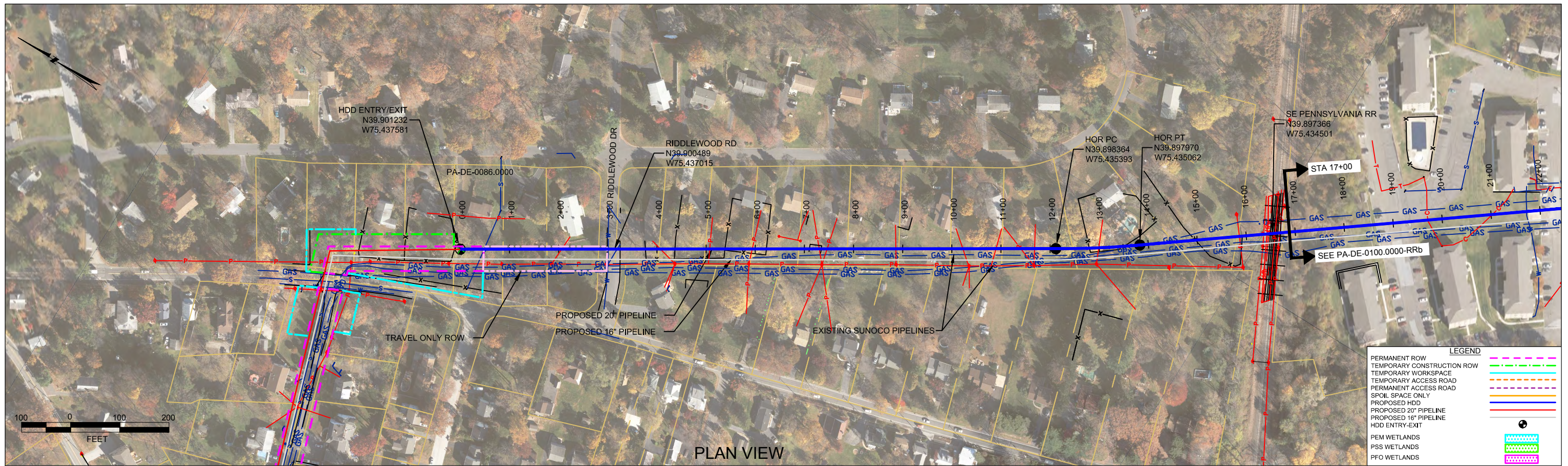


HDD PA-DE-0100.0000-RR (W-I1, and S-S12)

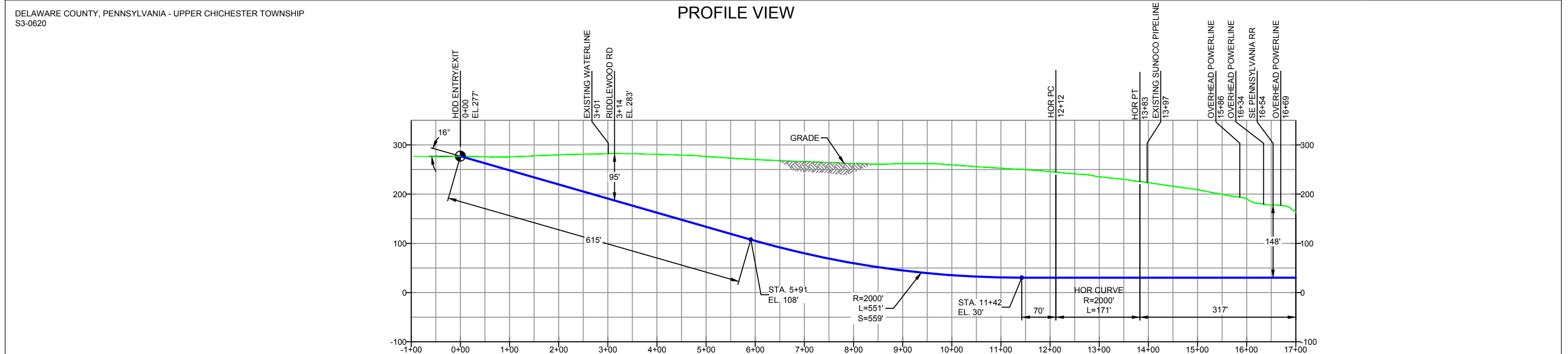
Given the design, the threat of inadvertent return has been reduced to the maximum extent practicable and in this case that threat is considered to be low. Implementing this design, along with adherence to the Pennsylvania Pipeline Project Inadvertent Return Contingency Plan will ensure inadvertent impacts,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

The drill will enter/exit 2820 feet northwest of the northwestern most boundary of wetland I1. The other entry/exit point is 390 feet southeast of the southeastern most boundary of this wetland. The drill will pass 40 feet under this wetland. 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 clayey sand, clay, silty sand and gneiss.

