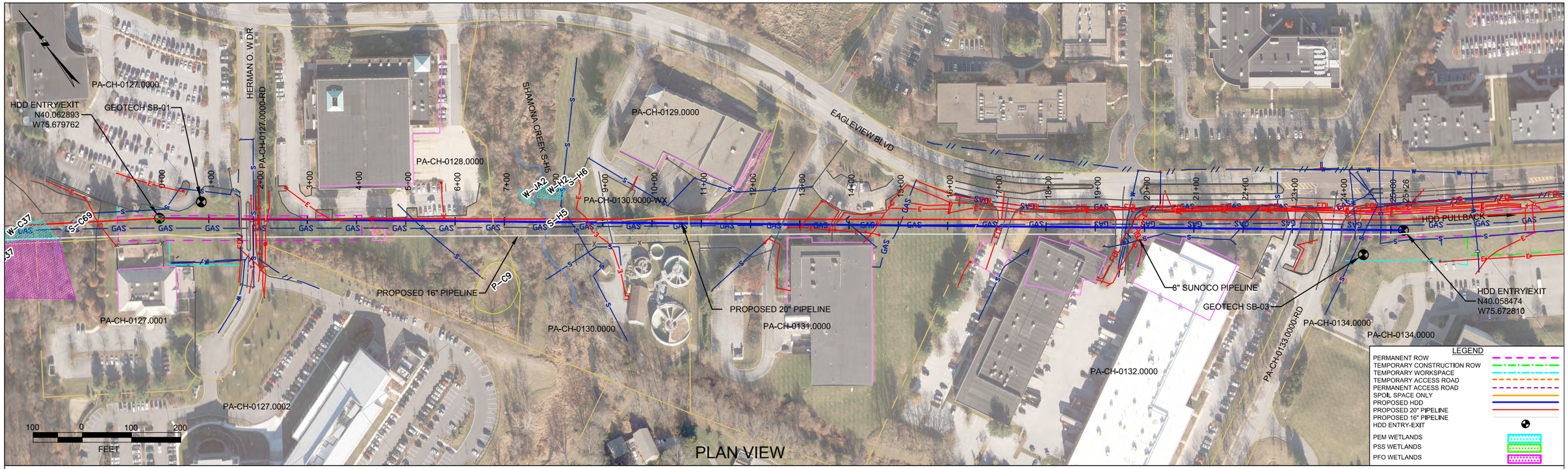
HDD PA-CH-0127.0000-RD (S-H5)

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.

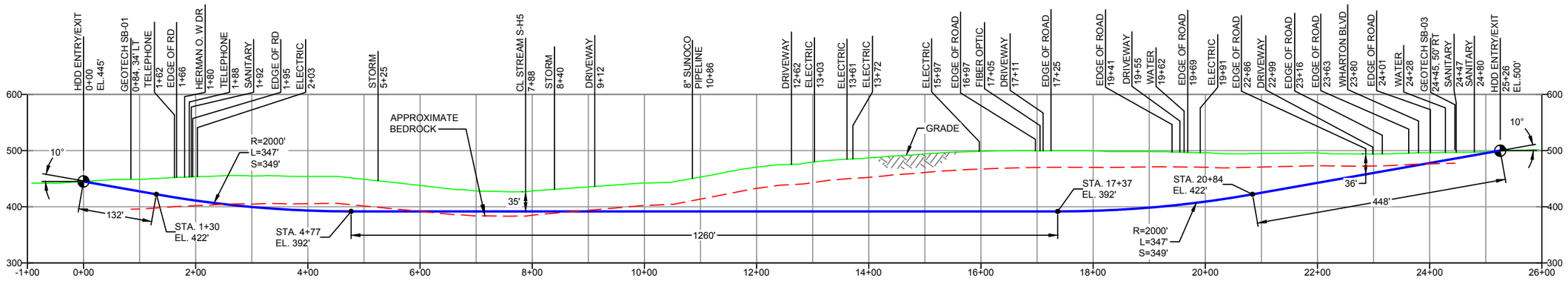
The drill will enter/exit 788 feet northwest of stream H5. The other entry/exit point is 1740 feet southeast of the stream. The drill will pass 35 feet under the stream. Using the results of the geotechnical investigation, as well as several other data points, the entry/exit, angles, and depths have 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.



