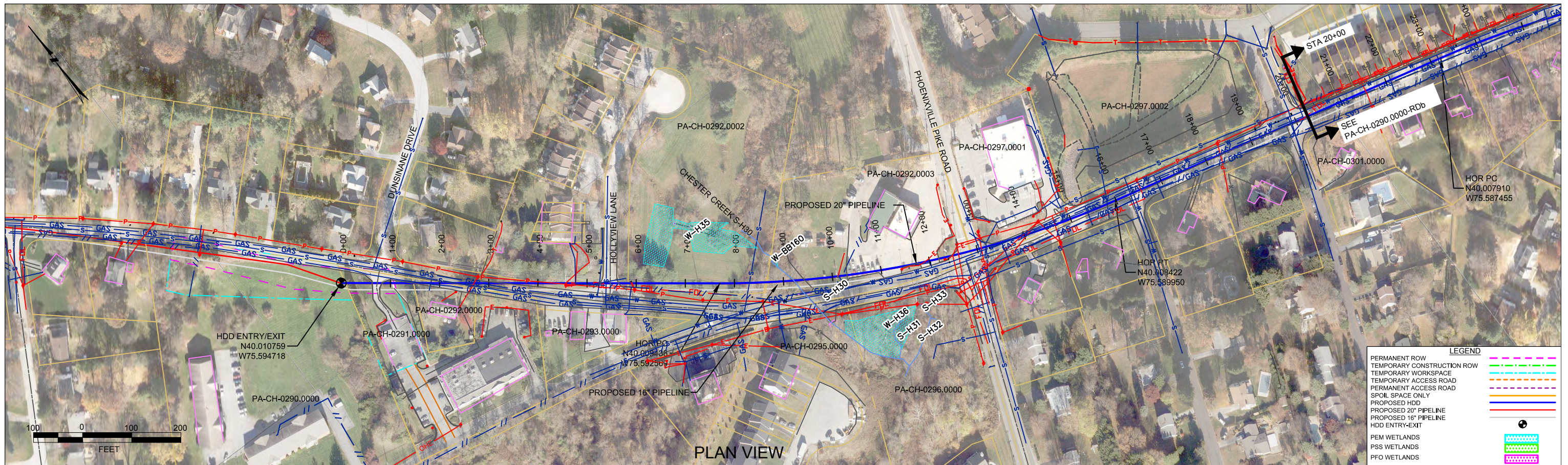


HDD PA-CH-0290.0000-RD (S-H30)

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.

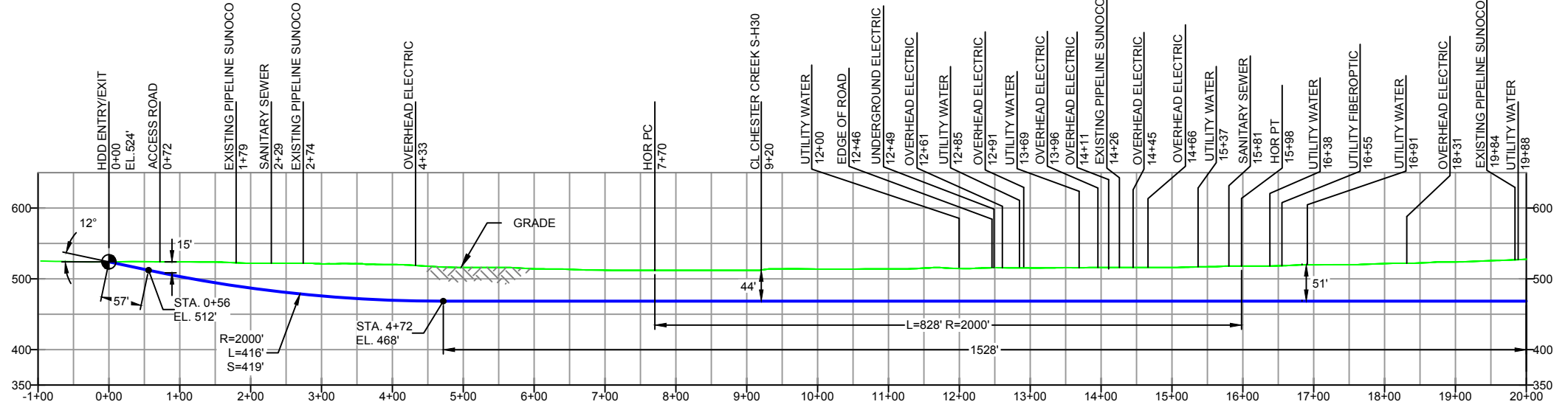
The drill will enter/exit 920 feet northwest of stream H30. The drill will pass 44 feet under this stream. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have been configured to pass through the best substrates while maintaining pipe integrity (e.g., no large bends). The majority of the substrate that will be passed through is estimated to be silty sand, and schist.



PLAN VIEW

WEST WHITELAND COUNTY, PENNSYLVANIA - CHESTER TOWNSHIP
 WEST GOSHEN COUNTY, PENNSYLVANIA - CHESTER
 S3-0421A

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): 4350'
 HDD PIPE LENGTH (S): 4357'
 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-6.54	TO ES-6.56	EROSION & SEDIMENT PLAN	
SHEET 36	TO SHEET 38	AERIAL SITE PLAN	EP1 REVISED PER PADEP COMMENTS
			EP
			C ISSUED FOR BID
			B ISSUED FOR BID
			A ISSUED FOR REVIEW
DWG NO	DWG NO	DESCRIPTION	NO.

