Attachment A
HDD Table
Washington County

Drawing Name	Drill Name	County	Township	Drill Location	Risk Assessment Level (Low / Medium / High)
PA-WA-0072.0000-SR.pdf	Pike Street	Washington	Chartiers	N: 40.237056 W: 80.218499	low
PA-WA-0074.0000-RR.pdf	Pittsburgh & Ohio Central Railway, I-79	Washington	Chartiers & North Strabane	N: 40.235073 W: 80.213066	low
PA-WA-0102.0000-SR.pdf	Cultural Area #2	Washington	North Strabane	N: 40.234366 W: 80.144241	medium
PA-WA-0103.0000-RD.pdf	Linden Creek Road	Washington	North Strabane	N: 40.235362 W: 80.139373	medium
PA-WA-0106.0000-SR.pdf	Cultural Area #3	Washington	North Strabane	N: 40.235652 W: 80.132392	medium
PA-WA-0111.0000-SR.pdf	Cultural Area #4	Washington	North Strabane	N: 40.238062 W: 80.117729	medium
PA-WA-0119.0000-RD.pdf	Linden Road	Washington	North Strabane	N: 40.235514 W: 80.103237	low
PA-WA-0119.0003-RD.pdf	Munntown Road	Washington	North Strabane & Nottingham	N: 40.233359 W: 80.100624	low
PA-WA-0127.0000-RR.pdf	Allegheny Vally RR	Washington	Nottingham	N: 40.235766 W: 80.092434	low
PA-WA-0164.0000-RD.pdf	Mingo Church Road	Washington	Union	N: 40.231411 W: 80.009203	low
PA-WA-0171.0000-RR.pdf	Wheeling and Lake Erie RR	Washington	Union	N: 40.231135 W: 79.998609	low
PA-WA-0172.0000-RD.pdf	Highway 43	Washington	Union	N: 40.229580 W: 79.986851	low
PA-WA-0176.0000-RR.pdf	Norfolk Southern RR & Monongahela River	Washington Allegheny	Union Forward	N: 40.229918 W: 79.975984	low

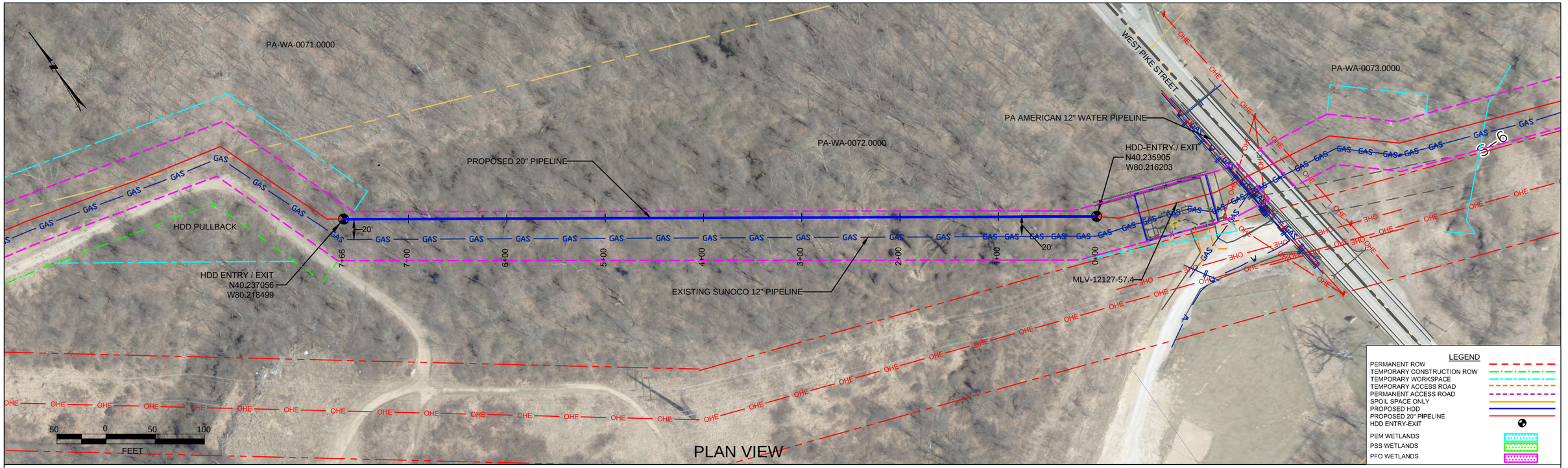
Prepared By:
Tetra Tech Rooney

10/14/2016

HDD PA-WA-0072.0000-SR

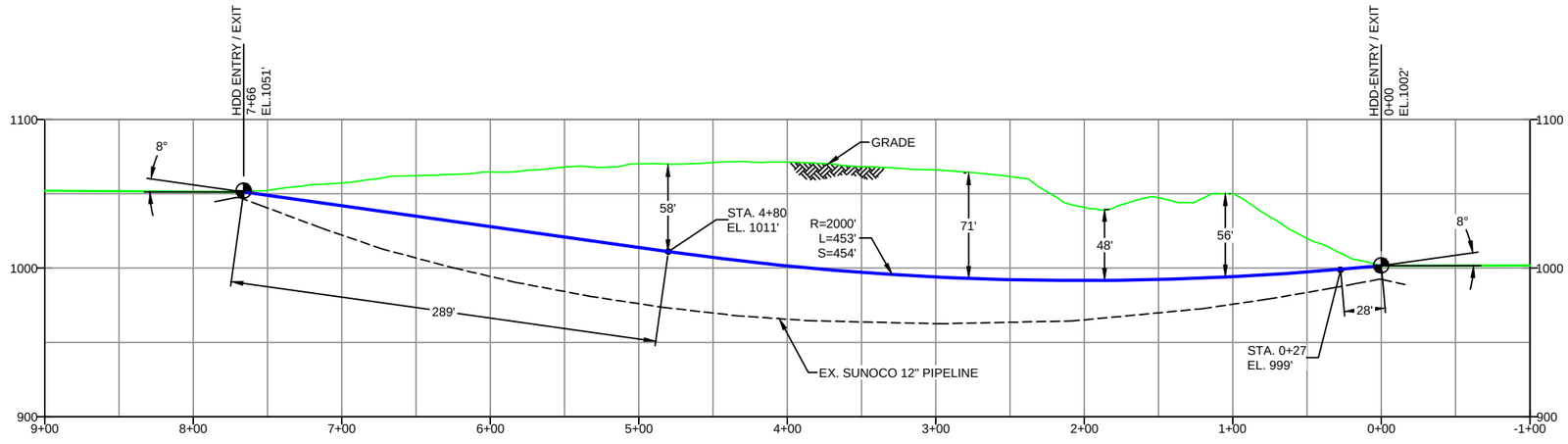
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

This drill will not cross any high risk environmental areas, such as streams or wetlands, or any transportation lines, such as roads or railroads. The 20" drill does parallel the existing ME1 12" pipeline drill. The geotechnical results from November 2014, as well as the previous drill information and 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 substrate the drill will travel through is a silty clay down to 20 feet and potentially rock beyond that. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW



WASHINGTON COUNTY,PENNSYLVANIA, CHARTIERS TOWNSHIP
SIB-0010

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=):766'
   HDD PIPE LENGTH (S=):771'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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-1.13	TO	ES-1.13	EROSION & SEDIMENT PLAN
SHEET 9	TO	SHEET 9	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/05/16	RMB	05/05/16	AAW	05/05/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
PIKE STREET
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

DWG. NO: PA-WA-0072.0000-SR

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location:	WEST PIKE VALVE SITE		Page 1 of 1
Test Boring No.:	SB-01	Dates(s) Drilled: 11/14/14	Inspector: J. COSTELLO
Drilling Contractor:	HYNES	Drilling Method: SPT - ASTM D1586	Driller: JUSTIN
Surface Elevation (ft):		Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 21.0

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
1	0	2.0	0.0		18		VARI-COLORED (BROWN, BLACK, GRAY) SILTY CLAY WITH SOME	5	5	8	**13**
							FINE SAND, TRACE F-GRAVEL. STIFF. (USCS: CL).				
2	3.0	4.5			16		DARK BROWN SILTY CLAY AND FINE SAND WITH THIN APPARENT	5	10	13	**23**
							COAL SEAMS, TRACE F-GRAVEL. VERY STIFF.				
3	6.0	7.5			18		DARK BROWN TO REDDISH BROWN (WITH MOTTLES OF GRAY)	5	7	12	**19**
						CL	SILTY CLAY AND FINE SAND, TRACE F-GRAVEL. VERY STIFF.				
4	9.0	10.5			14		DARK BROWN TO REDDISH BORWN (WITH MOTTLES OF GRAY)	5	6	9	**15**
							SILTY CLAY, A LITTLE F- SAND, TRACE F-GRAVEL. USCS: CL.				
							STIFF TO VERY STIFF.				
5	14.0	15.5			16		YELLOWISH TO GREENISH BROWN SILTY CLAY AND FINE SAND,	5	6	10	**16**
				19.5			TRACE FINE SILTSTONE GRAVEL. VERY STIFF.				
6	19.0	20.5	19.5	21.0	14		PARTIALLY WEATHERED LIGHT GRAY SHALE OR SILTSTONE.	10	25	29	**54**
							AUGER REFUSAL AT 21'.				
							CAVED AND DRY AT 13'.				
							BORING LOCATION IS LOCATED APPROXIMATELY 10' BELOW				
							PREVIOUS NATURAL GRADE (ROUGH, VISUAL ONLY).				

Notes/Comments:

Pocket Pentrometer Testing
S1: 2.0 TSF
S3: 3.0 TSF
S4: 3.0 TSF

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 MARINER EAST			Project No.: 103IP2762
Project Location:	WEST PIKE VALVE SITE		Page 1 of 1
Test Boring No.:	SB-02	Dates(s) Drilled: 11/14/14	Inspector: J. COSTELLO
Drilling Contractor:	HYNES	Drilling Method: SPT - ASTM D1586	Driller: JUSTIN
Surface Elevation (ft):		Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 20.0

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
1	0	2.0	0.0		18	CL	VARI-COLORED (BROWN, BLACK, GRAY) SILTY CLAY WITH SOME	3	5	7	**12**
							FINE SAND, TRACE F-GRAVEL (USCS: CL). STIFF.				
2	3.0	4.5			16		LIGHT GRAY TO BROWN SILTY CLAY, WITH A TRACE OF FINE	3	7	10	**17**
				5.5			SAND, TRACE F-GRAVEL (USCS: CL). VERY STIFF.				
3	6.0	7.5	5.5		14	SC/CL	YELLOWISH BROWN FINE SAND AND SILTY CLAY WITH A LITTLE	4	9	15	**24**
				10.0			SILTSTONE F-GRAVEL. MEDIUM DENSE.				
4	9.0	10.5	10.0		16	CL	GRAY TO YELLOWISH BROWN SILTY CLAY AND FINE SAND WITH	6	19	22	**41**
							SOME FINE TO COARSE SHALE GRAVEL. HARD.				
5	14.0	15.5			16		REDDISH BROWN SILTY CLAY WITH A LITTLE FINE SAND AND	15	24	26	**50**
				17.0			GRAVEL (USCS: CL). HARD.				
6	19.0	19.4	17.0	20.0	4		PARTIALLY WEATHERED REDDISH BROWN SHALE.	50/5"			
							AUGER REFUSAL AT 20'.				
							CAVED AND DRY AT 9'.				

Notes/Comments:

Pocket Pentrometer Testing

S1: 2.75 TSF
S2: 3 TSF
S5: >4 TSF

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.

LABORATORY TESTING SUMMARY
SUNOCO MARINER EAST
VARIOUS VALVE SITES

Valve Site/ Soil Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
		From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
WEST PIKE/SB-01	1	0.0	2.0	18.2	72.7	40	23	17	CL
	2	3.0	4.5	14.5	59.4	-	-	-	-
	3	6.0	7.5	17.0	60.8	-	-	-	-
	4	9.0	10.5	23.3	83.5	37	23	14	CL
	5	14.0	15.5	18.3	62.3	-	-	-	-
	6	19.0	20.5	12.4	51.3	-	-	-	-
WEST PIKE/SB-02	1	0.0	2.0	19.8	70.0	-	-	-	-
	2	3.0	4.5	16.8	97.9	38	23	15	CL
	3	6.0	7.5	10.1	49.0	-	-	-	-
	4	9.0	10.5	8.5	61.5	-	-	-	-
	5	14.0	15.5	8.3	89.9	39	22	17	CL
	6	19.0	19.4	9.6	85.4	-	-	-	-

Notes:

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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).

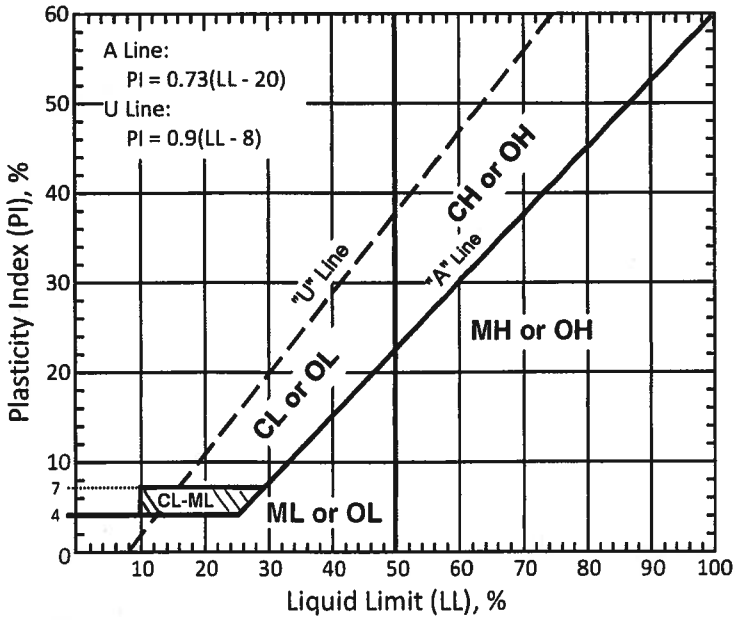
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

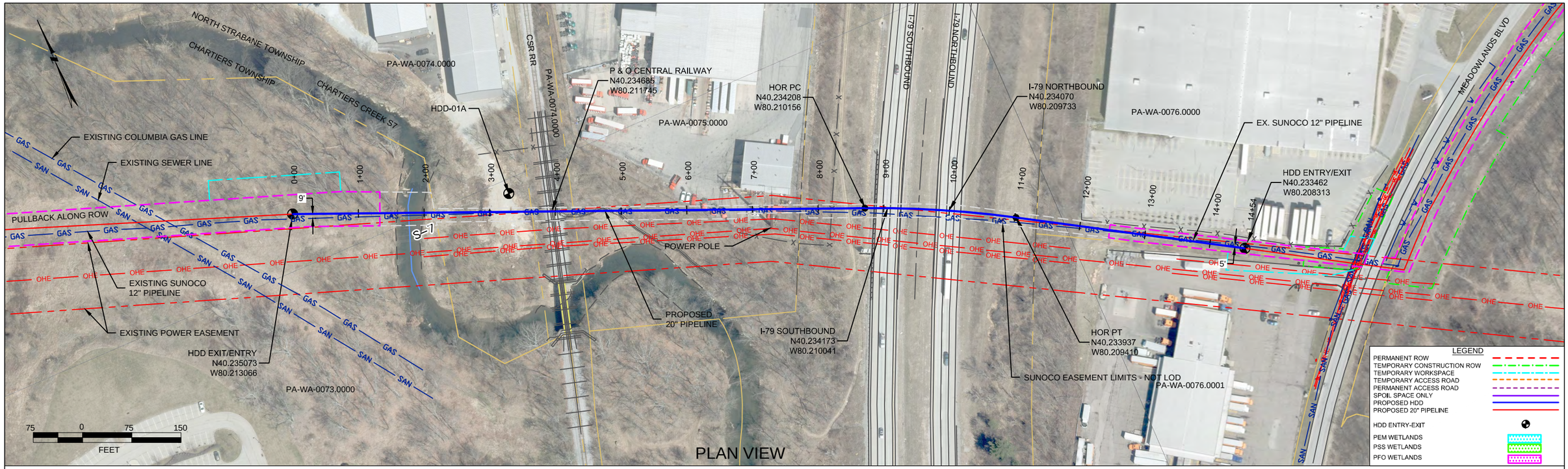


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0074.0000-RR (S7)

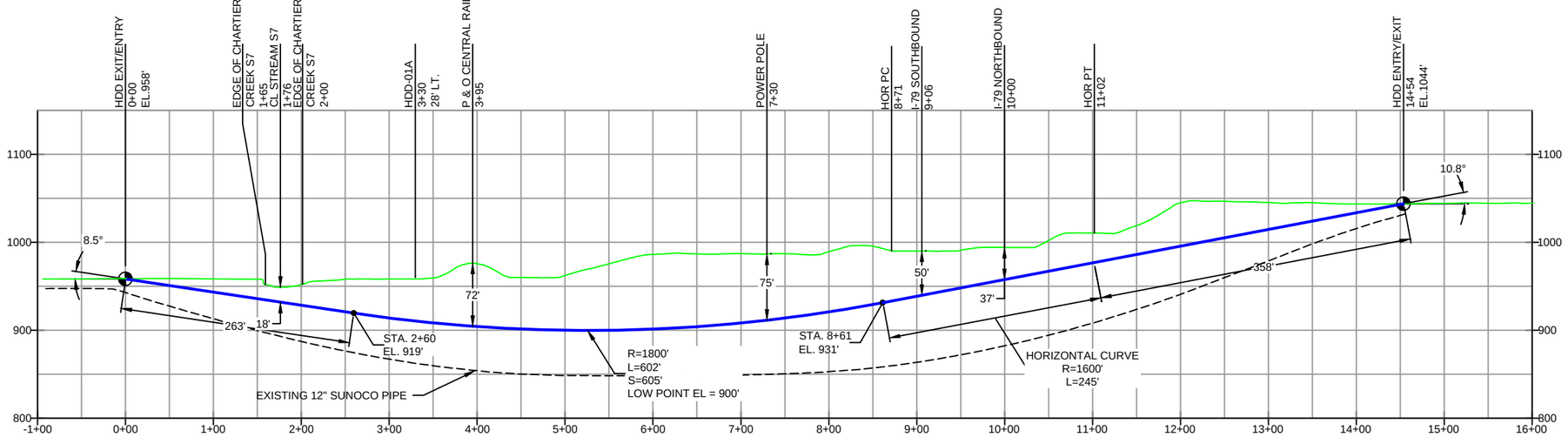
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 150 feet from the edge of the western most boundary of Chartiers Creek (S7) and enter/exit 1,200 feet from the eastern most boundary after crossing under Interstate 79. The drill will pass 15 feet under the western most boundary of the creek and 25 feet under the eastern most boundary. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate that will be passed through below 12 feet is estimated to be rock. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW



WASHINGTON COUNTY, PENNSYLVANIA - CHARTIERS/NORTH STRABANE TOWNSHIPS
S1B-0020

GEOTECH HDD-01A

-NG EL. 960'
-SILTY CLAY/SAND (0.0' - 10.0')
-COMPLETION DEPTH EL. 950'

NOTE: REFER TO TEST BORING LOG HDD-01A 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=): 1454'
   HDD PIPE LENGTH (S=): 1471'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
12. BLASTING NOT PERMITTED.
13. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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-1.14	TO	ES-1.15	EROSION & SEDIMENT PLAN
SHEET 8	TO	SHEET 9	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
PITTSBURGH & OHIO CENTRAL RAILWAY, I-79
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

DWG. NO: PA-WA-0074.0000-RR

Source: Topo data from USGS DLG, Roads from DelDOT

S:\03-Projects\Intercounty\T1 - Rooney (RE)\GIS\Boring Map HDD-01A_01A2_01B.mxd

Figure
Boring Locations HDD-01A/01A2/01B
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
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TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: WASHINGTON COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-01A | Dates(s) Drilled: 06/10/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: T. REDMAN

Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): VARIOUS, SEE BELOW.