The drill will enter/exit 3226 feet northwest of stream S12. The other entry/exit point is 102 feet southeast of this stream. The drill will pass 14 feet under this stream. 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 clayey sand, clay, silty sand and gneiss.



PLAN VIEW



PROFILE VIEW

DELAWARE COUNTY, PENNSYLVANIA - UPPER CHICHESTER TOWNSHIP
S3-0620

DESIGN AND CONSTRUCTION:

- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
- THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
- DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
- CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L=): 3338'
HDD PIPE LENGTH (S=): 3373'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
- INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
- PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
- CARRIER PIPE NOT ENCASED.
- PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
- CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
- PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
- BLASTING NOT PERMITTED.
- SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

NOTES	
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		REVISIONS	
ES-6.18	TO ES-6.20	EROSION & SEDIMENT PLAN	
SHEET 12	TO SHEET 13	AERIAL SITE PLAN	EP1 REVISED PER PADEP COMMENTS
			EP
			C ISSUED FOR BID / DESIGN CHANGE
			B ISSUED FOR BID
			A ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

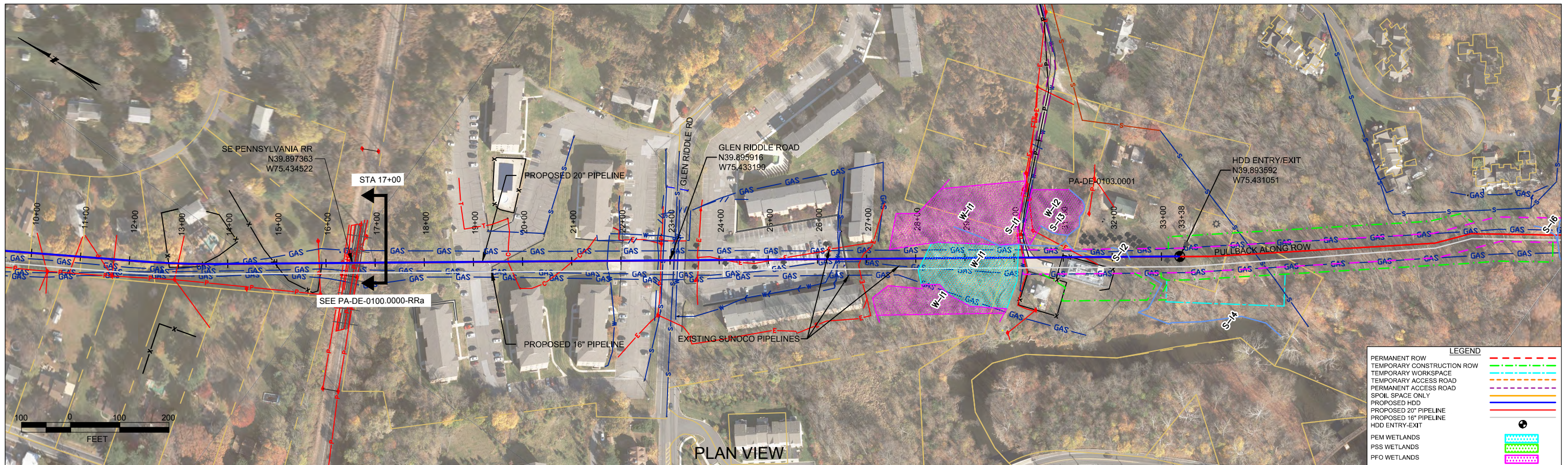
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
GLEN RIDDLE RD, SOUTHEASTERN PENNSYLVANIA RR
PENNSYLVANIA PIPELINE PROJECT

