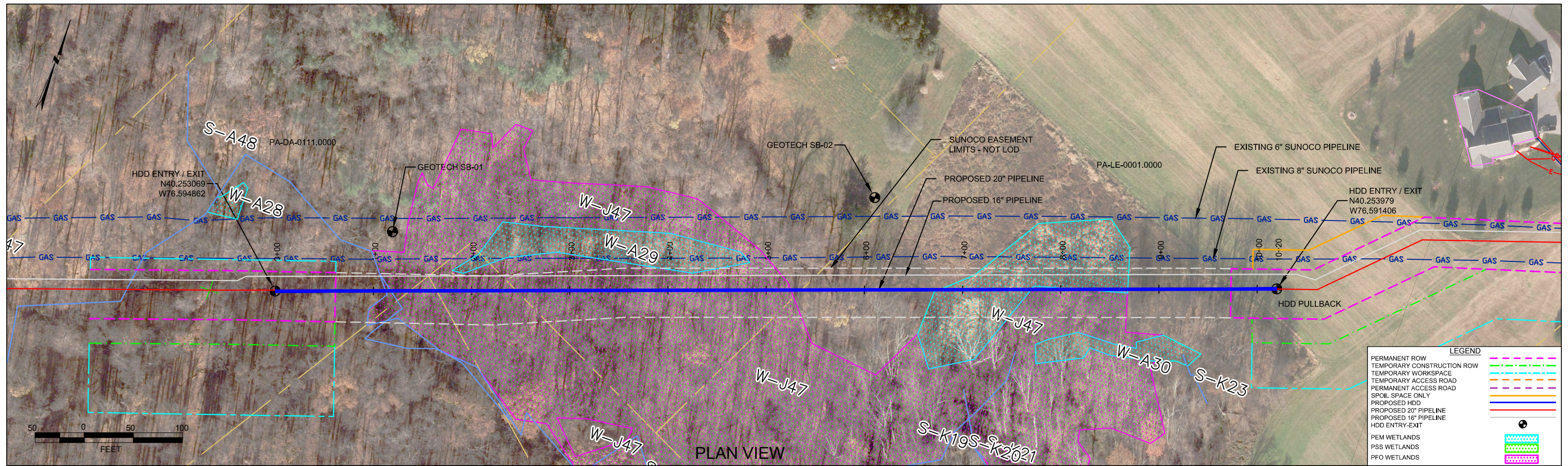


HDD PA-LE-0001.0000-SR (S-A47, S-K18, PFO-J47, PEM-J47)

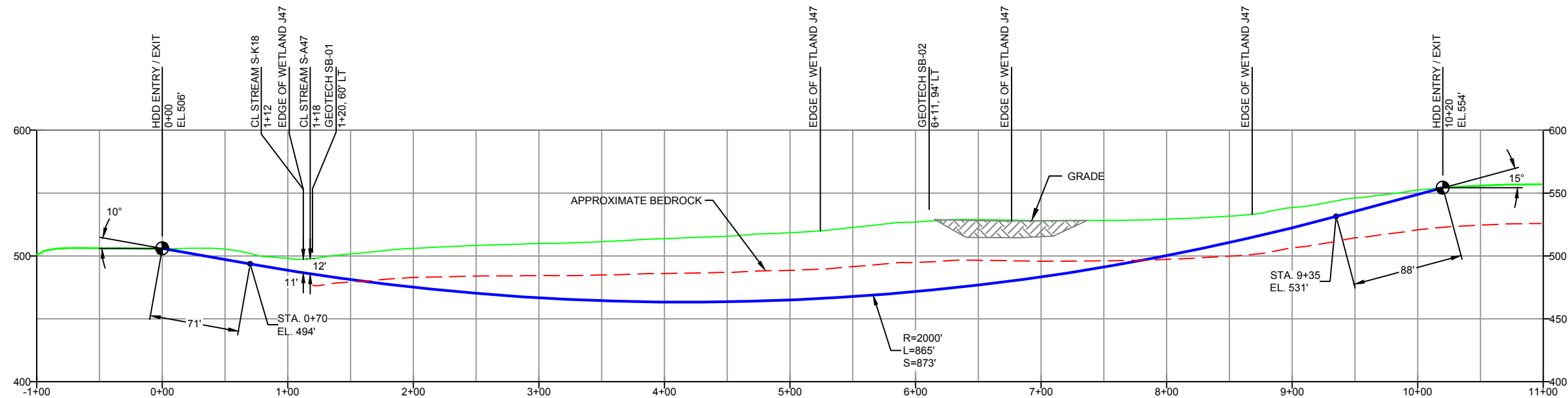
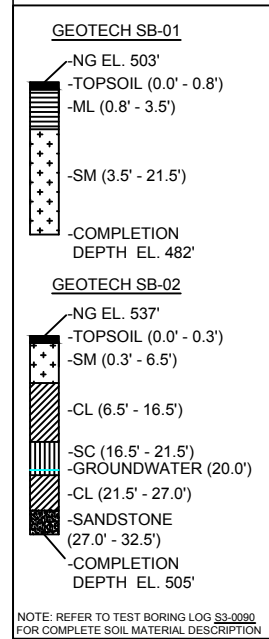
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts, if they were to occur, are also minimized to the maximum extent.

