Attachment A
HDD Table
Berks County

Drawing Name	Drill Name	County	Township	Drill Location	Risk Assessment Level (Low / Medium / High)
PA-BR-0032.0000-RD.pdf	Wernersville Road	Berks	South Heidelberg	N: 40.308209 W: 76.057110	low
PA-BR-0075.0000-RD.pdf	HWY 222	Berks	Cumru	N: 40.277404 W: 76.021026	low
PA-BR-0079.0000-RD.pdf	Peach Tree Lane	Berks	Cumru	N: 40.276733 W: 76.014263	low
PA-BR-0138.0001-RD.pdf	Gerhart School Road	Berks	Brecknock	N: 40.226330 W: 75.952419	low
PA-BR-0181.0000-RD.pdf	Joanna Road	Berks	Caernarvon	N: 40.170400 W: 75.863673	low

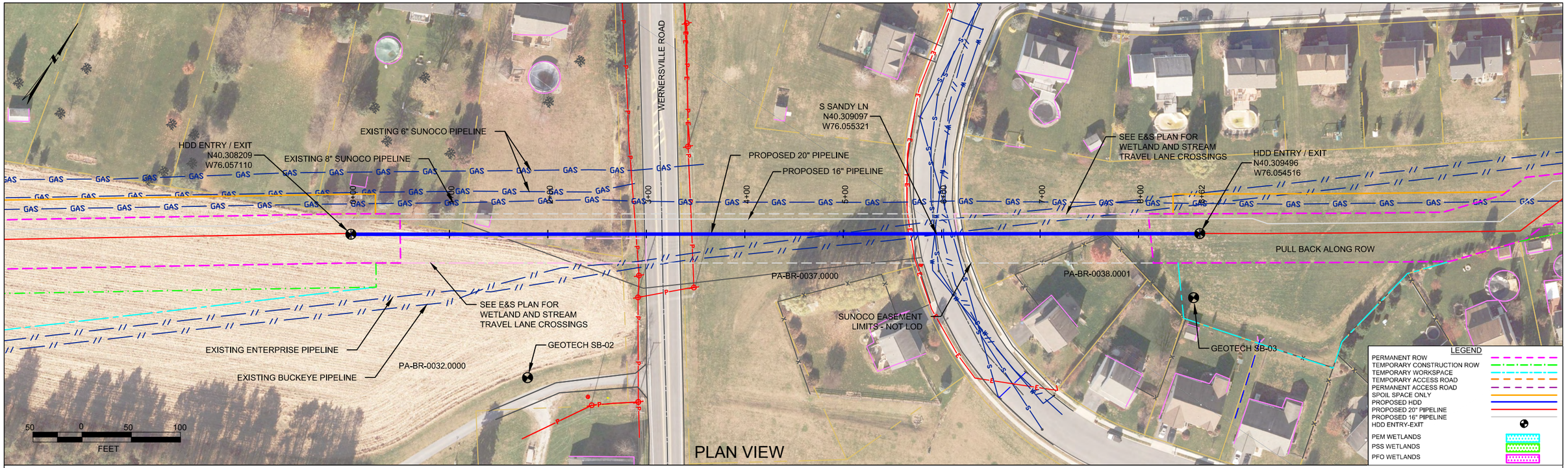
Prepared By:
Tetra Tech Rooney

10/14/2016

HDD PA-BR-0032.0000-RD (S-A47, S-K18, PFO-J47, PEM-J47)

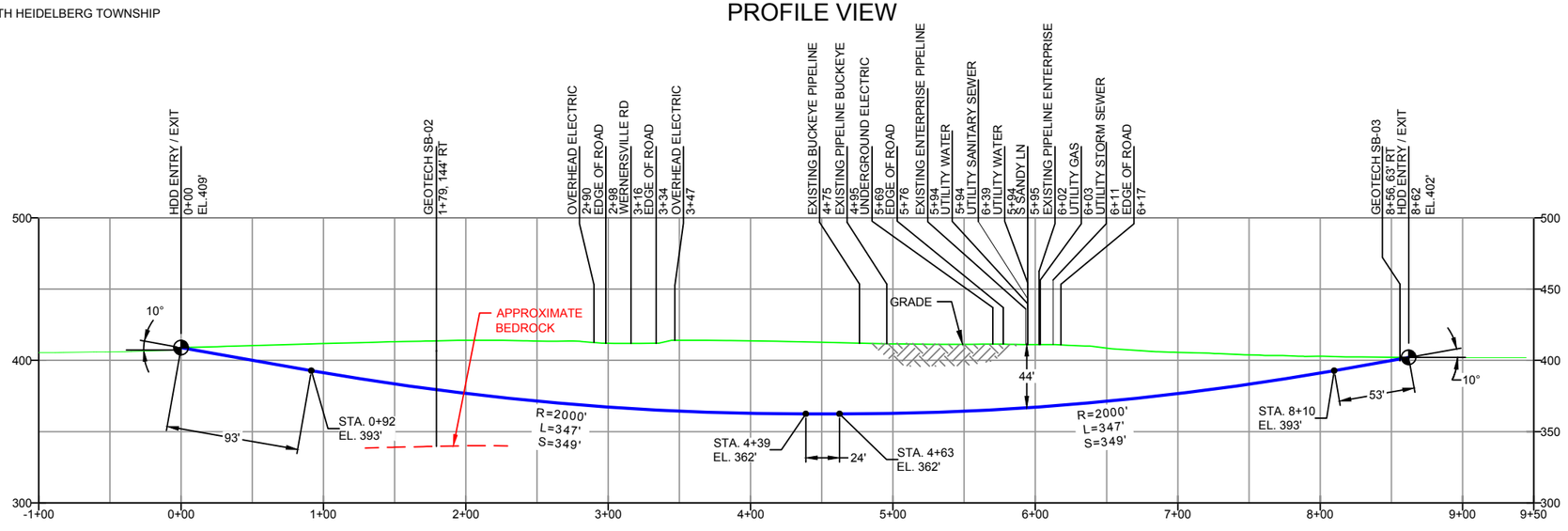
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 370 feet from the western edge of Wernersville Road and enter/exit 560 feet from the eastern edge. The horizontal directional drill will enter/exit 640 feet from the western edge of N. Sandy Lane and enter/exit 270 feet from the eastern edge. The drill will pass approximately 40 feet below both roads. 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 the primary substrates being drilled through are silty clays and fine sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



BERKS COUNTY, PENNSYLVANIA - SOUTH HEIDELBERG TOWNSHIP
S3-0180

PROFILE VIEW



GEOTECH SB-02

-NG EL. 406'
-TOPSOIL (0' - 0.4')
-GROUNDWATER (30.0')
-ML/CL (0.4' - 74.0')
-LIMESTONE (74.0' - 74.3')
-COMPLETION DEPTH EL. 332'

GEOTECH SB-03

-NG EL. 400'
-TOPSOIL (0' - 0.6')
-ML/CL (0.6' - 30.0')
-GROUNDWATER (22.0')
-COMPLETION DEPTH EL. 370'

NOTE: REFER TO TEST BORING LOG S3-0180 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=):942'
   HDD PIPE LENGTH (S=):947'
   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.

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

DWG NO		DWG NO	DESCRIPTION
ES-5.11	TO	ES-5.11	EROSION & SEDIMENT PLAN
SHEET 6	TO	SHEET 6	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
C	ADDED GEOTECH INFO	MRS	09/24/15	RMB	09/24/15	AAW	09/24/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	JVA	04/15/15	RMB	04/15/15	AAW	04/15/15

Sunoco Logistics Partners L.P.

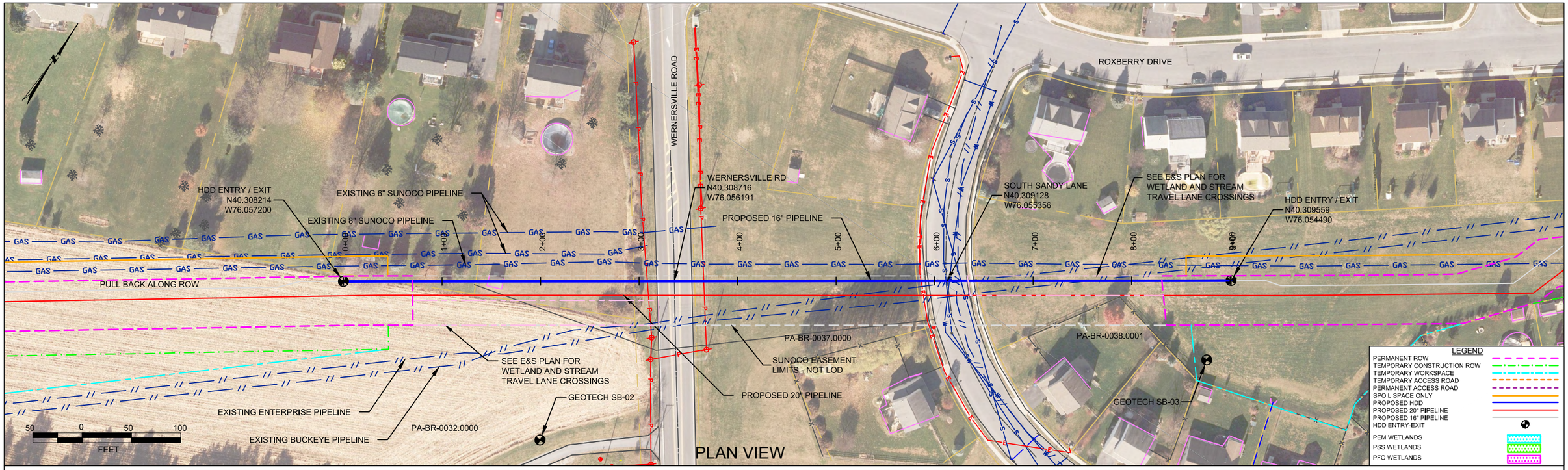
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
WERNERSVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

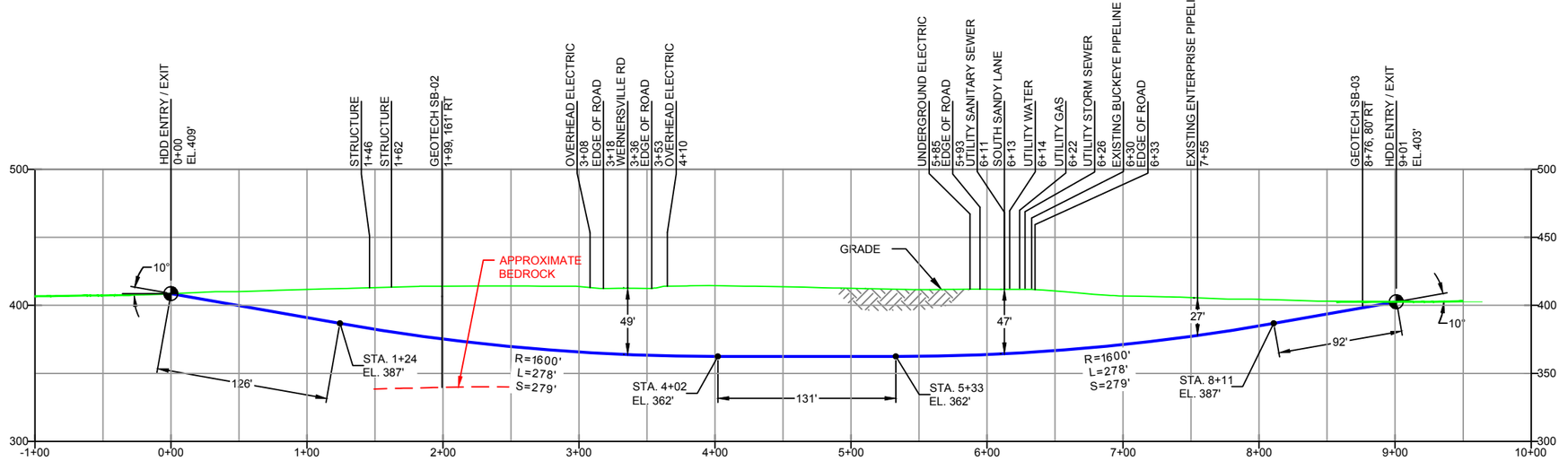
SCALE: 1"=100'

DWG. NO: PA-BR-0032.0000-RD

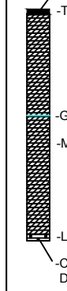


PLAN VIEW

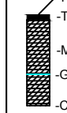
PROFILE VIEW



GEOTECH SB-02



GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S3-0180 FOR COMPLETE SOIL MATERIAL DESCRIPTION

BERKS COUNTY, PENNSYLVANIA - SOUTH HEIDELBERG TOWNSHIP
S3-0180-16

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=):901'
   HDD PIPE LENGTH (S=):907'
   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).
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.