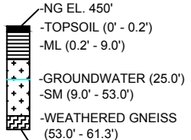
PLAN VIEW

PROFILE VIEW

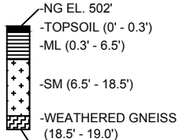
CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-320



GEOTECH SB-01



GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S3-0320 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=):2526'
   HDD PIPE LENGTH (S=):2538'
   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-6.35	TO	ES-6.36	EROSION & SEDIMENT PLAN
SHEET 20	TO	SHEET 21	AERIAL SITE PLAN

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	11/13/15	RMB	11/13/15	AAW	11/13/15
D	ADDED GEOTECH INFO	MRS	10/02/15	RMB	10/02/15	AAW	10/02/15
C	ISSUED FOR BID	DLM	08/21/15	RMB	08/21/15	AAW	08/21/15
B	ISSUED FOR BID	DLM	07/31/15	RMB	07/31/15	AAW	07/31/15
A	ISSUED FOR REVIEW	KB	03/28/15	RMB	03/28/15	AAW	03/28/15

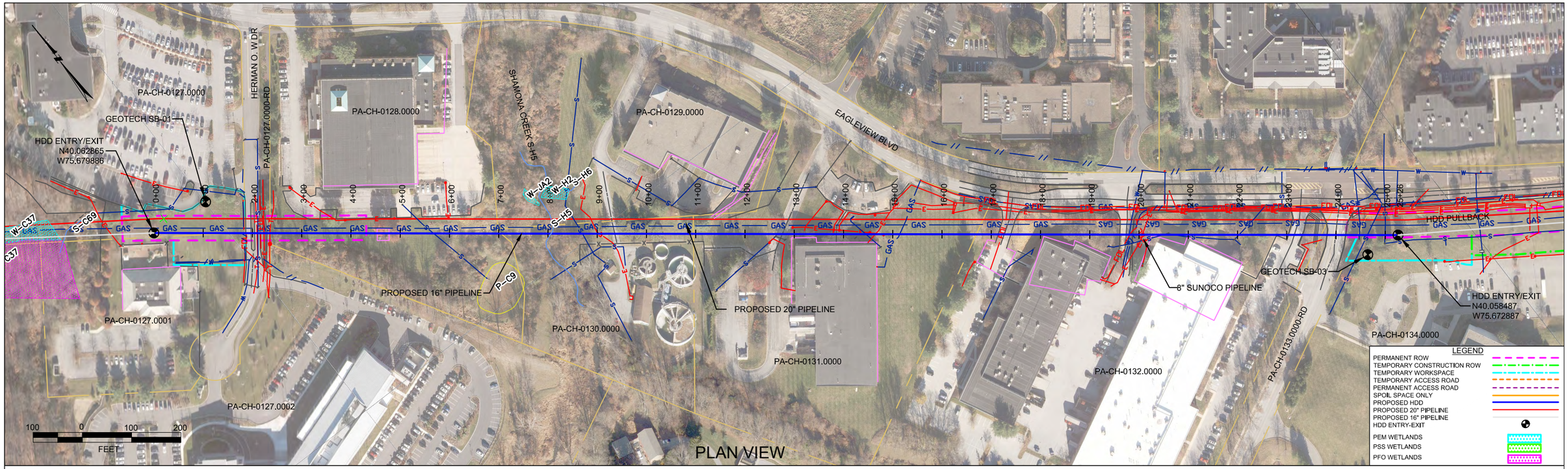
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
HERMAN O. W DRIVE
PENNSYLVANIA PIPELINE PROJECT

