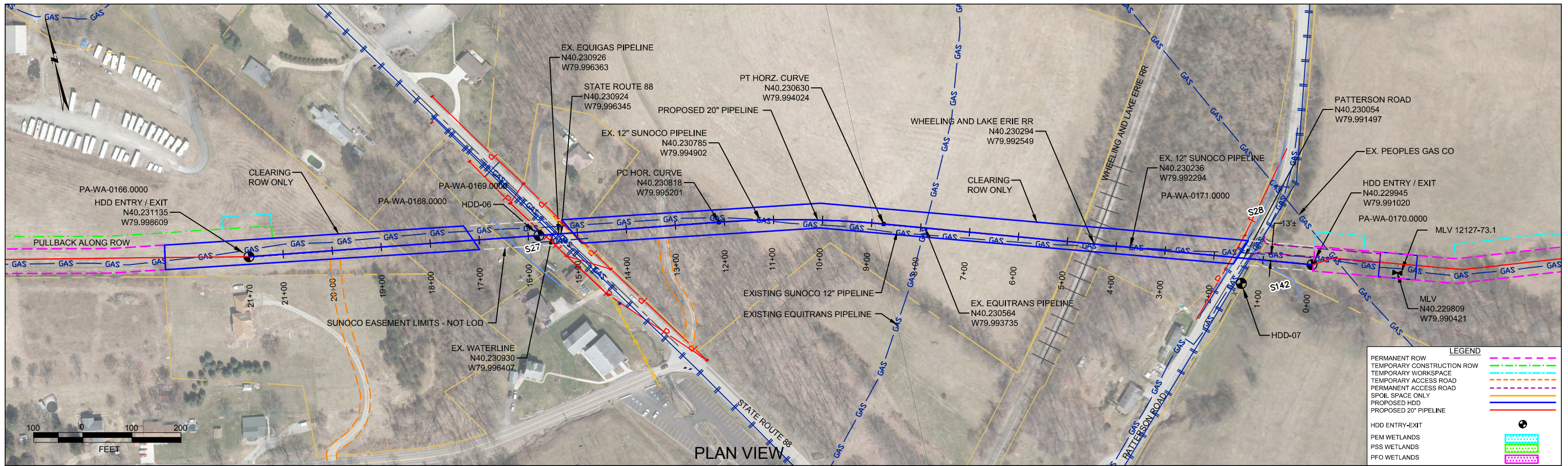


***HDD PA-WA-0171.0000-RR (S27, S28, S142)***

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

The drill will enter/exit 530 feet from the western edge of a Stream 27 (S27) and enter/exit 1,650 feet from the eastern edge. The horizontal directional drill will enter/exit 2,020 feet from the western edge of Stream 28 (S28) and enter/exit 160 feet from the eastern edge. The drill will enter/exit 2,080 feet from the western edge of Stream 142 (S142) and will enter/exit 100 feet from the eastern edge. The drill will cross below S27 at more than 50 feet, and S28 and S142 at about 10 feet. The 20" drill will closely follow the existing ME1 12" pipeline drill. The geotechnical results from the previous drill, as well as other data points, were used to determine the entry/exit angles, and depths to pass through the best substrates while maintaining the pipe integrity (e.g., no large bends). According to the geotechnical reports the primary substrate at the crossings is either rock with limestone and shale (S28) or medium sand with silty clay (S28, S142). Based on the geotechnical report, the drill profile, and the previous drill data minimal inadvertent returns are expected.



