STORMWATER REPORT

NEW BEDFORD HAULING

1228, 1200 AND 1166 SHAWMUT AVENUE
NEW BEDFORD, MASSACHUSETTS 02746

Applicant:

WASTE CONNECTIONS
11400 PARKSIDE DRIVE, STE. 500
KNOXVILLE, TENNESSEE 37934

Prepared By:

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CEC Project 324-365

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Civil & Environmental Consultants, Inc.

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1.0 PROJECT NARRATIVE

1.1 INTRODUCTION

On behalf of Waste Connections (the "Applicant"), Civil & Environmental Consultants, Inc. (CEC) has prepared this stormwater report and analysis to demonstrate compliance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards and the City of New Bedford Stormwater Management Ordinance.

The Applicant is proposing to redevelop three (3) parcels of land identified as the City of New Bedford parcels APN 123-0018, APN 123-0132, and APN 123-0101, located in the Industrial A (IA) District.

The redevelopment includes the following work:

- Demolition of an existing building on 1200 Shawmut Avenue.
- Demolition and replacement of a portion of the existing building on 1166 Shawmut Avenue as well as the rehabilitation of its remaining portion.
- Removal of all the pavement on 1200 & 1166 Shawmut Avenue along with all associated landscape and a portion of its utility features.
- Construction of a parking lot with landscape features and stormwater and utility infrastructure improvements on 1200 Shawmut Avenue.
- Construction of parking and landscape features associated to the new building on 1166 Shawmut Avenue along with stormwater and utility infrastructure improvements.
- Offsite improvements include the construction of landscape and pavement features along the southerly and easterly portion of the site.

1.2 EXISTING CONDITIONS

The 8.01-acre Site is located at the corner of Shawmut Avenue and Nash Road in New Bedford, Massachusetts. The Site is bordered to the west by Shawmut Avenue, Nash Road to the south, and Bordering Vegetated Wetlands (BVW) to the east and north. Access to the Site is currently provided via paved driveways off Shawmut Avenue. A portion on the Site on 1228 Shawmut Avenue consists of an office building and a shipping/receiving building with paved parking features. The remaining of the parcel is covered with pavement and BVW areas. 1200 Shawmut Avenue consists of a building surrounded by pavement and a small portion of landscaped areas and BVW areas. 1166 Shawmut Avenue consists of a large open storage building and associated office spaces, along with paved parking features and a small portion of BVW areas. The majority of the pavement is in poor condition and in need of repair.

The property is in the Industrial A (IA) district and is adjacent to commercial sites to the south across Nash Road and to the west across Shawmut Avenue. See Figure 1 for a Site Locus Map and Figure 2 for an Aerial Map.

Under existing conditions, approximately 78% of the Site is covered by impervious areas consisting of the pavement and building roof areas. The remainder of the Site consists of landscaped, gravel and wooded areas. Existing topography within the Site ranges from elevation 64 feet (NAVD88) along the northerly portion to elevation 70 feet at the southern part of the Site. Refer to the Existing Conditions Plan included in the Site Plans under separate cover for additional detail.

Most of the stormwater runoff from the Site flows overland and untreated to the adjacent wetlands and public right-of-way, providing little to no water quality treatment or stormwater recharge.

1.2.1 Geotechnical Conditions

According to the geotechnical report prepared by Terracon Consultants, Inc., dated September 22, 2022, the test borings generally encountered 2-5 inches of asphalt pavement; otherwise, the ground surface was bare ground. Existing fill was observed to depths ranging between 2-7 feet below existing ground surface. The fill generally consisted of brown to gray sand with varying amounts of silt and gravel and occasionally included asphalt and brick fragments, which is generally underlain by silty sands. Groundwater was observed during the drilling operations at depths ranging between approximately 4-10 feet below existing ground surface. Additional detail on the subsurface conditions can be found in the Geotechnical Report attached in Appendix B.

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey, the Site is classified as Swansea muck (#51A) and Urban land (#602). Swansea muck is described to be highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits. Urban land refers to excavated and filled land.

For the purpose of the hydrologic analysis, a Hydrologic Soils Group (HSG) "D" was assigned to the Project. As the predominant underlying soils were classified as silty sand, infiltration (where proposed) conservatively used a rate of 1.02 in/hr associated with a Rawl's Rate for "sandy loam".

1.2.2 Flood Zone

The Site is located within an Area of Minimal Flood Hazard shown on the Federal Emergency Agency (FEMA) Flood Insurance Rate Map (FIRM) for the City of New Bedford, Map #

25005C0387G, effective July 6, 2021. Refer to Figure 3 for the FEMA Flood Insurance Rate Map (FIRM) Firmette.

1.3 PROPOSED PROJECT

The Project is proposing a stormwater management system with controls designed to protect surface and groundwater resources and adjacent properties from potential impacts resulting from the proposed work. The proposed improvements have been designed in accordance with the MassDEP Stormwater Management Standards and the City of New Bedford Stormwater Management Ordinance.

In the proposed condition, approximately 75% of the Site will be impervious consisting primarily of building roof areas and the pavement. There will be a net decrease of approximately 0.28 acres (±12,200 sq. ft.) of impervious area when compared to existing conditions. This is due to addition of landscaped areas at the frontage of the site. The remainder of the Site will consist of building roof areas and pavement. Stormwater runoff conveyance will include new catch basins and water quality improvements.

The project will result in a decrease in peak runoff from the site due to the addition of landscaped areas. The overall drainage runoff volume from the Site will also be decreased in the proposed condition, due to the inclusion of proposed stormwater infiltration BMP's.

2.0 STORMWATER MANAGEMENT SYSTEMS

2.1 DESCRIPTION OF RUNOFF CONTROLS

The stormwater management improvements consist of components designed to manage runoff from the Site. These components attenuate runoff discharge peaks, minimize erosion, minimize the transport of sediments, improve water quality, and minimize impacts to downstream resource areas.

The stormwater management system implements a treatment drain of the Best Management Practices designed to provide 80% TSS (Total Suspended Solids) removal for stormwater runoff from the proposed pavement, roof and parking areas. The proposed stormwater management system will use the following specific control measures:

- Deep Sump Hooded Catch Basins: Deep sump catch basins, also known as oil and grease catch basins, are storm drain inlets that typically include a grate or curb inlet and a sump to capture trash, debris and some sediment and oil and grease. Stormwater runoff enters the catch basin via an inlet pipe located at the top of the basin. Deep sump catch basins provide pretreatment of runoff before it is delivered to other BMPs and should be inspected and cleaned in accordance with the Operations and Maintenance (O&M) Plan and per manufacturer's recommendations. See the Long Term Pollution Prevention and O&M Plan included in Section 6.0.

- Proprietary particle separators (Stormceptor water quality units): The proposed Stormceptor water quality units provide efficient removal of free oils, debris, and total suspended solids (TSS). Although not the main objective of the water quality unit, some removal of heavy metals and other nutrients is also achieved. Water quality units allow for safe and easy removal of collected material and should be inspected and cleaned in accordance with the O&M Plan and per manufacturer's recommendations. See the Long Term Pollution Prevention and O&M Plan included in Section 6.0 and Appendix D for supporting information.

  The use of these units for treatment of stormwater is accepted as a good practice and is in accordance with sound professional standards. Testing was performed by a third party in order to determine the maximum treatment flow rates for both 80% and 50% TSS removal. The testing was also verified by the New Jersey Department of Environmental Protection and the results were verified under the NJCAT program. See Appendix D for supporting information.

- Infiltration basin: Infiltration basins reduce runoff volume, remove fine sediment and associated pollutants, recharge groundwater, and provide attenuation of peak flows. Infiltration basins are stormwater impoundments designed to capture and infiltrate the water quality volume over several days, but do not retain a permanent pool. The bottom of the basins will contain vegetation to increase the infiltration capacity of the basin, allow for vegetative uptake, and reduce soil erosion, and scouring of the basin.

An infiltration basin is proposed on southeastern side of the Site. Clean roof runoff will be conveyed to the infiltration basin. The basin has been sized to contain all storm events up to and including the 100-year storm event with all runoffs discharging through a new outlet control structure.

- Lever Spreaders: Riprap outlet protection will be placed at all stormwater outfalls in order to reduce flows to non-erosive velocities to prevent erosion and conform to natural topography where appropriate.

Each of these proposed runoff controls are detailed on the Site Plans included under a separate cover.

2.2 CONSTRUCTION SEQUENCE PLAN

The purpose of the Construction Sequence Plan is to develop a working schedule for the implementation of the proposed stormwater improvements. Prior to initiating work, the siltation control barriers will be installed along the limit of work. Once the appropriate permits are obtained, the construction project will commence in the following sequence:

1. Install all necessary siltation barriers as shown on the design drawings.
2. Perform demolition of existing pavement, building and landscape areas and cut, cap, and remove existing utility services as shown on the design drawings.
3. Perform excavation for building foundation areas, retaining walls, and subsurface utilities.
4. Install proposed utilities and stormwater infrastructure and construct building foundations.
5. Place clean fill/pavement base materials and install pavement base.
6. Construct buildings.
7. Install proposed final landscaping.
8. Remove existing erosion control measures.

All construction water will be collected and treated in accordance with the Erosion and Sediment Control Plan included in Section 5.0.

3.0 STORMWATER ANALYSIS

3.1 METHOD OF ANALYSIS

A hydrologic analysis has been performed for the Site comparing existing conditions and post-development conditions using a software program developed by HydroCAD. This program analyzes site hydrology by the graphic peak discharge method documented in Technical Release No. 20 and Technical Release No. 55 published by the United States Department of Agriculture (USDA) Soil Conservation Service.

The following variables were developed for the contributing watersheds (drainage areas) in order to complete the analysis:

- **Rainfall Depth:** A hydrologic analysis was performed for the 24-hour 2-year, 10-year, 25-year, and 100-year, Type III storm events (3.4, 4.8, 5.6, and 7 inches respectively) for each drainage area. The rainfall depths for the study area were obtained from available charts published in Technical Paper No. 40.

- **Runoff Curve Number (RCN):** The RCN is a hydrologic characteristic that contributes to the peak rate of runoff and volume from a given storm event. It is dependent upon soil conditions and land use. Generally, higher curve numbers are associated with less pervious soils and, hence, greater amounts of runoff. As previously noted, based on the geotechnical investigation, Hydrologic Soil Group (HSG) D was used in determining RCNs.

- **Time of Concentration:** The time of concentration is defined as the time it takes runoff to travel from the hydraulically most distant part of the watershed to the downstream point of interest. This parameter is dependent on the characteristics of the ground surface and condition of the travel path. Times of concentration were calculated for the various sub catchments using the HydroCAD program, with a minimum time of concentration of six (6) minutes used in accordance with the protocol outlined in Technical Release No. 55.

3.2 DRAINAGE AREAS

In order to perform the analysis, the contributing drainage areas for pre-development, existing, and post-development conditions were delineated. The delineation of the drainage areas was determined by the topography depicted on the Existing Conditions plan. Brief descriptions of the existing conditions and proposed conditions drainage areas are as follows:

- **Existing Conditions:** The Site is divided into six (6) drainage areas and the stormwater runoff was evaluated for two (2) design points, the surrounding Bordering Vegetated Wetlands (Design Point A) and the Municipal Stormwater System (Design Point B). Refer to Figure HYD-EX for the existing conditions drainage areas. For the purpose of the analysis, the times of concentration were calculated to the edge of the wetlands where present. A summary of existing conditions drainage areas is listed below:

TABLE 3.1
EXISTING CONDITIONS

Drainage Area	Design Point	Area (ac.)	Curve Number	Time of Concentration (minutes)
A1-EX	A	4.90	91	6.0
A2-EX		0.61	98	6.0
A3-EX		0.64	98	6.0
A4-EX		0.78	98	7.5
B1-EX	B	1.96	97	20.5

- **Proposed Conditions:** The Site is composed of thirteen (13) drainage areas and the stormwater runoff will continue to flow to two (2) design points, the surrounding Bordering Vegetated Wetlands (Design Point A) and the Municipal Stormwater System (Design Point B). Refer to Figure HYD-PR for the proposed conditions drainage area. A summary of the proposed conditions drainage areas are listed below:
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TABLE 3.2
POST-DEVELOPMENT CONDITIONS

Drainage Area	Design Point	Area (ac.)	Curve Number	Time of Concentration (minutes)
A1-PR	A	1.76	85	6.0
A2-PR		0.68	95	6.0
A3-PR		0.73	97	6.0
A4-PR		0.75	95	18.6
A5-PR		0.54	97	6.0
A6-PR		0.35	98	6.0
A7-PR		0.69	98	6.0
A8-PR		0.41	94	25.3
A9-PR		0.21	96	6.1
A10-PR		0.16	96	6.1
A11-PR		0.47	97	6.1
A12-PR		0.40	82	6.0
B1-PR	B	1.74	96	23.6

3.3 RESULTS OF ANALYSIS

A stormwater analysis was performed for the 24-hour 2-year, 10-year, 25-year, and 100-year storm events to determine that there will be no increase in stormwater runoff discharge off-site once the proposed construction is complete. Detailed calculations are attached in Appendix C. Compliance for existing and post-development conditions was evaluated for the site as a whole. A summary of the peak stormwater runoff is provided below.

As shown below in Table 3.3, post-development runoff rates from the Site do not exceed existing runoff rates. Supporting calculations are provided in Appendix C.

TABLE 3.3
PROJECT STORMWATER RUNOFF RATES

	Peak Runoff Rate (cfs)							
	2-Year		10-Year		25-Year		100-Year	
	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.
A	19.91	13.85	29.55	26.83	35.02	31.89	44.55	40.76
B	4.30	3.53	6.15	5.09	7.20	5.98	9.04	7.52

cfs = cubic feet per second

As shown below in Table 3.4, post-development discharge volume from the Site decreased for design point A. Supporting calculations are provided in Appendix C.

TABLE 3.4 PROJECT STORMWATER RUNOFF RATES								
	Runoff Volume (af)							
	2-Year		10-Year		25-Year		100-Year	
	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.
A	1.53	1.20	2.32	2.00	2.77	2.46	3.57	3.27
B	0.50	0.43	0.72	0.63	0.85	0.74	1.08	0.94

af = acre feet

4.0 STORMWATER CONTROL SYSTEM DESIGN CRITERIA

4.1 MASSDEP STORMWATER MANAGEMENT POLICY

Stormwater discharge from the proposed Project is subject to the Massachusetts DEP Stormwater Management Policy (the Policy). The Policy is designed *"to protect the wetlands and waters of the Commonwealth from adverse impacts of storm water runoff."* To accomplish this goal, the Policy establishes ten (10) performance standards to control stormwater quantity and quality. These standards establish the level of required controls that can be achieved with site planning, structural and non-structural controls, and other best management practices (BMPs). The Stormwater Checklist is provided in Appendix A. Stormwater modeling methodology is discussed in detail in Section 3.0. Results of the stormwater modeling of the existing and proposed conditions are provided as Appendix C.

4.1.1 Stormwater Management Standards

The following section documents compliance with the MassDEP Stormwater Management Standards.

Standard 1
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The project is designed to limit to the extent possible new stormwater conveyances that could discharge untreated stormwater into, or cause erosion to, wetlands or waters of the Commonwealth. The proposed project captures and provides treatment for all the runoff from old and new impervious paved areas and roof areas and will be conveyed through an existing series of stormwater BMPs, then will eventually discharge to the bordering vegetated wetlands.

As seen on the results of the stormwater analysis in Section 3.3, the reduction of impervious areas in the proposed conditions resulting in the decrease of the peak discharge rates and volumes represents an overall improvement to the existing conditions. There will be no new stormwater conveyances that will discharge untreated runoff directly to or that can cause erosion in wetlands or waters of the Commonwealth.

Standard 2

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

The post-development peak discharge rate to design points A and B do not exceed pre-development rates. Stormwater modeling methodology is discussed in detail in Section 3.0. The model output is provided as Appendix C. A summary of the model results are provided above in Table 3.3.

Standard 3

Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.

The project will result in a reduction of impervious areas. Therefore, annual recharge will naturally be increased/ Additionally, although there is not a formal recharge requirement, the Project will provide 2,429 cf of recharge in the proposed infiltration basin.

Standard 4

For new development, stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when:

A. *Suitable nonstructural practices for source control and pollution prevention are implemented;*
B. *Stormwater management best practices (BMPs) are sized to capture the prescribed runoff volume; and*
C. *Stormwater management BMPs are maintained as designed.*

The proposed redevelopment utilizes several methods of stormwater management to reduce TSS generation including the use of deep sump hooded catch basins, particle separators (Stormceptor 450i and 900) and level spreaders prior to discharging, consistent with the Policy.

The estimated TSS removal rate from the proposed BMP pre-treatment is approximately 80%, which complies with the 80% requirement.

Supporting information is provided in Appendix C.

A comprehensive Operations and Maintenance Plan (O&M) has been developed and is included in Section 6.0 of this report.

Standard 5
Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pre-treatment is prohibited.

As a waste disposal facility, the Site has a land use that has the potential to generate highly contaminated runoff. Therefore, it is identified as Land Use with Higher Potential Pollutant Load (LUHPPL). As a redevelopment, the Site is required to use specific stormwater management BMPs only to the maximum extent possible. Accordingly, pretreatment is provided by the use deep sump hooded catch basins, particle separators and level spreaders prior to discharging. Infiltration is provided for clean stormwater runoff from roof areas.

Standard 6
Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resources Waters (ORWs), shellfish beds, bathing beaches, cold water fisheries, and recharge areas for public water supplies.

The Site is not anticipated to discharge to critical areas.

Standard 7
Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. Where it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

The Project includes proposed work entirely within previously developed areas and results in a reduction in impervious areas. As a redevelopment, the Project has been designed to meet the Stormwater Management Standard to the maximum extent practicable. The redevelopment project has been designed to comply fully with the Stormwater Management Standards 1 through 4, and

6 through 10. The project will comply to Stormwater Management Standard 5 to the maximum extent practicable and will result in a net improvement over existing conditions.

Standard 8

Erosion and sediment controls must be implemented to prevent impacts during construction, or land disturbance activities.

Erosion and sediment controls are integral to the project improvements. The plan includes compost silt socks, which will be installed down-gradient of the proposed work area. A temporary stabilized construction exit will be constructed as well. Prior to, and during construction, the Site's Erosion and Sediment Control Plan, included in Section 5.0 of this report will be followed. These measures will be utilized throughout construction to prevent erosion, control sediments, and stabilize exposed soils as discussed in Section 5.0. Additionally, a Storm Water Pollution Prevention Plan (SWPPP) will be prepared before the start of construction.