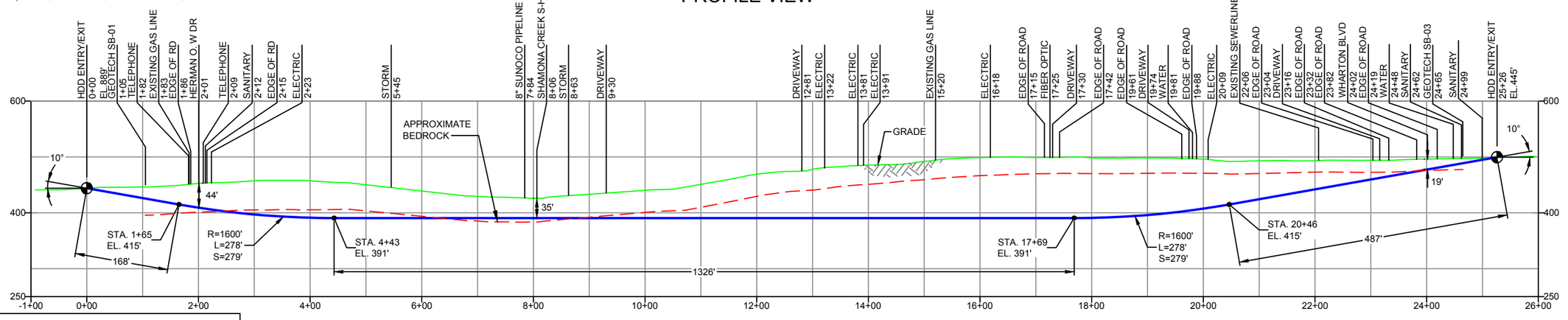
SCALE: 1"=200' | DWG. NO: PA-CH-0127.0000-RD



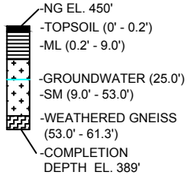
PLAN VIEW

PROFILE VIEW

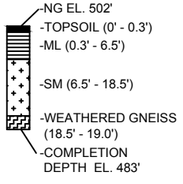
CHESTER COUNTY, PENNSYLVANIA - UWCHLAN TOWNSHIP
S3-320-16



GEOTECH SB-01



GEOTECH SB-03



NOTE: REFER TO TEST BORING LOG S3-0320 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

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3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):2526'
   HDD PIPE LENGTH (S=):2538'
   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.
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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.
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5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

ES-6.35	TO	ES-6.36	EROSION & SEDIMENT PLAN
SHEET 20	TO	SHEET 21	AERIAL SITE PLAN

DWG NO		DWG NO	DESCRIPTION

REVISIONS

NO.	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP1	REVISED PER PADEP COMMENTS	MRS	05/18/16	RMB	05/18/16	AAW	05/18/16
EP		MRS	11/13/15	RMB	11/13/15	AAW	11/13/15
B	ADDED GEOTECH INFO	MRS	10/02/15	RMB	10/02/15	AAW	10/02/15
A	ISSUED FOR BID	MRS	08/31/15	RMB	08/31/15	AAW	03/28/15

Sunoco Logistics Partners L.P.