PROFILE VIEW

WASHINGTON COUNTY, PENNSYLVANIA - UNION TOWNSHIP  
S1B-0120

**GEOTECH HDD-06**

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

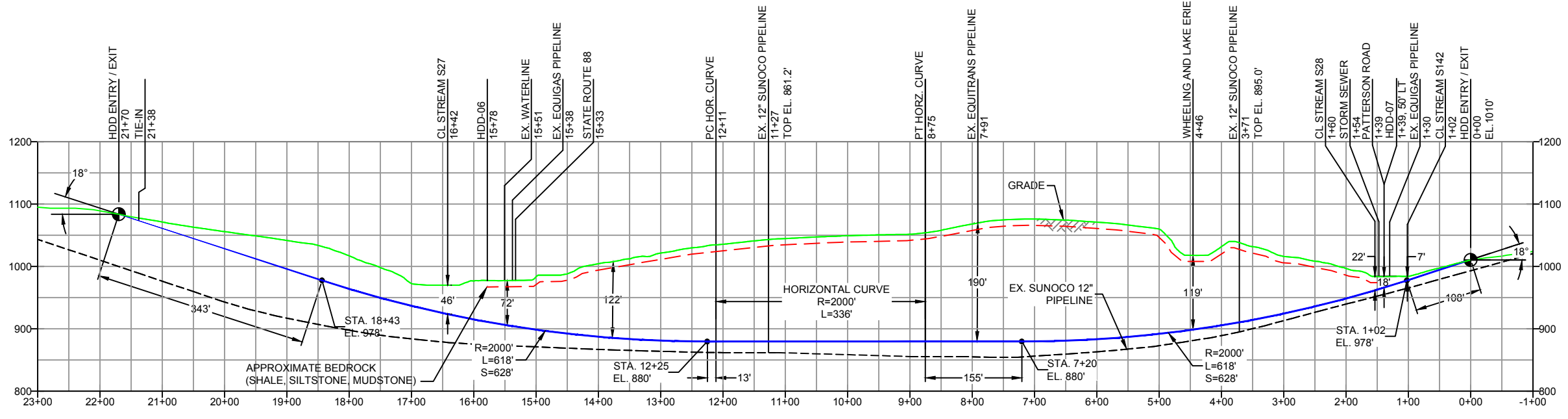
NOTE: REFER TO TEST BORING LOG HDD-06 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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**GEOTECH HDD-07**

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

NOTE: REFER TO TEST BORING LOG HDD-07 FOR COMPLETE SOIL MATERIAL DESCRIPTION



- DESIGN AND CONSTRUCTION:
- 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-): 2170'  
HDD PIPE LENGTH (S-): 2212'  
20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW  
COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
  - 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