Standard 9

All stormwater management systems must have an operations and maintenance plan to ensure that systems function as designed.

A comprehensive Operations and Maintenance Plan (O&M) has been developed and is included in Section 6.0 of this report. The Manufacturer's O&M Procedures for the proposed water quality units are included in Appendix D.

Standard 10

All illicit discharges to the stormwater management system are prohibited.

There are no known illicit discharges at the Site. If found, any illicit discharges will be eliminated, and the project will not be constructed with any illicit connections. A draft Illicit Discharge Statement is provided in Appendix D.

5.0 CONSTRUCTION SEDIMENTATION AND EROSION CONTROL PLAN

5.1 INTRODUCTION

The greatest potential for sediment generation will occur during the construction. An extensive erosion and sedimentation program is proposed and will be diligently implemented during construction of the project. The erosion control program will minimize erosion and sedimentation that could potentially impact resources areas. Water quality will be maintained by minimizing erosion of exposed soils and siltation. Erosion control barriers will be installed and exposed soil areas re-vegetated as soon as possible after work in an area is completed.

Responsible Party for Plan Compliance:

Waste Connections
11400 Parkside Drive, Ste. 500
Knoxville, TN 37934

Contact: Matthew Crockett, P.E.
Phone: (865) 312-9514

5.2 CONSTRUCTION PHASE EROSION CONTROL MEASURES

The adjacent resource areas will be protected during construction by implementing siltation control measures, including the placement of compost silt socks as close as feasible to the downgradient limit of construction activity. The project may also implement other stabilization methods such as erosion netting and hydroseeding.

5.2.1 Short- and Long-Term Goals and Criteria

Short and long-term goals will include a variety of stabilizing sediment and erosion controls around the limit of work. All construction-phase erosion and sediment controls have been designed to retain sediment on-site to the extent practicable and limit runoff and the discharge of pollutants (sediment) from exposed areas of the Site.
All control measures will be installed and maintained in accordance with the manufacturer's specifications and good engineering practices. Weekly inspections and routine monitoring will be used to determine the effectiveness of controls in use.

Litter and solid construction debris potentially exposed to the stormwater will be prevented from becoming a pollution source through routine monitoring and the use of laborers to “pick” litter, as necessary.

5.2.2 Stabilization Practices

The construction site activities will include numerous stabilizing practices. Sediment and erosion controls such as erosion netting, mulching, and hydro-seeding may act as interim practices. Erosion netting material may include single net straw blankets or coconut blankets. Permanent stabilization practices will include the use of a hydro-seeding over vegetative support soil where additional exposure threatens stormwater quality. Seeding will be carried out with a seed mixture equal to the "Roadside Slope Mix" included below. All siltation barriers will remain in place until all exposed areas are re-vegetated.

PLANTING SCHEDULE FOR EXPOSED AREAS

1. All exposed areas will receive 6 inches of topsoil or compost material.
2. Seed will be equal to "Roadside Slope Mix" as specified by the Mass. Highway Department. Please refer to chart below for specifications. This mixture will be spread at a rate of 5 pounds per 1,000 square feet.

TABLE 5.1
ROADSIDE SLOPE MIX

Common Name	Germination Proportion	Purity Minimum	Minimum
Creeping Red Fescue	50%	85%	95%
Kentucky 3	30%	85%	95%
Domestic Rye	10%	90%	98%
Red Top	5%	85%	92%
Ladino Clover	5%	85%	96%

5.2.3 Structural Practices

Perimeter controls will consist of compost silt socks. In order to ensure effective performance, proper installation is required. Wooden stakes, measuring 2” x 2”, will be positioned on the downhill side (away from the job Site) of the silt socks. The posts will be driven at least one foot into the ground.

If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the Site.

5.3 NON-STRUCTURAL CONTROLS

5.3.1 Good Housekeeping

Non-structural controls are as effective as structural controls in sediment control. Non-structural controls to be used at the construction Site include:

- Regular sweeping of paved surfaces; and
- Prompt cleanup of any waste or spilled waste materials.

5.3.2 Exposure Minimization

Exposure will be minimized by providing both permanent and temporary soil stabilization (see Section 5.2.2) over areas that have been completely constructed, or areas that will not be revisited within a 30-day period.

Where practicable, industrial materials and activities will be protected from exposure to rain, snow, snowmelt, or runoff.

5.3.3 Preventative Maintenance

A preventative maintenance program includes the timely inspection and maintenance of stormwater management devices. Examples of preventative maintenance include:

- Removal of obstructions, if any, from inlets and outlets.
- Removal of accumulated sediment and vacuuming water from sumps.
- Repairing and re-planting slope areas that experience erosion.

5.3.4 Inspections

An experienced Construction Monitor will conduct inspections of construction areas once every 7 calendar days and within 24 hours of the occurrence of a storm event of 0.25 inches or greater, or the occurrence of runoff from snowmelt sufficient to cause a discharge. Storm event information from a weather station representative of the Site's location may be used to determine if a storm event of 0.25 inches or greater has occurred on the Site. Total rainfall will be measured for any day of rainfall during normal business hours that measures 0.25 inches or greater. Construction areas an experienced Construction Monitor will inspect include:

- Disturbed areas of the construction Site that have not been finally stabilized,
- Areas used for storage of materials that are exposed to precipitation,
- Structural control measures,
- Locations where vehicles enter or exit the Site, and
- The stormwater management system and discharge outlets.

Disturbed areas and areas used for storage of materials that are exposed to precipitation will be inspected for evidence of, or the potential for, pollutants entering the drainage system.

Sediment and erosion control measures identified will be observed to ensure that they are operating correctly. The discharge locations or points will be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the Site will be inspected for evidence of offsite sediment tracking.

Based on the results of these routine inspections, the Contractor will correct any deficiencies found as soon as practicable. Results of the inspections, corrective actions taken in response to any deficiencies, and any opportunities for improvement that are identified will be documented in an inspection report.

5.4 OTHER CONTROLS

5.4.1 Waste Disposal

All waste materials will be disposed of offsite in accordance with all applicable local, State, and Federal regulations. No construction waste is to be buried on site. All personnel will be instructed regarding the correct procedure for waste disposal. The individual who manages the day-to-day site operations will be responsible for seeing that these procedures are followed.

5.4.2 Hazardous Waste

All hazardous waste materials will be disposed of in a manner specified by local, State, and Federal regulations and in accordance with any manufacturer's recommendations.

5.4.3 Sanitary Waste

All sanitary waste will be collected in portable units installed on site. The portable units will be cleaned and emptied by a qualified licensed contractor.

5.4.4 Concrete Waste

All concrete washings will be disposed on in a designated area away from wetlands and any property line. When the concrete hardens it be removed from the site.

5.5 POLLUTION AND SPILL PREVENTION

5.5.1 Materials

The following materials are anticipated to be present onsite during construction:

- General construction materials
- Asphalt/concrete
- Paint
- Petroleum-based products
- Cleaning solvents

5.5.2 Material Management Practices

Good Housekeeping Practices

- Store only enough materials needed for current construction activities.
- All materials that are stored outside will be stored in a neat, orderly manner, in the original containers.
- Materials will be kept in their original containers with manufacturer's labels.
- Whenever possible, all materials should be used before disposing the container.
- The site contractor shall be responsible for daily inspections to ensure proper handling and disposal of materials on site.

Product Specific Practices

Petroleum/Fertilizer Products:

- Refueling vehicles shall be DOT certified and shall contain SPCC Plans in place along with emergency equipment to contain and clean up spills.
- All on site construction vehicles shall be inspected for leaks and receive regular preventive maintenance to reduce the chance of leakage.
- Petroleum-based products will be stored in tightly sealed containers, which are properly marked.
- All fertilizers will be stored in a dry protected area and only used according to manufacturer’s recommendation.

Paints:

- All containers will be tightly sealed and stored when not required for use.
- All procedures will be followed to minimize spills and to keep products in the original containers.

Concrete Trucks:

- The site contractor is responsible for designating a safe area, away from abutting property and resource areas, for excess concrete disposal.

Product Specific Practices

In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup during construction:

- Manufacturer recommended methods for spill clean-up will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.
- All spills will be cleaned up immediately after discovery.
- In any case or threat of explosion or life threatening condition, all personnel shall evacuate the are to safety and then contact the local fire department for assistance.
- The spill area will be ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance.
- The site contractor shall be responsible for spill prevention and cleanup and will designate at least three personnel who will receive spill prevention and cleanup training. The names of the assigned three personnel will be posted in the material storage area in the field office on site.

5.6 RECORDKEEPING

The following records will be maintained on the Site:

1. Dates when major grading activities occur,
2. Dates when construction activities temporarily or permanently cease on a portion of the Site,
3. Dates when stabilization measures are initiated, and
4. In addition, the following records will also be kept:
    - The Order of Conditions; and any additional permit conditions/approvals,
    - All inspection reports, and
    - Any spill reports.

Table 5.2 - Construction BMPs Maintenance Log

Project Name:	New Bedford Hauling	Date:	1/4/2023
Project Location:	1228, 1200 & 1166 Shawmut Avenue, New Bedford	Prepared By:	KLP
Project Number:	324-365	Approved By:	KPS

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed (List Items if Required)	Date of Cleaning or Repair	Performed by
Pavement Sweeping	To be monitored as needed			Paved areas within the active construction site can be swept on a regular basis to remove larger sediment particles from construction activities. Pavement areas adjacent to the Site will be swept if dirt and debris is tracked from the active construction site.			
Catch Basin Inlet Protection (Silt Sack Sediment Trap)	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			Inspect for proper operation. If clogged, remove accumulated sediment and properly dispose of to maintain the capacity of the catch basin.			
Erosion Control Barrier (Straw Bales and Silt Fence)	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			Inspect for deterioration or failure. Remove sediment when buildup exceeds 6 inches or half the barrier height. The underside of straw bales should be kept in close contact with the earth and reset as necessary.			
Stabilized Construction Exit	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			The exit shall be maintained in a condition that will prevent tracking of sediment onto public rights-of-way. The contractor shall sweep or wash pavement at exits which have experienced mud-tracking onto the pavement or traveled way. When wheel washing is required, it shall be done on an area stabilized with aggregate that drains into an approved sediment trapping device. When the construction exit becomes ineffective, the stone shall be removed along with the collected soil material and redistributed on-site in a stable manner. The exit should then be reconstructed. All sediment shall be prevented from entering storm drains, ditches, or waterways.			

Stormwater Supervisor Contact Information: ____________________________

6.0 OPERATIONS AND MAINTENANCE (O&M) PLAN

6.1 GENERAL

Stormwater management systems with multiple components, such as the one proposed for the project, assures the cleanest possible discharges of stormwater to the environment. However, these systems must be routinely maintained to keep them in good working order. Additionally, this plan identifies potential sources of pollution that may affect the quality of stormwater discharges and describes the implementation of Long-Term Pollution Prevention practices to reduce potential pollutants in stormwater discharge. The party identified below will be responsible for the operation and maintenance of the stormwater management system and Site. Schedules and procedures for inspection and maintenance of the existing and proposed stormwater management system components are provided in the following sections.

Responsible Party for Plan Compliance:

Waste Connections
11400 Parkside Drive, Ste. 500
Knoxville, TN 37934

Contact: Matthew Crockett, P.E.
Phone: (865) 312-9514

Emergency Contact Information:
Civil & Environmental Consultants, Inc.
(774) 501-2176

Estimated O&M Budget
It is estimated that an annual budget of $3,000-$4,000 should be allocated to performing routine inspections and maintenance identified in this O&M Plan.

Upon a transfer of ownership, the future owner shall assume the responsibilities for compliance with this O&M Plan.

6.2 ROUTINE INSPECTIONS

Inspections of the stormwater management system as a whole, and of the individual components of the system, will be carried out on a routine basis in accordance with the schedule identified in Section 6.3. Components to be inspected include the catch basins and subsurface infiltration chambers. Each will be inspected for sediment buildup, presence of oil, color, and structural damage.

6.3 MAINTENANCE PLAN

The Responsible Party will incorporate a routine maintenance program to assure proper operation of the stormwater management system. The program will include the following maintenance activities:

Deep Sump and Hooded Catch Basins

- All catch basins shall be inspected a minimum of at least four times per year.
- Sediment, if more than two (2) feet deep, and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary.
- During cleanings, confirm the oil/debris trap (hood) is installed properly, is free of clogs, and is functional. Reinstall or replace as needed.
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Roof Drain Leaders

- Perform routine roof inspections twice per year, typically in the spring and fall.
- Inspect for blockage and remove debris if required.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.

Water Quality Units

- See the attached Manufacturer's instructions on operation and maintenance requirements and methodology.
- Inspect and clean twice per year or as required by manufacturer.
- Remove sediment and other trapped pollutants at the frequency or level specified by the manufacturer.

Infiltration Basins

- Inspect at least twice a year, after a 2-year storm event. After every significant storm event, inspect the high outlet orifice on the outlet control structure.
- During the first year, inspect the basin after each storm event greater than 1 inch and confirm that the basin is draining within 72 hours after the storm event.
- Mow grass as needed, but at least twice per year. Remove trash and clippings at least twice per year and re-seed eroded or barren areas.
- Remove accumulated sediment with light equipment, as necessary, when the floor of the basin is dry.
- Inspect pre-treatment devices at least twice per year. Inspect outlet control structures for signs of deterioration, confirm orifices are unblocked and free of debris.

Level Spreaders

- Inspect after the first several rainfall events and after any major storm events within the first year. After the first year, inspect regularly on an annual basis.
- Remove any sediment, trash, debris, leaves and grass clippings. Remove any tree seedlings before they become firmly established.
- Note and repair any erosion or low spots in the level spreader.

6.4 LONG TERM POLLUTION PREVENTION MAINTENANCE

The Responsible Party will incorporate a routine maintenance program to ensure the continued effectiveness of the structural water quality controls. Maintenance will be performed based on the results of inspections in accordance with the schedules identified below. The program will include the following maintenance activities:

Maintenance of Pavement Systems

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum asphalt pavement areas annually with a commercial cleaning unit and dispose of removed material.
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas: install appropriate erosion control measures when native soil is exposed, or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- Grass vegetation should not be cut to a height less than four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow-release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas but should not be applied on a regular basis unless necessary.

Management of Snow and Ice

Should significant snow fall events occur, which result in stockpiled snow impacting the operation of the Project Site, through the temporary loss of parking or limiting access in any way, the property manager may choose to have snow removed from the site. All snow removal operations will be done in accordance with Massachusetts DEP guidelines BRPG01-01, effective date March 8, 2001.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site-specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials.

6.5 EMPLOYEE TRAINING

Training of personnel is essential to achieving proper operation and maintenance of the stormwater management system. Therefore, those Facility personnel who are responsible for operation and maintenance will be trained on the following subjects:

- Environmental laws and regulations relating to stormwater,
- The components and goals of the current Erosion and Sediment Control Plan,
- Site specific permit conditions and requirements,
- General Facility spill response procedures,
- General good housekeeping procedures, and
- General material management procedures.

Refresher training sessions will be held once a year following the completion of the Site Compliance Evaluation.

6.6 RECORDKEEPING

Records of inspections and maintenance shall be up to date and available for review and inspection, if requested by the City's official.

Table 6.1 - Stormwater Operations and Maintenance Log

Project Name: New Bedford Hauling
Project Location: 1228, 1200 & 1166 Shawmut Avenue, New Bedford
Project Number: 324-365

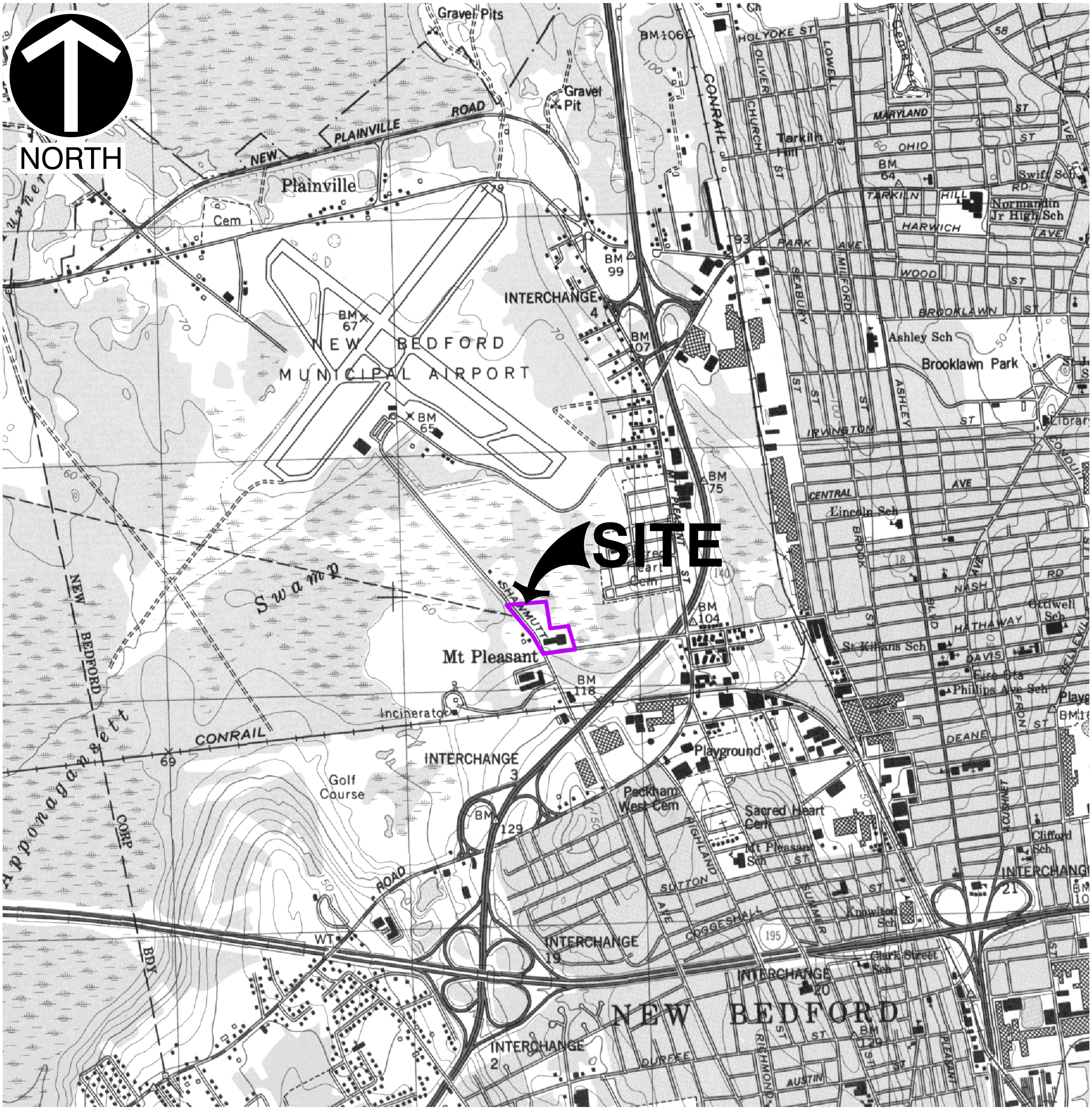
Date: 1/4/2023
Prepared By: KLP
Approved By: KPS

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed (List Items if Required)	Date of Cleaning or Repair	Performed by
Pavement Sweeping	Inspect quarterly.			Paved areas will be swept annually at a minumum, and as otherwise needed.			
Deep Sump and Hooded Catch Basins	Inspect four times per year. Clean four times per year, in the spring and fall, or whenever sediment buildup exceeds two (2) feet in depth.			Remove trash and deposits. During cleanings, confirm the oil/debris trap (hood) is installed properly, is free of clogs, and is functional. Reinstall or replace as needed. Take care not to damage the oil/debris trap (hood) during cleaning.			
Water Quality Structure	Inspect twice per year or as required by the manufacturer.			Clean twice per year or as required by the manufacturer. Remove sediment and other trapped pollutants at the frequency or level specified by the manufacturer. No use of clamshell buckets without prior approval. Increase inspection frequency, as needed, based on observed sediment loading.			
Roof Drain Leaders	Inspect twice per year, typically in the spring and fall.			Inspect for blockage and remove debris if required.			
Infiltration Basin	Inspect monthly for the first three months. Then, at a minimum, the treatment structure is to be inspected twice annually.			Remove sediment once per year or when buildup exceeds two (2) inches in depth.			
Level Spreader	Inspect after the first several rainfall events and after any major storm events within the first year. After the first year, inspect regularly on an annual basis.			Remove any sediment, trash, debris, leaves and grass clippings. Remove any tree seedlings before they become firmly established. Note and repair any erosion or low spots in the level spreader.			
Vegetated Areas	Inspect twice per year, typically in the spring and fall.			Perform maintenance on a regular basis during the growing season. Mow grassed areas on a regular basis to maintain growth. Plant alternative mixture of grass species in the event of unsuccessful establishment. Grass vegetation should not be cut to a height less than six inches. Maintain planted areas adjacent to pavement to prevent soil washout and immediately clean any soil deposited on pavement. Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming. Remove trash, sediment debris and invasive vegetation.			

