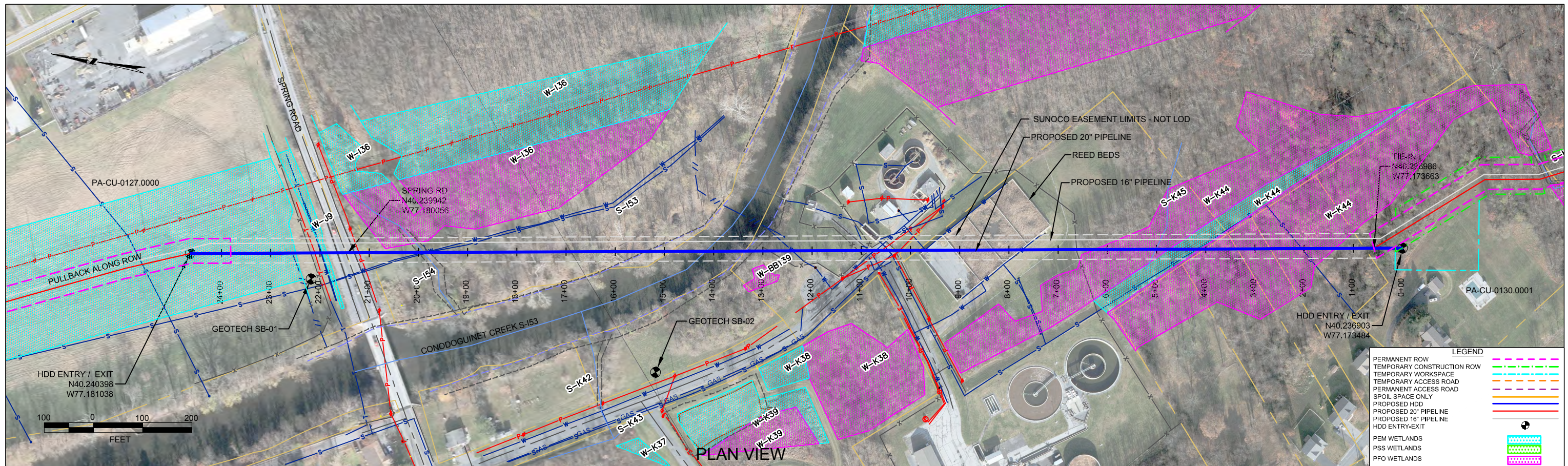


HDD PA-CU-0128.0000-WX (PEM-J10, PEM-J9, S, I54, S-I53, W-K44, S-K45)

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.

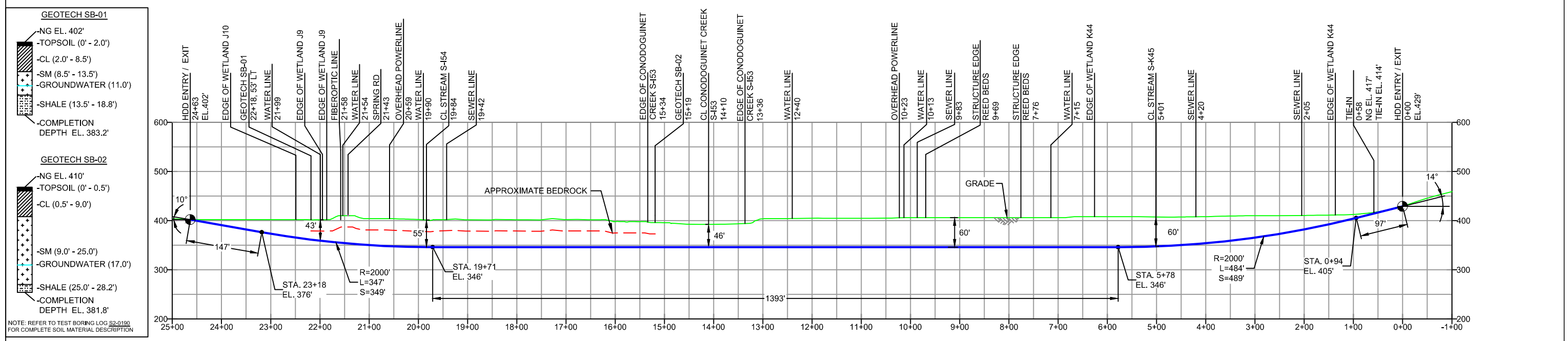
The drill will enter/exit within the Grassy Wetland J10 (PEM-J10) the eastern edge of which is 220 feet from the western drill entrance/exit. The drill will enter/exit 270 feet from the western edge of Grassy Wetland J9 (PEM-J9) and enter/exit 2,130 feet from the eastern edge. The drill enters/exits 480 feet from the western edge of Stream I54 (S-I54) and enters/exits 1,930 feet from the eastern edge. The western bank of Conodoguinet Creek (S-I53) is 990 feet from the western entrance/exit for the drill and the eastern bank is 1,230 feet from the eastern entrance/exit. The drill will enter/exit 1,840 feet from the western edge of Wetland K44 (W-K44) and 80 feet from the eastern edge. Stream K45 (S-K45) flows through W-K44 and is 1,960 feet from the western entrance/exit of the drill and 450 feet from the eastern entrance/exit. The drill will pass 35 feet or more below each of the listed waterways or wetlands, peaking at 60 feet below W-K44 and S-K45, except for W-K44 where the drill is 15 feet below the surface at 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 substrate to be drilled through is calcereous shale below layers of silty clays and fine sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



