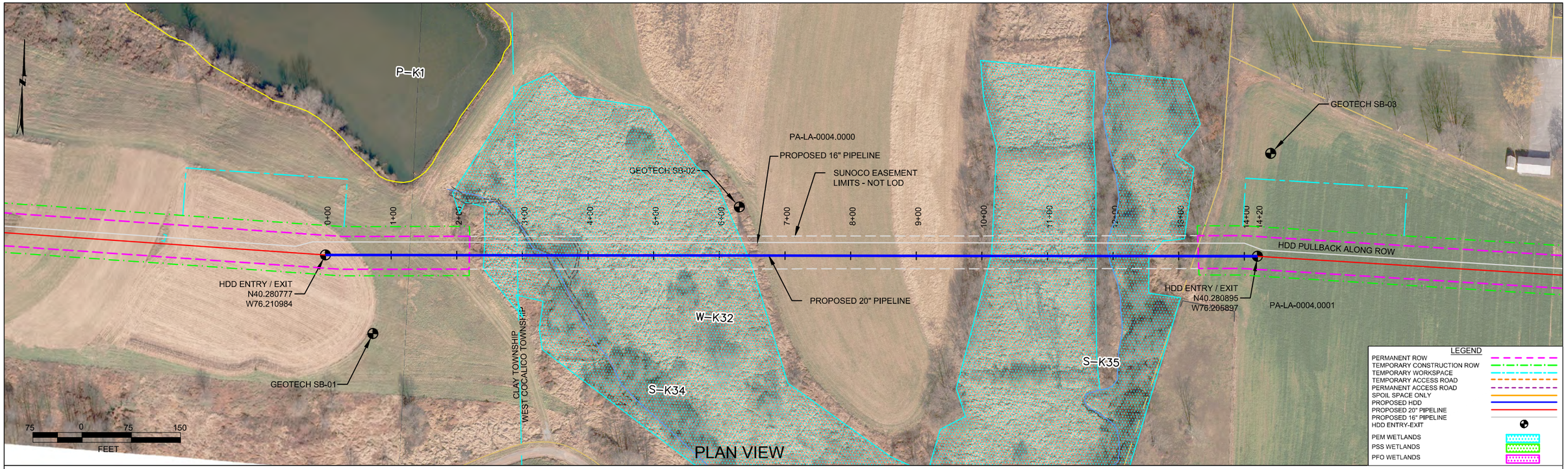
Attachment A
HDD Table
Lancaster County

Drawing Name	Drill Name	County	Township	Drill Location	Risk Assessment Level (Low / Medium / High)
PA-LA-0004.0000-SR.pdf	Wetland K32 & S-K35	Lancaster	Clay & West Cocalico	N: 40.280777 W: 76.210984	low
PA-LA-0014.0000-SR.pdf	Wetland A54 & A55	Lancaster	West Cocalico	N: 40.283950 W: 76.177510	low

HDD PA-LA-0004.0000-SR (S-K34, S-K35, PEM-K32)

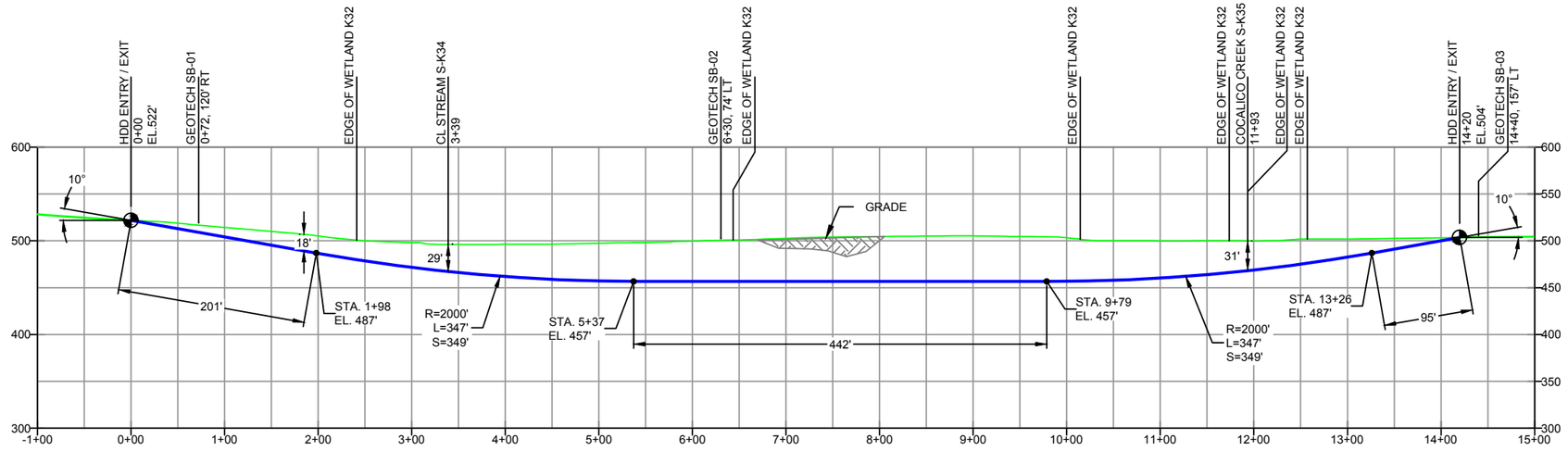
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 368 feet from the western edge of Stream K34 (S-K34) and enter/exit 1,080 feet from the eastern edge. The drill will enter/exit 1,220 feet from the western edge of Stream K35 (S-K35) and enter/exit 230 feet from the eastern edge. The Grassy Wetland K32 (PEM-K32) crosses the drill in two different locations with a non-wetland field in between. The drill will enter/exit 270 feet from the western-most edge of the western crossing of PEM-K32 and enter/exit 780 feet from the eastern edge of the western crossing. The drill will enter/exit 1,040 feet from the western edge of the eastern crossing and enter/exit 160 feet from the eastern edge. The drill will cross 30 feet below the streams (S-K34 and S-K35) and will range from 20 feet to 45 feet below the wetland. The geotechnical results, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). According to the geotechnical report the primary substrates being drilled through are fine to medium sands with silty clays (down to 30 feet) and medium to course sand below that. Based on the geotechnical reports and the drill profile minimal inadvertent returns are expected.



LANCASTER COUNTY, PENNSYLVANIA - CLAY/WEST COCALICO TOWNSHIP
S3-0111

PROFILE VIEW



GEOTECH SB-01

-NG EL. 519'
-TOPSOIL (0' - 0.3')
-SC (0.3' - 30.0')
-GROUNDWATER (19.0')
-COMPLETION DEPTH EL. 489'

GEOTECH SB-02

-NG EL. 502'
-TOPSOIL (0' - 0.4')
-SM (0.4' - 6.5')
-GROUNDWATER (5.0')
-CL (6.5' - 11.5')
-SM (11.5' - 29.1')
-CL (29.1' - 31.5')
-SM (31.5' - 66.0')
-ML (66.0' - 71.0')
-SM (71.0' - 73.5')
-COMPLETION DEPTH EL. 429'

NOTE: REFER TO TEST BORING LOG S3-0111 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-03

-NG EL. 505'
-TOPSOIL (0' - 0.4')
-GROUNDWATER (8.0')
-ML (0.2' - 21.5')
-SM (21.5' - 26.0')
-ML (26.0' - 30.0')
-COMPLETION DEPTH EL. 475'

NOTE: REFER TO TEST BORING LOG S3-0111 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=):1420'
   HDD PIPE LENGTH (S=):1436'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

DWG NO		DWG NO	DESCRIPTION
ES-4.05	TO	ES-4.05	EROSION & SEDIMENT PLAN
SHEET 3	TO	SHEET 3	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	DLM	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
C	ADDED GEOTECH INFO	MRS	09/23/15	RMB	09/23/15	AAW	09/23/15
B	ISSUED FOR BID	MRS	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	JVA	04/15/15	RMB	04/15/15	AAW	04/15/15

Sunoco Logistics Partners L.P.