Stormwater Supervisor Contact Information:____

FIGURES

Figure 1 – Site Locus
Figure 2 – Aerial Exhibit
Figure 3 – FEMA Firmette
Figure HYD-EX – Existing Conditions Drainage Area Map
Figure HYD-PR – Proposed Conditions Drainage Area Map



REFERENCE

1. U.S.G.S. 7.5' TOPOGRAPHIC MAP, Q245822, Q245826, Q249822, Q249826 QUADRANGLE, MA DATED: 1977, ACCESSED: NOVEMBER 2022 VIA https://maps.massgis.digital.mass.gov/MassMapper/MassMapper-Ashby.html

SCALE IN FEET

0 2000 4000

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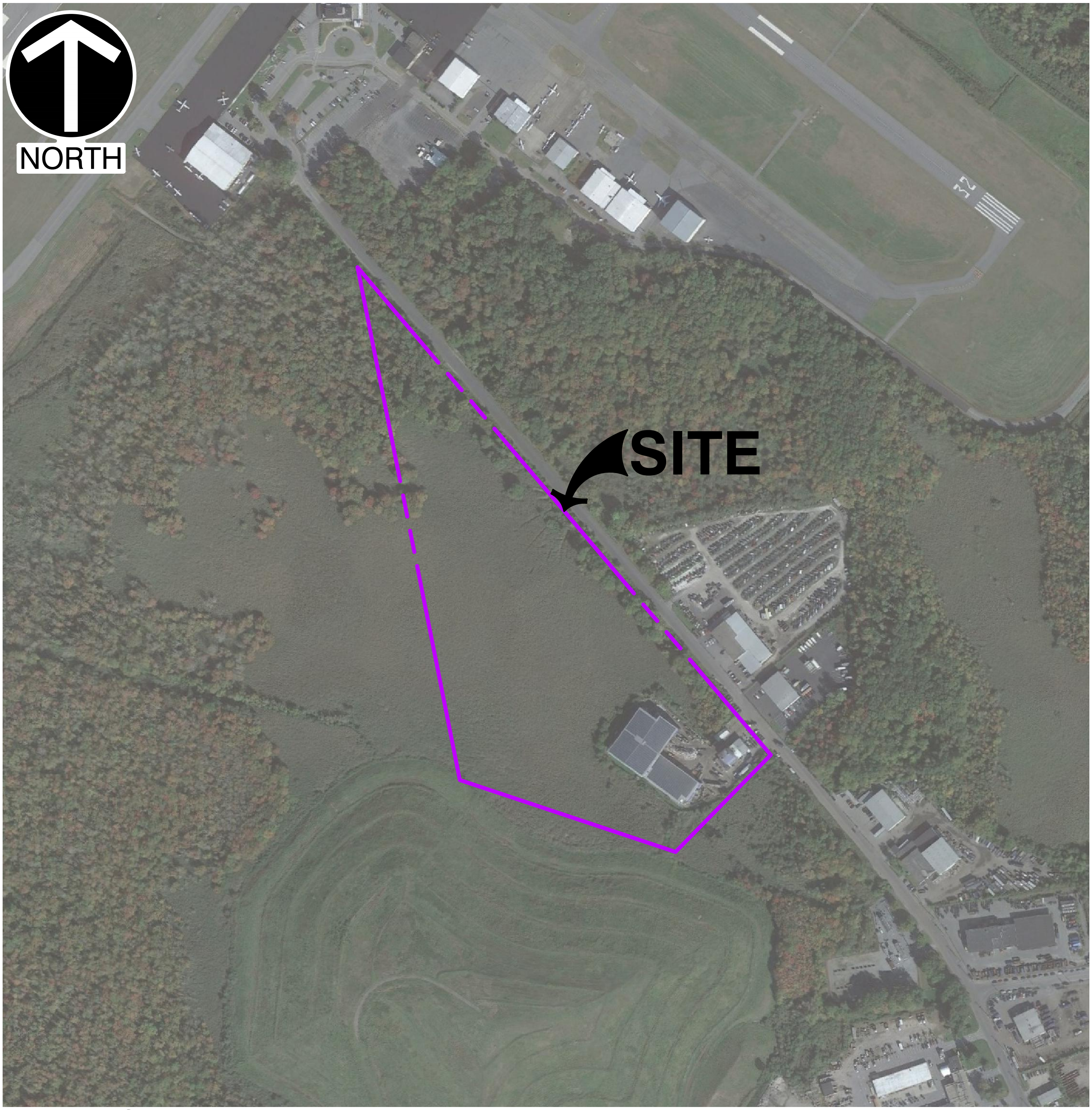
www.cecinc.com

WASTE CONNECTIONS
NEW BEDFORD HAULING
1228, 1200 & 1166 SHAWMUT AVENUE
NEW BEDFORD, MA 02746

SITE LOCUS MAP

DRAWN BY: KLP	CHECKED BY:	DRAFT	APPROVED BY:	DRAFT	FIGURE NO.:	
DATE: NOVEMBER 2022	DWG SCALE:	1"=2000'	PROJECT NO:	324-365		1

P:\320-000\324-363\-CADD\Dwg\SP01\NOI and Stormwater Report\324365-CV01-SP01-NOI Figures.dwg{1-1166} LS:(11/30/2022 - kpascua) - LP: 11/30/2022 3:50 PM



REFERENCE

1. ORTHOGRAPHIC AERIAL IMAGERY AND MAPS ARE BASED ON GIS DATA OBTAINED FROM MASSGIS PROVIDED BY THE BUREAU OF GEOGRAPHIC INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS, EXECUTIVE OFFICE OF TECHNOLOGY AND SECURITY SERVICES.

SCALE IN FEET

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WASTE CONNECTIONS
NEW BEDFORD HAULING
1245 SHAWMUT AVENUE
NEW BEDFORD, MA 02746

AERIAL MAP

DRAWN BY: KLP	CHECKED BY:	DRAFT	APPROVED BY:	DRAFT	FIGURE NO.:	2
DATE: NOVEMBER 2022	DWG SCALE:	1"=500'	PROJECT NO:	324-365		

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National Flood Hazard Layer FIRMette

FEMA

70°57'18"W 41°40'8"N

70°56'40"W 41°39'41"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS

- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD

- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS

- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES

- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES

- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/29/2022 at 1:44 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

NORTH

LEGEND

A	DESIGN POINT
A1–PR	SUBCATCHMENT AREA
P1	POND/DETENTION AREA
A	SOIL MAP UNIT/HYDROLOGIC SOIL GROUP
	SUBCATCHMENT BOUNDARY
	TIME OF CONCENTRATION PATH
	SOILS BOUNDARY
	PAVED AREA
	ROOF AREA
	WOODS AREA
	GRAVEL AREA

SCALE IN FEET

0 100 200

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WASTE CONNECTIONS
NEW BEDFORD HAULING
1228, 1200 & 1166 SHAWMUT AVENUE
NEW BEDFORD, MA

DRAINAGE AREA MAP
PRE-DEVELOPMENT

DRAWN BY: KLP	CHECKED BY: KPS	APPROVED BY: KPS	FIGURE NO.:
DATE: JANUARY 2023	DWG SCALE: 1"=100'	PROJECT NO: 324-363	HYD-EX

NORTH

LEGEND

DESIGN POINT

SUBCATCHMENT AREA

POND/DETENTION AREA

SOIL MAP UNIT/HYDROLOGIC SOIL GROUP

SUBCATCHMENT BOUNDARY

TIME OF CONCENTRATION PATH

SOILS BOUNDARY

PAVED AREA

ROOF AREA

WOODS AREA

WATER SURFACE

SCALE IN FEET

0 100 200

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WASTE CONNECTIONS
NEW BEDFORD HAULING
1228, 1200 & 1166 SHAWMUT AVENUE
NEW BEDFORD, MA

DRAINAGE AREA MAP
POST-DEVELOPMENT

DRAWN BY: KLP	CHECKED BY: KPS	APPROVED BY: KPS	FIGURE NO.: HYD-PR
DATE: JANUARY 2023	DWG SCALE: 1"=100'	PROJECT NO: 324-363	

P:\320-000\324-363\-CADD\Dwg\SP01\NOI and Stormwater Report\324363-CV01-HD1-Post-1166.dwg{LAYOUT1} LS:(1/4/2023 - kpascua) - LP: 1/4/2023 3:25 PM

APPENDIX A

DEP STORMWATER CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
KARLIS
SKULTE
CIVIL
No. 47703
REGISTERED
PROFESSIONAL ENGINEER

1/4/2022

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☐ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☒ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☐ Other (describe): ____________________

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☒ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☐ is near or to other critical areas

  ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☒ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☒ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☒ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☒ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☐ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX B

GEOTECHNICAL INFORMATION

NRCS Soil Resource Report
Geotechnical Report

NRCS Soil Resource Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Bristol County, Massachusetts, Southern Part

December 29, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:1,930 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Bristol County, Massachusetts, Southern Part
Survey Area Data: Version 16, Sep 9, 2022

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

Date(s) aerial images were photographed: Sep 26, 2020—Oct 15, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
51A	Swansea muck, 0 to 1 percent slopes	2.6	33.1%
602	Urban land	5.3	66.9%
Totals for Area of Interest		**8.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Bristol County, Massachusetts, Southern Part

51A—Swansea muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2trl2
Elevation: 0 to 1,140 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Swansea and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Swansea

Setting

Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material over loose sandy and gravelly glaciofluvial deposits

Typical profile

Oa1 - 0 to 24 inches: muck
Oa2 - 24 to 34 inches: muck
Cg - 34 to 79 inches: coarse sand

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 16.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Freetown

Percent of map unit: 10 percent
Landform: Bogs, swamps

Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

602—Urban land

Map Unit Setting

National map unit symbol: v5ry
Frost-free period: 120 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Excavated and filled land

Minor Components

Udorthents

Percent of map unit: 15 percent
Hydric soil rating: Unranked

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Geotechnical Report

Geotechnical Engineering Report

New Bedford Hauling Company Improvements
New Bedford, Massachusetts
September 22, 2022
Terracon Project No. J2225034

Prepared for:
The Cambridge Companies, Inc.
Griffith, Indiana

Prepared by:
Terracon Consultants, Inc.
Rocky Hill, Connecticut

September 22, 2022

Terracon GeoReport

The Cambridge Companies, Inc.
500 E Ridge Road, Suite 200
Griffith, IN 46319

Attn: Ms. Lisa Redmond – Contract Administrator
P: (219) 972-1155
E: lisa@cambridgecoinc.com

Re: Geotechnical Engineering Report
New Bedford Hauling Company Improvements
1166 & 1200 Shawmut Avenue
New Bedford, Massachusetts
Terracon Project No. J2225034

Dear Ms. Redmond:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJ2225034 dated June 10, 2022. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Marc A. Gullison, P.E. (NH)
Project Engineer (NH)

Michael A. Ciance, P.E.
Principal / Office Manager (NH)

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report
New Bedford Hauling Company Improvements
1166 & 1200 Shawmut Avenue
New Bedford, Massachusetts
Terracon Project No. J2225034
September 22, 2022

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed site improvements to be located at 1166 & 1200 Shawmut Avenue in New Bedford, Massachusetts. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Excavation considerations
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Exterior slab design and construction
- Seismic site classification per MSBC
- Pavement design and construction
- Frost considerations

The geotechnical field Scope of Services for this project included the advancement of 33 test borings to depths ranging from approximately 7 to 22 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The boring logs and laboratory testing are included in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available topographic maps.

Item	Description
Parcel Information	The project is located at 1166 & 1200 Shawmut Avenue in New Bedford, Massachusetts. The site is located at the approximate coordinates of 41.6654° N, 70.9500° W. See **Site Location**.

Item	Description
Existing Improvements	The site is currently an operations facility for ABC Disposal Service, a Waste Connections company and split into two lots. The southern lot (1166 Shawmut Avenue) includes a two-story office building with an approximately 12,800 square feet (sf) first floor footprint and 7,700 sf second floor. There is an approximately 14,900 sf open-air canopy at the east end of the office building. The area surrounding the building and canopy is mostly paved and generally used as storage for garbage disposal containers. The northern lot (1200 Shawmut Avenue) includes an approximately 24,000 sf transfer station warehouse. The area surrounding the building is mostly bare ground and generally used as storage for garbage disposal containers.
Current Ground Cover	Both asphalt pavement and bare ground.
Existing Topography (from USGS Topographic Map)	The site is relatively level with elevations (El.) varying between approximately El. 65 and El. 70 feet.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Cambridge Companies provided the following information: ■ “Geotechnical Evaluation Request for Proposal”, prepared by Cambridge Companies, Inc., dated May 31, 2022 ■ “Preliminary Site Plan”, prepared by Cambridge Companies, Inc., last dated April 13, 2022
Project Description	The project includes the renovation of the existing 20,500 sf office building and replacement of the existing canopy with an approximately 18,000 sf 10-bay shop and drive-thru wash bay. The existing northern transfer station warehouse will be demolished for proposed parking areas. The remaining site development will include a 148 car parking spaces, 118 route truck parking spaces, and a fuel station. A potential stormwater basin may also be considered at the north end of the properties.
Pavements	Both rigid (Portland cement concrete) and flexible (asphalt) pavement sections are planned for the site. Design traffic volumes and/or pavement details were not available at the time of this report.

GEOTECHNICAL CHARACTERIZATION

Subsurface Conditions

In existing paved areas, the test borings generally encountered 2 to 5 inches of asphalt pavement; otherwise, the ground surface was bare ground. Existing fill was observed to depths ranging between 2 feet and 7 feet below existing ground surface. Borings B-24 and B-26 did not encounter fill. Existing fill generally consisted of brown to gray sand with varying amounts of silt and gravel and occasionally included asphalt and brick fragments.

Throughout most of the site, a layer of dark brown to black organic silt deposits was observed beneath the existing fill, ranging in thickness from approximately 0.5 feet and 3.5 feet. The native deposits beneath the organic deposits consisted of brown to gray sand with varying amounts of silt and gravel and occasional cobbles. Groundwater was observed during drilling operations at depths ranging between approximately 4 and 10 feet below existing ground surface.

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Surface Material**	Bituminous concrete / aggregate base course
2	**Fill**	Sand with varying amounts of silt and gravel, occasional cobbles, asphalt and brick fragments, brown to gray
3	**Organic Deposits**	Organic silt, with roots and wood fibers, organic odor, dark brown to black, very soft to medium stiff
4	**Glacial Deposits**	Silty sand to poorly graded sand, with varying amounts of gravel, occasional cobbles, brown to gray, medium dense to very dense

Groundwater Conditions

The borings were observed while drilling for the presence and level of groundwater. Groundwater was observed during drilling operations at depths ranging between approximately 4 and 10 feet below existing ground surface. Groundwater depths upon completion of each test boring varied between 5.8 and 14.4 feet. The water levels observed in the borings can be found on the individual boring logs in the **Exploration Results** section.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the boring was performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (ppm)	Soluble Chloride (ppm)	Electrical Resistivity (Ω-cm)	pH
P-2	0 to 4	Poorly graded sand with silt	5	22	22,000	8.22
P-21	0 to 4	Silty sand with gravel	10	23	14,000	6.73

Results of water-soluble sulfate testing indicate samples of the on-site soils tested have an exposure class of S0 when classified in accordance with Table 19.3.1.1 of the American Concrete Institute of Concrete (ACI) Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

These test results are provided to assist in determining the type and degree of corrosion protection that may be required. For protection against corrosion to buried metals, Terracon recommends that an experienced corrosion engineer be retained to design a suitable corrosion protection system for underground metal structures or components.

GEOTECHNICAL OVERVIEW

The site appears suitable for the proposed development based upon the geotechnical conditions encountered in the borings provided the recommendations in this report are implemented during design and construction.

The proposed 10-bay shop and drive-thru wash bay will be constructed within the footprint of an existing canopy which will need to be demolished, as well as exterior sidewalks, pavements, and utilities. We recommend existing foundations, slabs, and utilities be removed from within the proposed structure footprint and at least 5 feet beyond the outer edge of foundations. Additional demolition considerations are provided in the **Earthwork** section.

