ATTACHMENT 5 – Infiltration Test Results

TABLE 1
SUMMARY OF INFILTRATION RATES
BLOCK VALVE LOCATIONS - CONSTRUCTION SPREADS 2, 3, 4, 5, and 6
PENNSYLVANIA PIPELINE PROJECT
SUNOCO PIPELINE, LP

Block Valve Site	Construction Spread	Test Type	Test ID [1]	Test Depth (bgs)	Test Infiltration Rate (in/hr)	Average Infiltration Rate (in/hr)	Geometric Mean Infiltration Rate (in/hr)	FS	Recommended Rate (in/hr)	Soil Type (USDA Class)	Seasonal High Water, Mottling, Bedrock (bgs)	Rationale for Recommended Design Rate
KOONTZ ROAD EFRD	2	DR	IT-A (IT-1a)	4 inches	5.91	7.13	7.02	2	3.5	sandy loam	not encountered, > 30 inches	IT-1 and IT-2 (performed in 2015) are outside BMP Area.
		DR	IT-B (IT-1b)	4 inches	8.34					sandy loam	not encountered, > 26 inches	
BUSH ROAD VALVE	2	DR	IT-A (IT-2a)	3 inches	18.6	10.60	6.95	3	2.3	silt loam	not encountered, > 25 inches	IT-1 and IT-2 (performed in 2015) are outside BMP Area.
		DR	IT-B (IT-2b)	3 inches	2.6					silt loam	not encountered, > 26 inches	
WESTINGHOUSE ROAD EFRD	2	DR	IT-A (IT-3a)	1 foot	1.1	1.86	1.70	3	0.6	silt loam	Refusal at 12 inches bgs	IT-A (IT-3a) and IT-1, IT-2 are within or near BMP Berm/Ponding Area. IT-2 data not included in determination of Recommended Rate due to highest result in group.
		DRCH	IT-1	6 inches	2.62					SC	not encountered, > 24 inches	
		DRCH	IT-2	6 inches	3.42					SM/ML	not encountered, > 24 inches	
NEWPORT ROAD VALVE	2	DR	IT-A (IT-4a)	2.5 inches	2.94	NA[2]	NA[2]	3	1.0	silt loam	Refusal at 24 inches bgs	IT-B (IT-4b), IT-D (IT-4d), IT-3 and IT-4 are outside of BMP Berms/Ponding Areas. IT-1 and IT-2 are at BMP Area 1, IT-A (IT-4a) is at BMP Area 2, and IT-C (IT-4c) is at BMP Area 3.
		DR	IT-B (IT-4b)	2 inches	6	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 30 inches	
		DR	IT-C (IT-4c)	2.5 inches	1.63	NA[2]	NA[2]	3	0.5	silt loam	Refusal at 26 inches bgs	
		DR	IT-D (IT-4d)	2 inches	8.5	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 30 inches	
		DRCH	IT-1	6 inches	1.95	2.22	2.20	3	0.7	SM/ML	not encountered, > 15 inches	
		DRCH	IT-2	6 inches	2.49					SM/ML	not encountered, > 14 inches	
CHESTNUT RIDGE ROAD VALVE	2	DR	IT-A (IT-5a)	2 inches	13.88	6.94	0.37	3	0.1	sandy loam	not encountered, > 13 inches	Rock at 26 inches, but likely not bedrock. Assumed sandy loam at C, data missing in upper 6 inches. Only IT-1 and IT-A (IT-5a) within or near BMP Area, all other infiltration tests performed in 2015 or 2016 are outside of BMP Area - IT-2, IT-B (IT-5b) and IT-C (IT-5c).
		DRCH	IT-1	6 inches	0					CL	not encountered, > 36 inches	
		DR	IT-B (IT-5b)	2 inches	1.03	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	> 26 inches bgs (rock)	
		DR	IT-C (IT-5c)	2 inches	2.47	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	> 26 inches bgs (rock)	
GRANGE HALL ROAD EFRD	2	DR	IT-A (IT-6a)	3 feet	0.81	0.47	0.32	3	0.1	silty clay	not encountered, > 62 inches	IT-1 and IT-2 (performed in 2015) are within BMP Area and both shallow (6 inches). IT-A (IT-6a) and IT-B (IT-6b) are near BMP Area and both deep (3 feet). Recommended rates are provided separately for shallow and deep tests.
		DR	IT-B (IT-6b)	3 feet	0.13					silty clay	not encountered, > 62 inches	
		DRCH	IT-1	6 inches	0	0.00	0.00	3	0.0	CL	not encountered, > 36 inches	
		DRCH	IT-2	6 inches	0					CL	not encountered, > 38 inches	
COONEY ROAD VALVE	2	DR	IT-A (IT-7a)	3 feet	0.41	1.68	1.10	3	0.4	silty clay loam	not encountered, > 60 inches	IT-A (IT-7a) and IT-B (IT-7b) are within or near BMP Area.
		DR	IT-B (IT-7b)	3 feet	2.94					silty clay loam	not encountered, > 60 inches	
KOZAK ROAD VALVE	2	DR	IT-A (IT-8a)	3 feet	0.97	0.08	0.06	2	0.0	loam	not encountered, > 54 inches	Some moisture noted at > 53 inches, all infiltration tests are deep tests (>2 feet). No infiltration test performed at IT-2 (2015). IT-A (IT-8a), IT-B (IT-8b), IT-1 and IT-2 are within or near BMP Area 1. IT-C (IT-8c) and IT-D (IT-8d) are within or near BMP Area 2. IT-A data not included in determination of Recommended Rate due to highest result in group.
		DR	IT-B (IT-8b)	3 feet	0.03					loam	not encountered, > 56 inches	
		SRFH	IT-1	2 feet	0.12					CL	not encountered, > 24 inches	
		DR	IT-C (IT-8c)	3 feet	0.13	0.13	0.13	2	0.1	loam	not encountered, > 56 inches	
		DR	IT-D (IT-8d)	3 feet	0.13					loam	not encountered, > 56 inches	
VALLEY FORGE ROAD EFRD	3	DR	IT-A	4 inches	3.66	NA[2]	NA[2]	2	1.8	loam	not encountered, > 25 inches	IT-B shallow at 10 inches, not bedrock. IT-01 and IT-02 within BMP Area 1. IT-A near BMP Area C. IT-B is outside of BMP Areas.
		DR	IT-B	4 inches	11.34	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 10 inches	
		DR	IT-01	6 inches	0.5	0.75	0.71	3	0.2	silt loam	not encountered, > 30 inches	
		DR	IT-02	6 inches	1					silt loam	not encountered, > 30 inches	
CHARGER HIGHWAY EFRD	3	DR	IT-A	1 inches	*[1]	NA[2]	NA[2]	NA[3]	NA[3]	silty clay loam	Bedrock at 7 inches bgs	See notes at end of table.
		DR	IT-B	2 inches	*[1]	NA[2]	NA[2]	NA[3]	NA[3]	clay loam	Bedrock at 5 inches bgs	
		DR	IT-C	2 inches	*[1]	NA[2]	NA[2]	NA[3]	NA[3]	clay loam	Bedrock at 16 inches bgs	
		DR	IT-D	2 inches	*[1]	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	Bedrock at 12 inches bgs	
LOCKE MOUNTAIN ROAD VALVE	3	DR	IT-A	2.5 inches	0	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 60 inches	Some water on shale at 60 inches. No Recommended Rate required because engineering design only shows slow release BMP areas.
		DR	IT-A Deep	3 feet	8.72	NA[2]	NA[2]	NA[3]	NA[3]	sapprolite	not encountered, > 60 inches	
		DR	IT-B	3 inches	0.13	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	Water at 58 inches bgs	
		DR	IT-B Deep	3 feet	0.13	NA[2]	NA[2]	NA[3]	NA[3]	sapprolite	Water at 58 inches bgs	
JUNIATA VALLEY ROAD EFRD	3	DR	IT-A	3 inches	0	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 36 inches	IT-A located outside of BMP Area (> 25 feet). IT-B, IT-C, IT-01 and IT-02 within or near (approxmately 25 feet) BMP Area. IT-01 data not included in determination of Recommended Rate due to highest result in group.
		DR	IT-B	2.5 inches	0	2.81	0.20	2	0.1	loam	not encountered, > 36 inches	
		DR	IT-C	2.5 inches	8.34					loam	not encountered, > 36 inches	
		DR	IT-01	6 inches	46.5					loam	not encountered, > 21 inches	
		DR	IT-02	6 inches	0.1					loam	not encountered, > 21 inches	
HIGH STREET VALVE	3	DR	IT-A	4 inches	1.66	NA[2]	NA[2]	3	0.6	silt loam	not encountered, > 60 inches	IT-A within BMP Area A at shallow depth. IT-A Deep within BMP Area at deep depth. Recommended rates are provided separately for shallow and deep tests. IT-B, IT-02 and IT-3 are outside BMP Area.
		DR	IT-A Deep	3 feet	5.44	NA[2]	NA[2]	3	1.8	silty clay loam	not encountered, > 60 inches	
		DR	IT-B	5 inches	4.31	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 36 inches	
		DR	IT-B Deep	1 foot	5.63	NA[2]	NA[2]	NA[3]	NA[3]	silty clay loam	not encountered, > 36 inches	

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SUMMARY OF INFILTRATION RATES
BLOCK VALVE LOCATIONS - CONSTRUCTION SPREADS 2, 3, 4, 5, and 6
PENNSYLVANIA PIPELINE PROJECT
SUNOCO PIPELINE, LP