CUMBERLAND COUNTY, PA - NORTH MIDDLETON TOWNSHIP
S2-0190

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=): 2463'
HDD PIPE LENGTH (S=): 2475'
20" x 0.456" W.T., X-65, API 5L, 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		REF. DRAWING		REVISIONS		MRS		RMB		AAW		DATE	
1.	ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83	ES-4.51	TO ES-4.52	EROSION & SEDIMENT PLAN	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16	
2.	STATIONING IS BASED ON HORIZONTAL DISTANCES.	SHEET 32	TO SHEET 32	AERIAL SITE PLAN	EP1	REVISED PER PADEP COMMENTS	MRS	05/20/16	RMB	05/20/16	AAW	05/20/16	
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.				EP		JTW	11/23/15	RMB	11/23/15	AAW	11/23/15	
4.	CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.				C	ADDED GEOTECH INFO	MRS	09/06/15	RMB	09/06/15	AAW	09/06/15	
5.	SUNOCO EMERGENCY HOTLINE NUMBER IS 1-800-786-7440.				B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15	
					A	ISSUED FOR REVIEW	RTT	03/24/15	RMB	03/24/15	AAW	03/24/15	
		DWG NO	DWG NO	DESCRIPTION	NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE	

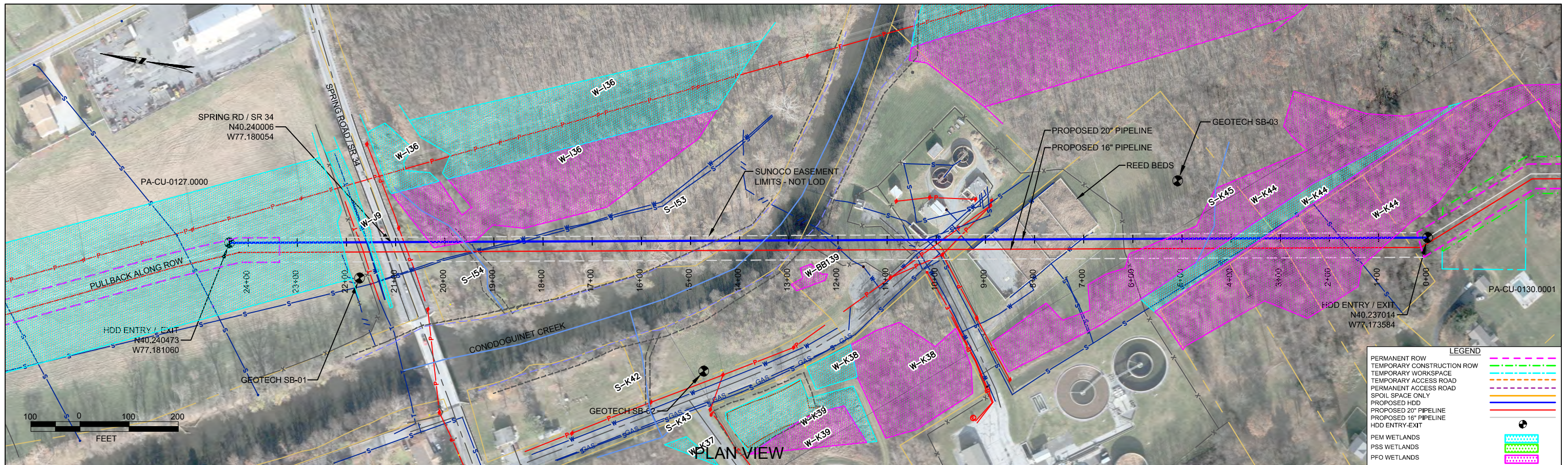
**Sunoco Logistics
Partners L.P.**

TETRA TECH ROONEY
(303) 792-5911

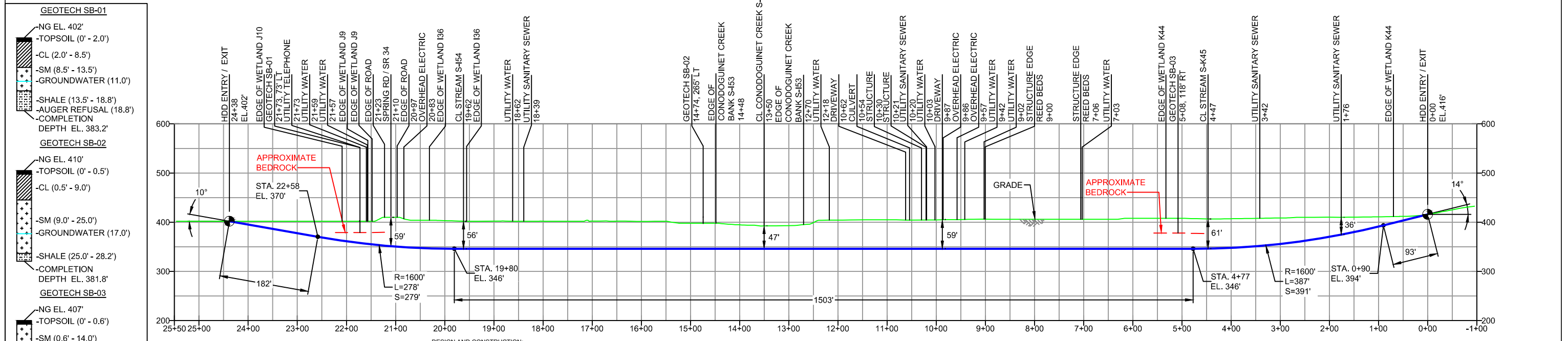
SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
CONODOGUINET CREEK
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO: PA-CU-0128.0000-WX



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)=2438'
HDD PIPE LENGTH (S)=2448'
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
- 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-4.51	TO	ES-4.52	EROSION & SEDIMENT PLAN	
SHEET 32	TO	SHEET 32	AERIAL SITE PLAN	EP2
				REVISED PER PADEP COMMENTS RECEIVED 09-06-16
				EP1
				REVISED PER PADEP COMMENTS
				EP
				B
				ADDED GEOTECH INFO
				A
				ISSUED FOR BID

**Sunoco Logistics
Partners L.P.**

SUNOCO PIPELINE, L.P.