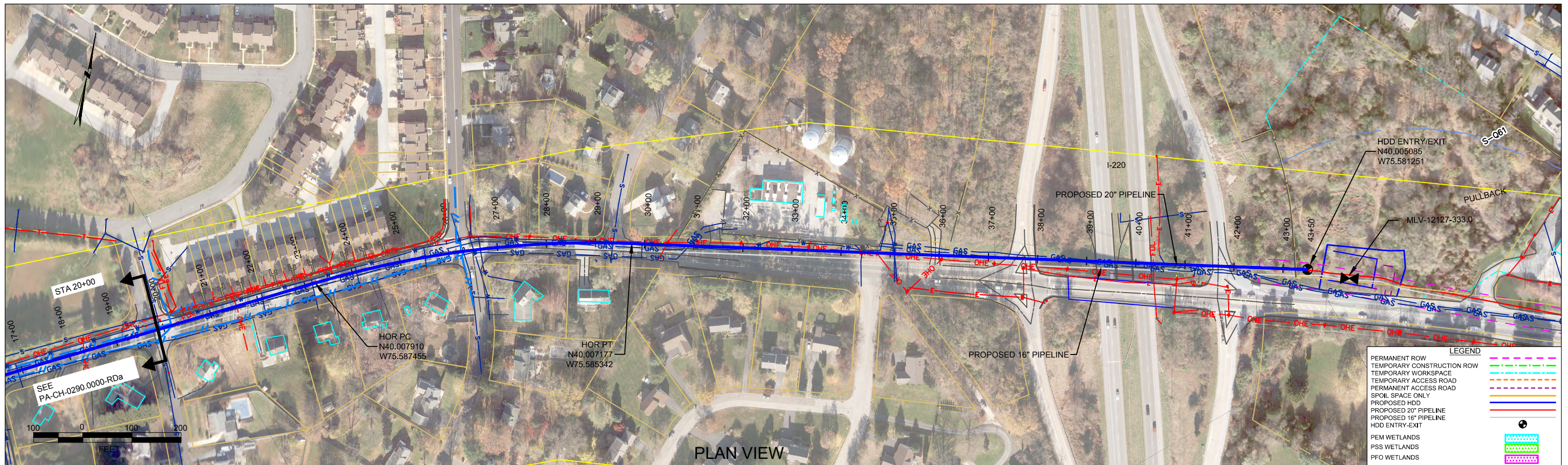
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

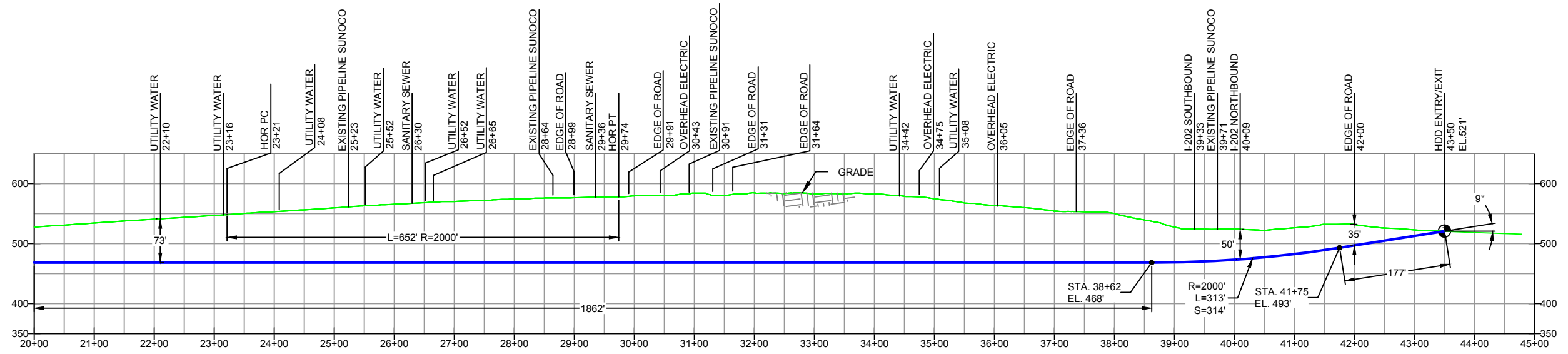
SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
 PHOENIXVILLE PIKE ROAD
 PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO: PA-CH-0290.0000-RDa



WEST WHITELAND COUNTY, PENNSYLVANIA - CHESTER TOWNSHIP
 WEST GOSHEN COUNTY, PENNSYLVANIA - CHESTER
 S3-0421B



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)=4350'
 HDD PIPE LENGTH (S)=4357'
 20" x 0.456" W.T., X-65, APISL, 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

- 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	
DWG NO	DWG NO	DESCRIPTION	NO.
ES-6.54	TO ES-6.56	EROSION & SEDIMENT PLAN	
SHEET 36	TO SHEET 38	AERIAL SITE PLAN	EP1
			EP
			C
			B
			A