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

DWG NO		DWG NO	DESCRIPTION
ES-5.11	TO	ES-5.11	EROSION & SEDIMENT PLAN
SHEET 6	TO	SHEET 6	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
B	ADDED GEOTECH INFO	MRS	09/24/15	RMB	09/24/15	AAW	09/24/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

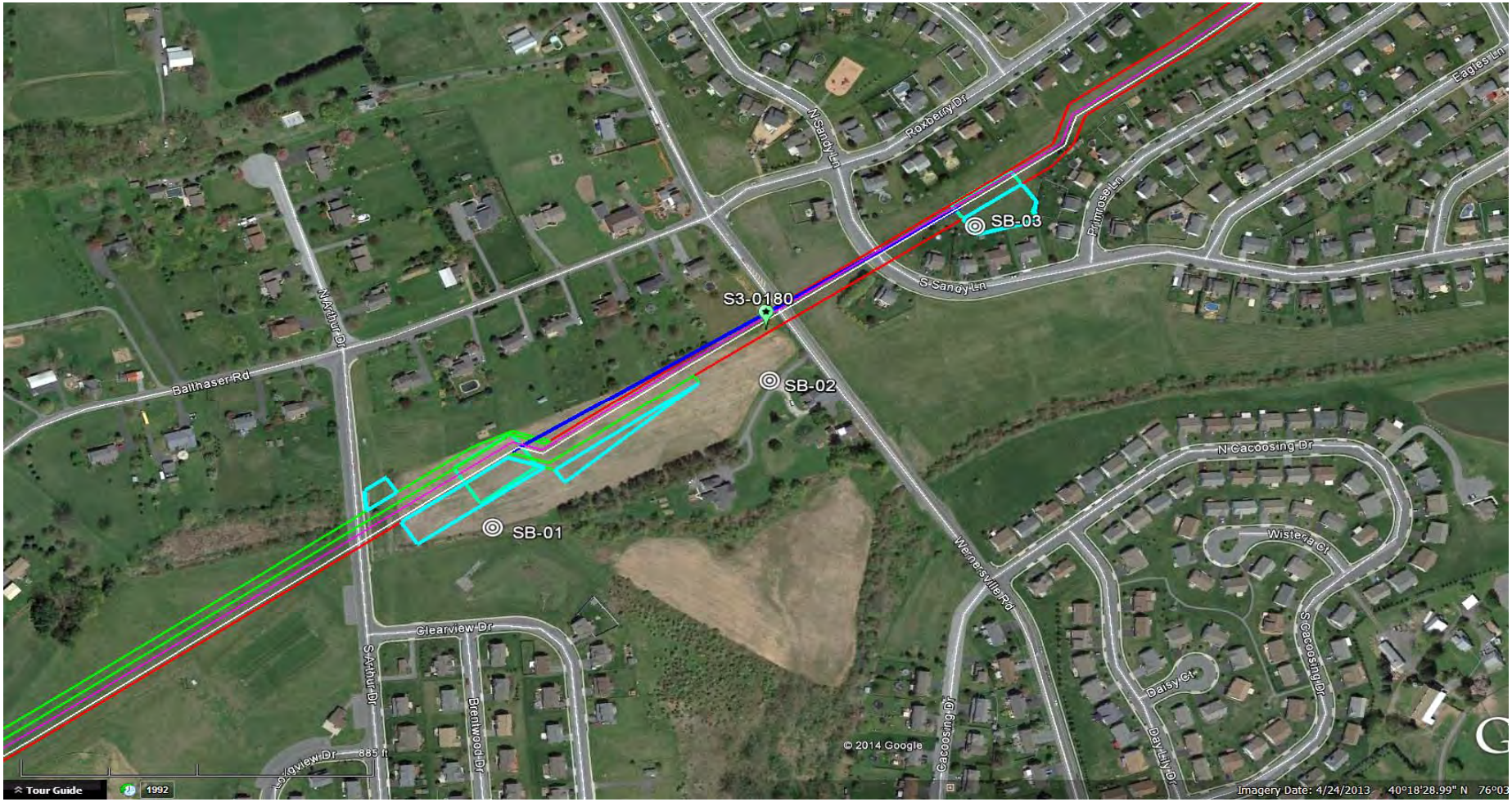
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
WERNERSVILLE ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

DWG. NO: PA-BR-0032.0000-RD-16



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0180
BERKS COUNTY, SOUTH HEIDELBERG 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:	ARTHUR DRIVE, SOUTH HEIDELBERG TWP		Page 1 of 1
HDD No.:	S3-0180	Dates(s) Drilled: 12-10-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 26.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 18' 25.187" N	76° 3' 31.680" 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	0.0			TOPSOIL (NONE)					
1	3.0	5.0	0.0		11		MOTTLED ORANGE BROWN, LIGHT BROWN, AND GRAY SILTY CLAY	1	2	4	6	**6**
							WITH SOME FINE SAND, TRACE F-C UNWEATHERED GRAVEL.					
2	8.0	10.0			12		MOTTLED BROWN, LIGHT BROWN, AND GRAY SILTY CLAY WITH	1	1	3	5	**4**
							SOME F-SAND, TRACE F-C UNWEATHERED GRAVEL. (USCS: CL)					
3	13.0	15.0			20		MOTTLED ORANGE BROWN, LIGHT BROWN, AND GRAY SILTY CLAY	1	2	3	5	**5**
						CL	WITH A LITTLE F-SAND.					
4	18.0	20.0			24		MOTTLED GRAY AND ORANGE BROWN SILTY CLAY WITH SOME FINE	1	1	2	3	**3**
							SAND, TRACE FINE UNWEATHERED GRAVEL.					
5	23.0	25.0			24		LIGHT GRAY TO WHITE SILTY CLAY WITH SOME FINE SAND	1	2	5	9	**7**
6	28.0	30.0		30.0	22		LIGHT GRAY T WHIITE SILTY CLAY, TRACE FINE SAND (USCS: CL).	4	8	7	7	**15**
							CAVED AT 29'.					
							WATER LEVEL ON CAVE AT 26'.					

Notes/Comments:

Pocket Pentrometer Testing
S2: 1.25 TSF S5: 2.25 TSF
S3: 1.25 TSF
S4: 1.0 TSF

DR: DECOMPOSED ROCK

ALL ABOVE SAMPLES ARE DR.

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:	WERNERSVILLE ROAD, SOUTH HEIDELBERG TWP		Page 1 of 1
HDD No.:	S3-0180	Dates(s) Drilled: 12-09-14	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 30.0	Total Depth (ft): 74.3
Boring Location Coordinates:		40° 18' 29.311" N	76° 3' 22.567" 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	0.4			TOPSOIL (5")					
1	3.0	5.0	0.4		18		MOTTLE BROWN AND ORANGE BROWN SLT AND CLAY WITH SOME	1	2	5	6	**7**
							FINE SAND, TRACE F-GRAVEL.					
2	8.0	10.0			18		MOTTLED ORANGE TO YELLOW BROWN SILT AND CLAY, AND FINE	4	4	5	5	**9**
							SAND.					
3	13.0	15.0			22		MOTTLED ORANGE BROWN AND LIGHT GRAY CLAY AND SILT, AND	1	2	6	6	**8**
							FINE SAND. (USCS: CL/ML)					
4	18.0	20.0			19		MOTTLED ORANGE BROWN AND LIGHT GRAY CLAY AND SILT, AND	2	4	5	5	**9**
							FINE SAND.					
5	23.0	25.0			24		MOTTLED ORANGE BROWN AND LIGHT GRAY CLAYEY SILT WITH	1	1	3	8	**4**
							SOME FINE SAND. (USCS: ML)					
6	28.0	30.0			24		MOTTLED LIGHT GRAY AND BROWN SILT/CLAY AND FINE SAND,	1	2	3	6	**5**
							TRACE UNWEATHERED FINE GRAVEL.					
7	33.0	35.0			24		MOTTLED LIGHT GRAY AND BROWN SILT/CLAY AND FINE SAND,	3	6	6	8	**12**
							TRACE UNWEATHERED FINE GRAVEL.					
8	38.0	40.0			20		MOTTLED BROWN AND GRAY SILT/CLAY, AND FINE SAND, TRACE	1	1	4	13	**5**
							UNWEATHERED FINE GRAVEL.					
9	43.0	45.0			12		MOTTLED BROWN AND GRAY CLAY/SILT AND FINE SAND, TRACE	2	5	9	10	**14**
							UNWEATHERED FINE GRAVEL. (USCS: CL/ML)					
10	48.0	50.0			14		MOTTLED BROWN AND GRAY CLAY/SILT AND FINE SAND, TRACE	WH	WH	1	1	**1**
							UNWEATHERED FINE GRAVEL.					
11	53.0	55.0			18		MOTTLED (SHADES OF BROWN) SILT/CLAY AND FINE SAND, TRACE	1	3	7	15	**10**
							UNWEATHERED FINE GRAVEL.					
12	58.0	60.0			17		MOTTLED (SHADES OF BROWN) SILT/CLAY AND FINE SAND, TRACE	11	26	20	15	**46**
							UNWEATHERED FINE GRAVEL.					
13	63.0	65.0			14		MOTTLED (SHADES OF BROWN) SILT/CLAY AND FINE SAND, TRACE	4	8	10	10	**18**
							UNWEATHERED FINE GRAVEL.					
14	68.0	70.0			16		MOTTLED (SHADES OF BROWN) SILT/CLAY AND FINE SAND, TRACE	2	5	5	6	**10**
							UNWEATHERED FINE GRAVEL.					
15	73.0	74.3			12		MOTTLED (SHADES OF BROWN) SILT/CLAY AND FINE SAND, TRACE	1	17	50/4"		**>50**
				74.0			UNWEATHERED FINE GRAVEL.					
			74.0	74.3			GRAY LIMESTONE (BROKEN UP)					

INTERLAYERING OF ML, ML/CL, AND CL/ML

Notes/Comments:

Pocket Pentrometer Testing

WET ON SPOON AT 33'.
CAVED AT 67'
WATER LEVEL ON CAVE AT 38'.
WATER LEVEL THROUGH AUGERS AT 30'.

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:	S. SANDY LANE, SOUTH HEIDELBERG TWP		Page 1 of 1
HDD No.:	S3-0180	Dates(s) Drilled: 12-10-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 22.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 18' 33.618" N	76° 3' 15.803" 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	0.6			TOPSOIL (7")					
1	3.0	5.0	0.6		18	INTERLAYERED ML/CL AND CL/ML	ORANGE BROWN SILT AND CLAY WITH SOME FINE SAND, WITH A	2	8	6	6	**14**
							LITTLE FINE GRAVEL.					
2	8.0	10.0			22		MOTTLED BROWN, ORANGE TO YELLOWISH BROWN SILT AND CLAY	1	2	3	3	**5**
							WITH A LITTLE FINE SAND (USCS: ML/CL)					
3	13.0	15.0			24		MOTTLED BROWN, ORANGE BROWN, AND LIGHT GRAY CLAY/SILT	1	2	3	10	**5**
							AND FINE SAND (USCS: CL/ML)					
4	18.0	20.0			8		BROWN TO ORANGE BROWN CLAYEY SILT AND FINE SAND, TRACE	1	2	3	2	**5**
							WEATHERED FINE GRAVEL.					
5	23.0	25.0			24		MOTTLED BROWN, ORANGE BROWN, AND LIGHT GRAY CLAY/SILT	2	3	7	9	**10**
							AND FINE SAND, TRACE UNWEATHERED FINE GRAVEL.					
6	28.0	30.0			11		MOTTLED BROWN, ORANGE BROWN, AND LIGHT GRAY CLAY/SILT	1	1	1	1	**2**
				30.0			AND FINE SAND, TRACE UNWEATHERED FINE GRAVEL.					
							WET ON SPOON AT 23'.					
							WATER LEVEL THROUGH AUGERS AT 22'.					
							CAVED AT 27'.					
							WATER LEVE ON CAVE AT 22'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 1.5 TSF

DR: DECOMPOSED ROCK

ALL ABOVE SAMPLES ARE DR.

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 S3-0180

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)
S3-0180	SB-01	2	8.0	10.0	22.8	70.3	39	24	15	CL
		3	13.0	15.0	32.0	85.4	-	-	-	-
		5	23.0	25.0	25.6	79.5	-	-	-	-
		6	28.0	30.0	28.6	97.4	37	20	17	CL
	SB-02	3	13.0	15.0	34.3	62.4	36	24	12	CL/ML
		5	23.0	25.0	37.3	79.3	44	33	11	ML
		7	33.0	35.0	28.9	52.5	-	-	-	-
		9	43.0	45.0	35.3	63.2	39	25	14	CL/ML
		12	58.0	60.0	23.8	52.0	-	-	-	-
		14	68.0	70.0	25.6	56.9	-	-	-	-
	SB-03	1	3.0	5.0	23.3	71.7	-	-	-	-
		2	8.0	10.0	44.6	88.0	34	24	10	ML/CL
		3	13.0	15.0	30.5	69.5	38	24	14	CL/ML
		5	23.0	25.0	25.3	52.1	-	-	-	-
		6	28.0	30.0	28.8	59.1	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0170

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
S3-0180	Vernersville Roa	SB-01	**Millbach Fm** - Pinkish gray and medium gray laminated limestone and interbeds of light to medium gray finely crystalline dolomite	level upland farmland	Millbach Fm	Interbedded limestone	1,500	40-79	
		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)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

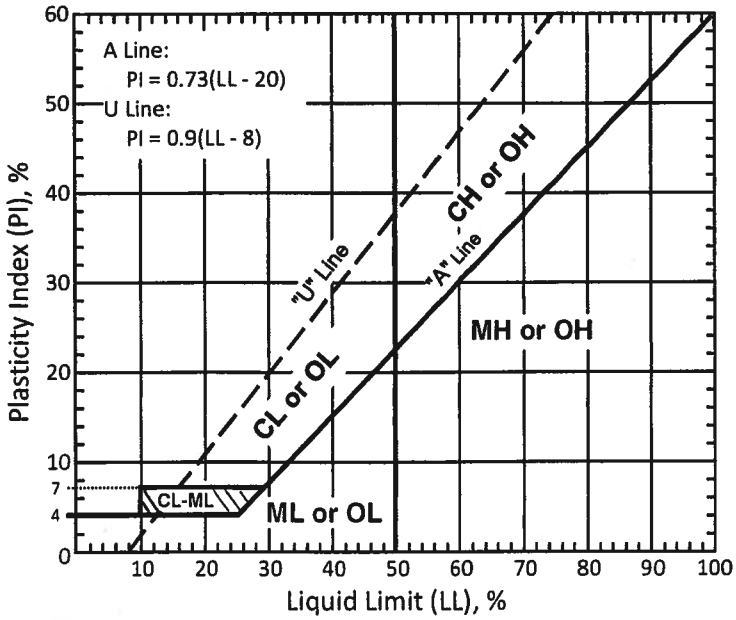
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.

