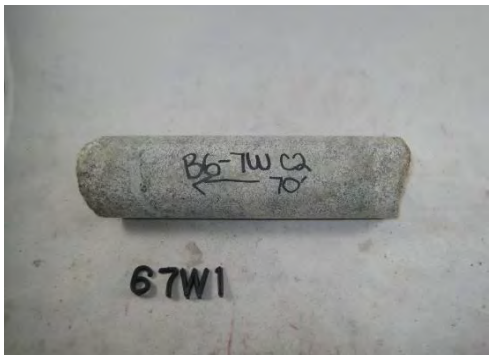
Project No.: J217P078 | Exhibit: A-2

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

Boring No.:	B6-7W	Lithology :	Schist/Gneiss
Sample No.:	1	Moisture Content :	As received
Sample Depth:	70 feet	Lab Temperature :	70° F
Sampling Date:	9/8/17	Loading Rate:	55 psi/s
		Time to Failure:	13 min

Diameter:	1.99 in	Maximum Axial Load at Failure:	41,830 lb
Length:	4.38 in	Compressive Strength:	13,449 psi
L/D:	2.20	Compressive Strength:	92.73 Mpa
End Area:	3.11 in^2	Unit Weight	192 pcf

Before the Test



After the Test

Drawing # : PA-CH-0400.0000-RD
PO # : 20170818-2
Crossing : SR 352/Strasburg Rd.
Spread : Spread 6

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

Photograph 1: B6-7W, Samples C-1 to C-4 (60 to 80 feet)

Photograph 2: B6-7W, Samples C-5 to C-8 (80 to 100 feet)

Photograph 3: B6-7W, Sample C-9 (100 to 105 feet)

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ 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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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 ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

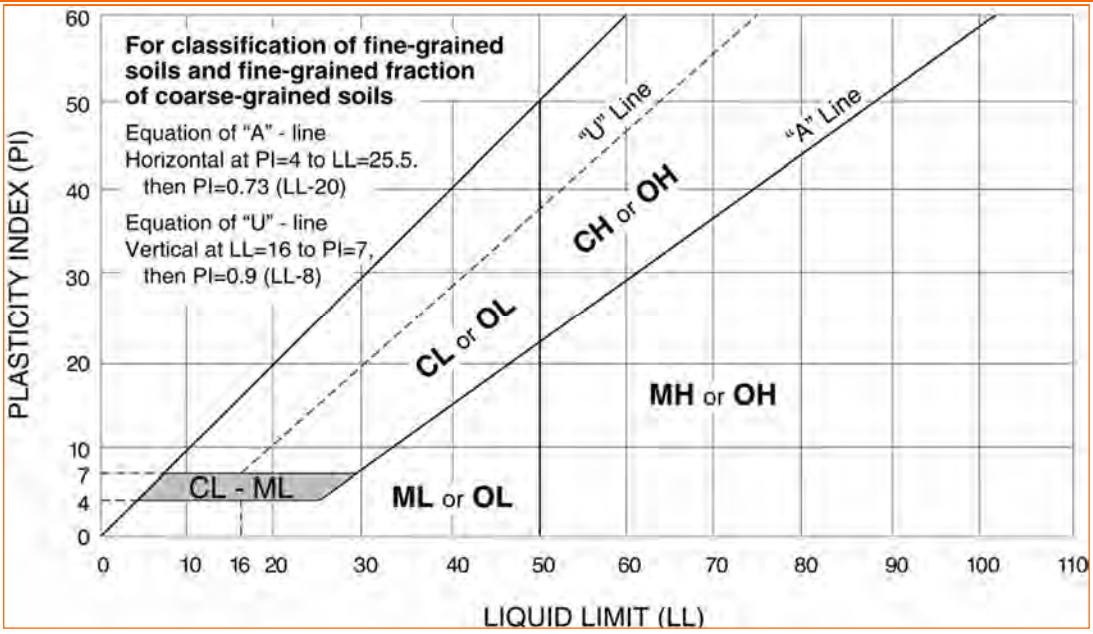
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 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