Block Valve Site	Construction Spread	Test Type	Test ID [1]	Test Depth (bgs)	Test Infiltration Rate (in/hr)	Average Infiltration Rate (in/hr)	Geometric Mean Infiltration Rate (in/hr)	FS	Recommended Rate (in/hr)	Soil Type (USDA Class)	Seasonal High Water, Mottling, Bedrock (bgs)	Rationale for Recommended Design Rate
RAYSTOWN ROAD EFRD	3	DR	IT-A	4 inches	20.06	NA[2]	NA[2]	2	10.0	loamy sand	Mottling at 37 inches	IT-1 and IT-2 (performed in 2015) are outside BMP Area. IT-A Deep, IT-B Deep and IT-C Deep are not applicable for determining Recommended Rate because mottling was observed within 24 inches of infiltration testing. IT-A within BMP Area A, IT-C and IT-D within or near BMP Area B.
		DR	IT-A Deep	2 feet	4.97	NA[2]	NA[2]	NA[3]	NA[3]	loamy sand	Mottling at 37 inches	
		DR	IT-B	4 inches	0.41	NA[2]	NA[2]	NA[3]	NA[3]	silty clay	Mottling at 38 inches	
		DR	IT-B Deep	3 feet	0.31	NA[2]	NA[2]	NA[3]	NA[3]	silty clay	Mottling at 38 inches	
		DR	IT-C	4 inches	0	1.97	0.20	3	0.1	silty clay	Mottling at 38 inches	
		DR	IT-D	4 inches	3.94					silty clay	Mottling at 38 inches	
		DR	IT-C Deep	3 feet	0	NA[2]	NA[2]	NA[3]	NA[3]	silty clay	Mottling at 38 inches	
		DR	IT-D Deep	3 feet	0.13	NA[2]	NA[2]	NA[3]	NA[3]	silty clay	Mottling at 38 inches	
SEVEN POINTS LOOP EFRD	3	DR	IT-A	2 inches	0.63	NA[2]	NA[2]	NA[3]	NA[3]	silty clay loam	not encountered, > 25 inches	*Did not perform infiltration test at IT-A Deep due to access issue. Weathered rock depth estimated to be center of C horizon (24 to 62 inches). Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
		DR	IT-A Deep	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	not encountered, > 25 inches	
		DR	IT-B	2 inches	3.75	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 44 inches	
		DR	IT-B Deep	3 feet	0.13	NA[2]	NA[2]	NA[3]	NA[3]	weathered rock	Bedrock at ~ 44 inches bgs	
HAPPY HILLS ROAD VALVE	3	DR	IT-A	3 inches	13.5	11.35	11.14	3	3.7	sandy loam	not encountered, > 27 inches	IT-02 and IT-03 appear to be > 25 feet of BMP Area A. IT-A and IT-01 are both outside BMP Area A but approximately 25 feet.
		DR	IT-1	6 inches	9.2					silt loam	not encountered, > 36 inches	
HARES VALLEY ROAD VALVE	3	DR	IT-A	2 inches	8.2	NA[2]	NA[2]	3	2.7	silt loam	not encountered, > 30 inches	IT-01 outside BMP Area A (> 25 feet). IT-02 within BMP Area B. IT-03 near BMP Area D. IT-A near (<25 feet) BMP Area E.
		DR	IT-02	6 inches	2.6	NA[2]	NA[2]	3	0.9	silty clay loam	not encountered, > 40 inches	
		DR	IT-03	6 inches	0.4	NA[2]	NA[2]	3	0.1	silty clay loam	not encountered, > 40 inches	
SHADE VALLEY ROAD VALVE	3	DR	IT-A	3 inches	3.56	4.88	4.70	2	2.3	loam	not encountered, > 27 inches	IT-A and IT-02 are within or near BMP Area A, IT-B and IT-01 are within or near BMP Area B. IT-D is within BMP Area D. IT-C and IT-D are outside of BMP areas. Soil types are consistent between 2015 and 2016.
		DR	IT-02	6 inches	6.2					sandy loam	not encountered, > 19 inches	
		DR	IT-B	3 inches	1.06	2.13	1.84	2	0.9	loam	not encountered, > 27 inches	
		DR	IT-01	6 inches	3.2					sandy loam	not encountered, > 19 inches	
		DR	IT-C	4 inches	9.56	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 27 inches	
		DR	IT-D	3 inches	5.72	NA[2]	NA[2]	2	2.9	loam	not encountered, > 26 inches	
		DR	IT-E	3 inches	4.31	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 27 inches	
PLAINFIELD	4	DR	IT-A	6 inches	3.13	NA[2]	NA[2]	NA[3]	NA[3]	clay/clay loam	not encountered, > 26 inches	Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rate was determined.
CREEK ROAD EFRD	4	DR	IT-A (36A)	6 inches	*	NA[2]	NA[2]	NA[3]	NA[3]	silt loam/silty clay loam	not encountered, > 16 inches	* Infiltration testing not performed at IT-A (36A) and IT-C (36C) due to excessive water level drop during pre-test. Based on previous work (Percolation testing in 2015), bedrock likely very shallow. IT-B (36B) near BMP Area (<25 feet).
		DR	IT-B (36B)	6 inches	5.91	NA[2]	NA[2]	3	2.0	clay loam	not encountered, > 18 inches	
		DR	IT-C (36C)	6 inches	*	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 16 inches	
WOLF BRIDGE ROAD VALVE	4	DR	IT-A	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 21 inches	No test due to thin soil cover. Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
W TRINDLE ROAD VALVE	4	DR	IT-A (19A)	2.5 inches	12	4.87	0.68	3	0.2	silt loam	not encountered, > 24 inches	IT-A (19A), IT-B (19B), IT-04 and IT-05 are within or near (approximately 25 feet) in BMP Area. IT-04 data not included in determination of Recommended Rate due to highest result in group. IT-01, IT-02 and IT-03 are near Infiltration Trench. IT-02 data not included in determination of Recommended Rate due to highest result in group. Current area is maintained agricultural field (corn field) with annual soil disturbances at surface.
		DR	IT-B (19B)	2 inches	0					silty clay	Mottling at 12 inches bgs	
		DR	IT-04	6 inches	13.5					silt loam	not encountered, > 90 inches	
		DR	IT-05	6 inches	2.6					silt loam	not encountered, > 90 inches	
		DR	IT-01	3 feet	0.1	0.10	0.10	3	0.0	silt loam	not encountered, > 88 inches	
		DR	IT-02	3 feet	1.9					silt loam	not encountered, > 88 inches	
		DR	IT-03	3 feet	0.1					silt loam	not encountered, > 90 inches	
ARCONA ROAD VALVE	4	DR	IT-A (20A)	2 inches	7.88	6.59	6.52	3	2.2	silt loam	not encountered, > 59 inches	IT-A (20A) within BMP Area and IT-B (20B), IT-01, and IT-02 near the BMP Area (approximatley 25 feet or less). IT-B (20B) data not included in determination of Recommended Rate due to highest result in group. Recommended rates are provided separately for shallow and deep tests.
		DR	IT-B (20B)	2 inches	12.36					silt loam	not encountered, > 60 inches	
		DR	IT-01	6 inches	5.4					silty clay loam	not encountered, > 42 inches	
		DR	IT-02	6 inches	6.5					silty clay loam	not encountered, > 42 inches	
		DR	IT-A Deep (20A)	3 feet	5.25	2.72	1.00	3	0.3	silty clay	not encountered, > 59 inches	
		DR	IT-B Deep (20B)	3 feet	0.19					clay	not encountered, > 60 inches	
OLD YORK ROAD EFRD	4	DR	IT-A (21A)	3 inches	*	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	Mottling at 16 inches	* Test was suspended early due to Landowner dispute w/ Sunoco. Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
		DR	IT-A Deep (21A)	3 feet	*	NA[2]	NA[2]	NA[3]	NA[3]	sand	not encountered, > 36 inches	
		DR	IT-B (21B)	3 inches	*	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 59 inches	
		DR	IT-B Deep (21B)	3 feet	*	NA[2]	NA[2]	NA[3]	NA[3]	clay	not encountered, > 59 inches	