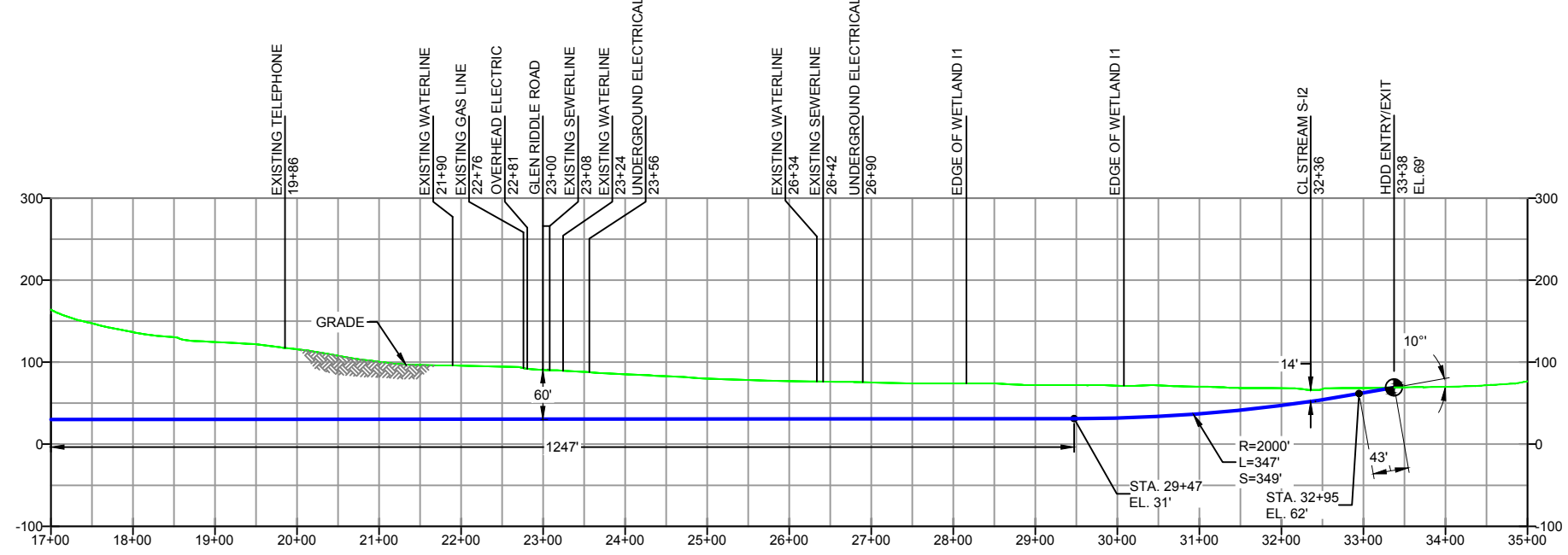
SCALE: 1"=200' DWG. NO. PA-DE-0100.0000-RRa



PLAN VIEW

DELAWARE COUNTY, PENNSYLVANIA - UPPER CHICHESTER TOWNSHIP
S3-0620

PROFILE VIEW



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L-): 3338'
HDD PIPE LENGTH (S-): 3373'
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
 - SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
 - SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

NOTES	
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		REVISIONS	
ES-6.18	TO ES-6.20	EROSION & SEDIMENT PLAN	
SHEET 12	TO SHEET 13	AERIAL SITE PLAN	EP1 REVISED PER PADEP COMMENTS
			EP
			C ISSUED FOR BID / DESIGN CHANGE
			B ISSUED FOR BID
			A ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

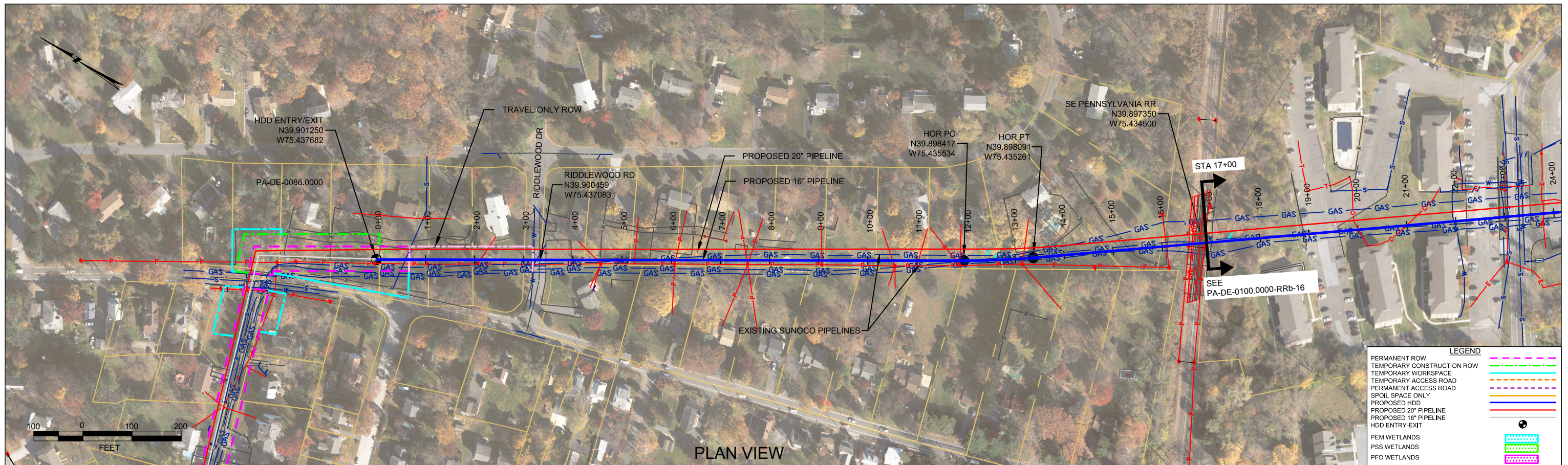
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