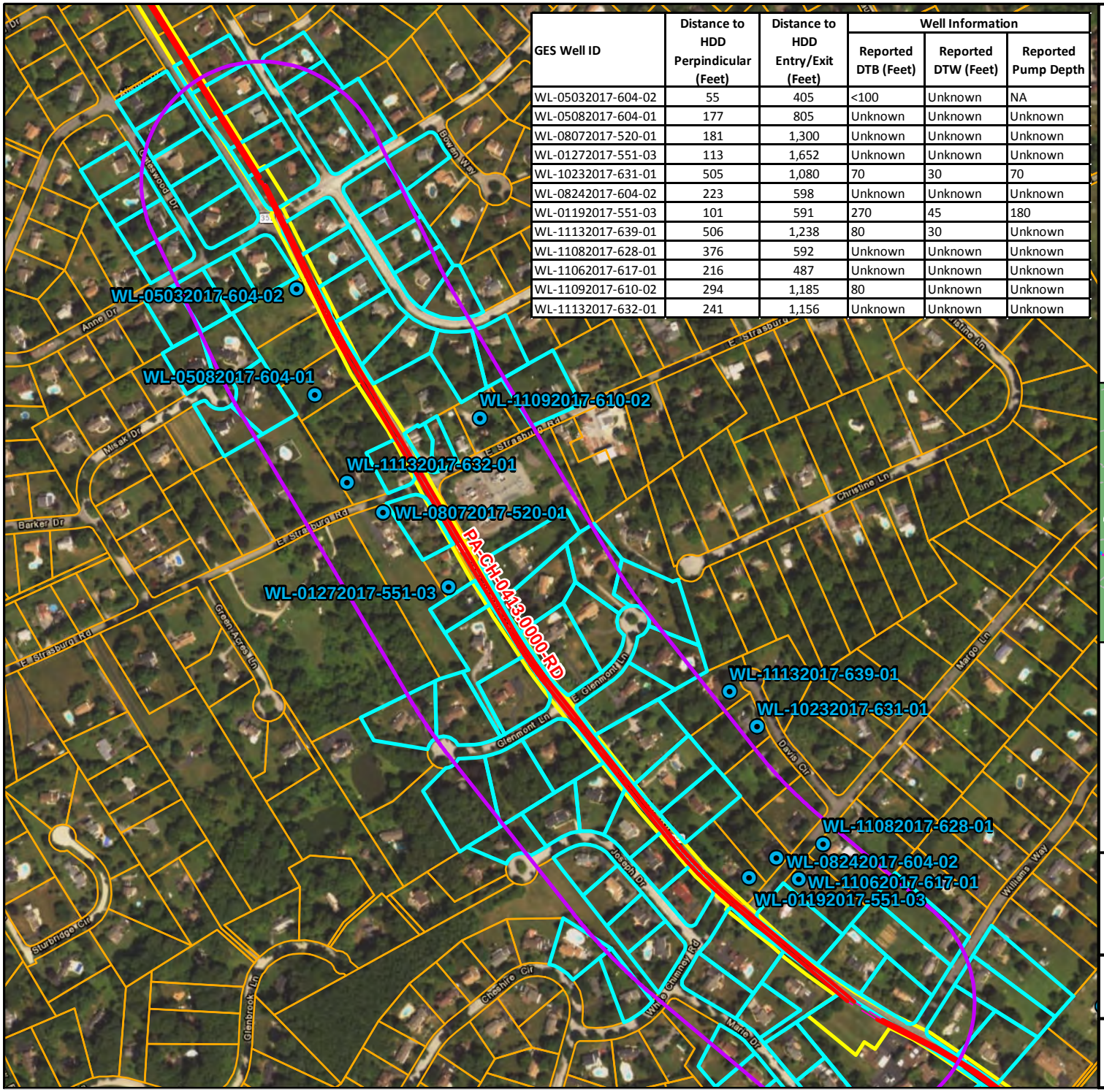
Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

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.