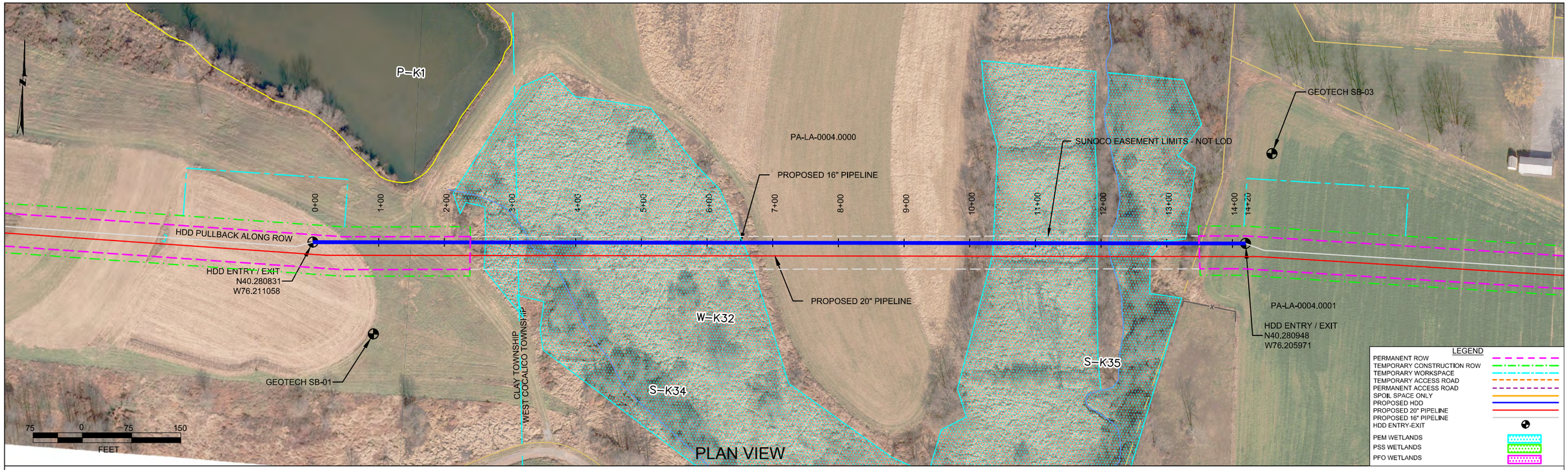
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
WETLAND K32 & S-K35
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

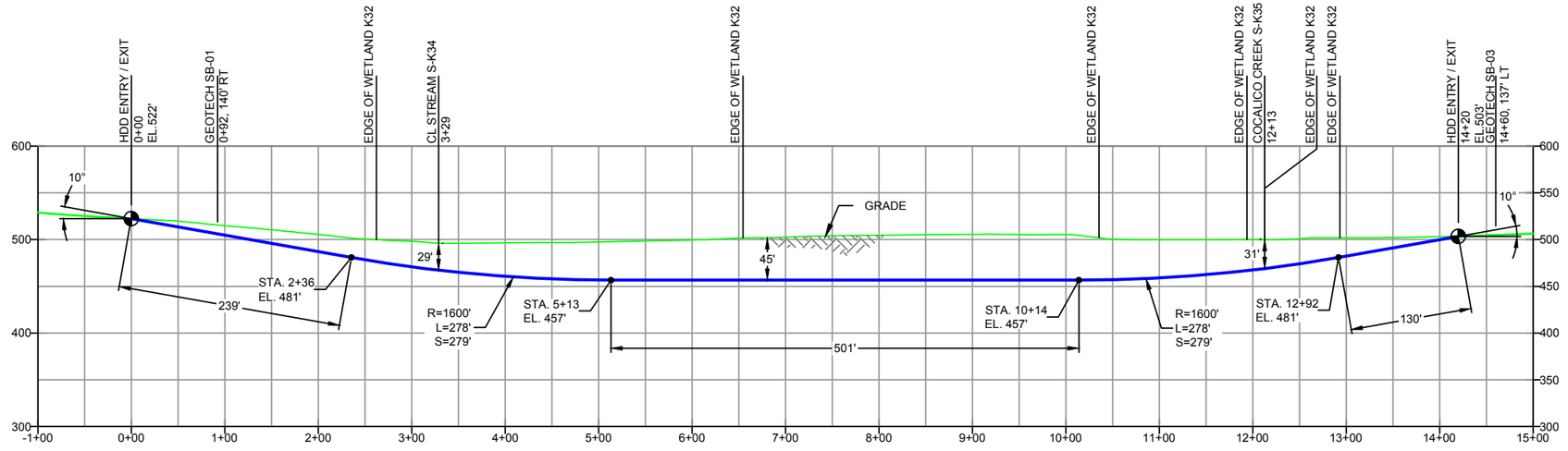
DWG. NO: PA-LA-0004.0000-SR



PLAN VIEW

LANCASTER COUNTY, PENNSYLVANIA - CLAY/WEST COCALICO TOWNSHIP
S3-0111-16

PROFILE VIEW



GEOTECH SB-01

-NG EL. 519'
-TOPSOIL (0' - 0.3')
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-GROUNDWATER (19.0')
-COMPLETION DEPTH EL. 489'

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-NG EL. 502'
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-SM (0.4' - 6.5')
-GROUNDWATER (5.0')
-CL (6.5' - 11.5')
-SM (11.5' - 29.1')
-CL (29.1' - 31.5')
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NOTE: REFER TO TEST BORING LOG S3-0111 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-03

-NG EL. 505'
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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1420'
   HDD PIPE LENGTH (S=):1428'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-4.05	TO ES-4.05	EROSION & SEDIMENT PLAN	
SHEET 3	TO SHEET 3	AERIAL SITE PLAN	
DWG NO	DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/07/16	RMB	10/07/16	AAW	10/07/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
B	ADDED GEOTECH INFO	MRS	09/24/15	RMB	09/24/15	AAW	09/24/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	08/31/15

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792–5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
WETLAND K32 & S-K35
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'

DWG. NO: PA-LA-0004.0000-SR-16

LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0111 WETLAND K32
LANCASTER COUNTY, CLAY TOWNSHIP AND
LANCASTER COUNTY, WEST COCALICO TOWNSHIP, PA
SUNOCO PENNSYLVANIA PIPELINE PROJECT

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	PINTAIL DRIVE, MIDDLE CREEK WILDLIFE MAMAGEMENT AREA, DENVER, PA		Page 1 of 1
HDD No.:	S3-0111	Dates(s) Drilled: 05-06-15	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 19.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 16' 49.644" N	76° 12' 38.503" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.3			TOPSOIL (4")					
1	3.0	5.0	0.3			22	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	7	10	10	12	**20**
							TRACE FINE GRAVEL.					
2	8.0	9.4				17	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	4	18	50/5"		**>50**
							TRACE FINE GRAVEL. TRACE CONGLOMERATE MATRIX.					
3	13.0	13.8				4	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	38	50/3"			**>50**
							TRACE FINE GRAVEL. TRACE CONGLOMERATE MATRIX.					
4	18.0	20.0			SC	7	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	4	3	6	11	**9**
							TRACE FINE GRAVEL. (USCS: SC).					
5	23.0	23.5				6	REDDISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, WITH A	50/6"				**>50**
							LITTLE FINE GRAVEL.					
6	28.0	28.5				5	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILTY CLAY,	50/6"				**0**
				30.0			WITH A LITTLE FINE GRAVEL.					
							AUGERED TO 30'.					
							CAVED AT 26', WATER LEVEL ON CAVE AT 19'.					
							BORING WAS RELOCATED WEST FROM INTENDED LOCATION TO					
							KEEP OUT OF WINTER WHEAT FIELD (PER LO REQUEST).					

