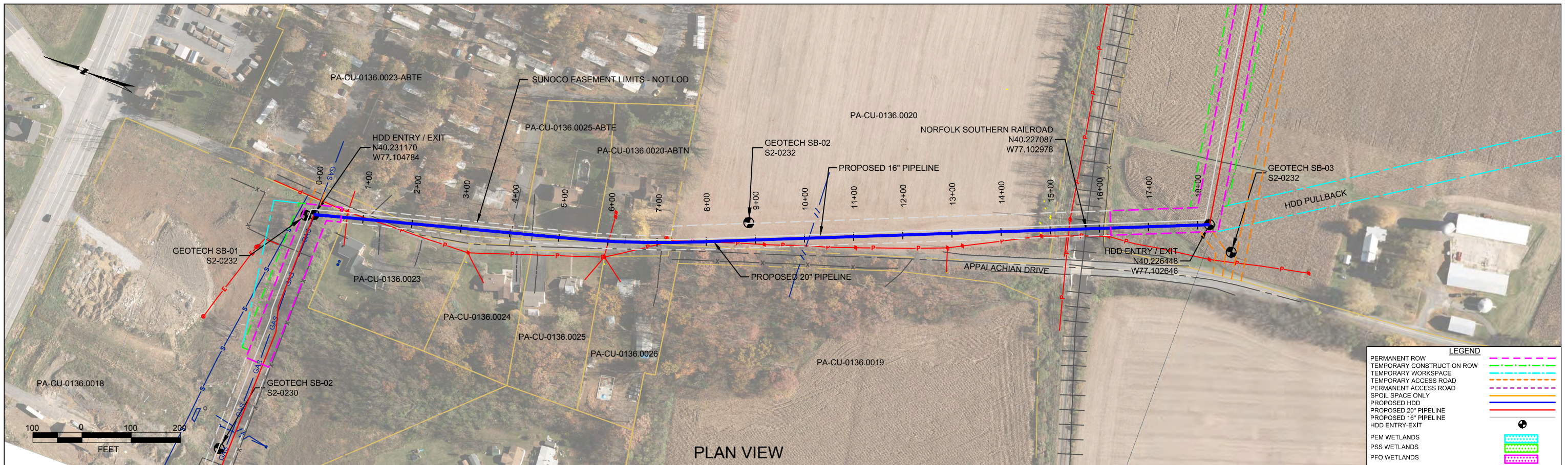


HDD PA-CU-0136.0020-RR

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 120 feet from the western edge of Appalachian Drive and enter/exit 1,640 feet from the eastern edge. The horizontal directional drill will enter/exit 1,560 feet from the western edge of the Norfolk Southern Railroad and enter/exit 240 feet from the eastern edge. The drill will pass 17 feet below Appalachian Drive and 27 feet below Norfolk Southern Railroad. 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 being drilled through is limestone with silty clay layers above it. The limestone is permeable but the drill should be at a depth to prevent most inadvertent returns. Based on the geotechnical report, the drill profile, and no water bodies inimal inadvertent returns are expected. Additional inspection is recommended due to the limestone substrate.

