TRIP REPORT

Date: November 17, 2015

To: Rob Simcik

From: Scott R. Anderson, Hydrogeologist

Subject: Summary of Soil Infiltration Tests
Schaeffer Road
Sunoco Pipeline/Valve Stations
South Lebanon Township, Lebanon County, Pennsylvania

This trip report provides results of soil infiltration tests that were completed as part of the Segment 3 Pipeline Project for Sunoco, in South Lebanon Township, Lebanon County, Pennsylvania.

1.0 PURPOSE

This report presents the field data and results of double ring soil infiltration tests conducted to support the design of stormwater management systems at several locations in South Lebanon Township, Lebanon County, Pennsylvania. Five shallow tests (IT-1 through IT-5) were performed at the property. Test locations are listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figures.

2.0 FIELD ACTIVIES

The infiltration tests were conducted by Terry Rojahn and Keith Simpson of Tetra Tech, Inc., on October 1, 2015. The test locations were positioned in the field using a handheld, WAAS-enabled GPS unit and reference to google earth map. Table 1 provides the coordinates recorded in the field. All five locations are within a corn field. Standing, mature corn was present during the testing. Photographs of testing locations are attached to this report.

The infiltration tests were performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. Double ring tests were performed at this site. The double ring test locations were prepared for test locations with a shovel. The double-ring infiltrometers that were used for testing consisted of 10-inch and 6-inch diameter sections of 10-inch steel casing. After digging to the target depth, the test surface was leveled, and any loose soil or fallen vegetation was removed. The rings were driven a minimum of 2 inches into the soil. Infiltration test depths are provided on Table 1.

Test locations were pre-soaked for 1 hour. The tests were then conducted with measurements at 10 or 30-minute intervals, based on the observed water level drops during the pre-soak period. Pre-soak and test information was recorded on infiltration test sheets; copies of the test sheets are attached to this report.

During the testing, the weather was cool, approximately 50 degrees Fahrenheit, with occasional rain observed during the tests. Total precipitation did not exceed 0.2 inches during the testing. Approximately 0.43 inches of rain were received in the area in the previous 24-hours.

In addition, two hand auger locations were advanced to 3.5 feet bgs near the testing locations to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table. The hand auger advancements were identified with the corresponding infiltration test name. The hand auger advancements were completed to refusal.

Descriptions of the soil were recorded on field logs, which were based on the form example in the BMP manual. Copies of the field soil logs are attached to this report.

3.0 RESULTS

3.1 SOILS DESCRIPTION

Soils encountered generally consisted of moderately thick (up to 12 inches) brown silt with clay and minor gravel and rocks (silt loam) topsoil/surface soil layer, underlain primarily by an orange brown silt loam to silty clay loam with minor sands and gravels. This horizon is underlain by similar soils, being a silty clay with gravel (silty clay loam). Bedrock was not encountered though increasing gravel content was observed with depth and below 36 inches bgs. Thick corn roots were encountered in the topsoil/surface soils with trace roots being observed in the underlying soil horizons. Table 1 summarizes the depths of the infiltration tests (hand auger completed approximately 2.5 feet deeper than infiltration test depths).

The soils were noted to be moist during the hand augering activities. No mottling of soils or groundwater was recorded. The moist soils were likely due to recent rainfall received in prior days to testing (0.5 inches was not observed over a 24-hour period before testing however more than 0.5 inches had been received over the prior 7 days).

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey[1] data, the soil types for the test locations are mapped as follows:

- IT-1, IT-2, IT-3 – Clarksburg silt loam (CkA soil symbol) with 0 to 3 percent slopes
- IT-4 and IT-5 – Duffield silt loam (DfA soil symbol) with 0 to 3 percent slopes

Based on the interactive website PaGEODE, the geology of the site is limestone of the Buffalo Springs Formation. The Buffalo Springs Formation consists of light gray to pink, fine to coarse grained limestone and interbedded dolomite. A Geologic map is attached to this report.

[1] http://websoilsurvey.nrcs.usda.gov/. Accessed November 4, 2015.

3.2 INFILTRATION TEST RESULTS

Table 1 summarizes the infiltration rates (inches per hour) calculated from the test data. Infiltration rates presented in Table 1 were calculated from the average water level drop of the last four readings measured in the inner ring.

