Site Restoration and Post-Construction Stormwater Management Plan

Houston Injection Station

PADEP Southwest Region Submission

November 2016

Prepared for:

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LIST OF ACRONYMS

ACRONYM	MEANING
ABACT	Antidegradation Best Available Combination of Technologies
BMP	Best Management Practice
E&SC	Erosion and Sediment Control
HDD	Horizontal directional drilling
HDPE	High-density polyethylene
HQ	High quality
NGL	Natural gas liquids
PADEP	Pennsylvania Department of Environmental Protection
PASDA	Pennsylvania Spatial Data Access
PCSM	Post-Construction Stormwater Management
PPP	Pennsylvania Pipeline Project
ROW	Right of way
SPLP	Sunoco Pipeline, L.P.
SR	Site Restoration
Tt	Tetra Tech, Inc.
UNT	Unnamed tributary
USGS	United States Geological Survey
WWF	Warm water fisheries

1.0 INTRODUCTION

Tetra Tech, Inc. (Tt) has prepared this Site Restoration and Post-Construction Stormwater Management Plan for Sunoco Pipeline, L.P. (SPLP) – Pennsylvania Pipeline Project (PPP) Houston Injection Station. The Plan addresses restoration and post-construction stormwater management following installation of the proposed Houston Injection Station (Project). The Project is located in Chartiers Township, Washington County, Pennsylvania. A USGS site location map is provided in Appendix A.

2.0 SITE DESCRIPTION

SPLP is proposing to construct the Project in Chartiers Township, Washington County, PA. The Project will be located adjacent to Ullom Road at latitude 40.262°, longitude -80.267°. The Project will be connected to a proposed transmission pipeline and will include the construction of a rock construction entrance off of an existing driveway, a 60,613 square foot gravel equipment pad, a Power Distribution Center, knockout tank, enclosed vapor combustion unit, and above-ground piping and valves. The proposed Project will be constructed within an LOD of approximately 2.70 acres.

Past and present land use of the Project area and surrounding area is meadowland, residential, and woodland. Future land use will be a maintained gravel pad which the injection station will sit on, access road, and restored areas being returned to meadowland in good condition. The project area drains to Chartiers Run. Site soils information was taken from the USDA NRCS Web Soil Survey. A soil map and list of existing soil types is located in Appendix B. Relevant topographic features including streams, streets, pipelines, structures, utility lines, fences, paving and other significant items along the pump station LOD are indicated on the plans, where applicable. The PCSM BMPs at the site include a Geoweb infiltration area and a berm. PCSM BMPs are discussed in detail in section 4.3.

2.1 TOPOGRAPHY

The work zone is located on ground gently sloping southeast toward the confluence of Chartiers Run and Westland Run. Site elevations vary from approximately 1005 feet (northwest corner of pad area) to 996 feet (southeast corner of pad area) above mean sea level based on the Pennsylvania Spatial Data Access. The site development plans show the topography of the site and the surrounding area.

2.2 GEOLOGY AND SOILS

Soil and geologic formations figures are provided in Appendix B. The site consists of Newark silt loam (Nw), 0 to 2 percent slopes, and Udorthents, Strip mine, steep (UkF), 25 to 75 percent slopes, which are described below.

Nw – Newark silt loam, 0 to 2 percent slopes. This well-draining soil is located on linear flood plains at elevations ranging from 660 to 1,500 feet above mean sea-level. It is formed from mixed alluvium derived from limestone, sandstone, and shale. The typical soil profile is: 0 to 9 inches: silt loam (Hydrological Soil Group A); 9 to 34 inches: silt loam (Hydrological Soil Group B); and 34 to 60 inches: silt loam (Hydrological Soil Group C). The depth to water table is 6 to 18 inches. The restrictive feature is encountered 80 inches below the surface. Flooding is frequent. Limiting soil characteristics of the Newark silt loam include erodibility, caving cutbanks, corrosivity, a seasonable high water table, low strength, lack of organic content for topsoil use, and hydric soils.

UkF - Udorthents, strip mine, steep, 25 to 75 percent slopes. This well-draining soil is located on convex and linear backslopes at elevations ranging from 700 to 1,500 feet above mean sea-level. It is formed from moderately acid to neutral loamy coal extraction mine spoil derived from limestone, sandstone, and shale. The typical soil profile is: 0 to 2 inches: very channery silt loam (Hydrological Soil Group C); and 2 to 75 inches: very channery clay loam (Hydrological Soil Group C). The depth to water table more than 80 inches below the surface. The restrictive feature is encountered 80 inches below the surface. There is no frequency of flooding or ponding. The limiting soil characteristics of the Udorthents soil type include erodibility, caving cutbanks, corrosivity, low strength, and lack of organic content for topsoil use. In addition, the Udorthents strip mine soil may contain pyritic material in sufficient quantities that could result in discharges which do not meet water quality standards for nearby surface runoff and thus may not be suitable for restoration uses. In this instance, areas of the Udorthents soil which is seen to contain significant pyrite will be isolated, covered with an impermeable cover (i.e. hdpe, or plastic sheeting) and disposed of off-site during construction activities. The UkF soils are found in the northern portion of the site which is to be fill therefore limiting the likelihood of encountering pyrite.

Geologically, the site is underlain by the Pennsylvanian-Aged Casselman Formation of the Conemaugh Group as well as the Pennsylvania-Aged undifferentiated Monongahela Group. The Conemaugh Group is composed of cyclic sequences of sedimentary shale, siltstone, sandstone, redbeds, limestone, and occasionally coal lenses. The Monongahela Group is composed of cyclic sequences of sedimentary limestone, shale, sandstone and some commercial coal beds--including the Pittsburgh coal seam at its base. Excavation in the redbeds or alternatively coal seams, if present, is to be avoided due to general instability and possible release of acidic pyritic material to streams, respectively.

2.3 SURFACE WATER HYDROLOGY

The Project area surface water runoff drains to Westland Run and Chartiers Run which are both designated as warm water fishes (WWF) under PA Code 25 Chapter 93. Westland Run is designated as having impaired aquatic life due to: Construction - Siltation; Construction - Other Habitat Alterations; Abandoned Mine Drainage - Metals; Abandoned Mine Drainage - TDS; Habitat Modification - Siltation; and Habitat Modification - Other Habitat Alterations. Chartiers Run is designated as having impaired aquatic life due to: Agriculture - Nutrients; Agriculture - Siltation; Agriculture - Turbidity; Habitat Modification - Siltation; and Habitat Modification - Other Habitat Alterations.

No streams and wetlands will be affected during construction. Offsite primary receiving waters include: Westland Run (WWF) and Chartiers Run (WWF). The Project area surface water runoff drains to the southeast towards the confluence of Westland Run (WWF) and Chartiers Run (WWF), approximately 400 feet downgradient. Offsite secondary receiving waters include: Chartiers Creek (WWF).

3.0 SITE RESTORATION PRACTICES

Grounds disturbed by any of the operations necessary to complete the work for this project are to be permanently seeded, or if specified, sodded, unless occupied by structures, paved, graveled, or designated as a permanent access road. Disturbed areas will be seeded and mulched within 24 hours once final grades are achieved. If seeding cannot be completed within a four (4) day period due to weather conditions, the disturbed area will be mulched with straw at the rate of three (3) tons per acre. This straw will be anchored using a method described in Section 3.4. A Geoweb infiltration/storage area and diversion berm will be installed as a post construction stormwater BMP to mitigate the permanent stormwater impacts of construction.

3.1 CONSTRUCTION SEQUENCE

A generalized construction sequence is provided below for installing post construction stormwater BMPs. The construction sequence is intended to provide a general course of action to conform to the applicable regulatory agency requirements for restoration and post-construction stormwater management of the site. Necessary steps for proper and complete execution of work pertaining to this plan, whether specifically mentioned or not, are to be performed by the contractor. The contractor will comply with all requirements listed in this section and the Pennsylvania Stormwater Best Management Practices Manual. The contractor may be required to alter controls based on the effectiveness of controls or differing conditions encountered in the field. If the contractor plans on deviating from the methods and controls in this PCSM Plan, they must get approval from the county conservation district and DEP before any actions commence.

A pre-construction meeting is required prior to the start of any construction activity. The Pennsylvania Department of Environmental Protection (PADEP) or applicable county conservation district, contractors, the landowner, appropriate municipal officials, and the plan preparer must be invited to this meeting at least 7 days prior to construction commencement. All construction activities shall be discussed in this meeting including, but not limited to, the PCSM features and any deviations the contractor has planned.

1) Install post construction BMPs after completion and stabilization of the site to prevent sediment accumulation in the BMPs.
2) Geoweb Infiltration/Storage Area Installation
    a) Prepare the subgrade as shown on the construction drawings.
    b) Do not compact subgrade.
    c) Provide geotextile separation layer.
    d) Expand the geoweb sections into position and connect the end-to-end and interleaf connections with atra keys.

e) Place the specified infill material to 2 inches above cell walls and compact lightly until settlement of infill is negligible.

3) Berm Installation

a) Complete site grading and stabilize within the limit of disturbance except where the berm will be constructed; make every effort to minimize berm footprint and necessary zone of disturbance (including both removal of existing vegetation and disturbance of empty soil) in order to maximize infiltration.

b) Lightly scarify the soil in the area of the proposed berm before delivering soil to site.

c) Bring in fill material to make up the majority of the berm. Soil shall be added and compacted according to design specifications. The slope and shape of the berm shall be graded out as soil is added.

d) Complete final grading of berm after the top layer of soil is added. Tamp soil down lightly and smooths sides of the berm. The crest and base of the berm shall be at level grade.

e) Plant berm with permanent grass seed mix.

f) Mulch planted and disturbed areas with compost mulch to prevent erosion while plants become established.