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N UNION ST EFRD	4	DR	IT-A (22A)	4 inches	2	NA[2]	NA[2]	3	0.7	silt loam	not encountered, > 25 inches	IT-B (22B) within BMP Area A and IT-01 and IT-02 are near BMP Area A (< 25 feet). IT-A (22A) and IT-04 are within or near BMP Area B but at different depths. Recommended rates are provided separately for shallow and deep tests.
		SRFH	IT-04	14 inches	1.32	NA[2]	NA[2]	2	0.7	SM	not encountered, > 24 inches	
		DR	IT-B (22B)	2 inches	16	NA[2]	NA[2]	3	5.3	silt loam	not encountered, > 25 inches	
		SRFH	IT-01	42 inches	1.44	1.56	1.56	2	0.8	SM	not encountered, > 43 inches	
		SRFH	IT-02	3 feet	1.68					SM	not encountered, > 46 inches	
GATES ROAD VALVE	4	DR	IT-A	4 inches	6	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	not encountered, > 27 inches	IT-A appears to be outside BMP Area (not provided on Figure). IT-01 and IT-02 are within BMP Area. Lithologies consistent with 2015.
		DRCH	IT-01	6 inches	0.1	0.90	0.41	3	0.1	CL	not encountered, > 48 inches	
		DRCH	IT-02	6 inches	1.69					SC	not encountered, > 48 inches	
SCHAEFFER ROAD VALVE	5	DR	IT-A	1 foot	15.19	12.19	11.82	3	3.9	silty clay loam	not encountered, > 37 inches	IT-A and IT-B within or near BMP Area. IT-04 and IT-05 outside (>25 feet) from BMP Area. IT-01 through IT-03 not on Figure, >500 feet from BMP Area.
		DR	IT-B	1 foot	9.19					silty clay loam	not encountered, > 39 inches	
SINCLAIR ROAD VALVE	5	DR	IT-A	4 inches	15.19	NA[2]	NA[2]	NA[3]	NA[3]	loamy sand	not encountered, > 60 inches	IT-01 and IT-02 within BMP Area B. IT-A within soil ammendments area - outside of BMP Area, no Recommended Rate determined.
		DR	IT-A Deep	3 feet	12.94	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	not encountered, > 60 inches	
		DRCH	IT-01	5 inches	5.51	4.74	4.68	2	2.3	SM	not encountered, > 40 inches	
		DRCH	IT-02	5 inches	3.97					SM	not encountered, > 43 inches	
HOPELAND ROAD VALVE	5	DR	IT-A	2 inches	1.1	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 28 inches	IT-01 and IT-02 within or near BMP Area. IT-A outside BMP Area (> 25 feet).
		DRCH	IT-01	6 inches	2.62	1.35	0.43	3	0.1	SM	not encountered, > 42 inches	
		DRCH	IT-02	6 inches	0.07					CL	not encountered, > 36 inches	
BLAINSPORT	5	DR	IT-A	2 feet	0	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	not encountered, > 49 inches	Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
		DR	IT-B	2 feet	0	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	not encountered, > 49 inches	
		DR	IT-C	2 feet	0	NA[2]	NA[2]	NA[3]	NA[3]	sandy loam	not encountered, > 49 inches	
MONTELLO	5	DR	IT-A	3 inches	6.84	NA[2]	NA[2]	NA[3]	NA[3]	silty clay loam	not encountered, > 27 inches	IT-A outside of BMP Area A (> 25 feet). IT-01 and IT-02 are near (< 25 feet) BMP Area A. IT-03 in 2 foot deep V trench. IT-4 within 25 feet of BMP Area B. IT-B within 25 feet of 3 foot wide infiltration trench.
		SRFH	IT-01	9.75 inches	4.08	4.92	4.85	3	1.6	ML/SM	not encountered, > 48 inches	
		SRFH	IT-02	9.1 inches	5.76					ML/SM	not encountered, > 48 inches	
		DRCH	IT-03	9 inches	1.14	NA[2]	NA[2]	3	0.4	ML	not encountered, > 48 inches	
		DRCH	IT-04	9 inches	0.13	NA[2]	NA[2]	3	0.0	ML/SM	not encountered, > 48 inches	
		DR	IT-B	3 feet	0.38	NA[2]	NA[2]	3	0.1	silty clay	not encountered, > 62 inches	
WYOMISSING ROAD VALVE	5	DR	IT-A	7 inches	3.19	NA[2]	NA[2]	NA[3]	NA[3]	silt loam	not encountered, > 28 inches	Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
		DR	IT-B	8 inches	3.5	NA[2]	NA[2]	NA[3]	NA[3]	loam	not encountered, > 28 inches	
		DR	IT-C	2 inches	10.31	NA[2]	NA[2]	NA[3]	NA[3]	silty clay loam	not encountered, > 27 inches	
MORGANTOWN ROAD VALVE	5	DR	IT-A	3 inches	28.31	NA[2]	NA[2]	2	14.2	silty sand	not encountered, > 27 inches	IT-A within/near BMP Area A, IT-C within/near BMP Area B. IT-C and IT-D between BMP Areas A and B, but >25 feet from either.
		DR	IT-B	4 inches	24.94	NA[2]	NA[2]	NA[3]	NA[3]	silty sand	not encountered, > 27 inches	
		DR	IT-C	4 inches	15.66	NA[2]	NA[2]	2	7.8	silty sand	not encountered, > 27 inches	
		DR	IT-D	3 inches	17.63	NA[2]	NA[2]	NA[3]	NA[3]	silty sand	not encountered, > 27 inches	
FAIRVIEW ROAD ME2 EFRD	6	DR	IT-A	6 inches	0.5	NA[2]	NA[2]	3	0.2	silty clay	not encountered, > 24 inches	IT-2 (performed in 2015) within BMP Area A. IT-01 within BMP Area A, but not peformed (2015). IT-A within BMP Area B.
		SRFH	IT-2	6 inches	0.6	NA[2]	NA[2]	3	0.2	CL/SC	not encountered, > 6 inches	
EAST LINCOLN HIGHWAY VALVE	6	DR	IT-A	4 inches	5.25	1.14	0.84	2	0.4	loamy sand	not encountered, > 27 inches	IT-A and IT-01 through IT-03 are within or near (< 25 feet) of BMP Area A. IT-A data not included in determination of Recommended Rate due to highest result in group.
		DRCH	IT-01	6 inches	0.51					ML	not encountered, > 36 inches	
		DRCH	IT-02	6 inches	2.45					SM	not encountered, > 48 inches	
		DRCH	IT-03	6 inches	0.47					ML	not encountered, > 36 inches	
BOOT ROAD EFRD	6	DR	IT-A	2 inches	0.2	NA[2]	NA[2]	2	0.1	loam	Bedrock at 48 inches	* No deep test conducted at IT-B due to presence of bedrock within 2 feet of Infiltration Test depth.
		DR	IT-A Deep	2 feet	0.2	NA[2]	NA[2]	2	0.1	loam	Bedrock at 48 inches	
		DR	IT-B	2 inches	1	NA[2]	NA[2]	2	0.5	loam	Bedrock at 30 inches	
		DR	IT-B Deep	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	bedrock	Bedrock at 30 inches	

TABLE 1
SUMMARY OF INFILTRATION RATES
BLOCK VALVE LOCATIONS - CONSTRUCTION SPREADS 2, 3, 4, 5, and 6
PENNSYLVANIA PIPELINE PROJECT
SUNOCO PIPELINE, LP

Block Valve Site	Construction Spread	Test Type	Test ID [1]	Test Depth (bgs)	Test Infiltration Rate (in/hr)	Average Infiltration Rate (in/hr)	Geometric Mean Infiltration Rate (in/hr)	FS	Recommended Rate (in/hr)	Soil Type (USDA Class)	Seasonal High Water, Mottling, Bedrock (bgs)	Rationale for Recommended Design Rate
MIDDLETOWN ROAD EFRD (S.Chester Road)	6	DR	IT-A	4 inches	3.34	NA[2]	NA[2]	2	1.7	sandy loam	not encountered, > 60 inches	* "Sensitive" site near residential development. IT-C, IT-D, IT-E and IT-F were not completed at direction of project engineers (due to sensitive nature of site). Post-Construction Stormwater Management Plan does not indicate a BMP design, therefore, no Recommended Rates were determined.
		DR	IT-A Deep	3 feet	0.13	NA[2]	NA[2]	2	0.1	loamy sand	not encountered, > 60 inches	
		DR	IT-B	3 inches	0.97	NA[2]	NA[2]	2	0.5	sandy loam	not encountered, > 60 inches	
		DR	IT-B Deep	3 feet	2.81	NA[2]	NA[2]	2	1.4	loamy sand	not encountered, > 60 inches	
		DR	IT-C	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	
		DR	IT-D	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	
		DR	IT-E	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	
		DR	IT-F	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	
S PENNELL RD EFRD	6	DR	IT-A	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	* Gary Wisniewski, the Percheron Field Services Right of Way Agent told field crew to only do Infiltration Tests for Locations IT-C and IT-D. IT-C at BMP Berm/Ponding Area B, IT-D and IT-1, IT-2 at BMP Berm/Ponding Area A.
		DR	IT-B	NA[1]	*	NA[2]	NA[2]	NA[3]	NA[3]	NA[4]	NA[4]	
		DR	IT-C	2 inches	3.6	NA[2]	NA[2]	2	1.8	loam	not encountered, > 24 inches	
		DR	IT-D	2 inches	0.1	0.20	0.17	3	0.1	silt loam	not encountered, > 13 inches	
		DR	IT-1	6 inches	1.9					silt loam	not encountered, > 53 inches	
		DR	IT-2	6 inches	0.3					silt loam	not encountered, > 53 inches	

Notes:
DR = Double Ring Inflitrometer Test - consistent with pages 6 to 7 of Appendix C of Pennsylvania Stormwater Best Management Practices Manual, December 30, 2006
DRCH = Double Ring Constant Head Infiltration Test - ASTM D3385
SRFH = Single Ring Falling Head Infiltration Test - ASTM D5126
bgs = below ground surface
in = inch
hr = hour
FS = Factor of Safety. Assumed 2 for soils coarser than loam, and 3 for finer-grained soils, in accordance with Appendix C of Pennsylvania Stormwater Best Management Practices Manual, December 30, 2006
1 Test ID is consistent with Site Trip Reports. ID provided in parantheses is Test ID as shown on PCSM Figures.
NA[1] - Infiltration Test not conducted (see Rationale for Recommended Design Rate column)
NA[2] - Insufficient data to perform calculation (i.e. single data point)
NA[3] - Safety Factor and Recommended Rate not determined because Infiltration Test performed outside of BMP Area.
NA[4] - Not applicable or data not available
*[1] No tests conducted due to rapid infiltration rate and/or bedrock within 24 inches of test depth (e.g. 2 foot soil separation not present).

General Notes applicable to whole Table -
Blue shading signifies positive detection/observation of bedrock, seasonal high groundwater or mottling.
Only 2015 Infiltration Test Results provided in Table 1 if relevant to determination of Recommended Rate.
2015 Infiltration Tests designated with sequential numbers (e.g. IT-1, IT-2, etc.).
2016 Infiltration Tests designated with sequential letters (e.g. IT-A, IT-B, etc.).
Recommend Rate determined by dividing Geometric Mean by Factor of Safety
Seasonal High Water, Mottling, and Bedrock determined based on 2016 Trip Report Soil Boring Logs.