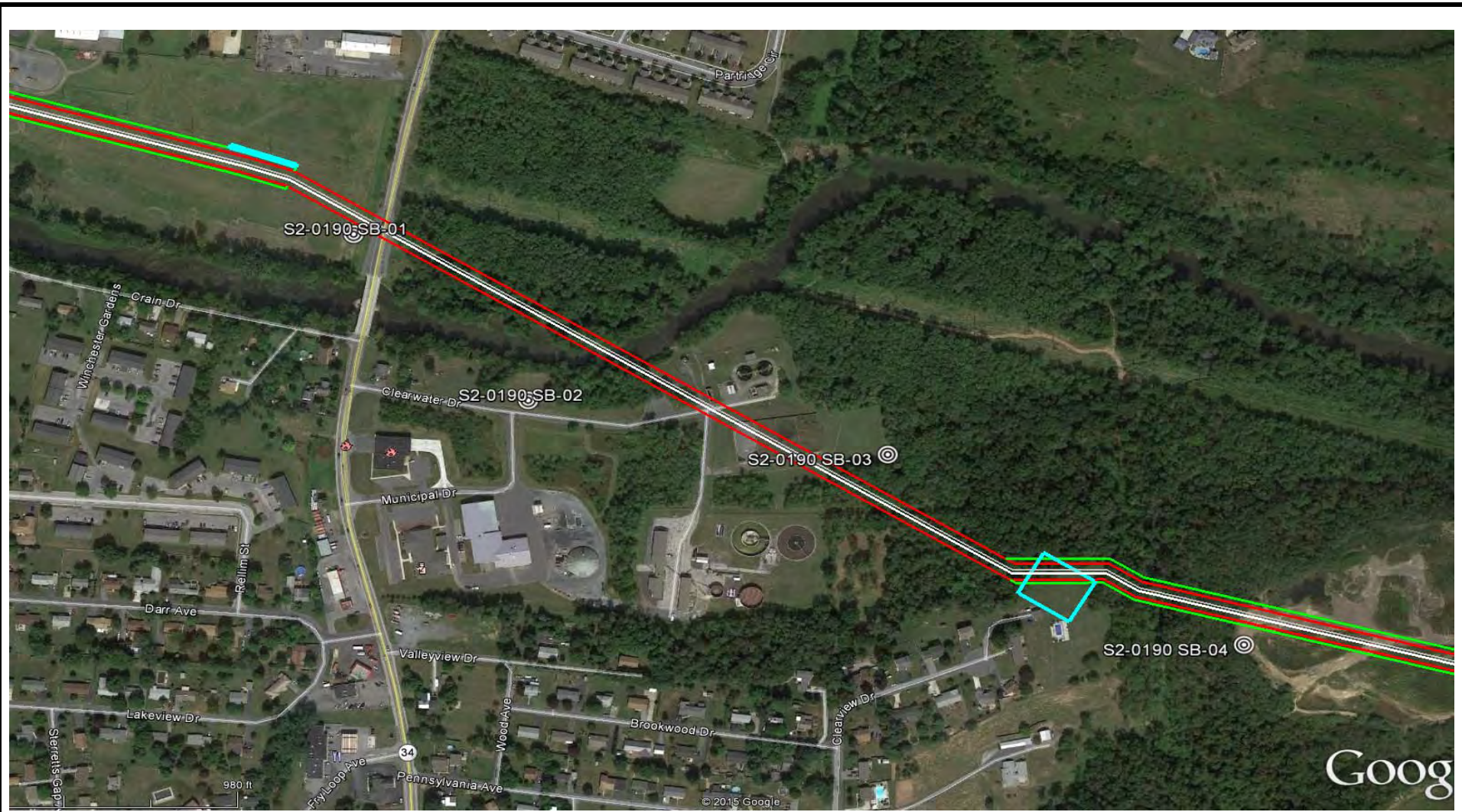
16-INCH HORIZONTAL DIRECTIONAL DRILL
CONODOGUINET CREEK
PENNSYLVANIA PIPELINE PROJECT

BY	DATE	CHK	DATE	APP	DATE
MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
MRS	05/20/16	RMB	05/20/16	AAW	05/20/16
JTW	03/15/16	RMB	03/15/16	AAW	03/15/16
MRS	09/06/15	RMB	09/06/15	AAW	09/06/15
MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

TETRA TECH ROONEY
(303) 792-5911

SCALE: 1"=200'