Notes/Comments:
Pocket Pentrometer Testing

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

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

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	PINTAIL DRIVE, MIDDLE CREEK WILDLIFE MAMAGEMENT AREA, DENVER, PA		Page 1 of 1
HDD No.:	S3-0111	Dates(s) Drilled: 05-06-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 5.0	Total Depth (ft): 75.0
Boring Location Coordinates:		40° 16' 51.722" N	76° 12' 31.379" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.4			TOPSOIL (5")					
1	3.0	5.0	0.4		16	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, TRACE	5	14	8	9	**22**
				6.5			FINE GRAVEL.					
2	8.0	10.0	6.5		12	CL	REDDISH BROWN SILTY CLAY AND FINE SAND (USCS: CL)	3	11	15	15	**26**
				11.5								
3	13.0	14.5	11.5		16	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE	18	28	50/5"		**>50**
							FINE TO COARSE GRAVEL (SOME CONGLOMERATE MATRIX)					
4	18.0	18.6			5		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILT, TRACE	30	50/1"			**>50**
							FINE TO COARSE GRAVEL (SOME CONGLOMERATE MATRIX)					
5	23.0	24.3			16		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, TRACE	4	35	50/4"		**>50**
				29.1			FINE TO COARSE GRAVEL (SOME CONGLOMERATE MATRIX)					
6	28.0	30.0	29.1		24	CL	REDDISH BROWN MICACEOUS SILT CLAY, TRACE FINE SAND	14	35	37	50	**72**
				31.5			(USCS: CL).					
7	33.0	33.8	31.5		9	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	23	50/4"			**>50**
							WITH A LITTLE FINE GRAVEL.					
8	38.0	38.8			10		REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	6	50/4"			**>50**
							WITH A LITTLE FINE GRAVEL.					
9	43.0	43.1			<1		REDDISH BROWN WEATHERED CONGLOMERATE.	50/1"				**>50**
10	48.0	48.9			5		REDDISH BROWN WEATHERED CONGLOMERATE.	6	50/5"			**>50**
11	53.0	53.4			5		REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME SILT, WITH	50/5"				**>50**
							A LITTLE F-C GRAVEL (SOME CONGLOMERATE MATRIX).					
12	58.0	58.8			9		REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME SILT, WITH	17	50/3"			**>50**
							A LITTLE F-C GRAVEL (SOME CONGLOMERATE MATRIX). (USCS: SM)					
13	63.0	63.5			6		REDDISH BROWN MEDIUM TO COARSE SAND WITH SOME SILT, WITH	50/6"				**>50**
				66.0			A LITTLE F-C GRAVEL (SOME CONGLOMERATE MATRIX).					
14	68.0	68.4	66.0		3	ML	REDDISH BROWN MICACEOUS SLIGHTLY WEATHERED SILTSTONE.	50/5"				**>50**
				71.0								
15	73.0	73.5	71.0		6	SM	REDDISH BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT, AND	50/6"				**>50**
				73.5			WITH A LITTLE FINE GRAVEL.					

Notes/Comments:

Pocket Pentrometer Testing

WET ON SPOON AT 5'.
CAVED AT 51', WATER LEVEL ON CAVE AT 3'.

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

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

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	S. COCLICO ROAD, DENVER, PA		Page 1 of 1
HDD No.:	S3-0111	Dates(s) Drilled: 12-16-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): SEE BELOW	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 16' 52.781" N	76° 12' 20.970" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.2			TOPSOIL (2")					
1	3.0	5.0	0.2		14		MOTTLED BROWN AND ORANGE BROWN CLAYEY SILT WITH A LITTLE	1	5	7	10	**12**
							FINE SAND (USCS: ML).					
2	8.0	10.0			19		REDDISH BROWN MICACEOUS CLAYEY SILT AND FINE SAND.	4	6	13	20	**19**
						ML						
3	13.0	15.0			24		REDDISH BROWN CLAYEY SILT WITH A LITTLE FINE SAND	2	11	16	30	**27**
							(USCS: ML).					
4	18.0	19.9			18		REDDISH BROWN CLAYEY SILT AND FINE SAND.	3	21	28	50/5"	**49**
				21.5								
5	23.0	23.8	21.5		9	SM	REDDISH BROWN MICACEOUS FINE SAND WITH SOME CLAYEY SILT.	5	50/4"			**>50**
				26.0								
6	28.0	30.0	26.0		14	ML	REDDISH BROWN CLAYEY SILT WITH A LITTLE FINE SAND.	2	14	36	40	**50**
				30.0								
							WET ON SPOON AT 16'.					
							WATER LEVEL THROUGH AUGERS AT 4'.					
							CAVED AT 28.5', WATER LEVEL ON CAVE AT 8'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0111 WETLAND K32

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S3-0111	SB-01	2	8.0	9.4	7.5	35.0	-	-	-	-
		3	13.0	13.8	6.6	32.5	-	-	-	-
		4	18.0	20.0	12.9	38.0	31	16	15	SC
		5	23.0	23.5	6.3	40.4	-	-	-	-
		6	28.0	28.5	8.9	20.2	-	-	-	-
	SB-02	2	8.0	10.0	15.8	67.5	28	18	10	CL
		3	13.0	14.5	11.4	22.7	-	-	-	-
		5	23.0	24.3	11.9	17.8	-	-	-	-
		6	28.0	30.0	12.0	91.8	38	21	17	CL
		7	33.0	33.8	16.9	17.7	-	-	-	-
		11	53.0	53.4	10.9	25.4	-	-	-	-
		12	58.0	58.8	12.0	31.1	31	24	7	SM
		14	68.0	68.4	6.1	73.4	-	-	-	-
		15	73.0	73.5	13.6	20.2	-	-	-	-
	SB-03	1	3.0	5.0	20.1	78.7	39	27	12	ML
		2	8.0	10.0	15.3	53.1	-	-	-	-
		3	13.0	15.0	17.9	82.0	26	26	NP	ML
		4	18.0	19.9	10.1	61.1	-	-	-	-
		5	23.0	23.8	14.2	32.5	-	-	-	-
		6	28.0	30.0	17.5	82.2	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0111

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S3-0111	Wetland K32	SB-01 SB-02 SB-03	**Hammer Creek Formation** - Gray and pale red, fine- to coarse-grained quartzose sandstone, siltstone, and mudstone, interbeds of red shale and quartz conglomerate	Level to very gently rolling	Hammer Creek Fm	sandstone with quartz pebble conglomerate	9,360	20-35	Yields 8-22 gpm

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Relative Proportions

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

Particle Size Identification

Boulders	8 in. diameter or more	
Cobbles	3 to 8 in. diameter	
Gravel	Coarse (C)	3 in. to ¾ in. sieve
	Fine (F)	¾ in. to No. 4 sieve
Sand	Coarse (C)	No. 4 to No. 10 sieve (4.75mm-2.00mm)
	Medium (M)	No. 10 to No. 40 sieve (2.00mm – 0.425mm)
	Fine (F)	No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)	

COHESIVE SOILS

(Silt, Clay & Combinations)

Consistency	***N (blows)****
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

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

ROCK

(Rock Cores)

Rock Quality Designation (RQD), %	***Rock Quality Description***
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

N - Standard Penetration Resistance. Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

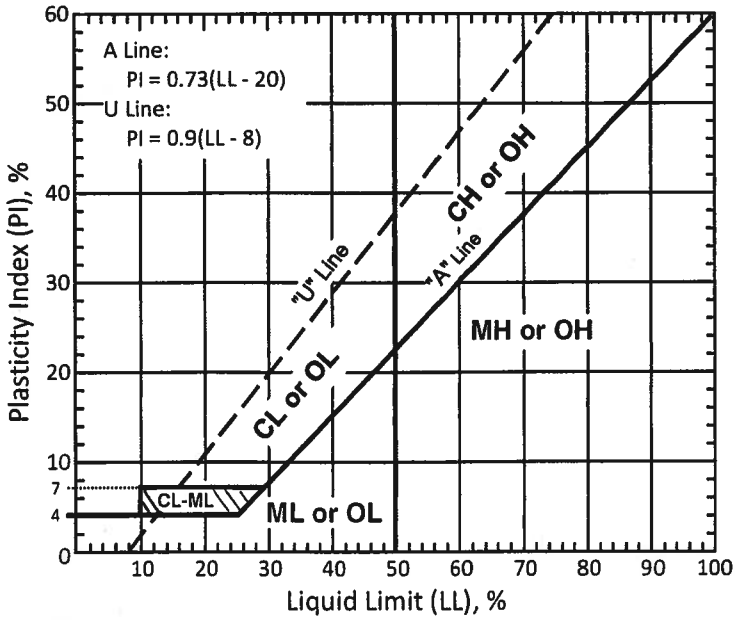
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions			Group Symbols	Typical Descriptions	Laboratory Classifications		
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols[1]	$C_u=\frac{D_{60}}{D_{10}}$ greater than 4: $C_c=\frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW	
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravely sands, little or no fines		$C_u=\frac{D_{60}}{D_{10}}$ greater than 6: $C_c=\frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7	

Major Divisions		Group Symbols	Typical Descriptions
Fine–grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays , sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
	Highly organic soils	Pt	Peat and other highly organic soils

For soils plotting nearly on A line use dual symbols i.e ., I_p = 29.5, w_L=60 gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.



