

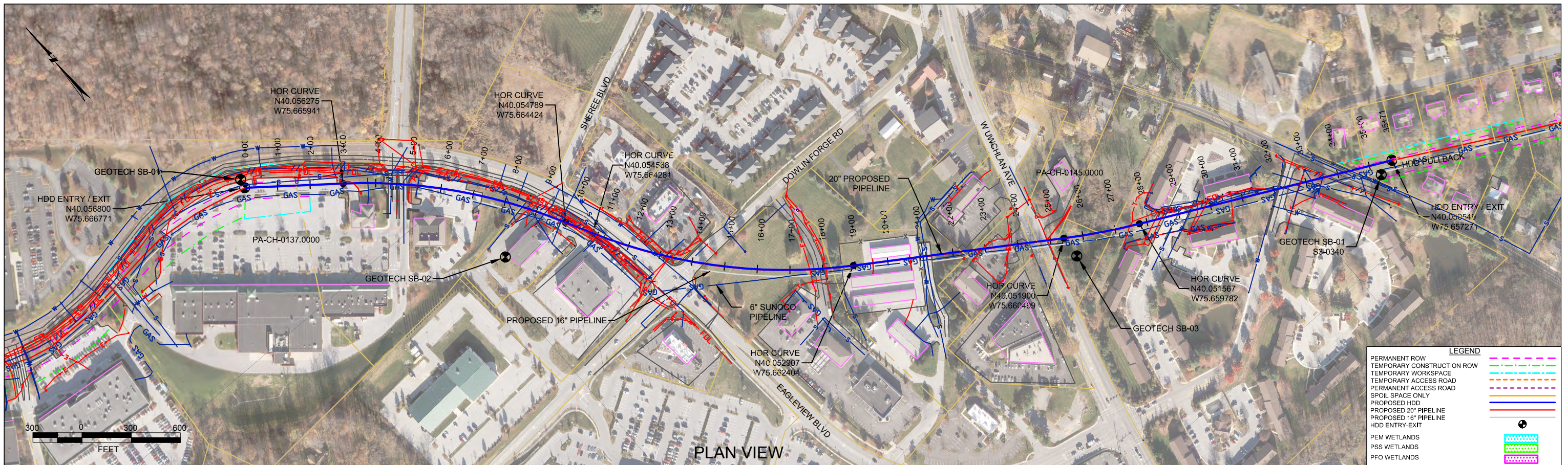
***HDD PA-CH-0138.0000-RD (Eagleview Blvd, Dowlin Forge Rd, and Wuwchlan Ave)***

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 1213 feet northwest of Eagleview Blvd. The drill will pass 30 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand.

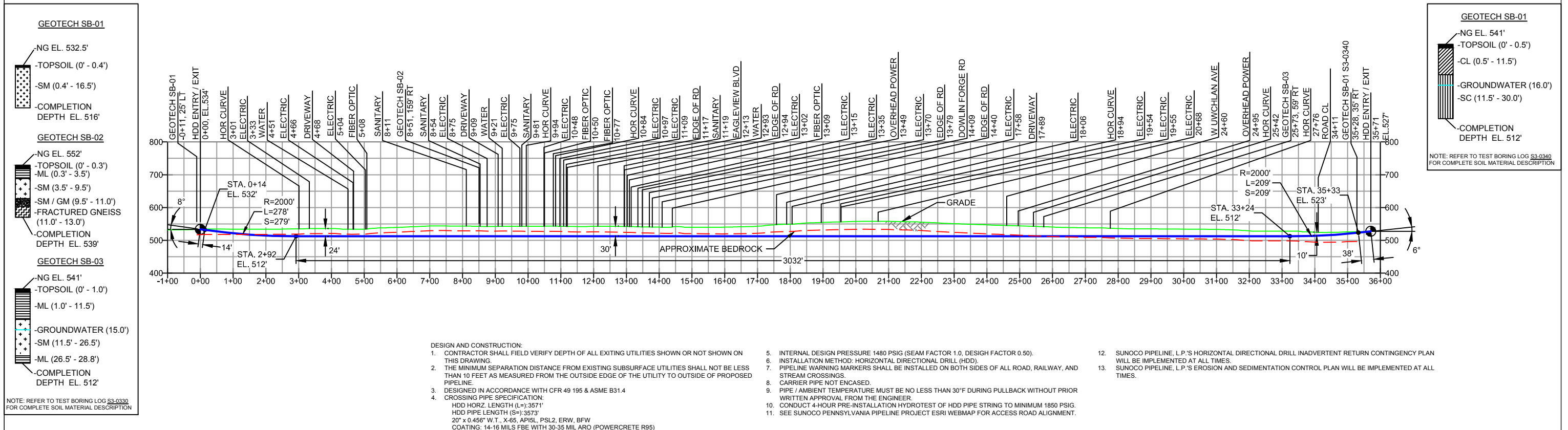
The drill will enter/exit 1409 feet northwest of Dowlin Forge Rd. The drill will pass 30 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand, and gneiss.