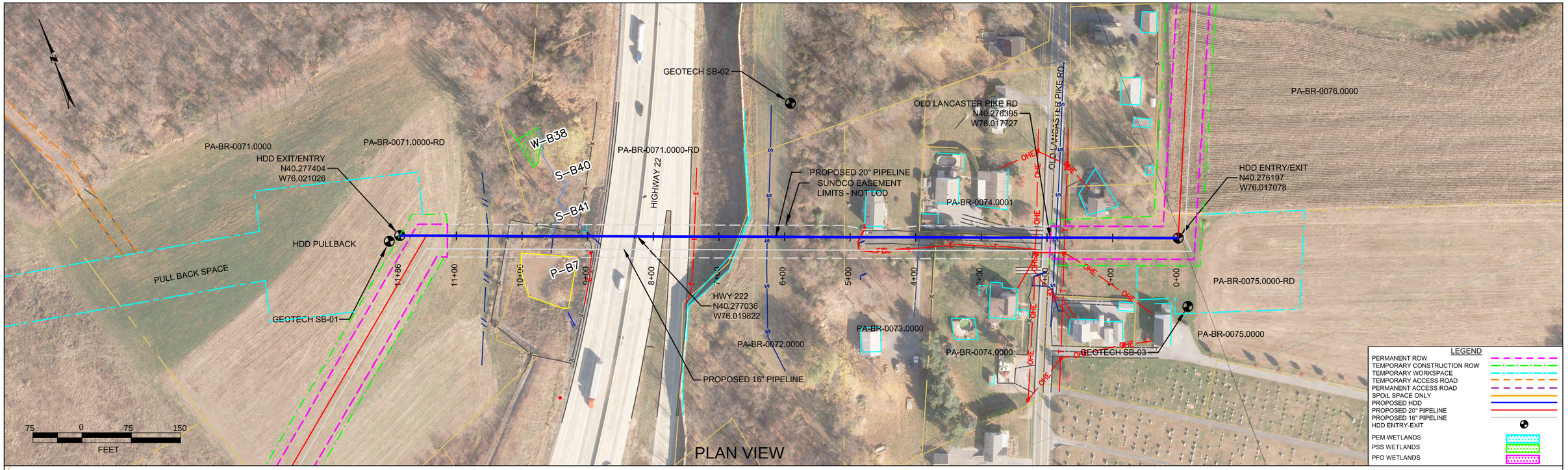


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-BR-0075.0000-RD (S-B41, S-B40)

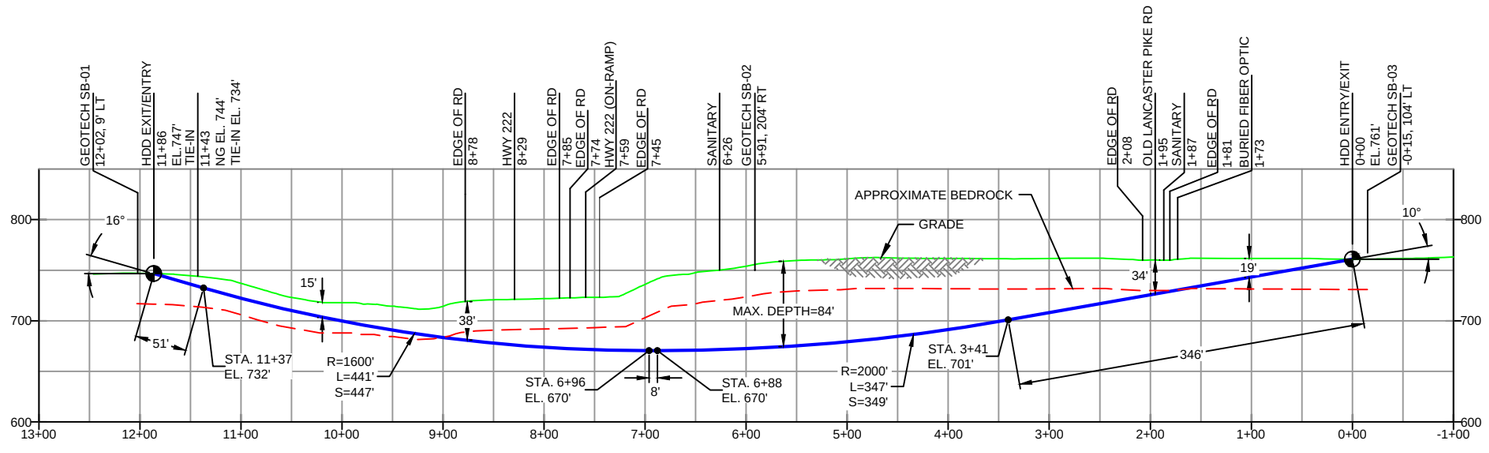
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 190 feet from the western edge of Stream B41 (S-B41) and enter/exit 960 feet from the eastern edge. The horizontal directional drill will enter/exit 240 feet from the western edge of Stream B40 (S-B40) and enter/exit 910 feet from the eastern edge. The drill will also enter/exit 270 feet from the western edge of Highway 222 and enter/exit 740 feet from the eastern edge. The drill will pass 15 feet underneath S-B41, 20 feet beneath S-B42, and 45 feet below Highway 222. 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 the primary substrates being drilled through are fractured conglomerate of quartz and sandstone with layers of sandy clays and silts above the drill. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.

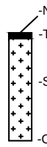


BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200

PROFILE VIEW



GEOTECH SB-01

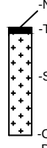


-NG EL. 747'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 30.0')
-COMPLETION DEPTH EL. 717'

GEOTECH SB-02

-NG EL. 750'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 11.0')
-SM/GM (11.0' - 24.0')
-FRACTURED CONGLOMERATE (24.0' - 32.0')
-COMPLETION DEPTH EL. 718'

GEOTECH SB-03



-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0')
-COMPLETION DEPTH EL. 737'

NOTE: REFER TO TEST BORING LOG S3-0290 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=):1186'
   HDD PIPE LENGTH (S=):1201'
   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.

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

DWG NO		DWG NO	DESCRIPTION
ES-5.27	TO	ES-5.28	EROSION & SEDIMENT PLAN
SHEET 15	TO	SHEET 16	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
C	ADDED GEOTECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	KB	04/15/15	RMB	04/15/15	AAW	04/15/15

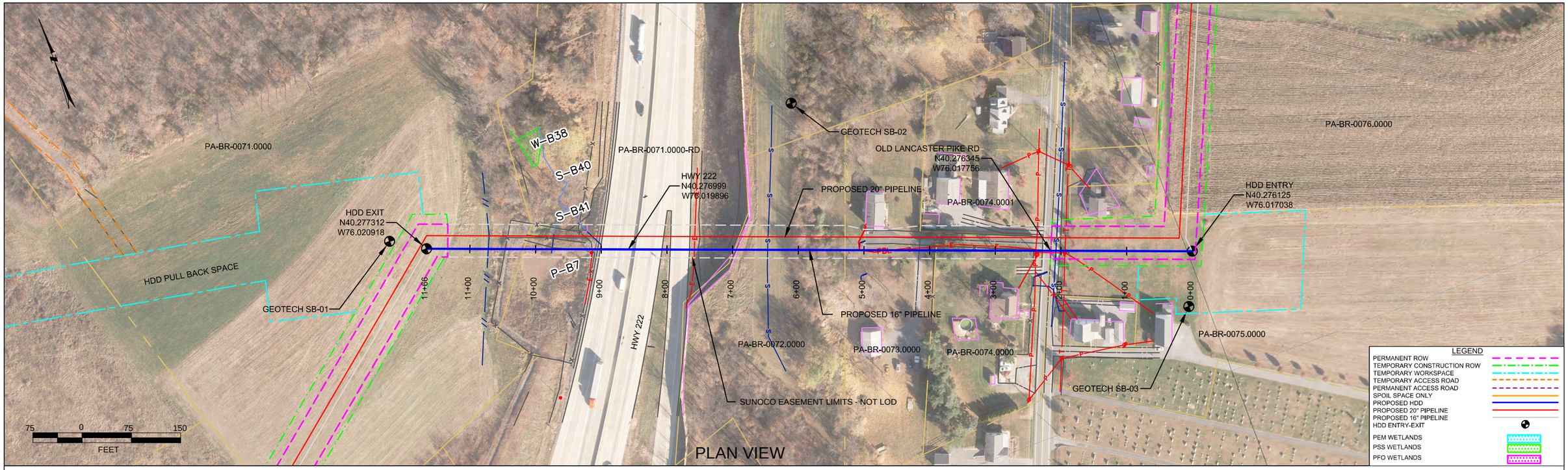
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

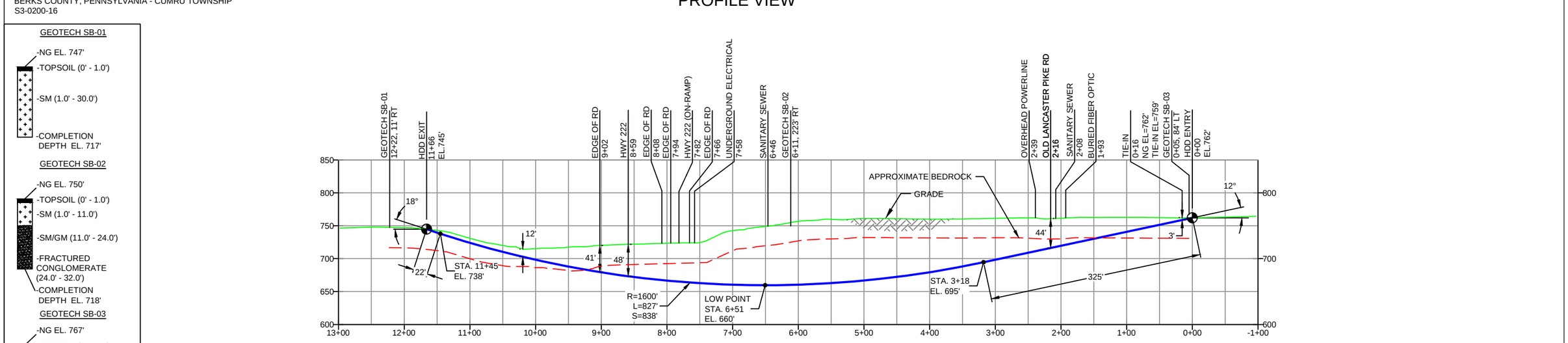
20-INCH HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG. NO: PA-BR-0075.0000-RD



BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0200-16

PROFILE VIEW



GEOTECH SB-01
-NG EL. 747'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 30.0')
-COMPLETION DEPTH EL. 717'

GEOTECH SB-02
-NG EL. 750'
-TOPSOIL (0' - 1.0')
-SM (1.0' - 11.0')
-SM/GM (11.0' - 24.0')
-FRACTURED CONGLOMERATE (24.0' - 32.0')
-COMPLETION DEPTH EL. 718'

GEOTECH SB-03
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-SM (0.7' - 30.0')
-COMPLETION DEPTH EL. 737'

NOTE: REFER TO TEST BORING LOG S3-0290 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=):1166'
   HDD PIPE LENGTH (S=):1185'
   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).
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.
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-5.27	TO	ES-5.28	EROSION & SEDIMENT PLAN	
SHEET 15	TO	SHEET 16	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	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GOETECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

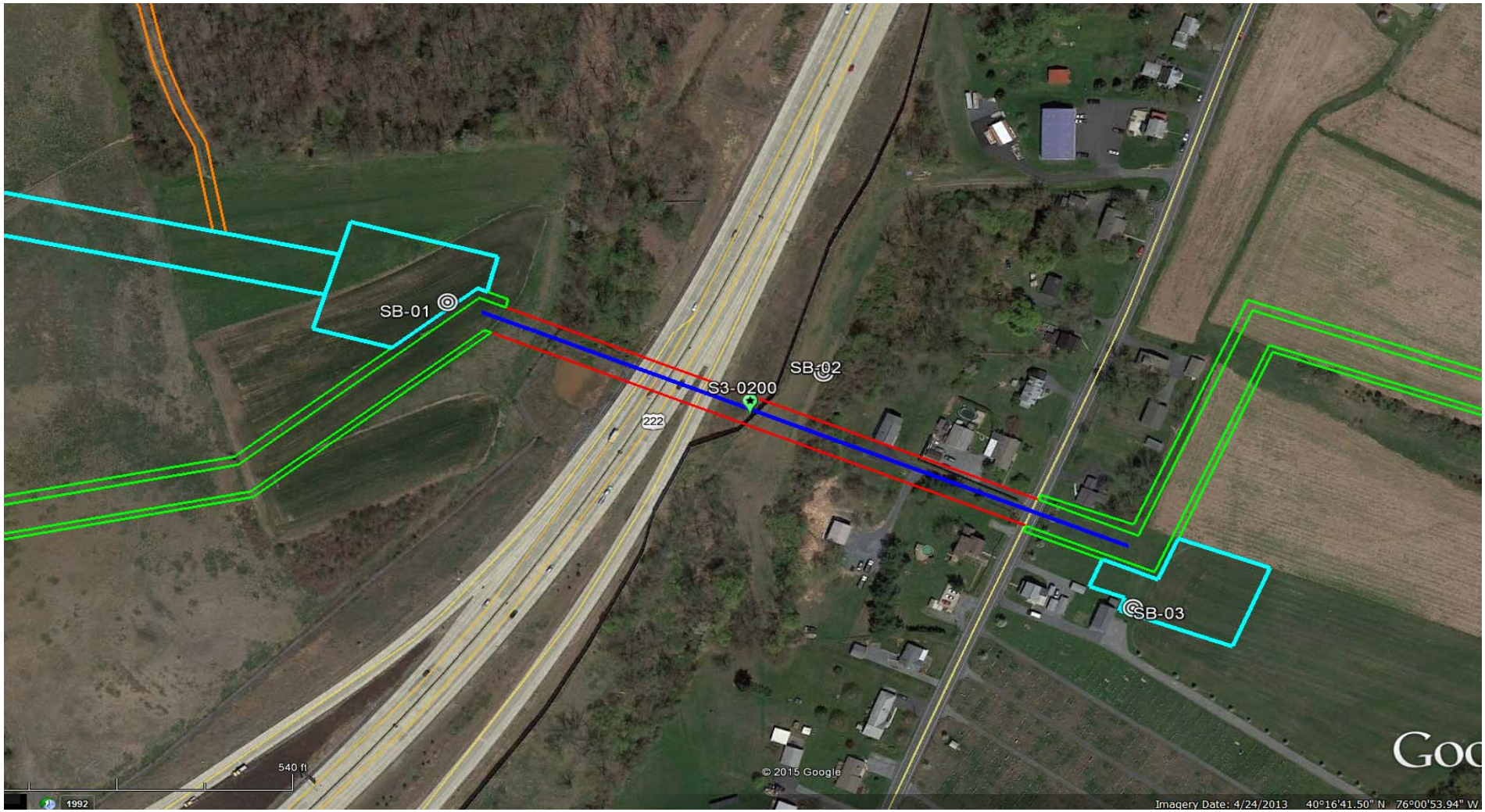
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
HWY 222
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

DWG. NO: PA-BR-0075.0000-RD-16



LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0200
BERKS COUNTY, CUMRU 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:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 12-11/12-14	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): 30.0
Boring Location Coordinates:		40° 16' 38.638" N	76° 1' 15.864" 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	1.0			TOPSOIL (12")					
1	3.0	5.0	1.0		17	SM	MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	8	14	22	15	**36**
							GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
2	8.0	8.7			6		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50	50/2"			**>50**
							GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
3	13.0	13.9			8		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	16	50/5"			**>50**
							GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
4	18.0	18.8			5		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50	50/3"			**>50**
							GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
5	23.0	25.0			24		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	3	31	48	25	**79**
							GRAVEL/CONGLOMERATE MATRIX, A LITTLE SILT.					
6	28.0	28.4			6		MAROON FINE TO COARSE SAND WITH A LITTLE FINE TO COARSE	50/5"				**0**
				30.0			GRAVEL/CONGLOMERATE MATRIX, SOME SILT.					
							AUGERED TO 30'.					
							GRINDING BEGINS 5' TO 6', THEN OFF AND ON BETWEEN					
							10 TO 28'.					
							CAVED AND DRY AT 27'.					