BOW TREE DRIVE / STRASBURG ROAD CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

ATTACHMENT 2

WATER SUPPLY ILLUSTRATION



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
WL-05032017-604-02	55	405	<100	Unknown	NA
WL-05082017-604-01	177	805	Unknown	Unknown	Unknown
WL-08072017-520-01	181	1,300	Unknown	Unknown	Unknown
WL-01272017-551-03	113	1,652	Unknown	Unknown	Unknown
WL-10232017-631-01	505	1,080	70	30	70
WL-08242017-604-02	223	598	Unknown	Unknown	Unknown
WL-01192017-551-03	101	591	270	45	180
WL-11132017-639-01	506	1,238	80	30	Unknown
WL-11082017-628-01	376	592	Unknown	Unknown	Unknown
WL-11062017-617-01	216	487	Unknown	Unknown	Unknown
WL-11092017-610-02	294	1,185	80	Unknown	Unknown
WL-11132017-632-01	241	1,156	Unknown	Unknown	Unknown

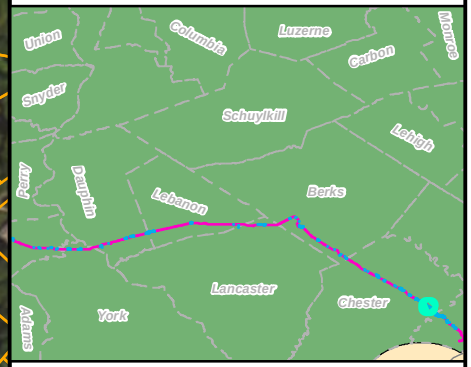
Legend

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

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

- GES Testing Location

Location



0 250 500 Feet

Well Location Map
HDD# PA-CH-0413.0000-RD
Chester County, PA.

Prepared By: TETRA TECH

Date: 12/11/2017

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

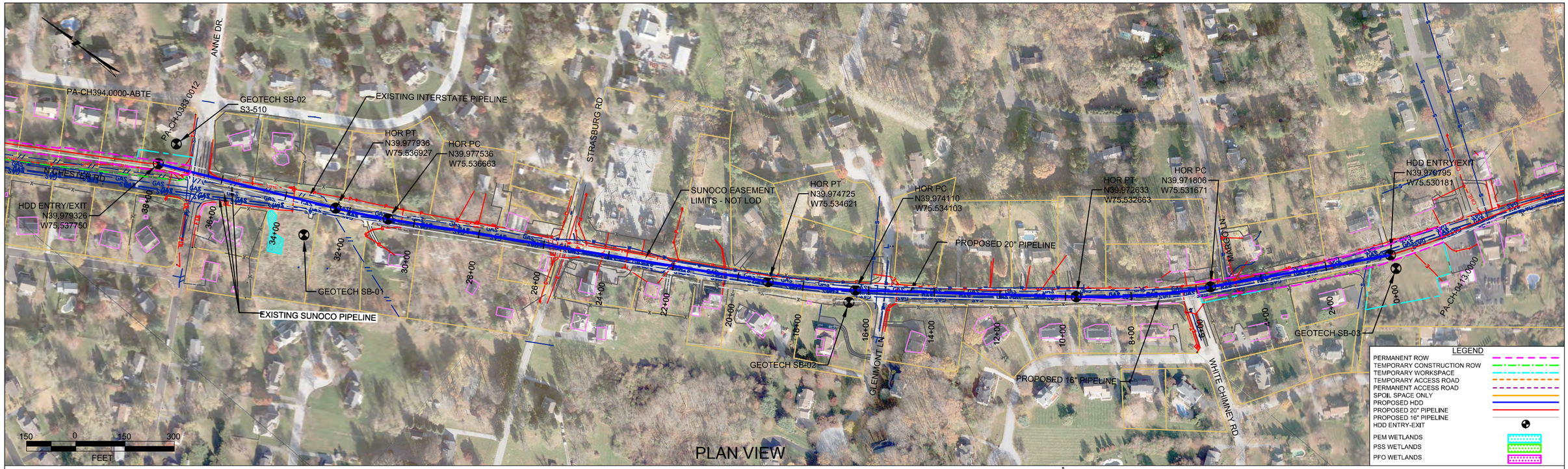
Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\05958-PPP\MXD\WellLocations\WellLocation_PA_CH_0413_00000.mxd LN