The drill will enter/exit 2460 feet northwest of Wuwchlan Ave. The southeast entry/exit point is 1111 feet southeast of Wuwchlan Ave. The drill will pass 30 feet under this street. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand, and silty clay.



PLAN VIEW  
PROFILE VIEW

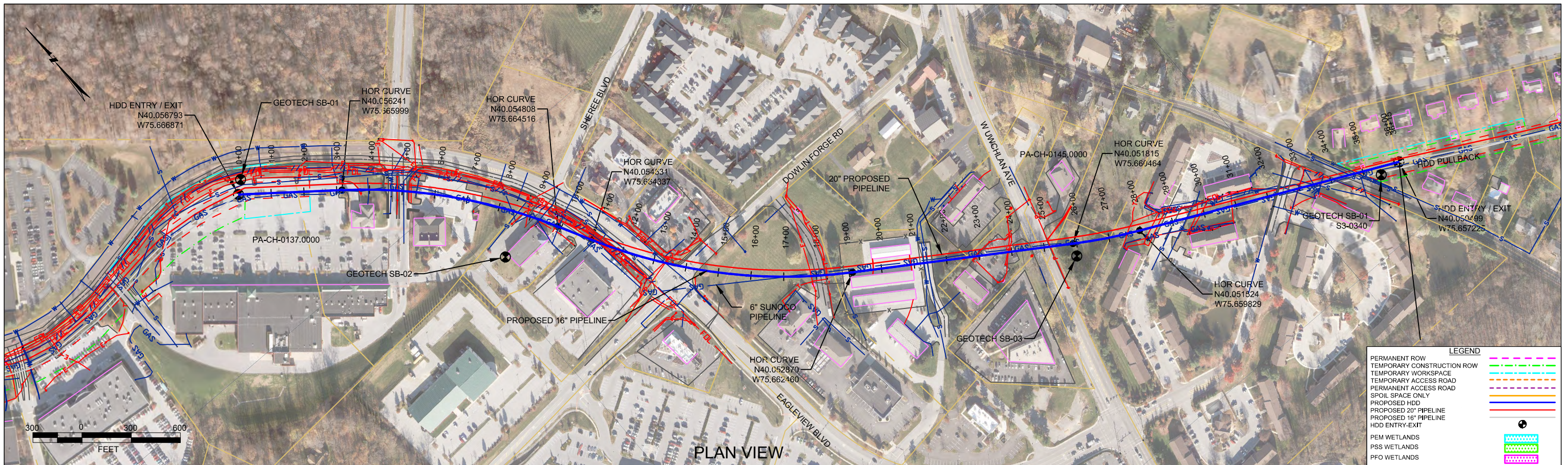
CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP  
S3-0331



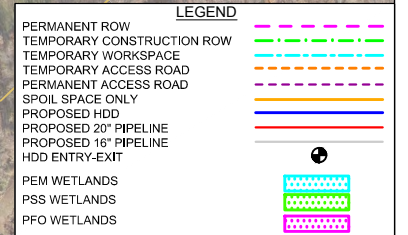
NOTES		REF. DRAWING		REVISIONS		DESIGN AND CONSTRUCTION:							
1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83	ES-6.38	TO	ES-6.40	EROSION & SEDIMENT PLAN	EP1	REVISED PER PADEP COMMENTS	MRS	05/11/16	RMB	05/11/16	AAW	05/11/16	1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.	SHEET 22	TO	SHEET 23	AERIAL SITE PLAN	EP	ADDED GEOTECH INFO	MRS	03/15/16	RMB	03/15/16	AAW	03/15/16	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. 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.					C	ISSUED FOR BID	MRS	09/29/15	RMB	09/29/15	AAW	09/29/15	3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.					B	ISSUED FOR BID	DLM	08/21/15	RMB	08/21/15	AAW	08/21/15	4. CROSSING PIPE SPECIFICATION: HDD HORZ. LENGTH (L)=3571' HDD PIPE LENGTH (S)=3573' 20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.	DWG NO		DWG NO	DESCRIPTION	NO.	DESCRIPTION	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15	5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
					A	ISSUED FOR REVIEW	KB	03/29/15	RMB	03/29/15	AAW	03/29/15	6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
							BY	DATE	CHK	DATE	APP	DATE	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.