The drill will enter/exit 140 feet from the western edge of Forested Wetland J47 (PFO-J47) and enter/exit 514 feet from the eastern edge. Two small streams (S-A47, S-K18) flow through the forested wetland. The horizontal directional drill will enter/exit 710 feet from the western edge of Grassy Wetland J47 (PEM-J47) and enter/exit 170 feet from the eastern edge. The drill will pass below PFO-J47 starting at 10 feet (western edge) with a maximum depth of 60 feet at the eastern edge. It will continue below PEM-J47 starting at 50 feet along the western edge and 20 feet below grade on the eastern edge. The geotechnical results, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining the pipe integrity (e.g., no large bends). According to the geotechnical report primary substrates being drilled through are clays and silty sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PROFILE VIEW

LEBANON COUNTY, PENNSYLVANIA - CONEWAGO TOWNSHIP
S3-0090



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L)=1020'
HDD PIPE LENGTH (S)=1032'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

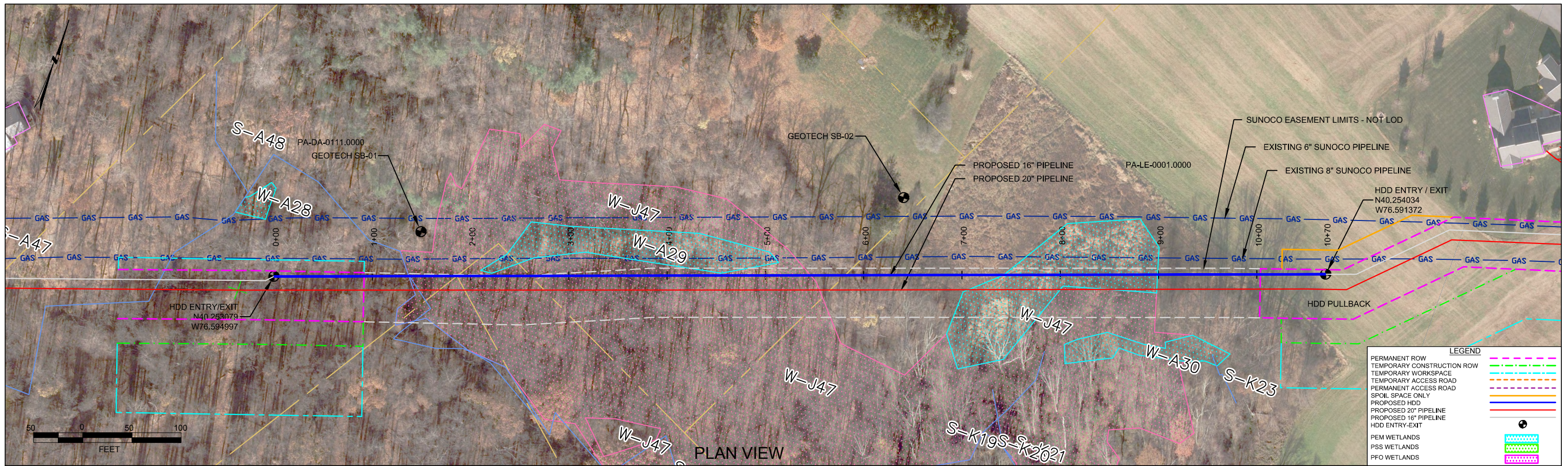
- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES
- ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED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