STRASBURG ROAD / BOW TREE DRIVE CROSSING
PADEP SECTION 105 PERMIT NO.: E15-862
PA-CH-0413.0000-RD & PA-CH-0413.0000-RD-16
(SPLP HDD# S3-0520)

ATTACHMENT 3

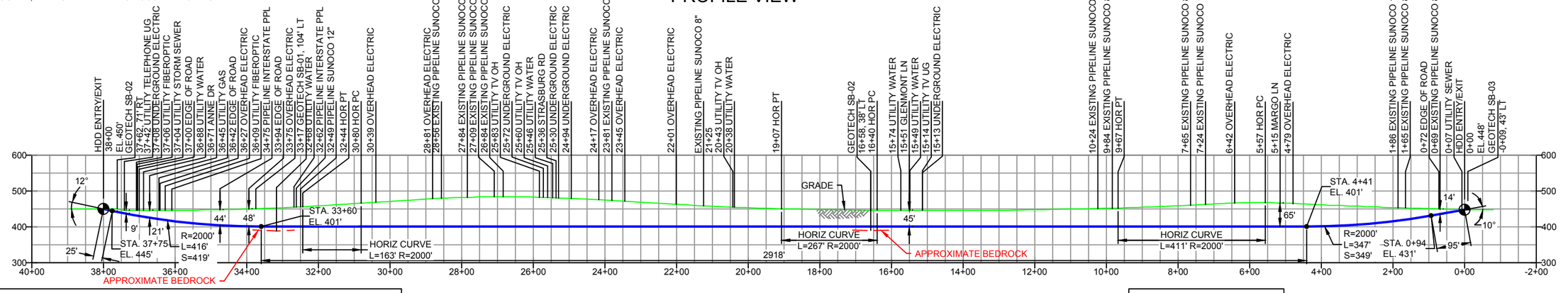
HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



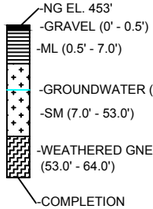
PLAN VIEW

PROFILE VIEW

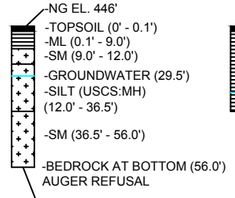
CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520



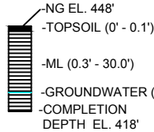
GEOTECH SB-01



GEOTECH SB-02



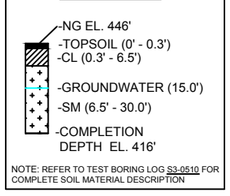
GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3800'
   HDD PIPE LENGTH (S=):3806
   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, DESIGN 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.

GEOTECH SB-02



NOTE: REFER TO TEST BORING LOG S3-0510 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTES

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

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	REVISED PROFILE WITH 2017 LIDAR	MRS	02/13/17	RMB	02/13/17	AMC	02/13/17
3	REVISED PER ENGINEERING COMMENTS	MRS	08/12/16	RMB	08/12/16	AAW	08/12/16
2	ADDED DEPTH DIMENSIONS AT PPL CROSSINGS	JTW	07/12/16	RMB	07/12/16	AAW	07/12/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	03/03/16	RMB	03/03/16	AAW	03/03/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

Sunoco Logistics Partners L.P.