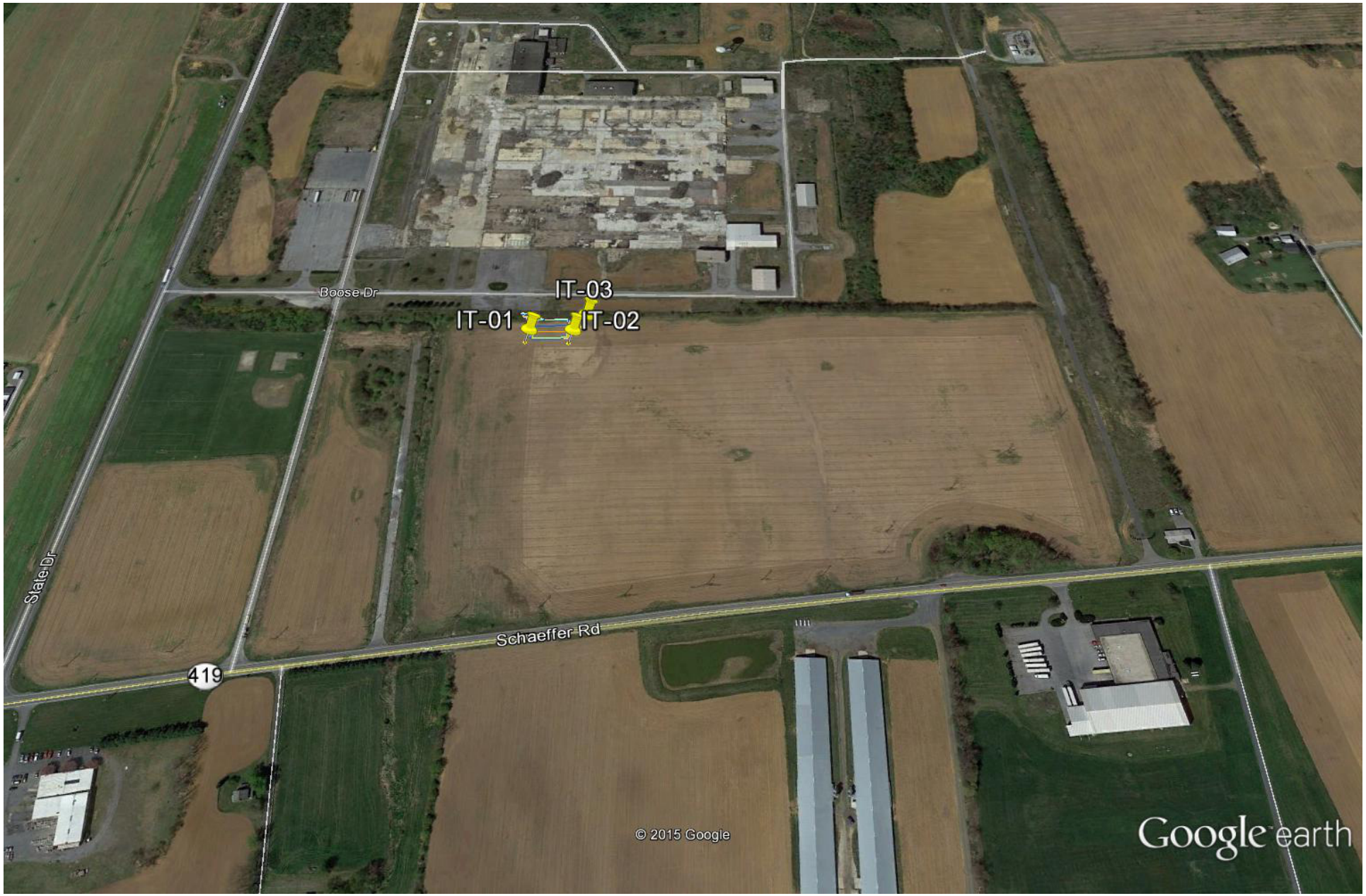
The IT-1 test exhibited a slow rate of infiltration requiring a 30-minute test cycle while the remaining test locations (IT-2 to IT-5) exhibited a moderate rate of infiltration requiring a 10-minute test cycle.