DWG. NO: PA-CU-0128.0000-WX-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S2-0190
 CUMBERLAND COUNTY, NORTH MIDDLETON 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: SPRING ROAD (RT 34), NORTH MIDDLETOWN TWP, PA			Page 1 of 1		
HDD No.: S2-0190		Dates(s) Drilled: 10-24-14		Inspector: E. WATT	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 11.0		Total Depth (ft): 18.8	
Boring Location Coordinates:			40°14'23.73"N		77°10'49.38"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	2.0			TOPSOIL (24 ")						
1	3.0	5.0	2.0		10	CL	MOTTLED DARK GRAY AND BROWN SILTY CLAY, TRACE COARSE GRAVEL. (USCS: CL)	1	1	4	6		5
2	8.0	9.3	8.5		11	SM	DR SHALE (FISSILE) WEATHERED TO A FINE SAND WITH SOME F-C UNWEATHERED GRAVEL (WHEN DISTURBED), SOME SILT.	3	50	50/3"			>50
3	13.0	13.9	13.5		4		PARTIALLY WEATHERED GRAY SHALE	50	50/4"				>50
4	18.0	18.8		18.8	3		PARTIALLY WEATHERED GRAY SHALE	3	50/3"				>50

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK
 S1: 2.0 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.



TETRA TECH

240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
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TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location: CLEARWATER DRIVE, NORTH MIDDLETOWN TWP, PA		Page 1 of 1
HDD No.: S2-0190	Dates(s) Drilled: 10-24-145	Inspector: E. WATT
Boring No.: SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor: HAD DRILLING	Groundwater Depth (ft): 17.0	Total Depth (ft): 28.2
Boring Location Coordinates: 40°14'18.53"N		77°10'42.94"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	0.5			TOPSOIL (6")					
1	3.0	5.0	0.5		20	CL	MOTTLED (OR. BRWN, LIGHT GRAY, LIGHT BROWN) SILT CLAY WITH A LITTLE FINE SAND, TRACE FINE GRAVEL (USCS: CL).	2	7	11	13	18
2	8.0	9.3	9.0		15	SM	DR SHALE WEATHERED TO A GRAY TO BROWN FINE SAND AND F-C ANGULAR GRAVEL (WHEN DISTURBED) AND SILT.	4	12	50/3"		>50
3	13.0	14.4			11	SM	DR SHALE WEATHERED TO A DARK GRAY FINE SAND WITH A LITTLE F-C ANGULAR GRAVEL, A LITTLE SILT (WHEN DISTURBED). FISSILE.	3	34	50/5"		>50
4	18.0	18.7			8	SM	DR SHALE WEATHERED TO A DARK GRAY FINE SAND WITH A LITTLE F-C ANGULAR GRAVEL, SOME SILT (WHEN DISTURBED). FISSILE.	20	50/2"			>50
5	23.0	24.2		25.0	9	SM	DR SHALE WEATHERED TO A GRAY FINE SAND WITH SOME F-C ANGULAR GRAVEL, A LITTLE SILT (WHEN DISTURBED).	10	50	50/2"		>50
6	28.0	28.2	25.0	28.2	2		PARTIALLY WEATHERED GRAY SHALE.	50/2"				>50

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.



TETRA TECH

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 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: CLEARWATER DRIVE, WATER TREATMENT PLANT, CARISEL, PA			Page 1 of 1		
HDD No.: S2-0190		Dates(s) Drilled: 09-15-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: M. HYNES	
Drilling Contractor: HYNES		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 14' 16.839" N		77° 10' 29.727" 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	0.6			TOPSOIL (7 ")						
1	3.0	5.0	0.6		30	SM	MOTTLED BROWN AND ORANGE BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE SHALE FRAGS. (USCS: SM).	3	6	6	8		12
2	8.0	8.8			8	PARTIALLY WEATHERED SHALE	GRAY AND BROWN PARTIALLY WEATHERED SHALE.	30	50/3"				>50
3	13.0	13.6			6		LIGHT GRAY PARTIALLY WEATHERED SHALE. DRY.	50	50/2"				>50
				14.0		PARTIALLY WEATHERED ROCK	AUGER REFUSAL AT 14'. FIRST ATTEMPT TO ROCK CORE WAS UNSUCCESSFUL. ADVANCED CASING AND DRILLED WITH ROLLER BIT TO 20'.						
							ROCK CORING						
RUN 1	20.0	23.0	20.0		18		MODERATELEY FRACTURED GRAY CALCEROUS SHALE	TCR: 50%, SCR: 19%, RQD: 19%					
RUN 2	23.0	27.0			42		VERY INTENSELY FRACTURED GRAY CALCEROUS SHALE.	TCR: 88%, SCR: 12.5%, RQD: 0%					
RUN 3	27.0	30.0		29.5	35		MODERATELEY FRACTURED GRAY CALCEROUS SHALE.	TCR: 97%, SCR: 54%, RQD: 54%					
			29.5	30.0			GRAY LIMESTONE, WITH QUARTZ AND CALCITE DEPOSITS AT 30'.						
							GROUNDWATER NOT ENCOUNTERED WITHIN OVERBUREN SOILS (PRIOR TO AUGER REFUSAL).						
							CORE TESTING RESULTS (DEPTH 20-20.5'):						
							COMPRESSIVE STRENGTH: 7,400 PSI						
							UNIT WEIGHT: 168.8 PCF						
							CORE TESTING RESULTS (DEPTH 28.5-29'):						
							COMPRESSIVE STRENGTH: 7,250 PSI						
							UNIT WEIGHT: 155.7 PCF						