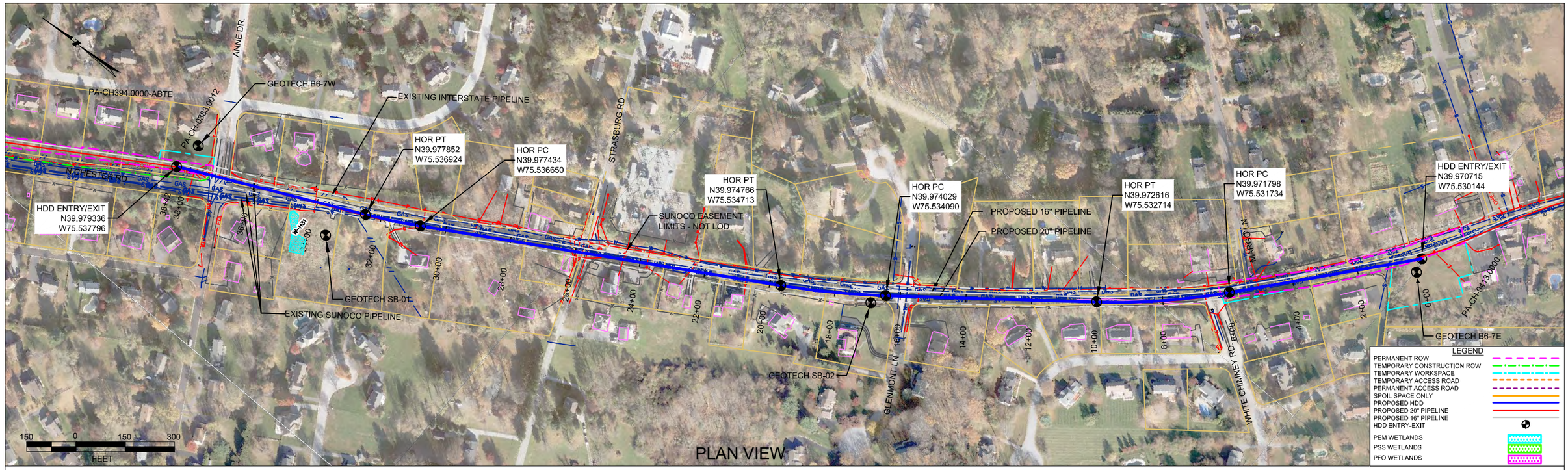
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

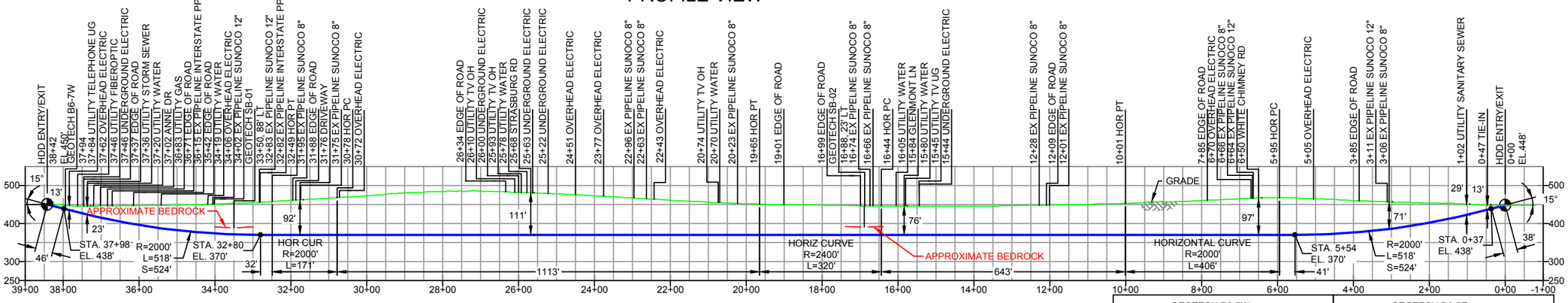
DWG. NUMBER: PA-CH-0400.0000-RD



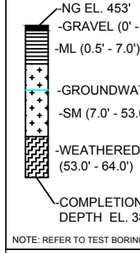
PLAN VIEW

PROFILE VIEW

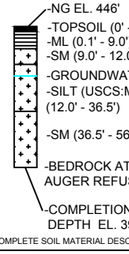
CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520



GEOTECH SB-01



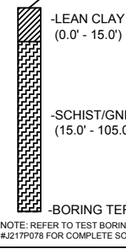
GEOTECH SB-02



NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

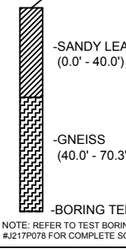
DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3842'
   HDD PIPE LENGTH (S=):3858'
   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, DESIGN 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.