SUNOCO PIPELINE, L.P.	
20-INCH HORIZONTAL DIRECTIONAL DRILL EAGLEVIEW BLVD PENNSYLVANIA PIPELINE PROJECT	
SCALE: 1"=300'	DWG. NO: PA-CH-0138.0000-RD

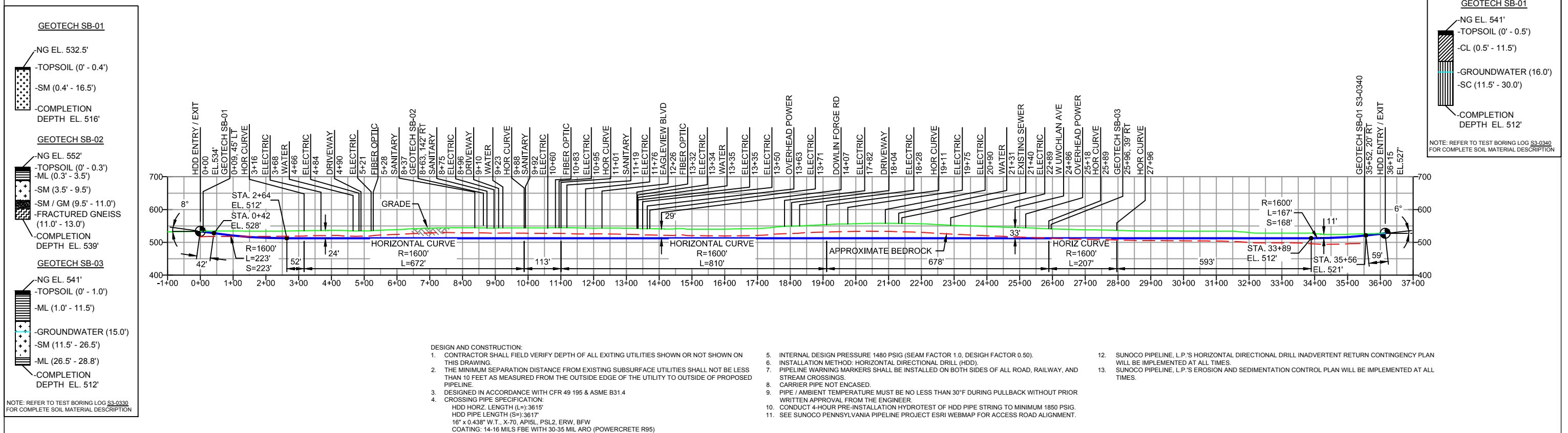


PLAN VIEW



CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP  
S3-0331-16

PROFILE VIEW



- GEOTECH SB-01**
- NG EL. 532.5'
  - TOPSOIL (0' - 0.4')
  - SM (0.4' - 16.5')
  - COMPLETION DEPTH EL. 516'
- GEOTECH SB-02**
- NG EL. 552'
  - TOPSOIL (0' - 0.3')
  - ML (0.3' - 3.5')
  - SM (3.5' - 9.5')
  - SM / GM (9.5' - 11.0')
  - FRACTURED GNEISS (11.0' - 13.0')
  - COMPLETION DEPTH EL. 539'
- GEOTECH SB-03**
- NG EL. 541'
  - TOPSOIL (0' - 1.0')
  - ML (1.0' - 11.5')
  - GROUNDWATER (15.0')
  - SM (11.5' - 26.5')
  - ML (26.5' - 28.8')
  - COMPLETION DEPTH EL. 512'
- NOTE: REFER TO TEST BORING LOG S3-0330 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- GEOTECH SB-01**
- NG EL. 541'
  - TOPSOIL (0' - 0.5')
  - CL (0.5' - 11.5')
  - GROUNDWATER (16.0')
  - SC (11.5' - 30.0')
  - COMPLETION DEPTH EL. 512'
- NOTE: REFER TO TEST BORING LOG S3-0340 FOR COMPLETE SOIL MATERIAL DESCRIPTION