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



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 Newark, Delaware 19713
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 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: WOLFS BRIDGE ROAD, CARLISEL, PA			Page 1 of 1		
HDD No.: S2-0190		Dates(s) Drilled: 09-16-15		Inspector: E. WATT	
Boring No.: SB-04		Drilling Method: SPT - ASTM D1586		Driller: M. HYNES	
Drilling Contractor: HYNES		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 14.0	
Boring Location Coordinates:			40° 14' 10.963" N		77° 10' 16.799" 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	0.5			TOPSOIL (6")					
1	3.0	5.0	0.5			PARTIALLY WEATHERED SHALE	GRAY AND BROWN PARTIALLY WEATHERED SHALE.	8	24	33	40	57
2	8.0	8.8					GRAY AND BROWN PARTIALLY WEATHERED SHALE.	18	50/3"			>50
3	13.0	13.7		14.0			GRAY AND BROWN PARTIALLY WEATHERED SHALE.	24	50/2"			>50
							AUGER REFUSAL AT 14'.					
							CAVED AND DRY AT 7'.					

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0190**

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S2-0190	SB-3	1	20	23	50	19	19	20	30	Moderate	Shale	Very thin (mm)	Dark gray	Fractures ranging from 26° to 72°, Avg. 47°
		2	23	27	88	13	0							
		3	27	30	97	54	54							

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0190**

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
S2-0190	Spring Rd	SB-01 and SB-02	Martinsburg Fm - buff-weathering, dark-gray to purple shale and slate with thin interbeds of siltstone, metabentonite, and fine-grained sandstone.	River crossing	Martinsburg Fm	Shale and slate with interbedded siltstone		36-52	
		SB-03 and SB-04		Gently rolling to level				12-18	

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.

**GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0190**

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, %	
S2-0190	SB-01	1	3.0	5.0	24.2	94.1	40	22	18	CL
		2	8.0	9.3	7.8	36.3	-	-	-	-
		3	13.0	13.9	4.4	20.4	-	-	-	-
		4	18.0	18.9	2.0	9.1	-	-	-	-
	SB-02	1	3.0	5.0	21.8	88.7	37	22	15	CL
		2	8.0	9.3	8.3	46.6	-	-	-	-
		3	13.0	13.4	8.6	11.5	-	-	-	-
		4	18.0	18.7	10.5	22.8	-	-	-	-
		5	23.0	24.2	5.0	11.6	-	-	-	-
	SB-03	1	3.0	5.0	13.2	24.5	NL	NP	NV	SM
		2	8.0	8.8	5.9	29.5	-	-	-	-
		3	13.0	13.6	4.3	24.3	-	-	-	-
	SB-04	1	3.0	5.0	8.1	25.3	-	-	-	-
		2	8.0	8.8	6.8	22.7	NL	NP	NV	N/A
		3	13.0	13.7	3.9	23.6	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-03	1	20 - 20.5	7,400	168.8
SB-03	3	28.5 - 29	7,250	155.7

Notes:

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

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	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for GW		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			
		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 Not meeting C_u or C_c requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		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		
		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⁾					
		Major Divisions		Group Symbols	Typical Descriptions	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.