GEOTECH B6-7W



NOTE: REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E



NOTE: REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN	
SHEET 43	TO	SHEET 45	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	11/15/17	RMB	11/15/17	AMC	11/15/17
EP3	UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/09/17	RMB	11/09/17	AMC	11/09/17
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	10/13/15	AAW	02/26/16
D	DESIGN CHANGE	MRS	10/13/15	RMB	10/13/15	AAW	10/13/15

Sunoco Logistics Partners L.P.

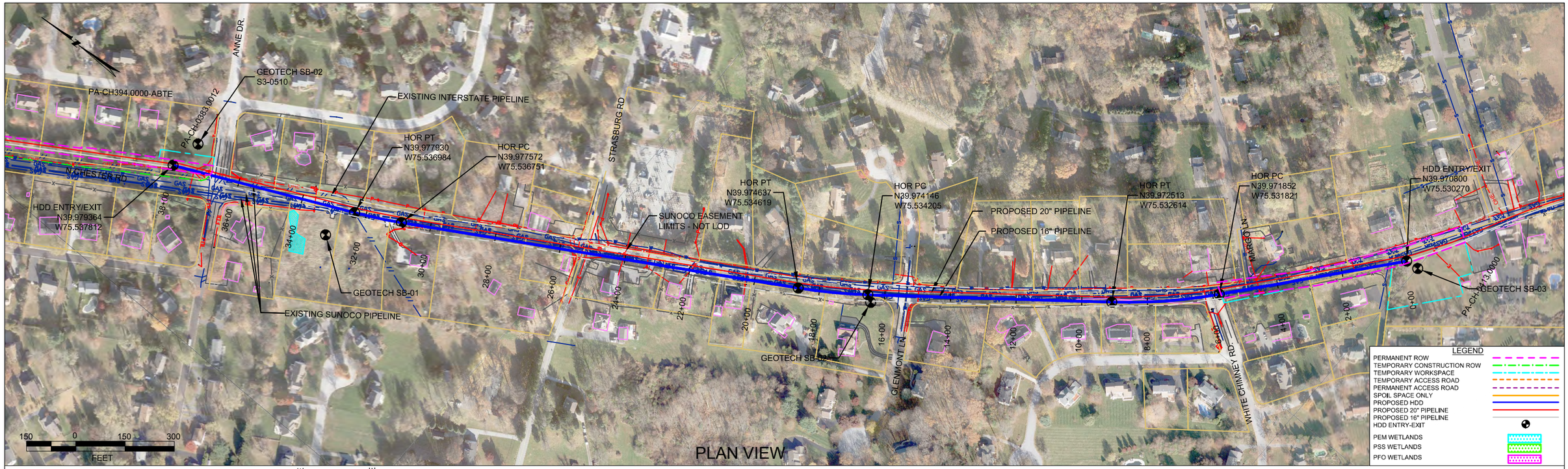
TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

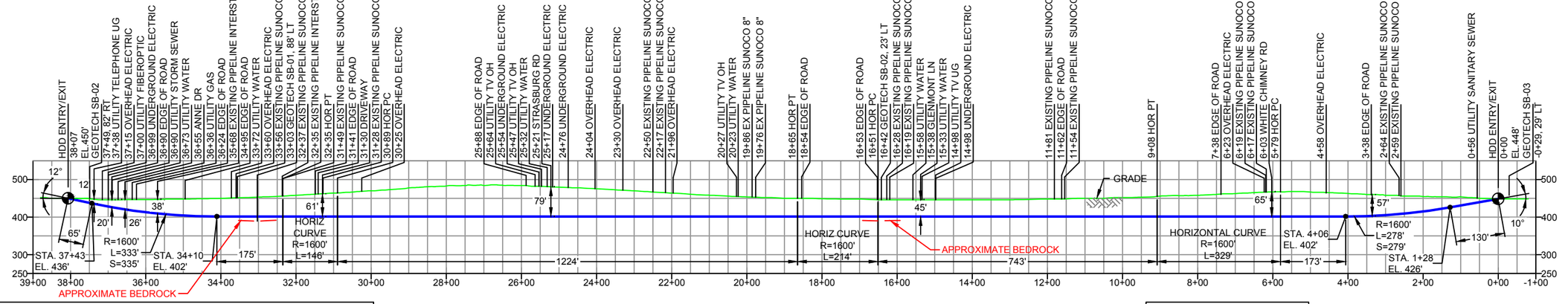
SCALE: 1"=300'