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

Bog Turtle Area HDDs

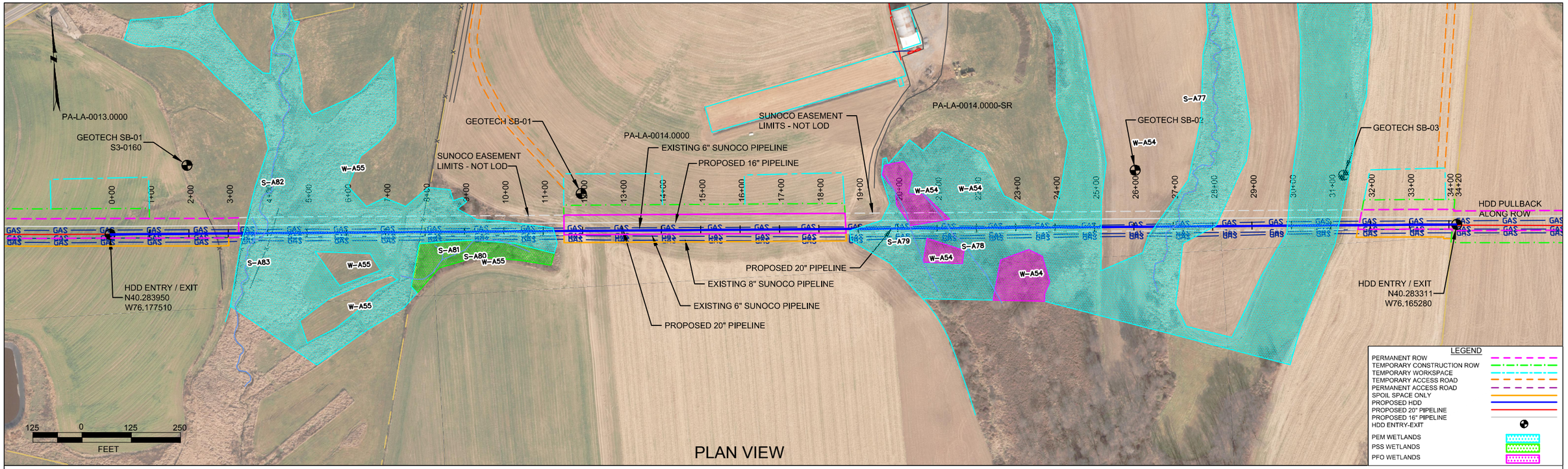
HDDs under bog turtle occupied wetlands is a primary avoidance measure. However, inadvertent return of drilling fluids to the surface of these wetlands is the primary threat to bog turtles. Therefore SPLP has implemented measures to ensure the potential for returns are reduced, including geotechnical investigations. At each of the bog turtle wetland, a summary of the HDD evaluation is provided below.

HDD PA-LA-0014.0000 (W-A55 and W-A54)

After consideration of the all data points, including the sensitivity of the area and geotechnical results, the preliminary design of this drill has been found to be adequate for safe installation and operation (see Attachment A for the drill design and the geotechnical investigation report).

The drill would enter/exit 250 feet from the edge of the western most boundary of the wetland A55PEM. The drill would pass 25 feet under the western most boundary of wetland A55PEM and 60 feet under the eastern most boundary of Wetland A55PEM. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand and clay at the western end of the wetland and weathered sandstone beneath the central and eastern portion of the wetland.

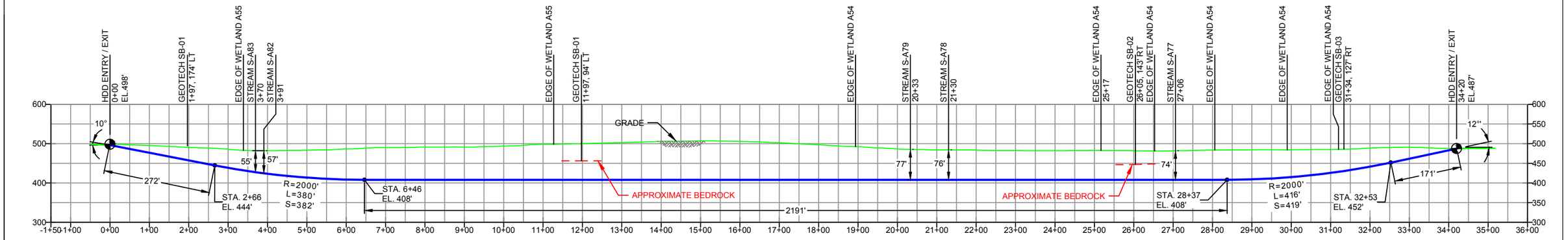
The drill would continue beneath the western most boundary of the wetland A54PEM and would enter/exit 125 feet from the eastern most edge of wetland A54PEM. The drill would pass 60 feet under the western most boundary of wetland A54PEM and 20 feet under the eastern most boundary of Wetland A54PEM. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be clay, silty clay and silty sand at the eastern end of the wetland and weathered siltstone/sandstone beneath the central and western portions of the wetland. Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable. Implementing this design, along with adherence to the *Pennsylvania Pipeline Project Inadvertent Return Contingency Plan – with Special Bog Turtle Procedures* will ensure the bog turtle is not impacted as result of this HDD.



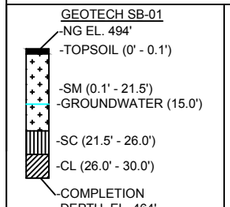
PLAN VIEW

PROFILE VIEW

LANCASTER COUNTY, PENNSYLVANIA - WEST COCALICO TOWNSHIP
S3-0161

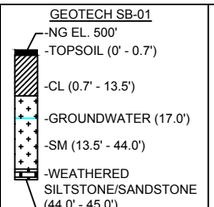


GEOTECH SB-01



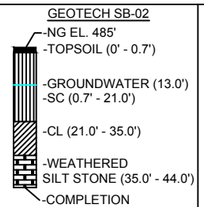
NOTE: REFER TO TEST BORING LOG S3-0160 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-01



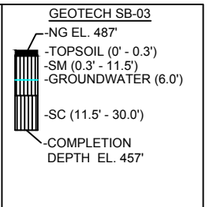
NOTE: REFER TO TEST BORING LOG S3-0170 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-02



NOTE: REFER TO TEST BORING LOG S3-0170 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S3-0170 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=): 3420'
   HDD PIPE LENGTH (S=): 3435'
   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-4.11	TO	ES-4.13	EROSION & SEDIMENT PLAN	
SHEET 6	TO	SHEET 8	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	DLM	10/24/16	RMB	10/24/16	AAW	10/24/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
1	DESIGN CHANGE	MRS	02/24/16	RMB	02/24/16	AAW	02/24/16
0	ISSUED FOR CONSTRUCTION	MRS	01/21/16	RMB	01/21/16	AAW	01/21/16