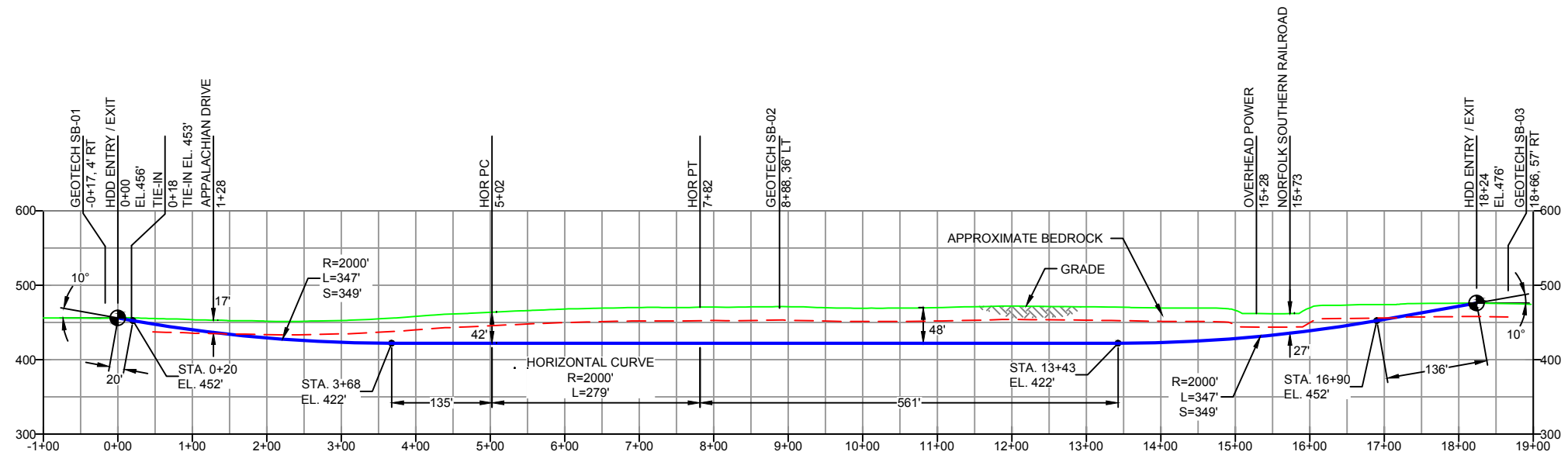


CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0240

PLAN VIEW
PROFILE VIEW

GEOTECH SB-01
-NG EL. 456'
-TOPSOIL (0.0' - 0.3')
-SILT (USCS:MH) (0.3' - 10.0')
-COMPLETION DEPTH EL. 446'
GEOTECH SB-02
-NG EL. 469'
-TOPSOIL (<1")
-SILT (USCS:CH) (0.0' - 20.0')
-COMPLETION DEPTH EL. 449'
GEOTECH SB-03
-NG EL. 481'
-TOPSOIL (0' - 0.2')
-CL (0.2' - 7.5')
-WEATHERED LIMESTONE (7.5' - 10.0')
-FRACTURED LIMESTONE (10.0' - 18.5')
-COMPLETION DEPTH EL. 463'

NOTE: REFER TO TEST BORING LOG S2-0232 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)= 1800'
HDD PIPE LENGTH (S)= 1829'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
 - 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.
 - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
 - BLASTING NOT PERMITTED.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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		REVISIONS	
ES-4.58	TO ES-4.59	DESCRIPTION	NO.
		EROSION & SEDIMENT PLAN	EP2
			EP1
		AERIAL SITE PLAN	EP1
			EP
			C
		ADDED GEOTECH INFO	B
		ISSUED FOR BID	A
		ISSUED FOR REVIEW	
DWG NO	DWG NO	DESCRIPTION	NO.

BY	DATE	CHK	DATE	APP	DATE
MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
JTW	11/23/15	RMB	11/23/15	AAW	11/23/15
MRS	09/16/15	RMB	09/16/15	AAW	09/16/15
DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
RTT	02/17/15	RMB	02/17/15	AAW	02/17/15