3.2 PERMANENT SEEDING

Site preparation and establishment of permanent cover will be conducted according to the following guidelines:

1. Install needed surface water control measures.
2. Hydroseed or follow Steps 3 through 6 below.
3. Perform all cultural operations at right angles to the slope.
4. Determine agricultural lime application rates by field pH testing. Perform testing at a rate of 1 test per acre (min.). In the absence of testing, apply at 6 tons per acre.
5. Apply dry 10-20-20 formulation of fertilizer at the rate of 678 lbs. per acre or at a rate determined by field testing.
6. Work in lime and fertilizer to a depth of 4 inches using suitable equipment.
7. Seed Mixture - The seed mixture will be:

TABLE 1: PENNDOT FORMULA W							
SCIENTIFIC NAME	**COMMON NAME**	**REQUIRED VARIETIES**	**% BY WEIGHT**	**MINIMUM % PURITY**	**MINIMUM % GERMINATION**	**MAX % WEED**	**SEEDING RATE (LBS/1000 SF)**
Festuca Arundinacea	Tall Fesuce	Festuca arundinacea var. Kentucy 31	70	98	85	0.15	7.5
Lotus Corniculatus	Birdsfoot Trefoil Mixture	A combination of varieties (Viking, Empire, Norcen, Dawn, Leo, Bull, Maitland) with no one variety exceeding 50% of the total Trefoil component.	20	98	80(1)	0.1	2
Agrostis Alba	Redtop	Agrostis alba	10	92	80	0.15	1

(1) Recommended 10% hardseed and 70% normal sprouts.

8. If not hydroseeding, apply mulch.

Notes:

1. Spread seeds where indicated and at the rates specified in Table 1, or as otherwise indicated.
2. Spread seeds within April 1 to June 15 or August 16 to September 15.
3. Extend seeding dates where project conditions warrant. Apply full treatment or apply only 50% of the permanent seeding and soil supplements and apply the remaining 50% within the next seeding dates, as directed in writing.
4. Use tillage and soil supplements before permanent seeding on topsoiled areas, where temporary seeding or mulching has been applied.
    a. On topsoiled areas, 1:3 (3:1) and flatter, loosen the surface to a depth of at least 50 mm (2 inches) by disking, harrowing, or other acceptable methods until the tillage is satisfactory. On untopsoiled areas, 1:3 (3:1) and flatter, till only as directed. Also, till or scarify areas if the surface is glazed or crusted.
    b. Correct surface irregularities by filling depressions and leveling rough or uneven areas. Remove metal objects, stones larger than 50 mm (2 inches) in any dimension, and other debris or objects deemed detrimental to maintenance operations.

5. Inoculate leguminous seed, such as Crownvetch and Birdsfoot Trefoil, with proper cultures, according to the manufacturer's directions.
6. At the rates specified in Table 1, sow seeds uniformly on the prepared areas by the helicopter, hydraulic placement, broadcasting, drilling, or hand seeding methods. Inspect seeding equipment and adjust the equipment, if required, to ensure the specified application rates. Periodically perform a check on the rate and uniformity of application, as directed. Prior to seed application of each designated seed formula, thoroughly clean-out seed tank by rinsing with clean water to prevent contamination from one seed formula to the next. Repeat rinsing cycle until tank is clean. Collect all non-applied seed derived from each clean-out event and remove as waste from the project.
7. After seeding, roll topsoiled areas that are to be mowed. Use a roller with a mass (weight) not more than 100 kg/m (65 pounds per foot). If soil is wet or frozen, roll only when directed.
8. Apply herbicides as directed, to areas that are to be mowed and where weed growth is prominent. The Representative will designate existing plants or groups of plants to be saved within these areas before herbicide application. If directed, more than one application may be required to control undesirable growth. Apply material with application personnel certified by the Department of Agriculture and with equipment specified in Section 108.05(c).
9. Final acceptance of seeding and soil supplement materials and installation are subject to the results of official sampling and testing as specified before use and installation and the resultant establishment of the specified vegetation. Remove non-approved materials from the project.
    a. Reseed rejected areas with additional applications of the specified seed and soil supplement materials. Redress soil surfaces when directed. Perform reapplication of seed and soil supplements within the next applicable seeding date if necessary or as directed. When directed, reseed areas damaged by herbicide applications and mowing operations. NOTE: Reseeded areas will also require the application of appropriate mulch as specified in Section 805.
    b. Seeded areas may be rejected based on the lack of actual grass seedling establishment exhibited in the area for the specified seed formula.
        i. Table 1 formula seeded areas that exhibit less than 70% surface area coverage with the specified germinated grass seedlings after 90 days of growth may be rejected upon visual inspection. The seed germination and growth period is determined from the date of the seeding operation for the area when these operations are performed within the specified seeding dates.
        ii. Special seed formula planted areas (seed mixtures not indicated in Table 1) may be rejected based on the lack of the specified seed germination and growth of less than 11 seedlings/m2 (9 seedlings/square yard) after 120 days of growth determined by visual inspection. The seed germination and growth period is determined from the date of the seeding operation of the area when these operations are performed within the specified seeding dates.
        iii. Seeded areas exhibiting soil surface erosion rills or gullies deeper than 250 mm (1-inch) may be rejected upon visual inspection. Redress and reseed designated eroded areas with specified materials and application rates as directed.

Liming Rates

Minimum 6 tons per acre at 100% effective neutralizing value (% ENV), unless the soil test determines that a lesser amount is needed. To determine the actual amount of regular lime to apply, divide the amount called for by the soil test by the % ENV for the product used. For example, if 6 tons per acre is needed and the ENV for the lime used is 88%, divide 6 by 0.88 resulting in 6.8 tons needing to be applied. For dolomitic

lime, which has a significant amount of magnesium in it, divide the amount called for by the soil test by the % calcium carbonate equivalent (% CCE) listed for the product instead of the % ENV. The % CCE may be above 100% which accounts for the fact that magnesium has a greater effect per pound than the calcium in regular lime. Note: When a soil test requires more than 8,000 pounds of lime per acre, the lime must be mixed into the top 6 inches of soil.

Fertilization Rates

Prepare areas for seeding by uniformly applying supplements. Document bulk delivery. Blend the initial soil supplements into the soil at least 50 mm (2 inches), on topsoiled areas, by raking, disking, harrowing, or other acceptable methods. Blend the supplements into the soil during tillage operations. Apply slow-release nitrogen fertilizer to the surface of Formula W seeded areas before project completion. Apply soil supplements as shown in the following table, unless otherwise indicated:

Permanent Seeding Application Rate				
Soil Amendment	**Per Acre**	**Per 1,000 sq. ft.**	**Per 1,000 sq. yds.**	**Notes**
Agricultural Lime	3872 LBS.	89 LBS.	800 LBS.	
10-20-20 Fertilizer	678 LBS.	16 LBS.	140 LBS.	
38-0-0 Ureaform Fertilizer, OR	242 LBS.	6 LBS.	50 LBS.	or as per soil test; may not be required in agricultural fields
32-0-0 to 38-0-0 Sulfur Coated Urea Fertilizer, OR	286 LBS.	7 LBS.	59 LBS.	
31-0-0 IBDU Fertilizer	295 LBS.	7 LBS.	61 LBS.	

3.3 TEMPORARY SEEDING

Temporary grass cover will be established in the following areas:

- Where vegetative filters must be established below filter bags, a minimum distance of 10 feet will be seeded down slope of the trap outlet. Seed mixture for temporary cover will consist of 100-percent annual ryegrass. Seed will be applied at the rate of 40 lb. per acre or as recommended by a local recognized seed supplier and approved by the owner's representative. Prior to seeding, apply 1 ton of agricultural grade limestone per acre plus 10-10-10 fertilizer at the rate of 500 lb. per acre and work into soil.
- Where soil stockpiles are to be exposed for a period greater than four (4) days, the stockpile shall be seeded.

Temporary Seeding Application Rate				
Soil Amendment	**Per Acre**	**Per 1,000 sq. ft.**	**Per 1,000 sq. yd.**	**Notes**
Agricultural Lime	1 ton	40lb.	410 lb.	Typically not required for topsoil stockpiles
10-10-10 Fertilizer	500lb.	12.5 lb.	100lb.	Typically not required for topsoil stockpiles

3.4 MULCHING

The purpose of mulch is to reduce runoff and erosion, prevent surface compaction or crusting, conserve moisture, aid in establishing plant cover, and control weeds. Mulch will be applied on any area subject to erosion, or which has unfavorable conditions for plant establishment and growth. The practice will be used alone or in conjunction with other structural and vegetative conservation practices, such as waterways, ponds, sedimentation traps or critical area planting. On sediment producing areas where the period of exposure is less than 2 months, mulch materials will be applied according to the following guidelines:

- Apply straw mulch at the rate of 3 tons per acre. Chemically treated or salted straw is not acceptable as mulch.
- Anchor straw mulch immediately after application by at least one of the following methods.

  A. "Crimp" straw mulch into the soil using tractor drawn equipment (straight bladed coulter or similar). This method is limited to slopes no steeper than 3:1. Operate machinery on the contour. Crimping of hay or straw by running it over with tracked machinery is not recommended.

  B. Uniformly apply asphalt, either emulsified or cut-back, containing no solvents or other diluting agents toxic to plant or animal life, at the rate of 31 gallons per 1,000 square feet.

  C. Use synthetic binders (chemical binders) as recommended by the manufacturer to anchor mulch provided sufficient documentation is provided to show that it is non-toxic to native plant and animal species.

  D. Staple lightweight plastic, fiber, or paper nets over the mulch according to the manufacturer's recommendations.

Mulched areas will be checked periodically and after each runoff event (e.g. rain, snowmelt, etc.) for damage until the desired purpose of the mulching is achieved. Damaged portions of the mulch or tie-down material will be repaired upon discovery.

3.5 MATERIAL RECYCLING AND DISPOSAL

The operator will remove from the site, recycle, or dispose of all building materials and wastes in accordance with PADEP's solid waste management regulations at 25 PA Code 260.1 et seq., 271.1 et seq., and

287.1 et seq. The contractor will not illegally bury, dump, or discharge building material or wastes at the site. Excess material brought into the site areas to facilitate construction access will be completely removed prior to rough grading and final surface stabilization. Expected construction wastes will consist of packaging material and sediment cleaned from BMPs. Packaging from the materials brought on-site will be disposed of by a licensed hauler. Sediment removed from BMPs will either be spread in a protected area, within the LOD, to dry and then recycled as fill material or disposed of off-site. In cases where disposal is necessary, waste materials are to be disposed of at an approved, permitted PADEP waste disposal facility. Off-site spoil and/or borrow sites greater than one acre must be operated under an E&SC Plan approved by the County Conservation District.