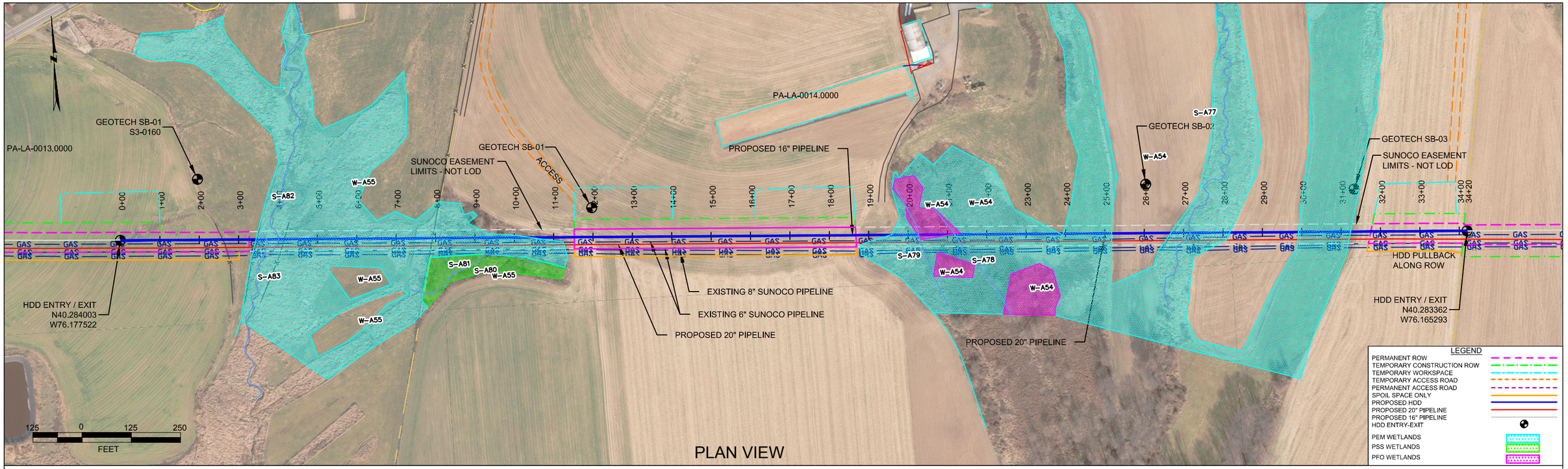
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
WETLAND A54 & A55
PENNSYLVANIA PIPELINE PROJECT

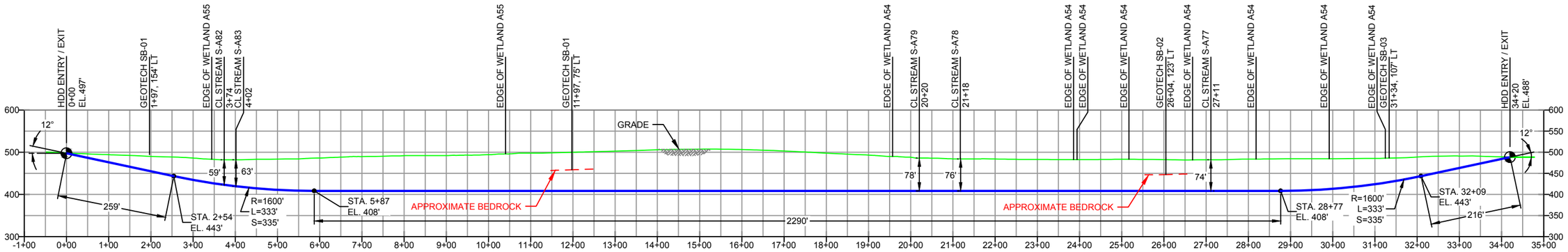
SCALE: 1"=250' | DWG. NO: PA-LA-0014.0000-SR



PLAN VIEW

PROFILE VIEW

LANCASTER COUNTY, PENNSYLVANIA - WEST COCALICO TOWNSHIP
S3-0161-16



GEOTECH SB-01
-NG EL. 500'
-TOPSOIL (0' - 0.7')
-CL (0.7' - 13.5')
-GROUNDWATER (17.0')
-SM (13.5' - 44.0')
-WEATHERED SILTSTONE/SANDSTONE (44.0' - 45.0')
-COMPLETION DEPTH EL. 441'

GEOTECH SB-02
-NG EL. 485'
-TOPSOIL (0' - 0.7')
-GROUNDWATER (13.0')
-SC (0.7' - 21.0')
-CL (21.0' - 35.0')
-WEATHERED SILT STONE (35.0' - 44.0')
-COMPLETION DEPTH EL. 441'

GEOTECH SB-03
-NG EL. 487'
-TOPSOIL (0' - 0.3')
-SM (0.3' - 11.5')
-GROUNDWATER (6.0')
-SC (11.5' - 30.0')
-COMPLETION DEPTH EL. 457'

NOTE: REFER TO TEST BORING LOG S3-0170 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=):3170'
   HDD PIPE LENGTH (S=):3177'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

GEOTECH SB-01
-NG EL. 494'
-TOPSOIL (0' - 0.1')
-SM (0.1' - 21.5')
-GROUNDWATER (15.0')
-SC (21.5' - 26.0')
-CL (26.0' - 30.0')
-COMPLETION DEPTH EL. 464'

NOTE: REFER TO TEST BORING LOG S3-0160 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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-4.11	TO	ES-4.13	EROSION & SEDIMENT PLAN	
SHEET 6	TO	SHEET 8	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	10/24/16	RMB	10/24/16	AAW	10/24/16
EP1	REVISED PER PADEP COMMENTS	JTW	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	02/26/16	RMB	02/26/16	AAW	02/26/16
1	DESIGN CHANGE	MRS	02/24/16	RMB	02/24/16	AAW	02/24/16
0	ISSUED FOR CONSTRUCTION	MRS	01/21/16	RMB	01/21/16	AAW	01/21/16

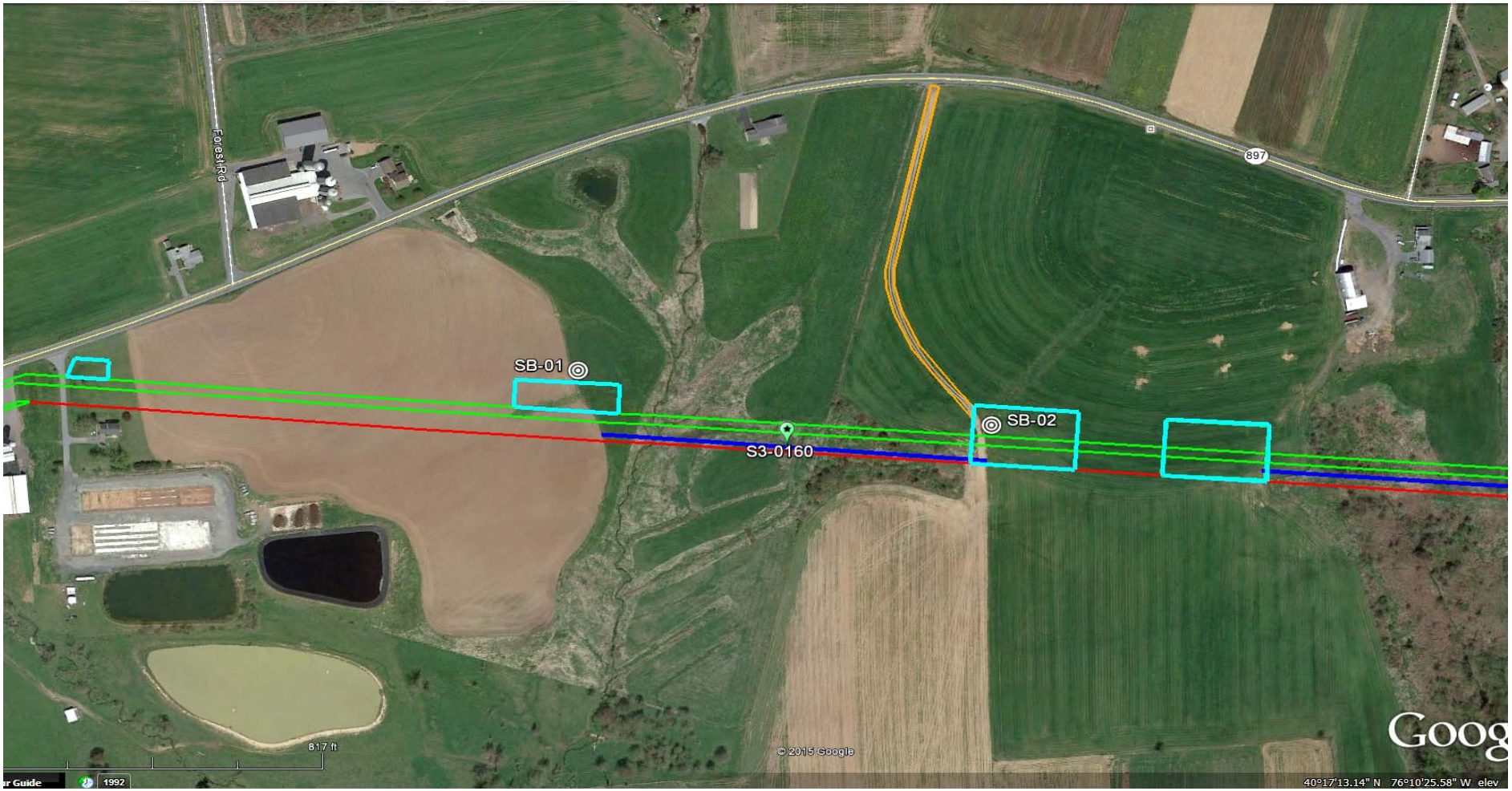
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
WETLAND A54 & A55
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=250' | DWG. NO: PA-LA-0014.0000-SR-16