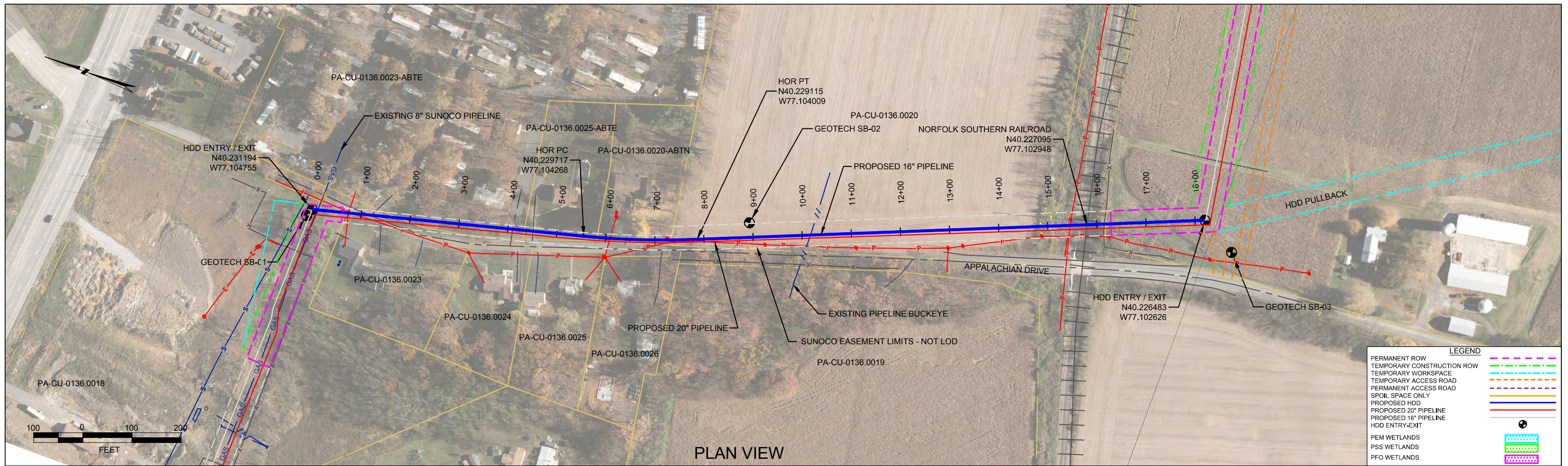
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
APPALACHIAN DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'
DWG. NO: PA-CU-0136.0020-RR