3.6 THERMAL IMPACTS

Potential pollution to surface waters from thermal impacts will be minimized by minimizing clearing and retaining existing vegetation where possible during construction. Following construction, permanent seeding will occur within 24 hours practicable to facilitate vegetative growth.

3.7 RIPARIAN FOREST BUFFERS

Existing riparian forest buffers do not exist within the Project area.

3.8 INSPECTION AND MAINTENANCE PROCEDURES

The following inspection and maintenance practices will be used to maintain PCSM BMPs on site:

- PCSM BMPs will be in place and inspected as seen in the schedule below. The Contractor will immediately repair any deficiencies.
- If BMPs are found to be inoperative or ineffective during an inspection, PADEP shall be contacted within 24 hours, followed by submission of a written noncompliance report to PADEP within 5 days of the initial contact. A licensed professional shall oversee all installation and testing procedures for the Geoweb and Berm.

Long-Term Maintenance

The owner will maintain the stormwater management facilities for this site. Maintenance of the stormwater management facilities includes, but is not limited to, the following:

1. The proposed stormwater BMPs will be inspected and maintained by the property owner in accordance with this approved operation and maintenance program. Any and all inspection and maintenance activities shall be recorded in a written report and kept on site at all times. BMP inspections shall be conducted quarterly and after significant rainfall events (more than 1 inch in 24 hours).
2. The stormwater BMPs are a fixture that can be altered or removed only after approval by PADEP.
3. Geoweb (pervious pavement):

a. The pavement surface shall be vacuumed biannually with a commercial cleaning unit. Pavement washing systems or compressed air units are not recommended.

b. Planted areas adjacent to pervious pavement shall be well maintained to prevent soil washout onto the pavement. If any washout does occur it shall be cleaned off the pavement immediately to prevent further clogging of the pores. Furthermore, if any bare spots or eroded areas are observed within the planted areas, they shall be replanted and/or stabilized within 24 hours. Planted areas shall be inspected on a semiannual basis. All trash and other litter that is observed during these inspections shall be removed.

c. Immediately clean any soil deposited on pavement. Trucks or other heavy vehicles shall be prevented from tracking or spilling dirt onto the pavement. Furthermore, all construction or hazardous materials carriers shall be prohibited from entering a pervious pavement lot.

4. Berm

a. Inspect for erosion or other failures quarterly.
b. Inspect structural components to ensure functionality quarterly.
c. Maintain turf grass and other vegetation by mowing and re-mulching
d. Remove invasive plants as needed.
e. Routinely remove accumulated trash and debris.

Long-Term Operation and Maintenance Schedule

PCSM BMP	Inspections	Repairs	Reconstruction	BMP Life Expectancy
Geoweb	1 hr Quarterly @ $70/hr	Replacing 10% of gravel infill Time: 1 day Cost: $1,300	Time: 3-4 days Cost: $15,000	20-30 years
Berm	1 hr Quarterly @ $70/hr	Replacing 10% of vegetation Time: 1 day Cost: $800	Time: 1-2 days Cost: $2,200	20-30 years

1. Sunoco Pipeline L.P. is the owner/operator of the Houston Injection Station and is responsible for the long term maintenance of the site PCSM BMPs. SPLP can be contacted at: 610-670-3200

3.9 ANTIDEGRADATION REQUIREMENTS

PCSM BMPs associated with the Houston Injection Station will be located within a siltation-impaired watershed. A combination of non-discharge alternatives and the use of ABACT BMPs on site will protect the water quality of the receiving waters.

Non-discharge alternatives were evaluated to minimize accelerated erosion and sedimentation and achieve zero net change in runoff between the pre- and post-construction conditions. The extent of the disturbed area will be minimized, and the duration of disturbance will be minimized by stabilizing disturbed areas

within 24 hours. ABACT BMPs will be used on site to protect and maintain the existing water quality of receiving waters.

ABACT site restoration BMPs will include the following:

- Pre-construction drainage pattern intact
- Minimizing the disturbed area
- No direct discharge to surface waters
- Prompt site restoration
- Proper vegetative cover techniques

4.0 POST-CONSTRUCTION STORMWATER MANAGEMENT ANALYSIS

4.1 DESIGN BASIS

This plan has been prepared to comply with the Township of Chartiers Subdivision and Land Development Ordinance, and the Washington County Act 167 County-Wide Stormwater Management Plan.

The site's pre-development and post-development drainage characteristics were modeled in accordance with local and state requirements. The hydrology calculations were performed utilizing the U.S. Soil Conservation Service (SCS) TR-55 Urban Hydrology for Small Watersheds. The 2, 10, 25, 50, and 100-year storm events have been analyzed for pre- and post-developed conditions. The rainfall depths for each storm event are 2.38, 3.35, 3.97, 4.47, and 5.00 inches, respectively, and follow the SCS 24-hour Type II rainfall distribution. Bentley PondPack V8i was used to perform the hydrology analysis. The pre-development watershed maps are located in Appendix C. The post-development watershed maps are located in Appendix D. The PondPack report is located in Appendix E.

Stormwater BMPs have been designed for the Project to comply with the stormwater quality and quantity management requirements where possible. The watershed calculations were performed using Bentley PondPack V8i. The BMPs also have been designed meet state stormwater quality and quantity management requirements where possible. Calculation worksheets from Chapter 8 of the Pennsylvania Stormwater Best Management Practices Manual were used to ensure compliance with state requirements. The completed worksheets are located in Appendix F.

The project area is within the Federal Emergency Management Agency (FEMA) Zone A floodplain of Chartiers Run and Westland Run. In accordance with the Chartiers Township Floodplain Management Ordinance, a floodplain study was prepared to determine base flood elevations at the proposed project area to quantify the effect of the proposed development on the base flood elevations of Chartiers Run and Westland Run. The resulting base flood elevations encroach into the proposed development and are shown on the design drawings in Appendix G.

4.2 HYDROLOGY

Pre-development and post-development runoff results were calculated using the previously described design basis. The pre-development and post-development watersheds have a single point of interest that encompass the developed pad area. Within the post-development watershed, the controlled area is directed to the BMP and the uncontrolled area is directed to the existing wetlands to the east of the development. Table 1 provides a summary of the pre-development and post-development hydrology and associated peak flow discharge rates without BMP controls. Table 2 provides a summary of the pre-development and post-development hydrograph volumes without BMP controls.

Table 1: Pre-Development and Post-Development Hydrology

				Peak Flow (cfs)				
	Drainage Area (ac.)	**Tc (hr)**	**CN**	**2-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Pre-Development	1.460	0.295	68	0.38	1.20	1.83	2.38	2.99
Post-Development Controlled	1.095	.083	88	2.11	3.53	4.45	5.19	5.98
Post-Development Uncontrolled	0.365	.083	88	0.70	1.18	1.48	1.73	1.99

Table 2: Pre-Development and Post-Development Hydrograph Volumes

Hydrograph Volume (ac-ft)					
	2-yr	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Pre-Development	0.041	0.099	0.144	0.184	0.229
Post-Development Controlled	0.117	0.195	0.246	0.289	0.335
Post-Development Uncontrolled	0.039	0.065	0.082	0.096	0.112

Maps for the pre-development and post-development watersheds are located in Appendix C and Appendix D, respectively.

4.3 BMP DESIGN

Because a floodplain encroaches into the developed area, it is not possible to design a BMP onsite that controls peak rate runoff for all design storms because the BMP would be in the floodplain. Therefore, the proposed goal of the BMP design is to contain and infiltrate the 2-year storm event volume and allow larger storm events to flood the development. A portion of the northeastern end of the developed area is not directed to any BMP. The reasoning for this was that it would be more beneficial to allow the wetlands directly to the east of the pad to receive and control water quality and peak flow rates of the runoff than to cut off the hydrology of the wetlands with a BMP. The goal was to replicate the 2-year storm hydrology of the wetlands, given that wetlands will likely be flooded during the larger storm events. The southwestern

end of the developed area is directed to the Geoweb via a diversion berm. The diversion berm was designed based upon sound engineering judgment and is expected to handle the 2-year storm event. The Geoweb infiltration/storage area is located on the southern end of the pad. The Geoweb consists of cells that are filled with and underlain by gravel. The gravel acts to store and infiltrate runoff, while the Geoweb structure provides support for vehicles and prevents compaction of the gravel. The BMP design details are shown in Appendix G.

The Geoweb installation covers a 7,000 square foot surface area. The total depth of gravel in the Geoweb installation is 1 foot. Using an estimate of 40% void space for the gravel, the volume of the Geoweb BMP is calculated as:

Vs = 7,000 ft^2 * 1 ft * 40% = 2,800 ft^3 = 0.0643 ac-ft.

The Geoweb BMP is slightly sloped; however, it is anticipated that the entire storage volume will be used when flooding occurs.

4.4 INFILTRATION AREAS

The BMP is designed to provide infiltration for volume control. Infiltration testing was performed according to the Pennsylvania Stormwater Best Management Practices Manual to determine the infiltration rates to use in the calculations. Infiltration test results are located in Appendix B. Infiltration rates were determined as follows:

The BMP is located at infiltration test points IT-1, IT-2 and IT-3. The infiltration rate at IT-1 was measured to be 2.31 in/hr. The infiltration rate at IT-2 was measured to be 11.06 in/hr. The infiltration rate at IT-3 was measured to be 2.63 in/hr. The average of IT-1, IT-2, and IT-3 is 5.33 in/hr. The surface area of the BMP is 7,000 ft^2. The Geoweb functions similarly to pervious pavement as described in the Pennsylvania Stormwater Best Management Practices Manual. The calculation for the infiltration volume of pervious pavement is as follows:

Infiltration Volume = Bed Bottom Area (sf) * Infiltration design rate (in/hr) * Infiltration period* (hr) * (1/12)

Assuming an infiltration period of 24 hours:

Vi = 7,000 sf * 5.33 in/hr * 24 hr / 12 = 74,620 ft^3 = 1.713 ac-ft

Infiltration tests indicated that the groundwater table was approximately 3 feet below ground surface at the test locations. This provides 2 feet of depth below the BMP for infiltration. However; during large storm events, it is expected that the groundwater table will be too high during flooding to allow the BMP to infiltrate.