As noted in the **Geotechnical Characterization** section, borings encountered existing fill to depths ranging from about 2.0 to 7.0 feet below existing ground surface. Furthermore, organic deposits were encountered beneath the existing fill at numerous boring locations to depths ranging from about 5.0 to 7.7 feet. Supporting new foundations and the floor slab on existing unimproved fill and organic deposits may cause structures to settle beyond tolerable limits. Consequently, we recommend complete excavation and removal of the existing undocumented fill and organic deposits and replacement with controlled compacted lifts of Structural Fill within the building footprint and foundation bearing zone to mitigate the risk of post-construction settlement. The foundation bearing zone is defined as the area beneath 1 horizontal to 1 vertical (1H:1V) lines extending downward and outward from footing edges.

Although not discussed further herein, consideration could be given to using helical piers to transfer structural loads to the deeper, suitable native deposits or using ground improvements such as aggregate piers (APs) to strengthen the fill and organic deposits and eliminate the need for over-excavation/replacement efforts. These alternatives are expected to be more costly than conventional over-excavation and replacement methods given the need for structural slabs and grade beams for helical piers and the relatively small building footprint for APs. However, if the fill is environmentally impacted such that premium costs are required to properly handle and dispose of impacted soil, then helical piers or APs may be a viable value-engineered alternative to conventional over-excavation and replacement.

Groundwater was generally encountered between 4.0 and 14.4 feet below existing grades within the proposed building footprint. Depending on the time of year, the groundwater table could affect over-excavation efforts. If dewatering becomes necessary, a temporary dewatering system could be used to achieve the recommended depth of over-excavation. Dewatering considerations are provided in the **Earthwork** section.

The near surface soil could become unstable with typical earthwork and construction traffic, especially after precipitation events, due to the elevated percentage of fines. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, excavations and grading should be performed during the warmer and drier times of the year (typically May to October). If grading is performed during the winter months (typically November to April), an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Shallow Foundations** section addresses support of the building bearing on a minimum 12 inches of compacted Structural Fill over proof-rolled native inorganic glacial sand deposits. The **Floor and Exterior Slabs** section addresses slab-on-grade support on a minimum 12 inches of compacted floor slab base course over proof-rolled native inorganic glacial sand deposits.

Ancillary structures are expected to be supported on exterior slabs on grade. Given the relatively lightly loaded slabs and the anticipated depth of over-excavation on the order of 8 feet below existing ground surface to completely remove the existing fill and organic deposits, exterior slabs may bear on a thickened slab base course placed above proof-rolled existing fill. However, as discussed below, there is an inherent risk for the owner that ancillary structures may settle beyond tolerable limits. If this risk is not acceptable, consideration should be given to complete over-excavation of the existing fill and organic deposits, improving the unsuitable material with aggregate piers, or supporting the ancillary structures/exterior slabs on helical piers. Recommendations for supporting ancillary structures on exterior slabs on grade are presented in the **Floor and Exterior Slabs** section.

Recommendations for flexible and rigid pavement systems are presented in the **Pavements** section. Support of exterior slabs and pavements on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill and organic deposits (where encountered) but can be reduced by following the recommendations contained in this report. To take advantage of the cost benefit of not removing the entire amount of undocumented fill and organic deposits, the owner must be willing to accept the risk associated with constructing exterior slabs and pavements over the undocumented fill and organic deposits following the recommended reworking of the material.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, removal of existing pavement, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, slabs, and pavements.

Demolition

The proposed 10-bay shop and drive-thru wash bay will be constructed within the footprint of an existing canopy which will need to be demolished, as well as exterior sidewalks, pavements, and utilities. We recommend existing foundations, slabs, and utilities be removed from within the proposed building and structure footprints and at least 5 feet beyond the outer edge of foundations.

For areas outside the proposed structure footprints and foundation bearing zones, existing foundations, floor slabs, and utilities should be removed where they conflict with proposed utilities and pavements. In such cases, existing foundations, floor slabs, and utilities should be removed to a depth of at least 2 feet below the affected utility or design pavement subgrade elevation.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas. Existing pavements and underground utilities (if present) should be removed from the proposed building footprint and be properly disposed off-site. Stripped topsoil may be stockpiled for reuse on-site within planned landscaping areas, or properly disposed off-site.

Subgrade Preparation

As noted in the **Geotechnical Characterization** section, borings encountered existing fill to depths ranging from about 2.0 to 7.0 feet below existing ground surface. Furthermore, organic deposits were encountered beneath the existing fill at numerous boring locations to depths ranging from about 5.0 to 7.7 feet. Supporting new foundations and the floor slab on existing unimproved fill and organic deposits may cause structures to settle beyond tolerable limits. Consequently, we recommend complete over-excavation and removal of the existing undocumented fill and organic deposits and replacement with controlled compacted lifts of Structural Fill within the building footprint and foundation bearing zones to mitigate the risk of post-construction settlement. Based on the results of the field exploration, over-excavations on the order of 2.0 to 4.0 feet below anticipated foundation bearing elevation (exterior footings) is expected; however, deeper fill and organic material could be encountered.

Ancillary structures are expected to be supported on exterior slabs on grade. Given the relatively lightly loaded slabs and depth of over-excavation on the order of 8 feet required to completely remove the existing fill and organic deposits, exterior slabs may bear on a thickened slab base course placed above proof-rolled existing fill.

Support of exterior slabs and pavements on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. The owner must be willing to accept the risk associated with constructing pavements over the undocumented fill to take advantage of the cost benefit associated with keeping undocumented fill in place.

If the owner elects to construct exterior slabs or pavements over the existing fill, the following protocol should be followed. Once the planned subgrade elevation has been reached the entire slab subgrade and/or pavement area should be proof-rolled (see following paragraph). Areas of soft or otherwise unsuitable material should be undercut and replaced with compacted General Fill or Structural Fill, depending on the intended use and location of the fill placement.

Following excavation to design subgrade elevation and before placing new fill, subgrades should be proof-rolled with at least six passes in perpendicular directions using a minimum 10-ton vibratory roller in open areas; or a minimum 1-ton self-propelled vibratory roller or large vibratory plate compactor in areas not accessible by a large vibratory roller.

Proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Soft or unstable areas should be over-excavated to more competent material and replaced with compacted Structural Fill or General Fill depending on the location of the fill placement. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted. Although not anticipated, if proof-rolling is required within deeper excavations near the groundwater table, proof-rolling may need to be accomplished statically (no vibration) to reduce the potential for disturbing the subgrade.

Fill Material Types

The following section presents material property requirements and suitable placement locations for various types of fill. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Reuse of On-site Soil: Excavated organic deposits are not suitable for reuse and should be properly disposed off-site. Excavated granular fill and/or native sand deposits may be selectively reused as raise-in-grade fill (General Fill) within pavement and landscaping areas. These materials are not suitable for reuse as Structural Fill and should not be placed beneath settlement sensitive structures and within foundation bearing zones. Portions of the fill and native sand have an elevated fines content and will be sensitive to moisture conditions (particularly during seasonally wet periods) and may not be suitable for reuse when above optimum moisture content. On-site soil may be used as General Fill provided it has the following properties:

- Free of deleterious materials
- A maximum particle size equal to the lesser of 6 inches or 2/3 of the lift thickness
- A suitable moisture content allowing for effective compaction
- Compactive efforts yield a firm and stable surface

Imported Fill Materials: Imported fill materials should meet the material property requirements in the following table.

Fill Type	Massachusetts Department of Transportation (MassDOT) Item	Acceptable Location for Placement
General Fill	M1.02.0 – Special Borrow	General raise-in-grade fill within pavement and landscaping areas. General Fill should not be placed beneath settlement sensitive structures and within foundation bearing zones.
Structural Fill	M1.03.0 – Gravel Borrow Type B	Beneath foundations, within foundation bearing zones, and as backfill within 5 feet of exterior foundation walls. Structural Fill should also be used as raise-in-grade fill to achieve subgrade elevations beneath floor slabs and settlement sensitive structures.
Crushed Stone [1]	M2.01.4 – ¾-inch Crushed Stone	Backfill of underdrains and over wet subgrades as needed. Crushed Stone may be substituted for Structural Fill when approved by the Geotechnical Engineer.
Non-Frost Susceptible Fill [2]	M1.03.1 – Processed Gravel for Subbase (Modified per Note 2) or M2.01.4 – ¾-inch Crushed Stone	Below exterior slabs, sidewalks, pavements, or other ancillary structures where frost heave may be a concern.
Pavement Base Course	M2.01.7 – Dense Graded Crushed Stone for Sub-base	Below floor slabs or pavements as aggregate base course.
Pavement Sub-base Course	M1.03.1 – Processed Gravel for Subbase	Below pavement areas as sub-base course below aggregate base course.

1. Crushed Stone should be separated from soil subgrades, excavation sidewalls, and backfill using a non-woven geotextile (such as Mirafi 140N or similar).
2. Non-Frost Susceptible (NFS) Fill should contain less than 5 percent material passing No. 200 sieve size.

Fill Compaction Requirements

Fill materials should meet the following compaction requirements.

Item	Description
Maximum Lift Thickness	*Vibratory Rollers:* 12 inches or less in loose thickness *Plate Compactors:* 6 inches or less in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used

Item	Description
Minimum Compaction Requirements [1, 2]	*General Fill:* At least 92% of the material's maximum dry density *Structural Fill:* At least 95% of the material's maximum dry density *Crushed Stone:* Compacted to a non-yielding state using at least six (6) passes of a vibratory roller or large vibratory plate compactor
Water Content Range [1]	±3% of optimum water content

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D1557, Method C).
2. We recommend testing fill for moisture content and compaction during placement. If the results of in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested, as required, until the specified moisture and compaction requirements are achieved.

Utility Trench Backfill

Trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Trenches should be backfilled with material that approximately matches the permeability characteristics of the surrounding soil. Fill placed as backfill for utilities located below slabs should consist of compacted Structural Fill or suitable bedding material approved by the utility designer.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge into the site drainage system.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect over-excavation efforts. If dewatering becomes necessary, a temporary dewatering system could be used to achieve the recommended depth of over-excavation. To maintain stable excavation subgrades and facilitate proper compaction of Structural Fill, temporary dewatering efforts should lower the groundwater table at least 2 feet below the bottom of excavation. Dewatering is a means and methods consideration for the contractor.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of demolition debris, vegetation, topsoil, pavement, unsuitable fill, and organic deposits. Foundation excavations and subgrade preparation should also be observed by the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should be notified to evaluate the need for supplemental mitigation recommendations.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in the **Earthwork** section, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1]	4,000 psf
Required Bearing Stratum [2, 3]	Minimum 12 inches of compacted Structural Fill and/or Crushed Stone over proof-rolled native glacial sand deposits (following over-excavation of existing fill and organic deposits)
Minimum Foundation Dimensions	Columns: 30 inches Continuous: 18 inches
Ultimate Passive Resistance [4] **(Equivalent Fluid Pressures)**	390 pcf (Structural Fill)
Ultimate Coefficient of Sliding Friction [5]	0.45 (Cast-in-Place Concrete on Structural Fill)
Minimum Embedment below Finished Grade [6]	Exterior footings in unheated areas: 48 inches Interior footings in unheated areas: 48 inches Interior footings in heated areas: 18 inches
Estimated Total Settlement from Structural Loads	Less than about 1 inch
Estimated Differential Settlement [7]	About 1/2 of total settlement

Item	Description

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. Values assume that exterior grades are no steeper than 2H:1V next to the structure.
2. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork** section.
3. Crushed Stone should be separated from soil subgrades, excavation sidewalls, and backfill using a non-woven geotextile (such as Mirafi 140N or similar).
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed, and compacted Structural Fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure. Interior footings in heated areas may be seated at the 18-inch depth if allowed by local building codes.
7. Differential settlements are as measured over a span of 40 feet.

Construction Adjacent to Existing Building

Differential settlement between the building addition and the existing building is expected to approach the magnitude of the total settlement of the new addition. Expansion joints and flexible structural connections should be provided between the existing building and the proposed addition to accommodate differential movements between the two structures. Underground piping between the two structures should be designed with flexible couplings and utility knockouts in foundation walls should be oversized, so minor deflections in alignment do not result in breakage or distress.

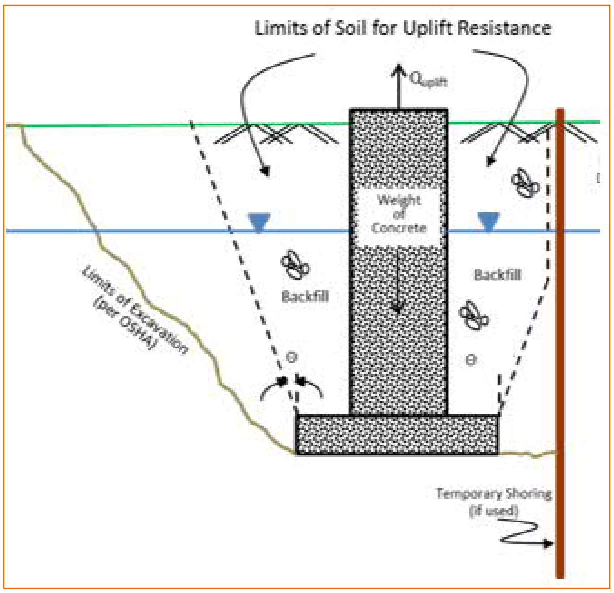
Care should be taken during excavation adjacent to existing foundations, to avoid disturbing existing foundation bearing soils. Over-excavation efforts should not extend into the foundation bearing zone of existing foundations. If unsuitable soils are observed within the existing foundation bearing zones, then underpinning may be warranted.

New foundations should bear at or near the bearing elevation of immediately adjacent existing foundations to avoid over-stressing existing foundations and to avoid the need for underpinning existing foundations. Depending upon their locations and current loads on the existing foundations, footings for the new addition could cause settlement of adjacent walls. To reduce this concern and risk, clear distances at least equal to the new footing widths should be maintained between the addition's footings and footings supporting the existing building.

If foundations for the existing building will support loads from the addition, the structural capacity of existing foundations should be evaluated by a licensed structural engineer, where increases in loading are planned.

Design Parameters - Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ, of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 120 pcf should be used for the backfill. This unit weight should be reduced to 57.6 pcf for portions of the backfill or natural soils below the groundwater elevation.



Foundation Construction Considerations

As noted in the **Earthwork** section, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before placing foundation concrete.

If unsuitable material is encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils. The over-excavation should be backfilled up to the foundation subgrade elevation with Structural Fill placed as recommended in the **Earthwork** section.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the Massachusetts State Building Code (MSBC), which references the International Building Code (IBC).

Based on the soil properties encountered at the site and standard penetration resistance values as described on the exploration logs, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 22 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

FLOOR AND EXTERIOR SLABS

Design parameters for floor and exterior slabs assume the requirements in the **Earthwork** section have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath slabs.

Slab Design Parameters

Item	Description
Floor Slab Support [1, 2]	Minimum 12 inches of compacted Floor Slab Base Course over proof-rolled native inorganic soil (following over-excavation of existing fill and organic deposits)
Exterior Slab Support [2]	Minimum 24-inch-thick layer of Floor Slab Base Course or Crushed Stone placed on a proof-rolled existing granular fill subgrade
Estimated Modulus of Subgrade Reaction, k [3]	150 pounds per square inch per inch (psi/in) for point loads
Modulus Correction Factor, K_c [3]	$K_c = k\left(\frac{b+1}{2b}\right)^2$

1. Floor slabs should be structurally independent of building foundations or walls to reduce the possibility of floor slab distress caused by differential movements between the slab and foundation.
2. Other design considerations such as cold temperatures and condensation development could warrant a different base course material.

Item	Description
3.	Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in the **Earthwork** section, and the floor slab support as noted in this table. It is provided for point loads. It is common to reduce the k-value to account for dimensional effects of large, loaded areas using the modulus correction factor provided, where K_c is the corrected or design modulus value and b is the mat width (short dimension) or tributary loaded area. The native soil at subgrade is expected to develop a subgrade modulus value of 150 psi/in when combined with the base course. Soft or unstable subgrade will be remediated by scarifying and re-compacting or by over-excavation and replacement.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of control joints, appropriate reinforcing, or other means.

Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of the slabs, the affected material should be removed, and compacted Structural Fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the slab support course.

The Geotechnical Engineer should approve the condition of the slab subgrades immediately prior to placement of the slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in the **Project Description** section and in the following sections. A critical aspect of pavement performance is site preparation. Specific attention should be given to subgrade preparation if the owner elects to construct pavements over existing fill. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Flexible Pavement Design Recommendations

Flexible pavement designs were based on "AASHTO Guide for Design of Pavement Structures (1993)". The thickness of each course is a function of subgrade strength, traffic, design life, serviceability factors, and frost susceptibility. Anticipated traffic volumes have not been provided at this time. For design purposes, we assumed traffic volumes and other design parameters based on our experience with similar projects. Our pavement section design was based on the following assumptions:

- Design Equivalent Single Axle Loads (ESALs): 1,000,000
- A subgrade California Bearing Ratio (CBR) of 5
- Soil drainage characterization of "fair", based on the encountered subsurface conditions
- Pavement design life of 20 years

The following table provides minimum thicknesses for flexible bituminous concrete pavements:

Layer [1]	Thickness (inches)
Asphalt Surface Course	2.0
Asphalt Binder Course	3.0
Aggregate Base Course	10.0
Aggregate Sub-base Course	12.0
Total Thickness	27.0

1. All materials should meet the current Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highways and Bridges, as list listed below for asphaltic materials. Base and sub-base course materials are listed in the **Earthwork** section.
   - Asphalt Top Course - MassDOT M3.11.0 Surface Course SSC - 12.5
   - Asphalt Binder Course - MassDOT M3.11.0 Intermediate Course SIC - 19.0

Dishing in parking lots surfaced with ACC is usually observed in frequently-used parking stalls (such as near the front of buildings) and occurs under the wheel footprint in these stalls. The use of higher-grade asphaltic cement, or surfacing these areas with PCC, should be considered. The dishing is exacerbated by factors such as irrigated islands or planter areas, and sheet surface drainage to the front of structures.

Rigid Pavement Design Recommendations

Design of Portland cement concrete (PCC) pavements are based upon “AASHTO Guide for Design of Pavement Structures (1993)”. A modulus of subgrade reaction of 150 pci was used for the PCC pavement designs. PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with ACI 330 and ACI 325. PCC pavements should be provided with mechanically reinforced joints (doweled or keyed) in accordance with ACI 330.