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0160
LANCASTER COUNTY, WEST COCALICO TOWNSHIP, PA
SUNOCO PENNSYLVANIA PIPELINE PROJECT

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

TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	RT 897, DENVER, PA		Page 1 of 1
HDD No.:	S3-0160	Dates(s) Drilled: 12-13-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 15.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 17' 3.801" N	76° 10' 36.352" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.1			TOPSOIL (<1")					
1	3.0	5.0	0.1		14	SM	REDDISH BROWN TO GRAYISH BROWN FINE TO MEDIUM SAND WITH	4	16	20	22	**36**
							A LITTLE SILT, TRACE FINE QUARTZ GRAVEL.					
2	8.0	10.0			24		REDDISH BROWN FINE TO COARSE SAND WITH SOME SILT, TRACE	2	14	10	12	**24**
							CONGLOMERATE MATRIX.					
3	13.0	14.5			18		REDDISH BROWN FINE SAND AND SILT, WITH A LITTLE	4	25	50		**75**
							CONGLOMERATE MATRIX.					
4	18.0	19.4			14		REDDISH BROWN FINE SAND AND SILT, WITH A LITTLE	9	33	50/5"		**>50**
				21.5			CONGLOMERATE MATRIX.					
5	23.0	23.9	21.5		10	SC	REDDISH BROWN FINE SAND AND SILTY CLAY, WITH A LITTLE	2	50/5"			**>50**
				26.0			FINE TO COARSE UNWEATHERED GRAVEL (USCS: SC)					
6	28.0	28.8	26.0		9	CL	REDDISH BROWN SILTY CLAY AND FINE SAND, WITH A LITTLE	23	50/4"			**>50**
				30.0			FINE TO COARSE UNWEATHERED GRAVEL.					
							AUGERED TO 30'.					
							WET ON SPOON AT 15'.					
							WATER LEVEL THROUGH AUGERS AT 17'.					
							CAVED AT 28'.					

Notes/Comments:
Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

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

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

TETRA TECH
240 Continental Drive, Suite 200
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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	MIDDLECREEK WILDLIFE MANAGEMENT AREA, NEWMANSTOWN, PA		Page 1 of 1
HDD No.:	S3-0160	Dates(s) Drilled: 11-20-14	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 17.0	Total Depth (ft): 53.0
Boring Location Coordinates:		40° 17' 2.346" N	76° 10' 23.538" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		24		MAROON SILTY CLAY AND FINE SAND, TRACE QUARTZ FINE	3	10	11	10	**21**
						CL	GRAVEL.					
2	8.0	10.0			8		MAROON MICACEOUS SILTY CLAY WITH SOME FINE SAND.	3	4	3	3	**7**
				13.5			(USCS: CL).					
3	13.0	13.9	13.5		11		MAROON FINE TO MEDIUM SAND WITH A LITTLE CLAYEY SILT, TRACE	28	50/5"			**>50**
							FINE GRAVEL.					
4	18.0	18.9			12		MAROON FINE TO MEDIUM SAND WITH A LITTLE CLAYEY SILT, TRACE	14	50/5"			**>50**
							FINE GRAVEL.					
5	23.0	25.0			16		MARRON FINE SAND WITH SOME CLAYEY SILT, TRACE	3	11	28	50	**39**
							CONGLOMERATE.					
6	28.0	29.0			11		MAROON FINE TO MEDIUM SAND WITH SOME CLAYEY SILT, TRACE	9	50/6"			**>50**
						SM	CONGLOMERATE.					
7	33.0	34.0			12		MAROON FINE SAND AND CLAYEY SILT, TRACE CONGLOMERATE.	28	50/6"			**>50**
8	38.0	38.9			8		MAROON FINE SAND AND CLAYEY SILT, TRACE CONGLOMERATE.	8	50/5"			**>50**
							(USCS: SM)					
9	43.0	43.9			10		MAROON MEDIUM TO COARSE SAND WITH SOME CLAYEY SILT,	12	50/5"			**>50**
				44.0			TRACE FINE QUARTZ GRAVEL.					
10	44.6	45.0	44.0	45.0	4		PARTIALLY WEATHERED SILTSTONE/SANDSTONE.	50/5"				**>50**
							AUGER REFUSAL AT 44.6'.					
							ROCK CORING					
RUN 1	45.0	48.0	45.0		20		HIGHLY FRACTURED AND WEATHERED REDDISH BROWN	TCR: 55%, SCR: 0%, RQD: 0%				
				49.3			SILTSTONE.					
RUN 2	48.0	53.0	49.3		60		HIGHLY FRACTURED AND WEATHERED MAROON SILTSTONE AND	TCR: 100%, SCR: 12%, RQD: 9%				
				51.3			MEDIUM TO COARSE GRAINED SANDSTONE INTERBEDS.					
			51.3				MODERATELY TO HIGHLY FRACTURED, MODERATELY WEATHERED					
				53.0		FRACTURED ROCK	MARRON SILTSTONE AND QUARTZ PEBBLE CONGLOMERATE.					

Notes/Comments:

Pocket Pentrometer Testing
S2: 0.5 TSF

DR: DECOMPOSED ROCK

WET ON SPOON AT 17'
WATER LEVEL THROUGH AUGERS AT 18'
CAVED AT 37'.