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
1	3.5	5.0			6		GRAY AND BROWN FINE TO MEDIUM SAND WITH SOME SILTY	5	4	4	8
							CLAY, TRACE FINE GRAVEL, TRACES OF WOOD (FILL)				
2	8.5	8.2			<1"		NO RECOVERY, GRAVEL IN SPOON TIP.	50/2"			
							AUGER REFUSAL AT 9.0'. OFFSET BORING 8' TO THE NORTH.				
3	12.0	12.1			0		CONTINUOUS DRILLING, AUGER REFUSAL AT 12'. NO RECOVERY.	50/1"			
							OFFSET BORING 13' TO THE WEST.				
4	13.5	15.0			8		CONTINUOUS DRILLING, AUGER REFUSAL AT 13.5'. GRAY	14	14	7	21
							GRAVEL AND SAND WITH SOME SILT AND CLAY (FILL). OFFSET				
							BORING 53' TO THE NORTH.				
							CONTINUOUS DRILLING, AUGER REFUSAL AT 10'.				
							ABOVE BORINGS PERFORMED IN MOUNDED HISTORIC FILL				
							FILL AREA; INDICATED BY STEEP SIDE SLOPES CONTAINING				
							MISCELLANEOUS SOIL FILL, CONCRETE RUBBLE, AND MISC.				
							DEBRIS.				
							WILL PERFORM AN ADDITIONAL BORING TO THE NORTH, AT				
							LOCATION BEYOND HISTORIC FILL AREA.				

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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TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA | Page 1 of 1
Test Boring No.: HDD-01A2 | Dates(s) Drilled: 06/14/13 | Inspector: E. WATT
Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: T. REDMAN
Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): VARIOUS, SEE BELOW.

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	3.5		CL	BROWN SILTY CLAY (AUGER CUTTINGS)		
							AUGER REFUSAL AT 3.5'.		
							OFFSET4' TO THE SOUTH. AUGER REFUSAL AT 4.0'.		
							OFFSET 7' FURTHER SOUTH. AUGER REFUSAL AT 5'.		
							AUGER REFUSAL SUSPECTED TO BE DUE TO ENCOUNTERING BEDROCK.		

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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TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA			Page 1 of 1
Test Boring No.: HDD-01B	Dates(s) Drilled: 09/10/13	Inspector: E. WATT	
Drilling Contractor: CONNELLY	Drilling Method: SPT - ASTM D1586	Driller: K. KERSH	
Surface Elevation (ft):	Groundwater Depth (ft):	Total Depth (ft): 57.0	

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
1	3.5	5.0	0.0		18	SUSPECTED FILL (SM)	BROWN FINE TO MEDIUM SAND, SILT, AND GRAVEL.	7	13	20	33
							SUSPECTED HISTORICAL FILL)				
2	8.5	10.0			17		SIMILAR TO ABOVE.	8	11	16	27
3	12.0	12.0		12.0	0		NO RECOVERY	50/0"			
							AUGER REFUSAL AT 12'. MADE SEVERAL FAILED ATTEMPTS TO				
							PENETRATE DEEPER THAN 12'.				
							ROCK CORING				
RUN 1	12.0	17.0	12.0			SUSPECTED FILL??	**78% RECOVERY, 56% RQD.** SUSPECTED HISTORICAL FILL:				
							GRAY SANDSTONE, MICA, BROWN SILT, GRAVEL.				
RUN 2	17.0	22.0					**40% RECOVERY, 0% RQD.** SUSPECTED HISTORICAL FILL:				
							SANDSTONE, BROWN AND GRAY SILT, GRAVEL/ROCK.				
RUN 3	22.0	27.0					**33% RECOVERY, 0% RQD.** SUSPECTED HISTORICAL FILL:				
							SOIL, GRAVEL, ROCK.				
RUN 4	27.0	32.0					**60% RECOVERY, 0% RQD.** SUSPECTED HISTORICAL FILL:				
				32.0			SANDSTONE GRAVEL WITH MICA.				
RUN 5	32.0	37.0	32.0			VIRGIN SOILS??	**50% RECOVERY, 0% RQD.** SUSPECTED HISTORICAL FILL:				
							BROWN AND GRAY SILT, SAND, GRAVEL, ROCK.				
RUN 6	37.0	42.0					**22% RECOVERY, 0% RQD.** SUSPECTED HISTORICAL FILL:				
				43.0			BROWN AND GRAY SILT, SAND, GRAVEL, ROCK.				
RUN 7	42.0	47.0	43.0			ROCK	**78% RECOVERY, 43% RQD.** GRAY TO DARK GRAY				
							SILTSTONE.				
RUN 8	47.0	52.0					**100% RECOVERY, 34% RQD.** GRAY TO DARK GRAY SILTSTONE.				
RUN 9	52.0	57.0		57.0			**87% RECOVERY, 45% RQD.** GRAY TO DARK GRAY SILTSTONE.				

Notes/Comments:

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.

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).

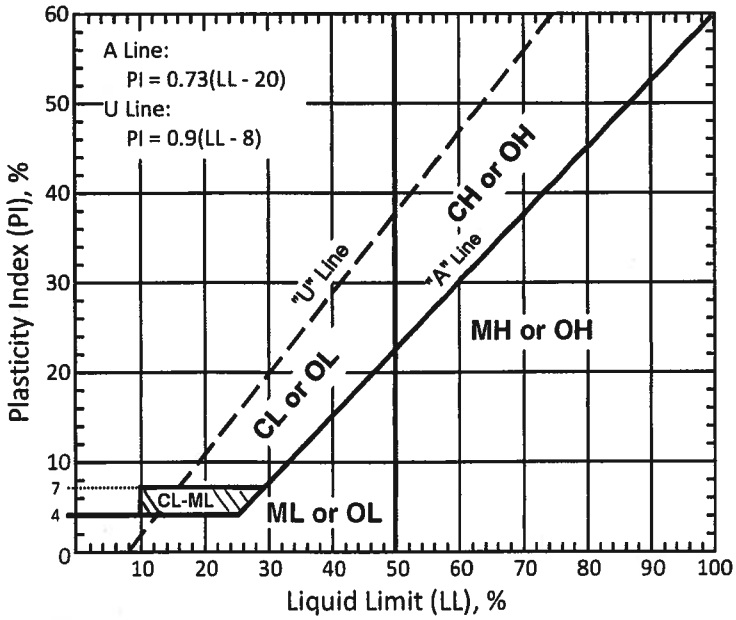
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.



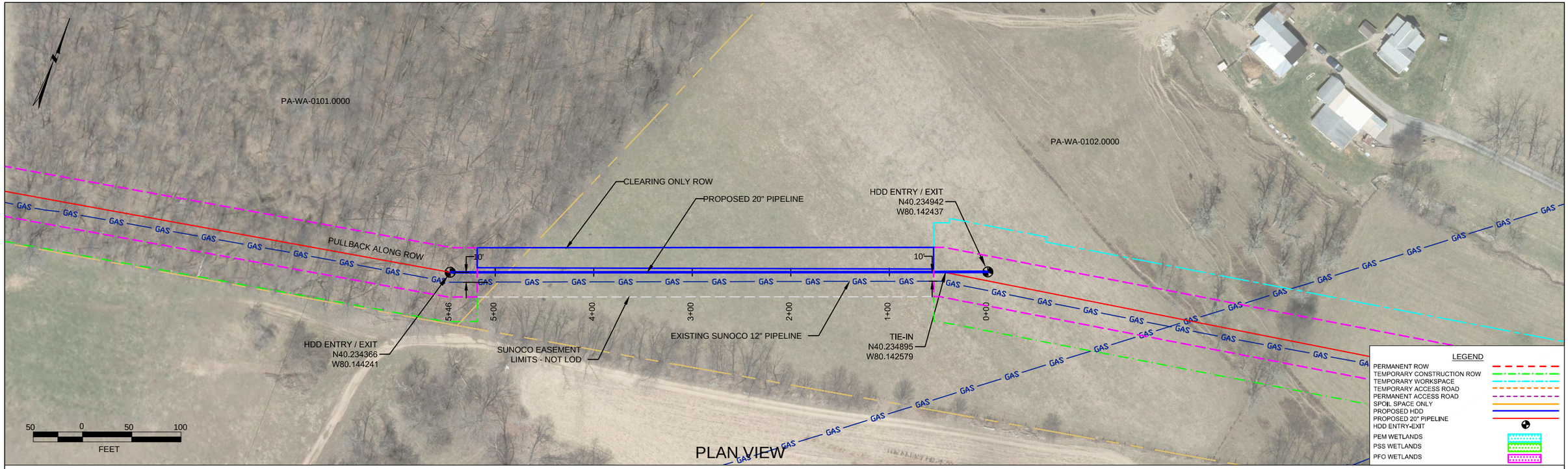
(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0102.0000-SR

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 medium. 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.

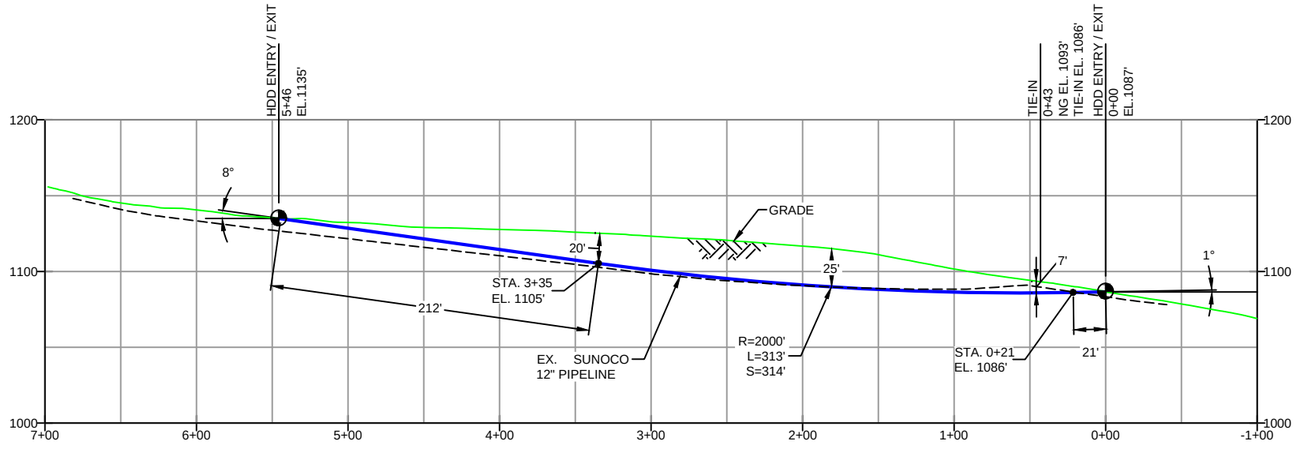
The horizontal directional drill is designed to prevent open cutting on a hillside. There are no crossings of roads, water bodies, or wetlands, nor are any of these features close to the drill location. The drill parallels the existing ME1 12" pipeline drill. No geotechnical boring was completed at this location.

There is no current geotechnical data on which to determine soil types and potential loss of drilling fluid causing the risk to be higher than locations with good drilling soils. However, there are also no major environmental areas of impact (wetlands, waterways, etc.) so the environmental risk for inadvertent returns is medium.



PLAN VIEW

PROFILE VIEW



WASHINGTON COUNTY, PENNSYLVANIA, NORTH STRABANE TOWNSHIP
S1B-0040

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=):546'
   HDD PIPE LENGTH (S=):547'
   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-1.28	TO	ES-1.28	EROSION & SEDIMENT PLAN	
SHEET 17	TO	SHEET 17	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/06/16	RMB	05/06/16	AAW	05/06/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
CULTURAL AREA #2
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

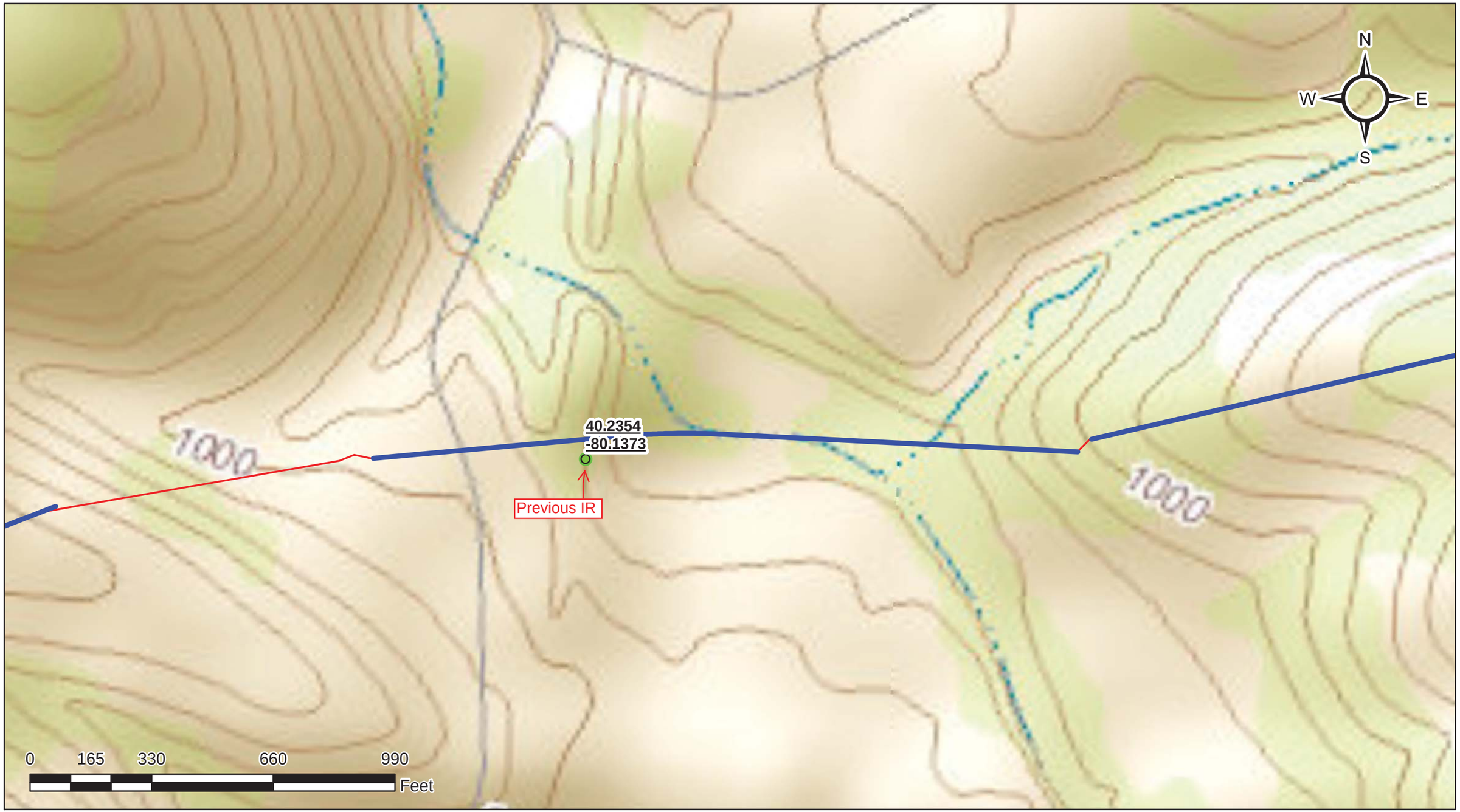
DWG. NO: PA-WA-0102.0000-SR

HDD PA-WA-0103.0000-RD (S16, S250)

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 medium. 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 890 feet from the western edge of Linden Creek (S16) and enter/exit 607 feet from the eastern edge. The horizontal directional drill will enter/exit 1,530 feet from the western edge of Stream 250 (S250) and enter/exit 380 feet from the eastern edge. From Linden Road the drill will enter/exit 226 feet from the western edge and enter/exit 1,660 feet from the eastern edge. The drill will cross 56 feet below Linden Creek Road, 41 feet below Linden Creek, and 25 feet below S250. The 20" drill will closely follow the existing ME1 12" pipeline drill, which had an inadvertent return.