PLAN VIEW

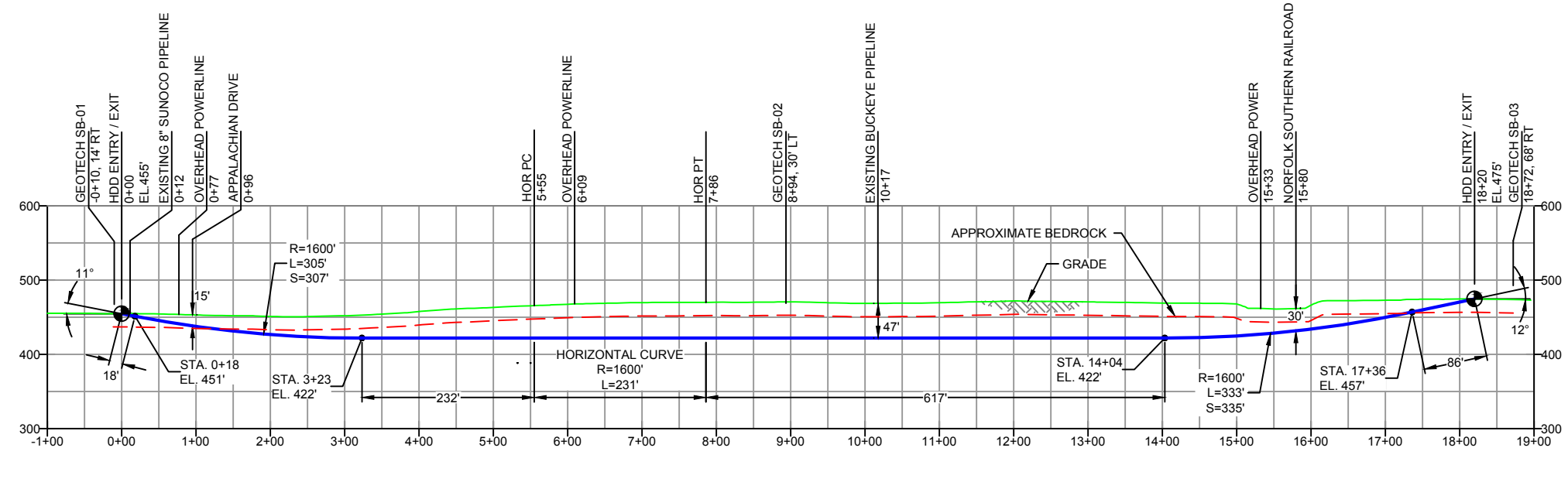


PROFILE VIEW

CUMBERLAND COUNTY, PENNSYLVANIA - MIDDLESEX TOWNSHIP
S2-0240-16

GEOTECH SB-01
NG EL. 456'
-TOPSOIL (0.0' - 0.3')
-SILT (USCS:MH) (0.3' - 10.0')
-COMPLETION DEPTH EL. 446'
GEOTECH SB-02
NG EL. 469'
-TOPSOIL (<1")
-SILT (USCS:CH) (0.0' - 20.0')
-COMPLETION DEPTH EL. 449'
GEOTECH SB-03
NG EL. 481'
-TOPSOIL (0' - 0.2')
-CL (0.2' - 7.5')
-WEATHERED LIMESTONE (7.5' - 10.0')
-FRACTURED LIMESTONE (10.0' - 18.5')
-COMPLETION DEPTH EL. 463'

NOTE: REFER TO TEST BORING LOG S2-0232 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): 1824'
HDD PIPE LENGTH (S): 1826'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)

- INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
- 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.

- PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
- BLASTING NOT PERMITTED.
- SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

NOTES

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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	NO.	DESCRIPTION	NO.	DESCRIPTION	
ES-4.58	TO	ES-4.59	EROSION & SEDIMENT PLAN	EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16
SHEET 40	TO	SHEET 41	AERIAL SITE PLAN	EP1	REVISED PER PADEP COMMENTS
				EP	
				C	ADDED GEOTECH INFO
				B	ISSUED FOR BID
				A	ISSUED FOR REVIEW

REVISIONS

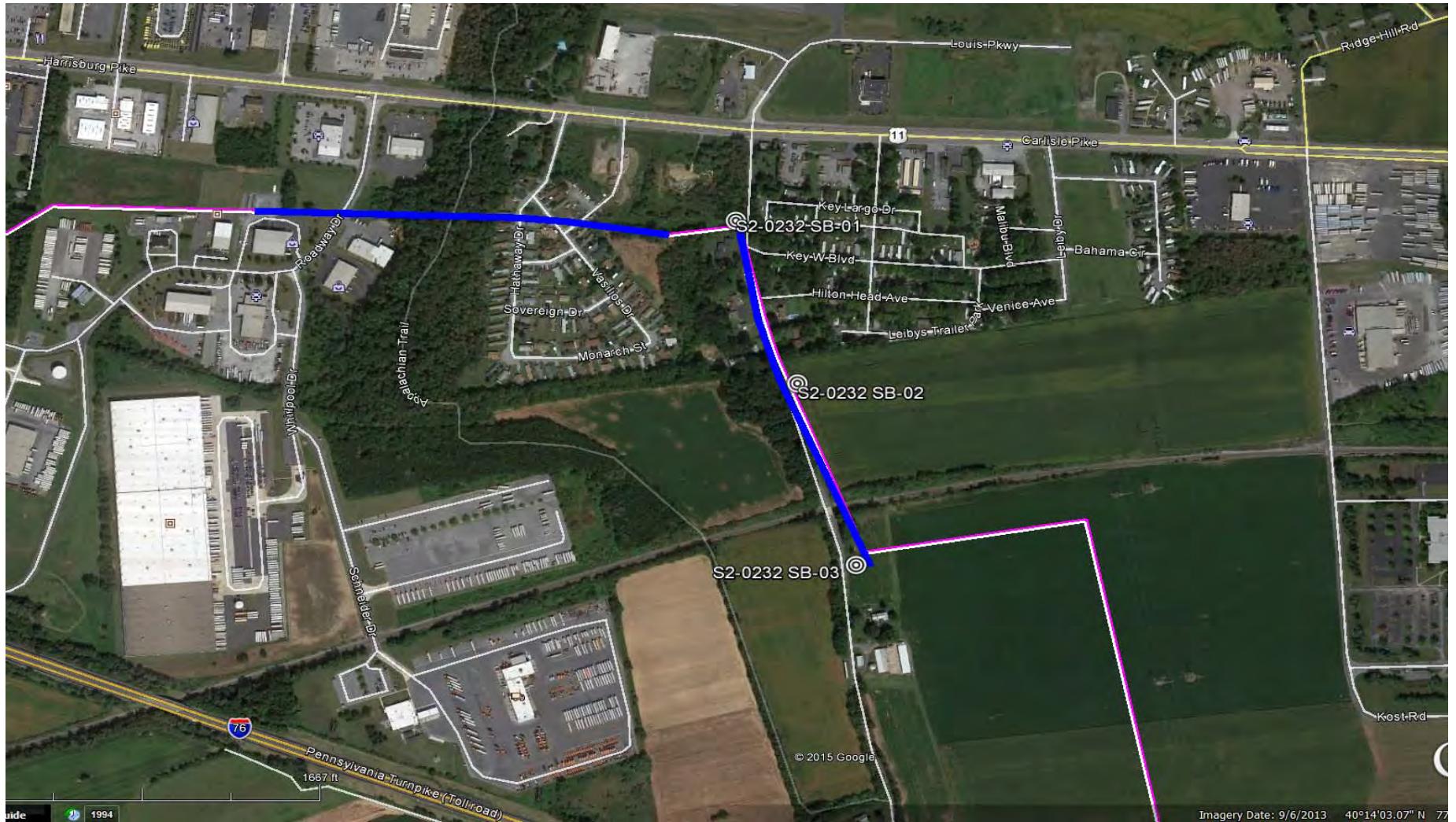
BY	DATE	CHK	DATE	APP	DATE
MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
MRS	05/11/16	RMB	05/11/16	AAW	05/11/16
MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
MRS	09/16/15	RMB	09/16/15	AAW	09/16/15
MRS	08/31/15	RMB	08/31/15	AAW	08/31/15
MRS	08/14/15	RMB	08/14/15	AAW	08/14/15



SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
APPALACHIAN DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO: PA-CU-0136.0020-RR-16



LEGEND:

☉ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S2-0232 APPALACHIAN DRIVE
 CUMBERLAND COUNTY, SILVER SPRING 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: APPALACHIAN DRIVE, CARLISLE, PA			Page 1 of 1		
HDD No.: S2-0232		Dates(s) Drilled: 04-25-15		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): 10.0	
Boring Location Coordinates:			40° 13' 52.370" N		77° 6' 17.264" 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		14	MH	BROWN CLAYEY SILT AND FINE SAND, TRACE FINE GRAVEL.	1	5	5	6	10	
2	8.0	9.4			14		BROWN CLAYEY SILT AND FINE SAND, MIXED WITH PIECES OF	3	15	50/5"		>50	
				10.0			GRAY LIMESTONE GRAVEL. SPOON BECAME BENT. (USCS: MH)						
							AUGER REFUSAL AT 10'. MADE SEVERAL ATTEMPTS TO AUGER						
							PAST REFUSAL DEPTH, ALL ENCOUNTERED SHALLOWER REFUSAL.						
							BASED ON OBSERVATION OF SOIL CUTTINGS AND BOREHOLES,						
							REFUSAL MATERIAL LIKELYA RESULT OF BOULDERY						
							SUBSURFACE CONDITIONS, AND NOT BEDROCK.						
							CAVED AND DRY AT 9.5'.						

Notes/Comments:
Pocket Pentrometer Testing
 5': 1.75 TSF
 8': 0.75 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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 Newark, Delaware 19713
 302.738.7551
 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: APPALACHIAN DRIVE, CARLISLE, PA			Page 1 of 1		
HDD No.: S2-0232		Dates(s) Drilled: 04-27-15		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): 20.0	
Boring Location Coordinates:			40° 13' 43.942" N		77° 6' 13.507" 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	0.0			TOPSOIL (<1")						
1	3.0	5.0	0.0		8	CH	REDDISH BROWN SILTY CLAY.	1	6	7	8	13	
2	8.0	10.0			22		REDDISH BROWN SILTY CLAY, HIGH PLASTICITY. (USCS: CH).	4	4	6	7	10	
3	13.0	15.0			24		REDDISH BROWN SILTY CLAY. (GRAY FINE SAND AND LIMESTONE IN SPOON SHOE).	1	2	7	10	9	
4	18.0	20.0		20.0	24		REDDISH BROWN SILTY CLAY, HIGH PLASTICITY. (USCS: CH)	1	1	1	1	2	
							AUGERS BECAME CROOKED WHILE DRILLING TO THIS DEPTH, LIKELY DUE TO COBBLES OR BOULDERS. GRINDING OCCURRED BETWEEN 8' AND 10' BGS.						
							OFF-SET BORING TO THE WEST, AND AUGERED TO DEPTH OF 15', AND AGAIN AUGERS BECAME CROOKED. COULD NOT GET DEEPER THAN 15'. GRINDING OCCURRED AGAIN AT APPROX. 12' BGS.						
							BASED ON ABOVE, SUBSURFACE MAY HAVE COBBLE AND/OR BOULDERY CONDITIONS. COULD NOT DETERMINE DEPTH TO BEDROCK. REFER TO GEOLOGY SECTION OF REPORT.						