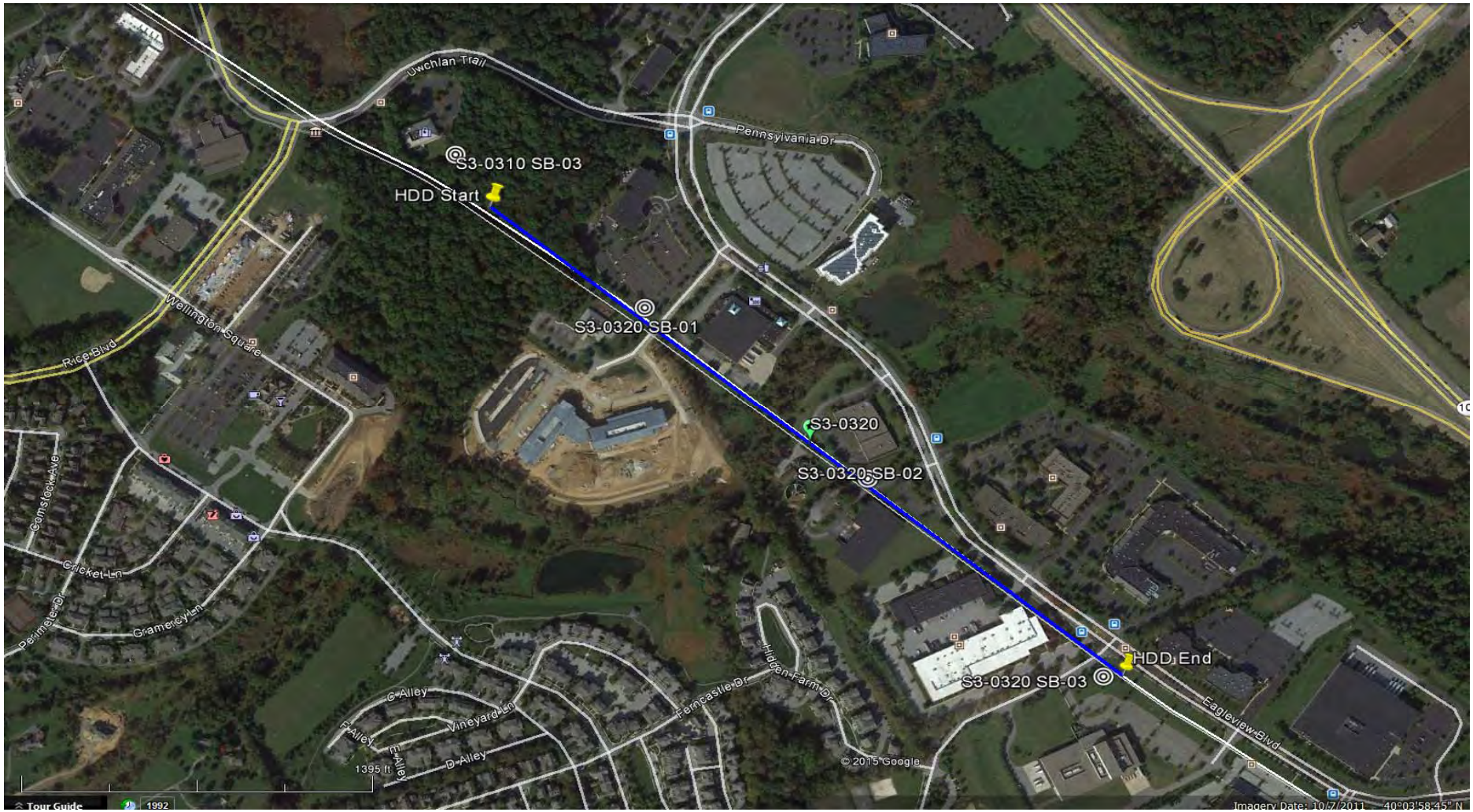
TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

16-INCH HORIZONTAL DIRECTIONAL DRILL
HERMAN O. W DRIVE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=200'

DWG. NO: PA-CH-0127.0000-RD-16



LEGEND:

◎ Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S3-0320
CHESTER COUNTY, UWCHLAN 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:	WORLED TRAVEL, Inc., 620 PENNSYLVANIA DRIVE, EXTON, PA		Page 1 of 1
HDD No.:	S3-0310	Dates(s) Drilled: 06-14-15	Inspector: E. WATT
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: S. HOFFER
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 3' 52.538" N	75° 40' 55.207" 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	4.0	0.3		10	SM	BROWN AND LIGHT BROWN FINE TO MEDIUM SAND AND SILT, WITH	11	50/6"			>50
							A LITTLE FINE GRAVEL.					
2	8.0	9.9			23		DR WEATHERED TO A BROWN, LIGHT BROWN, WHITE F-M SAND, SOME	25	14	21	50/5"	35
				12.0			SILT, TRACE UNWEATHERED F-GRAVEL (GNEISS). (USCS: SM)					
3	13.0	13.4	12.0		5	SM/ GM	DR WEATHERED TO A LIGHT BROWN F-M SAND WITH SOME SILT, AND	50/5"				>50
				14.0			FINE TO COARSE UNWEATHERED GNEISS GRAVEL.					
4	18.0	18.5	14.0		5	SM	DR WEATHERED TO A WHITE AND LIGHT BROWN FINE SAND, A LITTLE	50/5"				>50
							SILT, WITH A LITTLE FINE UNWEATHERED GNEISS GRAVEL.					
5	23.0	23.2			2		DR WEATHERED TO A WHITE AND LIGHT BROWN FINE SAND, SOME	50/2"				>50
							SILT, WITH A LITTLE FINE UNWEATHERED GNEISS GRAVEL.					
6	28.0	28.0		30.0	0		NO RECOVERY.	50/0"				>50
							AUGERED TO 30'.					
							CAVED AND DRY AT 26'.					