DWG. NO: PA-CH-0413.0000-RD



PLAN VIEW

PROFILE VIEW



CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520-16

GEOTECH SB-01
- NG EL. 453'
- -GRAVEL (0' - 0.5')
- -ML (0.5' - 7.0')
- -GROUNDWATER (25.0')
- -SM (7.0' - 53.0')
- -WEATHERED GNEISS (53.0' - 64.0')
- -COMPLETION DEPTH EL. 389'

GEOTECH SB-02
- NG EL. 446'
- -TOPSOIL (0' - 0.1')
- -ML (0.1' - 9.0')
- -SM (9.0' - 12.0')
- -GROUNDWATER (29.5')
- -SILT (USCS:MH) (12.0' - 36.5')
- -SM (36.5' - 56.0')
- -BEDROCK AT BOTTOM (56.0') AUGER REFUSAL
- -COMPLETION DEPTH EL. 390'

GEOTECH SB-03
- NG EL. 448'
- -TOPSOIL (0' - 0.1')
- -ML (0.3' - 30.0')
- -GROUNDWATER (28.0')
- -COMPLETION DEPTH EL. 418'

NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):3807'
   HDD PIPE LENGTH (S=):3814'
   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, DESIGN 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.

GEOTECH SB-02
- NG EL. 446'
- -TOPSOIL (0' - 0.3')
- -CL (0.3' - 6.5')
- -GROUNDWATER (15.0')
- -SM (6.5' - 30.0')
- -COMPLETION DEPTH EL. 416'

NOTE: REFER TO TEST BORING LOG S3-0510 FOR COMPLETE SOIL MATERIAL DESCRIPTION

NOTES

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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
4	REVISED PROFILE WITH 2017 LIDAR	MRS	02/13/17	RMB	02/13/17	AMC	02/13/17
3	REVISED PER ENGINEERING COMMENTS	MRS	08/12/16	RMB	08/12/16	AAW	08/12/16
2	ADDED DEPTH DIMENSIONS AT PPL CROSSINGS	JTW	07/12/16	RMB	07/12/16	AAW	07/12/16
1	REVISED PER COMMENTS FROM REI REVIEW	MRS	03/03/16	RMB	03/03/16	AAW	03/03/16
0	ISSUED FOR CONSTRUCTION	MRS	02/19/16	RMB	02/19/16	AAW	02/19/16

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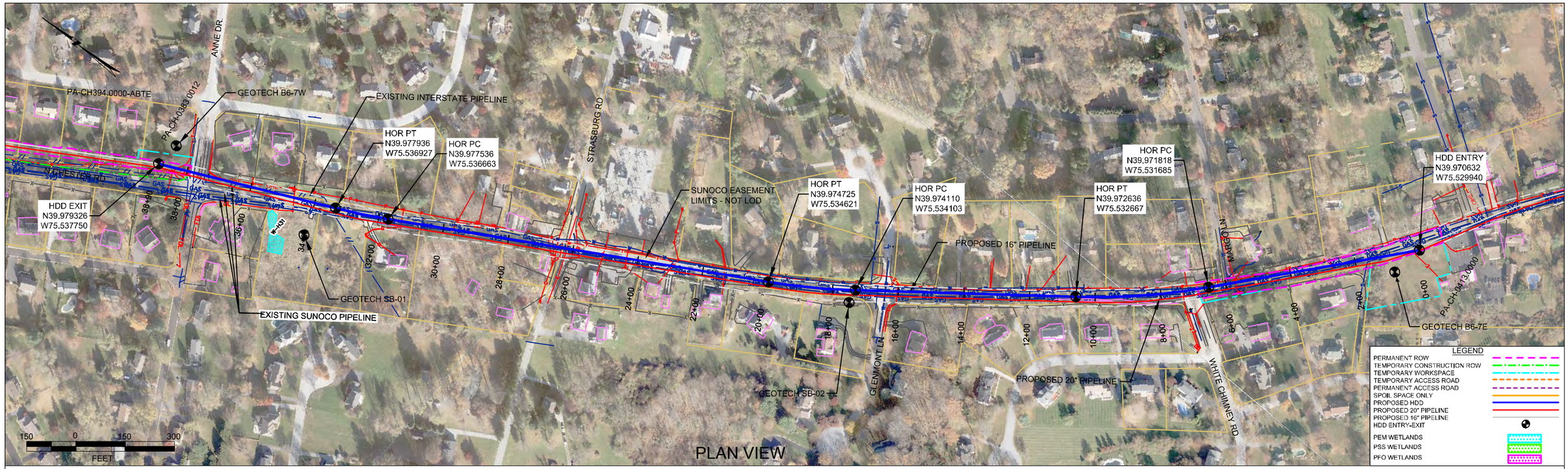
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