Notes/Comments:
Pocket Pentrometer Testing
 5': > 4 TSF 18': 0.5 TSF
 8': 3.25 TSF 20': 0.5 TSF
 9': 1.75 TSF
 10': 2.75 TSF
 14': 1.5 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
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 fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: APPALACHIAN DRIVE, CARLISLE, PA			Page 1 of 1		
HDD No.: S2-0232		Dates(s) Drilled: 04-25-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 18.5	
Boring Location Coordinates:			40° 13' 34.618" N		77° 6' 9.957" 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	0.2			TOPSOIL (2")					
1	3.0	5.0	0.2			CL	NO RECOVERY. AUGER RETURN RETURN WAS BROWN SILTY CLAY,	1	5	7	6	12
				7.5			TRACE FINE GRAVEL.					
2	8.0	8.5	7.5	10.0			PARTIALLY WEATHERED GRAY LIMESTONE.	50/6"				0
							STARTED GRINDING AT 6.5'.					
							AUGER REFUSAL AT 10'.					
							<u>ROCK CORING</u>					
RUN 1	10.0	13.5	10.0		33	LIMESTONE ROCK	MODERATELY FRACTURED GRAY LIMESTONE	TCR: 78%, SCR: 40%, RQD: 40%				
RUN 2	13.5	18.5		18.5	24		MODERATELY FRACTURED GRAY LIMESTONE	TCR: 40%, SCR: 33%, RQD: 33%				
			15.5	18.5			BROWN SILTY CLAY.					
							<u>CORE TESTING RESULTS (DEPTH 14')</u>					
							COMPRESSIVE STRENGTH: 15,260 PSI					
							UNIT WEIGHT: 167.4 PCF					

Notes/Comments:
Pocket Pentrometer Testing

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 S2-0232 APPALACHIAN DRIVE**

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, %	
S2-0232	SB-01	1	3.0	5.0	18.5	59.5	-	-	-	-
		2	8.0	9.4	44.0	63.5	60	38	22	MH
	SB-02	1	3.0	5.0	55.0	99.9	-	-	-	-
		2	8.0	10.0	35.6	99.9	96	33	63	CH
		3	13.0	15.0	39.7	99.3	-	-	-	-
		4	18.0	20.0	43.8	99.3	93	35	58	CH
	SB-03	2	8.0	8.5	5.3	16.3	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-03	Run 2	14.0	15,260	167.4

Notes:

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

**ROCK CORE DESCRIPTION SUMMARY
 SUNOCO PENNSYLVANIA PIPELINE PROJECT
 HDD S2-0232 APPALACHIAN DRIVE**

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					
S2-0232	SB-03	1	10	13.5	78	40	40	10	15.5	Moderate	Limestone	5.5, returned to eroded material at 15.5'	Light gray	Fractures ranging from 15° to 75°, Avg. 46°
		2	13.5	18.5	40	33	33							

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S2-0232 APPALACHIAN DRIVE**

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
S2-0232	Appalachian Drive	SB-01	St. Paul Group - consists of buff-colored magnesium limestone and very finely crystalline birdseye limestone at its top and base.	Gentle upward slope to South	St. Paul Group	Limestone and very finely crystalline "birdseye" limestone. Most beds are fissile to flaggy, and a few are thick bedded.	580	10-25	The middle section is fossiliferous and has dolomite and black chert. It is well bedded. Most beds are fissile to flaggy, and a few are thick bedded. Yields range from 10 to 20 gpm
		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.