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:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 02-10-15	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): 32.0
Boring Location Coordinates:		40° 16' 38.348" N	76° 1' 7.530" 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	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		17	SM	MAROON FINE TO COARSE SAND WITH A LITTLE SILT, AND WITH	19	26	21	42	**47**
							SOME FINE TO COARSE GRAVEL.					
2	8.0	8.7			6		REDDISH BROWN MEDIUM COARSE SAND WITH SOME CONGLOMERAT	34	50/2"			**>50**
				11.0			GRAVEL, AND A LITTLE SILT.					
							AUGER REFUSAL AT 10'. OFFSET 8' NORTH AND CONTINUOUSLY					
							AUGERED TO NEXT SAMPLE INTERVAL.					
3	13.0	13.7	11.0		8	SM/ GM	REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME	10	50/3"			**>50**
							CONGLOMERATE GRAVEL, TRACE ROCK FRAGMENTS, LITTLE SILT.					
4	18.0	18.3			5		REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME	50/4"				**>50**
							CONGLOMERATE GRAVEL, TRACE ROCK FRAGMENTS, LITTLE SILT.					
5	23.0	23.1		24.0	24		REDDISH BROWN CONGLOMERATE GRAVEL.	50/1"				**>50**
							AUGER REFUSAL AT 24'.					
							ROCK CORING					
RUN 1	24.0	27.0	24.0	27.0	21	CONGLOM.	REDDISH BROWN INTENSELY FRACTURED CONGLOMERATE.	TCR: 58%, SCR: 8%, RQD: 0%				
RUN 1	27.0	32.0	27.0	32.0	22		REDDISH BROWN INTENSELY FRACTURED CONGLOMERATE.	TCR: 37%, SCR: 17%, RQD: 0%				
							CAVED AND DRY AT 23'.					

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:	OLD LANCASTER PIKE, CUMRU, PA		Page 1 of 1
HDD No.:	S3-0200	Dates(s) Drilled: 12-11-14	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° 16' 33.303" N	76° 1' 1.736" 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	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		10		MAROON FINE SAND AND SILT, TRACE CONGLOMERATE MATRIX.	2	9	9	12	**18**
2	8.0	10.0			11		MAROON FINE TO MEDIUM SAND WITH SOME SILT, TRACE FINE	1	5	15	20	**20**
							TO COARSE GRAVEL.					
3	13.0	14.5			15		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	312	35	35		**70**
						SM	TO COARSE GRAVEL. (USCS: SM).					
4	18.0	19.4			15		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	7	8	50/5"		**>50**
							TO COARSE GRAVEL.					
5	23.0	23.8			7		MAROON FINE TO MEDIUM SAND AND SILT, WITH A LITTLE FINE	20	50/3"			**>50**
							TO COARSE GRAVEL.					
6	28.0	28.7			5		MAROON FINE TO MEDIUM SAND WITH SOME SILT, WITH A LITTLE FINE	30	50/2"			**>50**
				30.0			TO COARSE GRAVEL.					
							AUGERED TO 30'.					
							CAVED AND DRY AT 20'.					

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 S3-0200

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)
S3-0200	SB-01	2	8.0	8.7	8.5	24.0	-	-	-	-
		3	13.0	13.9	5.8	16.8	-	-	-	-
		5	23.0	25.0	7.3	19.3	-	-	-	-
		6	28.0	28.4	8.7	31.9	-	-	-	-
	SB-02	1	3.0	5.0	6.3	19.3	-	-	-	-
		2	8.0	8.7	5.7	12.6	-	-	-	-
		3	13.0	13.7	9.6	20.2	-	-	-	-
	SB-03	1	3.0	5.0	11.6	47.1	-	-	-	-
		2	8.0	10.0	8.4	28.2	-	-	-	-
		3	13.0	14.5	8.4	40.6	33	25	8	SM
		5	23.0	23.8	8.0	38.7	-	-	-	-
		6	28.0	28.7	4.5	26.8	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0200

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
S3-0200	Hwy 222 - Lancaster Pike	SB-01	**Hammer Creek Conglomerate** - very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.	level-rolling upland	Hammer Creek Conglomerate	quartz conglomerate; reddish brown cross-bedded sandstone	2,580	10-60	
		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.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0200

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					
S3-0200	SB-2	1	24	27	58	8	0	24	27	Slight to moderate	Conglomerate	Massive	Light Red	Heavily fractured in bottom half of core; fractures ranging from 0° to 65°, Avg. 25°
		2	27	32	37	17	0	27	32	Slight to moderate	Conglomerate	Massive	Light Red	Fractures ranging from 0° to 30°, Avg. 9°

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

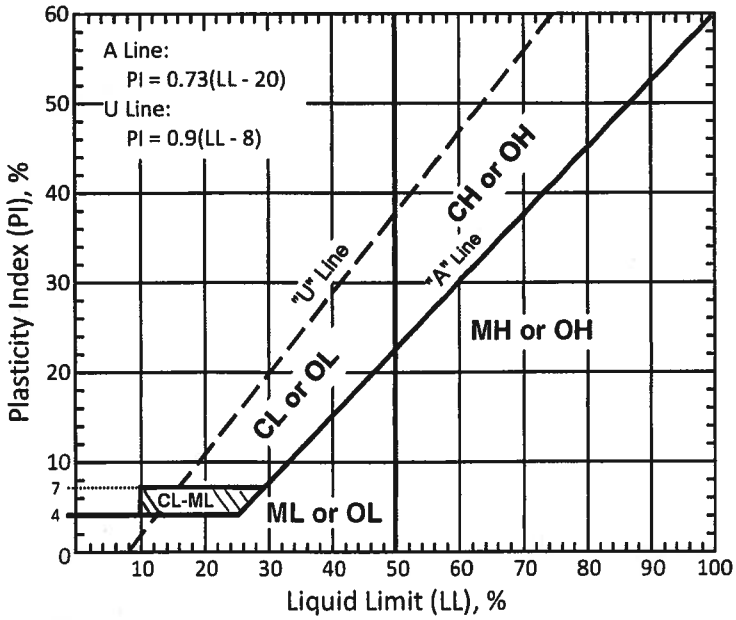
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.

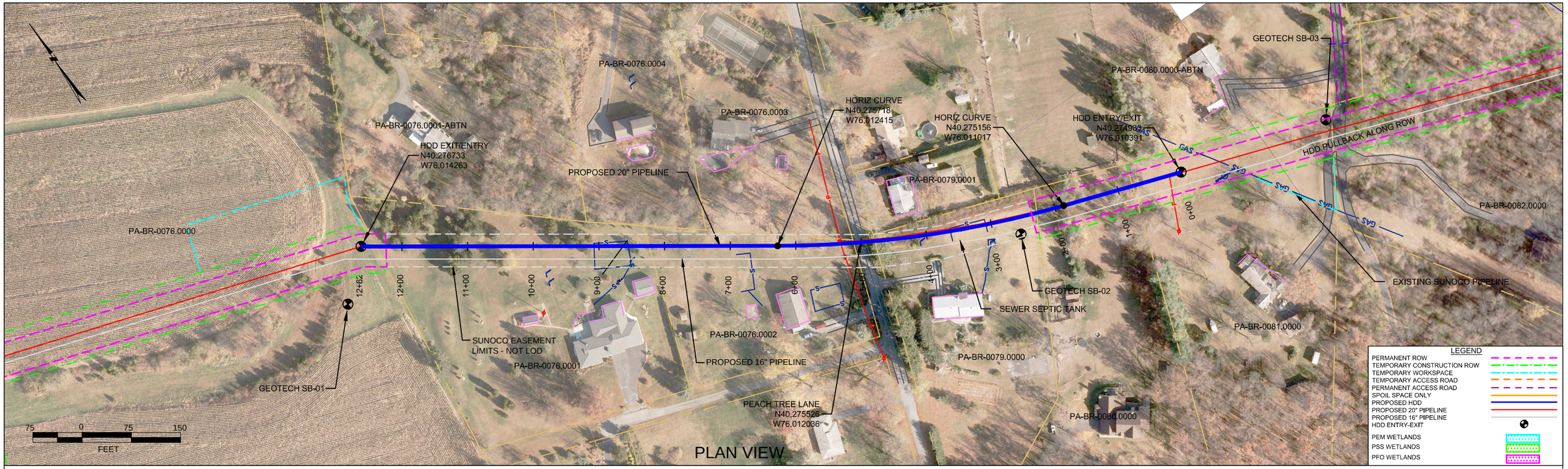


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-BR-0079.0000-RD

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.

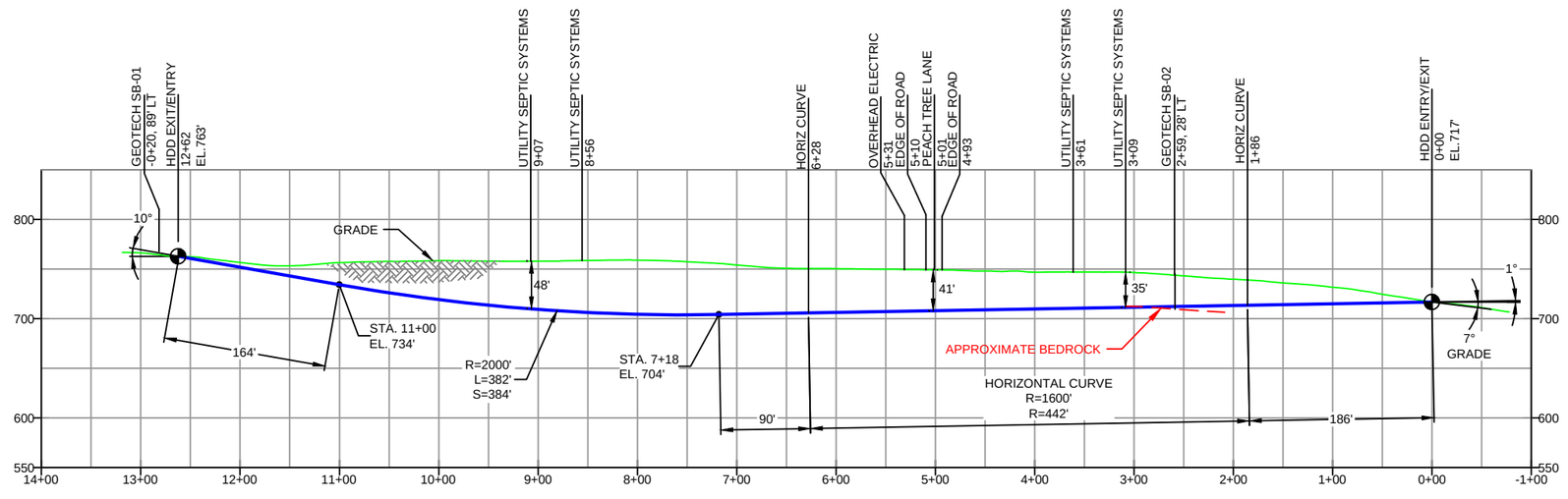
The drill will enter/exit 830 feet from the western edge of Peach Tree Lane and enter/exit 670 feet from the eastern edge. The drill will pass 63 feet below the road. The geotechnical results, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining the pipe integrity (e.g., no large bends). According to the geotechnical report the primary substrates being drilled through are sandstones with layers of clays and silty sands above the rock. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0201

PROFILE VIEW



GEOTECH SB-01
-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0')
-COMPLETION DEPTH EL. 737'

GEOTECH SB-02
-NG EL. 745'
-TOPSOIL (0' - 0.4')
-SC (0.4' - 17.0')
-SANDSTONE (17.0' - 34.1')
-COMPLETION DEPTH EL. 711'

GEOTECH SB-03
-NG EL. 745'
-TOPSOIL (0' - 0.1')
-SM (0.1' - 30.0')
-COMPLETION DEPTH EL. 715'

NOTE: REFER TO TEST BORING LOG S3-0201 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=):1262'
   HDD PIPE LENGTH (S=):1266'
   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.

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-5.28	TO	ES-5.29	EROSION & SEDIMENT PLAN	
SHEET 16	TO	SHEET 16	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
MB	ISSUED FOR BID/DESIGN CHANGE	DLM	08/22/15	RMB	08/22/15	AAW	08/22/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	KB	04/15/15	RMB	04/15/15	AAW	04/15/15

Sunoco Logistics Partners L.P.

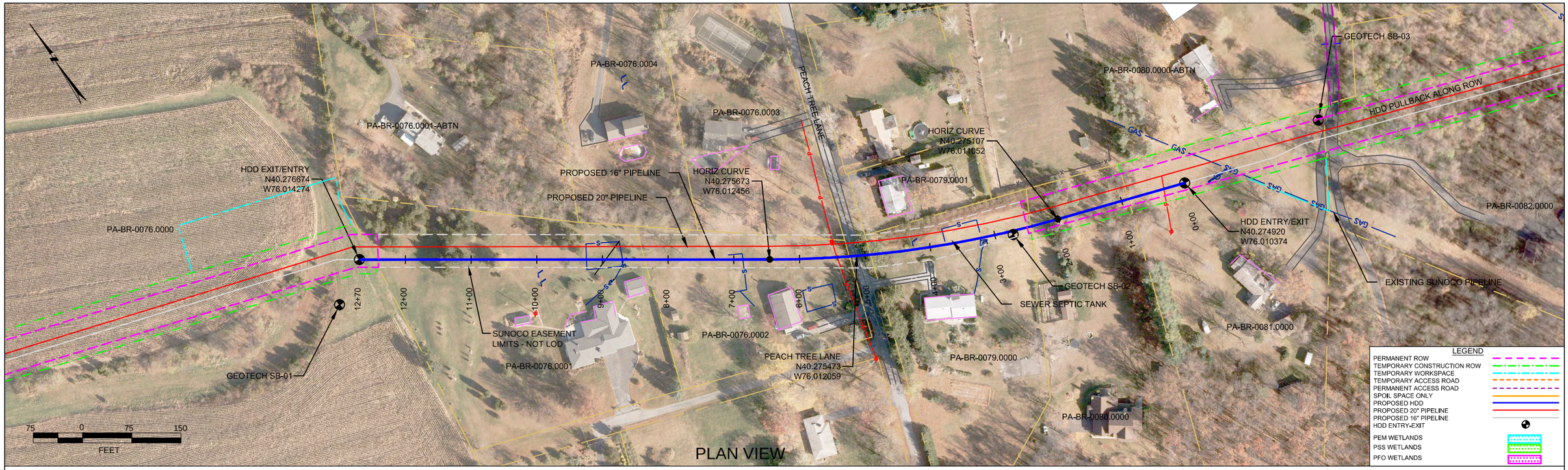
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
PEACH TREE LANE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