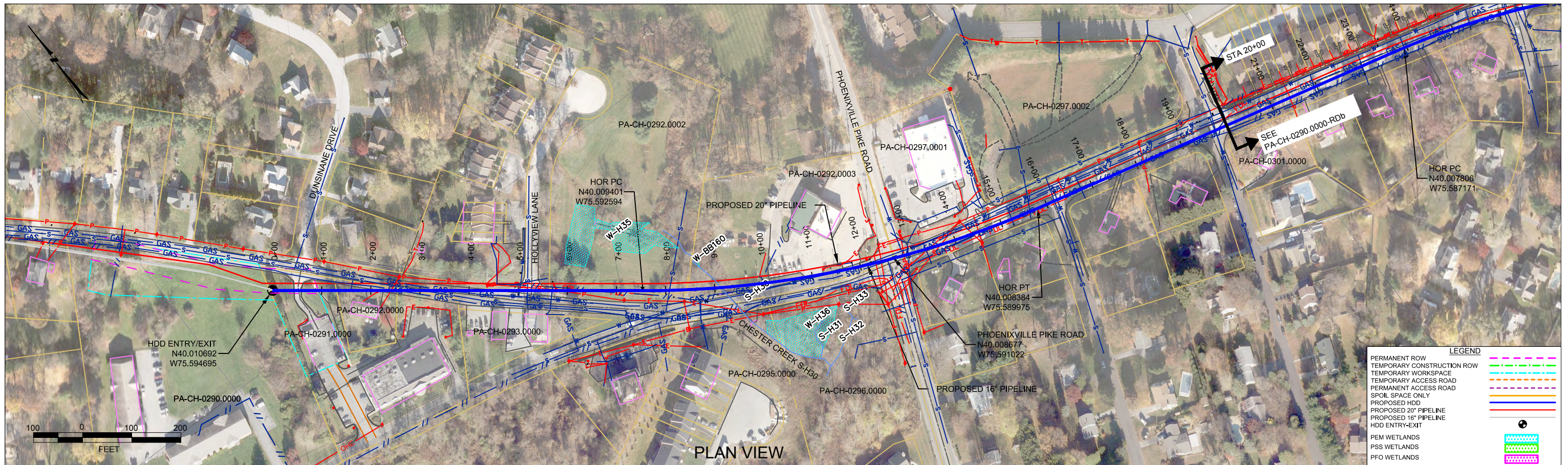
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
 PHOENIXVILLE PIKE ROAD
 PENNSYLVANIA PIPELINE PROJECT

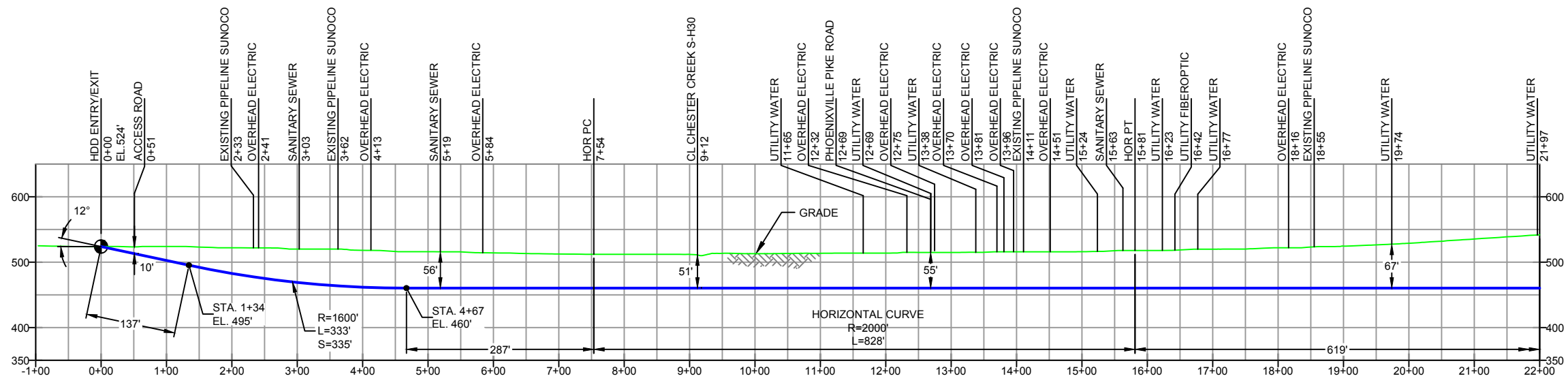
SCALE: 1"=200' DWG. NO. PA-CH-0290.0000-RDb



LEGEND	
PERMANENT ROW	
TEMPORARY CONSTRUCTION ROW	
TEMPORARY WORKSPACE	
TEMPORARY ACCESS ROAD	
PERMANENT ACCESS ROAD	
SPOIL SPACE ONLY	
PROPOSED HDD	
PROPOSED 20" PIPELINE	
PROPOSED 16" PIPELINE	
HDD ENTRY-EXIT	
PEM WETLANDS	
PSS WETLANDS	
PFO WETLANDS	

WEST WHITELAND COUNTY, PENNSYLVANIA - CHESTER TOWNSHIP
 WEST GOSHEN COUNTY, PENNSYLVANIA - CHESTER
 S3-0421-16

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): 4312'
 HDD PIPE LENGTH (S): 4324'
 16" x 0.438" W.T., X-70, 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	
ES-6.54	TO ES-6.56 EROSION & SEDIMENT PLAN
SHEET 36	TO SHEET 38 AERIAL SITE PLAN