The following table provides minimum thicknesses for rigid Portland cement concrete pavements:

Layer [1]	Thickness (inches)
Portland Cement Concrete	8.0
Aggregate Base	8.0
Total Thickness	16.0

1. All materials should meet the current Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highways and Bridges. Portland Cement concrete pavements should meet the specifications for MassDOT M4, using a 28-day compressive strength of 4,000 psi and ¾-inch coarse aggregate. The base course material is listed in the **Earthwork** section.

Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e., concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles. A maintenance program including surface sealing, joint cleaning and sealing, and timely repair of cracks and deteriorated areas will increase the pavement’s service life. As an option, thicker sections could be constructed to decrease future maintenance.

Proper joint spacing will be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and doweled where necessary for load transfer.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its “green” state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, requiring further repairs.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

FROST CONSIDERATIONS

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade, sidewalks, and pavements. Exterior slabs and pavements should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of Non-Frost Susceptible (NFS) Fill. Placement of NFS Fill in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site storm drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs, and pavements, and connect them to the storm drainage system.
- Grade subgrades, so groundwater potentially perched in overlying more permeable subgrades, such as sand or aggregate base, slope toward a site drainage system.
- Place NFS Fill as backfill beneath sidewalks, slabs, and pavements critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS Fill and other soils.

As an alternative to extending NFS Fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS Fill.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

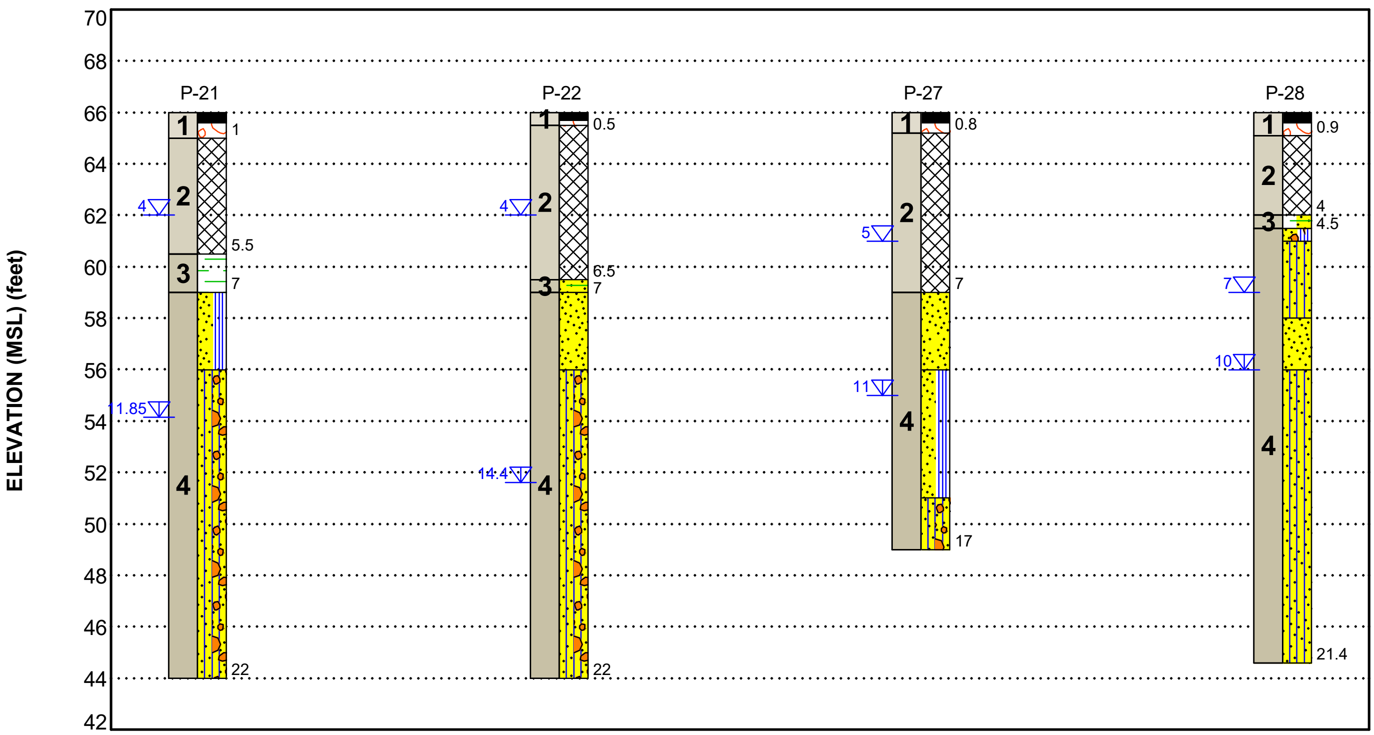
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

Contents:

GEOMODEL - BUILDING

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts
Terracon Project No. J2225034



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surface Material**	Bituminous concrete / aggregate base course
2	**Fill**	Sand with varying amounts of silt and gravel, occasional cobbles, asphalt and brick fragments, brown to gray
3	**Organic Deposits**	Organic silt, with roots and wood fibers, organic odor, dark brown to black, very soft to medium stiff
4	**Glacial Deposits**	Silty sand to poorly graded sand, with varying amounts of gravel, occasional cobbles, brown to gray, medium dense to very dense

LEGEND

- Asphalt
- Aggregate Base Course
- Fill
- Organic Silt
- Poorly-graded Sand with Silt
- Silty Sand with Gravel
- Sandy Organic Lean Clay
- Poorly-graded Sand
- Organic Silt with Sand
- Poorly-graded Sand with Silt and Gravel
- Silty Sand

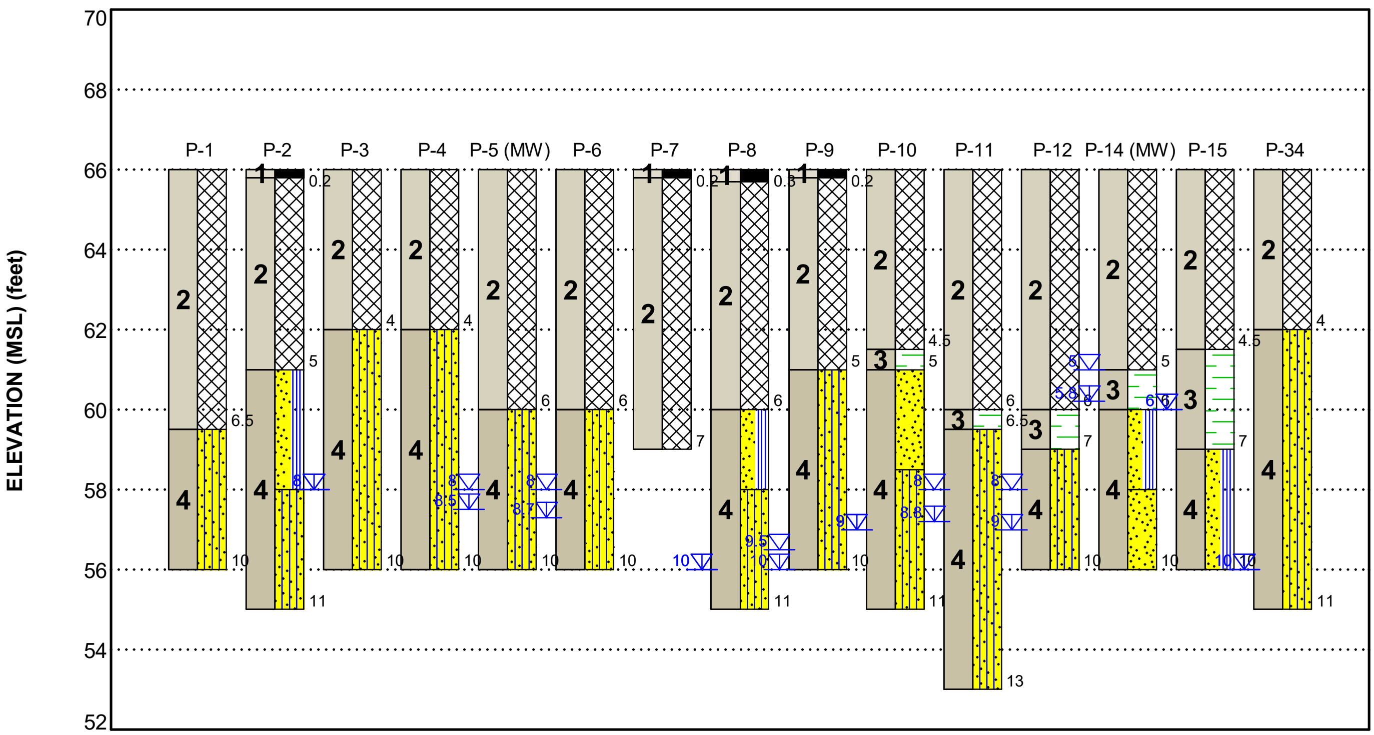
- First Water Observation
- Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

GEOMODEL - NORTHERN LOT

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts
Terracon Project No. J2225034



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surface Material**	Bituminous concrete / aggregate base course
2	**Fill**	Sand with varying amounts of silt and gravel, occasional cobbles, asphalt and brick fragments, brown to gray
3	**Organic Deposits**	Organic silt, with roots and wood fibers, organic odor, dark brown to black, very soft to medium stiff
4	**Glacial Deposits**	Silty sand to poorly graded sand, with varying amounts of gravel, occasional cobbles, brown to gray, medium dense to very dense

LEGEND

Fill
Silty Sand
Asphalt
Poorly-graded Sand with Silt
Organic Silt
Poorly-graded Sand

First Water Observation
Second Water Observation

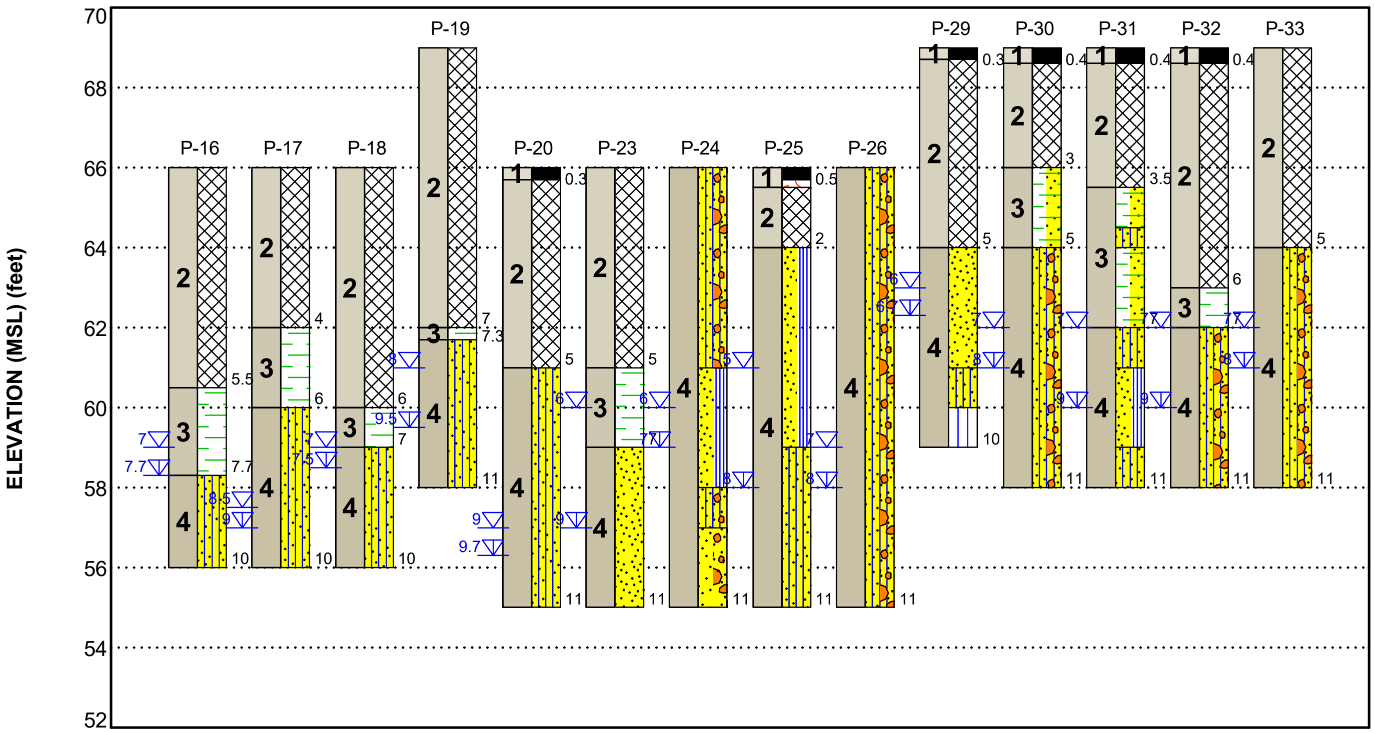
Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

GEOMODEL - SOUTHERN LOT

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts
Terracon Project No. J2225034

Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surface Material**	Bituminous concrete / aggregate base course
2	**Fill**	Sand with varying amounts of silt and gravel, occasional cobbles, asphalt and brick fragments, brown to gray
3	**Organic Deposits**	Organic silt, with roots and wood fibers, organic odor, dark brown to black, very soft to medium stiff
4	**Glacial Deposits**	Silty sand to poorly graded sand, with varying amounts of gravel, occasional cobbles, brown to gray, medium dense to very dense

LEGEND

- Fill
- Asphalt
- Poorly-graded Sand with Silt
- Silt
- Organic Silt
- Poorly-graded Sand
- Poorly-graded Sand with Gravel
- Organic Silt with Sand
- Silty Sand
- Silty Sand with Gravel
- Aggregate Base Course

- First Water Observation
- Second Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Location
4	17 to 22	Proposed building addition
29	7 to 11	Proposed pavement areas

Boring Layout and Elevations: Unless otherwise noted, Cambridge Companies personnel provided the boring layout. Test boring P-13 was removed from the drilling program by Cambridge Companies because it was not located within site boundaries. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from public topographic maps. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted rotary drill rig using continuous flight hollow stem flight augers. At the building borings, four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. At the pavement borings, five samples were obtained continuously to 10 or 11 feet, unless noted otherwise. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels while drilling and sampling. For safety purposes, borings were backfilled with soil cuttings upon completion. Pavements were patched with cold-mix asphalt.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered while drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Monitoring Wells: At the request of the civil engineer at Civil & Environmental Consultants, Inc., two monitoring wells were installed during our field program to support future stormwater basin necessities. The wells were installed at test borings P-5 and P-14 to depths of 10 feet below current site grades. Refer to the individual boring logs for well installation information.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM C136 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2974 Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
- ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D1883 Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
- ASTM G51 Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing
- ASTM C1580 Standard Test Method for Water-Soluble Sulfate in Soil
- ASTM D512 Standard Test Methods for Chloride Ion in Water
- ASTM G200 Standard Test Method for Measurement of Oxidation-Reduction Potential (ORP) of Soil
- ASTM G57 Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

The laboratory testing program included examination of soil samples by an engineer. Based on the material’s texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System, as shown in the **Supporting Information** section.

PHOTOGRAPHY LOG

Figure 1: Utility mark-out

Figure 2: Example of backfilled borehole

Figure 3: Drill rig setup at P-22

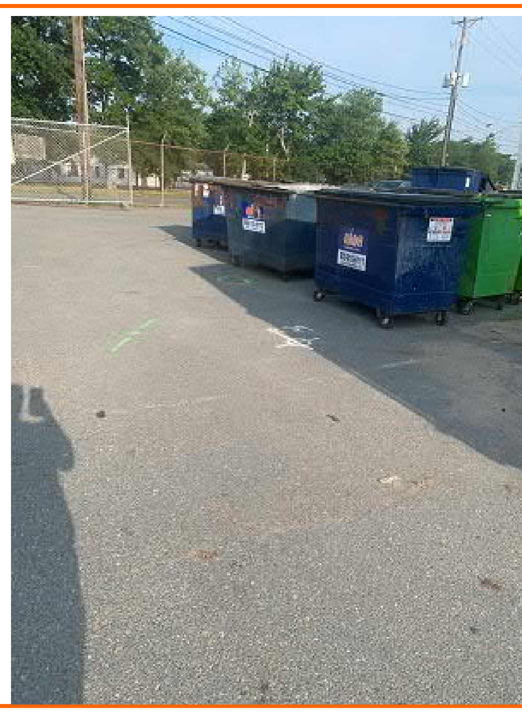


Figure 4: Utility mark-out near P-29

Figure 5: Installed monitoring well

Figure 6: Drill rig setup at P-33

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts
September 22, 2022 ■ Terracon Project No. J2225034

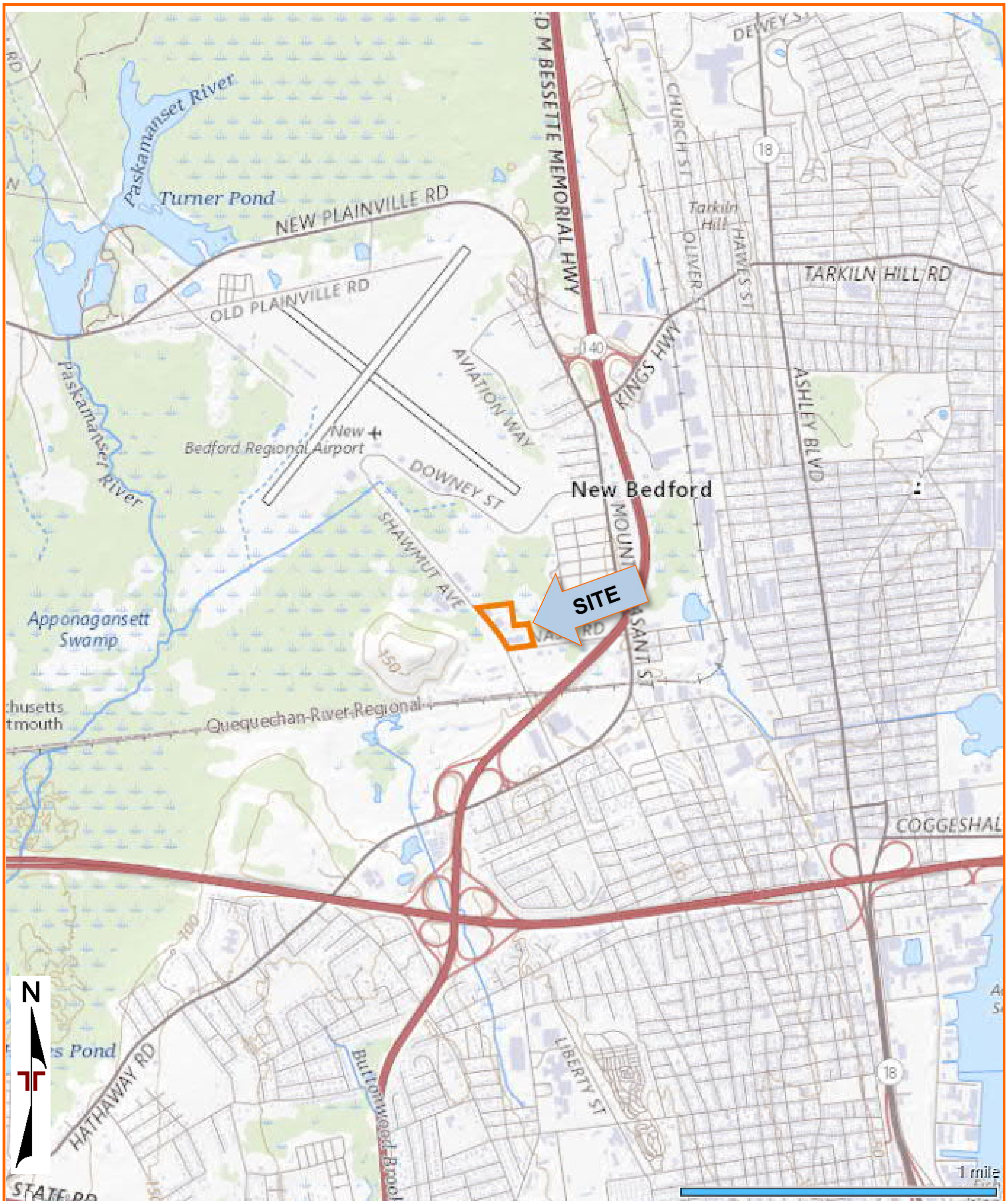


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP COURTESY OF THE U.S. GEOLOGIC SURVEY