A geotechnical boring was not completed for this drill location for either the ME1 project or the current ME2 project. The lack of a geotechnical report, and a waterway require an increase in the risk assessment for potential environmental impacts of inadvertent returns. The depth of crossing at the road and the creek are such that the potential for inadvertent returns, and their impacts, is mitigated to an extent. A previous drill in this location resulted in 700 gallons of inadvertent returns to the surface. Sandbags and a containment box were built to prevent the spread of the returns and no aquatic resources were impacted. The environmental risk for inadvertent returns associated with this drill is a medium. As such it is recommended that additional inspection in the area surrounding the drill be in place to monitor for potential inadvertent returns. 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.



Legend

- HDD Path
- Proposed Centerline

DRAWN	CHECKED	APPROVED	DATE	REV NO.	DESCRIPTION
AW	RB	RB	11/21/16	A	ISSUED FOR REVIEW

PREPARED BY: TETRA (303) 79

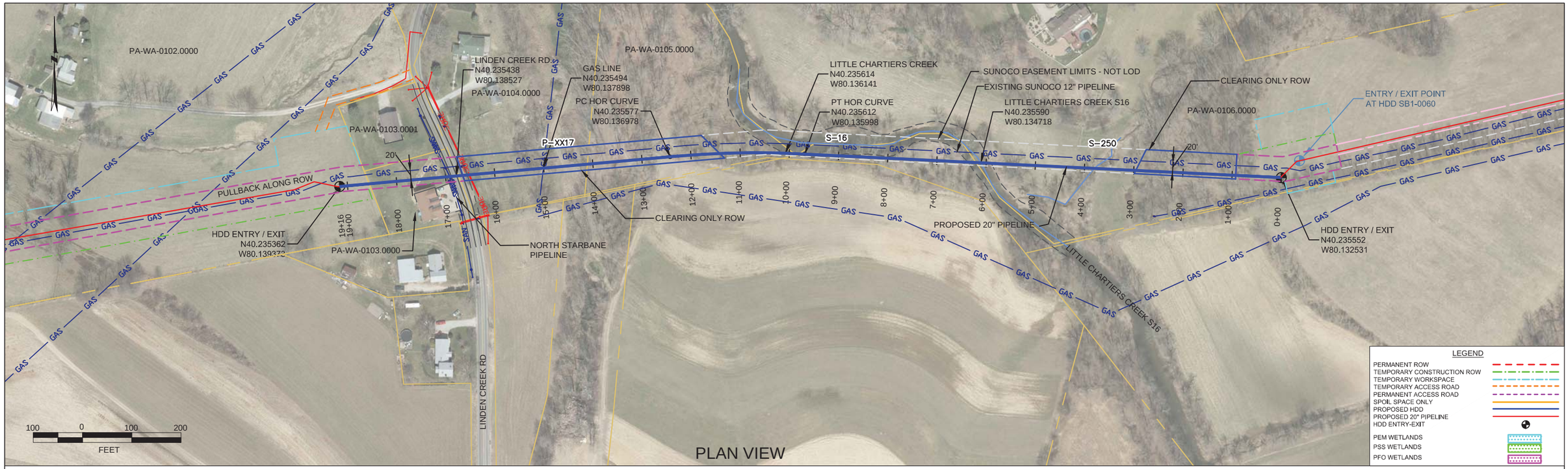
Sunoco Pipeline L.P.

PENNSYLVANIA PIPELINE PROJECT

INADVERTENT RETURN ASSESSMENTS

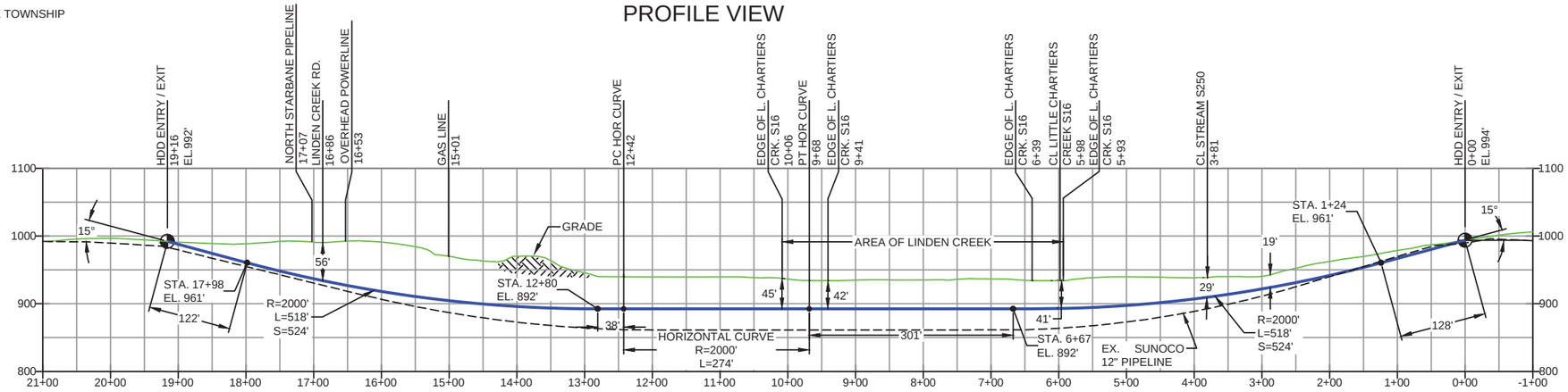
DRAWN:	AW	CHECKED:	RB
DATE:	11/21/16	SCALE:	AS SHOWN

PA-WA-0103-RD-HDD



PLAN VIEW

PROFILE VIEW



WASHINGTON COUNTY, PENNSYLVANIA, STRABANE TOWNSHIP
S1B-0050

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=):1916'
   HDD PIPE LENGTH (S=):1911'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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

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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

DWG NO		DWG NO	DESCRIPTION
ES-1.20	TO	ES-1.30	EROSION & SEDIMENT PLAN
SHEET 17	TO	SHEET 17	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/23/16	RMB	05/23/16	AAW	05/23/16
EP		DLM	03/23/16	RMB	03/23/16	AAW	03/23/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
LINDEN CREEK ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

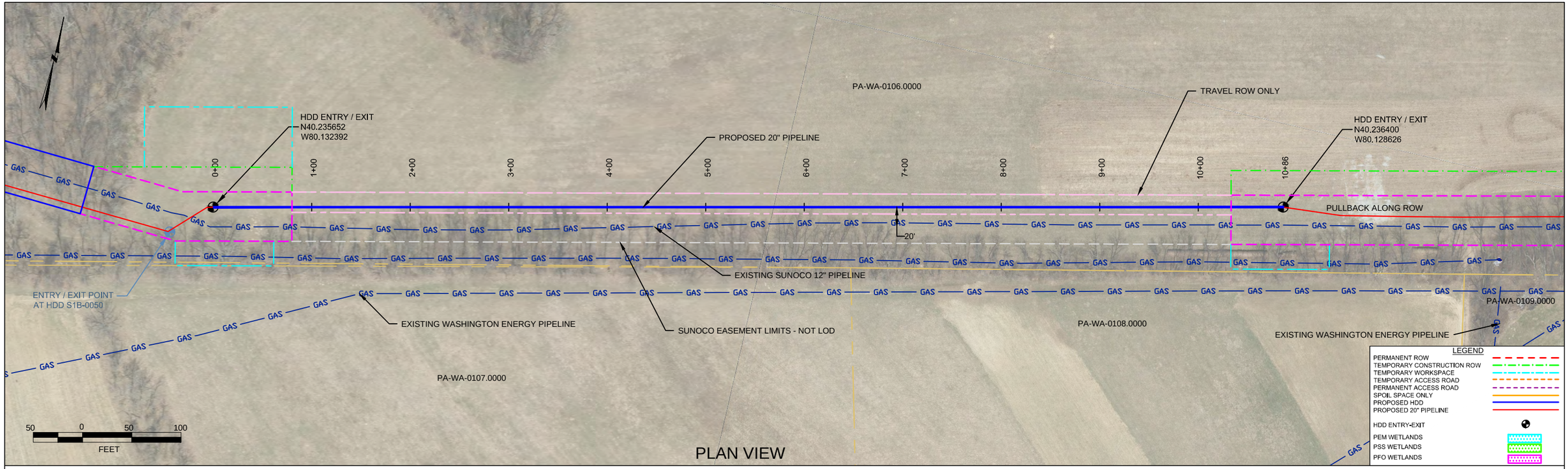
DWG. NO: PA-WA-0103.0000-RD

HDD PA-WA-0106.0000-SR

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 medium. 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 horizontal directional drill is designed to prevent open cutting on a hillside. There are no crossings of roads, water bodies, or wetlands, nor are any of these features close to the drill location. The drill parallels the existing ME1 12" pipeline drill. No geotechnical boring was completed at this location.

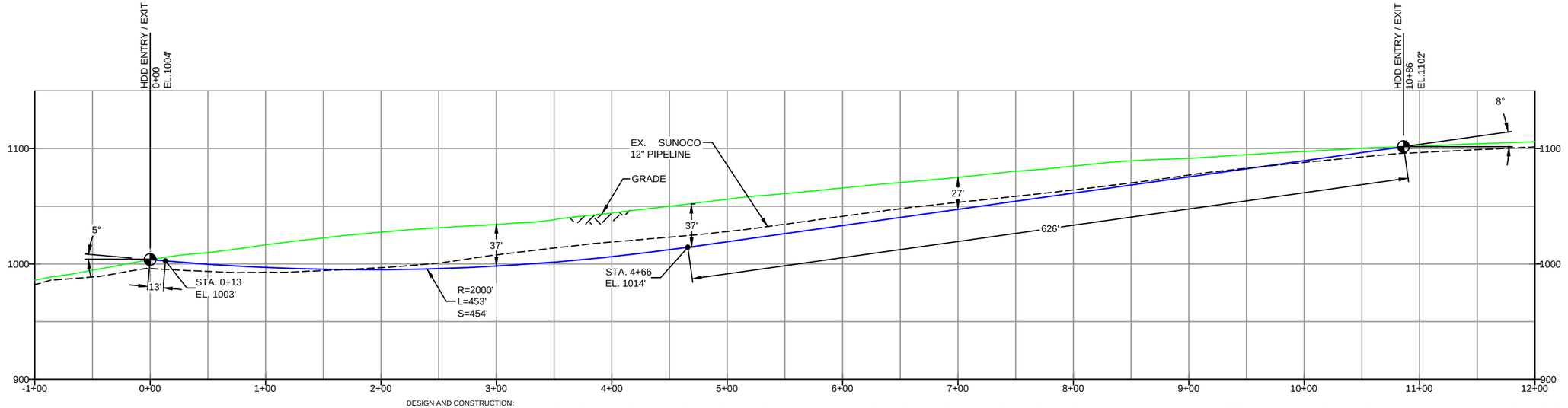
There is no current geotechnical data on which to determine soil types and potential loss of drilling fluid causing the risk to be higher than locations with good drilling soils. However, there are also no major environmental areas of impact (wetlands, waterways, etc.) so the environmental risk for inadvertent returns is medium. As such it is recommended that additional inspection in the area surrounding the drill be in place to monitor for potential inadvertent returns.



PLAN VIEW

PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - NORTH STRABANE TOWNSHIP
S1B-0060



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=):1086'
   HDD PIPE LENGTH (S=):1093'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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-1.30	TO	ES-1.31	EROSION & SEDIMENT PLAN	
SHEET 19	TO	SHEET 19	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
CULTURAL AREA #3
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

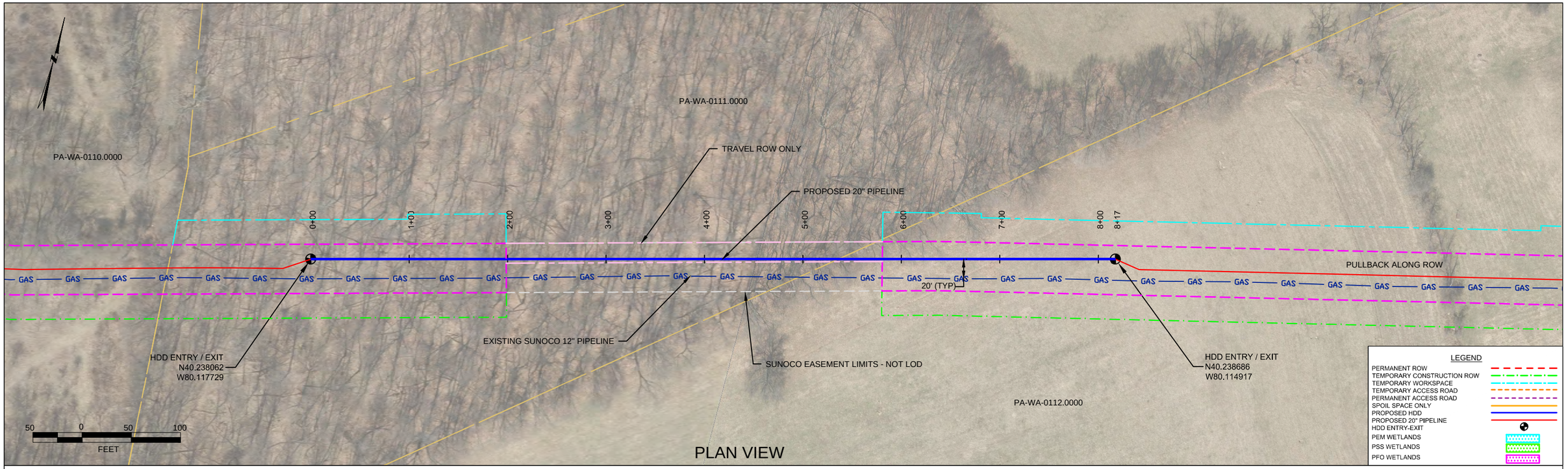
DWG. NO: PA-WA-0106.0000-SR

HDD PA-WA-0111.0000-SR

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 medium. 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 horizontal directional drill is designed to prevent open cutting a hillside. There are no crossings of roads, water bodies, or wetlands, nor are any of these features close to the drill location. The drill parallels the existing ME1 12" pipeline drill. No geotechnical boring was completed at this location.

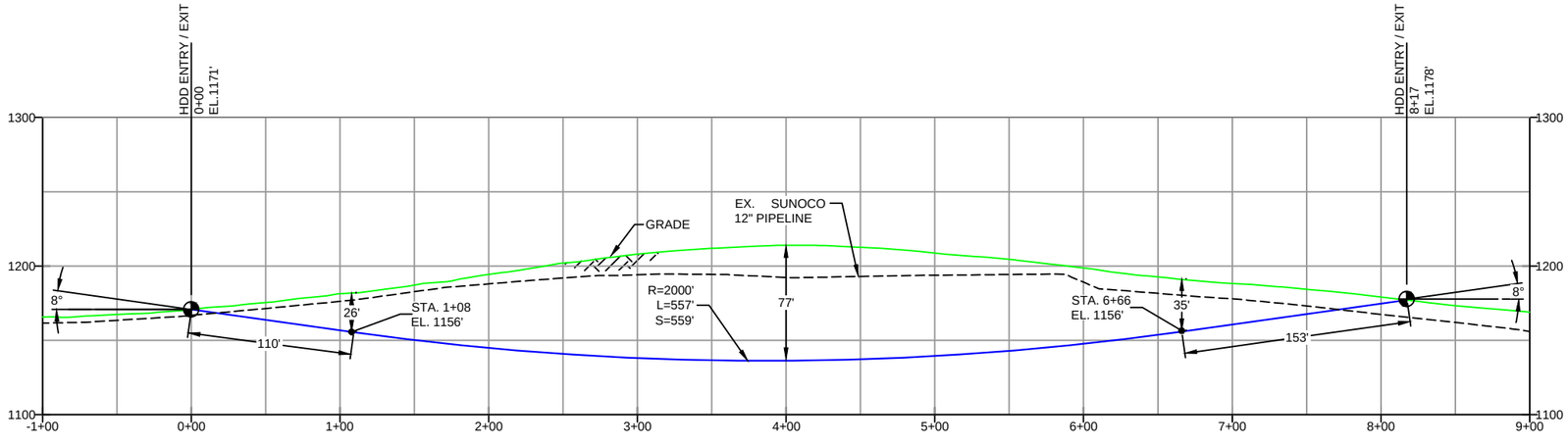
There is no current geotechnical data on which to determine soil types and potential loss of drilling fluid causing the risk to be higher than locations with good drilling soils. However, there are also no major environmental areas of impact (wetlands, waterways, etc.) so the environmental risk for inadvertent returns is medium. As such it is recommended that additional inspection in the area surrounding the drill be in place to monitor for potential inadvertent returns.