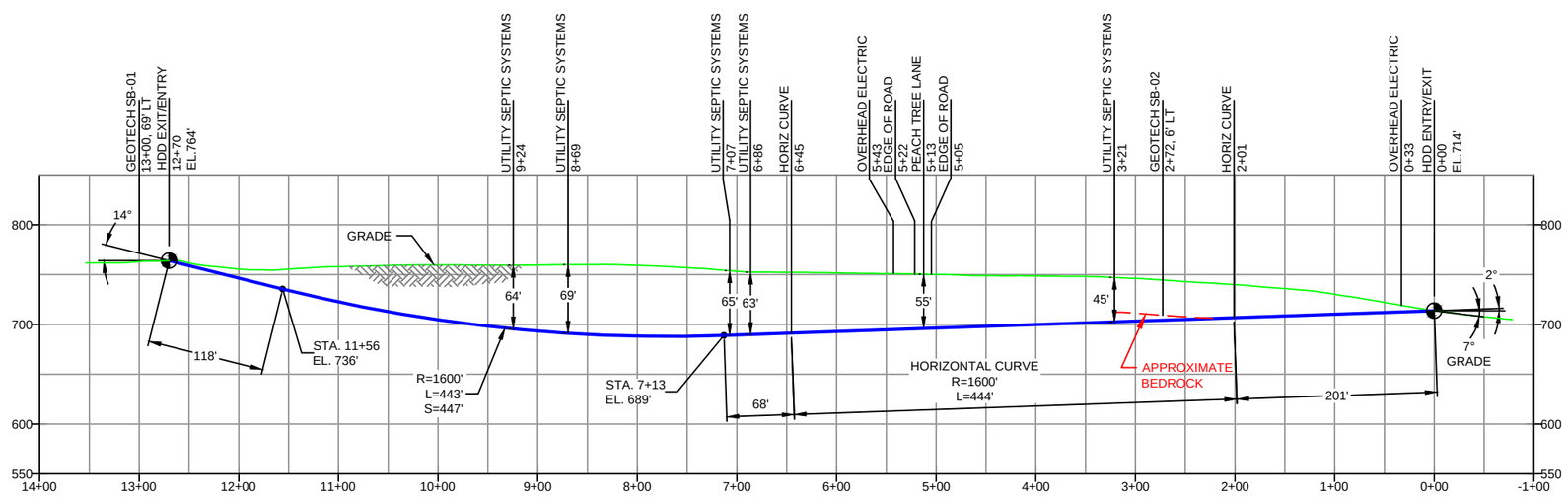
DWG. NO: PA-BR-0079.0000-RD



PLAN VIEW

BERKS COUNTY, PENNSYLVANIA - CUMRU TOWNSHIP
S3-0201-16

PROFILE VIEW



GEOTECH SB-01
-NG EL. 767'
-TOPSOIL (0' - 0.7')
-SM (0.7' - 30.0')
-COMPLETION DEPTH EL. 737'

GEOTECH SB-02
-NG EL. 745'
-TOPSOIL (0' - 0.4')
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GEOTECH SB-03
-NG EL. 745'
-TOPSOIL (0' - 0.1')
-SM (0.1' - 30.0')
-COMPLETION DEPTH EL. 715'

NOTE: REFER TO TEST BORING LOG S3-0201 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=):1270'
   HDD PIPE LENGTH (S=):1278'
   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).
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.
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NOTES

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

REF. DRAWING

ES-5.28	TO	ES-5.29	EROSION & SEDIMENT PLAN
SHEET 16	TO	SHEET 16	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	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		DLM	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GEOTECH INFO	MRS	09/25/15	RMB	09/25/15	AAW	09/25/15
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
PEACH TREE LANE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG. NO: PA-BR-0079.0000-RD-16

LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0201 PEACH TREE LANE
BERKS COUNTY, CUMRU 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:	OLD LANCASTER PIKE, READING, PA		Page 1 of 1
HDD No.:	S3-0201	Dates(s) Drilled: 05-08-15	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): 30.0
Boring Location Coordinates:		40° 16' 35.656" N	76° 0' 52.158" 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	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		16		REDDISH BROWN FINE TO MEDIUM SAND AND SILT, WITH A LITTLE	2	4	4	8	**8**
							FINE TO COARSE GRAVEL. (USCS: SM)					
2	8.0	10.0			10		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, AND WITH	15	21	25	35	**46**
							A LITTLE FINE GRAVEL (TRACE CONGLOMERATE MATRIX).					
3	13.0	14.4			13		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, AND WITH	4	35	50/5"		**>50**
							A LITTLE FINE GRAVEL (TRACE CONGLOMERATE MATRIX).					
4	18.0	19.4			15	SM	REDDISH BROWN FINE TO MEDIUM SAND AND SILT, WITH A LITTLE	8	25	50/5"		**>50**
							FINE GRAVEL (TRACE CONGLOMERATE MATRIX (USCS: SM).					
5	23.0	25.0			24		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND WIT	13	27	30	40	**57**
							A LITTLE FINE GRAVEL (TRACE CONGLOMERATE MATRIX).					
6	28.0	30.0			24		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND WIT	5	4	6	18	**10**
				30.0			A LITTLE FINE GRAVEL (TRACE CONGLOMERATE MATRIX).					
							DRY AND CAVED AT 23'.					

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.

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:	PEACH TREE LANE, READING, PA		Page 1 of 1
HDD No.:	S3-0201	Dates(s) Drilled: 05-07-15	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): 34.1
Boring Location Coordinates:		40° 16' 30.595" N	76° 0' 40.609" 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	0.4			TOPSOIL (5")					
1	3.0	5.0	0.4			SC	DARK BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY, LITTLE	4	7	6	5	**13**
							FINE GRAVEL.					
2	8.0	10.0					REDDISH BROWN FINE SAND AND SILTY CLAY (DECOMPOSED	4	15	10	12	**25**
							SILTSTONE) (USCS: SC), MICACEOUS.					
3	13.0	14.9					REDDISH BROWN FINE SAND AND SILTY CLAY (DECOMPOSED	8	16	15	50/5"	**31**
				17.0			SILTSTONE) MICACEOUS.					
4	18.0	18.5	17.0			PARTIALLY WEATHERED ROCK	PARTIALLY WEATHERED SANDSTONE.	50/6"				**>50**
5	23.0	23.5					PARTIALLY WEATHERED SANDSTONE.	50/6"				**>50**
6	28.0	28.0					NO RECOVERY	50/0"				**>50**
7	33.5	34.1		34.1			PARTIALLY WEATHERED CONGLOMERATE.	17	50/1"			**>50**
							AUGER REFUSAL AT 33.5'.					
							DRY AND CAVED AT 32.5'.					

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.

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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:	45 SCARLETT LANE, READING, PA		Page 1 of 1
HDD No.:	S3-0201	Dates(s) Drilled: 10-08-15	Inspector: J. COSTELLO
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: E. ODGEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 30.0
Boring Location Coordinates:		40°16'29.31"N	76° 0'34.43"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 (TRACE)					
1	3.0	5.0	0.1		20	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, INTER	5	27	21	40	**48**
							LAYERED WITH PARTIALLY WEATHERED ROCK SEAMS.					
2	8.0	10.0			16		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, AND	4	14	10	12	**24**
							WITH A LITTLE F-C SANDSTONE/CONGLOMERATE GRAVEL. (SM)					
3	13.0	15.0			16		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	1	6	12	15	**18**
							WITH TRACE F-C SANDSTONE/CONGLOMERATE GRAVEL.					
4	18.0	20.0			18		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	5	21	41	40	**62**
							WITH SOME F-C SANDSTONE/CONGLOMERATE GRAVEL.					
5	23.0	25.0			20		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	6	15	21	31	**36**
							WITH TRACE FINE SANDSTONE/CONGLOMERATE GRAVEL.					
6	28.0	29.0			18		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, AND	6	50/6"			**>50**
				30.0			WITH A LITTLE F-C SANDSTONE/CONGLOMERATE GRAVEL.					
							AUGERED TO 30'.					
							CAVED AND DRY AT 24'.					
							GROUNDWATER NOT ENCOUNTERED.					

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 S3-0201 PEACH TREE LANE

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)
S3-0201	SB-01	1	3.0	5.0	13.7	47.1	33	25	7	SM
		2	8.0	10.0	6.8	36.0	-	-	-	-
		3	13.0	14.4	7.5	25.2	-	-	-	-
		4	18.0	19.4	11.8	46.8	32	25	7	SM
		5	23.0	25.0	6.9	18.6	-	-	-	-
		6	28.0	30.0	8.2	18.8	-	-	-	-
	SB-02	1	3.0	5.0	11.8	31.9	-	-	-	-
		2	8.0	10.0	9.5	47.8	28	20	8	SC
		4	18.0	18.5	4.2	27.7	-	-	-	-
		5	23.0	23.5	6.2	41.2	-	-	-	-
		7	33.5	34.1	5.9	40.8	-	-	-	-
	SB-03	2	8.0	10.0	15.4	37.0	NL	NP	NV	SM
		3	13.0	15.0	6.4	19.4	-	-	-	-
		4	18.0	20.0	5.3	16.1	-	-	-	-
		5	23.0	25.0	4.4	10.6	-	-	-	-
		6	28.0	29.0	7.7	25.9	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0201

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
S3-0201	Peachtree Lane	SB-01	**Hammer Creek Fm** - reddish-brown, coarse grained sandstone with interbeds of red shale and quartz pebble conglomerate	level rolling upland	Hammer Creek Fm.	limestone with interbedded crystalline dolomite	9,360	generally 10-30 but some shallow outcrops present	Yields generally 5-30 range with some high yield outlier wells
		SB-02	**Hammer Creek Conglomerate** - very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.		Hammer Creek Conglomerate	quartz conglomerate; reddish brown cross-bedded sandstone	2,580		
		SB-03	**Hammer Creek Conglomerate** - very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.						

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)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

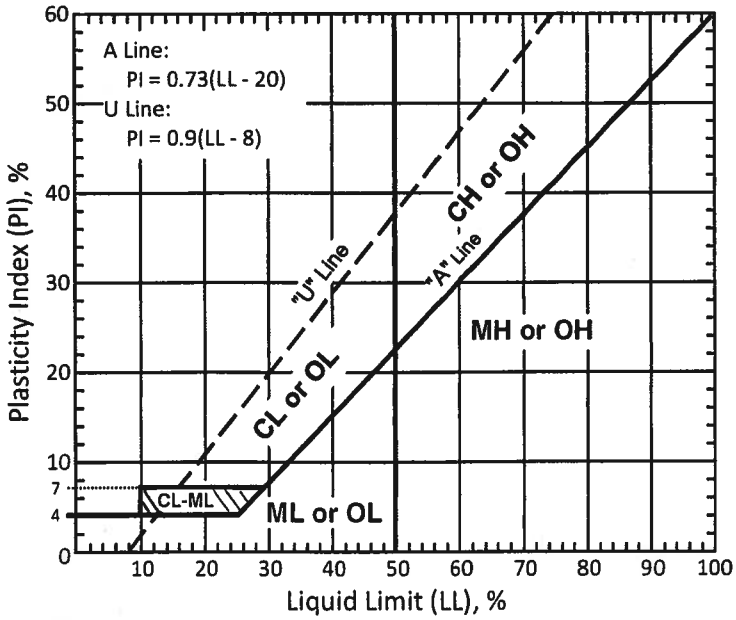
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.

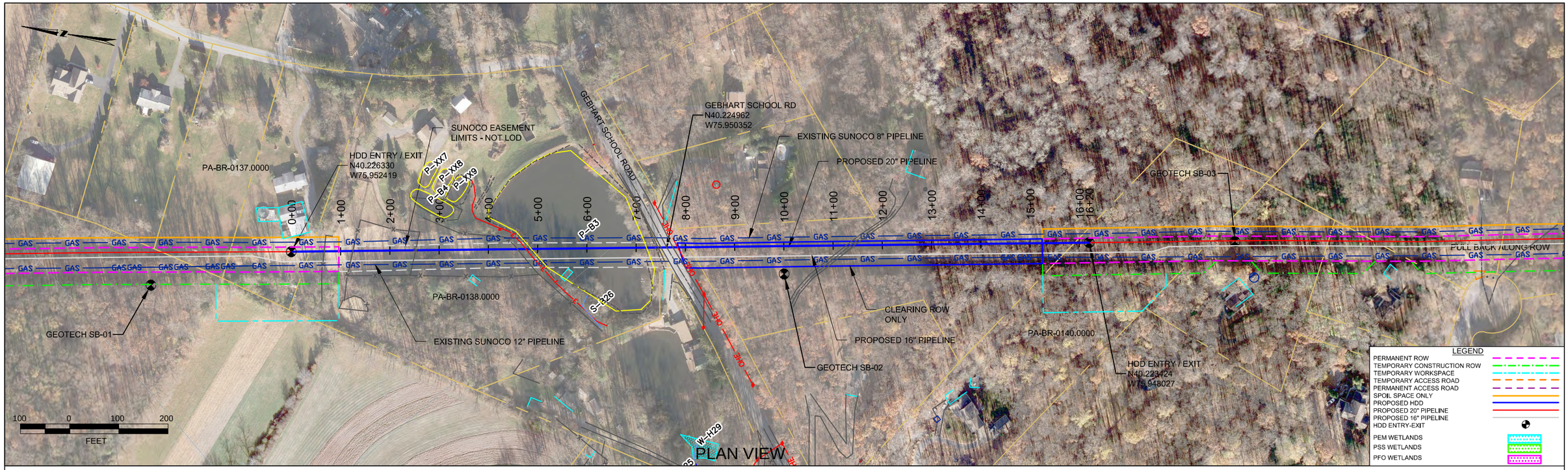


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-BR-0138.0001-RD (PuB-B3)

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 510 feet from the western edge of Pond B3 (PuB-B3) and enter/exit 1,050 feet from the eastern edge. The drill will pass 30 feet below PuB-B3. 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 the primary substrates being drilled through are siltstone, silty clays, and fine sands. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - BRECKNOCK TOWNSHIP
S3-0230

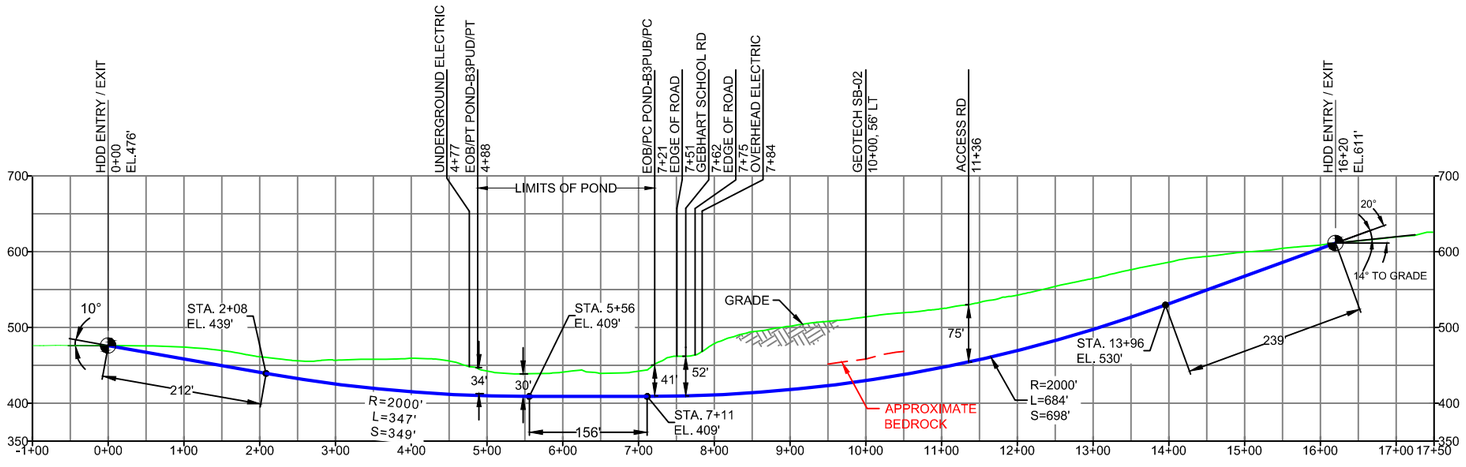
GEOTECH SB-01

-NG EL. 467'
-TOPSOIL (0' - 0.5')
-CL (0.5' - 8.7')
-SC (8.7' - 28.5')
-SILTY CLAY CL (28.5' - 30.0')
-COMPLETION DEPTH EL. 437'

GEOTECH SB-02

-NG EL. 518'
-TOPSOIL (0' - 1.0')
-SM (0.3' - 9.0')
-CL (9.0' - 11.5')
-SM (11.5' - 55.0')
-SILT STONE (55.0' - 57.5')
-CL (57.5' - 61.0')
-SILT STONE (61.0' - 68.0')
-COMPLETION DEPTH EL. 450'

NOTE: REFER TO TEST BORING LOG S3-0230 FOR COMPLETE SOIL MATERIAL DESCRIPTION



GEOTECH SB-03

-NG EL. 643'
-TOPSOIL (0' - 0.1')
-CL (0.1' - 16.5')
-CL/GC (16.5' - 25.0')
-COMPLETION DEPTH EL. 618'

NOTE: REFER TO TEST BORING LOG S3-0230 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=):1620'
   HDD PIPE LENGTH (S=):1654'
   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.