- DESIGN AND CONSTRUCTION:
- 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)=3615'  
HDD PIPE LENGTH (S)=3617'  
16" x 0.438" W.T., X-70, API6L, PSL2, ERW, 8FW  
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		EROSION & SEDIMENT PLAN	
ES-6.38	TO ES-6.40		
SHEET 22	TO SHEET 23	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ADDED GEOTECH INFO
		A	ISSUED FOR BID
DWG NO	DWG NO	DESCRIPTION	NO.

REVISIONS					
MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	03/15/16	RMB	03/15/16	AAW	03/15/16
MRS	09/29/15	RMB	09/29/15	AAW	09/29/15
MRS	08/31/15	RMB	08/31/15	AAW	03/29/15
BY	DATE	CHK	DATE	APP	DATE

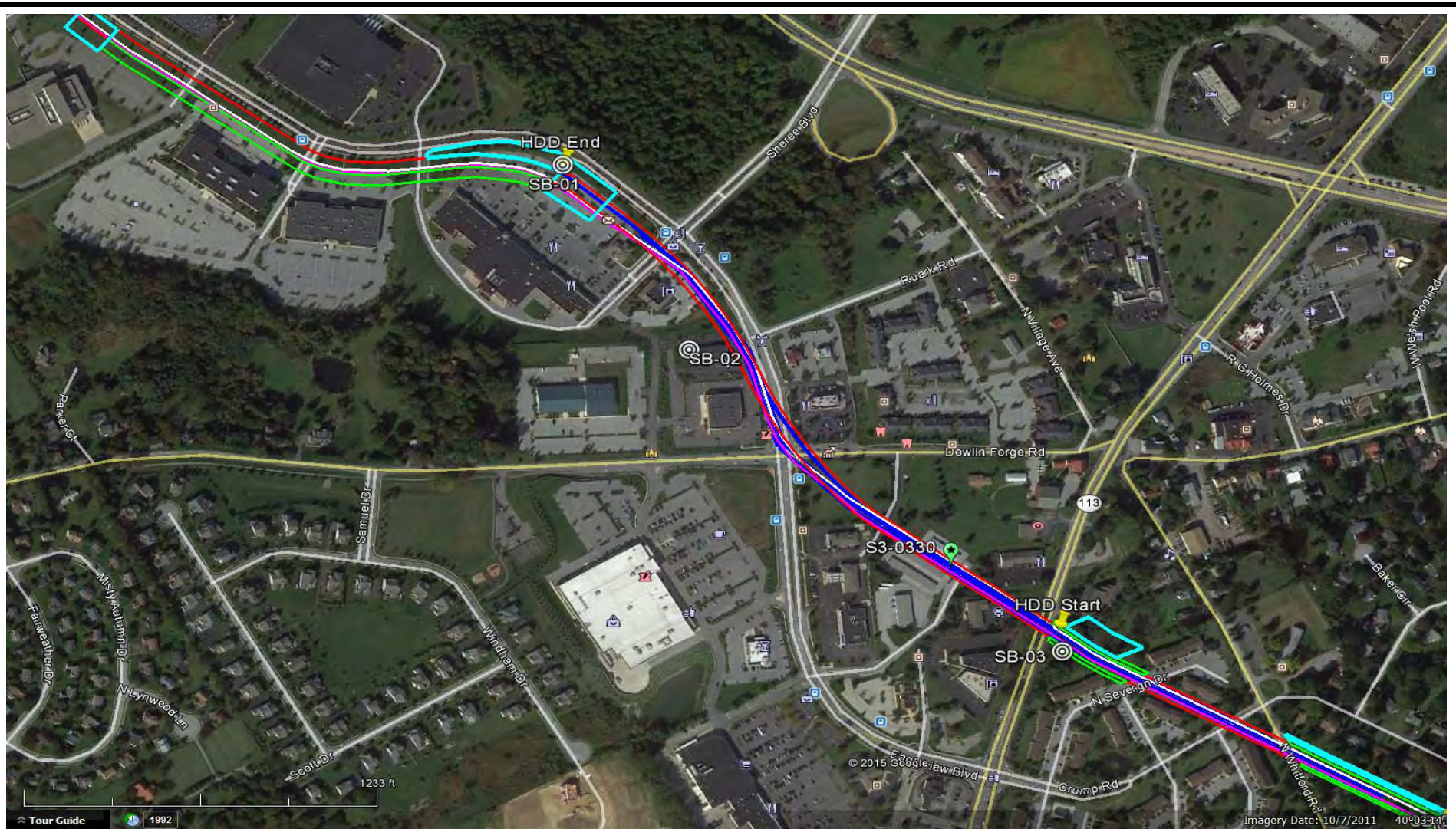
**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