TRIP REPORT
FAIRVIEW ROAD EFRD SITE – INFILTRATION TESTING

1.0 PURPOSE

This Trip Report presents the field data and results of double-ring soil infiltration tests conducted to support the design of a stormwater management system at the Fairview Road EFRD site located in Wallace Township, Chester County, Pennsylvania as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. One surface test (IT-A) was performed at the site. The test location is listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The infiltration test was conducted by Greg Ritson of Rettew, Inc., on September 27, 2016. The test location was positioned in the field using a handheld, WAAS-enabled GPS unit. Table 1 provides the coordinates of the test location. The test was located in a wooded area, approximately 35 feet east of Fairview Road.

The infiltration test was performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. The test location was prepared with hand tools and care was taken to minimize disturbance of the soil surface to be tested. Double-ring infiltrometers were used for testing and consisted of 12-inch diameter and 6-inch diameter sections of steel casing, each 7 inches in height. After digging to the target depth, the test surface was leveled, and loose soil and debris were removed. The rings were driven a minimum of 2 inches into the soil. The infiltration test depth is presented in Table 1.

The test location was pre-soaked for 1 hour. The test was then conducted with measurements at 10-minute or 30-minute intervals, based on the observed water level drop during the last half of the pre-soak period. Pre-soak and test information was recorded on an infiltration test data sheet; a copy of the test data sheet is attached to this report.

During the testing, the weather was sunny, approximately 70 degrees Fahrenheit, and no precipitation was observed during the time of testing. Rainfall within the previous 48 hours was 0.29 inches.

A hand auger was utilized to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table near the test area. The field team was unable to hand auger deeper than 24 inches below ground surface due to the presence of gravel and cobble sized rock. Descriptions of the soil were documented on a field log, which was based on the form example in the BMP manual. A copy of the soil log is attached to this report.

3.0 RESULTS

3.1 Soil Description

Soils encountered generally consisted of a thin (up to approximately 6 inches) dark brown (7.5YR 3/2) silt clay topsoil/surface layer which included a few small roots with rock content ranging up to 15% of cobble sized rock fragments. This topsoil/surface layer was underlain by two illuvial layers consisting of a strong brown (7.5YR 5/6) silt clay with clay increasing with depth. The lower illuvial lay contained roughly 35% cobble sized rock fragments. Bedrock was not encountered.

Seasonal high water was not observed at the testing location, nor was any mottling observed.

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey data, the soil type for the test locations is mapped as follows:

- Gladstone Gravelly Silt Loam - (GdC soil symbol) with 8-15 percent slopes; with low runoff and is well drained.

3.2 Infiltration Tests Results

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

The pre-soak test result for IT-A indicated a low infiltration rate, requiring a 30 minute test cycle.

Table 1
Summary of Infiltration Test Results
Fairview Road ME2 EFRD
Wallace Township, Chester County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-A	40.1018587°	- 075.7558787°	6	0.50

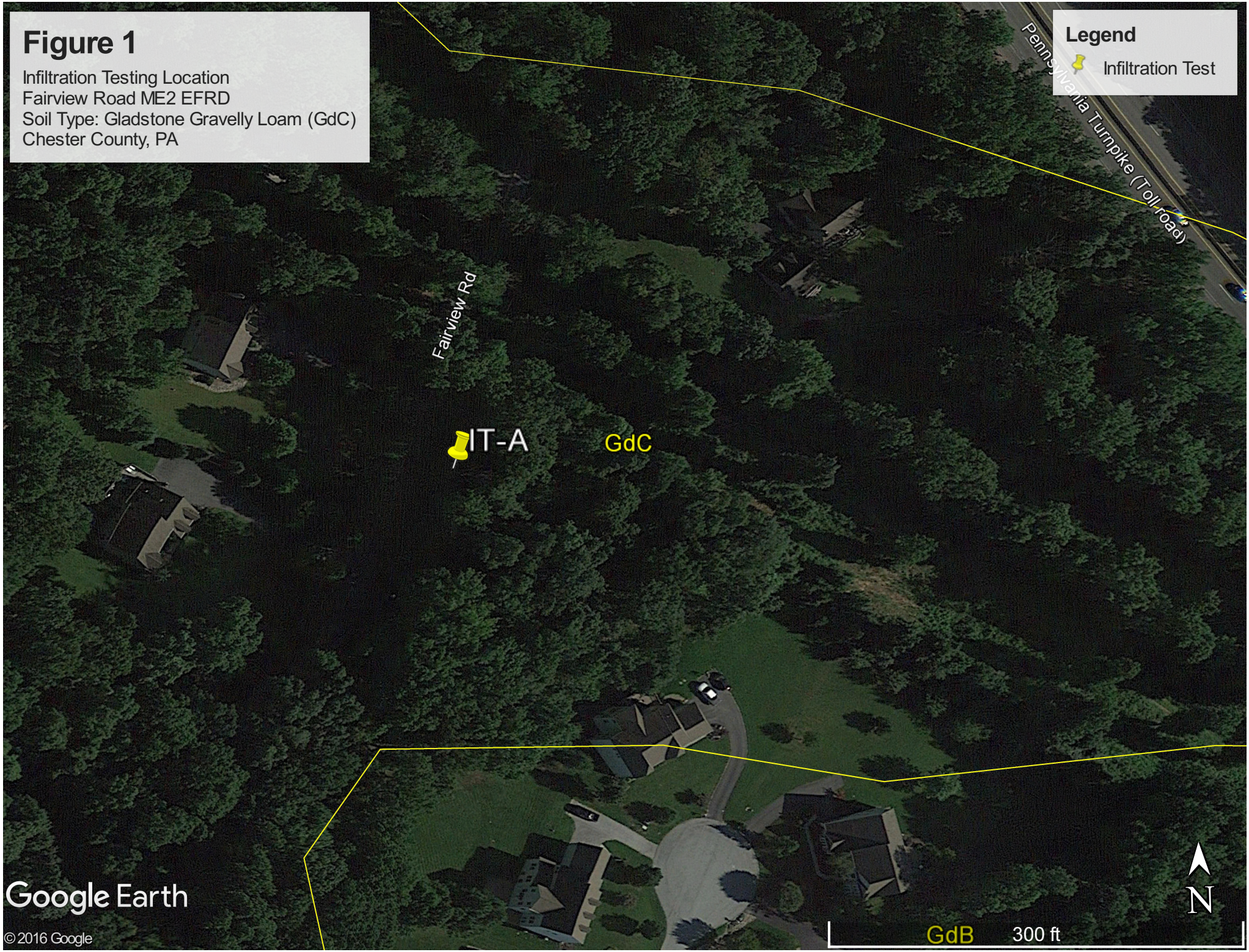
Figure 1
Infiltration Testing Location
Fairview Road ME2 EFRD
Soil Type: Gladstone Gravelly Loam (GdC)
Chester County, PA
Legend
Infiltration Test
Pennsylvania Turnpike (Toll road)
Fairview Rd
IT-A
GdC
GdB
300 ft
N
Google Earth
© 2016 Google

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: Greg Ritson (Rettew) Project: Sunoco PPP Project No.: 112IC05958

Test Pit: Fairview Road Date: 9/27/2016 Elevation: Equipment Used: sharp shooter

Geology: Soil Type: Land Use: Weather:

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
A	O	6"	SiL	weak, fine, SBK friable	7.5YR 3/2	—	common fine & med. cobbly (15%)	—	—	—
B	6"	24"	SiL	moderate, medium, SBK friable	7.5YR 5/6	—	few fine & med. roots	—	—	increase in clay content
B/C	24"+	—	—	—	—	—	very cobbly (35%)	—	—	denser fines

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

INFILTRATION TEST DATA SHEETS

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: SUNOCO PPP
PROJECT NUMBER: 112 IC 05958
TEST AREA ID: Fairview Road
PERSONNEL: Greg Ritson (RETTEW)

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

INNER RING INSIDE DIAMETER/HEIGHT: 6" / 7"
OUTER RING INSIDE DIAMETER/HEIGHT: 12" / 7"

Location Coordinates or Description:
40.1018587, -75.7558787

PERCOLATION HOLE DIAMETER: _____ (If performing an open hole perc test)

DATE(s): 9/27/2016 Rainfall in past ~~24~~ 48 hrs = 0.29"

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

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: Surface (6")

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
2:10	0	----------		
2:40	30	1/4	0.22	
3:14	60	1/4	0.2	
TEST DATA				
3:14	(60)	----------	0.2	
3:44	30	1/4	0.225	
4:14	60	1/4	0.225	
4:44	90	1/4	0.175	
5:14	120	1/4	0.2	

TRIP REPORT
EAST LINCOLN HIGHWAY VALVE SITE – INFILTRATION TESTING

1.0 PURPOSE

This Trip Report presents the field data and results of double-ring soil infiltration tests conducted to support the design of a stormwater management system at the East Lincoln Highway Valve site located in West Whiteland Township, Chester County, Pennsylvania as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. One shallow test (IT-A) was performed at the site. The test location is listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The infiltration test was conducted by Jim Goerdt and Jim Coffman of Tetra Tech, Inc., on October 7, 2016. The test location was positioned in the field using a handheld, WAAS-enabled GPS unit. Table 1 provides the coordinates of the test location. IT-A was located on a flat grassy area, approximately 800 feet south of East Lincoln Highway.

The infiltration test was performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. The test location was prepared with hand tools, and care was taken to minimize disturbance of the soil surface to be tested. Double-ring infiltrometers were used for testing and consisted of 10-inch diameter and 6-inch diameter sections of steel casing, each 10 inches in height. After digging to the target depth, the test surface was leveled, and loose soil and debris were removed. The rings were driven a minimum of 2 inches into the soil. The infiltration test depth is presented in Table 1.