4.5 STORMWATER MANAGEMENT

Stormwater quality management for the project will comply with the state regulations, Chapter 102 Erosion and Sediment Control, through the implementation of erosion and sediment controls during construction and implementation and maintenance of post construction stormwater management (PCSM) controls after construction. Stormwater quality is achieved with the proposed BMP design, which is in accordance with the Pennsylvania Stormwater Best Management Practices Manual.

The calculated infiltration volume (1.713 ac-ft) of the BMP will remove all runoff volume from the post-development controlled area during all storm events, up to the 100-year storm (0.335 ac-ft) until the BMP becomes flooded. Table 3 provides a summary of the pre-development and post-development hydrology and associated peak flow discharge rates with BMP controls. Table 4 provides a summary of the pre-development and post-development hydrograph volumes with BMP controls.

Table 3: Pre-Development and Post-Development BMP Hydrology

				Peak Flow (cfs)				
	Drainage Area (ac.)	**Tc (hr)**	**CN**	**2-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Pre-Development	1.460	0.295	68	0.38	1.20	1.83	2.38	2.99
Post-Development Controlled	1.095	.083	88	0	0	0	0	0
Post-Development Uncontrolled	0.365	.083	88	0	1.18	1.48	1.73	1.99

Note: Results assume that the BMP is operating in a non-flooded condition

Table 4: Pre-Development and Post-Development BMP Hydrograph Volumes

Hydrograph Volume (ac-ft)					
	2-yr	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Pre-Development	0.041	0.099	0.144	0.184	0.229
Post-Development Controlled	0	0	0	0	0
Post-Development Uncontrolled	0.039	0.065	0.082	0.096	0.112

Note: Results assume that the BMP is operating in a non-flooded condition

Table 4 shows that post-development volumes for all storms are less than or equal to pre-development volumes. Table 3 shows that post-development peak flow rates for all storms are less than pre-development peak flow rates. The post-development peak flow rate for the 2-year storm is shown to be zero in Table 3. However, the hydrology analysis shows the post-development peak flow rate for the 2-year storm to be 0.70 cfs as indicated in the PondPack Report in Appendix E. The existing wetlands adjacent to the pad will attenuate this peak flow. A calculation is provided in Appendix E showing the peak attenuation provided by the existing wetlands.

5.0 REFERENCES

Erosion and Sediment Pollution Control Program Manual, Commonwealth of Pennsylvania, Department of Environmental Protection, Office of Water Management, March 2012.

Pennsylvania Stormwater Best Management Practices Manual Draft, Pennsylvania Department of Environmental Protection, Bureau of Watershed Management, October, 2009.

Canonsburg Quadrangle, Pennsylvania – Washington County, Geological Survey, United States Department of Interior.

Midway Quadrangle, Pennsylvania – Washington County, Geological Survey, United States Department of Interior.

Washington E Quadrangle, Pennsylvania – Washington County, Geological Survey, United States Department of Interior.

Washington W Quadrangle, Pennsylvania – Washington County, Geological Survey, United States Department of Interior.

Soil Survey of Washington County, Pennsylvania, United States Department of Agriculture, Soil Conservation Service.

Washington County Act 167 Plan, Turtle Creek Watershed Act 167 Plan, and Monongahela River Watershed Act 167 Stormwater Management Plan, Indiana County Phase 1 Act 167 Stormwater Management Plan, Little Conemaugh River Watershed Act 167 Plan

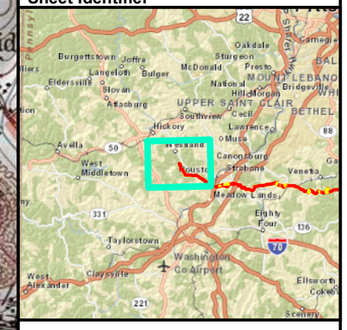
APPENDIX A – SITE LOCATION MAP

Houston Injection Station

Legend

- Access Road
- Alignment Centerline
- Limit of Disturbance
- Pump Station

Sheet Identifier



Feet
0 1,000 2,000

Meters
0 300 600

PROJECT LOCATION MAP
ATTACHMENT 1
PENNSYLVANIA PIPELINE PROJECT
AUGUST 2, 2015 ALIGNMENT
SUNOCO LOGISTICS, L.P.
WASHINGTON COUNTY, PA

TETRA TECH

Notes:
1) Topographic map provided by ESRI's ArcGIS Online USA Topo Maps map service (© 2013 National Geographic Society, i-cubed).
2) Quadrangles being displayed are Canonsburg, Midway, Washington E., Washington W.

P:\GIS\SUNOCO\MARINER EAST 2\MXD\PPP ESCGP\PUMP STATIONS\PENNPIPELINE_PUMPSTATIONS_USGS_ESCGP.MXD 11/03/15 JN

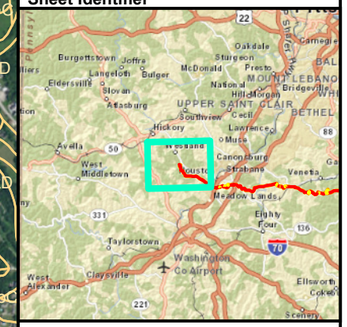
APPENDIX B – SOILS LOCATION MAP AND INFILTRATION TEST RESULTS

Houston Injection Station

Legend

- Access Road
- Alignment Centerline
- Limit of Disturbance
- Pump Station
- NRCS Soils and Codes

Sheet Identifier



N

0 1,000 2,000 Feet

0 300 600 Meters

PROJECT LOCATION MAP
ATTACHMENT 2
PENNSYLVANIA PIPELINE PROJECT
AUGUST 2, 2015 ALIGNMENT
SUNOCO LOGISTICS, L.P.
WASHINGTON COUNTY, PA

TETRA TECH

Notes:
Aerial photograph provided by ESRI's
ArcGIS Online World Imagery map service
(© 2011 ESRI and its data suppliers)

P:\GIS\SUNOCO\MARINER EAST 2\MXD\PPP ESC\PPP\PUMP STATIONS\PENNPIPELINE_PUMPSTATIONS_SOILS_ESCGP.MXD 11/03/15 JN

Hydrologic Soil Group—Greene and Washington Counties, Pennsylvania

Map Scale: 1:2,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Lines

A
A/D
B
B/D
C
C/D
D
Not rated or not available

Soil Rating Points

A
A/D
B
B/D
C
C/D
D
Not rated or not available

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 1:15,800.

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: Greene and Washington Counties, Pennsylvania
Survey Area Data: Version 8, 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 27, 2011—Oct 8, 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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Greene and Washington Counties, Pennsylvania (PA611)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
CaD	Culleoka channery silt loam, 15 to 25 percent slopes	B	1.1	6.6%
DtF	Dormont-Culleoka complex, 25 to 50 percent slopes	D	0.0	0.2%
Nw	Newark silt loam	B/D	12.2	72.3%
UkD	Udorthents, strip mine, moderately steep	C	1.7	10.3%
UkF	Udorthents, strip mine, steep	C	1.8	10.6%
Totals for Area of Interest			**16.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

TRIP REPORT

Date: October 26, 2015

To: Megan Carson

From: Tim Evans, PG

Subject: Summary of Soil Infiltration Tests
Houston Injection Station
Sunoco PPP
Chartiers Township, Washington County, Pennsylvania

This trip report provides results of soil infiltration tests that were completed as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP, in Chartiers Township, Washington 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 Chartiers Township, Washington County, Pennsylvania. Three shallow tests (IT-1, IT-2, and IT-3) 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 Mark Mengel and Scott Anderson of Tetra Tech, Inc., on October 12, 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 of the test locations. IT-1, IT-2 and IT-3 were located in a farm field in a relatively flat area. 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. The double-ring test locations were prepared for test locations with the assistance of a mini-excavator, with care taken to minimize disturbance of the soil surface to be tested. The double-ring infiltrometers that were used for testing consisted of 10-inch and 6-inch diameter sections of 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 clear and approximately 70 degrees Fahrenheit, and no precipitation was observed during the tests.

In addition, test pits were machine-excavated at 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 completed to two 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 SOILS DESCRIPTION

Soils encountered generally consisted of up to 14 inches of a dark brown/black topsoil/surface soil silt layer, underlain by silt and clayey silt soils (generally clayey silt to silt loam). Thin grass roots were encountered in the topsoil/surface soils with few roots being observed in the underlying soil horizons. Table 1 summarizes the depths of the infiltration tests (test pits completed approximately 2 feet deeper than infiltration test depths).

The soils were noted to be dry to moist during the excavation activities. No mottling of soils was observed in the test pits. Groundwater was observed at the bottom IT-1 and IT-2 test pits at approximately 3 feet below ground surface.

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 and IT-3 – Newark silt loam (Nw soil symbol)

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.

[1] http://websoilsurvey.nrcs.usda.gov/. Accessed October 21, 2015.

Two locations (IT-1 and IT-3) exhibited a slow rate of infiltration, requiring a 30-minute test cycle, and one location (IT-2) exhibited moderate infiltration rates, requiring 10-minute test cycle.