EXPLORATION PLAN WITH AERIAL IMAGE

New Bedford Hauling Company Improvements ▪ New Bedford, Massachusetts

September 22, 2022 ▪ Terracon Project No. J2225034

Terracon GeoReport

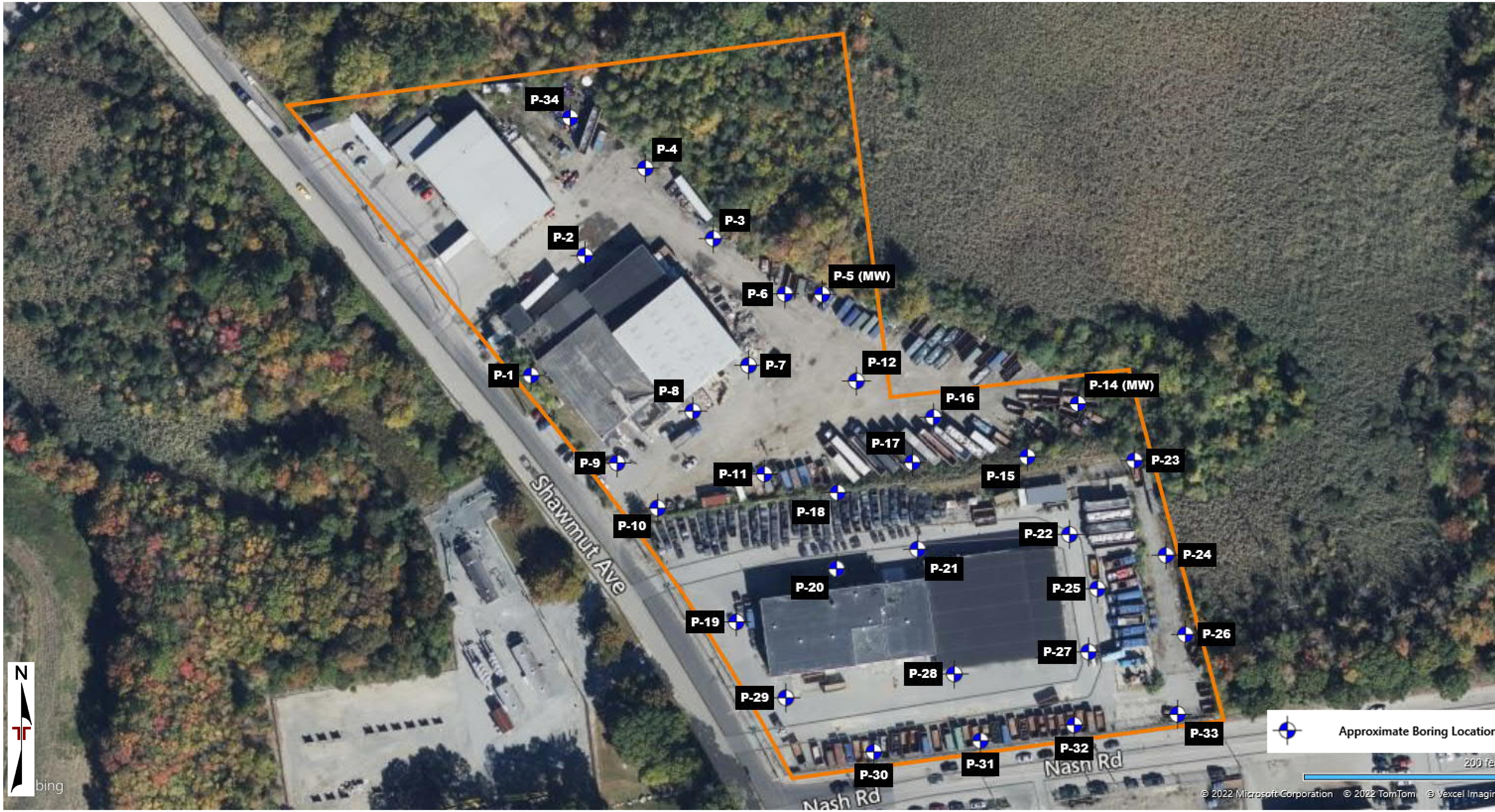


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN WITH PROJECT OVERLAY

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts

September 22, 2022 ■ Terracon Project No. J2225034

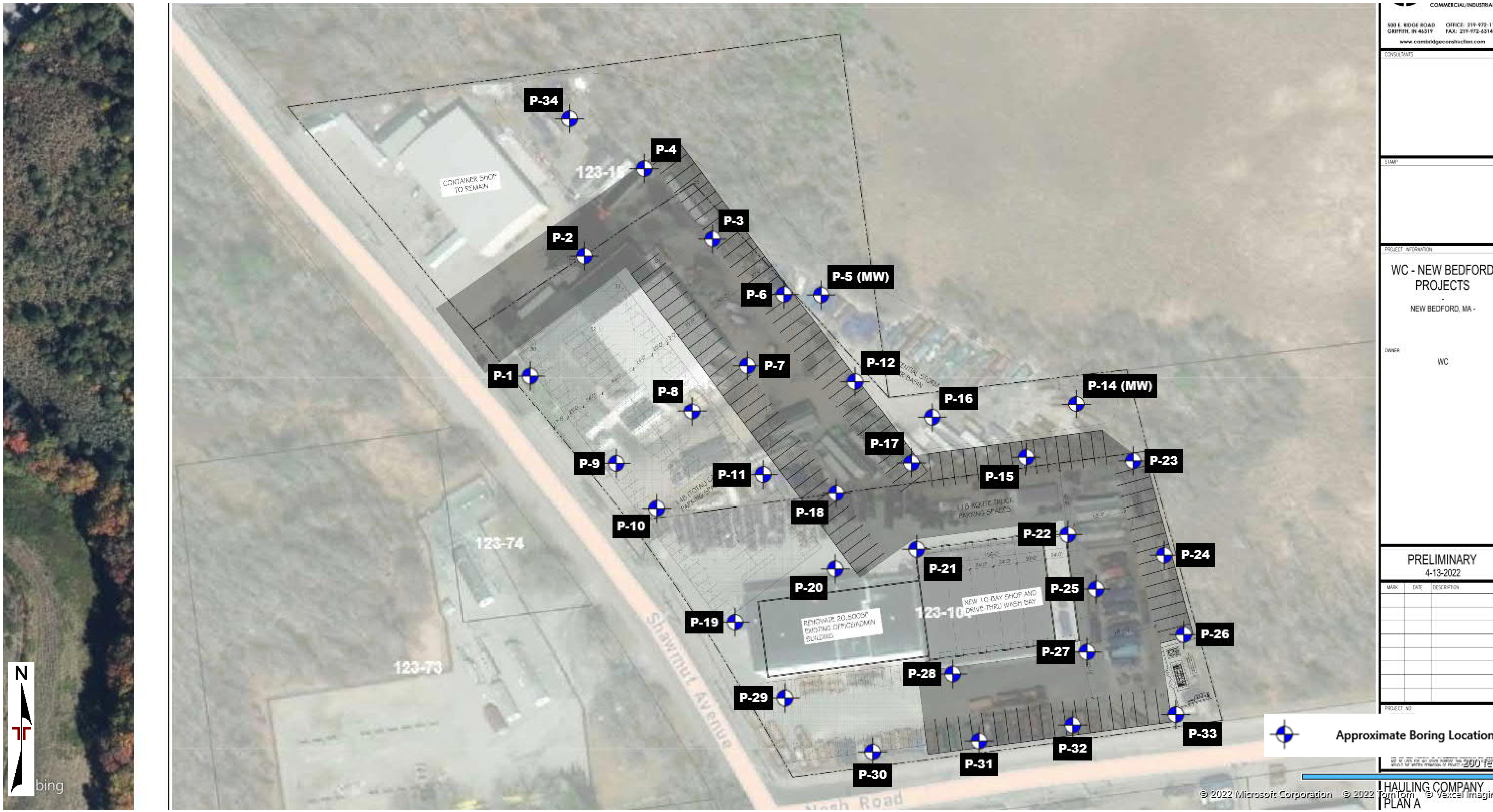


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. P-1

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue, New Bedford, Massachusetts

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

LOCATION See Exploration Plan

Latitude: 41.6657° Longitude: -70.9512°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - POORLY GRADED SAND**, trace gravel, brown				X	12	3-6-11-10 N=17		
2		**FILL - POORLY GRADED SAND WITH SILT**, brown				X	14	15-10-15-14 N=25	12.4	
2				5		X	19	7-7-9-10 N=16		
2	6.5		59.5+/-							
4		**SILTY SAND (SM)**, occasional cobbles, gray, medium dense to dense				X	20	7-7-11-16 N=18		
4						X		14-16-14-13 N=30		
4	10.0		56+/-	10						
		Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-2

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6661° Longitude: -70.9510°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.2	**BITUMINOUS CONCRETE**	65.8+/-							
2		**FILL - POORLY GRADED SAND WITH SILT**, brown				X	19	10-11-13-13 N=24		
	5.0	**FILL - POORLY GRADED SAND**, brown	61+/-			X	20	9-11-12-10 N=23		
4	8.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, brown-gray, medium dense to dense	58+/-	5		X	16	6-7-10-19 N=17		
						X	24	18-32-40-44 N=72		
	11.0	**SILTY SAND (SM)**, occasional cobbles, gray to brown-gray, very dense	55+/-	10		X	16	30-31-24-21 N=55		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Collect soil sample between 0 and 4 feet for corrosion testing.

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-3

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

LOCATION See Exploration Plan

Latitude: 41.6661° Longitude: -70.9505°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		4.0	**FILL - SILTY SAND WITH GRAVEL**, with asphalt and glass fragments and wood fibers, gray	62+/-				18	10-28-22-16 N=50		
								12	12-13-15-18 N=28		
4		10.0	**SILTY SAND (SM)**, trace gravel, occasional cobbles, brown-gray to brown, dense, trace oxidation	56+/-	5			15	23-14-18-31 N=32		
						▽		17	29-24-23-15 N=47		
					10			12	12-16-14-22 N=30		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-10-2022	Boring Completed: 08-10-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-4

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6663° Longitude: -70.9508°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND**, with rock fragments, brown				X	17	22-16-41-20 N=57		
							X	4	9-8-5-6 N=13		
		4.0		62+/-							
4			**SILTY SAND (SM)**, trace gravel, gray to brown, dense, trace oxidation		5		X	14	5-11-21-22 N=32		
							X	22	23-20-19-24 N=39		
							X	15	8-12-18-17 N=30		
		10.0		56+/-	10						
			Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-10-2022	Boring Completed: 08-10-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-5 (MW)

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6659° Longitude: -70.9501°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT
2		**FILL - SILTY SAND**, trace gravel, black to gray	2-inch PVC Riser with Native Backfill; 2-inch PVC Riser with Bentonite; 2-inch PVC Riser with Filter Sand			X	6	6-19-13-11 N=32		
						X	2	10-5-1-1 N=6		
		6.0 — 60+/-		5		X	6	WOH/12"-6-11 N=6	11.4	
4		**SILTY SAND (SM)**, trace gravel, gray to brown, dense	2-inch PVC Screen with Filter Sand		▽ ▽	X	15	21-24-25-23 N=49		
		10.0 — 56+/-		10		X	11	33-25-19-18 N=44		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Monitoring well installed upon completion. See installation details.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

WOH = Weight of Hammer

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *8.5 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-10-2022	Boring Completed: 08-10-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-6

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6659° Longitude: -70.9502°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND**, with asphalt and brick fragments, brown-gray					17	14-15-9-9 N=24		
								11	8-7-6-3 N=13		
		6.0		60+/-	5			12	4-3-3-7 N=6		
4			**SILTY SAND (SM)**, trace gravel, occasional cobbles, gray, dense			▽		17	8-16-17-16 N=33		
		10.0		56+/-	10	▽		15	13-13-21-16 N=34		
			Boring Terminated at 10 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *8.7 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-10-2022	Boring Completed: 08-10-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-7

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

LOCATION See Exploration Plan

Latitude: 41.6658° Longitude: -70.9504°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1		0.2	**BITUMINOUS CONCRETE**	65.8+/-							
2			**FILL - SILTY SAND WITH GRAVEL (SM)**, gray, loose to very dense				X	18	25-20-24-18 N=44		
							X	15	14-30-21-15 N=51		
			3-inch layer of organic material with roots (compacted topsoil) at 5 feet		5		X	8	7-2-4-50/4" N=6		
		7.0		59+/-							
			Auger Refusal at 7 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-8

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6656° Longitude: -70.9506°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.3	**BITUMINOUS CONCRETE**	65.7+/-							
2		**FILL - SILTY SAND**, trace gravel, occasional cobbles, brown					16	25-21-23-22 N=44	4.3	
							8	11-10-8-6 N=18		
	6.0		60+/-	5						
		POORLY GRADED SAND WITH SILT (SP-SM), brown, medium dense to dense					3	2-1-10-20 N=11		
	8.0		58+/-							
4		**SILTY SAND (SM)**, brown, medium dense to very dense					17	13-17-34-19 N=51		
	11.0		55+/-	10	▽		16	8-8-9-7 N=17		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Collected composite sample with P-9 for CBR testing.

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *10 feet while drilling*

▽ *10 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-9

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6655° Longitude: -70.9509°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.2	**BITUMINOUS CONCRETE**	65.8+/-							
2		**FILL - SILTY SAND WITH GRAVEL**, gray				X	18	13-18-20-19 N=38		
		FILL - POORLY GRADED SAND WITH SILT, gray				X	20	13-13-11-4 N=24	12.2	
	5.0	Thin layer of organic matter at 5 feet	61+/-	5						
4		**SILTY SAND (SM)**, occasional cobbles, gray to brown-gray, dense to very dense				X	15	6-15-15-14 N=30		
						X	20	15-21-22-22 N=43		
					▽	X	9	9-15-50/0"		
	10.0		56+/-	10	▽					

Sampler Refusal at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Collected composite sample with P-8 for CBR testing.

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *9.5 feet while drilling*

▽ *10 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-10

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6654° Longitude: -70.9507°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - SILTY SAND**, gray				X	18	10-6-6-8 N=12		
						X	16	5-7-3-2 N=10		
	4.5		61.5+/-							
3	5.0	**ORGANIC SILT (OL)**, with roots, dark brown to black, medium stiff	61+/-	5						
		POORLY GRADED SAND (SP), gray, dense				X	19	9-19-19-19 N=38		
	7.5		58.5+/-							
4		**SILTY SAND (SM)**, trace gravel, gray, medium dense to dense				X	24	17-15-16-13 N=31		
					▽					
				10		X	15	10-14-10-10 N=24		
	11.0		55+/-							
		Boring Terminated at 11 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *9 feet while drilling*

▽ *9 feet at completion of drilling*

Terracon

201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-11

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6655° Longitude: -70.9503°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - SILTY SAND WITH GRAVEL**, with asphalt fragments, brown				X	20	11-14-16-12 N=30		
				5		X	10	10-6-5-17 N=11	13.5	
	6.0		60+/-							
3	6.5	**ORGANIC SILT (OL)**, with roots, dark brown to black, medium stiff	59.5+/-			X	16	7-4-3-13 N=7		
4		**SILTY SAND (SM)**, trace gravel, gray to light brown, medium dense to dense			▽ ▽	X	15	19-14-13-12 N=27		
				10		X	0	32-17-22-22 N=39		
						X	10	18-15-12-9 N=27		
	13.0		53+/-							

Boring Terminated at 13 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *8.8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-12

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6657° Longitude: -70.9500°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND WITH GRAVEL**, occasional cobbles, with asphalt fragments, brown					16	13-27-35-27 N=62		
								14	20-23-28-14 N=51		
		6.0		60+/-	5			6	10-5-3-1 N=8		
3		7.0	**ORGANIC SILT (OL)**, with roots, black, medium stiff	59+/-							
4			**SILTY SAND (SM)**, gray, medium dense			▽		16	4-6-9-16 N=15		
		10.0		56+/-	10	▽		16	14-13-12-13 N=25		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *9 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL J2225034 NEW BEDFORD HAULI.GPJ TERRACON_DATATEMPLATE.GDT 9/22/22

BORING LOG NO. P-14 (MW)

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6656° Longitude: -70.9492°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT
2		**FILL - SILTY SAND WITH GRAVEL**, occasional cobbles, with glass fragments, dark brown		2-inch PVC Riser with Native Backfill; 2-inch PVC Riser with Bentonite				14	9-17-52-16 N=69		
								4	6-5-9-6 N=14		
	5.0	**FILL - SILTY SAND**, trace gravel, black	61+/-	2-inch PVC Riser with Filter Sand	5	▽		4	4-4-WOH/12" N=4		
3	6.0	**ORGANIC SILT (OL)**, with roots, trace gravel, dark brown to black, very soft	60+/-			▽					
4	8.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, gray, medium dense	58+/-	2-inch PVC Screen with Filter Sand				17	3-16-8-5 N=24		
	10.0	**POORLY GRADED SAND (SP)**, gray, loose	56+/-		10			13	2-2-7-15 N=9		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Monitoring well installed upon completion. See installation details.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

WOH = weight of hammer

Monitoring well has an approximate 3.7-foot stickup.