Table 1
Summary of Infiltration Test Results
Schaeffer Road
South Lebanon Township, Lebanon County, PA
Sunoco Pipeline/Valve Stations

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-1	40° 17’ 22.47”	76° 22’ 47.93”	6	1.0
IT-2	40° 17’ 22.45”	76° 22’ 46.43”	6	8.3
IT-3	40° 17’ 22.98”	76° 22’ 45.99”	6	3.4
IT-4	40° 17’ 21.32”	76° 22’ 31.73”	6	5.9
IT-5	40° 17’ 21.09”	76° 22’ 31.79”	6	7.7

ATTACHMENTS

SITE FIGURE



Google earth

feet 1000

meters 400

SOIL LOGS

TETRA TECH

Soil Log

Tested By: Scott Anderson
Test Pit: Shaeffer Rd TP 1/2/3 Date: 9/30/15
Geology: Cbs Buffalo Springs Formation Soil Type: CkA Clarksburg Silt Loam

Project: Sunoco Pipeline Project No.: 112IC07309 25
Elevation: Equipment Used Hand Auger
Land Use: Agricultural Weather: 60°F, clear

Additional Comments

Horizon	Upper Boundary	Lower Boundary	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Color	Color Patterns	Pores, Roots, Rock Structure	Depth to Bedrock	Depth to Water	Comments
O	0"	10"	Silt loam	Silt w/clay - minor gravel and rocks	Brown	None	Numerous pores roots	—	—	Moist
A	10"	26"	Silt loam Silty clay loam	clayey silt to silt and clay - minor sand, gravel	Orange/ Brown	None	few pores, roots	—	—	moist
B	26"	36"	Silty clay	Silty clay w/ fine gravel	Brown/ orange	None	No pores, some roots	>36"	>36"	moist

Horizon:	USDA Definition	Soil Textural Class	Boundary	Notes:
O	Organic debris	Use ternary diagram from US Department of Agriculture Soil Conservation Service	Use depth and classification	
A	Dark colored, mixed mineral organic matter		Classification as Follows: Abrupt	
B	Maximum accumulation of silicate clay minerals		(Clear)	
C	Weathered parent material		Gradual	
R	Layer of consolidated rock beneath the soil		Diffuse	

Table based on: Sample soil log located on page 12 of the Pennsylvania Stormwater Best Management Practices Manual
USDA Definitions located from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054308

TETRA TECH

Soil Log

Tested By: Scott Anderson
Test Pit: Shaeffer Road ST 4/5
Date: 9/30/15
Geology: Cbs Buffalo Springs Formation
Soil Type: DfA Duffield Silt Loam
Project: Sunoco Pipeline
Elevation:
Land Use: Agricultural
Project No.: 112107309.25
Equipment Used Hand Auger
Weather: 60°F, clear

Additional Comments

Horizon	Upper Boundary	Lower Boundary	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Color	Color Patterns	Pores, Roots, Rock Structure	Depth to Bedrock	Depth to Water	Comments
O	0"	12"	Silt Loam	Silt w/clay and some gravel and rocks	Brown	None	Numerous pores roots	—	—	Moist
A	12"	24"	Silt loam to silty clay loam	clayey silt to silt and clay - minor gravel/rocks	Orange/ Brown	None	Few pores and roots	—	—	Moist
B	24"	36"	Silty clay	Silty clay w/gravel	Orange/ Brown	None	No pores, roots	>36"	>36"	Moist

Horizon:	USDA Definition	Soil Textural Class	Boundary	Notes:
O	Organic debris	Use ternary diagram from US Department of Agriculture Soil Conservation Service	Use depth and classification	
A	Dark colored, mixed mineral organic matter		Classification as Follows: Abrupt	
B	Maximum accumulation of silicate clay minerals		Clear	
C	Weathered parent material		Gradual (circled)	
R	Layer of consolidated rock beneath the soil		Diffuse	

Table based on: Sample soil log located on page 12 of the Pennsylvania Stormwater Best Management Practices Manual
USDA Definitions located from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054308

INFILTRATION TEST DATA SHEETS

Scheaffer Road #1 | Test Loc. 6" deep | Test Date 10/1/2015

Time	Elapsed Time (minutes)	Water Level Drop (in)	Volume of Water Added (L)
1410	30	0.50	0.50
1440	60	0.50	0.50
1510	90	0.50	0.50
1540	120	0.44	0.45

Infiltration Rate

Average Stabilized Rate (in/hr)

1.0

Scheaffer Road #2 | Test Loc. 6" deep | Test Date 10/1/2015

Time	Elapsed Time (minutes)	Water Level Drop (in)	Volume of Water Added (L)
1355	10	1.50	1.00
1405	20	1.50	1.00
1415	30	1.25	0.90
1425	40	1.25	0.90