Table 1
Summary of Infiltration Test Results
Houston Injection Station
Chartiers Township, Washington County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Depth (inches)	Infiltration Test Result (inches/hour)
	LATITUDE	LONGITUDE		
IT-1	40.261406	-80.267686	8	2.31
IT-2	40.261514	-80.2673.78	8	11.06
IT-3	40.261606	-80.266942	6	2.63


Figure 1
Infiltration Test Locations
Houston Injection Station
Washington County PA
Legend
Infiltration Test Location
Ullom Rd
Washington IT-3
Washington IT-2
Washington IT-1
Google earth
© 2015 Google
N
400 ft

ATTACHMENTS

SOIL LOGS

TETRA TECH

Soil Log

Tested By: Scott Anderson **Project:** Sunoco Stations **Project No.:** 112IC0771

Test Pit: Houston IT-1 **Date:** 10/12/15 **Elevation:** _____ **Equipment Used** Mini Excavator Bob cat E35

Geology: _____ **Soil Type:** _____ **Land Use:** _____ **Weather:** 70°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"	14"	silt loam	Silt with vegetation and trace clays	Dark Brown/ Black	NONE	Numerous pores & roots	>3'	3'	-some clayey areas Moist
A	14"	24"	silt loam	Silt with clay & trace clay	Dark Brown/ Black	NONE	few pores and roots	↓	↓	-few >1" rocks Moist
B	24"	36"+	silt loam to silty clay loam	silt w/clay to clayey silt	Dark Brown/ Black	NONE	No pores and roots	↓	↓	very 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	- Dug to ~40" - water @ 3' - Boundaries are gradual → overall fairly consistent
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 **Project:** Sunoco Stations **Project No.:** 112IC07771

Test Pit: Houston IT-2 **Date:** 10/12/15 **Elevation:** _____ **Equipment Used** Mini Excavator

Geology: _____ **Soil Type:** _____ **Land Use:** _____ **Weather:** ~70°, 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"	8"	Silt Loam	clayey silt to silt with little clay	Dark Brown/ Black	NONE	Pores, roots	>3'	~3'	Moist
A	8"	24"	silt Loam	clayey silt to silt with clay	Brown/tan w/ Orange		few roots, no pores	↓	↓	Moist
B	24"	36"+	silty clay loam	clayey silt with fine/micaceous sands	Brown/ Black		no roots no pores	↓	↓	very moist

Horizon:	USDA Definition	Soil Textural Class	Boundary	Notes:
O	Organic debris	Use ternary diegram from US Department of Agriculture Soil Conservation Service	Use depth and classification Classification as Follows: Abrupt	- increasing clays with depth
A	Dark colored, mixed mineral organic matter			- Boundaries generally distinct/clear
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 Andorsor **Project:** Sunoco Stations **Project No.:** 112IC07771

Test Pit: Houston IT-3 **Date:** 10/12/15 **Elevation:** _____ **Equipment Used** Mini Excavator

Geology: _____ **Soil Type:** _____ **Land Use:** _____ **Weather:** 70°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"	11"	Silt loam	Silt with trace to minor clay	Dark Brown	NONE	roots, pores	>3'	>3'	- some black silt/topsoil
A	11"	23"	Silt loam	Silt with minor clay & silt with clay	Brown (with orange)		Minor roots, few to no pores	↓	↓	- some reduction/oxidation (iron staining areas)
B	23"	36"+	Silt loam to silty clay loam	Silt w/minor clay to nearly clayey silt	Dark Brown		No pores or roots	↓	↓	- some black areas

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	
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 beneeth 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 Stations
PROJECT NUMBER: 112IC07771
TEST AREA ID: HOUSTAN IT-2
PERSONNEL: MM, SA

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

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

Location Coordinates or Description:
Lat 40.261406
Long -80.267686

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

DATE(s): 10/12/15

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: 8"

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				
0958	0	----------	9.4	
1028	30	1 2/16	0.7	
1058	60	1 4/16	0.65	
TEST DATA				
1058	0	----------		
1128	30	1 2/16	0.7	
1158	60	1 2/16	0.7	
1228	90	1 3/16	0.7	
1258	120	1 3/16	=	END OF TEST

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco Stations
PROJECT NUMBER: 112IC07771
TEST AREA ID: HOUSTON IT-2
PERSONNEL: MM, SA

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

Location Coordinates or Description:
Lat 40.261514
Long -80.267378

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

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

DATE(s): 10/12/15

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: 8"

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				
0942	0	----------	9.4	952, 3 3/4" - 2.2L added
1012	30	2 14/16	2	1002, 3 7/8" - 2.5L added
1042	60	3 8/16	2.2	1028, 5+" - 4.1L added
TEST DATA				
1042	0	----------		
1052	10	3 3/16	1.8	
1102	20	2 12/16	1.6	
1112	30	2 13/16	1.6	
1122	40	2 12/16	1.6	
1132	50	2 12/16	-	END OF TEST

INFILTRATION TEST DATA SHEET

Tetra Tech, Inc.

PROJECT NAME: Sunoco Stations
PROJECT NUMBER: 112IC07771
TEST AREA ID: Houston IT-3
PERSONNEL: Scott Anderson, Mark Mergel

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

Location Coordinates or Description:
Lat 40.261606
Long -80.266942

INNER RING INSIDE DIAMETER/HEIGHT: 6" x 10"
OUTER RING INSIDE DIAMETER/HEIGHT: 4" x 10"

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

DATE(s): 10/12/15

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: ~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				
930	0	---	~9.5 L	start test/soak
940	10	3 1/4	1.60 L	
1000	30	1 7/8	1.00 L	
1030	60	1 3/4	0.900 L	
TEST DATA				
1030	0	---	—	start test
1100	30	1 3/8	0.750 L	
1130	60	1 3/8	0.750 L	
1200	90	1 2/8	0.700 L	
1230	120	1 2/8	—	
	END TEST,	stable		

PHOTOGRAPHS

SITE PHOTOGRAPHIC LOG

Date:	View:	Photographer:
10/12/15		S. Anderson

IT-1 Test Pit. Groundwater infiltration observed at 3 feet bgs.

Date:	View:	Photographer:
10/12/15		S. Anderson

IT-2 Infiltration Test.

Date:	View:	Photographer:
10/12/15		S. Anderson

IT-2 Test Pit for lithology.

Date:	View:	Photographer:
10/12/15		S. Anderson

IT-3 Infiltration Test.

SITE PHOTOGRAPHIC LOG

Date:	View:	Photographer:
10/12/15		S. Anderson

IT-3 Test Pit.

TRIP REPORT
HOUSTON INJECTION STATION

1.0 PURPOSE

This Trip Report presents the field data and results of test pitting conducted to support the design of a stormwater management system at the Houston Injection Station site located in Chartiers Township, Washington County, Pennsylvania, as part of the Pennsylvania Pipeline Project (PPP) for Sunoco Pipeline, LP. Three test pits (IT-1, IT-2 and IT-3) were excavated using a backhoe at the site to obtain Munsell color designations of the subsurface soils. The test locations are listed by coordinates (latitude and longitude) in Table 1 and shown on the attached figure.

2.0 FIELD ACTIVITIES

The test pit field observations were made by Keith Simpson and Jake Marlow of Tetra Tech, Inc., on September 26**,** 2016. The test pit locations were positioned in the field using a handheld, WAAS-enabled GPS unit. The test pit locations were located in a farm field in a relatively flat area.

A mini-excavator (backhoe) was utilized to expose the subsurface lithologies and to obtain Munsell color designations applicable to test pits previously excavated in October 2015. The three test pits were dug within five feet of the previous test pit locations and to the same depths (36”). Munsell color designations were documented on previously completed field logs, which were based on the example form in the Pennsylvania Stormwater Best Management Practices Manual (December 30, 2006). Copies of the soil logs are attached to this report.

3.0 RESULTS

3.1 Soil Description

Soils encountered generally consisted of up to 14 inches of a dark brown/black (10YR 4/3, 7.5YR 3/3 and 10YR 3/3) topsoil/surface soil silt layer, underlain by silt and clayey silt soils (generally clayey silt to silt loam – 10YR 3/1 and 7.5YR 3/1 at IT-1, 7.5YR 3/2 and 7.5YR 2.5/2 at IT-2, and 10YR 3/2 and 10YR 4/3 at IT-3). Grass roots and pores were encountered in the topsoil/surface soils with few roots being observed in the underlying soil horizons. Table 1 summarizes the depths of the test pits.

The soils were noted to be dry to very moist during the excavation activities. No mottling of soils was observed in the test pits. Groundwater was observed at the bottom of all test pits (approximately 3 feet below ground surface).

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

- IT-1, IT-2 and IT-3 – Newark silt loam (Nw soil symbol) with very high runoff and somewhat poorly drained.

Table 1
Summary of Infiltration Test Results
Houston Injection Station
Chartiers Township, Washington County, PA
Sunoco PPP

Test Location (IT-)	Location Data		Test Pit Depth (feet bgs)
	LATITUDE	LONGITUDE	
IT-1	40.261406	-80.267686	3.33
IT-2	40.261514	-80.267378	3
IT-3	40.261606	-80.266942	3


Figure 1
Infiltration Testing Locations
Houston Injection Station
Soil Type: Newark Silt Loam (Nw)
Washington County, PA
Legend
Infiltration Tests
UkF
DtF
GdC
GdB
Nw
UkF
IT-1
IT-2
IT-3
Google Earth
© 2016 Google
N
300 ft

ATTACHMENTS

SOIL LOGS

TETRA TECH **Soil Log**

Tested By: Scott Anderson **Test Pit:** Houston IT-1 **Date:** 10/12/15 **Geology:** _____ **Soil Type:** _____

Project: Sunoco Stations **Elevation:** _____ **Land Use:** _____

Project No.: 112IC0771 **Equipment Used** Mini Excavator Bob cat E35 **Weather:** 70°F, clear

Additional Comments 40.231406 -80.267686

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"	14"	Silt loam	Silt with vegetation and trace clays	Dark Brown/ Black	NONE	numerous pores & roots	>3'	3'	-some clayey areas
A	14"	24"	Silt loam	Silt with clay & trace clay	Dark Brown/ Black	NONE	few pores and roots	↓	↓	-few >1" rocks
B	24"	36"+	Silt loam to silty clay loam	Silt w/clay to clayey silt	Dark/ Brown/ Black	NONE	No pores and roots	↓	↓	very Moist

10YR 4/3 Brown Moist

10YR 3/1 Very Dark Gray Moist

7.5YR 3/1 Very Dark Gray Moist

Moist

Moist

Revised 9/26/16 BY Jake Mudrow

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:

- Dug to ~40"
- water @ 3'
- Boundaries are gradual → overall fairly consistent

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 Andersen **Project:** Sunoco Stations **Project No.:** 112IC07771

Test Pit: Houston IT-2 **Date:** 10/12/15 **Elevation:** _____ **Equipment Used** Mini Excavator

Geology: _____ **Soil Type:** _____ **Land Use:** _____ **Weather:** ~70°, Clear

Additional Comments 40.261514 -80.267378

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 (7.5YR 3/3 Dark Brown Moist)	0"	8"	Silt Loam	clayey silt to silt with little clay	Dark Brown/ Black	NONE	pores, roots	>3'	~3'	Moist
A (7.5YR 3/2 Dark Brown Moist)	8"	24"	silt Loam	clayey silt to silt with clay	Brown/tan w/Orange		few roots, no pores	↓	↓	Moist
B (7.5YR 2.5/2 very Dark Brown Moist)	24"	36"+	silty clay loam	clayey silt with trace/minor F. Sands	Brown/ Black		no roots no pores	↓	↓	very Moist

Revised 9/26/16 BY Jake Marlow

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	- increasing clays with depth
A	Dark colored, mixed mineral organic matter		Classification as Follows: Abrupt	- Boundaries generally distinct/clear
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 **Project:** Sunoco Stations **Project No.:** 112C07771

Test Pit: Houston IT-3 **Date:** 10/12/15 **Elevation:** _____ **Equipment Used** Mini Excavator

Geology: _____ **Soil Type:** _____ **Land Use:** _____ **Weather:** 70°F, clear

Additional Comments [illegible] -80.266942

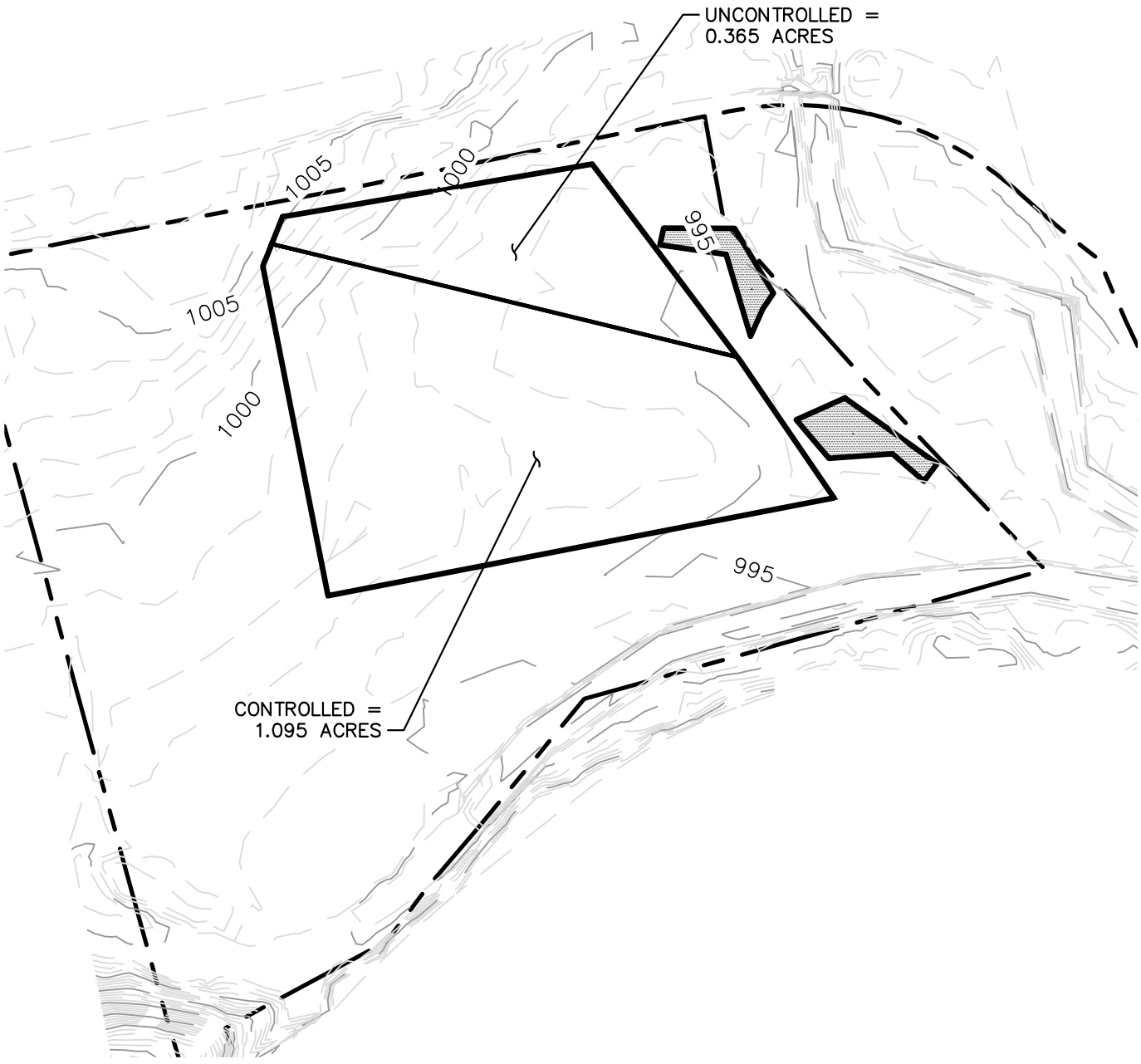
	Horizon	Upper Boundary	Lower Boundary	Soil Textural Class	Type, Size, Coarse Fragments, etc.	Soil Color	Color Patterns	Pores, Roots, Rock Structure	Depth to Bedrock	Depth to Water	Comments
10YR 3/3 Dark Brown Moist	O	0"	11"	Silt loam	Silt with trace to minor clay	Dark Brown	NONE	roots, pores	>3'	>3'	- some black silt/topsoil
10YR 3/2 very Dark Greyish Brown Moist	A	11"	23"	Silt loam	Silt with minor clay & silt with clay	Brown (with orange)		Minor roots few to no pores	↓	↓	- some roots/organics (less in stained areas)
10YR 4/3 Brown Moist	B	23"	36"+	Silt loam to silty clay loam	Silt w/minor clay to majority clayey silt	Dark Brown		No pores or roots	↓	↓	- some black areas

Revised 9/26/16 By Jake Marlow

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

APPENDIX C – PRE-DEVELOPED RUNOFF MAP



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TETRA TECH
WWW.TETRATECH.COM
661 ANDERSEN DRIVE – FOSTER PLAZA 7
PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

HOUSTON INJECTION

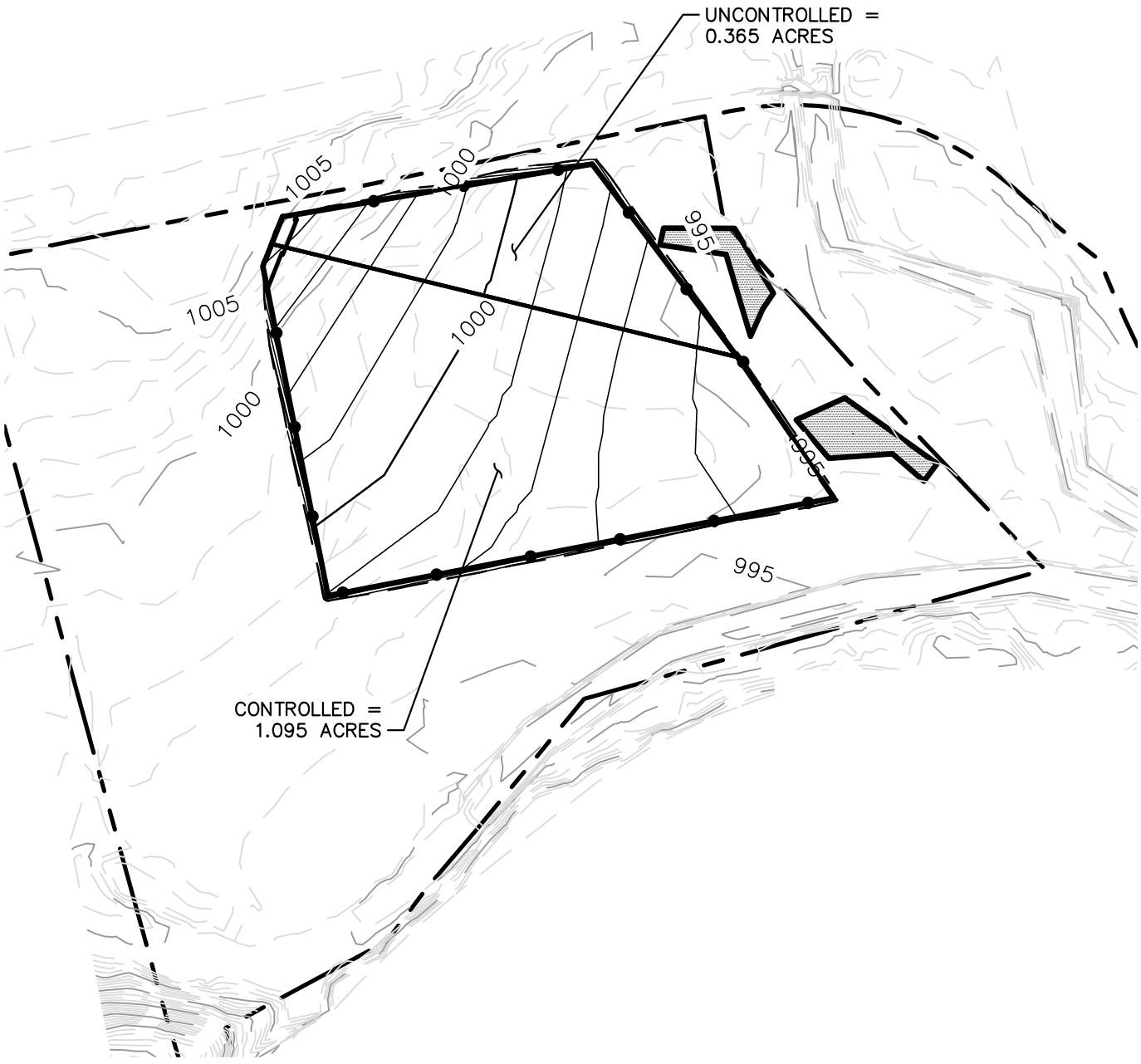
PRE CONSTRUCTION

SCALE: 1" = 100'