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:	568 VALLEYVIEW, DOWNINGTOWN, PA		Page 1 of 1
HDD No.:	S3-0320	Dates(s) Drilled: 06-14 & 08-02-15	Inspector: J. COSTELLO
Boring No.:	SB-01	Drilling Method: SPT - ASTM D1586	Driller: GREG/OGDEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): 25.0	Total Depth (ft): 30.0
Boring Location Coordinates:		40° 3' 46.148" N	75° 40' 45.963" 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		22	ML	YELLOWISH BROWN SILT AND FINE SAND, TRACE FINE	7	7	8	12	**15**
				9.0			GRAVEL.					
2	8.0	10.0	9.0		25		DR WEATHERED TO A VARI-COLORED (BRWN, REDDISH BRWN, GRAY,	1	2	7	8	**9**
							WHITE) F-M SAND AND SILT, TRACE FINE GRAVEL (USCS: SM).					
3	13.0	15.0			19		DR WEATHERED TO A BROWN TO REDDISH BROWN FINE TO MEDIUM	1	7	11	11	**18**
							SAND AND SILT, TRACE UNWEATHERED GNEISS GRAVEL.					
4	18.0	20.0			24		DR WEATHERED TO A BROWN TO REDDISH BROWN FINE TO MEDIUM	1	5	9	12	**14**
							SAND AND SILT, TRACE UNWEATHERED GNEISS GRAVEL.					
5	23.0	25.0			22		DR WEATHERED TO A BROWN, BLACK, GRAY, ORANGE BRWN F-M	1	7	11	36	**18**
							SAND AND SILT, TRACE UNWEATHERED GNEISS GRAVEL.(USCS: SM)					
6	28.0	28.8			5	SM	DR WEATHERED TO A LIGHT BROWN AND GRAY, F-M SAND WITH	12	50/3"			**>50**
							SOME SILT, TRACE UNWEATHERED GNEISS GRAVEL.					
7	33.0	35.0			13		DR, WHITE AND GRAY F-M SAND WITH A LITTLE SILT, WITH A LITTLE	2	23	25	29	**48**
(8/2/15)							F-C GNEISS GRAVEL.					
8	38.0	38.8			6		DR, WEATHERED TO A BROWN SILTY FINE SAND, TRACE F-C	14	50/4"			**>50**
							GRAVEL.					
9	43.0	44.3			10		DR, VARIEGATED (WHITE, YELLOW, BROWN, RED) FINE TO MEDIUM	10	32	50/4"		**>50**
							SAND, A LITTLE SILT, WITH A LITTLE F-C GNEISS GRAVEL.					
10	48.0	48.8			8		DR, VARIEGATED (WHITE, YELLOW, BROWN, RED) FINE TO MEDIUM	15	50/4"			**>50**
				53.0			SAND, A LITTLE SILT, WITH A LITTLE F-C GNEISS GRAVEL.					
11	53.0	53.5	53.0		2	DECOMPOSED TO HIGHLY WEATH. GNEISS	HIGHLY WEATHERED GNEISS.	50/6"				**>50**
							AUGER REFUSAL AT 55'.					
							ROCK CORING					
RUN 1	55.0	56.5			10		VARIEGATED GRAY, BROWN, BLACK, RED DECOMPOSED TO	TCR: 55.5%, SCR: 11.1%, RQD: 0%				
RUN 2	56.5	61.3		61.3	24		HIGHLY WEATHERED GNEISS.	TCR: 42%, SCR: 4%, RQD: 0%				
							COULD NOT ROCK CORE ANY DEEPER; BARRELL JAMBING.					
							WATER LEVEL THROUGH AUGERS AT 25'.					
							CAVED AT 28', WATER LEVEL ON CAVE AT 25'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 3.5 TSF
S2: 2.25 TSF