16-INCH HORIZONTAL DIRECTIONAL DRILL  
ENGLEWOOD BLVD  
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300' DWG. NO: PA-CH-0138.0000-RD-16



**LEGEND:**

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS  
 HDD S3-0330  
 CHESTER COUNTY, UWCHLAN TOWNSHIP, PA  
 SUNOCO PENNSYLVANIA PIPELINE PROJECT



**TETRA TECH**

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

**TEST BORING LOG**

Project Name:		SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406	
Project Location:		278 EAGLEVIEW BLVD, EXTON, PA		Page 1 of 1	
HDD No.:	S3-0330	Dates(s) Drilled:	05-27-15	Inspector:	E. WATT
Boring No.:	SB-01	Drilling Method:	SPT - ASTM D1586	Driller:	S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft):	NOT ENCOUNTERED	Total Depth (ft):	16.5
Boring Location Coordinates:		40° 3' 24.749" N		75° 40' 0.214" W	

Sample No.	Sample Depth (ft)		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		18	SM	DR WEATHERED TO A BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE UNWEATHERED FINE GRAVEL.	9	11	16	18	27	
2	8.0	10.0			16		VARIEGATED WHITE, LIGHT BROWN, LIGHT GRAY, GRAY F-M SAND, SOME SILT, TRACE UNWEATH. F-C GRAVEL. (USCS: SM)	2	13	25	45	38	
3	13.0	14.3			13		VARIEGATED WHITE, LIGHT BROWN, LIGHT GRAY, GRAY F-M SAND, A LITTLE SILT, TRACE UNWEATH. F-C GRAVEL.	20	40	50/3"		>50	
4	16.5	16.5		16.5			NO RECOVERY	50/0"					
							AUGER REFUSAL AT 16.5'. REFUSAL MATERIALS APPEARS TO BE GRAY GNEISS.						

Notes/Comments:  
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



**TETRA TECH**

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

**TEST BORING LOG**

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: 200 EAGLEVIEW BLVD, EXTON, PA (BEHIND CJs TIRE)			Page 1 of 1		
HDD No.: S3-0330		Dates(s) Drilled: 05-28-15		Inspector: E. WATT	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 13.0	
Boring Location Coordinates:			40° 3' 17.676" N		75° 39' 54.522" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.3			TOPSOIL (4")						
			0.3	3.5		ML	BROWN SILT WITH SOME FINE SAND, TRACE FINE GRAVEL.						
1	3.0	5.0	3.5		16	SM	DR WEATHERED TO A BROWN, GRAY, WHITE FINE TO MEDIUM SAND WITH A LITTLE SILT (MICACEOUS), TRACE FINE GNEISS GRAVEL.	7	14	16	25	30	
				9.5									
2	8.0	9.9	9.5		12	GM/SM	LIGHT GRAY AND WHITE GNEISS F-C GRAVEL AND FINE TO MEDIUM SAND, TRACE SILT. (PARTIALLY WEATHERED GNEISS).	5	18	40	50/5"	58	
				11.0									
							AUGER REFUSAL AT 11'.						
							ROCK CORING						
RUN 1	11.0	13.0	11.0	11.8	24	ROCK	INTENSELY FRACTURED LIGHT GRAY GNEISS.	TCR: 100%, SCR: 52%, RQD: 38%					
			11.8	12.4			MODERATELY FRACTURED LIGHT GRAY GNEISS.						
			12.4	13.0			INTENSELY FRACTURED LIGHT GRAY GNEISS.						
							ROCK CORE BORING COLLAPSED, COULD NOT ADVANCE						
							ANOTHER ROCK CORE RUN.						
							CORE TESTING RESULTS (RUN 1, DEPTH 12.3'):						
							COMPRESSIVE STRENGTH: 6,660 PSI						
							UNIT WEIGHT: 170.7 PCF						