The test location was pre-soaked for 1 hour. The test was then conducted with measurements at 10-minute or 30-minute intervals, based on the observed water level drops during the last half of the pre-soak period. Pre-soak and test information was recorded on an infiltration test data sheet; a copy of the test data sheet is attached to this report.

During the testing, the weather was sunny, approximately 60 degrees Fahrenheit, and no precipitation was observed during the time of testing. Additionally, less than 0.5 inches of precipitation was observed 24 hours prior to testing.

A hand auger was utilized to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table near the test area. This was completed from the ground surface down to two feet below the target infiltration test depth. Descriptions of the soil were documented on a field log, which was based on the form example in the BMP manual. A copy of the soil log is attached to this report.

3.0 RESULTS

3.1 Soil Description

Soils encountered generally consisted of a relatively deep (up to approximately 23 inches) brown (7.5YR 4/4) loamy sand topsoil/surface layer with rock fragments ranging up to large gravels. This topsoil/surface layer was underlain by a brown (7.5YR 4/4) sandy loam with rock fragments ranging up to large gravels. Bedrock was not encountered.

Seasonal high water was not observed at the testing location, nor was any mottling observed.

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey data, the soil type for the test locations is mapped as follows:

- Urban Land - (UudB soil symbol) with 0-8 percent slopes; Web soil survey did not have data regarding runoff or drainage patterns.

3.2 Infiltration Tests Results

Table 1 summarizes the infiltration rate (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 stabilized readings measured in the inner ring.

The pre-soak test result indicated a high infiltration rate, requiring a 10 minute test cycle.

Table 1
Summary of Infiltration Test Results
East Lincoln Highway Valve
West Whiteland Township, Chester County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-A	40.02707°	- 075.61652°	4	5.25


Figure 1
Infiltration Testing Location
East Lincoln Highway Valve
Soil Type: Urban Land - Udorthents, Limestone Complex (UudB)
Chester County, PA
Legend
Infiltration Test
Lincoln Hwy E
PdA
UudB
IT-A
CtB
PdB
Tabas Ln
CtB
Google Earth
©2016 Google
N
500 ft

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: J. Coffman **Project:** Sunoco Marine-E2 **Project No.:** 112IC05958

Test Pit: E. Lindy (Exton) A **Date:** 10/7/16 **Elevation:** _____ **Equipment Used:** hand auger

Geology: soil **Soil Type:** loamy sand **Land Use:** grass area (mowed) **Weather:** Ptly Cloudy

Additional Comments Photo #24, *GPS coordinates of A test location: N 40.0270~~8~~ 7, W 75.616~~5~~ 52 (stored in # 080 retrex 10 unit)

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
A	0"	23"	loamy sand	little rock frag up to large gravels.	BW ~~2.5Y~~ 7.5YR 4/4	solid no mottling	small roots down to 2"	—	—	moist
A	23"	27"	sandy loam	"	BW 7.5YR 4/4	solid no mottling		—	—	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 Classification as Follows: Abrupt	* changed LOD resulted in about a 40 ft shift to the NE for location A (to be clear of Sunoco pipelines). LOD was moved E to fenceline, then toward private drive (away from Tabor Ln)
A	Dark colored, mixed mineral organic matter			
B	Maximum accumulation of silicate clay minerals		Clear	
C	Weathered parent material		Gradual	
R	Layer of consolidated rock beneath the soil		Diffuse	

*see GPS data in Add. Comments above for test loc.

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

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco PPP TEST AREA ID: IT-A Exton (East Lincoln Highway Valley)
PROJECT NUMBER: 112ICO5958 PERSONNEL: J. Goerdt

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

Location Coordinates or Description:
~20 feet E. of fenceline
* N: 40.02707
* W: 75.61652

INNER RING INSIDE DIAMETER/HEIGHT: 6"/10"
OUTER RING INSIDE DIAMETER/HEIGHT: 10"/10"

PERCOLATION HOLE DIAMETER: — (If performing an open hole perc test)

DATE(s): 10/7/16 Rainfall within last 24 hrs < 0.5"

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

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: 4"

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
905	—	----------	4 L	Start Pr. Soak
935	30	3 14/16"	2 L	
1005	60	2 13/16"	1.6 L	End Pr. Soak
TEST DATA				
1005	0 (60)	----------	—	Start test
1015	10 (70)	14/16"	0.50 L	
1025	20 (80)	14/16"	0.50 L	
1035	30 (90)	14/16"	0.50 L	End test?
1045	40 (100)	14/16"	—	

* Moved location of test due to original location outside limit of disturbance

* Existing Sunoco lines running parallel w/ 4' chain link fence, approximately 36' NE of fenceline.

* Final location approx 40' from original location.

TRIP REPORT
BOOT ROAD EFRD SITE – INFILTRATION TESTING

1.0 PURPOSE

This Trip Report presents the field data and results of double-ring soil infiltration tests conducted to support the design of a stormwater management system at the Boot Road EFRD site located in West Goshen Township, Chester County, Pennsylvania as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. One deep and two shallow tests (IT-A and IT-B) were performed at the site. The test locations are listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The infiltration tests were conducted by Ken McGill and Heather Rychlak of CH2M Hill, Inc., on October 6, 2016. The test locations were positioned in the field using a handheld, WAAS-enabled GPS unit. Table 1 provides the coordinates of the test locations. All three tests were located in a grassy field, approximately 50 feet northeast of East Boot Road.

The infiltration tests were performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. The test locations were prepared with hand tools and a mini-excavator, and care was taken to minimize disturbance of the soil surface to be tested. Double-ring infiltrometers were used for testing and consisted of 24-inch diameter and 12-inch diameter sections of steel casing, each 20 inches in height, as well as a set of double-ring infiltrometers with ring sizes consisting of an 8-inch and a 4-inch with both being 10-inches in height. After digging to the target depth, the test surface was leveled, and loose soil and debris were removed. The rings were driven a minimum of 2 inches into the soil. The infiltration test depths are presented in Table 1.

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

During the testing, the weather was sunny, approximately 65 degrees Fahrenheit, and no precipitation was observed during the time of testing. Additionally, no precipitation was observed 24 hours prior to testing.

Test pits were excavated near each testing location to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table. The test pits were identified with the corresponding infiltration test name. The test pits were machine-excavated to 2 feet below the target infiltration test depth or refusal, whichever was encountered first. 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 Soil Description

Soils encountered generally consisted of a thin (up to approximately 4 inches) brown (7.5YR 4/4) organic loam topsoil/surface layer. This topsoil/surface layer was underlain by a dark brown (7.5YR 3/4) silt loam layer which ranged down to approximately 48 inches below ground surface. Bedrock/excavator refusal was encountered at approximately 30-48 inches below ground surface.

Seasonal high water was not observed at the testing location. Lithochromatic mottling was observed in the test pit for IT-B. Roughly 15% of the soil profile contained mottles of strong brown (7.5YR 5/6).

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey data, the soil type for the test locations is mapped as follows:

- Glenelg Silt Loam - (GgB soil symbol) with 3-8 percent slopes; with medium runoff and is well drained.

3.2 Infiltration Tests 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 stabilized readings measured in the inner ring.

The pre-soak test results for IT-A (surface and deep) and IT-B (surface) indicated low infiltration rates, requiring 30 minute test cycles. Test IT-B (deep) was not conducted due to bedrock encountered at approximately 30 inches below ground surface during test pit excavation.

Table 1
Summary of Infiltration Test Results
Boot Road EFRD
West Goshen Township, Chester County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-A (shallow)	40.0047902°	- 075.5805140°	4	0.20
IT-A (deep)			24	0.20
IT-B (shallow)	40.0047081°	- 075.5806076°	4	1.00
IT-B (deep)			NA	NA

Note:

NA = Test not conducted due to encountering bedrock at approximately 30 inches below ground surface.


Figure 1
Infiltration Testing Locations
Boot Road EFRD
Soil Type: Glenelg Silt Loam (GgB)
Chester County, PA
Legend
Infiltration Tests
IT-A
IT-B
GgB
GgA
GlB
uugB
Ba
E Boot Rd
Culbertson Dr
Greenhill Rd
N
300 ft
Google Earth
© 2016 Google

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: H Rychlak
Test Pit: 9; Boat Road
Geology: Schist
Date: 10/6/16
Soil Type:
Project: Sunoco PPP
Elevation:
Land Use: Roadside ROW
Project No.: N/A 112C05958
Equipment Used: backhoe
Weather: Sunny 70°F

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	2"	loam	silt	7.5YR 4/4	N/A	roots	4'	N/A	
A	2	48"	loam	silts	7.5YR 3/4	N/A	rocks	0"	N/A	
shist Bedrock		48"								refusal at bedrock

Horizon:	USDA Definition
O	Organic debris
A	Dark colored, mixed mineral organic matter
B	Maximum accumulation of silicate clay minerals
C	Weathered parent material
R	Layer of consolidated rock beneath the soil

Soil Textural Class
Use ternary diagram from US Department of Agriculture Soil Conservation Service

Boundary
Use depth and classification
Classification as Follows:
Abrupt
Clear
Gradual
Diffuse

Notes:
area is adjacent to highway ROW/pipeline ROW

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: H. Rycheck; K. McGill
Test Pit: a; Boot Road
Geology: Shi
Date: 10/6/2016
Soil Type:
Project: Sunoco
Elevation:
Land Use: ROW
Project No.: 112IC0595B
Equipment Used: Backhoe/Auger (Hand)
Weather: Sunny 70°F

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	O	2"	loam	silts	7.5YR 4/4	N/A	roots	4'	N/A	
A	2"	48"	loam	silts	7.5YR 3/4	N/A	rocks	0"	N/A	
shist Bedrock		48"								Refusal at Bedrock