DATE:	11/02/15
PROJECT NO.:	212IC-PB-0069
DESIGNED BY:	TD
DRAWN BY:	SW
CHECKED BY:	TD
SHEET:	1 OF 1

APPENDIX C

APPENDIX D – POST-DEVELOPED RUNOFF MAP



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HOUSTON INJECTION

POST CONSTRUCTION

SCALE: 1" = 100'

DATE:	11/02/15
PROJECT NO.:	212IC-PB-0069
DESIGNED BY:	TD
DRAWN BY:	SW
CHECKED BY:	TD
SHEET:	1 OF 1

APPENDIX D

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APPENDIX E – PONDPACK AND FLOWMASTER CALCULATIONS

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Pre Development	2-year	2	0.041	12.100	0.38
Pre Development	10-year	10	0.099	12.100	1.20
Pre Development	25-year	25	0.144	12.100	1.83
Pre Development	50-year	50	0.184	12.100	2.38
Pre Development	100-yr	100	0.229	12.100	2.99
Post Controlled	2-year	2	0.117	11.900	2.11
Post Controlled	10-year	10	0.195	11.900	3.53
Post Controlled	25-year	25	0.246	11.900	4.45
Post Controlled	50-year	50	0.289	11.900	5.19
Post Controlled	100-yr	100	0.335	11.900	5.98
Post Uncontrolled	2-year	2	0.039	11.900	0.70
Post Uncontrolled	10-year	10	0.065	11.900	1.18
Post Uncontrolled	25-year	25	0.082	11.900	1.48
Post Uncontrolled	50-year	50	0.096	11.900	1.73
Post Uncontrolled	100-yr	100	0.112	11.900	1.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Post Unc Out	2-year	2	0.039	11.900	0.70
Post Unc Out	10-year	10	0.065	11.900	1.18
Post Unc Out	25-year	25	0.082	11.900	1.48
Post Unc Out	50-year	50	0.096	11.900	1.73
Post Unc Out	100-yr	100	0.112	11.900	1.99
Pre Out	2-year	2	0.041	12.100	0.38
Pre Out	10-year	10	0.099	12.100	1.20
Pre Out	25-year	25	0.144	12.100	1.83
Pre Out	50-year	50	0.184	12.100	2.38
Pre Out	100-yr	100	0.229	12.100	2.99
Post Cont Out	2-year	2	0.117	11.900	2.11
Post Cont Out	10-year	10	0.195	11.900	3.53
Post Cont Out	25-year	25	0.246	11.900	4.45
Post Cont Out	50-year	50	0.289	11.900	5.19
Post Cont Out	100-yr	100	0.335	11.900	5.98

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.011
Slope	0.023 ft/ft
2 Year 24 Hour Depth	2.4 in
Average Velocity	1.26 ft/s
Segment Time of Concentration	0.022 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	True
Slope	0.023 ft/ft
Average Velocity	3.08 ft/s
Segment Time of Concentration	0.027 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.083 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.240
Slope	0.023 ft/ft
2 Year 24 Hour Depth	2.4 in
Average Velocity	0.11 ft/s
Segment Time of Concentration	0.261 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	300.00 ft
Is Paved?	False
Slope	0.023 ft/ft
Average Velocity	2.45 ft/s
Segment Time of Concentration	0.034 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.295 hours

==== SCS Channel Flow

Tc =

R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:

R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =

Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:

V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Index

CN Area Collection - Pre Development (Catchment)

Description	CN	Area (acres)	Percent Connected Impervious Area (%)	Percent Unconnected Impervious Area (%)
Meadow - cont. grass (non grazed) - ---- - Soil B/D	68.000	1.460	0.0	0.0

CN Area Collection - Post Controlled (Catchment)

Description	CN	Area (acres)	Percent Connected Impervious Area (%)	Percent Unconnected Impervious Area (%)
Impervious Areas - Gravel (w/ right-of-way) - Soil B/D	88.000	1.095	0.0	0.0

CN Area Collection - Post Uncontrolled (Catchment)

Description	CN	Area (acres)	Percent Connected Impervious Area (%)	Percent Unconnected Impervious Area (%)
Impervious Areas - Gravel (w/ right-of-way) - Soil B/D	88.000	0.365	0.0	0.0

STANDARD DESIGN CALCULATION WORKSHEET

TETRA TECH, INC.	CALCULATION WORKSHEET		PAGE __1__ OF __3__
Client: Sunoco Pipeline LP		**Project Number: 112IC05958**	
Subject: Houston Injection - Analysis of Wetland Function for Stormwater Treatment			
By: T. Dunaway	**Checked By:** D. Witt	**Approved By:** B. Smith	**Date:** 9/28/2016

Problem Statement:
Provide calculation that supports the assumption that the existing on-site wetlands will attenuate the additional post-development peak flow for the 2-year storm that is not treated by proposed BMPs.

Analysis:
The Geoweb BMP proposed to treat stormwater at the Houston Injection Site was intentionally designed to capture only a portion of the impervious runoff. Based on site topography, capturing runoff from the entire impervious area would cut off almost all of the hydrology to the existing wetlands adjacent to the northeast. However, by not capturing all impervious runoff, the results of the hydrology analysis showed that the 2-year post-development peak runoff (0.70 cfs) was greater than the pre-development peak runoff (0.38 cfs) by 0.32 cfs.

To maintain minimal impact to wetlands, the goal was to replicate the 2-year storm hydrology of the wetlands, given that wetlands will likely be flooded during the larger storm events. This was achieved by replicating total volume instead of peak flow. The pre-development hydrograph volume feeding the wetlands is 0.041 ac-ft compared to a post-development hydrograph volume feeding the wetlands of 0.039 ac-ft. Therefore the design provides a slightly lower total volume of water to the wetland during a 2-year storm event.

Three soil test pits taken in the wetlands show groundwater to be approximately 6" – 12" deep (see Groundwater Elevation Map Attached).

Given the surveyed surface area of the wetlands:
North Wetland Surface Area = 0.032 acres
South Wetland Surface Area = 0.041 acres
Total Wetland Area = 0.073 acres

And assuming a pore space volume adjustment of 40%, the volume available for storage below the surface in the wetlands is roughly estimated to be:

40% * 0.75 ft * 0.073 ac = 0.022 ac-ft

Ground surface topography indicates that both wetlands are in a ground depression (see Groundwater Elevation Map Attached). Topography and field observations indicate that approximately 3" -6" of storage exists in the depressions. Assuming a conservative 3 inches of above ground storage, the volume available for storage above the surface in the wetlands is roughly estimated to be:

TETRA TECH, INC.	CALCULATION WORKSHEET		PAGE __2__ OF __3__
Client: Sunoco Pipeline LP		**Project Number: 112IC05958**	
Subject: Houston Injection - Analysis of Wetland Function as Stormwater Treatment			
By: **T. Dunaway**	**Checked By:** **D. Witt**	**Approved By:** **B. Smith**	**Date:** **9/28/2016**

0.25 ft * 0.073 ac = 0.018 ac-ft

Therefore, the total storage provided by the wetlands is estimated to be roughly equal to the total volume of runoff to the wetlands during a 2-year storm event:

Wetland storage = 0.022 ac-ft + 0.018 ac-ft = 0.040 ac-ft
Post-development hydrograph volume = 0.039 ac-ft

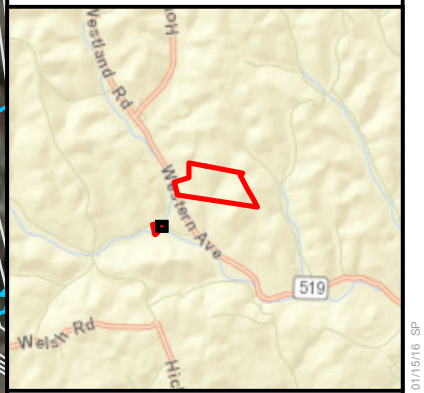
In this case, the 2-year storm post-development peak flow would be reduced to zero and peak flow requirements for the 2-year storm would be met.

Attachment (Page 3 of 3):
Groundwater Elevation Map

Legend

- Soil Test Pit
- Groundwater Contour (0.5-foot)
- Topographic Contour (1-foot)
- Stream
- Study Area
- Parcel Boundary
- PEM Wetland
- Approximate Project LOD
- Mitigation Site (Improvements)

Sheet Identifier



Feet
0 25 50

Meters
0 7.62 15.24

GROUNDWATER ELEVATION MAP
FIGURE 6B
LOCATION #2 PROPOSED ULLOM ROAD MITIGATION SITE
SPLP HOUSTON TANK FARM
SUNOCO PIPELINE, LP (SPLP)
WASHINGTON COUNTY, PENNSYLVANIA

TETRA TECH

Notes:
1) Aerial photograph provided by ESRI's ArcGIS Online World Imagery map service (© 2011 ESRI and its data suppliers).
2) Coordinate system is NAD 83 State Plane Pennsylvania South.
3) Inverse Distance Weighting (IDW) with a Power of 2 was used to interpolate data from soil test pits.