REF. DRAWING	NO.	DESCRIPTION	NO.	DESCRIPTION	
ES-4.39	TO	ES-5.02	EROSION & SEDIMENT PLAN	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16
SHEET 1	TO	SHEET 1	AERIAL SITE PLAN	EP1	REVISED PER PADEP COMMENTS
				EP	
				C	ADDED GEOTECH INFO/DESIGN ADJUSTMENT
				B	ISSUED FOR BID
				A	ISSUED FOR REVIEW

REVISIONS					
BY	DATE	CHK	DATE	APP	DATE
DLM	09/30/16	RMB	09/30/16	AAW	09/30/16
DLM	05/10/16	RMB	05/10/16	AAW	05/10/16
MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
MRS	09/22/15	RMB	09/22/15	AAW	09/22/15
DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
JVA	04/15/15	RMB	04/15/15	AAW	04/15/15

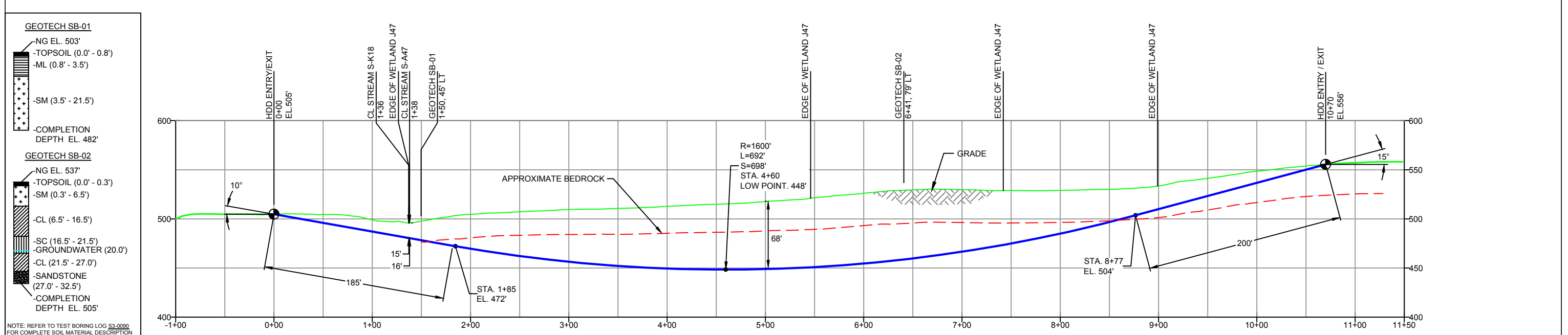


SUNOCO PIPELINE, L.P.	
20-INCH HORIZONTAL DIRECTIONAL DRILL WETLAND PENNSYLVANIA PIPELINE PROJECT	
SCALE: 1"=100'	DWG. NO: PA-LE-0001.0000-SR



LEBANON COUNTY, PENNSYLVANIA - CONEWAGO TOWNSHIP
S3-0090-16

PROFILE VIEW



- DESIGN AND CONSTRUCTION:**
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L-): 1070'
HDD PIPE LENGTH (S-): 1083'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED.
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

- ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
- STATIONING IS BASED ON HORIZONTAL DISTANCES
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- CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
- SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING		REVISIONS	
DWG NO	DESCRIPTION	NO.	DESCRIPTION
ES-4.39	TO ES-5.02	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16
SHEET 1	TO SHEET 1	EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ADDED GEOTECH INFO
		A	ISSUED FOR BID