REVISIONS	
EP1	REVISED PER PADEP COMMENTS
EP	
A	ISSUED FOR BID

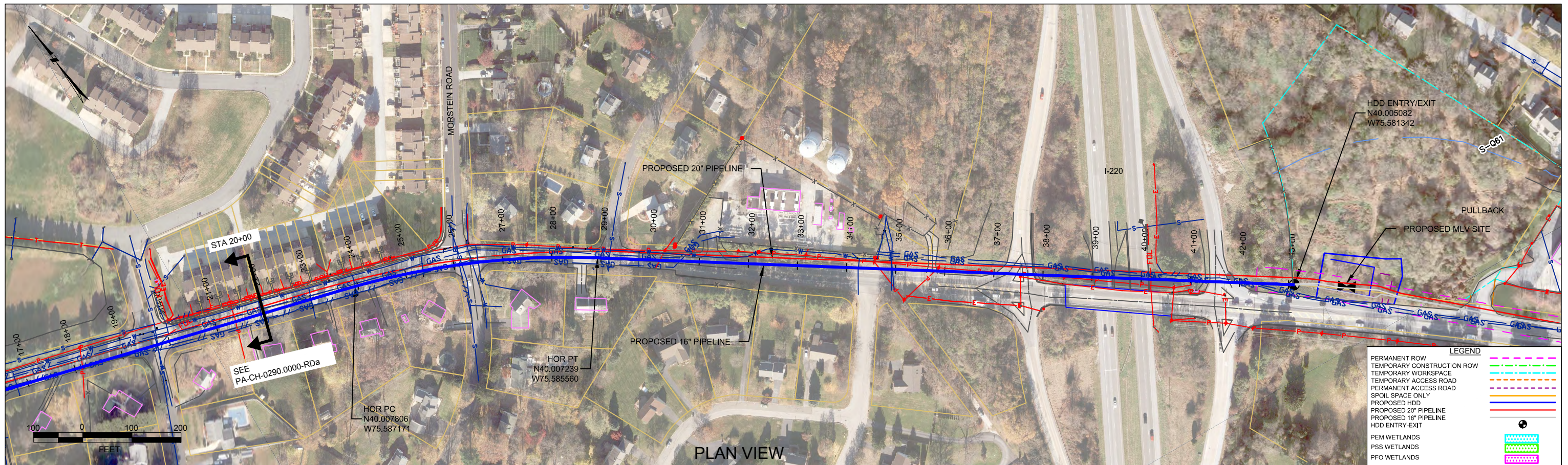
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
 PHOENIXVILLE PIKE ROAD
 PENNSYLVANIA PIPELINE PROJECT

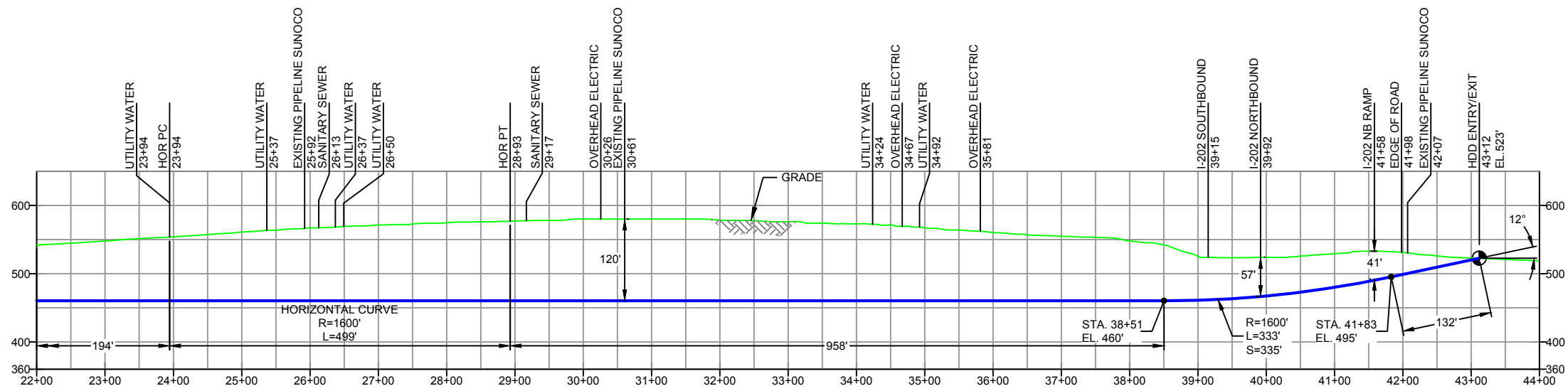
SCALE: 1"=200' DWG. NO: PA-CH-0290.0000-RDa-16



PLAN VIEW

WEST WHITELAND COUNTY, PENNSYLVANIA - CHESTER TOWNSHIP
 WEST GOSHEN COUNTY, PENNSYLVANIA - CHESTER
 S3-0421B-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 HORIZ. LENGTH (L)=4312'
 HDD PIPE LENGTH (S)=4324'
 16" x 0.438" W.T., X-70, 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