Infiltration Rate
Average Stabilized Rate (in/hr)
8.3

Scheaffer Road #3 | Test Loc. 6" deep | Test Date 10/1/2015

Time	Elapsed Time (minutes)	Water Level Drop (in)	Volume of Water Added (L)
1555	10	0.50	0.50
1605	20	0.56	0.45
1615	30	0.56	0.52
1625	40	0.56	0.52
1635	50	0.56	0.52

Infiltration Rate
Average Stabilized Rate (in/hr)
3.4

Scheaffer Road #4 | Test Loc. 6" deep | Test Date 10/1/2015

Time	Elapsed Time (minutes)	Water Level Drop (in)	Volume of Water Added (L)
1400	10	2.25	2.10
1410	20	1.56	1.40
1420	30	1.56	1.00
1430	40	0.94	0.90
1440	50	1.00	1.00
1450	60	1.06	1.10
1500	70	0.94	0.90

Infiltration Rate
Average Stabilized Rate (in/hr)
5.9

Scheaffer Road #5 | Test Loc. 6" deep | Test Date 10/1/2015

Time	Elapsed Time (minutes)	Water Level Drop (in)	Volume of Water Added (L)
1410	10	1.88	1.20
1420	20	1.38	1.10
1430	30	1.50	1.10
1440	40	1.38	1.10
1450	50	1.38	1.10

Infiltration Rate
Average Stabilized Rate (in/hr)
8.5

TETRA TECH

INFILTRATION TEST DATA SHEET

PROJECT NAME: Sunoco Pipeline TEST AREA ID: Shaeffer Road IT #1
PROJECT NUMBER: 112IC07309 PERSONNEL: Simpson / Rojahn

TEST METHOD: (Double-Ring Infiltrometer) Percolation

Location Coordinates or Description:
N 40° 17' 22.47"
W 76° 22' 47.93"

INNER RING INSIDE DIAMETER: 6"

OUTER RING INSIDE DIAMETER: 10"

PERCOLATION HOLE DIAMETER: NA (If performing an open hole percolation test)

DATE(s): 10-01-15

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 4-6 inches): 7.5"

MEASURING POINT: (Ring Rim) Indicator Mark DEPTH OF TEST: 6" Corn Field

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE* (units ____)	REMARKS
PRESOAK DATA				
1240	0	0	~9	
1310	30	3/4	2.15"	
1340	60	1/2	0.55	
TEST DATA				
1410	0	1/2	0.50	
1440	30	1/2	0.50	
1510	60	1/2	0.50	
1540	90	7/16	0.45	

*For double ring test, the volume of water added equals the sum for the inner and outer rings.

TETRA TECH

INFILTRATION TEST DATA SHEET

PROJECT NAME: SUNOCO PIPELINE
PROJECT NUMBER: 112ICO7309
TEST AREA ID: Shaeffer Road IT #2
PERSONNEL: SIMPSON / ROJAHN

TEST METHOD: (Double-Ring Infiltrometer) Percolation

Location Coordinates or Description:
N 40° 17' 22.45"
W 76° 22' 46.43"

INNER RING INSIDE DIAMETER: 6"
OUTER RING INSIDE DIAMETER: 10"
PERCOLATION HOLE DIAMETER: NA (If performing an open hole percolation test)
DATE(s): 10/01/15

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 4-6 inches): 7.5"

MEASURING POINT: (Ring Rim) Indicator Mark
DEPTH OF TEST: 6" CORN FIELD

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE* (units L)	REMARKS
PRESOAK DATA				
1245	0	0	~9	
1315	30	7 14/16	4.5	1300 5 1/4" 2.5L 1315 2 5/8 2
1345	60	3 3/4	2.6	
TEST DATA				
1355	0	1 1/2	1.0	
1405	10	1 1/2	1.0	
1415	20	1 1/4	0.9	
1425	30	1 1/4	0.9	
			LT RAIN STARTED @ END OF TEST	

*For double ring test, the volume of water added equals the sum for the inner and outer rings.