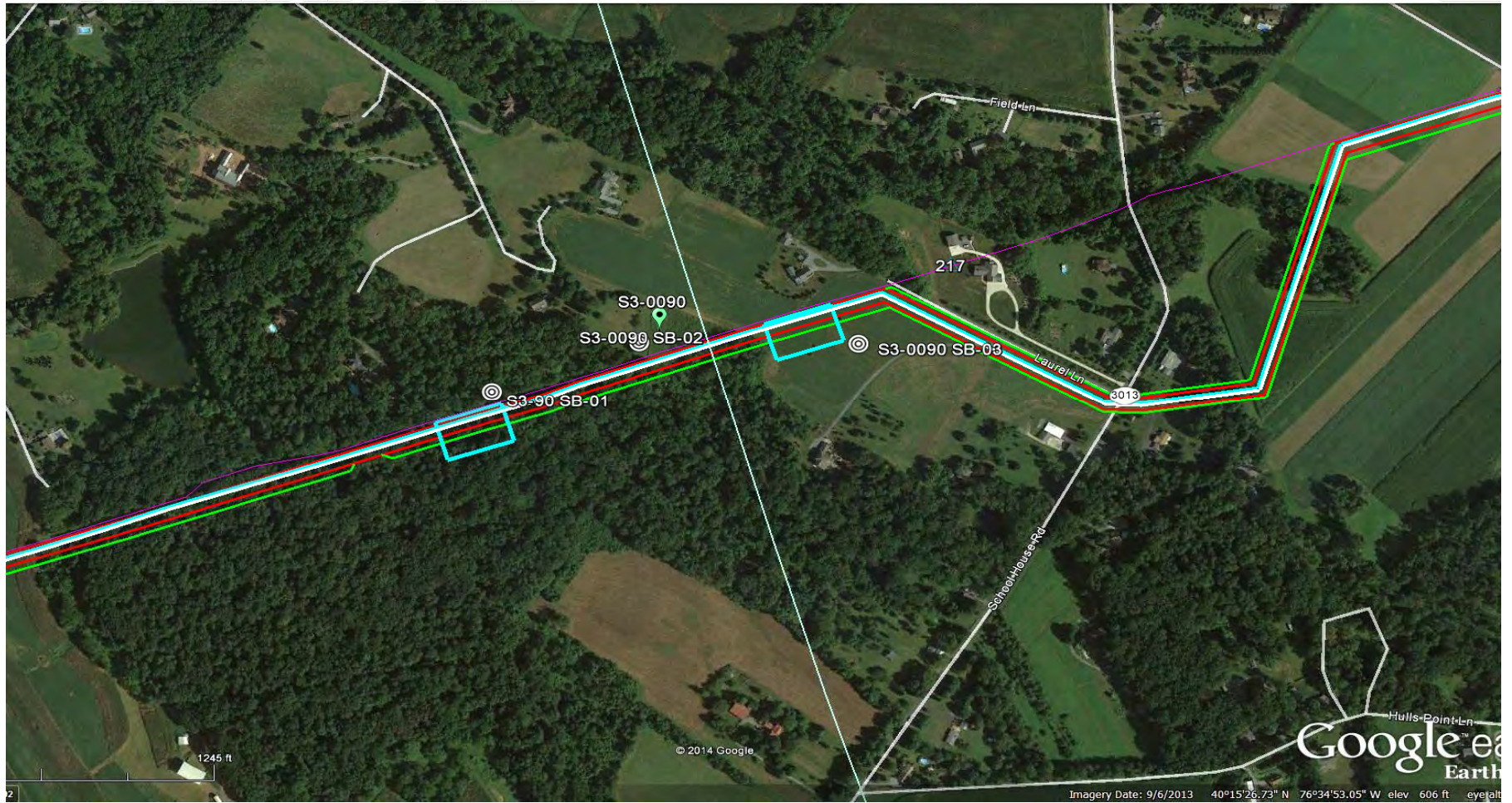
**Sunoco Logistics
Partners L.P.**

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
WETLAND
PENNSYLVANIA PIPELINE PROJECT

TETRA TECH ROONEY
(303) 792-5911

SCALE: 1"=100'	DWG. NO: PA-LE-0001.0000-SR-16
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LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