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 Classification as Follows: Abrupt	Test location on level ground. Area is adjacent to highway ROW/Pipeline ROW
A	Dark colored, mixed mineral organic matter			
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

112IC05958

Tested By: H Rychlak K McGill
Project: Sunoco
Project No.: N/A
Test Pit: b ; Boot Road
Date: 10/6/16
Elevation:
Equipment Used: backhoe
Geology: Schist
Soil Type:
Land Use: ROW Roadside
Weather: Sunny 70° F

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"	4"	loam	silts	7.5YR 3/3	N/A	roots	2.5'	N/A	Refusal at bedrock
A	4"	30"	loam	silts	7.5YR 4/4	15% 7.5YR 5/6	Rocks	0	N/A	
Bedrock schist	30"+									Refusal at shallow bedrock

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 Classification as Follows: Abrupt	Area adjacent to highway ROW. Appears to be fill material
A	Dark colored, mixed mineral organic matter			
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

INFILTRATION TEST DATA SHEETS

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco PPP
PROJECT NUMBER: 112 IC 05958
TEST AREA ID: Boot Road EFRD (15289+40)
PERSONNEL: K. McGill; H. Ryckeck

TEST METHOD: (Double Ring Infiltrometer) Percolation
(Single Ring Infiltrometer)

INNER RING INSIDE DIAMETER/HEIGHT: 4" / 10"
OUTER RING INSIDE DIAMETER/HEIGHT: 8" / 10"

Location Coordinates or Description:
Location a - PCS-6.03
Latitude = 40.0047902°
Longitude = -075.5805140°

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

DATE(s): 10/6/2016

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

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: Deep Test 2ft.

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
12:30	0	----------		No rain for 24 hours
13:00	30	0.2"	0.1 liter	
13:30	60	0.2"	0.1 liter	0.4" per hour
TEST DATA				
13:35	0	----------		Started Test
14:05	30	0.1"	0.05 liters	
14:35	60	0.1"	0.05 liters	
15:05	90	0.1"	0.05 liters	
15:35	120	0.1"	0.05 liters	Ended Test
				Infiltration = 0.2" per hour

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco PPP
PROJECT NUMBER: 112IC05958
TEST AREA ID: BootRoadEFRD(15289+40)
PERSONNEL: K. McGill; H. Rychack

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

INNER RING INSIDE DIAMETER/HEIGHT: 12" / 20"
OUTER RING INSIDE DIAMETER/HEIGHT: 24" / 20"

Location Coordinates or Description:
Location a - PCS-6.03
Latitude = 40.004790 2°
Longitude = -075.5805140°

PERCOLATION HOLE DIAMETER: _____ (If performing an open hole perc test)

DATE(s): 10/6/2016 Rainfall within last 24 hrs < 0.5"

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

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: Shallow Test

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
12:35	0	----------		No rain for 24 hours
13:05	30	0.1"	0.05 liters	
13:35	60	0.1"	0.05 liters	0.2" inches per hour
TEST DATA				
13:40	0	----------		Started Test
14:10	30	0.1"	0.05 liters	
14:40	60	0.1"	0.05 liters	
15:10	90	0.1"	0.05 liters	
15:40	120	0.1"	0.05 liters	Ended Test
				Infiltration 0.2 inches/hour

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco PPP
PROJECT NUMBER: 121C05958
TEST AREA ID: Boot Road EFRD (15289+40)
PERSONNEL: K. McGill; H. Rychcik

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

INNER RING INSIDE DIAMETER/HEIGHT: 12" / 20"
OUTER RING INSIDE DIAMETER/HEIGHT: 24" / 20"

Location Coordinates or Description:
Location b. PCS-6.03
Lat: 40.0047081° Long: -75.5806076°

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

DATE(s): 10/6/2016

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

MEASURING POINT (Ring Rim) Indicator Mark

DEPTH OF TEST: Shallow Test

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
13:30	0	----------		No rain for 24 hours
14:00	30	1.0"	1.5 liters	
14:30	60	0.5"	0.5 liters	1.0" per hour
TEST DATA				
14:30	0	----------		Started Test
15:00	30	0.5"	0.5 liters	
15:30	60	0.5"	0.5 liters	
16:00	90	0.5"	0.5 liters	
16:30	120	0.5"	0.5 liters	Ended TEST
				Infiltration = 1.0 inches/hour

TRIP REPORT
MIDDLETOWN ROAD EFRD SITE – INFILTRATION TESTING

1.0 PURPOSE

This Trip Report presents the field data and results of double-ring soil infiltration tests conducted to support the design of a stormwater management system at the Middletown Road EFRD site located in Edgmont Township, Delaware County, Pennsylvania, as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. Two deep and two shallow tests (IT-A and IT-B) were performed at the site. The test locations are listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The infiltration tests were conducted by Jim Goerdt and Jim Coffman of Tetra Tech, Inc., on October 6, 2016. The test locations were positioned in the field using a handheld, WAAS-enabled GPS unit. Table 1 provides the coordinates of the test locations. Both tests were located in a grassy area, approximately 40 feet southwest of Middletown Road.

The infiltration tests were performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. The test locations were prepared with hand tools and a mini-excavator, and care was taken to minimize disturbance of the soil surface to be tested. Double-ring infiltrometers were used for testing and consisted of 10-inch diameter and 6-inch diameter sections of steel casing, each 10 inches in height. After digging to the target depth, the test surface was leveled, and loose soil and debris were removed. The rings were driven a minimum of 2 inches into the soil. The infiltration test depths are presented in Table 1.

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

During the testing, the weather was sunny, approximately 65 degrees Fahrenheit, and no precipitation was observed during the time of testing. Additionally, less than 0.5 inches of precipitation was observed 24 hours prior to testing.

Test pits were excavated near each testing location to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table. The test pits were identified with the corresponding infiltration test name. The test pits were machine-excavated to 2 feet below the target infiltration test depth or refusal, whichever was encountered first. 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 Soil Description

Soils encountered generally consisted of a deep (up to approximately 36 inches) yellowish red (5YR 4/6) sandy loam topsoil/surface layer with rock fragments ranging from small cobble to small boulder sized. This topsoil/surface layer was underlain by a yellowish red (7.5YR 4/6) loamy sand with rock fragments of similar size as the previous layer. Bedrock was not encountered.

Seasonal high water was not observed at the testing location, nor was any mottling observed.

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey data, the soil type for the test locations is mapped as follows:

- Glenelg Channery Silt Loam - (GeC2 soil symbol) with 8-15 percent slopes; with medium runoff and is well drained.

3.2 Infiltration Tests 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 stabilized readings measured in the inner ring.

The pre-soak test results for IT-A (surface and deep) and IT-B (surface) indicated low infiltration rates, requiring 30 minute test cycles; whereas, the pre-soak test results for IT-B (deep) indicated a high infiltration rate, requiring a 10 minute test cycle.

Two additional test locations (IT-C and IT-D) were not conducted due to their locations being on a berm. The project engineer was notified and a decision was made to cancel the tests.

Table 1
Summary of Infiltration Test Results
Middletown Road ERFD
Edgmont Township, Delaware County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-A (shallow)	39.9476638°	- 075.5063165°	4	3.34
IT-A (deep)			36	0.13
IT-B (shallow)	39.9475682°	- 075.5061965°	3	0.97
IT-B (deep)			36	2.81

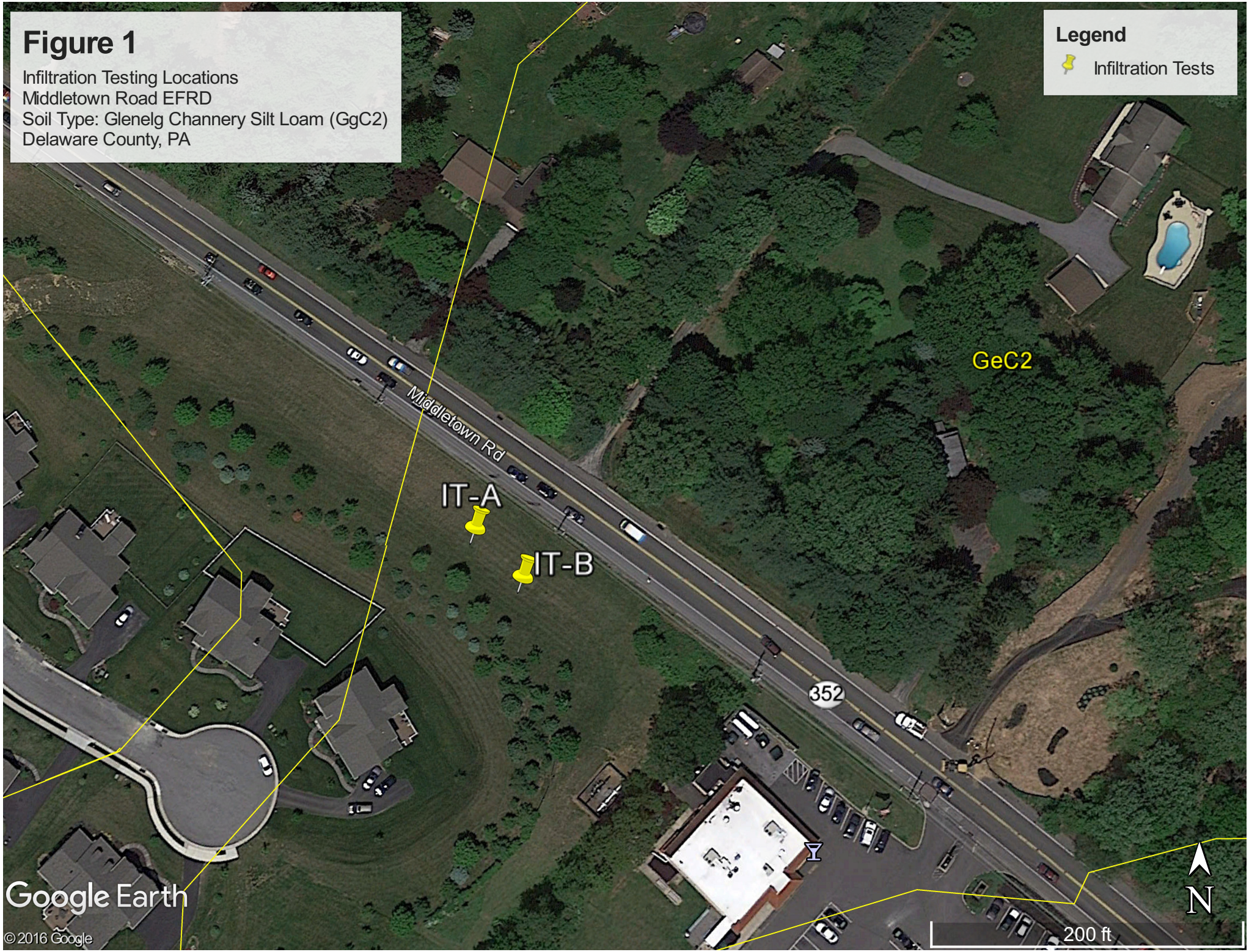
Figure 1
Infiltration Testing Locations
Middletown Road EFRD
Soil Type: Glenelg Channery Silt Loam (GgC2)
Delaware County, PA
Legend
Infiltration Tests
GeC2
Middletown Rd
IT-A
IT-B
352
N
200 ft
Google Earth
© 2016 Google