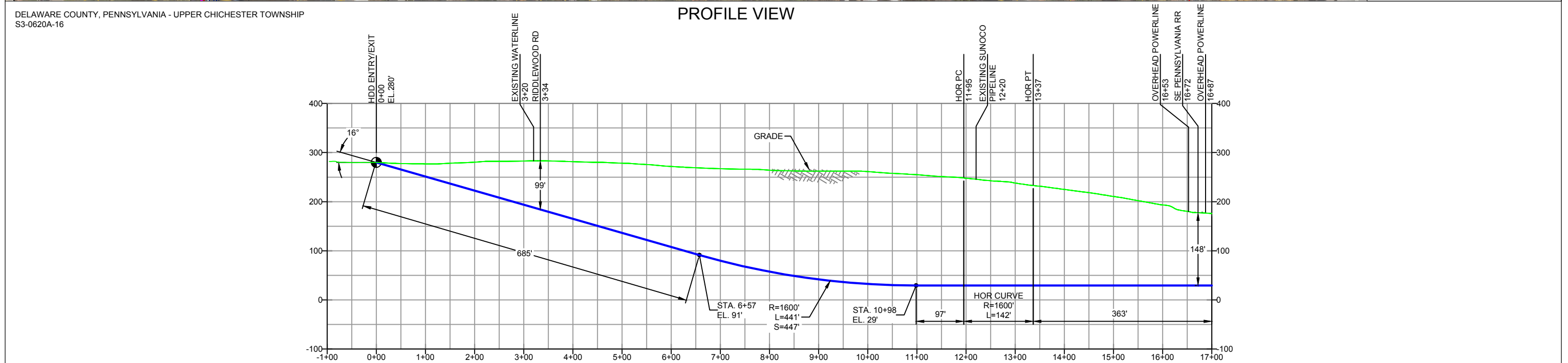
SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
GLEN RIDDLE RD, SOUTHEASTERN PENNSYLVANIA RR
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-DE-0100.0000-RRb



PLAN VIEW



PROFILE VIEW

DELAWARE COUNTY, PENNSYLVANIA - UPPER CHICHESTER TOWNSHIP
S3-0620A-16

DESIGN AND CONSTRUCTION:

- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
- THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
- DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
- CROSSING PIPE SPECIFICATION:
HDD HORZ. LENGTH (L=): 3379'
HDD PIPE LENGTH (S=): 3416'
16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
- INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
- PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
- CARRIER PIPE NOT ENCASED.
- PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
- CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
- PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
- BLASTING NOT PERMITTED.
- SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

NOTES	
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		REVISIONS	
ES-6.18	TO ES-6.20	EROSION & SEDIMENT PLAN	
SHEET 12	TO SHEET 13	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		B	ISSUED FOR BID
		A	ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

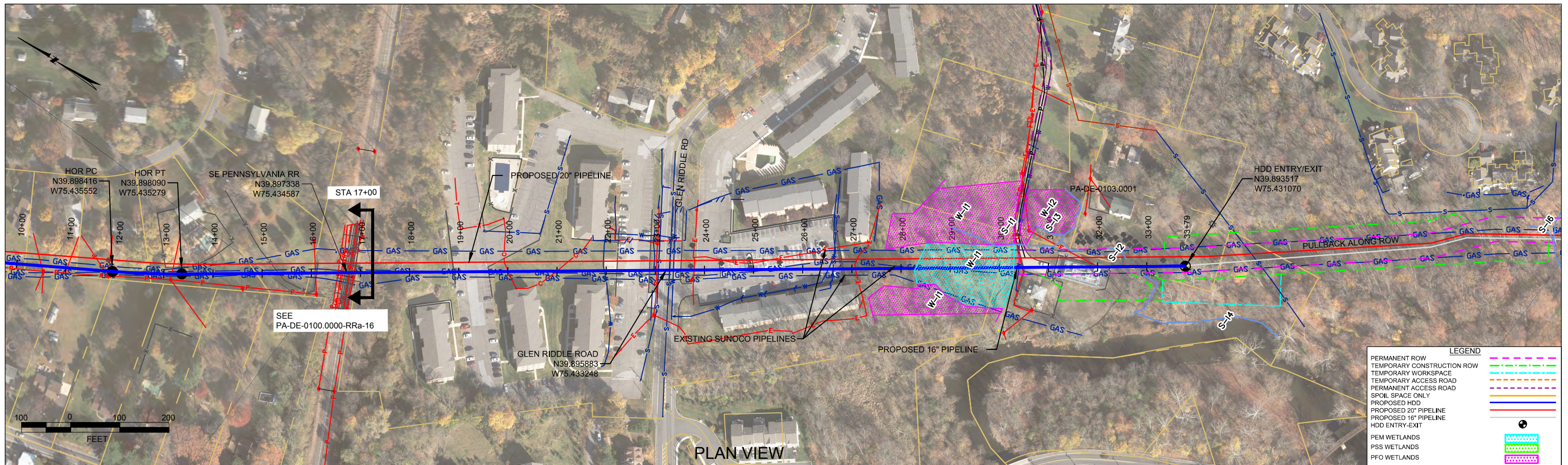
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