PLAN VIEW

PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - NORTH STRABANE TOWNSHIP
S1B-0070



DESIGN AND CONSTRUCTION:

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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=):818'
   HDD PIPE LENGTH (S=):822'
   20" x 0.456" 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

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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-1.33	TO	ES-1.33	EROSION & SEDIMENT PLAN
SHEET 20	TO	SHEET 20	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
CULTURAL AREA #4
PENNSYLVANIA PIPELINE PROJECT

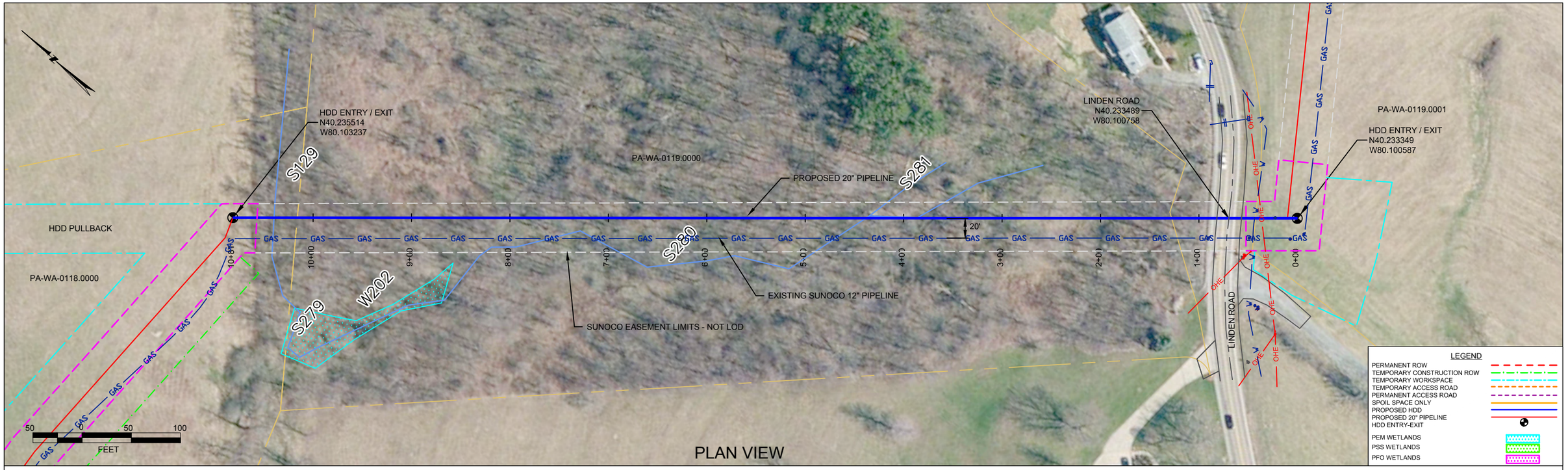
SCALE: 1"=100'

DWG. NO: PA-WA-0111.0000-SR

HDD PA-WA-0119.0000-RD (S129, S279, S280, S281, W202)

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.

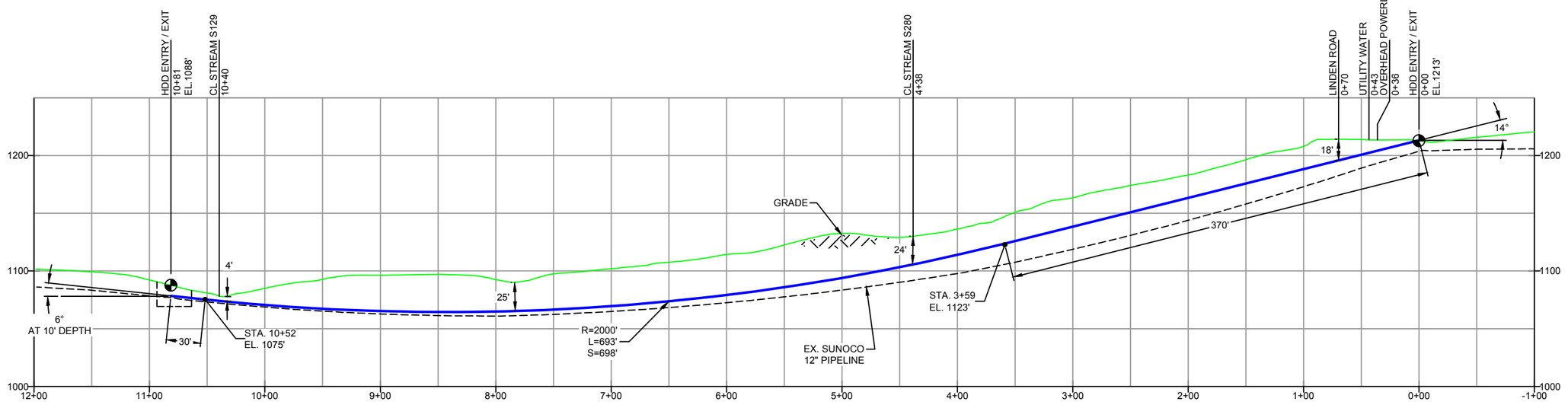
The drill will enter/exit 30 feet from the western edge of a Stream 129 (S129) and enter/exit 1000 feet from the eastern edge. The horizontal directional drill will enter/exit 650 feet from the western edge of streams 280 and 281 (S280, S281) and enter/exit 430 feet from the eastern edge. The drill will cross below S129 at 4 feet and S280/S281 at 25 feet. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate at both crossings (S129 and S280/S281) is estimated to be rock. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - NORTH STRABANE TOWNSHIP
S1B-0080



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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1081'
   HDD PIPE LENGTH (S=):1098'
   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.
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-1.35	TO	ES-1.36	EROSION & SEDIMENT PLAN
SHEET 22	TO	SHEET 22	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

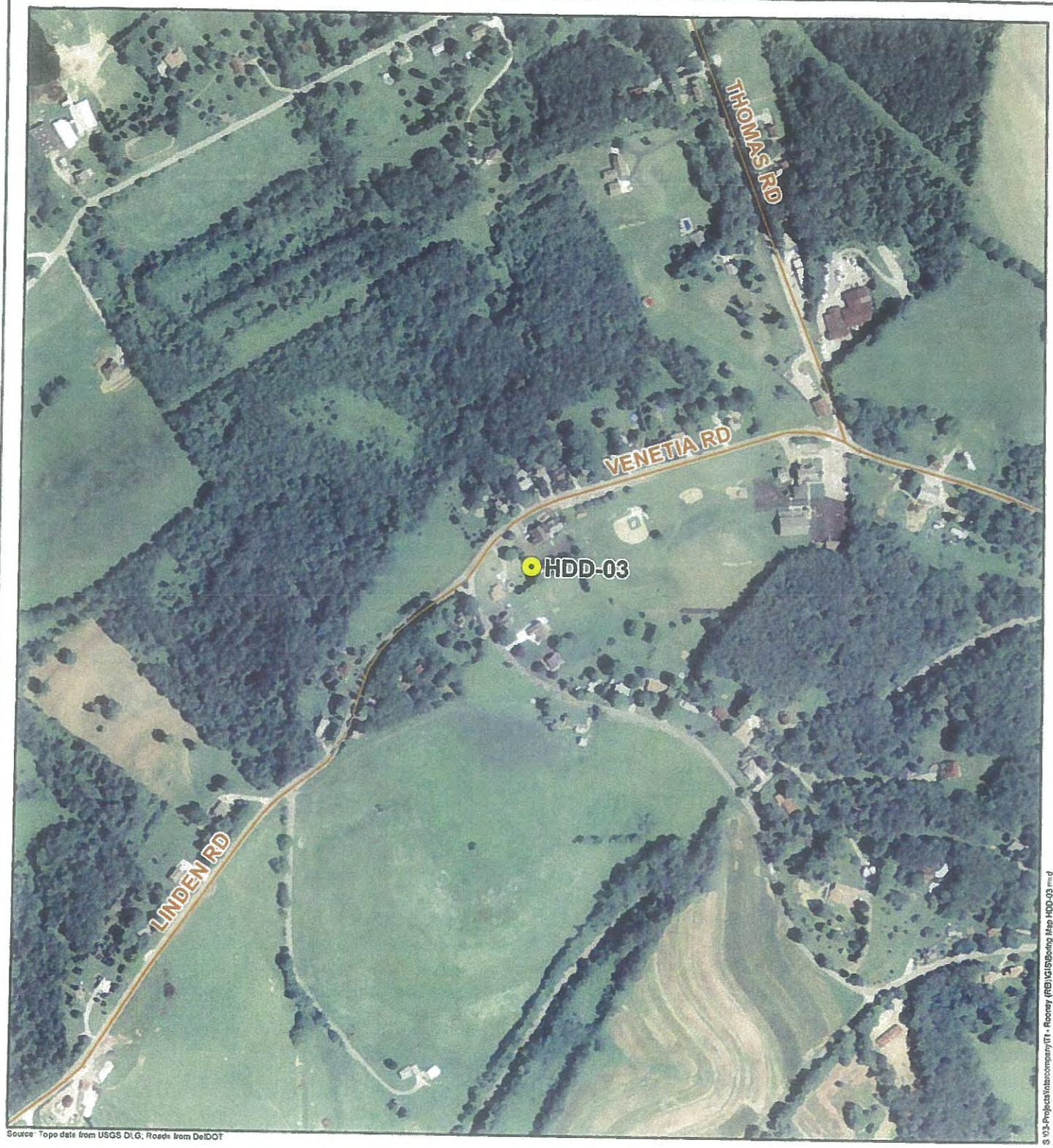
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
LINDEN ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100' | DWG. NO: PA-WA-0119.0000-RD



Source: Topo data from USGS DLG, Roads from DelDOT

S:\03-Projects\Interoil\company\TT - Rooney (RB)\GIS\Boring Map HDD-03.mxd

Figure
Boring Location HDD-03
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA			Page 1 of 1
Test Boring No.: HDD-03	Dates(s) Drilled: 06/12/13	Inspector: E. WATT	
Drilling Contractor: CONNELLY	Drilling Method: SPT - ASTM D1586	Driller: T. REDMAN	
Surface Elevation (ft):	Groundwater Depth (ft): Not Encountered	Total Depth (ft): 23.2	

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
1	3.5	5.0	0.0		15	CL	MOTTLED BROWN AND GRAY SILTY CLAY WITH A LITTLE FINE	4	5	8	**13**
				7.5			SAND, TRACE MICA. USCS: CL				
2	8.5	10.0	7.5		12	ML	BLACK CLAYEY SILT, TRACE FINE SAND. HAS APPEARANCE OF	9	10	11	**21**
				11.0			COAL?				
3	13.5	15.0	11.0		18	ML/ SM	BROWN TO GRAY SILT AND FINE SAND (WEATHERED	20	25	15	**40**
							SANDSTONE/SHALE)				
4	18.5	19.4			11		BROWN TO GRAY FINE SAND AND SILT (WEATHERED SANDSTONE/	30	50/5"		**>50**
				19.0			SHALE). ROCK FRAGMENTS IN SPOON TIP.				
5	23.0	23.3	19.0	23.3			PARTIALLY WEATHERED LIGHT GRAY SILTSTONE.	50/3"			
							AUGER REFUSAL ENCOUNTERED AT 23.0'.				
							OFF-SITE BORING AND CONTINUOUSLY DRILLED TO AUGER				
							REFUSAL AT 22.0 FEET.				

Notes/Comments:

Pocket Pentrometer Testing

S1: 2.75 TSF

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

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

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.739.7551
fax 302.454.5988

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: WASHINGTON COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-03 CORING | Dates(s) Drilled: 09/10/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: K. KERSH

Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): 37.0

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	27.0			CONTINUOUS AUGERING. SEE BORING LOG HDD-03.		
							AUGER REFUSAL AT 27.0'.		
							ROCK CORING		
RUN 1	27.0	32.0	27.0			ROCK	97% **RECOVERY**, 87% RQD: INTERBEDED GRAY TO DARK GRAY		
							SANDSTONE AND SILTSTONE.		
RUN 2	32.0	37.0		37.0			100% **RECOVERY**, 65% RQD: INTERBEDED GRAY TO DARK GRAY		
							SANDSTONE AND SILTSTONE.		
							GROUNDWATER NOT ENCOUNTERED WITHIN OVERBURDEN.		

Notes/Comments:

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.

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).

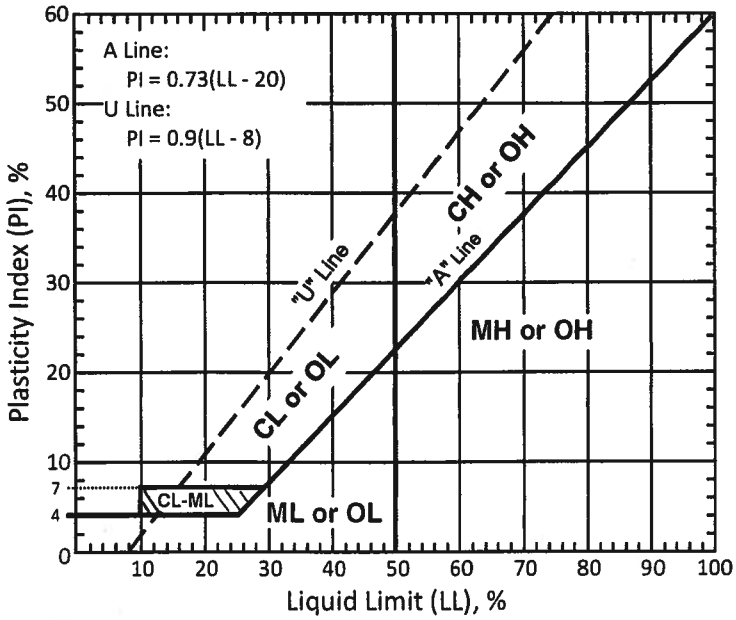
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

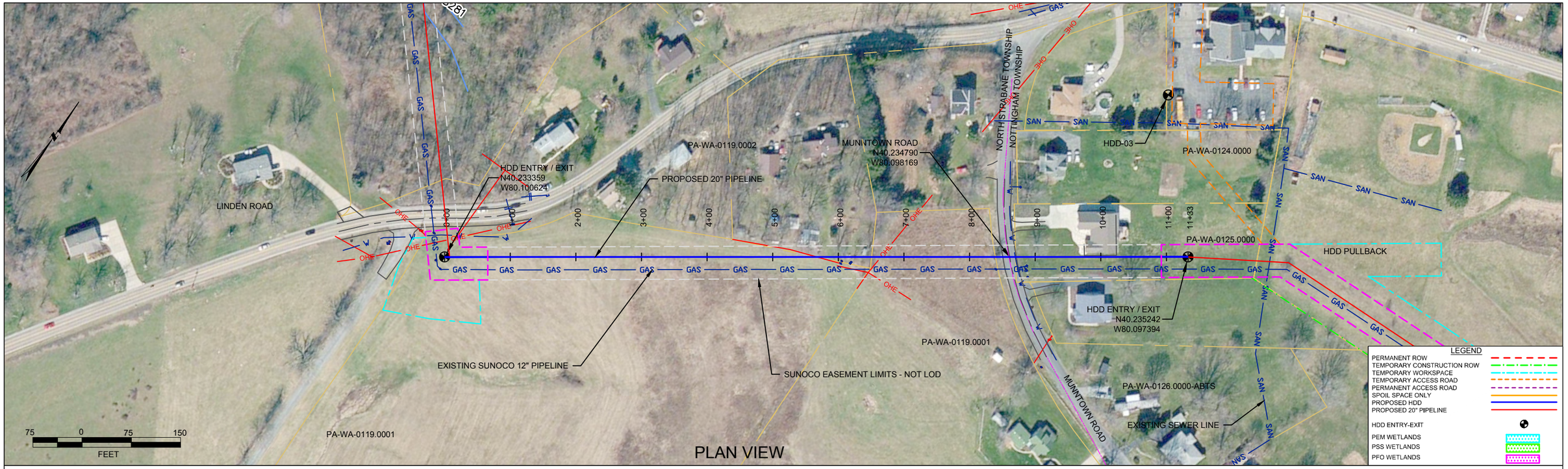


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0119.0003-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 860 feet from the southern edge of Munntown Road and will enter/exit 260 feet from the northern edge. There are no known water crossings or wetlands associated with this drill that parallels the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate for the drill is rock while the substrate closest to the surface is clay. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

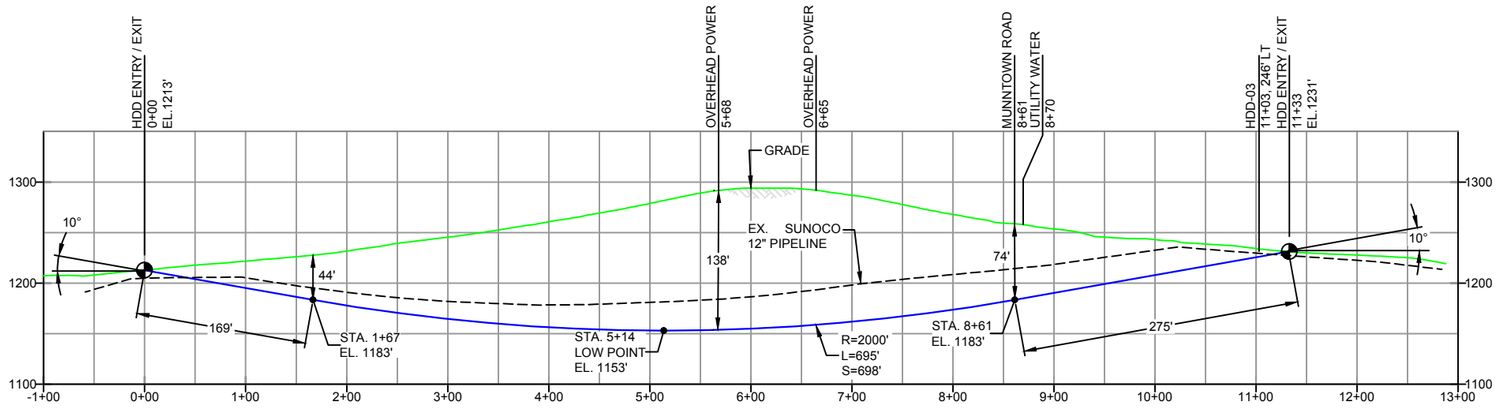
PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - NORTH STRABANE/NOTTINGHAM TOWNSHIPS
S1B-0090

GEOTECH HDD-03

- -NG EL. 1232'
- -CL (0.0' - 7.5')
- -SILTY CLAY (7.5' - 11.0')
- -SM (11.0' - 19.0')
- -SILT STONE (19.0' - 23.3')
- COMPLETION DEPTH EL. 1210'

NOTE: REFER TO TEST BORING LOG HDD-03 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=):1133'
   HDD PIPE LENGTH (S=):1142'
   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-1.35	TO	ES-1.36	EROSION & SEDIMENT PLAN	
SHEET 22	TO	SHEET 22	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	NO.