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

REVISIONS

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

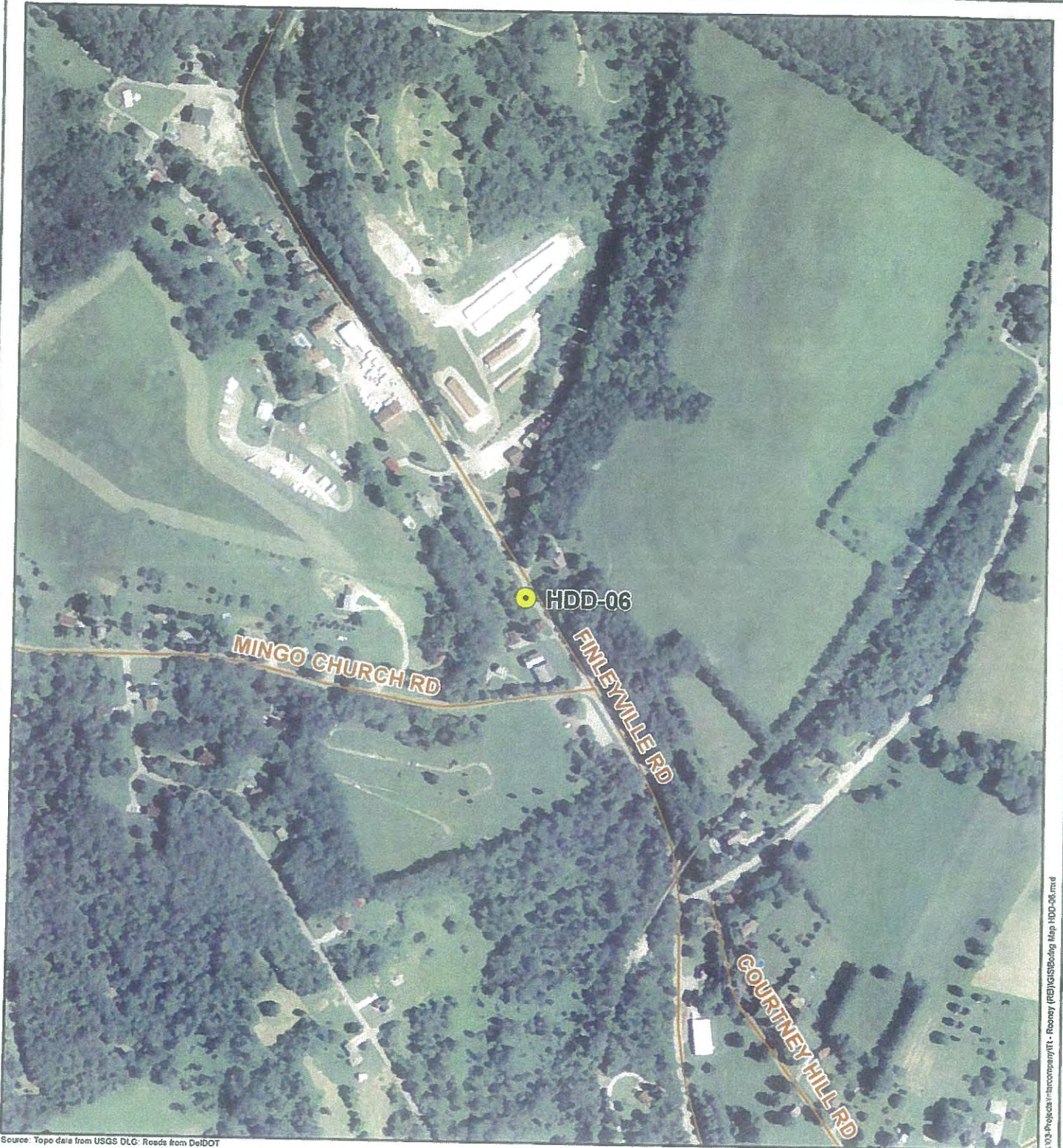
**Sunoco Logistics Partners L.P.**

**TETRA TECH ROONEY**  
(303) 792-5911

**SUNOCO PIPELINE, L.P.**

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

SCALE: 1"=200'  
DWG. NO. PA-WA-0171.0000-RR



Source: Topo data from USGS DLG; Roads from DelDOT

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



1 inch = 500 feet

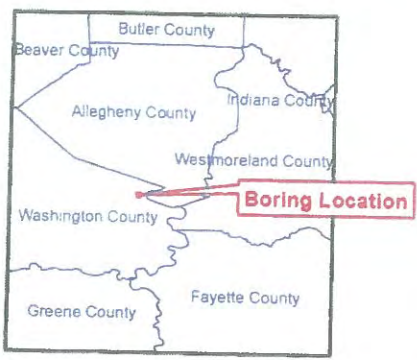

**Tetra Tech, Inc.**  
 Phone: (302) 738-7551  
 Toll Free: (800) 462-0910  
[www.tetrattech.com](http://www.tetrattech.com)

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Source: \*Topo data from USGS DLG Roads from DelDOT

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



1 inch = 500 feet

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# 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        |

### Relative Proportions

| <u>Description Term</u> | <u>Percent</u> |
|-------------------------|----------------|
| 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<br>Fine (F) ¾ in. to No. 4 sieve  |
| Sand      | Coarse (C) No. 4 to No. 10 sieve<br>(4.75mm-2.00mm)<br>Medium No. 10 to No. 40 sieve<br>(M) (2.00mm – 0.425mm)<br>Fine (F) No. 40 to No. 200 sieve<br>(0.425 – 0.074mm) |
| Silt/Clay | Less Than a No. 200 sieve (<0.074mm)  |

## 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<br>(More than half of material is larger than No. 200 sieve)                       | Gravels<br>(More than half of coarse fraction is larger than No. 4 sieve size)            | Clean gravel<br>(Little or no fines)   | GW<br>Well-graded gravels, gravel-sand mixtures, little or no fines | Determine Percentage of sand and gravel from grain size curve.<br>Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows:<br><br>Less than 5 percent GW, GP, SW, SP<br>More than 12 percent GM, GC, SM, SC<br>5 to 12 percent Borderline cases requiring dual symbols <sup>(1)</sup> | $C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3             |   |  |  |
|   |   | GP<br>Poorly graded gravels, gravel-sand mixtures, little or no fines            | Not meeting $C_u$ or $C_c$ requirements for GW                      |  |   |   |  |  |
|   |   | Gravel with fines<br>(Appreciable amount of fines)                               | GM<br>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<br>Clayey gravels, gravel-sand-clay mixtures                     |  | Atterberg limits above A line with $I_p$ greater than 7   |   |  |  |
|   | Sands<br>(More than half of coarse fraction is smaller than No. 4 Sieve)                  | Clean sands<br>(Little or no fines)  | SW<br>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<br>Poorly graded sands, gravelly sands, little or no fines       |  | Not meeting $C_u$ or $C_c$ requirements for SW  |   |  |  |
|   |   | Sands with fines<br>(Appreciable amount of fines)                                | SM<br>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<br>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 $\pm 2$ percent. |  |  |
|   |   | Fine-grained soils<br>(More than half of material is smaller than No. 200 sieve) | Silt and clays<br>(Liquid limit less than 50)                       |  | ML<br>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity |   |  |  |
| CL<br>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays |   |  |   |  |   |   |  |  |
| OL<br>Organic silts and organic silty clays of low plasticity   |   |  |   |  |   |   |  |  |
| Silt and Clays (Liquid limit greater than 50)   | MH<br>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts |  |   |  |   |   |  |  |
|   | CH<br>Inorganic clays of high plasticity, fat clays                                       |  |   |  |   |   |  |  |
|   | OH<br>Organic clays of medium to high plasticity, organic silts                           |  |   |  |   |   |  |  |
| Highly organic soils  | Pt<br>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.