- 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-6.54	TO ES-6.56	EROSION & SEDIMENT PLAN	
SHEET 36	TO SHEET 38	AERIAL SITE PLAN	
		EP1	REVISED PER PADEP COMMENTS
		EP	
		A	ISSUED FOR BID
DWG NO	DWG NO	DESCRIPTION	DESCRIPTION

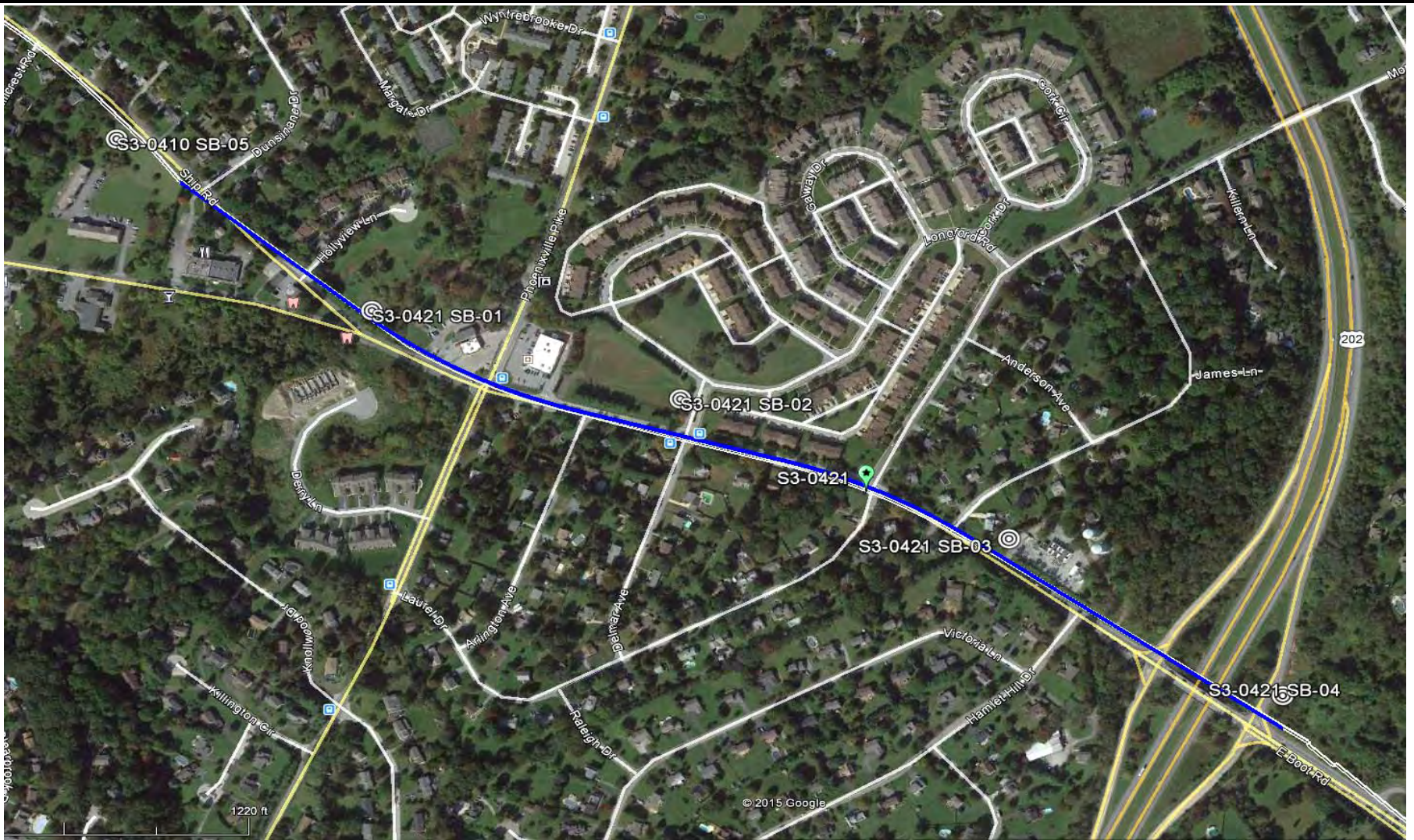
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
 (303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
 PHOENIXVILLE PIKE ROAD
 PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200' DWG. NO. PA-CH-0290.0000-RDb-16



LEGEND:

⊙ Geotechnical Soil Boring (SB) Locations



GEOTECHNICAL BORING LOCATIONS
 HDD S3-0421
 CHESTER COUNTY, W. WHITELAND/GOSHEN TWP, 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: NORTHWYN CT APTS, 803 BOOT ROAD, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0410		Dates(s) Drilled: 08-04-15		Inspector: J. COSTELLO	
Boring No.: SB-05		Drilling Method: SPT - ASTM D1586		Driller: E. OGDEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 8.0		Total Depth (ft): 24.4	
Boring Location Coordinates:			40° 0' 40.30" N		75° 35' 43.63" 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		16	SM	DR, VARIEGATED BROWN FINE TO MEDIUM SAND (WITH LAYERS OF MICA SCHIST), SOME SILT.	1	4	4	4	8	
2	8.0	10.0			15		DR, VARIEGATED BROWN AND REDDISH BROWN FINE TO MEDIUM SAND, SOME SILT, MICACEOUS.	1	4	5	7	9	
3	13.0	15.0			12		DR, GRAY AND REDDISH BROWN FINE TO MEDIUM SAND (WITH LAYERS OF MICA SCHIST), SOME SILT.	1	5	10	21	15	
4	18.0	20.0			14		HIGHLY WEATHERED GRAY SCHIST.	7	5	21	27	26	
				23.5									
5	23.0	24.4	23.5		14		DARK GRAY HIGHLY WEATHERED TO PARTIALLY WEATHERED SCHIST.	7	32	50/5"		>50	
				24.4									
							AGUER REFUSAL AT 24'.						
							WET ON SPOON AT 8'.						
							WATER LEVEL THROUGH AUGERS AT 8.						
							CAVED AT 21.5', WATER LEVE ON CAVE AT 2.5'.						
							PETROLEUM ODORS APPARENT WITHIN SAMPLES 3 TO 5, AND DURING AUGURING.						