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0160

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
S3-0160	SB-01	2	8.0	10.0	10.9	29.2	-	-	-	-
		3	13.0	14.5	8.4	39.2	-	-	-	-
		4	18.0	19.4	7.0	41.2	-	-	-	-
		5	23.0	23.9	10.4	46.2	26	16	8	SC
		6	28.0	28.8	7.8	65.3	-	-	-	-
	SB-02 (Also S3-0170, SB-01)	2	8.0	10.0	16.7	78.1	27	16	11	CL
		4	18.0	18.9	11.3	19.7	-	-	-	-
		6	28.0	29.0	8.6	27.9	-	-	-	-
		8	38.0	38.9	10.7	44.4	18	18	NP	SM
		9	43.0	43.9	10.6	25.1	-	-	-	-

Notes:

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

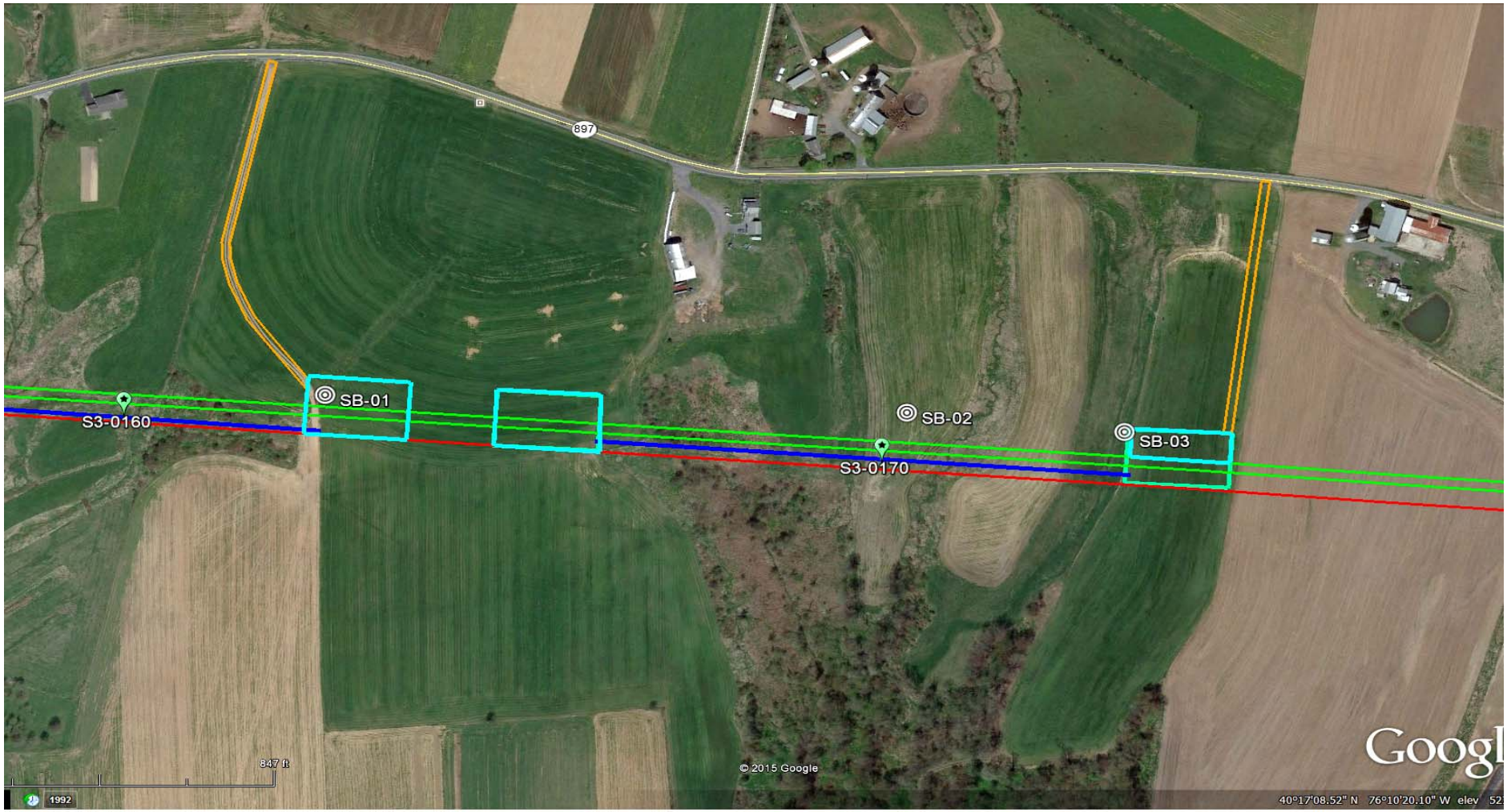
REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0160

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S3-0160	Wetland A55	SB-01 SB-02	**Hammer Creek Formation** - Gray and pale red, fine- to coarse-grained quartzose sandstone, siltstone, and mudstone	Lowland, wetlands area	Hammer Creek Fm	sandstone with quartz pebble conglomerate	9,360	50-70	

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

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0160

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S3-0160	SB-2	1	45	48	55	0	0	45	48	Heavily	Siltstone	Massive	Red	Heavily fractured, ranging from 0° to 45°
		2	48	53	100	12	9	48	53	Heavily	Siltstone with interbedded Sandstone	Massive, bedding is gradational	Red	Heavily fractured, ranging from 0° to 65°



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0170
LANCASTER COUNTY, WEST COCALICO TOWNSHIP, PA
SUNOCO PENNSYLVANIA PIPELINE PROJECT

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	RT 897, DENVER, PA		Page 1 of 1
HDD No.:	S3-0170	Dates(s) Drilled: 11-20-14	Inspector: E. WATT
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 17.0	Total Depth (ft): 53.0
Boring Location Coordinates:		40° 17' 2.346" N	76° 10' 23.538" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		24		MAROON SILTY CLAY AND FINE SAND, TRACE QUARTZ FINE	3	10	11	10	**21**
						CL	GRAVEL.					
2	8.0	10.0			8		MAROON MICACEOUS SILTY CLAY WITH SOME FINE SAND.	3	4	3	3	**7**
				13.5			(USCS: CL).					
3	13.0	13.9	13.5		11		MAROON FINE TO MEDIUM SAND WITH A LITTLE CLAYEY SILT, TRACE	28	50/5"			**>50**
							FINE GRAVEL.					
4	18.0	18.9			12		MAROON FINE TO MEDIUM SAND WITH A LITTLE CLAYEY SILT, TRACE	14	50/5"			**>50**
							FINE GRAVEL.					
5	23.0	25.0			16		MARRON FINE SAND WITH SOME CLAYEY SILT, TRACE	3	11	28	50	**39**
							CONGLOMERATE.					
6	28.0	29.0			11		MAROON FINE TO MEDIUM SAND WITH SOME CLAYEY SILT, TRACE	9	50/6"			**>50**
						SM	CONGLOMERATE.					
7	33.0	34.0			12		MAROON FINE SAND AND CLAYEY SILT, TRACE CONGLOMERATE.	28	50/6"			**>50**
8	38.0	38.9			8		MAROON FINE SAND AND CLAYEY SILT, TRACE CONGLOMERATE.	8	50/5"			**>50**
							(USCS: SM)					
9	43.0	43.9			10		MAROON MEDIUM TO COARSE SAND WITH SOME CLAYEY SILT,	12	50/5"			**>50**
				44.0			TRACE FINE QUARTZ GRAVEL.					
10	44.6	45.0	44.0	45.0	4		PARTIALLY WEATHERED SILTSTONE/SANDSTONE.	50/5"				**>50**
							AUGER REFUSAL AT 44.6'.					
							ROCK CORING					
RUN 1	45.0	48.0	45.0		20		HIGHLY FRACTURED AND WEATHERED REDDISH BROWN	TCR: 55%, SCR: 0%, RQD: 0%				
				49.3			SILTSTONE.					
RUN 2	48.0	53.0	49.3		60		HIGHLY FRACTURED AND WEATHERED MAROON SILTSTONE AND	TCR: 100%, SCR: 12%, RQD: 9%				
				51.3			MEDIUM TO COARSE GRAINED SANDSTONE INTERBEDS.					
			51.3				MODERATELY TO HIGHLY FRACTURED, MODERATELY WEATHERED					
				53.0		FRACTURED ROCK	MARRON SILTSTONE AND QUARTZ PEBBLE CONGLOMERATE.					

Notes/Comments:

Pocket Pentrometer Testing
S2: 0.5 TSF

WET ON SPOON AT 17'
WATER LEVEL THROUGH AUGERS AT 18'
CAVED AT 37'.