TETRA TECH

GEOTECHNICAL BORING LOCATIONS

HDD S3-0090

LEBANON COUNTY, SOUTH LONDONDERRY TOWNSHIP &
DAUGHIN COUNTY, CONEWAGO TOWNSHIP, PA

SUNOCO PENNSYLVANIA PIPELINE PROJECT

**TETRA TECH**

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

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: 95 LAUREL LANE, PALMYRA, PA			Page 1 of 1		
HDD No.: S3-0090		Dates(s) Drilled: 11-18-14		Inspector: E. WATT	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 21.5	
Boring Location Coordinates:			40° 15' 11.995" N		76° 35' 40.296" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N		
	From	To	From	To										
			0.0	0.8			TOPSOIL (10")							
1	3.0	5.0	0.8	3.5	12	ML	REDDISH BROWN MICACEOUS SILT WITH A LITTLE FINE SAND.	4	11	18	45		29	
			3.5				REDDISH BROWN FINE TO MEDIUM SAND AND SILT.							
2	8.0	8.7			9	SM	REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.	30	50/2"				>50	
							REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.							
3	13.0	13.8			7		REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.	15	50/3"					>50
							REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.							
4	18.0	19.2			10		REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.	17	50	50/2"				>50
							REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.							
5	20.0	20.3			4		REDDISH BROWN FINE SAND AND SILT WITH SOME UNWEATHERED SANDSTONE GRAVEL.	50/4"					>50	
				21.5										
							AUGER GRINDING STARTING AT 12'.							
							AUGER REFUSAL AT 20'. OFFSET BORING AND CONTINUOUSLY							
							AUGERED TO REFUSAL AT 21.5'.							
							CAVED AND NO WATER AT 17', BOTTOM MUDDY.							
							PLACED CONCETE PLUG.							

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



TETRA TECH

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 Newark, Delaware 19713
 302.738.7551
 fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT	Project No.:	103IP3406
Project Location:	95 LAUREL LANE, PALMYRA, PA	Page 1 of 1	
HDD No.:	S3-0090	Dates(s) Drilled:	11-18-14
Boring No.:	SB-02	Inspector:	E. WATT
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	S. HOFFER
		Groundwater Depth (ft):	20.0
		Total Depth (ft):	32.5
Boring Location Coordinates:	40° 15' 13.887" N	76° 35' 34.446" W	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.3			TOPSOIL (3")						
1	3.0	5.0	0.3		16	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, WITH A LITTLE FINE TO COARSE SANDSTONE GRAVEL.	4	20	27	45	47	
2	8.0	10.0	6.5		22	CL	REDDISH BROWN MICACEOUS SILTY CLAY WITH A LITTLE FINE SAND, TRACE FINE GRAVEL. (USCS: CL)	3	6	14	18	20	
3	13.0	15.0			24	CL	MAROON MICACEOUS SILTY CLAY WITH SOME FINE SAND, TRACE FINE TO COARSE SANDSTONE GRAVEL.	3	8	30	43	38	
4	18.0	20.0	16.5		21	SC	MAROON FINE SAND (TRACE MICA) WITH A LITTLE SILTY CLAY, TRACE FINE SANDSTONE GRAVEL.	5	11	23	40	34	
5	23.0	24.4	21.5		15	CL	MAROON MICACEOUS SILTY CLAY WITH A LITTLE FINE SAND, WITH A LITTLE F-C SANDSTONE GRAVEL.	3	7	50/5"		>57	
6	28.0	28.5	27.0		5		PARTIALLY WEATHERED MAROON SANDSTONE.	50/6"				>50	
7	31.0	31.6		32.5	6		PARTIALLY WEATHERED MAROON SANDSTONE.	12	50/2"			>50	
							AUGER REFUSAL AT 31'. OFF-SET BORING AND CONTINUOUSLY AUGERED TO REFUSAL AT 32.5'.						
							WET ON SPOON AT 20'.						
							WATER LEVEL THROUGH AUGERS AT 22'.						
							CAVED AT 27', WATER LEVEL ON CAVE AT 14'.						

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S2: > 4 TSF
 S3: > 4 TSF

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

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



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 240 Continental Drive, Suite 200
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 fax: 302.454.5988

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.:	103IP3406
Project Location:	95 LAUREL LANE, PALMYRA, PA			Page 1 of 1	
HDD No.:	S3-0090	Dates(s) Drilled:	11-18-14	Inspector:	E. WATT
Boring No.:	SB-03	Drilling Method:	SPT - ASTM D1586	Driller:	S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft):	NOT ENCOUNTERED	Total Depth (ft):	30.0
Boring Location Coordinates:	40° 15' 13.813" N		76° 35' 24.341" W		