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



TETRA TECH

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

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: HOLLYVIEW LAND, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0421		Dates(s) Drilled: 12-16-15		Inspector: J. COSTELLO	
Boring No.: SB-01		Drilling Method: SPT - ASTM D1586		Driller: E. ODGEN	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): SEE BELOW		Total Depth (ft): 65.0	
Boring Location Coordinates:			40° 0'34.01"N		75°35'32.69"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		21	ML	DR, MOTTLED BROWN AND GRAY SILT AND FINE SAND, MICACEOUS.	1	5	6	7	11	
2	8.0	10.0		11.5	17		DR, MOTTLED REDDISH BROWN AND GRAY SILT AND FINE SAND, MICACEOUS (USCS: ML).	1	2	4	4	6	
3	13.0	15.0	11.5		24	SM	DR SCHIST, VARIEGATED BROWN AND GRAY FINE SAND WITH SOME SILT, MICACEOUS.	1	1	4	7	5	
4	18.0	20.0			24		SAME	1	3	6	8	9	
5	23.0	25.0			24	SM	DR SCHIST, VARIEGATED BROWN AND GRAY MICACEOUS FINE SAND AND SILT, TRACE FINE UNWEATHERED ROCK FRAGS.	1	8	15	21	23	
6	28.0	30.0			24		SAME	2	9	22	24	31	
7	33.0	35.0			10	SM	SAME	1	3	8	10	11	
8	38.0	40.0			16		SAME	1	13	22	39	35	
9	43.0	45.0			20	SM	DR SCHIST, VARIEGATED BROWN AND GRAY MICACEOUS FINE SAND AND SILT, TRACE BLACK NODULES, TRACE FINE ROCK FRAGS.	1	3	12	22	15	
10	48.0	49.9			14		SAME	3	8	27	50/5"	35	
11	53.0	55.0			12	SM	DR, VARIEGATED WHITE, RED, BROWN FINE SAND AND SILT. (USCS: SM) (WEATHERED SCHIST)	1	5	10	18	15	
12	58.0	60.0		63.5	11		DR, VARIEGATED GRAY AND WHITE FINE SAND, SOME SILT, TRACE FINE UNWEATHERED ROCK FRAGS., MICACEOUS.	1	5	6	28	11	
13	63.0	64.4	63.5	65.0	10		PARTIALLY WEATHERED GNEISS OR SCHIST.	5	50	50/5"		>50	
							AUGER REFUSAL AT 65'.						
							WATER LEVEL THROUGH AUGERS AT 23' (MAY BE PERCHED).						
							CAVED AND WET AT 55'.						

Notes/Comments:
Pocket Penetrometer Testing DR: DECOMPOSED ROCK
 S1: 2.5 TSF
 S2: 1.5 TSF

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

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



TETRA TECH

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

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: INTERSECTION OF BOOT ROAD AND LONGFORD BLVD, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0421	Dates(s) Drilled: 08-30-15		Inspector: J.COSTELLO		
Boring No.: SB-02	Drilling Method: SPT - ASTM D1586		Driller: E.ODEN		
Drilling Contractor: HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 22.0		
Boring Location Coordinates:			40° 0' 30.750" N		75° 35' 19.318" 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	0.1			TOPSOIL (2")						
1	3.0	5.0	0.1		19	ML	DARK BROWN SILT AND FINE SAND, POTENTIALLY ORGANIC, TRACE	4	3	4	4		7
				8.5			F-C GRAVEL (APPARENT FILL MATERIAL).						
2	8.0	8.8			6		WEATHERED TO PARTIALLY WEATHERED MICA SCHIST.	13	50/3"				>50
							AUGER REFUSAL AT 12.5', OFF-SET BORING 10' NORTH AND CONTINUOUSLY AURGERED TO 13'.						
3	13.0	13.9			5		WEATHERED TO PARTIALLY WEATHERED MICA SCHIST.	41	50/5"				>50
							AUGER REFUSAL AT 14'.						
							<u>ROCK CORING</u>						
RUN 1	14.0	16.0	14.0		23	FRACTURED SCHIST	VARIEGATED GRAY SCHIST WITH MICA, PARTIALLY DECOMPOSED, INTENSELY FRACTURED.	TCR: 96%, SCR: 33%, RQD: 24.5%					
RUN 2	16.0	22.0		22.0	72		MODERATELY FRACTURED VARIEGATED GRAY SCHIST, MICA.	TCR: 100%, SCR: 46%, RQD: 42%					
							DRY AND CAVED AT 13'.						
							<u>CORE TESTING RESULTS (RUN 2, DEPTH 20-21.5'):</u>						
							COMPRESSIVE STRENGTH: 4,040 PSI						
							UNIT WEIGHT: 154.2 PCF						