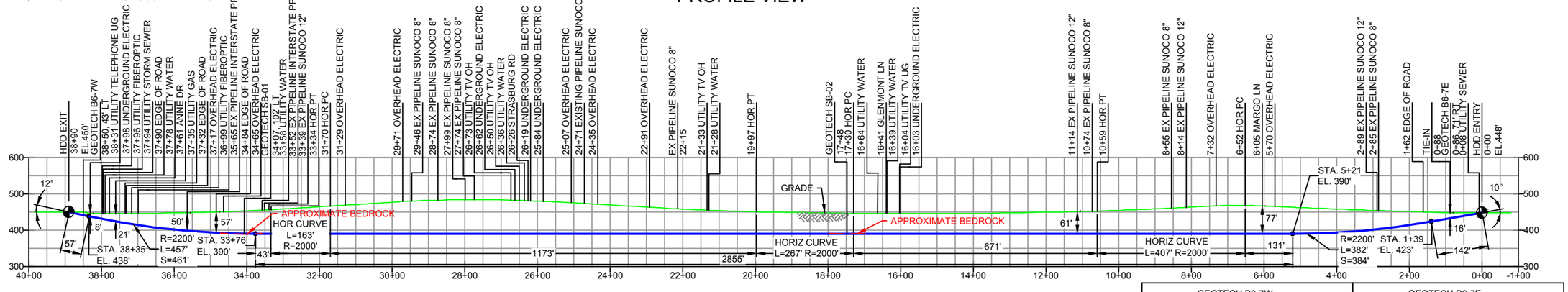
SCALE: 1"=300'

DWG. NO: PA-CH-0400.0000-RD-16

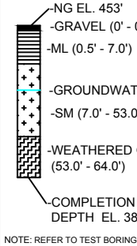


PLAN VIEW

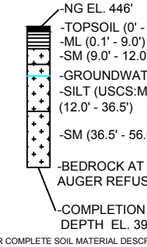
PROFILE VIEW



GEOTECH SB-01

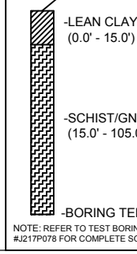


GEOTECH SB-02



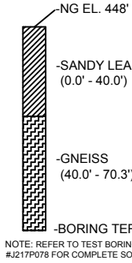
NOTE: REFER TO TEST BORING LOG S3-0520 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7W



NOTE: REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E



NOTE: REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #J217P078 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=):3890'
   HDD PIPE LENGTH (S=):3899'
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   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, DESIGN 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.
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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.

CHESTER COUNTY, PENNSYLVANIA - EAST GOSHEN TOWNSHIP
S3-0520-16

NOTES

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

REF. DRAWING

ES-6.66	TO	ES-6.68	EROSION & SEDIMENT PLAN
SHEET 43	TO	SHEET 45	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	11/15/17	RMB	11/15/17	AMC	11/15/17
EP3	UPDATED TO 16" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH	MRS	11/09/17	RMB	11/09/17	AMC	11/09/17
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
C	DESIGN CHANGE	MRS	10/13/15	RMB	10/13/15	AAW	10/13/15

Sunoco Logistics Partners L.P.

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SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300'

DWG. NO: PA-CH-0413.0000-RD-16