DR: DECOMPOSED ROCK

ROCK CORE SAMPLES NOT LONG ENOUGH FOR COMPRESSIVE STRENGTH 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:	420568 ' EAGLEVIEW BLVD, CH-0131, EXTON, PA		Page 1 of 1
HDD No.:	S3-0320	Dates(s) Drilled: 12-20-15	Inspector: J. COSTELLO
Boring No.:	SB-02	Drilling Method: SPT - ASTM D1586	Driller: E. OGDEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 24.9
Boring Location Coordinates:		40° 3'38.90"N	75°40'34.87"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		6	SM	DR, BROWN FINE TO MEDIUM SAND AND SILT, MICACEOUS, TRACE	2	5	7	8	**12**
							FINE GNEISS ROCK FRAGMENTS.					
2	8.0	10.0			20		DR, VARIEGATED YELLOWISH BROWN FINE TO MEDIUM SAND, SOME	2	4	7	13	**11**
							SILT, MICACEOUS, A LITTLE F-C GNEISS ROCK FRAGS.					
3	13.0	15.0			24		SAME (USCS: SM)	7	13	18	21	**31**
4	18.0	20.0			20		SAME	15	31	35	50	**66**
5	23.0	24.9			20		DR, VARIEGATED YELLOWISH BROWN FINE TO MEDIUM SAND AND	7	18	27	50/5"	**45**
				24.0			SILT, WITH A LITTLE F-C GNEISS ROCK FRAGS. (USCS: SM)					
							AUGER REFUSAL AT 24'. AUGER CUTTINGS INDICATE REFUSAL					
							MATERIAL TO BE PARTIALLY TO HIGHLY WEATHERED GNEISS.					
							CAVED AND DRY AT 20.5'.					

Notes/Comments:

Pocket Pentrometer Testing
S1: 3.5 TSF
S2: 2.25 TSF

DR: DECOMPOSED ROCK

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

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

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TEST BORING LOG

Project Name:	SUNOCO PENNSYLVANIA PIPELINE PROJECT		Project No.: 103IP3406
Project Location:	360 EAGLE ROAD, DOWNINGTOWN, PA		Page 1 of 1
HDD No.:	S3-0320	Dates(s) Drilled: 07-31-15	Inspector: J. COSTELLO
Boring No.:	SB-03	Drilling Method: SPT - ASTM D1586	Driller: E. OGDEN
Drilling Contractor:	HAD DRILLING	Groundwater Depth (ft): NOT ENCOUNTERED	Total Depth (ft): 19.0
Boring Location Coordinates:		40° 3' 30.634" N	75° 40' 23.263" 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			ML	REDDISH BROWN SILT AND FINE SAND, TRACE MICA.	1	1	2	4	**3**
				6.5								
2	8.0	10.0	6.5			SM	DR, REDDISH BROWN FINE SAND AND SILT, TRACE FINE GNEISS	4	4	5	9	**9**
							ROCK FRAGMENTS. (USCS: SM)					
3	13.0	15.0					DR, VARIEGATED (BROWN, YELLOW, BLACK) FINE TO MEDIUM SAND	7	13	22	29	**35**
				18.5			WITH SOME SILT, WITH A LITTLE F-C GNEISS ROCK FRAGS.					
4	18.0	18.8	18.5	19.0			PARTIALLY WEATHERED GNEISS.	9	50/3"			**>50**
							AUGER REFUSAL AT 19'.					
							CAVED AND DRY AT 16.4'.					

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 S3-0320

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					
S3-0320	SB-1	1	55	56.5	56	11	0	55	61.3	Heavily	Gneiss	Massive	Brown/ light gray	Rubble, no sample collected (not enough length needed to test for compressive strength)
		2	56.5	61.3	42	4	0							

GEOTECHNICAL LABORATORY TESTING SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0320

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)
S3-0310	SB-03	1	3.0	4.0	10.6	44.7	-	-	-	-
		2	8.0	9.9	10.8	28.3	NV	NP	NP	SM
		4	18.0	18.5	4.9	20.1	-	-	-	-
		5	23.0	23.2	4.6	22.8	-	-	-	-
S3-0320	SB-01	2	8.0	10.0	15.0	44.5	NV	NP	NP	SM
		3	13.0	15.0	12.7	48.9	-	-	-	-
		4	18.0	20.0	16.9	41.9	-	-	-	-
		5	23.0	25.0	22.3	48.0	NV	NP	NP	SM
		6	28.0	28.8	6.2	24.0	-	-	-	-
		7	33.0	35.0	13.7	18.1	-	-	-	-
		8	38.0	38.8	12.4	43.6	-	-	-	-
		9	43.0	44.3	8.6	17.3	-	-	-	-
	SB-02	1	3.0	5.0	23.3	43.2	-	-	-	-
		2	8.0	10.0	16.1	30.3	-	-	-	-
		3	13.0	15.0	12.2	23.3	NV	NP	NP	SM
		4	18.0	20.0	13.9	34.7	-	-	-	-
		5	23.0	24.9	22.0	46.1	32	25	7	SM
	SB-03	1	3.0	5.0	25.7	60.3	-	-	-	-
		2	8.0	10.0	27.7	47.8	40	27	13	SM
		3	13.0	15.0	10.3	33.6	-	-	-	-