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/06/16	RMB	05/06/16	AAW	05/06/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

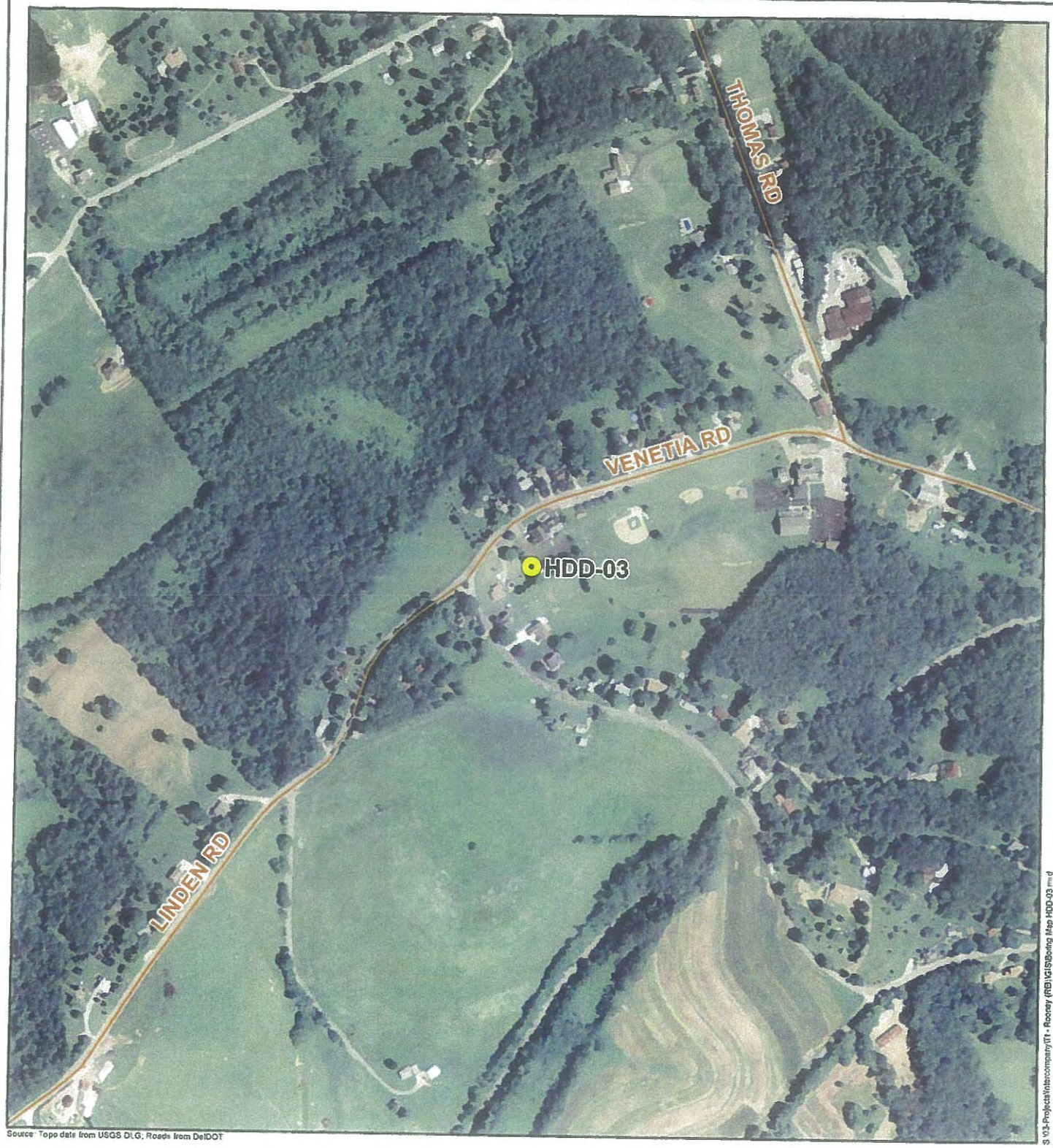
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
MUNNTOWN ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

DWG. NO: PA-WA-0119.0003-RD



Source: Topo data from USGS DLG, Roads from DelDOT

S:\03-Projects\Interoil\company\TT - Rooney (RB)\GIS\Boring Map HDD-03.mxd

Figure
Boring Location HDD-03
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA			Page 1 of 1
Test Boring No.: HDD-03	Dates(s) Drilled: 06/12/13	Inspector: E. WATT	
Drilling Contractor: CONNELLY	Drilling Method: SPT - ASTM D1586	Driller: T. REDMAN	
Surface Elevation (ft):	Groundwater Depth (ft): Not Encountered	Total Depth (ft): 23.2	

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
1	3.5	5.0	0.0		15	CL	MOTTLED BROWN AND GRAY SILTY CLAY WITH A LITTLE FINE	4	5	8	**13**
				7.5			SAND, TRACE MICA. USCS: CL				
2	8.5	10.0	7.5		12	ML	BLACK CLAYEY SILT, TRACE FINE SAND. HAS APPEARANCE OF	9	10	11	**21**
				11.0			COAL?				
3	13.5	15.0	11.0		18	ML/ SM	BROWN TO GRAY SILT AND FINE SAND (WEATHERED	20	25	15	**40**
							SANDSTONE/SHALE)				
4	18.5	19.4			11		BROWN TO GRAY FINE SAND AND SILT (WEATHERED SANDSTONE/	30	50/5"		**>50**
				19.0			SHALE). ROCK FRAGMENTS IN SPOON TIP.				
5	23.0	23.3	19.0	23.3			PARTIALLY WEATHERED LIGHT GRAY SILTSTONE.	50/3"			
							AUGER REFUSAL ENCOUNTERED AT 23.0'.				
							OFF-SITE BORING AND CONTINUOUSLY DRILLED TO AUGER				
							REFUSAL AT 22.0 FEET.				

Notes/Comments:

Pocket Pentrometer Testing

S1: 2.75 TSF

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

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

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.739.7551
fax 302.454.5988

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: WASHINGTON COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-03 CORING | Dates(s) Drilled: 09/10/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: K. KERSH

Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): 37.0

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	27.0			CONTINUOUS AUGERING. SEE BORING LOG HDD-03.		
							AUGER REFUSAL AT 27.0'.		
							ROCK CORING		
RUN 1	27.0	32.0	27.0			ROCK	97% **RECOVERY**, 87% RQD: INTERBEDED GRAY TO DARK GRAY		
							SANDSTONE AND SILTSTONE.		
RUN 2	32.0	37.0		37.0			100% **RECOVERY**, 65% RQD: INTERBEDED GRAY TO DARK GRAY		
							SANDSTONE AND SILTSTONE.		
							GROUNDWATER NOT ENCOUNTERED WITHIN OVERBURDEN.		

Notes/Comments:

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.

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).

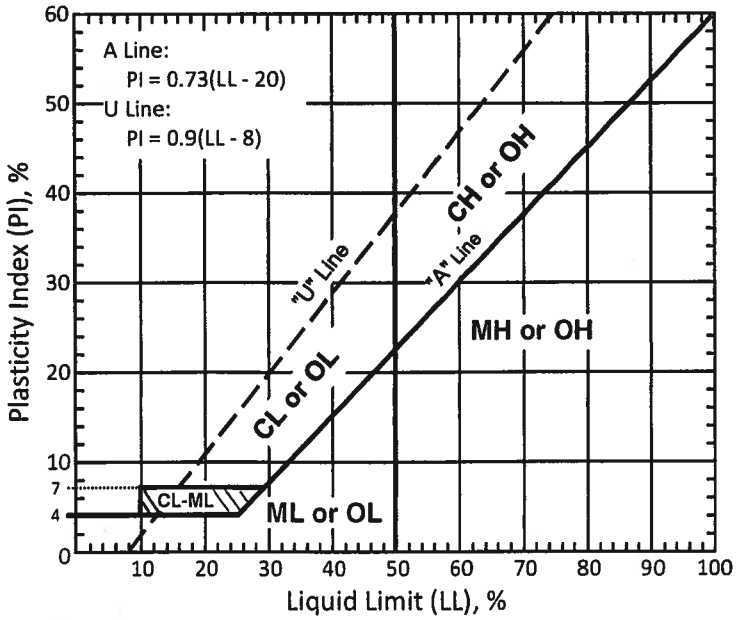
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

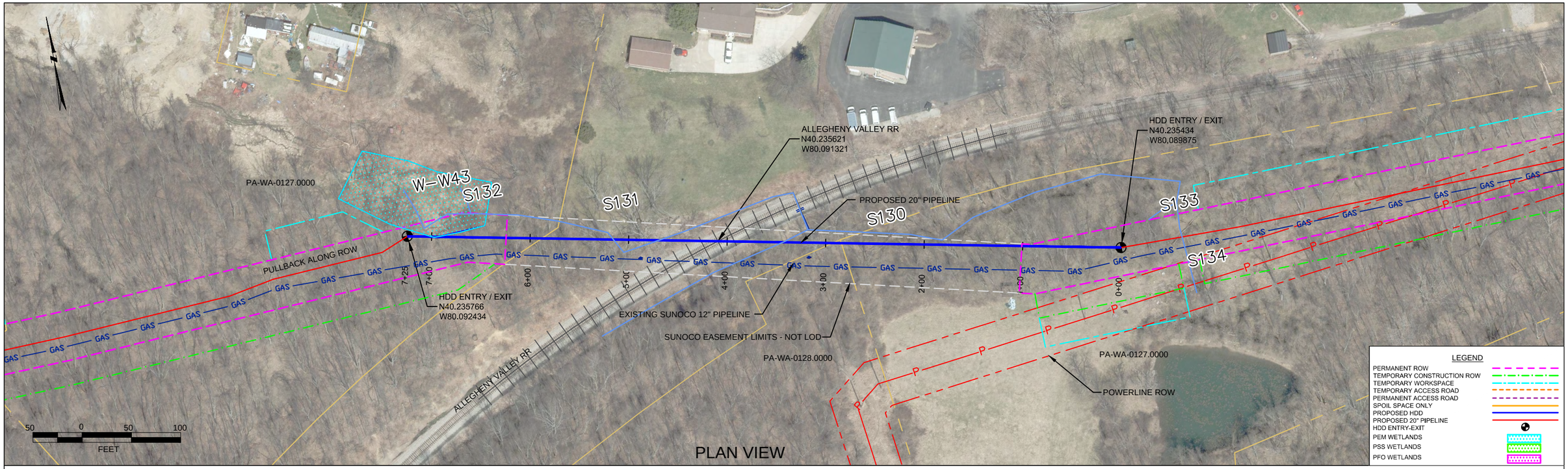


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0127.0000-RD (W43, S131, S130)

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.

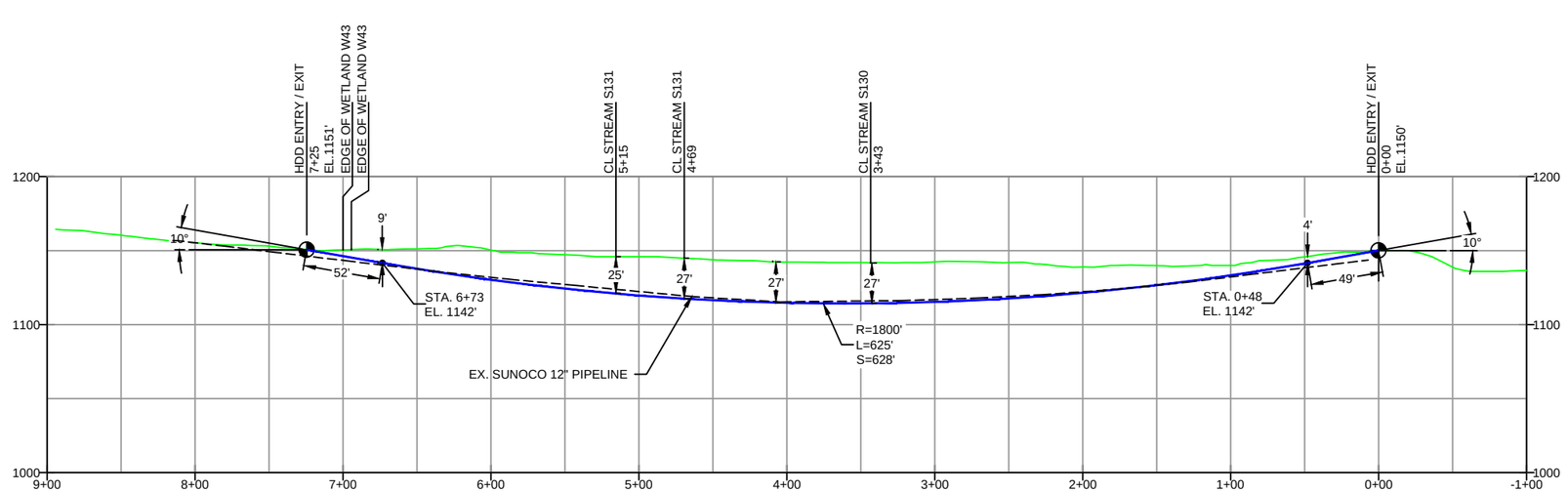
The drill will enter/exit 30 feet from the western edge of the grassy wetland (W43) and enter/exit 700 feet from the eastern edge with a depth of 5 feet. The horizontal directional drill will enter/exit 200 feet from the western edge and enter/exit 520 feet from the eastern edge and crossing at a depth of 25 feet from of the first crossing of Stream 131 (S131). For second crossing of S131 the drill will enter/exit 250 feet from the western edge and enter/exit 470 feet from the eastern edge of the drill and crossing at a depth of about 25 feet. The drill will enter/exit 375 feet from the western edge of Stream 130 (S130) and 345 feet from the eastern edge with a crossing depth of about 27 feet. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate at all crossings is estimated to be a sandy clay. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - NOTTINGHAM TOWNSHIP
S1B-0100



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=):725'
   HDD PIPE LENGTH (S=):729'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
12. BLASTING NOT PERMITTED.
13. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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-1.37	TO	ES-1.38	EROSION & SEDIMENT PLAN	
SHEET 23	TO	SHEET 23	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

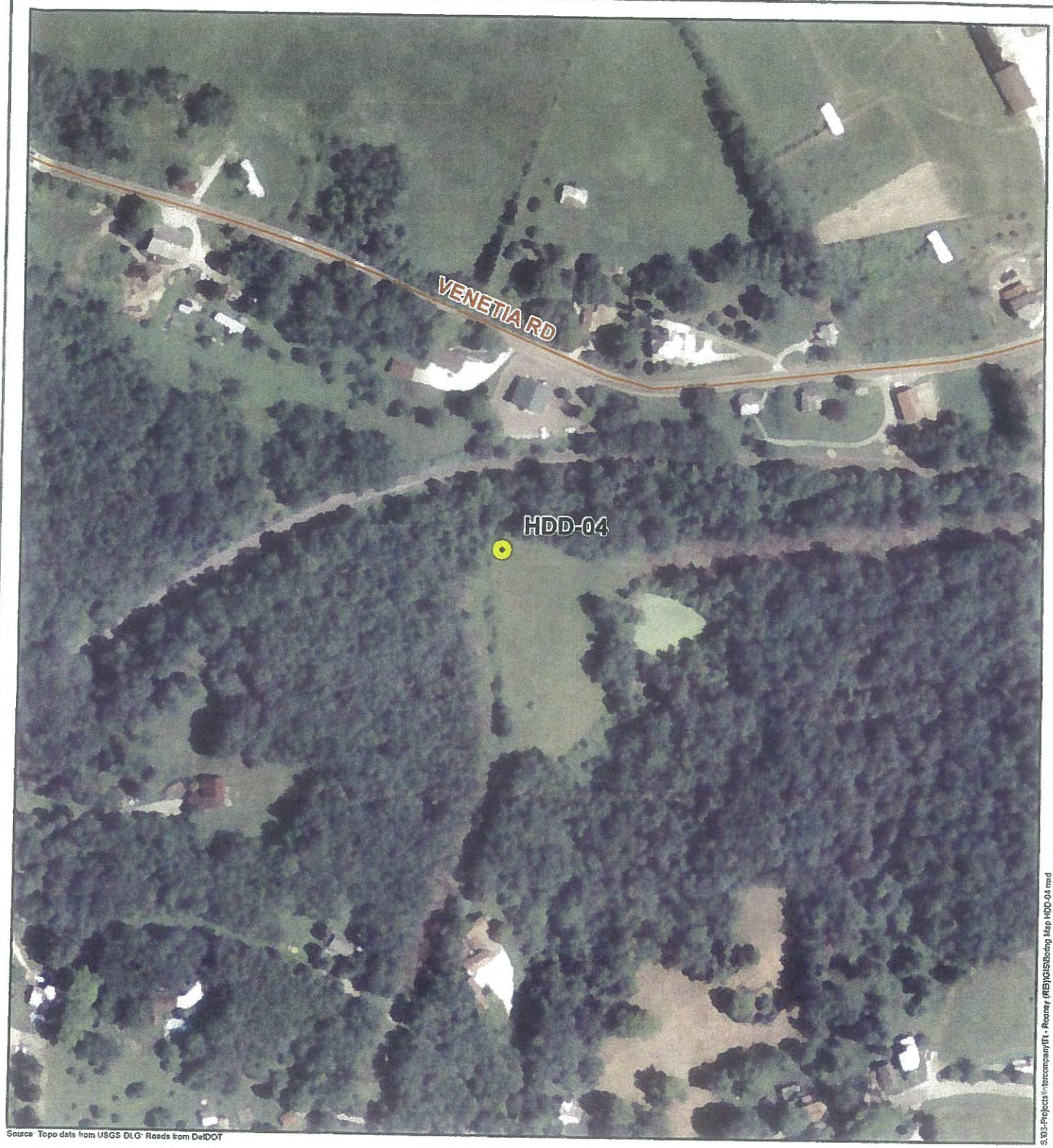
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
ALLEGHENY VALLEY RR
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

DWG. NO: PA-WA-0127.0000-RR



Source: Topo data from USGS DLG- Roads from DelDOT

S:\03-Projects\Intercompany\TT - Rooney (RB)\GIS\Boring Map HDD-04.mxd

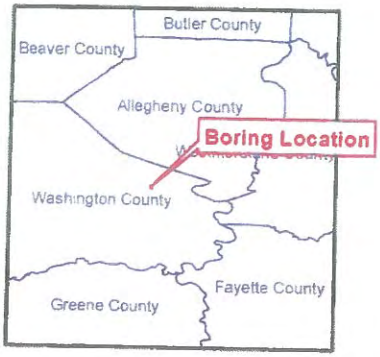


Figure
Boring Location HDD-04
Sunoco Mariner East Project
Washington County, PA

0 125 250 500 Feet

1 inch = 250 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax 302.454.5989

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA | Page 1 of 1
Test Boring No.: HDD-04 | Dates(s) Drilled: 09/03/13 | Inspector: E. WATT
Drilling Contractor: HYNES | Drilling Method: SPT - ASTM D1586 | Driller: M. HYNES
Surface Elevation (ft): | Groundwater Depth (ft): 18.0' | Total Depth (ft): 24.0

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	3.5	5.0	0.0		9	CL	LIGHT BROWN SANDY CLAY, TRACE FINE GRAVEL.	2	2	3	5
2	8.5	10.0			3		MOTTLED BROWN AND GRAY SILTY CLAY WITH SOME FINE	3	3	4	7
				12.0			SAND, TRACE FINE GRAVEL. USCS: CL				
3	13.5	15.0	12.0		15	SM	BROWN SILTY FINE TO MEDIUM SAND, THIN SEAM OF EITHER	2	2	4	6
							LIGNITE OR COAL.				
4	17.5	19.0			18		MOTTLED LIGHT GRAY TO BROWN SILTY FINE TO MEDIUM SAND,	6	8	8	16
				22.0			WITH A LITTLE UNWEATHERED SILTSTONE.				
5	22.5	24.0	22.0	24.0	13		LIGHT GRAY WEATHERED SILTSTONE.	8	20	30	50
							AUGER REFUSAL AT 22.5'. OFF-SET BORING 20' EAST AND				
							CONTINUOUSLY DRILLED TO AUGER REFUSAL AT 21'.				
							WET ON SPOON AT 18'.				
							WATER LEVEL THROUGH AUGERS AT 18'.				
							CAVED AT 18.5' AT COMPLETION.				