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

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

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	RT 897, DENVER, PA		Page 1 of 1
HDD No.:	S3-0170	Dates(s) Drilled: 02-06-15	Inspector: E. WATT
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 13.0	Total Depth (ft): 44.0
Boring Location Coordinates:		40° 17' 1.883" N	76° 10' 5.380" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.7			TOPSOIL (8")					
1	3.0	5.0	0.7		22		MOTTLED (REDDISH BROWN, GRAY AND ORANGE BROWN) FINE TO	3	7	11	14	**18**
							MEDIUM SAND, WITH SOME SILTY CLAY, TRACE FINE GRAVEL.					
2	8.0	10.0			18		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	3	2	4	5	**6**
						SC	TRACE FINE GRAVEL.					
3	13.0	14.9			17		REDDISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, WITH A	13	27	44	50/5"	**>50**
							LITTLE UNWEATHERED ROCK FRAGMENTS. (USCS: SC)					
4	18.0	19.0			12		REDDISH BROWN FINE TO MEDIUM SAND AND SILTY CLAY, WITH A	11	50/6"			**>50**
				21.0			LITTLE UNWEATHERED ROCK FRAGMENTS. (USCS: SC)					
5	23.0	25.0	21.0		24		REDDISH BRWON SILTY CLAY, TRACE FINE SAND, WITH TRACE	15	27	25	35	**52**
							UNWEATHERED ROCK FRAGMENTS. (USCS: CL).					
6	28.0	28.8			10		REDDISH BRWON SILTY CLAY, TRACE FINE SAND, WITH TRACE	20	50/4"			**>50**
						CL	UNWEATHERED ROCK FRAGMENTS.					
7	33.0	33.6			8		REDDISH BROWN SILTY CLAY AND FINE SAND, WITH A LITTLE	30	50/2"			**>50**
				35.0			UNWEATHERED ROCK FRAGMENTS. (USCS: CL).					
8	38.0	38.7	35.0		8	WEATHERED SILTSTONE	REDDISH BROWN HIGHLY WEATHERED SILTSTONE.	38	50/3"			**>50**
9	43.0	43.7		44.0	7		REDDISH BROWN HIGHLY WEATHERED SILTSTONE.	25	50/3"			**>50**
							AUGER REFUSAL AT 44'.					

Notes/Comments:

Pocket Pentrometer Testing

S4 to S7: > 4 TSF

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

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

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	RT 897, DENVER, PA		Page 1 of 1
HDD No.:	S3-0170	Dates(s) Drilled: 12-13-14	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 6.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 17' 1.365" N	76° 9' 58.579" W

Sample No.	Sample Depth (ft) From	Sample Depth (ft) To	Strata Depth (ft) From	Strata Depth (ft) To	Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
			0.0	0.3			TOPSOIL (3")					
1	3.0	5.0	0.3		11	SM	VARYING SHADES OF BROWN (TRACE WHITE) FINE TO COARSE	2	6	15	21	**21**
							SAND WITH A LITTLE SILT, TRACE FINE QUARTZ GRAVEL.					
2	8.0	10.0			22		REDDISH BROWN FINE TO COARSE SAND WITH A LITTLE SILT, TRACE	4	12	13	18	**25**
				11.5			FINE GRAVEL.					
3	13.0	15.0	11.5		17	SC	REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	16	26	25	35	**51**
							WITH A LITTLE FINE TO COARSE GRAVEL.					
4	18.0	18.8			9		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	10	50/3"			**>50**
							WITH A LITTLE FINE TO COARSE GRAVEL.					
5	23.0	23.7			5		REDDISH BROWN FINE TO MEDIUM SAND WITH SOME SILTY CLAY,	8	50/3"			**>50**
							WITH A LITTLE FINE TO COARSE GRAVEL.					
6	28.0	29.3		30.0	0		NO RECOVERY	11	20	50/3"		**>50**
							AUGERED TO 30'.					
							WET ON SPOON AT 13'.					
							WATER LEVEL THROUGH AUGERS AT 6'.					
							CAVED AT 27'.					

Notes/Comments:
Pocket Pentrometer Testing

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

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

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0170

HDD No.	Test Boring No.	Sample No.	Depth of Sample (ft.) From	Depth of Sample (ft.) To	Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterburg Limits (ASTM D4318) Liquid Limit, %	Atterburg Limits (ASTM D4318) Plastic Limit, %	Atterburg Limits (ASTM D4318) Plasticity Index, %	USCS Classif. (ASTM D2487)
S3-0170	SB-01	2	8.0	10.0	16.7	78.1	27	16	11	CL
		4	18.0	18.9	11.3	19.7	-	-	-	-
		6	28.0	29.0	8.6	27.9	-	-	-	-
		8	38.0	38.9	10.7	44.4	18	18	NP	SM
		9	43.0	43.9	10.6	25.1	-	-	-	-
	SB-02	2	8.0	10.0	17.0	28.6	-	-	-	-
		3	13.0	14.9	9.6	41.2	28	20	8	SC
		5	23.0	25.0	17.7	92.5	27	16	11	CL
		6	28.0	28.8	10.9	98.7	-	-	-	-
		7	33.0	33.6	10.0	53.6	28	16	12	CL
	SB-03	1	3.0	5.0	12.5	18.3	-	-	-	-
		2	8.0	10.0	13.6	17.1	-	-	-	-
		3	13.0	15.0	9.8	23.4	-	-	-	-
		4	18.0	18.8	9.3	19.8	-	-	-	-
		5	23.0	23.7	10.5	24.6	-	-	-	-

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0170

HDD No.	NAME	BORING NO.	REGIONAL GEOLOGY DESCRIPTION	GENERAL TOPOGRAPHIC SETTING	BEDROCK FORMATION	GENERAL ROCK TYPE	APPROX MAX FM THICKNESS (FT)	DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs	NOTES / COMMENTS
S3-0170	Wetland A54	SB-01	**Hammer Creek Formation** - Gray and pale red, fine- to coarse-grained quartzose sandstone, siltstone, and mudstone	Lowland, wetlands area	Hammer Creek Fm	sandstone with quartz pebble conglomerate	9,360	50-70	
		SB-02						50-75	
		SB-03						50-70	

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

ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0170

Location	Boring No.	Core Run	Core Depth (ft)		TCR (%)	SCR (%)	RQD (%)	Depth (ft)		Weathering	Classification	Bedding Thickness (ft)	Color	Discontinuity Data
			From	To				From	To					
S3-0170	SB-01	1	45	48	55	0	0	45	48	Heavily	Siltstone	Massive	Red	Heavily fractured, ranging from 0° to 45°
		2	48	53	100	12	9	48	53	Heavily	Siltstone with interbedded Sandstone	Massive, bedding is gradational	Red	Heavily fractured, ranging from 0° to 65°

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).

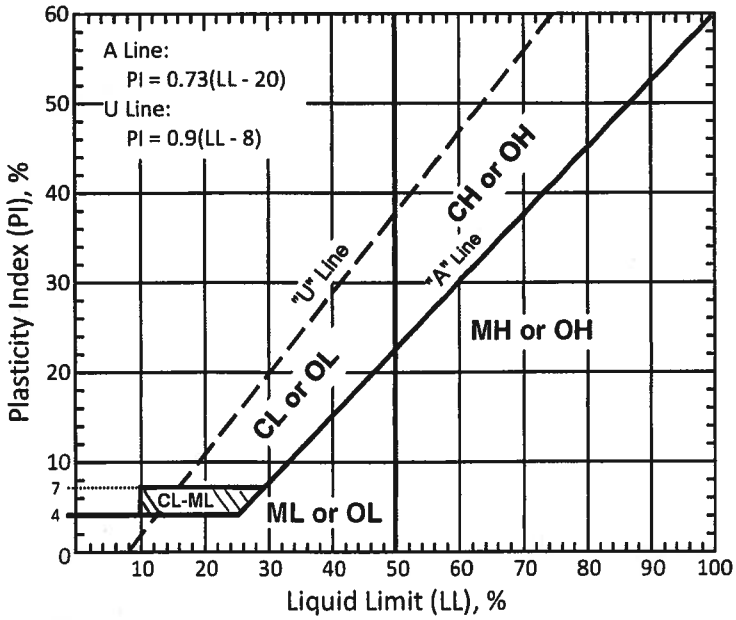
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.