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-5.45	TO	ES-5.47	EROSION & SEDIMENT PLAN
SHEET 26	TO	SHEET 27	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
C	ADDED GEOTECH INFO	MRS	09/28/15	RMB	09/28/15	AAW	09/28/15
B	ISSUED FOR BID	MRS	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	KB	04/15/15	RMB	04/15/15	AAW	04/15/15

Sunoco Logistics Partners L.P.

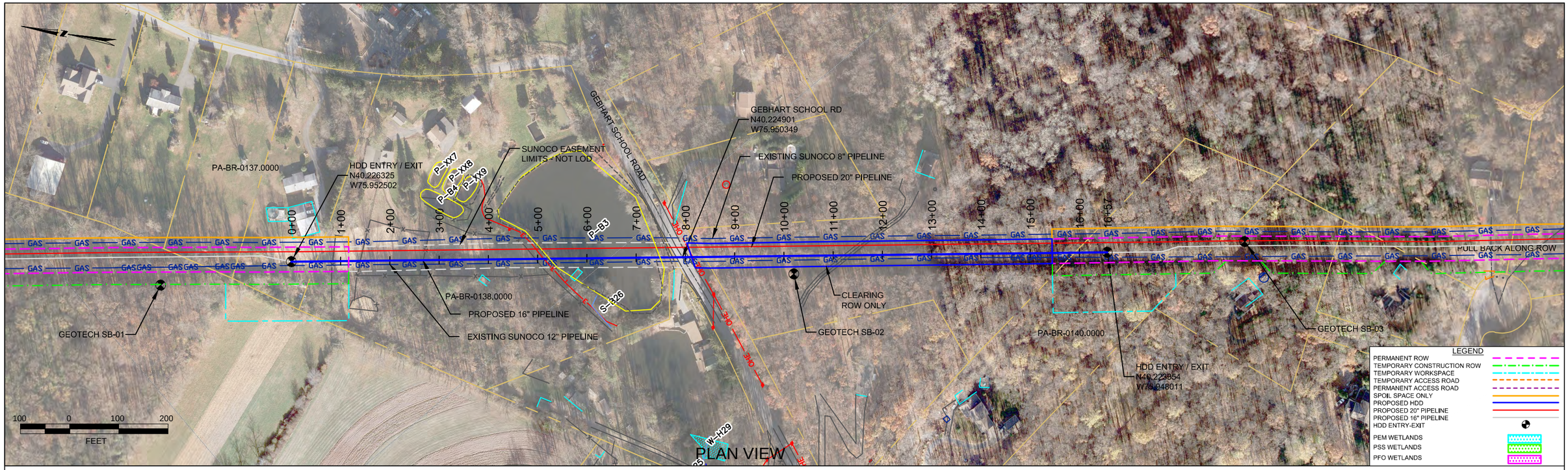
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
GERHART SCHOOL ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

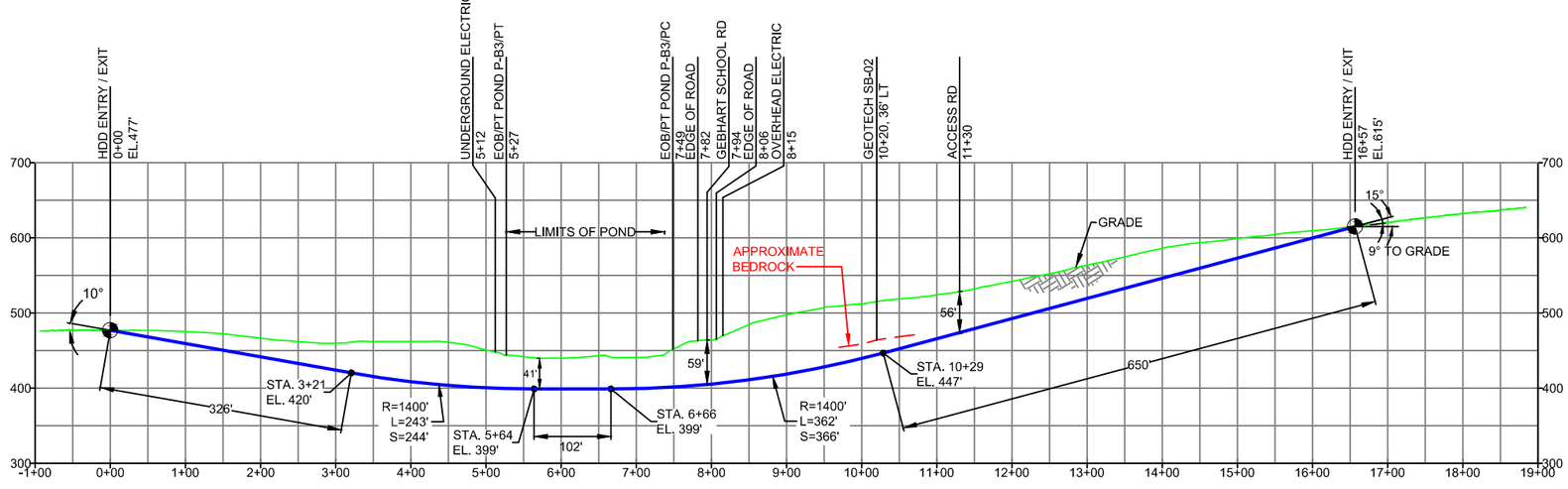
DWG. NO: PA-BR-0138.0001-RD



PLAN VIEW

PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - BRECKNOCK TOWNSHIP
S3-0230-16



GEOTECH SB-01

GEOTECH SB-02

NOTE: REFER TO TEST BORING LOG S3-0230 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-03

NOTE: REFER TO TEST BORING LOG S3-0230 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=):1657'
   HDD PIPE LENGTH (S=):1688'
   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).
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.
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13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

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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-5.45	TO	ES-5.47	EROSION & SEDIMENT PLAN
SHEET 26	TO	SHEET 27	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	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/09/16	RMB	05/09/16	AAW	05/09/16
EP		MRS	11/23/15	RMB	11/23/15	AAW	11/23/15
B	ADDED GEOTECH INFO	MRS	09/28/15	RMB	09/28/15	AAW	09/28/15
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
GERHART SCHOOL ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-BR-0138.0001-RD-16

LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-2300
BERKS COUNTY, BRECKNOCK 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:	GEBHART SCHOOL ROAD		Page 1 of 1
HDD No.:	S3-0230	Dates(s) Drilled: 02-08-15	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): 30.0
Boring Location Coordinates:		40° 13' 36.153" N	75° 57' 11.979" 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			TOPSOIL (6")					
1	3.0	5.0	0.5		13	CL	REDDISH BROWN SILTY CLAY WITH SOME FINE SAND, TRACE	1	2	3	5	**5**
				8.7			COARSE GRAVEL. (USCS: CL).					
2	8.0	10.0	8.7		24		REDDISH BROWN FINE SAND WITH SOME SILTY CLAY, TRACE	5	10	10	18	**20**
							MICA.					
3	13.0	15.0			24		REDDISH BROWN FINE SAND AND SILTY CLAY, WITH A LITTLE	2	18	16	17	**34**
						SC	UNWEATHERED SILTSTONE/SHALE ROCK FRAGMENTS.					
4	18.0	20.0			18		REDDISH BROWN FINE SAND, WITH INTERLAYERED SILTY CLAY	3	7	10	24	**17**
							LENSES. (USCS: SC).					
5	23.0	25.0			18		REDDISH BROWN MICACEOUS FINE TO MEDDIUM SAND WITH A	5	12	16	16	**28**
				28.5			LITTLE SILTY CLAY.					
6	28.0	29.3	28.5		15	CL	REDDISH BROWN SILTY CLAY, TRACE WEATHERED	2	25	50/3"		**>50**
				30.0			SILTSTONE/SHALE. (USCS: CL)					
							AUGERED TO 30'.					
							CAVED AND DRY AT 29'.					

Notes/Comments:

Pocket Pentrometer Testing

S1: 1.0 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.

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	GEBHART SCHOOL ROAD		Page 1 of 2
HDD No.:	S3-0230	Dates(s) Drilled: 02-25-15	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): 68.0
Boring Location Coordinates:		40° 13' 27.913" N	75° 56' 59.361" 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		23	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT,	3	9	9	8	**18**
				9.0			A LITTLE FINE GRAVEL.					
2	8.0	10.0	9.0		10	CL	REDDISH BROWN SILTY CLAY, TRACE FINE SAND.	4	3	4	4	**7**
				11.5			(USCS: CL).					
3	13.0	13.7	11.5		7		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE	25	50/2"			**>50**
							FINE UNWEATHERED GRAVEL.					
4	18.0	18.6			9		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, WITH	20	50/3"			**>50**
							A LITTLE FINE TO COARSE GRAVEL.					
5	23.0	23.3			4		LIGHT REDDISH BROWN FINE TO MEDIUM SAND, TRACE SILT, SOME	50/4"				**>50**
							FINE TO COARSE GRAVEL AND CONGLOMERATE.					
6	28.0	28.7			8		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, SOME	30	50/2"			**>50**
							FINE TO COARSE GRAVEL AND CONGLOMERATE.					
7	38.0	40.0			19	SM	REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME SILT, TRACE	36	42	16	20	**58**
							FINE GRAVEL.					
8	43.0	43.3			3		REDDISH BROWN FINE SAND AND WEATHERED ROCK FRAGMENTS.	50/3"				**>50**
9	48.0	48.4			4		REDDISH BROWN FINE SAND AND WEATHERED ROCK FRAGMENTS,	50/5"				**>50**
							SOME SILT. (USCS: SM).					
10	53.0	53.5			6		REDDISH BROWN FINE SAND AND WEATHERED ROCK FRAGMENTS,	50/6"				**>50**
				55.0			SOME SILT.					
							AUGER REFUSAL AT 55". BEGIN ROCK CORING:					
RUN 1	55.0	57.5	55.0	57.5	17		REDDISH BROWN SILTSTONE	TCR: 57%, SCR: 57%, RQD: 30%				
							CORE HOLE FILLED WITH MATERIAL, PULLED BARREL AND SWITCHED					
							BACK TO AUGER (SEE NEXT PAGE).					

Notes/Comments:

Pocket Pentrometer Testing
S2 (9.5'): 3.25 TSF
S11: > 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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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	GEBHART SCHOOL ROAD		Page 2 of 2
HDD No.:	S3-0230	Dates(s) Drilled: 02-26-15	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): 68.0
Boring Location Coordinates:		40° 13' 27.913" N	75° 56' 59.361" 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
11	57.5	58.8	57.5		15	CL	REDDISH BROWN SILTY CLAY AND FINE SAND, TRACE SILTSTONE	28	29	50/4"		**>50**
				61.0			FRAGMENTS. (DECOMPOSED SILTSTONE). (USCS: CL).					
12	64.0	64.3	61.0	65.0	3	SILTSTONE	REDDISH BROWN WEATHERED SILTSTONE.	50/3"				**>50**
RUN 2	65.0	68.0	65.0		30		HEAVILY WEATHERED REDDISH BROWN SILTSTONE.	TCR: 83%, SCR: 42%, RQD: 19%				
							SLIGHT TO MODERATELY WEATHERED SILTSTONE.					
				68.0			HEAVILY WEATHERED REDDISH BROWN SILTSTONE.					
							AUGER REFUSAL AT 65', BEGAN ROCK CORING AT 65'.					
							COULD NOT RESET CORE BARREL TO CONTINUE ROCK CORING					
							DUE TO MATERIAL CAVE WITHIN BOREHOLE.					
							WATER LEVEL NOT ENCOUNTERED WITHIN OVERBURDEN.					
							CAVED AND DRY AT 26'.					
							CORE TESTING RESULTS (RUN 2, DEPTH 66.7'):					
							COMPRESSIVE STRENGTH: 3,390 PSI					
							UNIT WEIGHT: 157.1 PCF					

Notes/Comments:

Pocket Pentrometer Testing
S2 (9.5'): 3.25 TSF
S11: > 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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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	GEBHART SCHOOL ROAD		Page 1 of 1
HDD No.:	S3-0230	Dates(s) Drilled: 02-11-15	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): 25.0
Boring Location Coordinates:		40° 13' 22.412" N	75° 56' 49.955" 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		14		REDDISH BROWN SILTY CLAY AND FINE SAND, TRACE FINE	1	5	8	13	**13**
							GRAVEL.					
2	8.0	10.0			24	CL	REDDISH BROWN SILTY CLAY AND FINE SAND, MICACEOUS,	8	13	23	35	**36**
							TRACE FINE GRAVEL.					
3	13.0	15.0			24		REDDISH BROWN SILTY CLAY. (USCS: CL)	4	11	18	17	**29**
				16.5								
4	18.0	19.5	16.5		18		REDDISH BROWN SILTY CLAY WITH SOME FINE MICACEOUS	3	31	50/6"		**>50**
							SAND, WITH SOME FINE GRAVEL.					
5	23.0	24.5			18	CL/ GC	REDDISH BROWN SILTY CLAY WITH SOME FINE MICACEOUS	10	41	50/6"		**>50**
				25.0			SAND, WITH SOME FINE GRAVEL. (USCS: CL)					
							AUGER REFUSAL AT 25'.					
							CAVED AND DRY AT 24'.					