Notes/Comments:
Pocket Pentrometer Testing
S1: 3.0 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.

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).

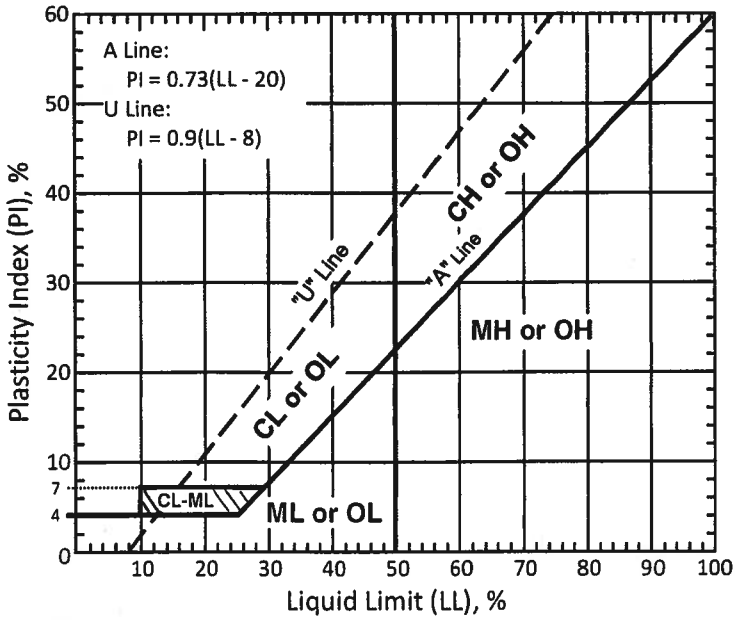
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

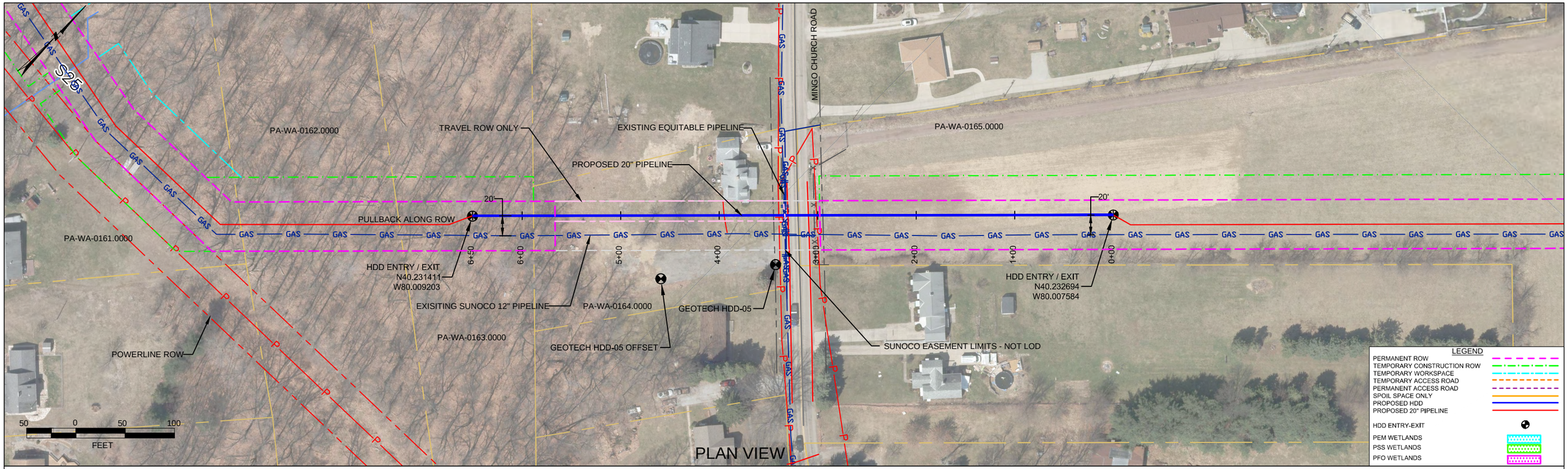


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0164.0000-RD

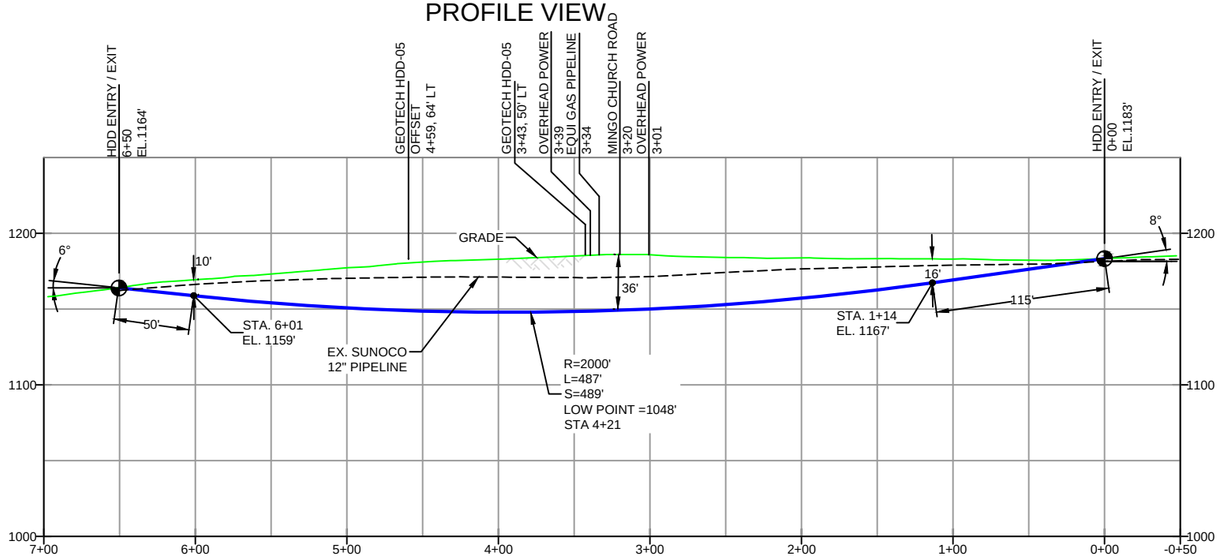
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 320 feet from the southern edge of Mingo Church Road and will enter/exit 300 feet from the northern edge. The drill will cross 36 feet below the road. The 20" drill will parallel the existing ME1 12" pipeline drill beneath the road. Geotechnical results from the previous drill, 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 substrate below 10 feet is sandstone rock. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

PROFILE VIEW



WASHINGTON COUNTY,PENNSYLVANIA -UNION TOWNSHIP
S1B-0110

GEOTECH HDD-05

-NG EL. 1186'
-CL/SC (0.0' - 7.6')
-COMPLETION DEPTH EL. 1178.4'

NOTE: REFER TO TEST BORING LOG HDD-05 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=):650'
   HDD PIPE LENGTH (S=):654'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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-1.53	TO	ES-1.53	EROSION & SEDIMENT PLAN
SHEET 32	TO	SHEET 32	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		JTW	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

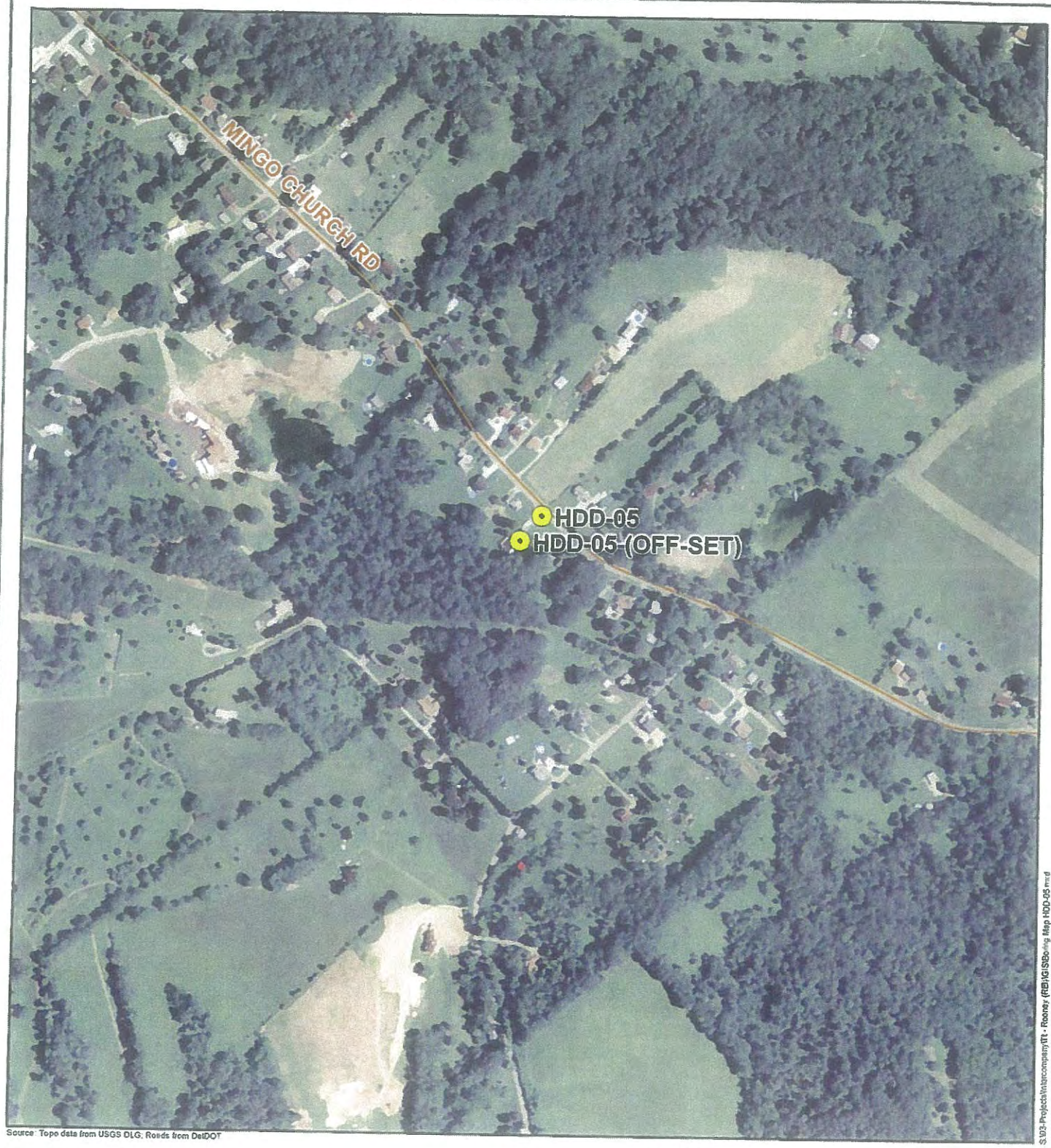
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
MINGO CHURCH ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

DWG. NO: PA-WA-0164.0000-RD



Source: Topo data from USGS DLG; Roads from DelDOT

S:\03-Projects\Intercompany\Tt - Rooney (RB)\GIS\Boring Map HDD-05.mxd

Figure
Boring Location HDD-05
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA | Page 1 of 1
Test Boring No.: HDD-05 | Dates(s) Drilled: 06/10/13 | Inspector: E. WATT
Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: T. REDMAN
Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): 7.6

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
1	3.5	5.0	0.0		11	CL/ SC	MOTTLED LIGHT BROWN TO MEDIUM BROWN SILTY CLAY AND	4	11	47	58
				4.5			FINE SAND. TRACE MICA.				
			4.5				WEATHERED AND BRITTLE SILTSTONE OR SANDSTONE.				
2	7.5	7.6		7.6	<1"		SANDSTONE	50/1"			
							AUGER REFUSAL ENCOUNTERED AT 7.5'.				
							OFF-SITE BORING 115' TO THE SOUTHWEST (DOWN THE DRIVE WAY) AND CONTINUOUSLY DRILLED TO AUGER REFUSAL AT 6.5'. REFUSAL MATERIAL OBSERVED TO BE SANDSTONE.				

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 302.454.5088

TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA			Page 1 of 1
Test Boring No.: HDD-05 CORING	Dates(s) Drilled: 09/10/13	Inspector:	E. WATT
Drilling Contractor: CONNELLY	Drilling Method: SPT - ASTM D1586	Driller:	K. KERSH
Surface Elevation (ft):	Groundwater Depth (ft): Not Encountered	Total Depth (ft): 18.5	

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	8.5			CONTINUOUS AUGERING. SEE BORING LOG HDD-05.		
							AUGER REFUSAL AT 8.5'.		
							ROCK CORING		
RUN 1	8.5	13.5	8.5			ROCK	**98% RECOVERY, 13 % RQD:** BROWN SANDSTONE.		
RUN2	13.5	18.5					**100% RECOVERY, 73% RQD:** BROWN SANDSTONE, GRAY IN		
				18.5			BOTTOM 6".		

Notes/Comments:

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.

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).

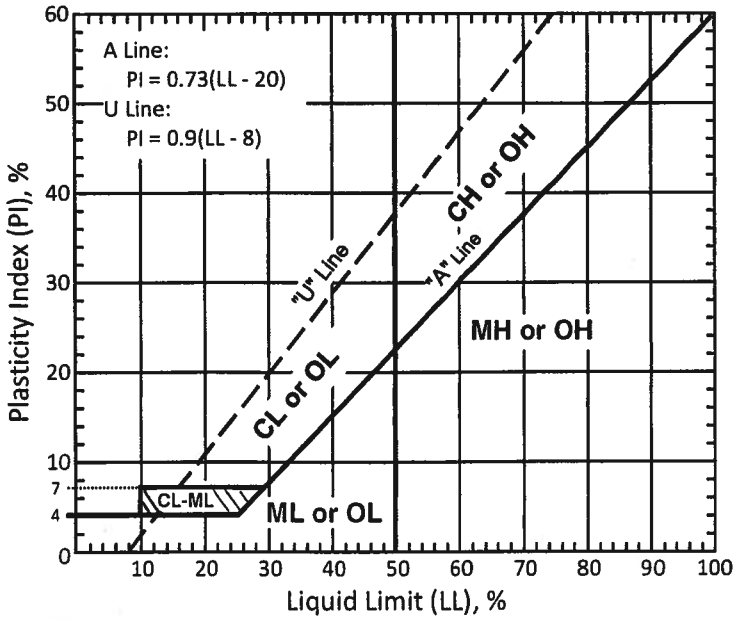
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

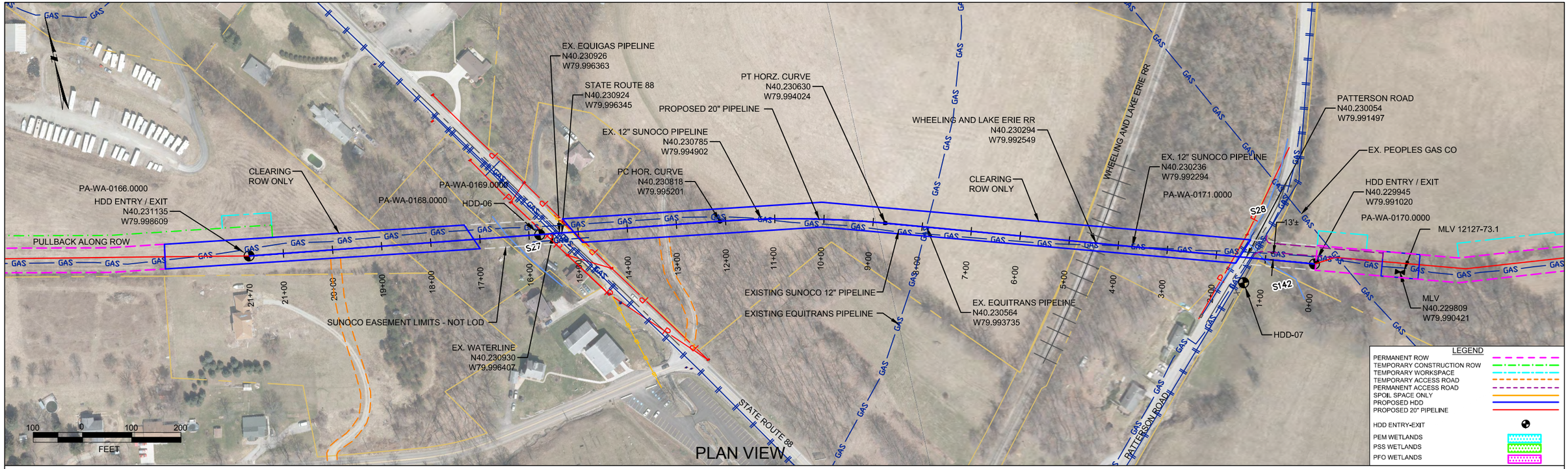


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0171.0000-RR (S27, S28, S142)