TETRA TECH

INFILTRATION TEST DATA SHEET

PROJECT NAME: Sunoco Pipeline
PROJECT NUMBER: 112IC07309
TEST AREA ID: Shaeffer Road #3
PERSONNEL: Simpson / Rojahn

TEST METHOD: (Double-Ring Infiltrometer) Percolation

Location Coordinates or Description:
N 40° 17' 22.98"
W 76° 22' 45.99"

INNER RING INSIDE DIAMETER: 6"
OUTER RING INSIDE DIAMETER: 10"
PERCOLATION HOLE DIAMETER: NA (If performing an open hole percolation test)
DATE(s): 10/01/15

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 4-6 inches): 8"

MEASURING POINT: (Ring Rim) Indicator Mark
DEPTH OF TEST: 6"
Corn Field

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE* (units L)	REMARKS
PRESOAK DATA				
1445	0	0	~9.5	
1515	30	2 1/16	1.4	
1545	60	2	1.2	
TEST DATA				
1555	0	9/16	0.50	
1605	10	9/16	0.45	
1615	20	9/16	0.52	
1625	30	9/16	0.52	
1635	40	9/16	0.52	

*For double ring test, the volume of water added equals the sum for the inner and outer rings.

TETRA TECH

INFILTRATION TEST DATA SHEET

PROJECT NAME: SUNOCO - MARINER
PROJECT NUMBER: 112IC05958

TEST AREA ID: Shaeffer Road 4
PERSONNEL: ROJAHN / SIMPSON

TEST METHOD: (Double-Ring Infiltrometer) Percolation

Location Coordinates or Description:
N 40° 17' 21.32" N
W 76° 22' 31.73 W

INNER RING INSIDE DIAMETER: 6"
OUTER RING INSIDE DIAMETER: 10"
PERCOLATION HOLE DIAMETER: NA (If performing an open hole percolation test)
DATE(s): 10/1/15

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 4-6 inches): 7.5" (2.5" IN GROUND)

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: 6" BGS

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE* (units L)	REMARKS
PRESOAK DATA				
1250	0	NA	9.2	TOTAL
1320	30	6 6/16	5.2	
1350	60	4 14/16	3.8	
TEST DATA				
1400	10	2 4/16	2.1	
1420	20	1 9/16	1.4	
1430	30	1 6/16	1.0	
1440	40	15/16	0.9	
1450	50	1 6/16	1.0	
1510	60	1 1/16	1.1	
1520	70	15/16	0.9	
			LT. RAIN	
			DURING	TEST

*For double ring test, the volume of water added equals the sum for the inner and outer rings.

TETRA TECH

INFILTRATION TEST DATA SHEET

PROJECT NAME: SUNOCO - MARINER
PROJECT NUMBER: 112IC05958
TEST AREA ID: Shreffler Road 5
PERSONNEL: ROJAHN / SIMPSON

TEST METHOD: Double-Ring Infiltrometer Percolation

Location Coordinates or Description:
N 40°17'21.09"
W 76°22'31.79"

INNER RING INSIDE DIAMETER: 6"
OUTER RING INSIDE DIAMETER: 10"
PERCOLATION HOLE DIAMETER: NA (If performing an open hole percolation test)
DATE(s): 10/1/15

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 4-6 inches): 7.5" (2.5" IN GROUND)