Notes/Comments:
Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



TETRA TECH

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

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: SUNOCO BOOT ROAD PUMP STATION, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0421		Dates(s) Drilled: 06-28-15		Inspector: E. WATT	
Boring No.: SB-03		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): 68.0		Total Depth (ft): 70.0	
Boring Location Coordinates:			40° 0' 25.653" N		75° 35' 5.227" W

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (ft)	Strata (USCS)	Description of Materials	6" Increment Blows *				N	
	From	To	From	To									
			0.0	0.0			TOPSOIL (NONE, GRAVEL SURFACE)						
1	3.0	5.0	0.0		18	SM	BROWN AND ORAGNE BROWN MICACEOUS FINE SAND, SOME SILT, TRACE UNWEATHERED FINE GRAVEL.	1	2	3	4	5	
2	8.0	10.0		14.3	14		DR SCHIST, VARIEGATED BROWN, ORANGE BROWN, LIGHT GRAY FINE TO MEDIUM SAND, SOME SILT, TRACE FINE SCHIST GRAVEL.	5	6	5	5	11	
3	13.0	15.0	14.3		24		DR SCHIST, VARIEGATED WHITE AND ORANGE BROWN FINE TO MEDIUM SAND, SOME SILT, TRACE FINE SCHIST GRAVEL.	6	23	32	35	86	
4	18.0	18.5			6		DR SCHIST, BROWN FINE TO MEDIUM SAND, SOME SILT, WITH A LITTLE FINE TO COARSE SCHIST GRAVEL.	50/6"				>50	
5	23.0	23.5			6		DR SCHIST, BROWN FINE TO MEDIUM SAND, TRACE SILT, WITH A LITTLE TO SOME F-C SCHIST GRAVEL.	50/6"				>50	
6	28.0	28.5			6		DR SCHIST, VARIEGATED SHADES OF BROWN FINE TO MEDIUM SAND, LITTLE SILT, WITH A LITTLE F-C SCHIST GRAVEL.	50/6"				>50	
7	33.0	33.4			5		SAME	50/5"				>50	
8	38.0	38.4			5	SM	SAME	50/5"				>50	
9	43.0	43.5			5		DR SCHIST, VARIEGATED SHADES OF BROWN FINE TO MEDIUM SAND, SOME SILT, WITH A LITTLE F-C SCHIST GRAVEL.	50/6"				>50	
10	48.0	48.5			5		DR SCHIST, VARIEGATED SHADES OF BROWN FINE TO MEDIUM SAND, LITTLE SILT, WITH A LITTLE F-C SCHIST GRAVEL.	50/6"				>50	
11	53.0	53.3			4		SAME	50/4"				>50	
12	58.0	58.3			3		SAME	50/3"				>50	
13	63.0	63.3			3		DR SCHIST, GRAY TO DARK GRAY FINE TO MEDIUM SAND, LITTLE SILT, WITH A LITTLE F-C SCHIST GRAVEL.	50/3"				>50	
14	68.0	68.4		70.0	5		SAME, STARTED TO GET WET, STRONG PERTROLEUM ODOR.	50/5"				>50	
							DISCONTIUED DRILLING AT 70'; DID NOT WANT TO BRING UP PETROLEUM ODOR CUTTINGS TO SURFACE DUE TO NEARBY RESIDENTS.						

Notes/Comments: Pocket Pentrometer Testing DR: DECOMPOSED ROCK

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

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



TETRA TECH

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

TEST BORING LOG

Project Name: SUNOCO PENNSYLVANIA PIPELINE PROJECT			Project No.: 103IP3406		
Project Location: N202 ON-RAMP FROM BOOT ROAD, WEST CHESTER, PA			Page 1 of 1		
HDD No.: S3-0421		Dates(s) Drilled: 06-18-15		Inspector: J.COSTELLO	
Boring No.: SB-04		Drilling Method: SPT - ASTM D1586		Driller: S. HOFFER	
Drilling Contractor: HAD DRILLING		Groundwater Depth (ft): NOT ENCOUNTERED		Total Depth (ft): 30.0	
Boring Location Coordinates:			40° 0' 19.841" N		75° 34' 53.309" 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	0.0			TOPSOIL (TRACE")						
			0.0	2.0		FILL	FILL MATERIALS - SILT AND FINE SAND, CRUSHED GRAVEL.						
1	3.0	5.0	0.0		14	SM	DR SCHIST, VARIEGATED REDDISH BROWN, BROWN, GRAY FINE TO MEDIUM SAND, SOME SILT, TRACE UNWEATHERED GRAVEL.	1	4	5	6	9	
2	8.0	10.0			18		DR SCHIST, VARIEGATED LIGHT GRAY TO TAN, FINE TO MEDIUM SAND WITH A LITTLE SILT, TRACE UNWEATHERED FINE GRAVEL.	4	9	12	19	21	
3	13.0	14.5			18		DR SCHIST, LIGHT GRAY TO TAN, FINE TO MEDIUM SAND WITH SOME SILT, TRACE UNWEATHERED FINE GRAVEL.	9	36	50/6"		86	
4	18.0	18.9			10		DR SCHIST, LIGHT GRAY TO TAN, FINE TO MEDIUM SAND WITH SOME SILT, TRACE UNWEATHERED F-C GRAVEL.	7	50/5"			>50	
5	23.0	24.0			10		DR SCHIST, VARIEGATED OLIVE, GRAY, BROWN FINE TO MEDIUM SAND, SOME SILT, WITH LAYERING OF UNWEATHERED SCHIST.	4	50/6"			>50	
6	28.0	29.3			14		DR SCHIST, VARIEGATED OLIVE, GRAY, BROWN FINE TO MEDIUM SAND, SOME SILT, WITH LAYERING OF UNWEATHERED SCHIST.	4	42	50/3"		>50	
				30.0									
								AUGERED TO 30'.					
								CAVED AND DRY AT 29'.					