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *5 feet while drilling*

▽ *5.8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-15

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6655° Longitude: -70.9493°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND WITH GRAVEL**, dark brown to black			X	15	5-8-10-9 N=18		
	4.5	61.5+/-	**FILL - SILTY SAND WITH GRAVEL**, gray			X	12	10-11-10-7 N=21		
3	7.0	59+/-	**ORGANIC SILT (OL)**, with roots, black, very soft	5	▽ (6 ft)	X	19	2-WOH/12"-1	384.4	75.2
4			**POORLY GRADED SAND WITH SILT (SP-SM)**, gray, medium dense to dense			X	20	4-7-14-23 N=21		
	10.0	56+/-		10		X	21	6-15-16-13 N=31		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:
WOH = weight of hammer

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *6 feet while drilling*

▽ *6 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-16

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6656° Longitude: -70.9497°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND WITH GRAVEL**, with asphalt fragments, dark brown to black				X	18	18-19-20-14 N=39		
			FILL - SILTY SAND WITH GRAVEL, with wood fibers, dark brown to black				X	19	13-10-10-19 N=20	12.7	
		5.5		60.5+/-	5		X	18	9-6-4-2 N=10		
3		7.7	**ORGANIC SILT (OL)**, with roots, dark brown to black, medium stiff	58.3+/-		▽ ▽	X	14	12-12-14-16 N=26		
4		10.0	**SILTY SAND (SM)**, gray, medium dense to very dense	56+/-	10		X	16	11-27-30-26 N=57		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *7.7 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-17

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6655° Longitude: -70.9498°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		4.0	**FILL - SILTY SAND WITH GRAVEL**, with asphalt and glass fragments, dark brown	62+/-				12	15-16-11-9 N=27		
								12	8-10-16-14 N=26		
3		6.0	**ORGANIC SILT (OL)**, with roots, dark brown to black, medium stiff	60+/-	5			10	6-4-2-6 N=6		
4		10.0	**SILTY SAND (SM)**, gray, medium dense to dense	56+/-				13	11-7-19-27 N=26		
					10	▽ ▽		20	16-19-16-14 N=35		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8.5 feet while drilling*

▽ *9 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-18

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6654° Longitude: -70.9500°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - SILTY SAND WITH GRAVEL**, with brick and plastic fragments, dark brown to black				X	17	8-9-21-28 N=30		
						X	5	30-50/5"		
		Auger refusal on obstruction at approximately 3 feet. Borehole offset 5 feet south and continued sampling at 5 feet.								
	6.0	**FILL - POORLY GRADED SAND**, brown-gray	60+/-	5		X	10	5-5-5-1 N=10		
3	7.0	**ORGANIC SILT (OL)**, with roots, dark brown to black, medium stiff	59+/-		▽ ▽	X	16	17-41-20-24 N=61		
4	10.0	**SILTY SAND (SM)**, gray, dense to very dense	56+/-	10		X	12	22-20-17-14 N=37		

Boring Terminated at 10 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *7.5 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-19

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6650° Longitude: -70.9504°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - SILTY SAND**, trace gravel, brown								
						X	18	7-8-9-15 N=17	6.1	
		FILL - SILTY SAND, trace gravel, occasional cobbles, trace wood fibers, brown-gray				X	13	14-12-7-6 N=19	13.5	
				5		X	3	4-6-7-11 N=13		
3	7.0	4-inch layer of organic matter at 7 feet	62+/-							
4	7.3	**SILTY SAND (SM)**, trace gravel, brown-gray, medium dense to dense	61.7+/-		▽	X	12	24-25-18-18 N=43		
					▽	X	24	8-13-15-16 N=28		
	11.0		58+/-	10						

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Collected composite sample with P-29 for CBR testing

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *8 feet while drilling*

▽ *9.5 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-20

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue, New Bedford, Massachusetts

CLIENT: The Cambridge Companies, Inc., Griffith, Indiana

LOCATION See Exploration Plan

Latitude: 41.6652° Longitude: -70.9500°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.3	**BITUMINOUS CONCRETE**	65.7+/-							
2		**FILL - SILTY SAND**, trace gravel, occasional cobbles, brown				X	7	7-32-13-8 N=45		
						X	0	8-8-10-12 N=18		
	5.0		61+/-	5						
4		**SILTY SAND (SM)**, trace gravel, occasional cobbles, brown-gray to gray, medium dense to very dense				X	19	9-11-14-12 N=25		
						X	11	35-35-16-15 N=51		
					▽ (9 ft) ▽ (9.7 ft)	X	11	12-20-19-15 N=39		
	11.0		55+/-	10						

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *9 feet while drilling*

▽ *9.7 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-21

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6652° Longitude: -70.9497°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.4	**BITUMINOUS CONCRETE**	65.6+/-							
	1.0	**AGGREGATE BASE COURSE**	65+/-							
2		**FILL - SILTY SAND WITH GRAVEL**, occasional cobbles and boulders, brown				X	16	10-13-14-13 N=27		
					▽ (4 ft)	X	12	11-10-8-7 N=18		
	5.5		60.5+/-	5						
3		**ORGANIC SILT (OL)**, with plant and wood fragments, black, very soft, organic odor				X	4	2-WOH/12"-1	53.7	8.5
	7.0		59+/-							
4		**POORLY GRADED SAND WITH SILT (SP-SM)**, occasional cobbles and boulders, gray, medium dense				X	14	9-10-13-18 N=23		
	10.0		56+/-	10						
		SILTY SAND WITH GRAVEL (SM), occasional cobbles and boulders, brown, medium dense to dense			▽ (11.85 ft)	X	12	10-9-14-12 N=23	10.3	
				15		X	12	8-10-9-14 N=19		
				20		X	18	11-16-24-39 N=40		
	22.0		44+/-							

Boring Terminated at 22 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

WOH = Weight of Hammer

Collected soil sample between 0 and 4 feet for corrosion testing.

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *4 feet while drilling*

▽ *11.85 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-04-2022	Boring Completed: 08-04-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-22

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6653° Longitude: -70.9492°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.3	**BITUMINOUS CONCRETE**	65.7+/-							
	0.5	**AGGREGATE BASE COURSE**	65.5+/-							
2		**FILL - POORLY GRADED SAND WITH GRAVEL**, occasional cobbles and boulders, brown-gray				X	16	13-15-13-11 N=28		
					▽	X	12	7-7-6-5 N=13		
		FILL - SILTY SAND WITH GRAVEL, brown-gray		5		X	10	4-2-3-10 N=5		
	6.5		59.5+/-							
3	7.0	**SANDY ORGANIC SILT (OL)**, with wood fibers, black, medium stiff	59+/-							
4		**POORLY GRADED SAND (SP)**, trace gravel, occasional cobbles and boulders, gray, dense				X	10	57-19-11-11 N=30	10.1	
	10.0		56+/-	10						
		SILTY SAND WITH GRAVEL (SM), occasional cobbles and boulders, gray to brown, medium dense to dense				X	14	13-14-20-18 N=34		
					▽					
				15		X	8	9-12-11-13 N=23		
				20		X	16	27-21-21-29 N=42		
	22.0	Probable weathered rock at 22 feet	44+/-							
		Boring Terminated at 22 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *4 feet while drilling*

▽ *14.4 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-04-2022	Boring Completed: 08-04-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-23

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6655° Longitude: -70.9489°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	Description	ELEVATION (Ft.)
2		**FILL - POORLY GRADED SAND WITH SILT AND GRAVEL**, brown-gray	
2	5.0	**FILL - SILTY SAND WITH GRAVEL**, occasional cobbles and boulders, brown-gray	61+/-
3	7.0	**ORGANIC SILT (OL)**, trace sand, black, soft, trace organic odor	59+/-
4	11.0	**POORLY GRADED SAND (SP)**, trace gravel, gray, medium dense to dense	55+/-
		Boring Terminated at 11 Feet	

Sample	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	4	12-14-12-7 N=26	4.2	
2	4	22-5-2-2 N=7		
3	10	6-2-1-11 N=3		
4	18	23-30-17-21 N=47		
5	16	6-5-10-9 N=15		

Water level observations: 6 ft (while drilling), 9 ft (at completion of drilling).

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

6 feet while drilling

9 feet at completion of drilling

201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-24

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6652° Longitude: -70.9488°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
4			**SILTY SAND WITH GRAVEL (SM)**, frequent cobbles and boulders, brown-gray, dense				X	12	7-12-32-50/4" N=44		
			Auger refusal on obstruction at approximately 3 feet. Borehole offset 5 feet north and continued sampling at 5 feet.								
		5.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, gray, medium dense to dense	61+/-	5	▽ ▽	X	14	6-12-16-15 N=28		
		8.0	**SILTY SAND WITH GRAVEL (SM)**, brown, dense	58+/-			X	18	17-24-21-22 N=45		
		9.0	**POORLY GRADED SAND WITH GRAVEL (SP)**, gray, dense	57+/-	10		X	18	10-19-25-25 N=44		
		11.0	***Boring Terminated at 11 Feet***	55+/-							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *6 feet while drilling*

▽ *7 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-25

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6651° Longitude: -70.9491°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.3	**BITUMINOUS CONCRETE**	65.7+/-							
2	0.5	**AGGREGATE BASE COURSE**	65.5+/-							
2	2.0	**FILL - SILT**, black **FILL - POORLY GRADED SAND WITH SILT AND GRAVEL**, brown-gray	64+/-			X	18	13-18-15-15 N=33		
4	7.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, occasional cobbles and boulders, brown-gray, medium dense	59+/-	5	∇ (5 ft)	X	14	12-10-9-11 N=19		
						X	12	7-5-6-4 N=11		
4	11.0	**SILTY SAND (SM)**, trace gravel, gray, dense	55+/-		∇ (8 ft)	X	14	11-14-18-20 N=32		
				10		X	12	14-13-17-21 N=30		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

∇ *5 feet while drilling*

∇ *8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-26

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6650° Longitude: -70.9488°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
4		**SILTY SAND WITH GRAVEL (SM)**, occasional cobbles and boulders, gray to brown, medium dense to very dense							
						12	6-4-8-5 N=12		
						16	6-10-20-16 N=30	10.9	
			5			16	18-16-19-22 N=35		
				▽ ▼		18	24-32-22-13 N=54		
		11.0 / 55+/-	10			16	4-10-11-16 N=21		
		Boring Terminated at 11 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▼ *8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-27

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6650° Longitude: -70.9491°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.4	**BITUMINOUS CONCRETE**	65.6+/-							
	0.8	**AGGREGATE BASE COURSE**	65.2+/-							
2		**FILL - POORLY GRADED SAND WITH GRAVEL**, frequent cobbles and boulders, brown-gray				X	6	23-50/1"		
						X	16	11-12-10-8 N=22		
				5	▽	X	8	6-2-3-12 N=5	6.8	
	7.0		59+/-							
4		**POORLY GRADED SAND (SP)**, occasional cobbles and boulders, gray, very dense				X	14	13-17-50/4"		
	10.0		56+/-	10						
		POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, occasional cobbles and boulders, gray, dense			▽	X	14	19-14-19-20 N=33		
	15.0		51+/-	15						
		SILTY SAND WITH GRAVEL (SM), with probable weathered rock, brown, very dense				X	10	16-32-18-24 N=50		
	17.0		49+/-							

Auger Refusal on Probable Bedrock at 17 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *5 feet while drilling*

▽ *11 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-04-2022	Boring Completed: 08-04-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-28

PROJECT: New Bedford Hauling Company Improvements	**CLIENT:** The Cambridge Companies, Inc. Griffith, Indiana
SITE: 1166 Shawmut Avenue New Bedford, Massachusetts	

LOCATION See Exploration Plan

Latitude: 41.6649° Longitude: -70.9496°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.4	**BITUMINOUS CONCRETE**	65.6+/-
1	0.9	**AGGREGATE BASE COURSE**	65.1+/-
2	4.0	**FILL - POORLY GRADED SAND WITH GRAVEL**, brown-gray	62+/-
3	4.5	**ORGANIC SILT WITH SAND (OL)**, black, medium stiff	61.5+/-
4	5.0	**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, occasional cobbles and boulders, gray, loose	61+/-
4	8.0	**SILTY SAND (SM)**, trace gravel, with wood fibers, gray, medium dense	58+/-
4	10.0	**POORLY GRADED SAND (SP)**, trace gravel, gray, dense	56+/-
4	21.4	**SILTY SAND (SM)**, trace gravel, occasional cobbles and boulders, brown, medium dense to very dense	44.6+/-

Sampler Refusal at 21.4 Feet

Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
14	13-13-11-8 N=24		
14	5-3-6-8 N=9		
16	4-3-14-18 N=17		
16	29-16-15-17 N=31		
18	10-11-10-13 N=21	11.9	
12	8-12-10-12 N=22		
10	20-28-50/5"		

DEPTH (Ft.): 5, 10, 15, 20

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

- *7 feet while drilling*
- *10 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-04-2022	Boring Completed: 08-04-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-29

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6648° Longitude: -70.9502°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)
1	0.3	**BITUMINOUS CONCRETE**	68.7+/-
2	5.0	**FILL - SILTY SAND WITH GRAVEL**, occasional cobbles	64+/-
4	8.0	**POORLY GRADED SAND (SP)**, brown-gray, medium dense	61+/-
4	9.0	**SILTY SAND (SM)**, brown-gray, dense	60+/-
4	10.0	**SILT (ML)**, brown, medium dense	59+/-

Sampler Refusal at 10 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1–3		Split spoon	14	12-13-14-15 N=27		
3–5		Split spoon	0	13-8-7-4 N=15		
5–7	▽ 6 ft / ▽ 6.7 ft	Split spoon	17	9-9-13-16 N=22		
7–9		Split spoon	24	24-23-18-15 N=41		
9–10		Split spoon	10	8-12-50/0"		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Collected composite sample with P-19 for CBR testing.

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *6 feet while drilling*

▽ *6.7 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-08-2022	Boring Completed: 08-08-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

BORING LOG NO. P-30

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6647° Longitude: -70.9499°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.4	**BITUMINOUS CONCRETE**	68.6+/-							
2	3.0	**FILL - SILTY SAND WITH GRAVEL**, with asphalt fragments, dark brown	66+/-				10	4-9-6-2 N=15	8.2	
3	5.0	**ORGANIC SILT WITH SAND (OL)**, with plant and wood fibers, occasional cobbles and boulders, black, stiff, organic odor	64+/-				12	2-5-9-3 N=14		
				5			3	50/4"		
4	11.0	**SILTY SAND WITH GRAVEL (SM)**, occasional cobbles and boulders, gray to brown, dense to very dense	58+/-		▽ ▽		14	7-19-25-27 N=44		
				10			16	24-21-21-22 N=42		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-31

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6647° Longitude: -70.9495°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.4	**BITUMINOUS CONCRETE**	68.6+/-							
2	3.5	**FILL - POORLY GRADED SAND WITH SILT AND GRAVEL**, brown-gray	65.5+/-			X	16	9-10-15-19 N=25		
3	4.5	**ORGANIC SILT WITH SAND (OL)**, with wood fibers, dark brown, medium stiff	64.5+/-			X	12	7-3-4-4 N=7		
	5.0	**SILTY SAND (SM)**, gray, loose	64+/-	5						
	7.0	**ORGANIC SILT WITH SAND (OL)**, with wood fibers, gray to black, soft, organic odor	62+/-		▽	X	12	2-1-1-2 N=2		
4	8.0	**SILTY SAND (SM)**, trace gravel, dark brown, dense	61+/-			X	16	16-20-18-19 N=38		
	10.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, brown, dense	59+/-		▽					
	11.0	**SILTY SAND (SM)**, brown-gray, dense	58+/-	10		X	16	8-11-16-17 N=27		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *9 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-32

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6648° Longitude: -70.9492°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
1	0.4	**BITUMINOUS CONCRETE**	68.6+/-							
2		**FILL - POORLY GRADED SAND WITH GRAVEL**, occasional cobbles and boulders, brown to gray				X	14	8-11-9-5 N=20		
						X	12	8-5-4-3 N=9		
	6.0	**FILL - SILTY SAND**, brown-gray	63+/-	5		X	8	3-2-WOH-16 N=2		
3	7.0	**ORGANIC SILT (OL)**, black, medium stiff	62+/-		▽					
4		**SILTY SAND WITH GRAVEL (SM)**, gray, dense to very dense			▽	X	14	17-15-21-24 N=36		
	11.0		58+/-	10		X	18	6-30-42-17 N=72		

Boring Terminated at 11 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

WOH = Weight of Hammer

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *9 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-33

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6648° Longitude: -70.9488°

Approximate Surface Elev.: 69 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2		**FILL - SILTY SAND WITH GRAVEL**, frequent cobbles and boulders, brown-gray				X	8	3-4-3-2 N=7		
							0	50/0"		
	5.0	Auger refusal on obstruction at approximately 4.5 feet. Borehole offset 5 feet east and continued sampling at 5 feet.	64+/-	5						
4		**SILTY SAND WITH GRAVEL (SM)**, gray to brown, dense				X	18	2-16-32-26 N=48		
					▽ (7 ft)	X	20	3-22-26-24 N=48		
		Similar, trace oxidation		10	▽ (8 ft)	X	16	7-20-23-23 N=43		
	11.0	***Boring Terminated at 11 Feet***	58+/-							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
4-1/4-inch hollow stem augers

Abandonment Method:
Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: J. Jurnack

WATER LEVEL OBSERVATIONS

▽ *7 feet while drilling*

▽ *8 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-05-2022	Boring Completed: 08-05-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Griffin
Project No.: J2225034	

BORING LOG NO. P-34

PROJECT: New Bedford Hauling Company Improvements

CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

SITE: 1166 Shawmut Avenue New Bedford, Massachusetts

LOCATION See Exploration Plan

Latitude: 41.6664° Longitude: -70.9510°

Approximate Surface Elev.: 66 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Recovery (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	ORGANIC CONTENT (%)
2			**FILL - SILTY SAND**, trace gravel, brown-gray				X	22	16-22-19-19 N=41	6.0	
			Sampler broke while sampling at 2 feet				X	5	14		
		4.0		62+/-							
4			**SILTY SAND (SM)**, trace gravel, occasional cobbles, brown, medium dense to dense		5		X	21	11-15-14-14 N=29		
							X	15	9-11-14-12 N=25		
					10	▽	X	16	9-20-22-23 N=42		
		11.0		55+/-							
			Boring Terminated at 11 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
Samples obtained using a 2-in. O.D. split spoon sampler