MEASURING POINT: Ring Rim Indicator Mark

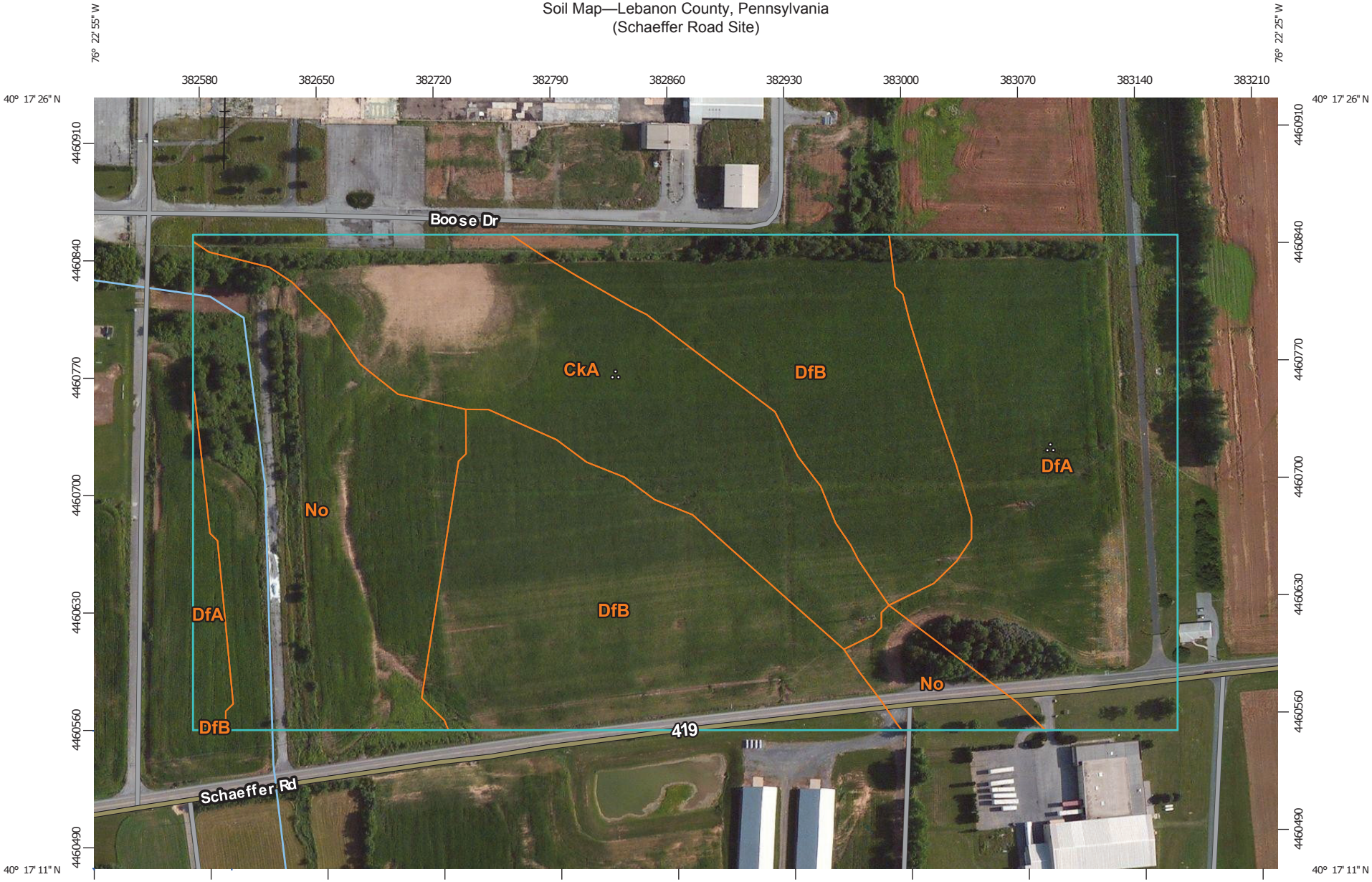
DEPTH OF TEST: 6" BGS

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE* (units L)	REMARKS
PRESOAK DATA				
1300	0	NA	9.2 TOTAL	
1330	30	7 4/16	4.6	
1400	60	6 3/16	4.1	
TEST DATA				
1400	0	3 3/16	1.9	
1410	10	1 14/16	1.2	
1420	20	1 6/16	1.1	
1430	30	1 8/16	1.1	
1440	40	1 6/16	1.1	
1450	50	1 6/16	1.1	
1500	60			
			LT RAIN	
			DURING TEST	

*For double ring test, the volume of water added equals the sum for the inner and outer rings.

SOIL MAP FIGURE AND SUPPORTING MATERIAL

Soil Map—Lebanon County, Pennsylvania
(Schaeffer Road Site)



Map Scale: 1:3,240 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lebanon County, Pennsylvania
Survey Area Data: Version 9, Sep 18, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