P:\GIS\SUNOCO\MARINER EAST 2\MXD\PENN\PIPELINE_HTF_ULLOM_MITIG_GW_ELEV.MXD 01/15/16 SP

APPENDIX F – CALCULATION WORKSHEETS

WORKSHEET 1. GENERAL SITE INFORMATION

Date:	May 25, 2016		
Project Name:	Sunoco - Houston Injection		
Municipality:	Chartiers Township		
County:	Washington		
Total Area (acres):	2.70		
Major River Basin:			
Watershed:	Chartiers Run		
Sub Basin:	Chartiers Run		
Nearest Surface Water to Receive Runoff:	Chartiers Run		
Chapter 93 - Designated Water Use:	WWF, MF		
Impaired according to Chapter 303(d) list?		YES	
List Causes of Impairment:		NO	X
Is Project Subject to, or Part of:			
Municipal Separate Storm Sewer System (MS4) Requirements		YES	
		NO	X
Existing or Planned drinking water supply?		YES	
		NO	X
If yes, distance from proposed discharge (miles):			
Approved Act 167 Plan?		YES	X
		NO	
Existing River Conservation Plan?		YES	
		NO	X

Worksheet 2. Sensitive Natural Resources

INSTRUCTIONS:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? yes/no/n/a	TOTAL AREA (Ac.)	PROTECTED AREA (Ac.)
Waterbodies	yes	0	0
Floodplains	yes	0	0
Riparian Areas	yes	0	0
Wetlands	yes	0	0
Woodlands	yes	0	0
Natural Drainage Ways	no	0	0
Steep Slopes, 15% - 25%	no	0	0
Steep Slopes, over 25%	no	0	0
Other:	n/a	0	0
Other:	n/a	0	0
TOTAL EXISTING:		0	0

Worksheet 3. Nonstructural BMP Credits

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2) 0 **Ac.**

1.2 Area of Riparian Forest Buffer Protection 0 **Ac.**

3.1 Area of Minimum Disturbance/Reduced Grading 0 **Ac.**

TOTAL 0 **Ac.**

Site Area	*minus*	Protected Area	=	Stormwater Management Area
2.70	-	0	=	2.70

This is the area that requires stormwater management

VOLUME CREDITS

3.1 Minimum Soil Compaction

Lawn _____ ft^2 x 1/4" x 1/12 = 0 ft^3

Meadow _____ ft^2 x 1/3" x 1/12 = 0 ft^3

3.3 Protect Existing Trees

For Trees within 100 feet of impervious area:

Tree Canopy _____ ft^2 x 1/2" x 1/12 = 0 ft^3

_____ 0

5.1 Disconnect Roof Leaders to Vegetated Areas

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area _____ ft^2 x 1/3" x 1/12 = 0 ft^3

For all other disconnected roof areas

Roof Area _____ ft^2 x 1/4" x 1/12 = 0 ft^3

5.2 Disconnect Non-Roof impervious to Vegetated Areas

For Runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Area _____ ft^2 x 1/3" x 1/12 = 0 ft^3

For all other disconnected roof areas

Impervious Area _____ ft^2 x 1/4" x 1/12 = 0 ft^3

0

** For use on Worksheet 5*

WORKSHEET 4. CHANGE IN RUNOFF VOLUME FOR 2-YR STORM EVENT

Project: Sunoco - Houston Injection
Drainage Area: 1.46 acres
2-Year Rainfall: 2.4 inches

Total Site Area (ac.): 2.70 acres
Protected Site Area: 0.00 acres
Managed Site Area: 2.70 acres

Existing Conditions								
Cover Type/Condition	**Soil Type**	**Area (sf)**	**Area (ac)**	**CN**	**S**	**Ia**	**Q**	**Runoff Volume (cf)**
Meadow	B/D	63,598	1.460	68	4.71	0.94	0.35	1829.59
TOTAL:								**1829.59**
Developed Conditions								
Cover Type/Condition	**Soil Type**	**Area (sf)**		**CN**	**S**	**Ia**	**Q**	**Runoff Volume (cf)**
Gravel	B/D	63,598	1.460	88	1.36	0.27	1.30	6870.17
TOTAL:		**63,598**						**6870.17**

2-Year Volume Increase (ft3):	**5040.582**

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = Q = (P - 0.2S)2 / (P+ 0.8S) where
   P = 2-Year Rainfall (in)
   S = (1000/CN)-10

2. Runoff Volume (CF) = Q x Area x 1/12
   Q = Runoff (in)
   Area = Land use area (sq. ft.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

Worksheet 5. Structural BMP Volume Credits

PROJECT: Sunoco - Houston Injection
SUB-BASIN: Chartiers Run

Required Control Volume (ft3) - *from Worksheet 4:* 5,041

Non-structural Volume Credit (ft3) - *from Worksheet 3:* N/A

Structural Volume Reqmt (ft3) 5,041
(Required Control Volume minus Non-structural Credit)

Proposed BMP		Area (ft2)	Storage Volume (ft3)
6.4.1	Porous Pavement		74,620
6.4.2	Infiltration Basin		
6.4.3	Infiltration Bed		
6.4.4	Infiltration Trench		
6.4.5	Rain Garden/Bioretention		
6.4.6	Dry Well/Seepage Pit		
6.4.7	Constructed Filter		
6.4.8	Vegetated Swale		
6.4.9	Vegetated Filter Strip		
6.4.10	Berm		
6.5.1	Vegetated Roof		
6.5.2	Capture and Re-Use		
6.6.1	Constructed Wetlands		
6.6.2	Wet Pond/Retention Basin		
6.6.3	Dry Extended Detention Basin		
6.6.4	Water Quality Filters		
6.7.1	Riparian Buffer Restoration		
6.7.2	Landscape Restoration/Reforestation		
6.7.3	Soil Amendment		
6.8.1	Level Spreader		
6.8.2	Special Storage Areas		
Other:			

Total Structural Volume Provided (ft3): **74,620**

Structural Volume Requirement (ft3): **5,041**

DIFFERENCE: **-69,579**

WORKSHEET 10. WATER QUALITY COMPLIANCE FOR NITRATE

Does the site design incorporate the following BMPs to address nitrate pollution? A summary "yes" rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the

PRIMARY BMPs FOR NITRATE:

	YES	NO
NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers		X
NS BMP 5.5.4 - Cluster Uses at Each Site		X
NS BMP 5.6.1 - Minimize Total Disturbed Area	X	
NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species)		X
NS BMP 5.9.1 - Street Sweeping / Vacuuming		X
Structural BMP 6.7.1 - Riparian Buffer Restoration		X
Structural BMP 6.7.2 - Landscape Restoration	X	

SECONDARY BMPs FOR NITRATE:

NS BMP 5.4.1 - Protect Sensitive / Special Value Features		X
NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features	X	
NS BMP 5.6.2 - Minimize Soil Compaction		X
Structural BMP 6.4.5 - Rain Garden / Bioretention		X
Structural BMP 6.4.8 - Vegetated Swale		X
Structural BMP 6.4.9 - Vegetated Filter Strip		X
Structural BMP 6.6.1 - Constructed Wetland		X
Structural BMP 6.7.1 - Riparian Buffer Restoration		X
Structural BMP 6.7.2 - Landscape Restoration	X	
Structural BMP 6.7.3 - Soils Amendment/Restoration		X

Stormwater BMP Information Chart 5.B revised March 15, 2016

	Infiltration Information					Drainage Information						BMP Information					
Proposed Infiltration BMP(s) (site specific)	Measured Infiltration Rate[9]	Factor of Safety	Design Infiltration Rate	Dewatering Time[1]	Elevation of Limiting Zone - Water Table, Bedrock, etc.[2]	Total Drainage Area to BMP	Total Impervious Drainage Area to BMP	Infiltration BMP Surface Area	Total Drainage Area Loading Ratio[6]	Impervious Area Loading Ratio[7]	Volume of Runoff Tributary to BMP During the 2yr/24hr Design Storm[5]	Calculated Infiltration Volume (from storms up to and including 2yr/24hr)	Calculated Managed Volume (from storms up to and including 2yr/24hr)[8]	Maximum water surface elevation in BMP from 2yr storm[3]	Infiltration Elevation Bottom of Bed/ Basin[3]	Elevation of Infiltration Test[4]	Elevation of E&S Sediment Basin Bottom (if applies)
	in./hr.	*Min. of 2*	*in./hr.*	*hrs.*		*sq. ft*	*sq. ft.*	*sq. ft.*			*cf*	*cf*	*cf*				
BMP 6.4.1 **Pervious Pvmnt w. Infilt. Bed**	5.33	3	5.33	2.25	3' BGS	47,698	47698.00	7000	7	7*	5,014.0	5,014	0	see note*	1' BGS	1' BGS	N/A
BMP 6.4.2 **Infiltration Basin**																	
BMP 6.4.3 **Subsurface Infiltration Bed**																	
BMP 6.4.4 **Infiltration Trench**																	
BMP 6.4.5 **Rain Garden/Bioretention**																	
BMP 6.4.6 **Dry Well / Seepage Pit**																	
Other																	
BMP 6.4.7 **Constructed Filter**																	
BMP 6.4.8 **Vegetated Swale**																	
BMP 6.4.9 **Vegetated Filter Strip**																	
BMP 6.4.10 **Infilt. Berm & Ret. Grading**																	

All information to be based on the 2-year/24-hour storm

Provide page numbers from the stormwater narrative identifying the location of the above information.

[1] Can include active infiltration time - dewatering time should not exceed 72 hours after the 2-year/24-hour storm

[2] Depth to limiting zone is recommended to be at least 2 ft below infiltration testing elevation/proposed infiltration elevation.

[3] A maximum of 2 feet of Hydraulic head is recommended.

[4] Provide supporting field notes/documenation from soil evaluation.

[5] This value should be greater than or equal to the Volume to be Infiltrated or Managed by the BMP.

[6] A maximum of 8:1 is recommended.

[7] A maximum of 5:1 is recommended; however, in carbonate geology areas, a maximum of 3:1 is recommended.

[8] Calculated runoff volume that is managed in ways other than infiltration to address 25 PA Code Ch 102.8(g)(2)

[9] The infiltration testing information should be located on the plan view of the PCSM Plan and should include infiltration test elevation and rate.

Any deviations from the recommendations above should be adequately justified by a qualified professional and included with the application.

NOTE: This chart is for summary purposes only and should be consistent with all design calculations and worksheets.

* Notes:

1. The impervious area loading ratio is slightly higher than recommended. A maintenance agreement will be established to ensure proper BMP repairs in the event of sedimentation.
2. The depth of the BMP is only 1 foot, preventing the hydraulic head from being greater than 2 feet.

APPENDIX G – STORMWATER MANAGEMENT PLANS

SEE FULL SIZE DRAWINGS