Rock Core Testing Results				
Boring No.	Core Run	Approximate Depth (ft)	Compressive Strength (psi)	Unit Weight (pcf)
SB-01	1/2	Cores did not have sections of suitable length to perform compressive strength testing		

Notes:

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

REGIONAL GEOLOGY SUMMARY
SUNOCO PENNSYLVANIA PIPELINE PROJECT
HDD S3-0320

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
S3-0310		SB-03	**Felsic and intermediate gneiss** - Medium grained, light pink to greenish gray; largely quartz, feldspar, and mica; commonly gneissic, containing alteration minerals; interfingers with gabbroic gneiss.	Gently sloping to the South	Felsic and intermediate gneiss (PreCambrian)	Felsic gneiss	No information found during literature review	Ranges from 30 to 95 ft bgs, Avg. 52 ft bgs (.5 mile radius)	
S3-320		SB-01	**Felsic and intermediate gneiss** - Medium grained, light pink to greenish gray; largely quartz, feldspar, and mica; commonly gneissic, containing alteration minerals; interfingers with gabbroic gneiss.	Generally level, slight slope to the west	Felsic and intermediate gneiss (PreCambrian)	Felsic gneiss	No information found during literature review	Ranges from 30 to 57 ft bgs, Avg. 44 ft bgs (.5 mile radius)	
		SB-02		Gently sloping to the NW	Felsic and intermediate gneiss (PreCambrian)			Ranges from 25 to 50 ft bgs, Avg. 38 ft bgs (.5 mile radius)	
		SB-03	**Banded mafic gneiss** - Dark, fine to medium grained; includes rocks of probable sedimentary origin; may be equivalent to "PZmgh."	Generally level, slightly sloping to the north	Banded mafic gneiss (PreCambrian)	Mafic gneiss		Ranges from 25 to 50 ft bgs, Avg. 42 ft bgs (.5 mile radius)	

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).

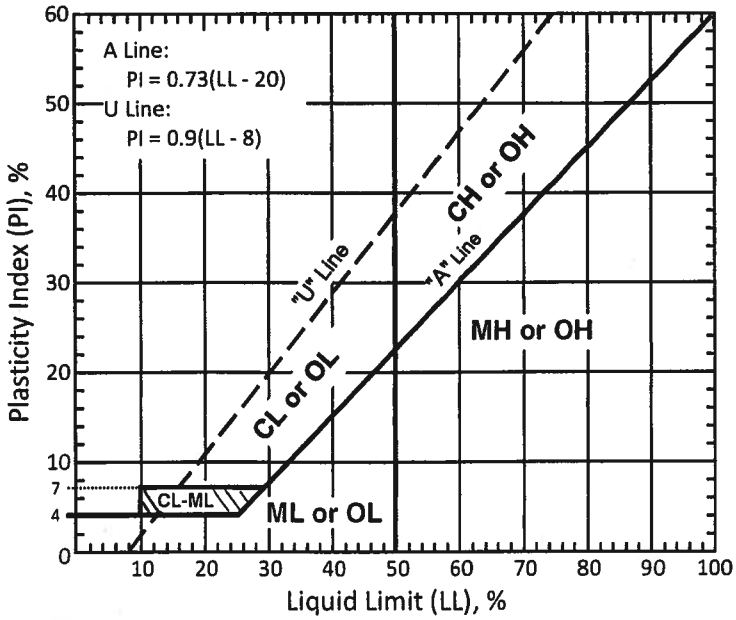
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

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.