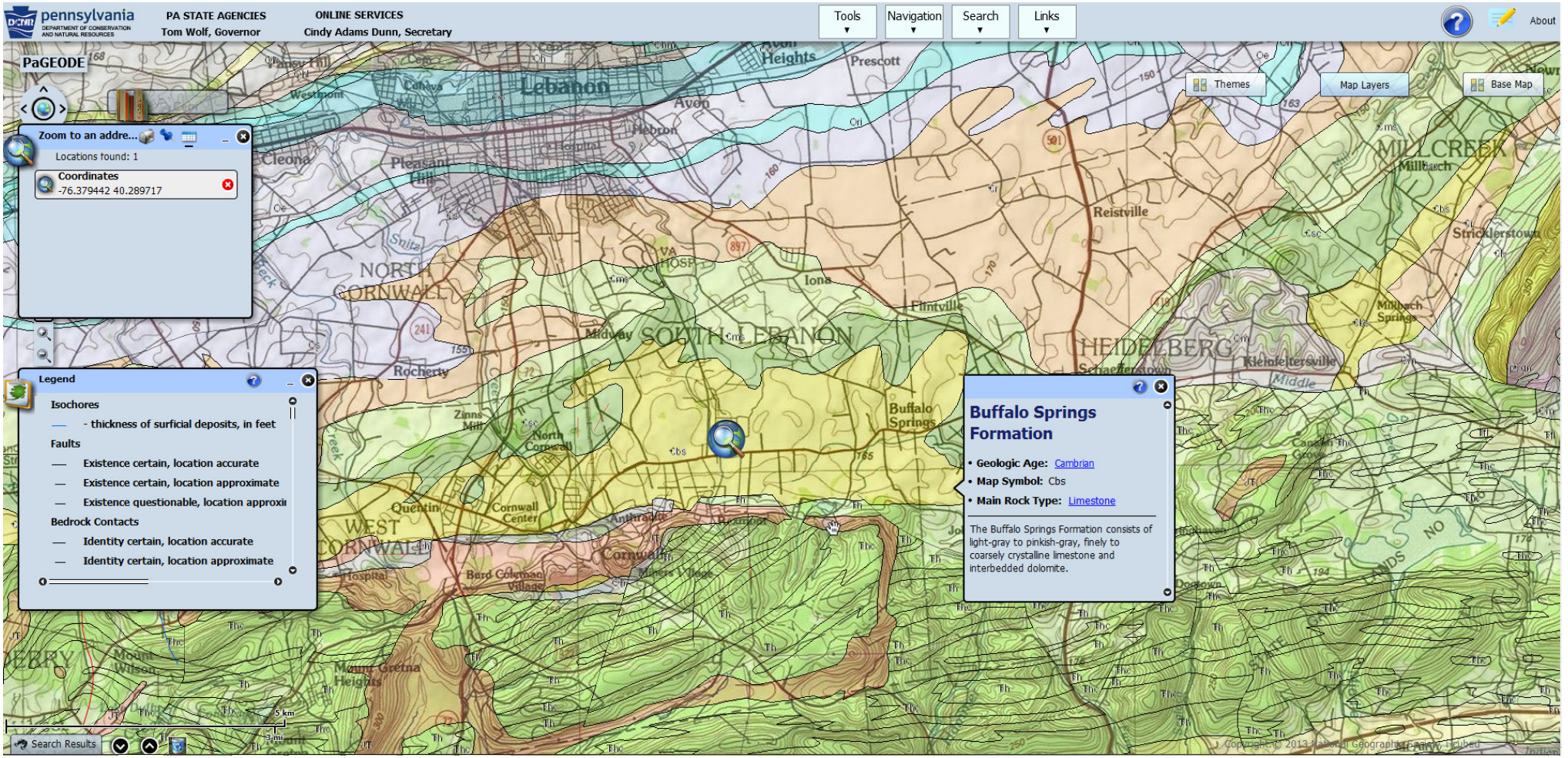
Date(s) aerial images were photographed: Mar 26, 2011—Jul 2, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Lebanon County, Pennsylvania (PA075)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CkA	Clarksburg silt loam, 0 to 3 percent slopes	8.2	18.9%
DfA	Duffield silt loam, 0 to 3 percent slopes	11.0	25.5%
DfB	Duffield silt loam, 3 to 8 percent slopes	14.5	33.6%
No	Nolin variant silt loam	9.5	22.0%
Totals for Area of Interest		**43.2**	**100.0%**

SITE GEOLOGY MAP



Geologic Map of the Schaeffer Road Site

PHOTOGRAPHS

PHOTOGRAPHS
INFILTRATION TESTING
SUNOCO PIPELINE
SCHAEFFER ROAD SITE
LEBANON COUNTY, PA

Description: Test at Schaeffer Rd. IT-4, approximately 6 inches deep.

Date: October 1, 2015

Description: Test at Schaeffer Rd. IT-5, approximately 6 inches deep.

Date: October 1, 2015

PHOTOGRAPHS
INFILTRATION TESTING
SUNOCO PIPELINE
SCHAEFFER ROAD SITE
LEBANON COUNTY, PA

Description: Soil from Schaeffer Rd. IT-4/5, approximately 3 feet deep (top at left, foot marks denoted by sticks).

Date: October 1, 2015

Description: Soil from Schaeffer Rd. IT-1/2/3, approximately 3 feet deep (top at left, foot marks denoted by sticks).

Date: October 1, 2015