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 S3-0230

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)
S3-0230	SB-01	1	3.0	5.0	19.6	73.5	34	19	15	CL
		2	8.0	10.0	6.6	28.6	-	-	-	-
		3	13.0	15.0	10.3	47.8	-	-	-	-
		4	18.0	20.0	12.8	41.0	30	20	10	SC
		5	23.0	25.0	9.2	17.6	-	-	-	-
		6	28.0	29.3	13.9	95.7	36	21	15	CL
	SB-02	2	8.0	10.0	21.0	97.7	42	24	18	CL
		3	13.0	13.7	7.6	35.5	-	-	-	-
		6	28.0	28.7	5.7	18.8	-	-	-	-
		7	38.0	40.0	12.3	27.9	-	-	-	-
		9	48.0	48.4	10.6	35.0	29	24	5	SM
		11	57.5	58.8	14.0	63.2	42	19	23	CL
	SB-03	1	3.0	5.0	12.9	52.8	-	-	-	-
		2	8.0	10.0	15.6	61.1	-	-	-	-
		3	13.0	15.0	14.9	99.0	35	20	15	CL
		4	18.0	19.5	8.8	72.4	-	-	-	-
		5	23.0	24.5	10.0	74.0	34	19	15	CL

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	66.7	3,390	157.1

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0230

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
S3-0230	Gebhart School Rd.	SB-01	**Hammer Creek Fm** - reddish-brown, coarse grained sandstone with interbeds of red shale and quartz pebble conglomerate	Rolling hills	Hammer Creek Fm.	sandstone with quartz pebble conglomerate	9,360	13-70	
		SB-02	**Hammer Creek Conglomerate** - very coarse quartz conglomerate having abundant pebbles and cobbles of gray quartzite.		Hammer Creek Conglomerate	quartz conglomerate; reddish brown cross-bedded sandstone	2,580	14-70	
		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.

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0230

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					
S3-0230	SB-2	1	55	57.5	57	57	30	55	57.5	Slight	Siltstone	Massive	Red	Fractures ranging from 0° to 35°, Avg. 15°
		2	65	38	83	42	19	65	66	Heavily	Siltstone	Approx. 1'	Red	Heavily fractured and appears as though fines washed out during drilling
								66	67	Slight to moderate	Siltstone	Approx. 1'	Red	Fractures (very few) ranging from 0° to 5°, Avg. 2.5°; infilling of fractures with minerals, probably quartz
								67	68	Heavily	Siltstone	Approx. 1'	Red	Heavily fractured and weathered, very broken up and soft

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

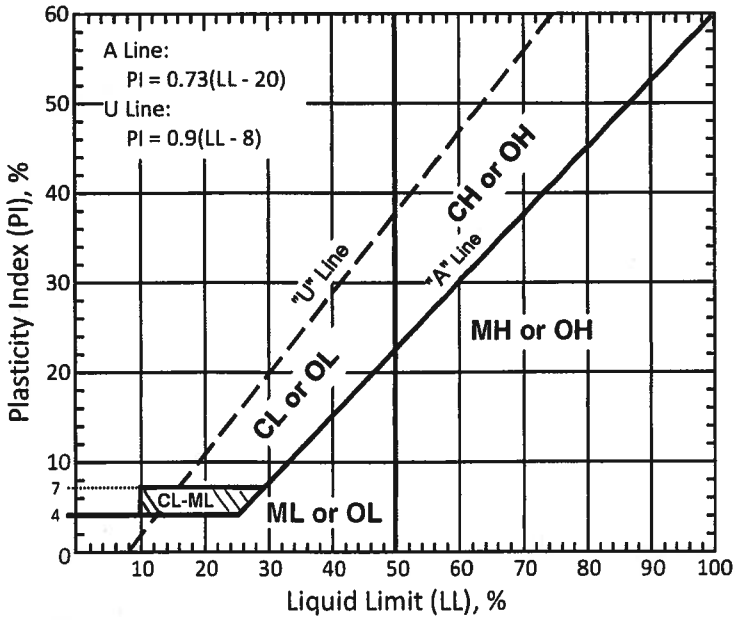
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.

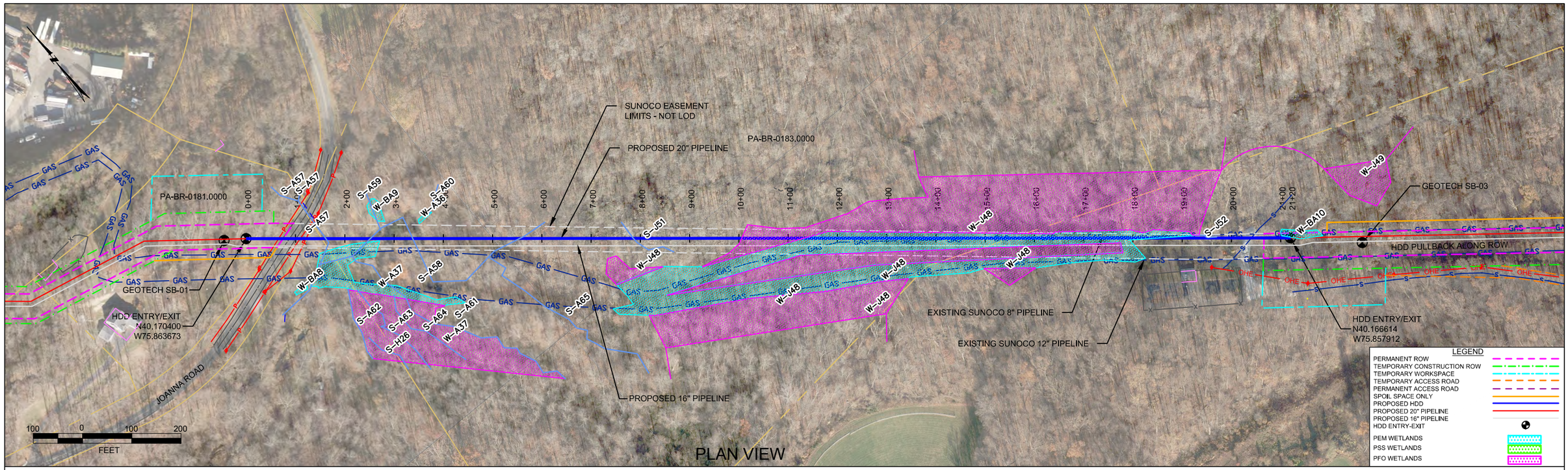


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-BR-0181.0000-RD (S-A57, S-A58, S-A59, S-A61, PFO-J48, PEM-J48, PEM-BA10)

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 180 feet from the western edge of Stream A57 (S-A57) and enter/exit 1,940 feet from the eastern edge. The horizontal directional drill will enter/exit 270 feet from the western edge of Stream A59 (S-A59) and enter/exit 1,900 feet from the eastern edge. The western edge of Stream A58 (S-A58) is 360 feet from the drill's western entrance/exit while the stream's eastern edge is 1,810 feet from the drill's eastern entrance/exit. The drill will enter/exit 570 feet from the western edge of Stream A61 (S-A61) and enter/exit 1600 feet from the eastern edge. The drill will then pass below Stream J51 (S-J51) whose western edge is 800 feet from the drill's entrance/exit and whose eastern edge is 1,360 feet from the drill's eastern entrance exit. The drill will enter/exit 1,020 feet from the western edge of Forested and Grassy Wetland J48 (PFO-J48 and PEM-J48) and enter/exit 220 feet from the eastern edge of the wetland. The eastern entrance/exit of the drill will be through Grassy Wetland BA10 (PEM-BA10). With the exception of PEM-BA10 the drill will pass at least 25 feet below each water feature, and at a maximum will be 75 feet below wetland J48. 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 a diabase rock bed with silty clays layers above. Based on the geotechnical report and the drill profile minimal inadvertent returns are expected.



PLAN VIEW

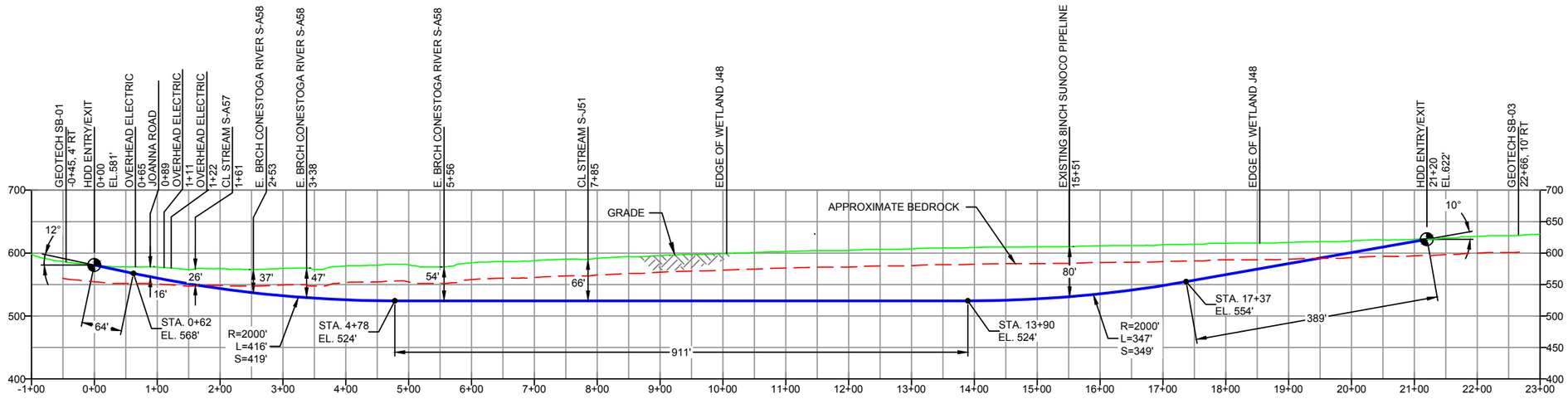
PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - CAERNARVON TOWNSHIP
S3-0250

GEOTECH SB-01
- -NG EL. 586'
- -TOPSOIL (0' - 0.1')
- -SC (0.1' - 6.5')
- -GROUNDWATER (9.0')
- -SC/GC (6.5' - 26.5')
- -SANDSTONE (26.5' - 27.0')
- -COMPLETION DEPTH EL. 559'

GEOTECH SB-03
- -NG EL. 629'
- -TOPSOIL (0' - 0.2')
- -CL (0.2' - 18.5')
- -GROUNDWATER (13.0')
- -FRACTURED DIABASE (18.0' - 26.5')
- -COMPLETION DEPTH EL. 602.5'

NOTE: REFER TO TEST BORING LOG S3-0250 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=):2120'
   HDD PIPE LENGTH (S=):2132'
   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.

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-5.68	TO	ES-5.69	EROSION & SEDIMENT PLAN	
SHEET 40	TO	SHEET 41	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
C	ADDED GEOTECH INFO	MRS	09/28/15	RMB	09/28/15	AAW	09/28/15
B	ISSUED FOR BID	MRS	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	JVA	04/15/15	RMB	04/15/15	AAW	04/15/15

Sunoco Logistics Partners L.P.

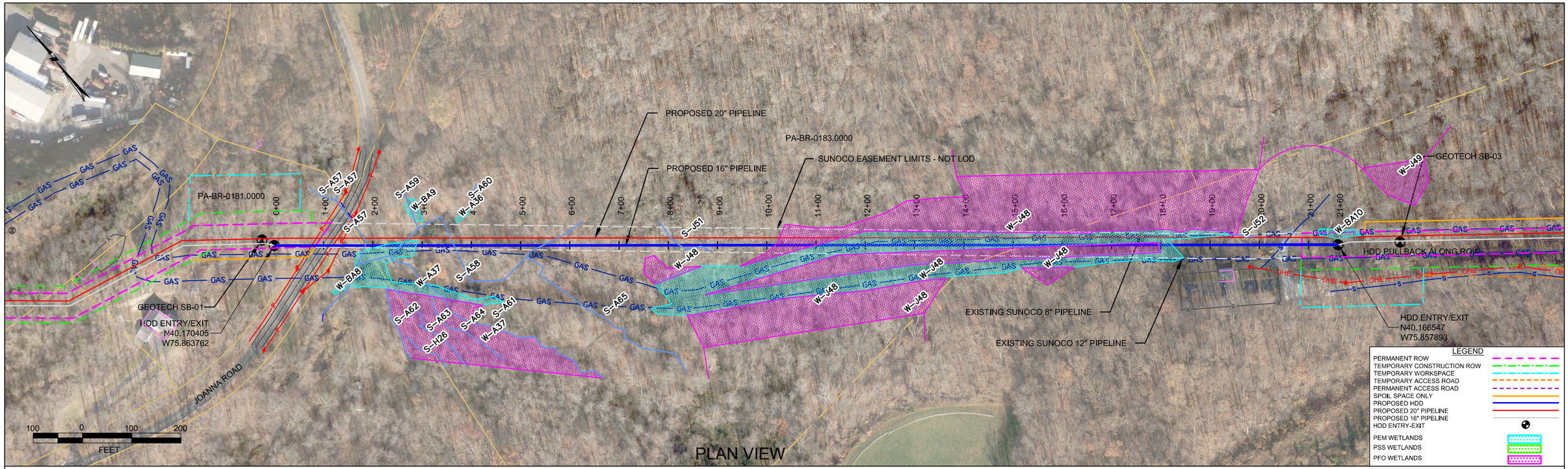
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
JOANNA ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