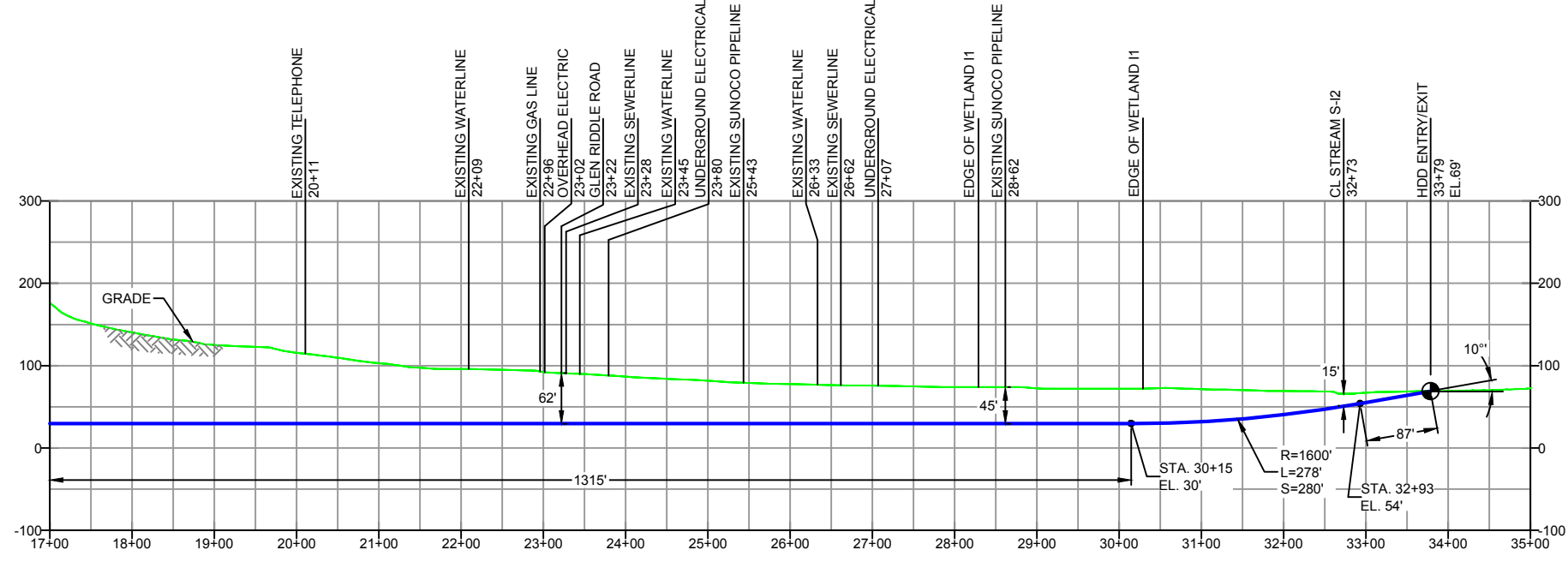
SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
GLEN RIDDLE RD, SOUTHEASTERN PENNSYLVANIA RR
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-DE-0100.0000-RRa-16



PROFILE VIEW



- DESIGN AND CONSTRUCTION:
- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
 - THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
 - DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
 - CROSSING PIPE SPECIFICATION:
 HDD HORZ. LENGTH (L=): 3379'
 HDD PIPE LENGTH (S=): 3416'
 16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
 COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
 - INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)),
 - INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
 - PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
 - CARRIER PIPE NOT ENCASED
 - PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
 - CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
 - PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
 - BLASTING NOT PERMITTED.
 - SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