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



**TETRA TECH**  
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**TEST BORING LOG**

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT	Project No.:	103IP3406
Project Location:	CH-0146, EXTON, PA	Page 1 of 1	
HDD No.:	S3-0330	Dates(s) Drilled:	05-28-15
Boring No.:	SB-03	Inspector:	J. COSTELLO
Drilling Contractor:	HAD DRILLING	Drilling Method:	SPT - ASTM D1586
		Driller:	GREGG
		Groundwater Depth (ft):	15.0
		Total Depth (ft):	28.8
Boring Location Coordinates:	40° 3' 6.180" N	75° 39' 37.819" W	

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	1.0			TOPSOIL (12")					
1	3.0	5.0	1.0		22	ML	YELLOWISH BROWN WITH LIGHT GRAY NODULES SILT AND FINE SAND, TRACE FINE GRAVEL.	3	5	9	9	14
2	8.0	10.0			18		BROWN, WITH WHITE NODULES, SILT AND FINE TO MEDIUM SAND, TRACE FINE GRAVEL. (USCS: ML).	1	3	5	8	8
3	13.0	15.0	11.5		24	SM	DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT, TRACE UNWEATHERED FINE GRAVEL. (USCS: SM).	1	2	10	50/3"	12
4	18.0	20.0			14		DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT, TRACE FINE GRAVEL.	1	14	16	22	30
5	23.0	24.3			12	ML	DR WEATHERED TO A BROWN FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE GRAVEL.	1	29	50/3"		>50
6	28.0	28.8	26.5		6		BROWN SILTY CLAY AND FINE SAND, WITH A LITTLE F-C GNEISS GRAVEL.	5	50/3"			>50

Notes/Comments:  
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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

**GEOTECHNICAL LABORATORY TESTING SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S3-0330**

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		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, %	
S3-0330	SB-01	1	3.0	5.0	11.2	24.8	-	-	-	-
		2	8.0	10.0	13.0	29.6	28	23	5	SM
		3	13.0	14.3	9.7	18.2	-	-	-	-
	SB-02	1	3.0	5.0	5.9	19.3	-	-	-	-
		2	8.0	9.9	1.4	9.3	-	-	-	-
	SB-03	1	3.0	5.0	19.2	61.7	-	-	-	-
		2	8.0	10.0	33.4	63.7	43	29	14	ML
		3	13.0	15.0	17.8	37.7	38	31	7	SM
		4	18.0	20.0	15.2	40.6	-	-	-	-
		6	28.0	28.8	19.3	59.1	39	28	11	ML

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

**Notes:**

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



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

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S3-330	SB-2	1	11	13	100	52	38	11	13	Slight	Felsic gneiss	Massive	Light gray	Fractures ranging from 0° to 40°, Avg. 17°

**REGIONAL GEOLOGY SUMMARY  
SUNOCO PENNSYLVANIA PIPELINE PROJECT  
HDD S3-0330**

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S3-0330		SB-01	Felsic and intermediate gneiss - Medium grained, light pink to greenish gray; largely quartz, feldspar, and mica; commonly gneissic, containing alteration minerals; interfingers with gabbroic gneiss.	Generally level	Felsic and intermediate gneiss (PreCambrian)	Felsic gneiss	Unknown	Ranges from 20 to 50 ft bgs, Avg. 40 ft bgs (.5 mile radius)	
		SB-02				Felsic gneiss	Unknown	Ranges from 10 to 65 ft bgs, Avg. 39 ft bgs (.25 mile radius)	
		SB-03				Felsic gneiss	Unknown	Ranges from 10 to 65 ft bgs, Avg. 32 ft bgs (.25 mile radius)	

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

# 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 <sup>(1)</sup>	$C_u = \frac{D_{60}}{D_{10}}$ 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 $\pm 2$ 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.