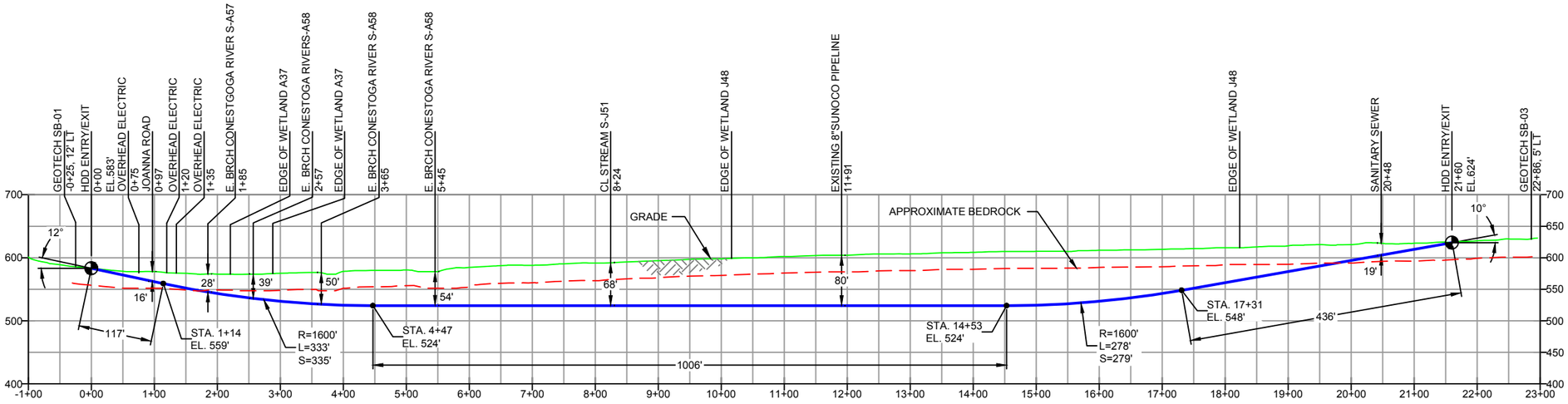
DWG. NO: PA-BR-0181.0000-RD



PLAN VIEW

PROFILE VIEW

BERKS COUNTY, PENNSYLVANIA - CAERNARVON TOWNSHIP
S3-0250-16



GEOTECH SB-01

-NG EL. 586'
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GEOTECH SB-03

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-TOPSOIL (0' - 0.2')
-CL (0.2' - 18.5')
-GROUNDWATER (13.0')
-FRACTURED DIABASE (18.0' - 26.5')
-COMPLETION DEPTH EL. 602.5'

NOTE: REFER TO TEST BORING LOG S3-0250 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2160'
   HDD PIPE LENGTH (S=):2173'
   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).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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SHEET 40	TO	SHEET 41	AERIAL SITE PLAN

DWG NO		DWG NO	DESCRIPTION

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A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

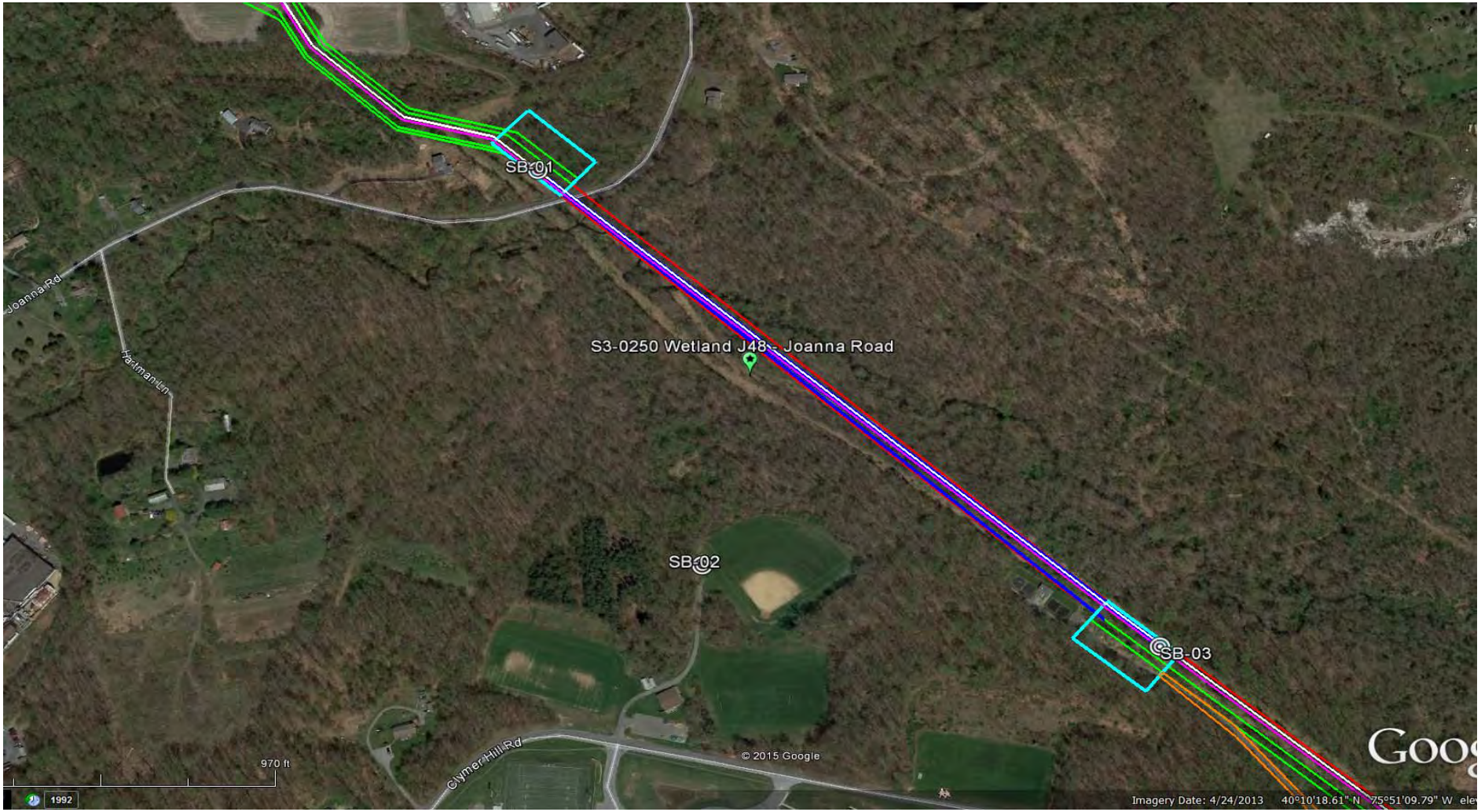
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
JOANNA ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-BR-0181.0000-RD-16



LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0250 WETLAND J48 - JOANNA ROAD
BERKS COUNTY, CAERNARVON 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:	JOANNA ROAD, MORGANTOWN, PA		Page 1 of 1
HDD No.:	S3-0250	Dates(s) Drilled: 03-15-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 9.0	Total Depth (ft): 27.0
Boring Location Coordinates:		40° 10' 13.705" N	75° 51' 49.628" 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		20	SC	REDDISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, TRACE	1	7	9	13	**16**
				6.5			FINE TO COARSE GRAVEL (USCS: SC).					
2	8.0	10.0	6.5		10	SC AND SC/ GC	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILTY CLAY,	2	6	12	10	**18**
							AND FINE TO COARSE SUBANGULAR GRAVEL.					
3	13.0	14.9			19		DARK MAROON FINE TO MEDIUM SAND AND SILTY CLAY, WITH A	6	37	37	50/5"	**74**
							LITTLE FINE TO COARSE GRAVEL.					
4	18.0	18.1			<1		MAROON GRAVEL PIECES.	50/1"				**>50**
5	23.0	23.8			8		DARK MAROON FINE TO COARSE GRAVEL AND FINE TO COARSE	10	50/4"			**>50**
				26.5			GRAVEL, AND SILTY CLAY. (USCS: SC)					
6	26.5	27.0	26.5	27.0	4		GRAY PARTIALLY WEATHERED SANDSTONE.	50/6"				**>50**
							AUGER REFUSAL AT 26.5'.					
							WET ON SPOON AT 8'.					
							WATER LEVEL THROUGH AUGERS AT 10'.					
							CAVED AT 20'. WATER LEVEL ON CAVE AT 9'.					

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:	CLYMER HILL ROAD, ELVERSON, PA		Page 1 of 1
HDD No.:	S3-0250	Dates(s) Drilled: 03-09-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 8.0	Total Depth (ft): 16.0
Boring Location Coordinates:		40° 10' 1.241" N	75° 51' 43.350" 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	0.2			TOPSOIL (2")					
1	3.0	5.0	0.2		19	CL	MOTTLED BROWN SILTY CLAY AND FINE SAND.	2	8	7	7	**15**
				6.5								
2	8.0	10.0	6.5		10	SC	DECOMPOSED ROCK WEATHERED TO A GREENISH GRAY TO BROWN	1	5	14	6	**19**
				14.8			CLAYEY FINE TO MEDIUM SAND.					
3	13.0	15.0	14.8		24	CL	GRAY AND GREENISH GRAY DECOMPOSED ROCK WEATHERED TO A	1	3	8	10	**11**
				16.0			SILTY CLAY AND FINE TO MEDIUM SAND. (USCS: CL).					
4	16.0	16.0	16.0	16.0	<1		REFUSAL MATERIAL APPEARS TO BE GRANITE or BASALT	50/0"				**>50**
							AUGER REFUSAL AT 16'.					
							WET ON SPOON AT 8'.					
							NO WATER LEVEL THROUGH AUGERS.					
							CAVED AT 11', WATER LEVEL ON CAVE AT 8'.					
							STARTED GRINDING AT 15.5'					
							AUGERS WERE TOO HIGH OUT OF GROUND TO BE ABLE TO SET					
							CORE BARREL.					

Notes/Comments:

Pocket Pentrometer Testing
5': 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.

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	CLYMER HILL ROAD, ELVERSON, PA		Page 1 of 1
HDD No.:	S3-0250	Dates(s) Drilled: 05-19-15	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 13.0	Total Depth (ft): 26.5
Boring Location Coordinates:		40° 9' 58.805"" N	75° 51' 27.075"" 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	0.2			TOPSOIL (2")					
1	3.0	5.0	0.2		18		MOTTLED BROWN, ORANGE BROWN, GRAY SILTY CLAY AND	1	4	6	10	**10**
							FINE SAND.					
2	8.0	10.0			12		MOTTLED BROWN, ORANGE BROWN, GRAY SILTY CLAY AND	5	5	5	8	**10**
						CL	FINE SAND.					
3	13.0	15.0			24		ORANGE BROWN SILTY CLAY AND FINE SAND.	1	2	2	2	**4**
							(USCS: CL).					
4	18.0	18.9			10		MOTTLED BROWN, LIGHT BROWN AND WHITE SILTY CLAY AND	1	50/5"			**>50**
				18.5			FINE SAND.					
			18.5	18.9			GRAY TO DARK GRAY PARTIALLY WEATHERED DIABASE.					
							AUGER REFUSAL AT 18.5'. AUGERS WERE TOO SKEWED TO CORE,					
							SO OFF-SET 6' AND AUGERED TO REFUSAL AT 18'. BEGIN CORING.					
							ROCK CORING					
RUN 1	18.0	21.5	18.0	19.2	42		MODERATELY FRACTURED DIABASE.	TCR: 100%, SCR: 93%, RQD: 74%				
			19.2	21.5		ROCK	SLIGHTLY FRACTURED DIABASE.					
RUN 2	21.5	26.5	21.5	22.4	48		INTENSELY FRACTURED DIABASE, SOME OLIVINE DEPOSITS.	TCR: 80%, SCR: 60%, RQD: 55%				
			22.4	25.5			UNFRACTURED DIABASE WITH OLIVINE DEPOSITS					
			25.5	26.5			FRACTURE, RODS DROPPED QUICKLY					
							CORE TESTING RESULTS (RUN 1, DEPTH 21'):					
							COMPRESSIVE STRENGTH: 1,510 PSI					
							UNIT WEIGHT: 187.3 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 S3-0250 WETLAND J48 - JOANNA ROAD

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)
S3-0250	SB-01	1	3.0	5.0	11.8	43.4	33	21	12	SC
		2	8.0	10.0	13.4	16.1	-	-	-	-
		3	13.0	14.9	12.0	37.6	-	-	-	-
		4	18.0	18.1	5.1	6.7	-	-	-	-
		5	23.0	23.8	18.0	42.9	34	21	13	SC
		6	26.5	27.0	10.5	24.5	-	-	-	-
	SB-02	1	3.0	5.0	21.0	57.1	-	-	-	-
		2	8.0	10.0	30.8	37.9	-	-	-	-
		3	13.0	15.0	41.2	54.4	41	21	20	CL
	SB-03	1	3.0	5.0	22.6	63.1	-	-	-	-
		2	8.0	10.0	20.9	59.2	-	-	-	-
		3	13.0	15.0	66.2	55.8	36	20	16	CL
		4	18.0	18.9	53.5	52.3	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-03	1	21.0	1,510	187.3

Notes:

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

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0250 WETLAND J48 - JOANNA ROAD

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					
S3-0250	SB-03	1	18	21.5	100	93	74	18	26.5	Slight	Diabase	Massive	Gray	Fractures ranging from 30° to 70°, Avg. 45°
		2	21.5	26.5	80	60	55							

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0250 WETLAND J48 - JOANNA ROAD

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
S3-0250	Wetland J48 - Joanna Rd.	SB-01	**Stockton Formation** - Light-gray to buff, coarse-grained, arkosic sandstone; includes reddish-brown to grayish-purple sandstone, siltstone, and mudstone.	Gently-moderately sloping lowlands	Stockton Fm	primarily sandstone with siltstone and mudstone		35-53	
		SB-02 and SB-03	**Diabase** - occurs primarily as dikes and sheets and forms a complex igneous network that extensively intrudes sedimentary rocks in the Gettysburg and Newark basins.		Diabase	Ophitic texture, an important variety of basalt texture where pyroxene (or occasionally olivine) forms larger crystals and typically contains numerous crystals of plagioclase		13	

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)

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

Relative Proportions

Description Term	*Percent*
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

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)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
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

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
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).

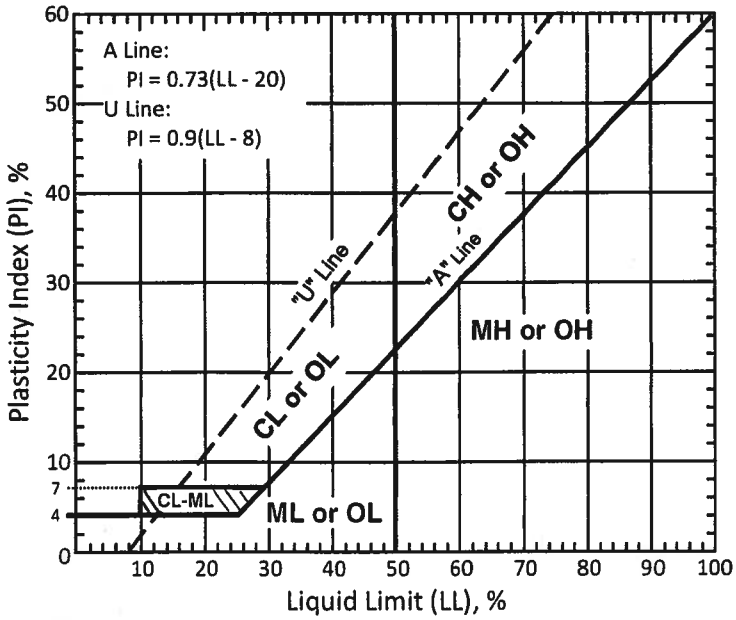
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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	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, gravely 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	

Major Divisions		Group Symbols	Typical Descriptions
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts 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
	Silts 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

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.



(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.