NOTES

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

REF. DRAWING	REVISIONS
ES-6.18 TO ES-6.20 SHEET 12 TO SHEET 13	EROSION & SEDIMENT PLAN AERIAL SITE PLAN
	EP1 REVISED PER PADEP COMMENTS
	EP ISSUED FOR BID
	A ISSUED FOR REVIEW
DWG NO	DWG NO DESCRIPTION NO. DESCRIPTION

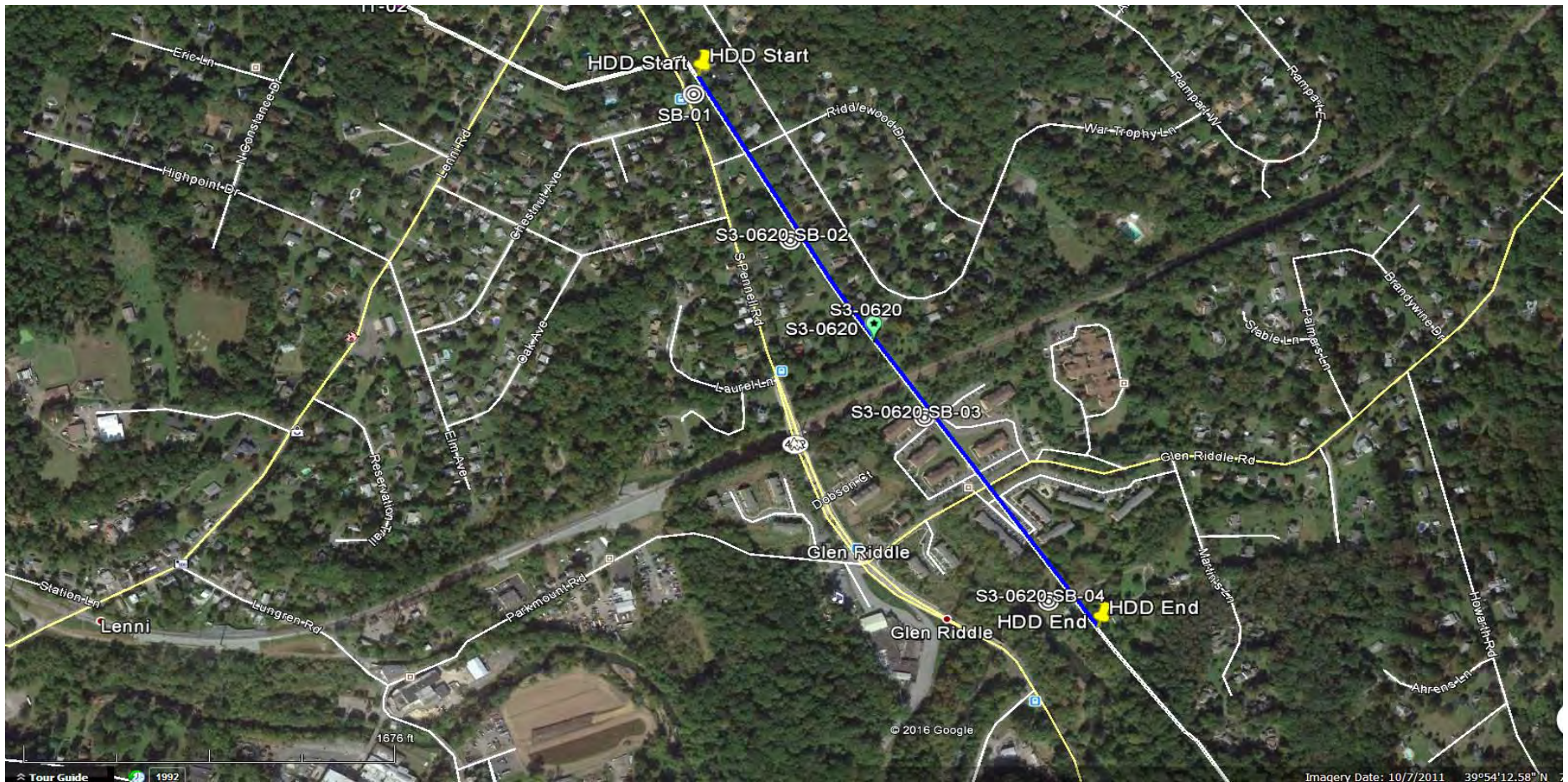
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911


SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
GLEN RIDDLE RD, SOUTHEASTERN PENNSYLVANIA RR
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-DE-0100.0000-RRb-16



LEGEND:

 Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS

HDD S3-0620

DELAWARE COUNTY, MIDDLETOWN 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: RIDDLEWOOD DRIVE, MEDIA, PA DE-0090.0004			Page 1 of 1		
HDD No.: S3-0620		Dates(s) Drilled: 09-09/10-15		Inspector: J. COSTELLO	
Boring No.: SB-02		Drilling Method: SPT - ASTM D1586		Driller: E. ODGEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 38.0		Total Depth (ft): 75.0	
Boring Location Coordinates:			39° 53' 57.462" N		75° 26' 10.827" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.3			TOPSOIL (3")						
1	3.0	5.0	0.3		4	ML	REDDISH BROWN SILT AND FINE SAND, TRACE MICACEOUS.	6	4	10	8	14	
2	8.0	10.0			24		DR WEATHERED TO A LAYERED REDDISH BROWN AND LIGHT GRAY SILT AND FINE SAND, TRACE FINE GRAVEL.	3	9	10	11	19	
3	13.0	15.0			24		SAME.	5	11	15	18	26	
4	18.0	20.0			24		DR, WEATHERED TO A LAYERED YELLOW BROWN AND BROWN SILT WITH SOME FINE SAND, TRACE FINE GRAVEL.	3	9	11	15	20	
5	23.0	25.0			24		DR, WEATHERED TO A VARIEGTED GRAY, YELLOW, WHITE SILT AND FINE SAND, TRACE FINE GRAVEL. (USCS: ML)	2	5	11	14	16	
6	28.0	30.0			24		SAME	4	11	18	23	29	
7	33.0	35.0			24		SAME (USCS: ML).	4	9	15	16	24	
				36.5									
8	38.0	40.0	36.5		12		SM	DR, WEATHERED TO A LAYERED GRAY AND REDDISH BROWN, FINE TO MEDIUM SAND WITH SOME SILT.	2	5	14	15	19
9	43.0	44.9			19			SAME	4	15	40	50/5"	55
10	48.0	50.0			23	SAME.		4	6	12	46	18	
11	53.0	55.0			24	SAME.		3	7	16	18	23	
12	58.0	60.0			15	DR, WEATHERED TO A LAYERED GRAY AND REDDISH BROWN, FINE TO MEDIUM SAND AND SILT.		2	5	12	20	17	
13	63.0	65.0			20	SAME.		2	9	15	50	24	
14	68.0	69.0			12	DR, WEATHERED TO A VARIEGATED REDDISH BROWN AND GRAY WITH BLACK SPECS, M-C SAND, SOME SILT, A LITTLE F-GRAVEL.		6	50/6"			>50	
15	73.0	74.3		75.0	9	SAME.		2	21	50/3"		>50	

Notes/Comments:
Pocket Penetrometer Testing
 S4; 3.5 TSF

DR: DECOMPOSED ROCK
 AUGERED TO 75'.
 WET ON SPOON AT 38'.
 WATER LEVEL THROUGH AUGERS AT 38'.
 CAVED AT 37', MOIST.

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: GLENN RIDDLE APTS., MEDIA, PA			Page 1 of 1		
HDD No.: S3-0620		Dates(s) Drilled: 11-17-15		Inspector: J. COSTELLO	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: E. ODGEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 28.0		Total Depth (ft): 36.0	
Boring Location Coordinates:			39° 53' 48.63" N		75° 26' 3.03" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.5			TOPSOIL (6")						
1	3.0	5.0	0.5		12	SM	DR, DARK BROWN MICACEOUS FINE TO MEDIUM SAND, SOME SILT, TRACE FINE GRAVEL.	4	7	12	12	19	
2	8.0	10.0			19		DR, VARIEGATED BROWN, TAN, WHITE FINE TO MEDIUM SAND, SOME SILT, TRAVE FINE GRAVEL.	4	7	10	12	17	
3	13.0	15.0			24		SAME.	2	8	12	31	20	
4	18.0	20.0			24		SAME.	2	12	31	50	43	
5	23.0	25.0			24		SAME.	2	10	11	27	21	
				28.5									
6	28.0	30.0	28.0	31.0	8		DR, HIGHLY WEATHERED TO PARTIALLY WEATHERED MAFIC GNEISS.	6	50/5"			>50	
							AUGER REFUSAL AT 31'.						
							<u>ROCK CORING</u>						
RUN 1	31.0	36.0	31.0		40	WEATH. TO PARTIALLY WEATH. GNEISS	WHITE AND GRAY MAFIC GNEISS, HIGHLY WEATHERED AND FRACTURED.	TCR: 67%, SCR: 7%, RQD: 0%					
				36.0									
RUN 2	36.0	41.0	36.0		43	WEATH. TO PARTIALLY WEATH. GNEISS	WHITE AND GRAY MAFIC GNEISS, WEATHERED TO PARTIALLY WEATHERED, SINGLE 8" INTACT SECTION AT 38.8'.	TCR: 72%, SCR: 22%, RQD: 13%					
				41.0									
							<u>CORE TESTING RESULTS (DEPTH 39-39.5'):</u>						
							COMPRESSIVE STRENGTH: 8,325 PSI						
							UNIT WEIGHT: 163.4 PCF						
							WET ON SPOON AT 28'.						
							CAVED AT 30'.						