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.4			TOPSOIL (5")						
1	3.0	5.0	0.4		13	CL	REDDISH BROWN SILTY CLAY WITH A TRACE TO A LITTLE FINE SAND (USCS: CL).	1	6	9	10	15	
2	8.0	10.0	6.5		23	SC	MAROON FINE TO MEDIUM MICACEOUS SAND WITH SOME SILTY CLAY.	2	18	26	20	44	
3	13.0	15.0			18	SC	MARRON FINE TO MEDIUM SAND WITH A LITTLE SILTY CLAY AND A LITTLE FINE TO COARSE QUARTZ GRAVEL.	4	23	23	50/5"	46	
4	18.0	20.0			24	SC	MARRON FINE TO MEDIUM SAND WITH SOME SILTY CLAY AND A LITTLE FINE TO COARSE SILT OR CLAYSTONE GRAVEL.	4	21	35	50/6"	56	
5	23.0	24.4	21.5		11	CL	REDDISH BROWN WEATHERED CLAYSTONE (SILTY CLAY WITH SOME FINE SAND).	10	27	50/5"		>77	
6	28.0	28.3	26.0	30.0	4		REDDISH BROWN PARTIALLY WEATHERED SANDSTONE.	50/4"				>50	
							CAVED AND DRY AT 28'.						

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S1: > 4 TSF

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 S3-0090

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S3-0090	SB-01	1	3.0	5.0	6.4	41.2	-	-	-	-
		2	8.0	8.7	3.6	39.2	-	-	-	-
		4	18.0	19.2	5.7	39.8	-	-	-	-
		5	20.0	20.3	6.3	41.9	-	-	-	-
	SB-02	1	3.0	5.0	9.2	21.9	-	-	-	-
		2	8.0	10.0	10.4	80.8	30	19	11	CL
		3	13.0	15.0	12.5	75.1	-	-	-	-
		4	18.0	20.0	14.2	16.3	-	-	-	-
		5	23.0	24.4	10.5	90.7	-	-	-	-
		6	28.0	28.5	5.7	21.4	-	-	-	-
	SB-03	1	3.0	5.0	14.2	99.2	32	19	13	CL
		2	8.0	10.0	9.2	21.1	-	-	-	-
		4	18.0	20.0	13.7	38.8	-	-	-	-
		5	23.0	24.4	9.6	75.3	-	-	-	-

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0090**

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
S3-0090	Wetland J47	SB-01	Gettysburg Fm - reddish-brown to maroon silty mudstone and shale and soft, red-brown, medium- to fine-grained sandstone, with minor amounts of yellowish-brown shale and sandstone and thin beds of impure limestone.	Gently sloping lowland to forested wetlands	Gettysburg Fm	Silty mudstone-shale-sandstone w/ some impure limestone		12-22	
		SB-02							
		SB-03							

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Particle Size Identification

Boulders	8 in. diameter or more
Cobbles	3 to 8 in. diameter
Gravel	Coarse (C) 3 in. to ¾ in. sieve Fine (F) ¾ in. to No. 4 sieve
Sand	Coarse (C) No. 4 to No. 10 sieve (4.75mm-2.00mm) Medium (M) No. 10 to No. 40 sieve (2.00mm – 0.425mm) Fine (F) No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)

Relative Proportions

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

COHESIVE SOILS

(Silt, Clay & Combinations)

<u>Consistency</u>	<u>N (blows)*</u>
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

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

ROCK

(Rock Cores)

<u>Rock Quality Designation (RQD), %</u>	<u>Rock Quality Description</u>
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

***N - Standard Penetration Resistance.** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

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

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications				
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
		GP Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting C_u or C_c requirements for GW					
		Gravel with fines (Appreciable amount of fines)	GM Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			GC Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7			
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
			SP Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW			
		Sands with fines (Appreciable amount of fines)	SM Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			SC Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7			
						For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.		
		Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt and clays (Liquid limit less than 50)		ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays								
OL Organic silts and organic silty clays of low plasticity								
Silt and Clays (Liquid limit greater than 50)	MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts							
	CH Inorganic clays of high plasticity, fat clays							
	OH Organic clays of medium to high plasticity, organic silts							
Highly organic soils	Pt Peat and other highly organic soils							

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