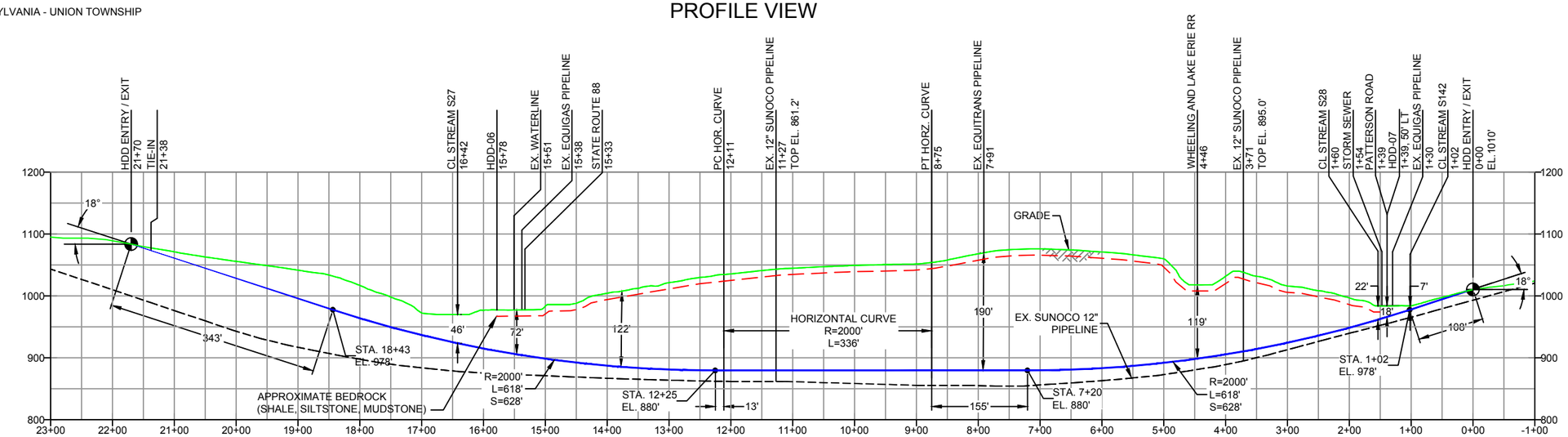
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 530 feet from the western edge of a Stream 27 (S27) and enter/exit 1,650 feet from the eastern edge. The horizontal directional drill will enter/exit 2,020 feet from the western edge of Stream 28 (S28) and enter/exit 160 feet from the eastern edge. The drill will enter/exit 2,080 feet from the western edge of Stream 142 (S142) and will enter/exit 100 feet from the eastern edge. The drill will cross below S27 at more than 50 feet, and S28 and S142 at about 10 feet. The 20" drill will closely follow the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 reports the primary substrate at the crossings is either rock with limestone and shale (S28) or medium sand with silty clay (S28, S142). Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



WASHINGTON COUNTY, PENNSYLVANIA - UNION TOWNSHIP
S1B-0120

PROFILE VIEW



GEOTECH HDD-06

-NG EL. 978'
-CL (0.0' - 6.0')
-COMPLETION DEPTH EL. 972'

NOTE: REFER TO TEST BORING LOG HDD-06 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH HDD-07

-NG EL. 984'
-SM (0.0' - 7.0')
-CL/SC (7.0' - 12.0')
-COMPLETION DEPTH EL. 972'

NOTE: REFER TO TEST BORING LOG HDD-07 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=): 2170'
   HDD PIPE LENGTH (S=): 2212'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
12. BLASTING NOT PERMITTED.
13. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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-1.55	TO	ES-1.56	EROSION & SEDIMENT PLAN
SHEET 32	TO	SHEET 33	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

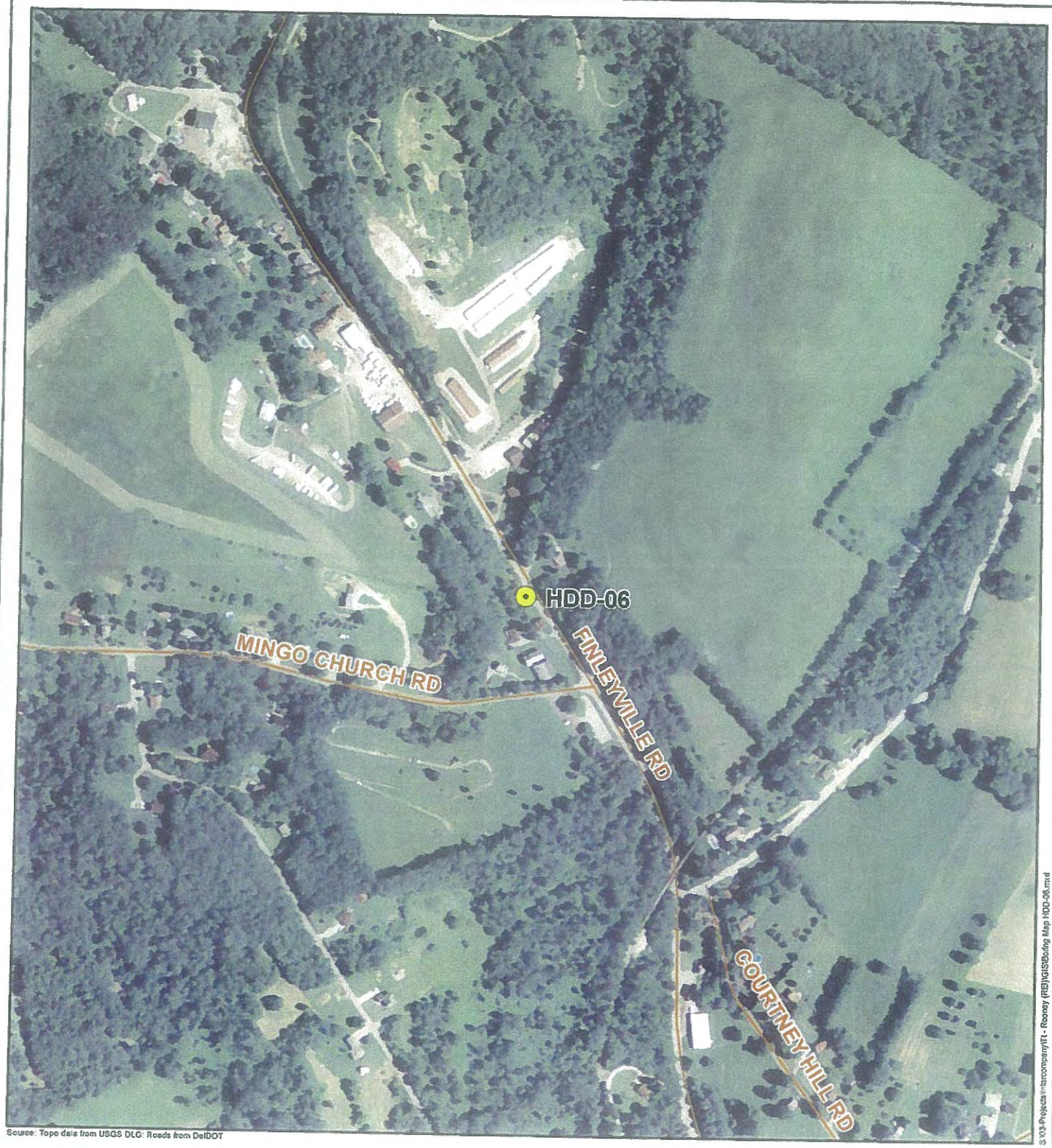
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
WHEELING AND LAKE ERIE RR
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-WA-0171.0000-RR



Source: Topo data from USGS DLG; Roads from DelDOT

S:\03-Projects\Intercompany\TI - Rooney (RB)\GIS\Boring Map HDD-06.mxd

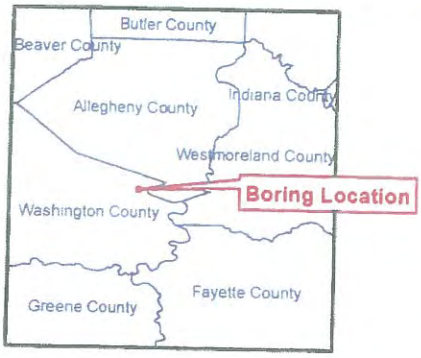


Figure
Boring Location HDD-06
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

Source: Topo data from USGS DLG; Roads from DelDOT

S:\03-Projects\Unicompany\T1 - Rooney (RE)\GIS\Boring Map HDD-07.mxd

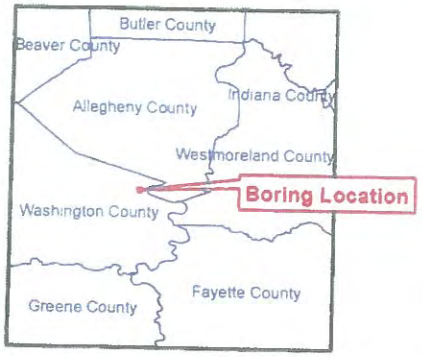


Figure
Boring Location HDD-07
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA | Page 1 of 1
Test Boring No.: HDD-06 | Dates(s) Drilled: 06/12/13 | Inspector: E. WATT
Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: T. REDMAN
Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): VARIOUS, SEE BELOW

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
1	3.5	5.0	0.0		6	CL	BROWN SILTY CLAY WITH A LITTLE FINE SAND, CONTAINED	4	7	5	12
				6.0			TRACES OF VEGETABLE MATTER (FILL?)				
2	6.0	6.1			<1"		PIECES OF LIMESTONE	50/1"			
							AUGER REFUSAL ENCOUNTERED AT 6.0'. OFF-SET BORING				
							6' TO THE SOUTHEAST. SUBSEQUENTLY DRILLED TO AUGER				
							REFUSAL AT 2.0 FEET. OFF-SET BORING AGAIN 14' FURTHER TO				
							SOUTHEAST.				
3	8.0	8.1			1"		AUGERED CONTINUOUSLY TO AUGER REFUSAL AT 8.0'.	50/1"			
							PARTIALLY WEATHERED GRAY SILTSTONE IN TIP.				

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 302.454.5989

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: WASHINGTON COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-06 CORING | Dates(s) Drilled: 09/10/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: K. KERSH

Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): 22.0

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	12.0			CONTINUOUS AUGERING. SEE BORING LOG HDD-06.		
							AUGER REFUSAL AT 12.0'.		
							ROCK CORING		
RUN 1	12.0	17.0	12.0			ROCK	**97% RECOVERY, 36% RQD:** INTERBEDDED GRAY LIMESTONE		
							AND GRAY FISSILE SHALE.		
RUN 2	17.0	22.0		22.0			**98% RECOVERY, 70% RQD:** DARK GRAY LIMESTONE, POSSIBLE		
							SILTSTONE INTERBEDS.		

Notes/Comments:

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: 302.454.5088

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA | Page 1 of 1
Test Boring No.: HDD-07 | Dates(s) Drilled: 06/10/13 | Inspector: E. WATT
Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: T. REDMAN
Surface Elevation (ft): | Groundwater Depth (ft): Not Encountered | Total Depth (ft): 12.0

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
1	3.5	5.0	0.0		6	SM	BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, TRACE	6	6	5	11
				7.0			SANDSTONE GRAVEL.				
2	8.5	10.0	7.0		7	CL/ SC	LIGHT BROWN AND GRAY SILTY CLAY AND FINE SAND, TRACE	2	6	12	18
				12.0			SANDSTONE FINE GRAVEL.				
3	12.0	12.0			<1/4"		SILTSTONE/SANDSTONE.	50/0"			
							AUGER REFUSAL ENCOUNTERED AT 12'. OFFSET BORING 9'				
							TO THE NORTHEAST, AND CONTINUOUSLY DRILLED TO AUGER				
							REFUSAL AT 12'.				

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.

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).

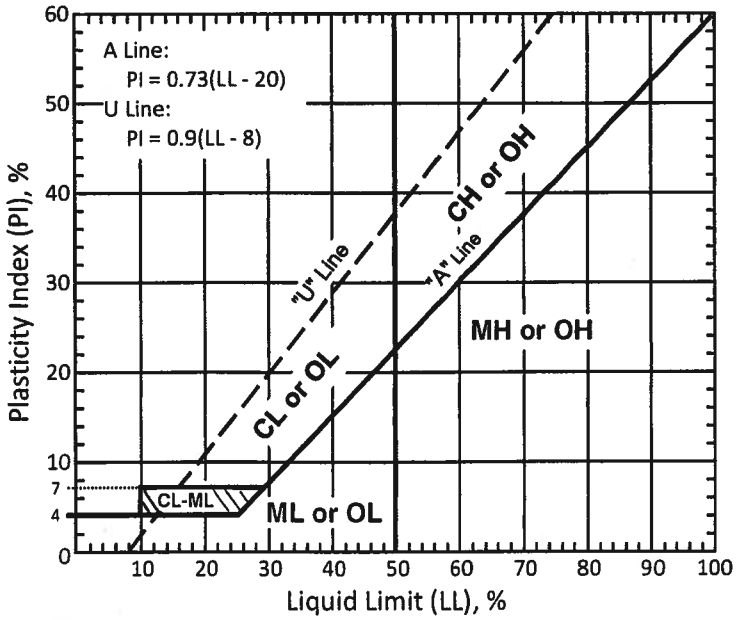
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

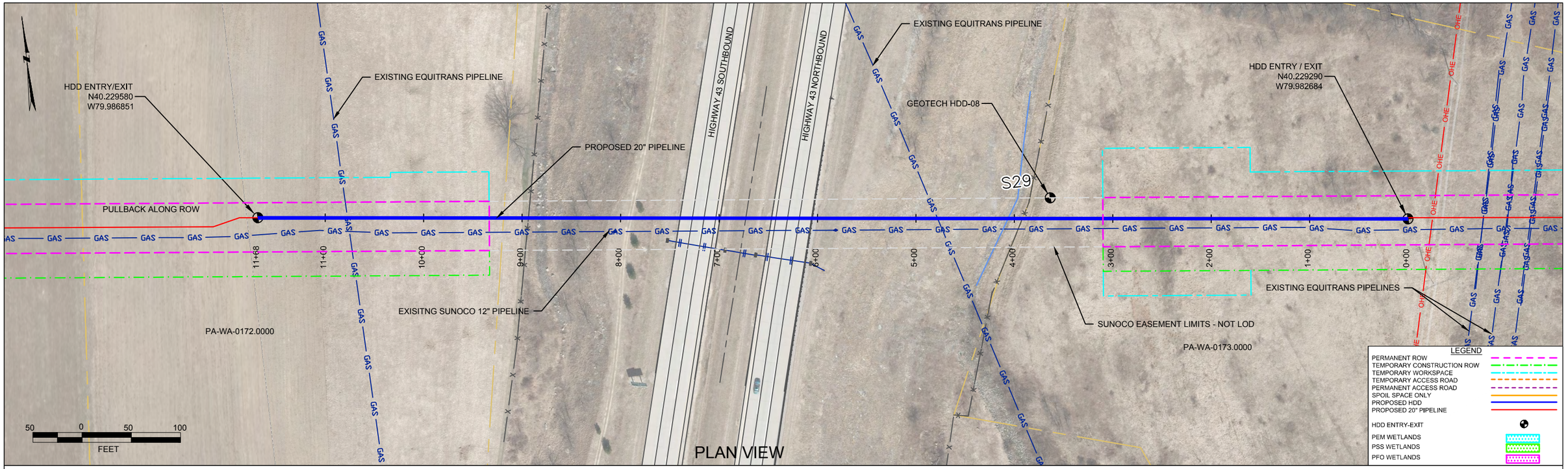


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0172.0000-RD (S29)

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 430 feet from the western edge of Highway 43 and enter/exit 600 feet from the eastern edge. The horizontal directional drill will enter/exit 760 feet from the western edge of stream 29 (S29) and enter/exit 410 feet from the eastern edge. The drill will cross below the highway at 90 feet and the stream at 30 feet. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate at the crossing depth is bedrock with clays and shales above. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PLAN VIEW

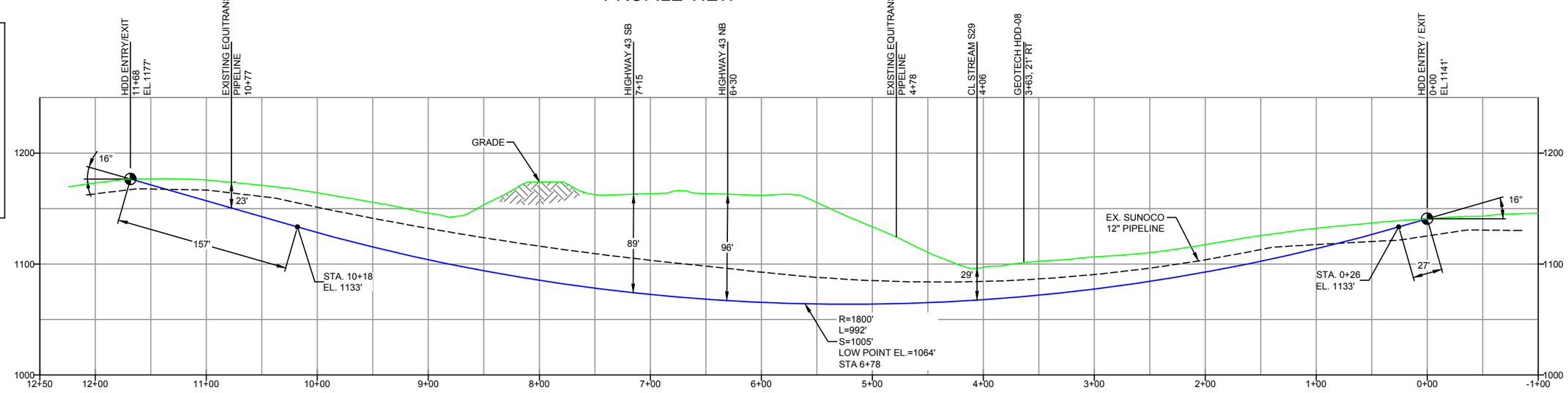
PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - UNION TOWNSHIP
S1B-0130