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.

**ROCK CORE DESCRIPTION SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0620**

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					
S3-0620	SB-03	1	31	36	67	7	0	31	36	Heavily	Mafic Gneiss	Massive	Gray/white	Rubble, increasingly weathered with depth
		2	36	41	72	22	13	36	41	Heavily	Mafic Gneiss	Massive	Gray/white	Mostly rubble, single unweathered section

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0620

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, %		
S3-0620	SB-01	2	8.0	10.0	31.8	62.2	39	27	12	ML	
		3	13.0	15.0	25.6	40.9					
		4	18.0	20.0	33.6	47.4	35	26	9	SM	
		5	23.0	25.0	21.6	30.9	-	-	-	-	
		6	28.0	30.0	17.4	53.1	-	-	-	-	
	SB-02	2	8.0	10.0	30.5	60.8	-	-	-	-	
		4	18.0	20.0	34.3	75.6	-	-	-	-	
		5	23.0	25.0	22.6	69.2	38	26	12	ML	
		7	33.0	35.0	22.4	61.6	37	26	11	ML	
		10	48.0	50.0	22.0	35.2	-	-	-	-	
		12	58.0	60.0	21.5	41.1	-	-	-	-	
	SB-03	15	73.0	74.3	15.1	23.9	-	-	-	-	
		2	8.0	10.0	13.6	30.7	-	-	-	-	
		3	13.0	15.0	13.0	23.2	NV	NP	NP	SM	
		4	18.0	20.0	10.7	31.9	-	-	-	-	
		5	23.0	25.0	9.9	22.4	-	-	-	-	
	SB-04	6	28.0	30.0	11.5	35.6	NV	NP	NP	SM	
		1	3.0	5.0	22.0	81.9	41	23	18	CL	
			2	8.0	10.0	7.2	15.3	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-03	2	39.0 - 39.5	8,325	163.4

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0620**

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
S3-0620		SB-01	Ultramafic rocks - Includes serpentine, steatite, and other products of alteration of peridotites and pyroxenites.	Generally level	Ultramafic rocks (Probably lower Paleozoic)	Serpentinite; Secondary - pyroxenite; Other - peridotite	No information found during literature review	Ranges from 15 to 70 ft bgs, Avg. 35 ft bgs (.5 mile radius)	All part of Glenarm Supergroup a name given to provincial series of pre-Cambrian metamorphosed sedimentary rocks present in northern VA, MD, southeastern PA, western NJ, and possibly southeastern NY. Rocks from this assemblage consists of a thick sequence of metasedimentary rock and include the following formations; Setters metaquartzite, Cockeysville marble, Wissahickon Schist (along with subset of the Octoraro schist), Peters Creek metaquartzite and meta siltstones and the Peach Bottom Clate (Geology of Pennsylvania SP-1, 1999). Drilling in these formations generally difficult to very difficult except where fractures and weathered exposed zones present.
		SB-02		Generally level, slightly sloping to the east					
		SB-03		Generally level, slightly sloping to the southeast					
		SB-04	Mafic gneiss - Dark, medium grained; includes rocks of probable sedimentary origin; may be equivalent to pCAmgh in places.	Generally level	Mafic gneiss (Probably lower Paleozoic)	Mafic gneiss; Secondary - paragneiss			

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Particle Size Identification

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

Relative Proportions

<u>Description Term</u>	<u>Percent</u>
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Silt, Clay & Combinations)

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

Plasticity

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

ROCK

(Rock Cores)

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

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

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

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications			
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for GW		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines			
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above A line with I_p greater than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3 Not meeting C_u or C_c requirements for SW		
			SP	Poorly graded sands, gravelly sands, little or no fines			
		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		
		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⁾					
		Major Divisions		Group Symbols	Typical Descriptions	For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity				
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays				
		OL	Organic silts and organic silty clays of low plasticity				
	Silt and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts				
		CH	Inorganic clays of high plasticity, fat clays				
		OH	Organic clays of medium to high plasticity, organic silts				
	Highly organic soils	Pt	Peat and other highly organic soils				

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