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 S3-0421**

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					
S3-0421	SB-2	1	14	16	96	33	25	14	22	Moderate	Amphibolite	Massive	Green/gray/ black	Fractures ranging from 39° to 82°, Avg. 63
		2	16	22	100	46	42							

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0421

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, %	
S3-0410	SB-05	1	3.0	5.0	19.6	32.7	-	-	-	-
		2	8.0	10.0	22.4	28.5	-	-	-	-
S3-0421	SB-01	2	8.0	10.0	28.9	60.9	NV	NP	NP	ML
		4	18.0	20.0	16.3	33.6	-	-	-	-
		6	28.0	30.0	16.0	41.0	-	-	-	-
		8	38.0	40.0	17.0	47.3	-	-	-	-
		10	48.0	49.9	20.1	42.3	-	-	-	-
		11	53.0	55.0	18.3	47.0	NV	NP	NP	SM
		12	58.0	60.0	16.1	35.2	-	-	-	-
		13	63.0	64.4	16.2	41.8	-	-	-	-
	SB-02	1	3.0	5.0	36.1	58.8	-	-	-	-
		2	8.0	8.8	20.9	52.9	-	-	-	-
		3	13.0	13.9	1.7	13.6	-	-	-	-
	SB-03	2	8.0	10.0	12.6	26.9	-	-	-	-
		3	13.0	15.0	6.1	31.0	-	-	-	-
		5	23.0	23.5	5.4	8.9	-	-	-	-
		7	33.0	33.4	3.4	17.9	-	-	-	-
		9	43.0	43.5	1.8	23.4	-	-	-	-
		11	53.0	53.3	6.5	17.5	-	-	-	-
		13	63.0	63.3	1.6	16.5	-	-	-	-
	SB-04	14	68.0	68.4	4.6	18.3	-	-	-	-
		1	3.0	5.0	10.9	24.5	-	-	-	-
		2	8.0	10.0	4.8	12.5	-	-	-	-
		3	13.0	14.5	7.0	29.4	-	-	-	-
		5	23.0	24.0	7.8	28.5	-	-	-	-
		6	28.0	29.3	6.1	20.1	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-02	2	20-21.5	4,040	154.2

Notes:

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

**REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0421**

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
S3-0410		SB-05	Octoraro Formation - Includes albite-chlorite schist, phyllite, some hornblende gneiss, and granitized members.	Generally level, slightly sloping to the South	Octoraro Formation (Probably Lower Paleozoic)	Schist; secondary: phyllite; other types: gneiss, gneissoid	Unknown	Widely ranging from 3 to 65 ft bgs, Avg. 27 ft bgs (.5 mile radius)	Formation is a subset of the Wissahickon Schist. 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.
S3-0421		SB-01	"Glenarm Wissahickon" formation - Lithologically similar to oligoclase-mica schist of the Wissahickon Formation (PZw), but also includes lenticular amphibolite bodies having ocean-floor basalt chemistry.	Generally level, slightly sloping to the South	"Glenarm Wissahickon" Formation (Probably Lower Paleozoic)	Mica schist; secondary: mafic gneiss; other types: amphibolite	Literature indicates uncertain but believed to be several miles thick	Ranges from 4 to 58 ft bgs, Avg. 20 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		Slightly sloping to the West					
		SB-03		Generally level					
		SB-04		Generally level, slightly sloping to the East					

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

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

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

Particle Size Identification

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

Relative Proportions

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

COHESIVE SOILS

(Silt, Clay & Combinations)

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

Plasticity

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

ROCK

(Rock Cores)

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

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

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

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions		Group Symbols	Typical Descriptions	Laboratory Classifications				
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravel (Little or no fines)	GW Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
		GP Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting C_u or C_c requirements for GW					
		Gravel with fines (Appreciable amount of fines)	GM Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			GC Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7			
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3			
			SP Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW			
		Sands with fines (Appreciable amount of fines)	SM Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols		
			SC Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7			
						For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.		
		Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silt and clays (Liquid limit less than 50)		ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays								
OL Organic silts and organic silty clays of low plasticity								
Silt and Clays (Liquid limit greater than 50)	MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts							
	CH Inorganic clays of high plasticity, fat clays							
	OH Organic clays of medium to high plasticity, organic silts							
Highly organic soils	Pt Peat and other highly organic soils							

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