GEOTECH HDD-08

-NG EL. 1102'
-SM (0.0' - 7.0')
-GROUNDWATER (5.5')
-CL (7.0' - 14.5')
-FISSILE SHALE (14.5' - 22.1')
-COMPLETION DEPTH EL. 1079.1'

NOTE: REFER TO TEST BORING LOG HDD-08 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=):1168'
   HDD PIPE LENGTH (S=):1189'
   20" x 0.456" W.T., X-65, APISL, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)
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-1.57	TO	ES-1.58.01	EROSION & SEDIMENT PLAN	
SHEET 33	TO	SHEET 35	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	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/17/16	RMB	05/17/16	AAW	05/17/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
HIGHWAY 43
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=100'

DWG. NO: PA-WA-0172.0000-RD

Source: Topo data from USGS DLG Roads from DelDOT

S:\03-Projects\Intercompany\IT - Rooney (REB)\GIS\Boring Map HDD-08.mxd

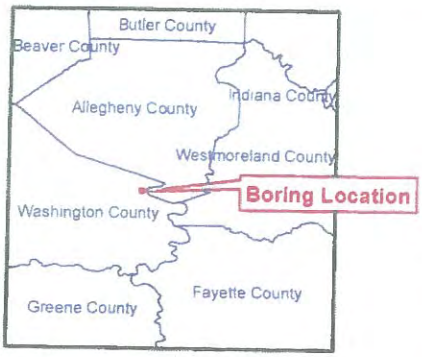


Figure
Boring Location HDD-08
Sunoco Mariner East Project
Washington County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

Tetra Tech, Inc.
Phone: (302) 738-7551
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302.738.7551
fax: 302.454.5988

TEST BORING LOG

Project Name: SUNOCO MARINER EAST			Project No.: 103IP2762
Project Location: WASHINGTON COUNTY, PA			Page 1 of 1
Test Boring No.: HDD-08	Dates(s) Drilled: 06/26/13	Inspector: E. WATT	
Drilling Contractor: CONNELLY	Drilling Method: SPT - ASTM D1586	Driller: K. Kersh	
Surface Elevation (ft):	Groundwater Depth (ft): SEE BELOW	Total Depth (ft): 22.5	

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
1	3.5	5.0	0.0		16	SM	LIGHT BROWN TO ORANGE BROWN FINE TO MEDIUM SAND WITH	5	7	11	18
				7.0			SOME CLAY, TRACE F-GRAVEL.				
2	8.5	10.0	7.0		10	CL	MOTTLED ORANGE, BROWN AND GRAY SILTY CLAY WITH SOME	3	4	4	8
							FINE SAND, TRACE FINE GRAVEL. USCS: CL				
3	13.5	15.0			14		GRAY, BROWN AND YELLOWISH BROWN SILTY CLAY, TRACE	11	15	50/5"	>50
				14.5			FINE SAND.				
			14.5			FS	HIGHLY WEATHERED FISSILE SHALE.				
4	18.5	18.7			2		GRAY FISSILE SHALE.	50/2"			
5	22.0	22.1		22.1	1		GRAY FISSILE SHALE.	50/1"			
							AUGER REFUSAL ENCOUNTERED AT 22.0'.				
							WET ON SPOON AT 9.5'.				
							WATER LEVEL THROUGH AUGERS AT 5.5'.				
							OFF-SET BORING 32' TO THE NORTH, AND CONTINUOUSLY				
							DRILLED TO AN AUGER REFUSAL DEPTH OF 22.5 FEET. NO				
							WATER WAS ENCOUNTERED WITHIN THIS BOREHOLE.				

Notes/Comments:

Pocket Pentrometer Testing
S1: >4 TSF
S2: 2.75 TSF

FS: FISSILE SHALE

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.

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).

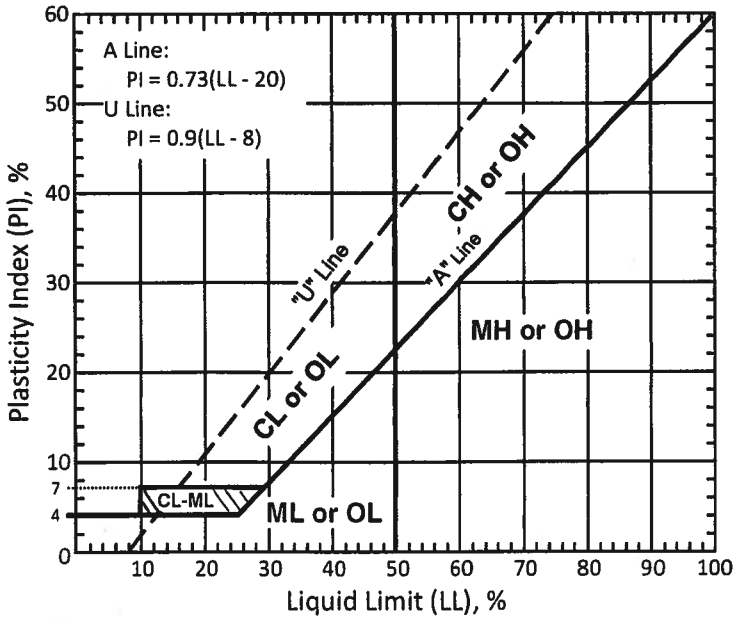
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.

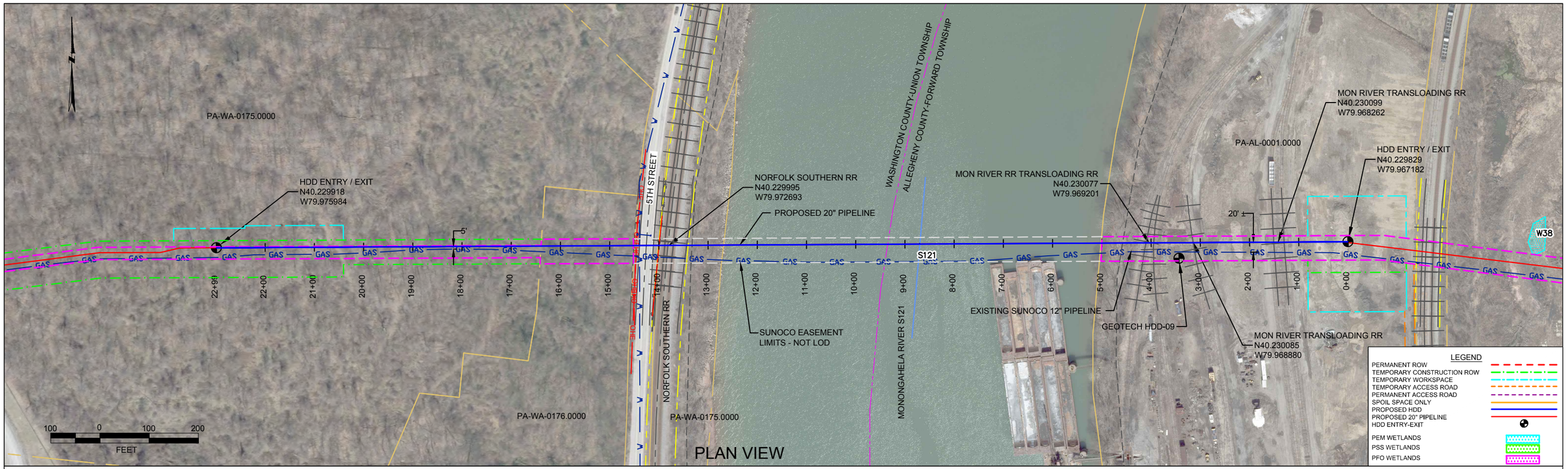


(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

HDD PA-WA-0176.0000-RD (S121)

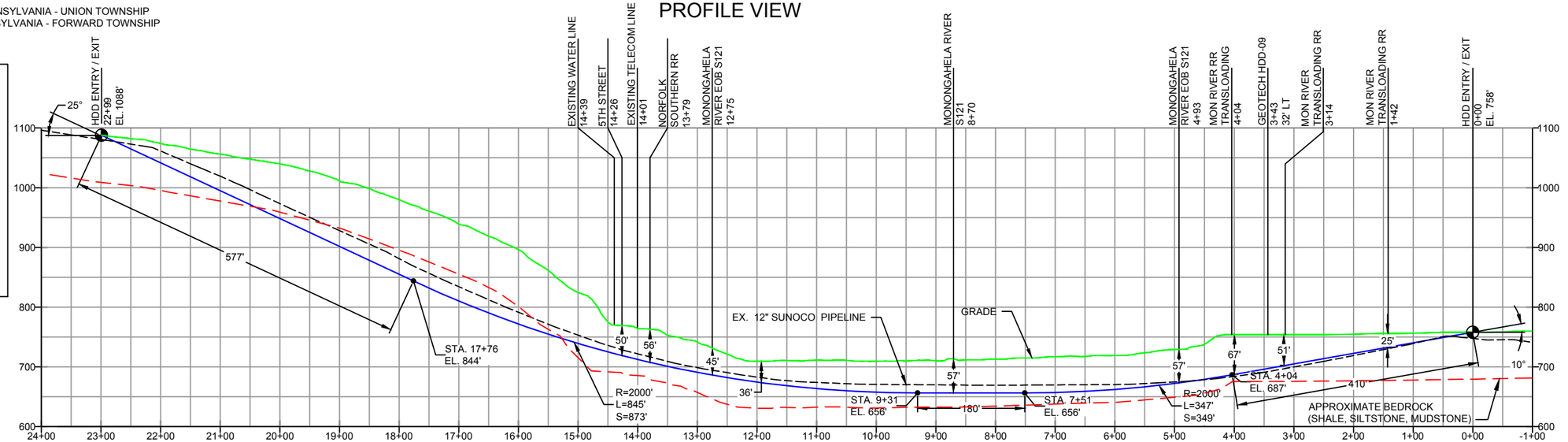
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 1,000 feet from the western edge of the Monongahela River (S121) and enter/exit 530 feet from the eastern edge and cross at depths greater than 40 feet. The 20" drill will parallel the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, 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 substrate at the crossing (S121) is estimated to be silt and clay. Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



WASHINGTON COUNTY, PENNSYLVANIA - UNION TOWNSHIP
ALLEGHENY COUNTY, PENNSYLVANIA - FORWARD TOWNSHIP
S1B-0140

PROFILE VIEW



GEOTECH HDD-09
-NG EL. 754'
-SM (0' - 12.0')
-CL (12.0' - 27.0')
-SM (27.0' - 62.0')
-SC (62.0' - 68.6')
-ROCK (68.6' - 78.5')
-COMPLETION DEPTH EL. 675.5'

NOTE: REFER TO TEST BORING LOG HDD-09 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=): 2299'
   HDD PIPE LENGTH (S=): 2389'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
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. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
12. BLASTING NOT PERMITTED.
13. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

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-1.59	TO	ES-1.01	EROSION & SEDIMENT PLAN
SHEET 35	TO	SHEET 36	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/20/16	RMB	05/20/16	AAW	05/20/16
EP		DLM	03/15/16	RMB	03/15/16	AAW	03/15/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

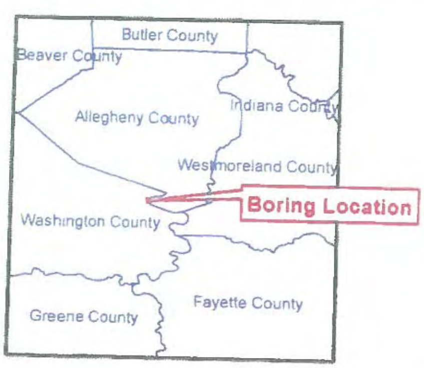
SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
NORFOLK SOUTHERN RR, MONONGAHELA RIVER
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-WA-0176.0000-RR

Source Topo data from USGS DLG Roads from DelDOT



N W E S

Tetra Tech, Inc.
Phone: (302) 738-7551
Toll Free: (800) 462-0910
www.tetratech.com

Figure
Boring Location HDD-09
Sunoco Mariner East Project
Allegheny County, PA

0 250 500 1,000 Feet

1 inch = 500 feet

This map is provided by Tetra Tech solely for display and reference purposes and is subject to change without notice. No claims, either real or assumed, as to the absolute accuracy or precision of any data contained herein are made by Tetra Tech, nor will Tetra Tech be held responsible for any use of this document for purposes other than which it was intended

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

TEST BORING LOG

Project Name: SUNOCO MARINER EAST | Project No.: 103IP2762

Project Location: ALLEGHANY COUNTY, PA | Page 1 of 1

Test Boring No.: HDD-09 | Dates(s) Drilled: 09/09/13 | Inspector: E. WATT

Drilling Contractor: CONNELLY | Drilling Method: SPT - ASTM D1586 | Driller: K. KERCH

Surface Elevation (ft): | Groundwater Depth (ft): 24.5 | Total Depth (ft): 78.5

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
1	3.5	5.0	0.0		6	SM	LIGHT BROWN FINE TO MEDIUM SAND WITH A TRACE OF	3	4	5	9
							SANDSTONE GRAVEL., AND A LITTLE SILT (HISTORIC FILL).				
2	8.5	10.0			2		LIGHT BROWN FINE TO MEDIUM SAND WITH A TRACE OF	3	3	5	8
				12.0			SANDSTONE GRAVEL, AND A LITTLE SILT (HISTORIC FILL).				
3	13.5	15.0	12.0		10	CL	MOTTLED BROWN AND GRAY SILTY CLAY, TRACE MICA, TRACE	2	3	3	6
							TO LITTLE SILT. USCS: CL				
4	18.5	20.0			18		BROWN SILTY CLAY WITH SOME FINE SAND, TRACE MICA.	3	3	3	6
5	23.5	25.0		27.0	18		BROWN SANDY CLAY, TRACE MICA.	1	1	2	3
6	28.5	30.0	27.0		1	SM	BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	2	3	3	6
7	33.5	35.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	3	3	6	9
8	38.5	40.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT. 2" BLACK	1	3	4	7
							SEAM PRESENT (LIGNITE?)				
9	43.5	45.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	3	4	7	11
10	48.5	50.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT. 2" BLACK	3	6	7	13
							SEAM PRESENT (LIGNITE?).				
11	53.5	55.0			18		BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, WITH A	3	17	30	47
							LITTLE FINE GRAVEL, INTERLAYERED WITH "LIGNITE?".				
12	58.5	60.0			17		BROWN FINE TO COARSE SAND WITH A LITTLE SILT, WITH A	8	16	17	33
				62.0			LITTLE FINE GRAVEL.				
13	63.5	65.0	62.0		18	SC	DECOMPOSED ROCK WEATHERED TO A MULT-COLORED FINE	19	32	50	82
							TO MEDIUM SAND, WITH SOME CLAY.				
14	68.5	68.6		68.6	<1		LIGHT GRAY PARTIALLY WEATHERED SILTSTONE.	50/1"			
							AUGER REFUSAL AT 68.5'.				
							ROCK CORING				
RUN 1	68.5	73.5	68.5			ROCK*	ROCK CORING: 89% RECOVERY, 37% RQD				
RUN 2	73.5	78.5		78.5			ROCK CORING: 95% RECOVERY, 58% RQD				
							*PREDOMINATELY GRAY AND GREENSIH GRAY SILTSTONE, WITH A				
							THIN SEAM OF CALCEROUS CLAYSTONE, AND A THIN SEAM OF				
							GRAY LIMESTONE.				

Notes/Comments:

Pocket Pentrometer Testing
S3: 0.75 TSF
S4: 0.75 TSF
S13: > 4 TSF

WET ON SPOON AT 28.0'.
WATER LEVEL THROUGH AUGERS AT 24.5'.

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.

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).

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	Silts and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
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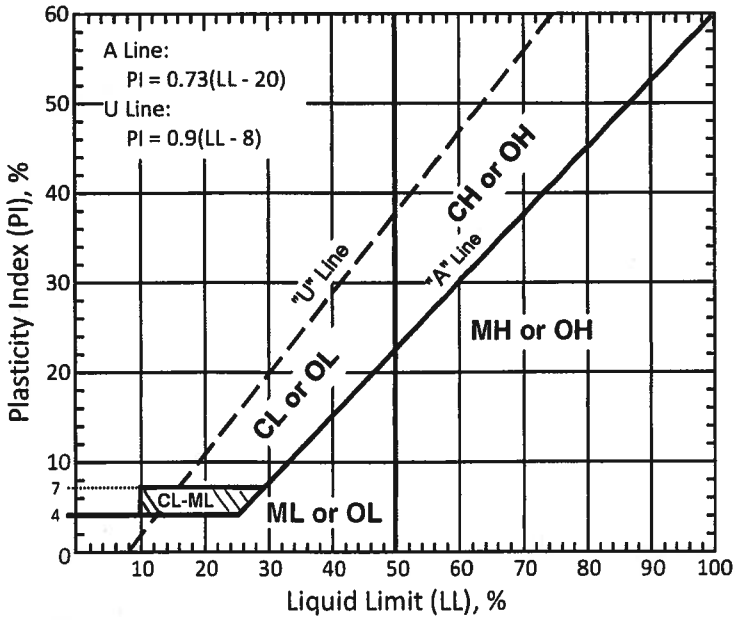

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