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: J. Coffman **Project:** Sunoco Mariner E2 **Project No.:** 112IC05958

Test Pit: Middletown Rd (Glen Mills) A/B **Date:** 10/6/16 **Elevation:** _____ **Equipment Used:** akeuch. TB260 track hoe

Geology: Soil **Soil Type:** sand/loam **Land Use:** grass field **Weather:** Sunny 70°

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
A	0"	36"	Sandy loam	little schist (crystalline rock) up to small cobble and boulder size	Org-Brn 5YR 4/6	Solid no mottling	small roots top 2"	—	—	moist
A	36"	60"	loamy sand	smoky quartz ↓	Org-Brn 5YR 4/6	Solid no mottling		—	—	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	* Locations C & D canceled - due to berm (Engineer's decision) (see photo #21, pin flags in upper left and right of photo. Photo #23 after backfilling.
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

INFILTRATION TEST DATA SHEETS

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco PPP
PROJECT NUMBER: 112IC07~~77980~~ 5958
TEST AREA ID: IT-A (Glen Mills) Middletown Rd
PERSONNEL: J. Goodt

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

39.9476638 -075.5063165
Location Coordinates or Description:
Grassy area just SW of Middletown Rd. Approx 100' SE NW of valve.

INNER RING INSIDE DIAMETER/HEIGHT: 6"
OUTER RING INSIDE DIAMETER/HEIGHT: 10"

PERCOLATION HOLE DIAMETER: — (If performing an open hole perc test)

DATE(s): 10/6/16 Rainfall within last 24 hrs < 0.5

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 6-8 inches): 7"

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: 4"

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
1220	—	----------	3.7 L	Start Pre-soak
1250	30	1 1/16"	0.90 L	
1320	60	1 3/16"	0.95 L	End Pre-Soak
TEST DATA				
1320	0 (60)	----------	—	Start Test
1350	30 (90)	1 1/16"	0.90 L	
1420	60 (120)	1 10/16"	0.90 L	
1450	90 (150)	1 10/16"	0.90 L	
1520	120 (180)	1 12/16"	—	End test

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco Marple E 2 TEST AREA ID: Middletown Rd (Glen Mills) A
PROJECT NUMBER: 112IC05958 PERSONNEL: J. Coffman

TEST METHOD: ~~Double Ring Infiltrometer~~ Percolation
~~Single Ring Infiltrometer~~

39.9476638 -075.5063165
Location Coordinates or Description:
grass field, slight slope
Photo #19, 22

INNER RING INSIDE DIAMETER/HEIGHT: 6"
OUTER RING INSIDE DIAMETER/HEIGHT: 10"

PERCOLATION HOLE DIAMETER: — (If performing an open hole perc test)

DATE(s): 10/6/16 Rainfall within last 29 hrs < 0.5"

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 6-8 inches): 7"

MEASURING POINT: Ring Rim ~~Indicator Mark~~ DEPTH OF TEST: 36"

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
1425	0	----------	2 1/2 gallons	start of presoak
1455	30	0 0/16	0	
1525	60	0 0/16	0	End Presoak
TEST DATA				
1525	0	----------	—	Start test
1555	30	0 1/16	0.05	
1625	60	0 1/16	0.05	
1655	90	0 1/16	0.05	
1725	120	0 1/16	—	end of test

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco Mariner E 2 TEST AREA ID: Middletown Rd / Glen Mills B
PROJECT NUMBER: 112IC05958 PERSONNEL: J. Coffman

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

39.9475682 -075.506/965
Location Coordinates or Description: grass area toe of berm - berm looks like fill to sound/privacy proof residential area

INNER RING INSIDE DIAMETER/HEIGHT: 6"
OUTER RING INSIDE DIAMETER/HEIGHT: 10"

PERCOLATION HOLE DIAMETER: — (If performing an open hole perc test)

DATE(s): 10/6/16 Rainfall within last 24 hrs < 0.5"

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 6-8 inches): 7"

MEASURING POINT: (Ring Rim) Indicator Mark DEPTH OF TEST: 3"

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
1342	0	----------	3.85 L	start of presoak
1412	30	1 1/16"	0.60 L	
1442	60	10/16"	0.40 L	End pre soak
TEST DATA				
1442	0 (60)	----------	—	Start test
1512	30 (90)	7/16"	0.30 L	
1542	60 (120)	9/16"	0.40 L	
1612	90 (150)	7/16"	0.30 L	
1642	120 (180)	8/16"	—	Stop test

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco Mariner E2 TEST AREA ID: Middletown Rd (Glen Mills) B
PROJECT NUMBER: 112Ic05458 PERSONNEL: J. Coffman

TEST METHOD: (Double Ring Infiltrometer) Percolation
Single Ring Infiltrometer

39.9475682 -075.5061965
Location Coordinates or Description:
toe of berm - berm looks like may be fill to southeast/visual block residential behind it

INNER RING INSIDE DIAMETER/HEIGHT: 6 "
OUTER RING INSIDE DIAMETER/HEIGHT: 10 "

PERCOLATION HOLE DIAMETER: — (If performing an open hole perc test) * Photo 20

DATE(s): 10/6/16 Rainfall within last 24 hrs < 0.5"

Distance from the bottom of the inner ring/hole to measuring point (minimum water column of 6-8 inches): 6.5"

MEASURING POINT: (Ring Rim) Indicator Mark DEPTH OF TEST: 36"

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
1442	0	----------	2 1/4 gallons	start of presoak
1512	30	2 9/16	1.5 L	
1542	60	2 1/16	1.1 L	End pre-soak
TEST DATA				
1542	0	----------	—	start test
1552	10	0 7/16	0.5	
1602	20	0 8/16	0.3	
1612	30	0 7/16	0.25	
1622	40	0 8/16	0.3	end of test (stabilized)
~~1632~~	~~50~~			

TRIP REPORT
SOUTH PENNELL ROAD EFRD SITE – INFILTRATION TESTING

1.0 PURPOSE

This Trip Report presents the field data and results of double-ring soil infiltration tests conducted to support the design of a stormwater management system at the South Pennell Road EFRD site located in Middletown Township, Delaware County, Pennsylvania, as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. Two shallow tests (IT-C and IT-D) were performed at the site. The test locations are listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The infiltration tests were conducted by Ken McGill and Heather Rychlak of CH2M Hill Inc., on October 6, 2016. The test locations were positioned in the field using a handheld, WAAS-enabled GPS unit. Table 1 provides the coordinates of the test locations. The tests were located in a utility right of way west of Lenni Road.

The infiltration tests were performed in accordance with the procedure specified in the 2006 Pennsylvania Stormwater Best Management Practices (BMP) Manual. The test locations were prepared with hand tools, and care was taken to minimize disturbance of the soil surface to be tested. Double-ring infiltrometers were used for testing and consisted of 8-inch diameter and 4-inch diameter sections of steel casing, each 10 inches in height. After digging to the target depth, the test surface was leveled, and loose soil and debris were removed. The rings were driven a minimum of 2 inches into the soil. The infiltration test depths are presented in Table 1.

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

During the testing, the weather was sunny, approximately 70 degrees Fahrenheit, and no precipitation was observed during the time of testing. Additionally, no precipitation was observed 24 hours prior to testing.

A hand auger was utilized to characterize the soil, determine the depth to bedrock, if encountered, and inspect for evidence of the seasonal high water table near the test areas. This was completed from the ground surface down to two feet below the target infiltration test depth. Descriptions of the soil were documented on field logs, which were based on the form example in the BMP manual. Copies of the soil logs are attached to this report.

3.0 RESULTS

3.1 Soil Description

Soils encountered generally consisted of a thin (up to approximately 6 inches) very dark brown (7.5YR 2.5/2) organic loam topsoil/surface layer with fine roots throughout. This topsoil/surface layer was underlain by a brown (7.5YR 4/4) silt loam with few rock fragments. A second silt loam layer was found from 18-29 inches below ground surface which was very dark brown (7.5YR 2.5/2) in color and contained few rocks. Both test units were located immediately adjacent to an existing utility corridor and soils found within the units appeared to be fill from construction. Bedrock was not encountered.

Seasonal high water was not observed at the testing location, nor was any mottling observed.

According to United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey data, the soil type for the test locations is mapped as follows:

- Neshaminy Gravelly Silt Loam - (NaC3 soil symbol) with 8-15 percent slopes; with high runoff and is well drained.

3.2 Infiltration Tests Results

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

The pre-soak test result for IT-C indicated a high infiltration rate, requiring a 10 minute test cycle; whereas, the pre-soak test result for IT-D indicated a low infiltration rate, requiring a 30 minute test cycle.

Two additional test locations (IT-A and IT-B) were proposed; however, discussions with the land agent indicated that the locations could not be tested due to land owner disputes.

Table 1
Summary of Infiltration Test Results
South Pennell Road EFRD
Middletown Township, Delaware County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-C (shallow)	39.9027274°	- 075.4428057°	3	3.60
IT-D (shallow)	39.9025743°	- 075.4429231°	3	0.10

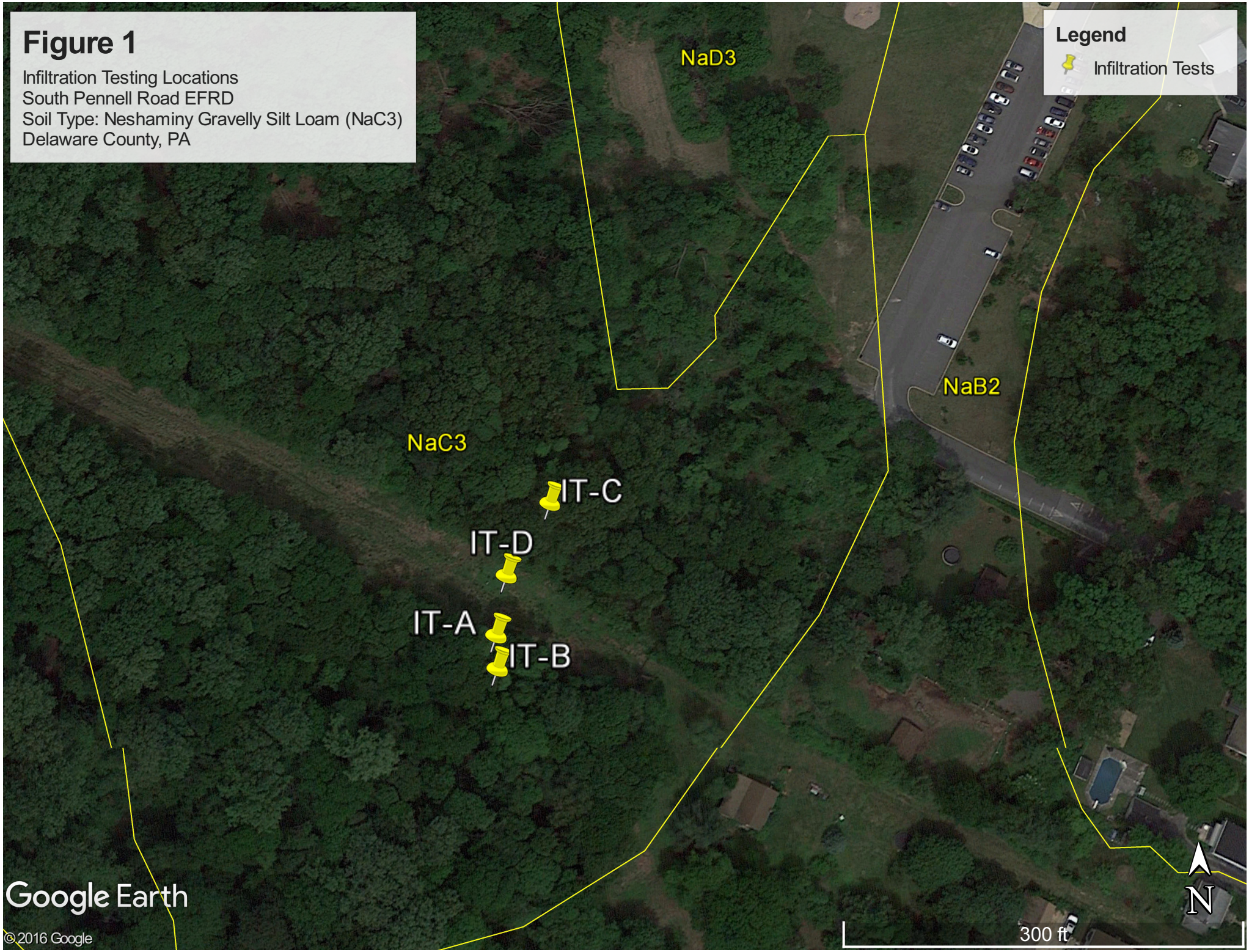
Figure 1
Infiltration Testing Locations
South Pennell Road EFRD
Soil Type: Neshaminy Gravelly Silt Loam (NaC3)
Delaware County, PA
Legend
Infiltration Tests
NaD3
NaB2
NaC3
IT-C
IT-D
IT-A
IT-B
Google Earth
©2016 Google
N
300 ft

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: H Rychlak ; K. McGill **Project:** Sunoco **Project No.:** 112IC05958

Test Pit: "C; S. Pennell Rd **Date:** 10/6/16 **Elevation:** — **Equipment Used:** Auger

Geology: — **Soil Type:** loam **Land Use:** Seconday successional woods **Weather:** 75° 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"	5"	loam	organic	7.5YR 2.5/2	N/A	roots	N/A	N/A	
A	5"	18"	loam	silts rocks	7.5YR 3/4	N/A	Rocks	N/A	N/A	
B	18"	24"	loam	silts	7.5YR 2.5/2	N/A	Rocks	N/A	N/A	

Horizon:	USDA Definition
O	Organic debris
A	Dark colored, mixed mineral organic matter
B	Maximum accumulation of silicate clay minerals
C	Weathered parent material
R	Layer of consolidated rock beneath the soil

Soil Textural Class
Use ternary diagram from US Department of Agriculture Soil Conservation Service

Boundary
Use depth and classification
Classification as Follows:
Abrupt
Clear
Gradual
Diffuse

Notes:

Adjacent to pipeline ROW. Secondary successional forest No bedrock encountered

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

112IC05958

Tested By: K. Nuble; K. McGill
Project: Sunoco PPP
Project No.: —
Test Pit: 4; S. Pennell Rd
Date: 10/5/2016
Elevation:
Equipment Used: Hand Auger
Geology:
Soil Type:
Land Use: ROW
Weather: Sunny 75°F

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	O	6"	Silt Loam	Organics	5YR3/3	None	Roots/ rocks	No	No	
A	6"	13"	Silt Loam	Mineral material/ gravel	7.5YR4/4		Rock fragments	No	No	Refusal at 13" increasing rock fragments

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 Classification as Follows: Abrupt	Test location located on a slope disturbed fill.
A	Dark colored, mixed mineral organic matter			
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

INFILTRATION TEST DATA SHEETS

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco
PROJECT NUMBER: 112SC05958
TEST AREA ID: S. Pennell Rd EFRD (15874.20)
PERSONNEL: K. McGill; H. Rychlak

TEST METHOD: ~~Double Ring Infiltrometer~~ Percolation
Single Ring Infiltrometer

Location Coordinates or Description:
Location "C" - PCS-6.05
Lat = 39.902 7274°
Long = -075.442 8057°

INNER RING INSIDE DIAMETER/HEIGHT: 4" / 10"
OUTER RING INSIDE DIAMETER/HEIGHT: 8" / 10"

PERCOLATION HOLE DIAMETER: _____ (If performing an open hole perc test)

DATE(s): 10/6/2016

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

MEASURING POINT: (Ring Rim) Indicator Mark

DEPTH OF TEST: Surface Test

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
17:55	0	----------		No Rain for 24 hours
18:25	30	2.5"	0.6L	
18:55	60	2.5"	0.6L	5 inches per hour
TEST DATA				
18:55	0			Started Test
19:05	10	1.1"	0.3L	
19:15	20	1.1"	0.3L	
19:25	30	1.1"	0.3L	
19:35	40	1.1"	0.3L	
19:45	50	0.6"	0.2L	
19:55	60	0.6"	0.2L	
20:05	70	0.6"	0.2L	
20:15	80	0.6"	0.2L	Ended Test
				Infiltration = 3.6" per hour

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco
PROJECT NUMBER: 112 IC 05958
TEST AREA ID: S. Penn II Rd. EFRD (15874-20)
PERSONNEL: K. McGill; H. Rychlak

TEST METHOD: ~~Double Ring Infiltrometer~~ Percolation
~~Single Ring Infiltrometer~~

Location Coordinates or Description:
Location "d" - PCS 6.05
Lat. = 39.9025743
Long = -075.4429231

INNER RING INSIDE DIAMETER/HEIGHT: 4"/10"
OUTER RING INSIDE DIAMETER/HEIGHT: 8"/10"

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

DATE(s): 10/6/2016

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

MEASURING POINT: ~~Ring Rim~~ Indicator Mark

DEPTH OF TEST: Surface

TIME	ELAPSED TIME SINCE START OF TEST (minutes)	WATER LEVEL DROP, INNER RING OR PERCOLATION HOLE (inches)	VOLUME OF WATER ADDED AT EACH CYCLE, INNER RING (liters)	REMARKS
PRESOAK DATA				
17:45	0	----------		No rain for 24 hrs
18:15	30	0.1"	0.05L	
18:45	60	0.1"	0.05L	0.2" inches per hour
TEST DATA				
18:46	0	----------		Started Test
19:15	30	0.1"	0.05L	
19:45	60	0.0"	0 L	
20:15	90	0.0"	0 L	
20:45	120	0.1"	0.05L	Stopped TEST
				Infiltration = 0.2"/hour