Advancement Method:
2-1/4-inch hollow stem augers

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from public topographic maps

Notes:

Logged by: V. Mendoza

WATER LEVEL OBSERVATIONS

▽ *10 feet while drilling*

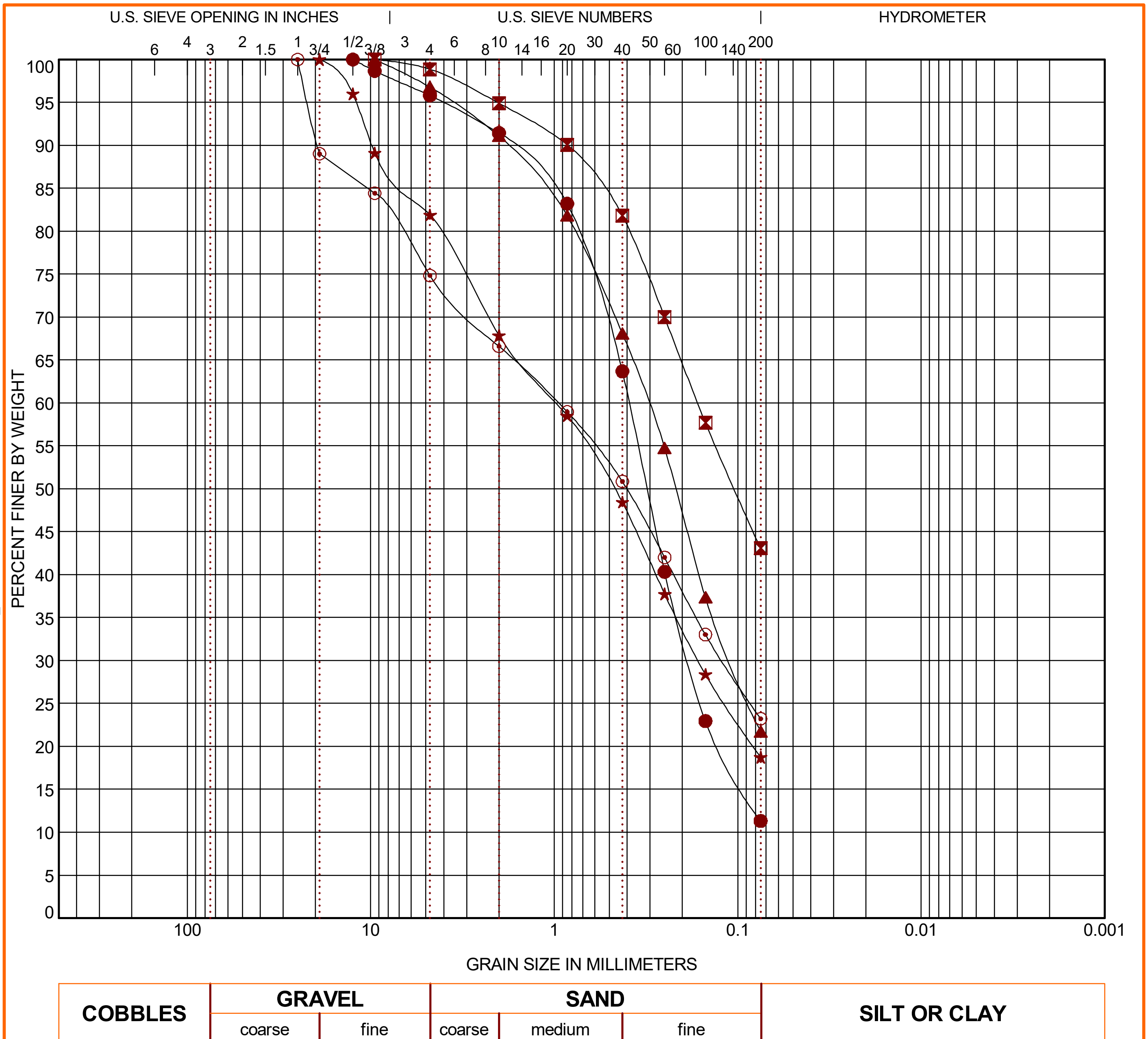
▽ *10 feet at completion of drilling*

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

Boring Started: 08-09-2022	Boring Completed: 08-09-2022
Drill Rig: Mobile B-53	Driller: Seaboard / D. Feeley
Project No.: J2225034	

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	P-1	2 - 4	Poorly graded sand with silt (SP-SM)	12.4				1.26	5.63
⊠	P-5 (MW)	4 - 6	Silty sand (SM)	11.4					
▲	P-9	3 - 5	Silty sand (SM)	12.2					
★	P-11	3 - 5	Silty sand with gravel (SM)	13.5					
⊙	P-16	2 - 4	Silty sand with gravel (SM)	12.7					

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	P-1	2 - 4	12.5	0.391	0.185		0.0	4.2	84.5		11.3	
⊠	P-5 (MW)	4 - 6	9.5	0.165			0.0	1.1	55.8		43.1	
▲	P-9	3 - 5	9.5	0.308	0.108		0.0	3.2	75.1		21.7	
★	P-11	3 - 5	19	0.973	0.164		0.0	18.1	63.2		18.7	
⊙	P-16	2 - 4	25	0.955	0.121		0.0	25.2	51.6		23.2	

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

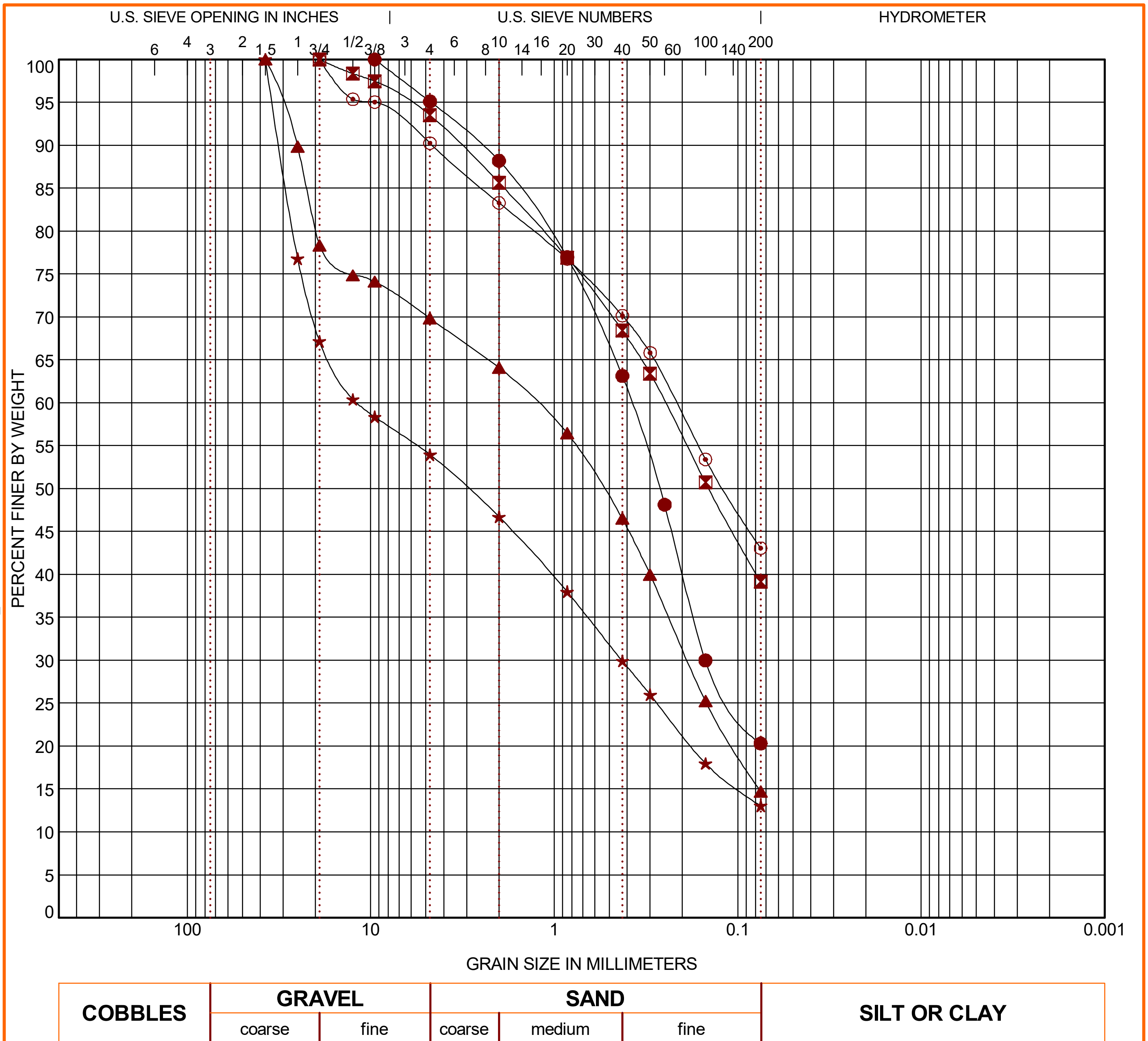
Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	P-19	3 - 5	Silty sand (SM)	13.5					
⊠	P-21	10 - 12	Silty sand (SM)	10.3					
▲	P-22	7 - 9	Silty sand with gravel (SM)	10.1					
★	P-23	1 - 3	Silty gravel with sand (GM)	4.2					
⊙	P-26	3 - 5	Silty sand (SM)	10.9					

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	P-19	3 - 5	9.5	0.381	0.15		0.0	4.9	74.8		20.3	
⊠	P-21	10 - 12	19	0.249			0.0	6.5	54.4		39.1	
▲	P-22	7 - 9	37.5	1.265	0.188		0.0	30.2	55.1		14.7	
★	P-23	1 - 3	37.5	11.846	0.428		0.0	46.0	40.9		13.0	
⊙	P-26	3 - 5	19	0.217			0.0	9.7	47.2		43.1	

PROJECT: New Bedford Hauling Company
Improvements

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

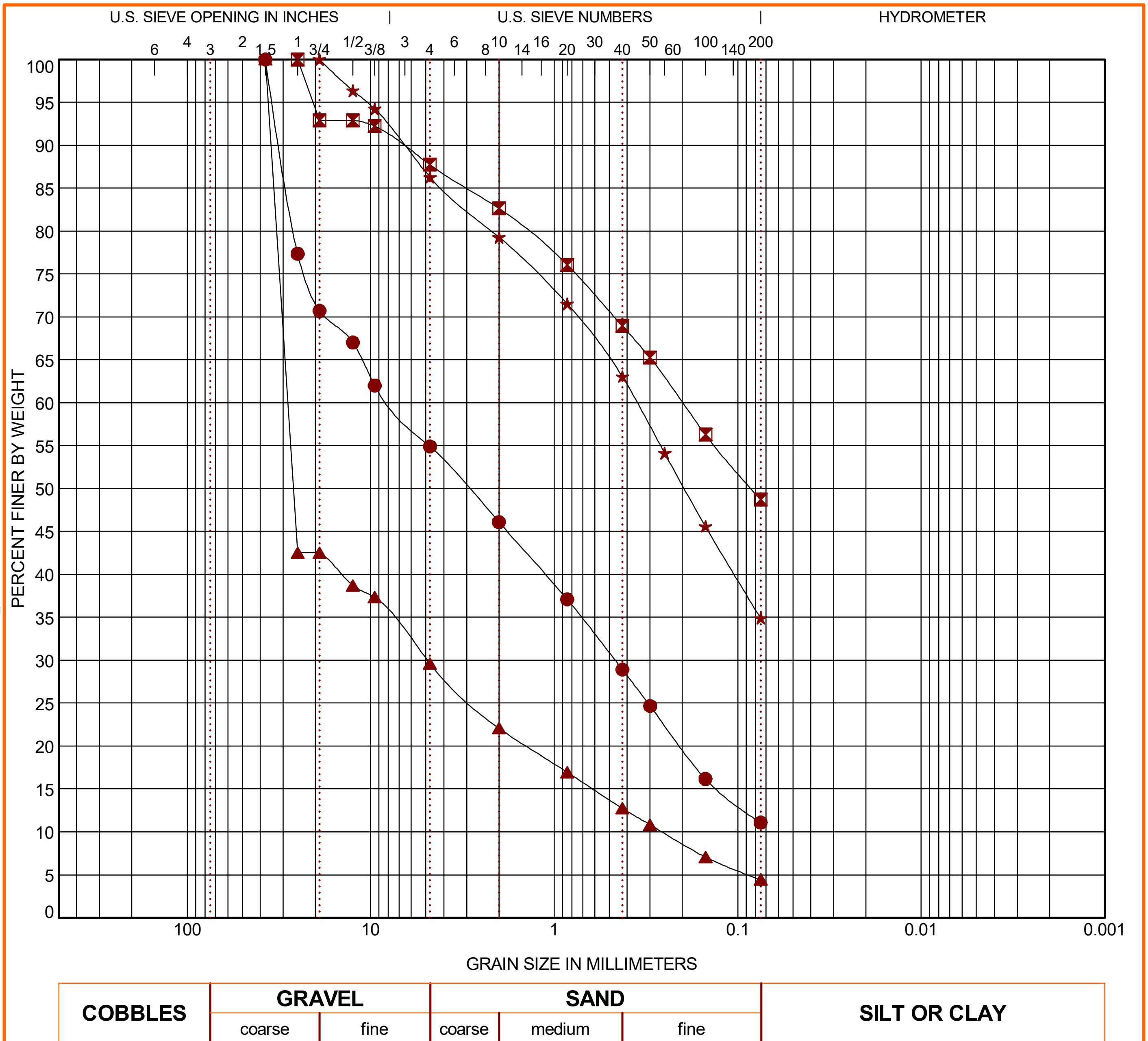
Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	P-27	5 - 7	Poorly-graded gravel with silt and sand (GP-GM)	6.8				0.43	120.57
⊠	P-28	10 - 12	Silty sand (SM)	11.9					
▲	P-30	1 - 3	Poorly-graded gravel w/ sand (GP)	8.2				3.31	109.68
★	P-34	0 - 2	Silty sand (SM)	6.0					

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	P-27	5 - 7	37.5	7.802	0.466		0.0	45.1	43.8		11.1	
⊠	P-28	10 - 12	25	0.2			0.0	12.3	39.0		48.7	
▲	P-30	1 - 3	37.5	28.278	4.913	0.258	0.0	70.4	25.2		4.4	
★	P-34	0 - 2	19	0.354			0.0	13.7	51.4		34.9	

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

Source of Material: **P-8 & P-9 @ 1 - 3 feet**

Description of Material:

Remarks:

Test Method: **ASTM D1557 Method A**

TEST RESULTS

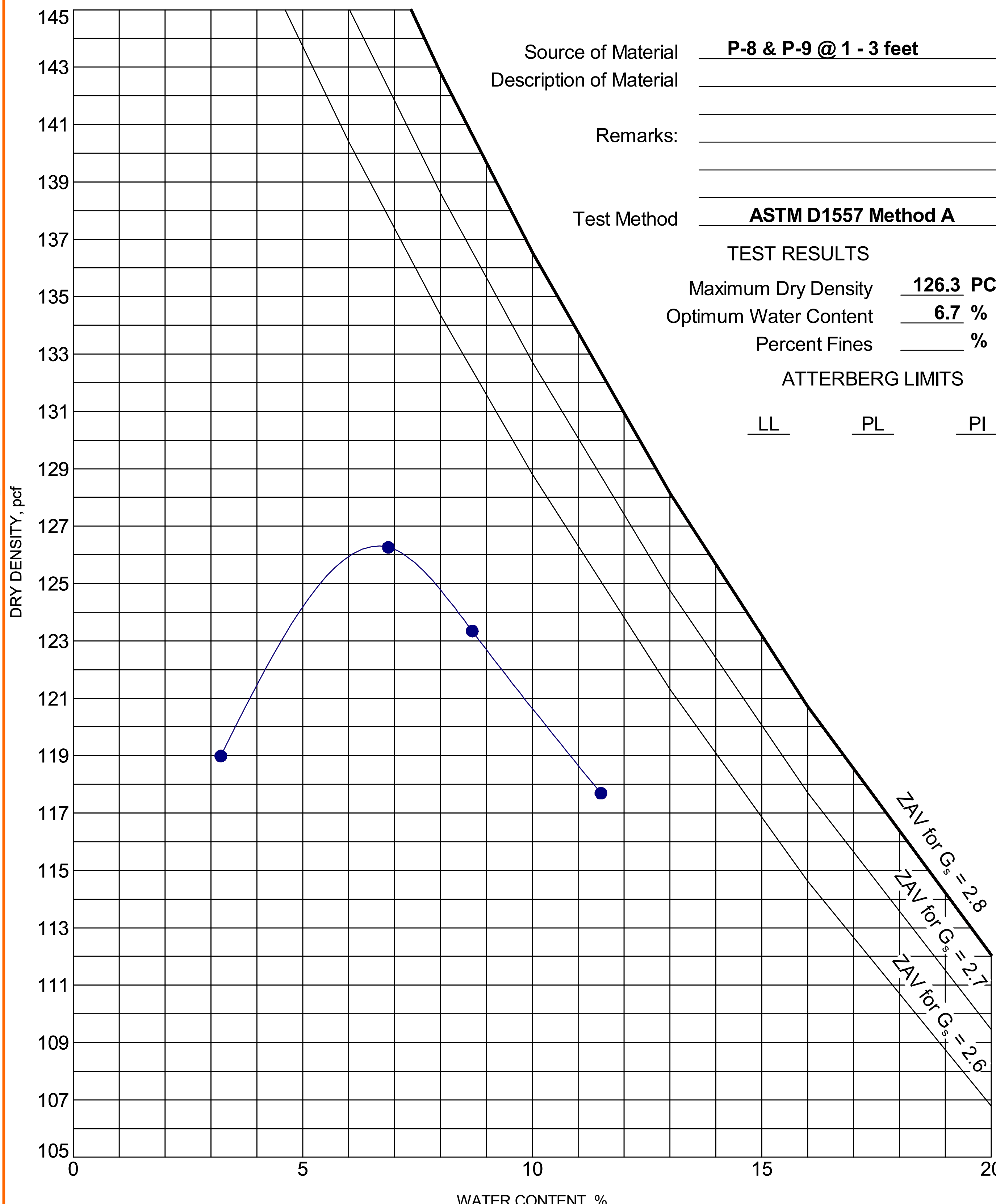
Maximum Dry Density **126.3 PCF**

Optimum Water Content **6.7 %**

Percent Fines **%**

ATTERBERG LIMITS

LL	PL	PI

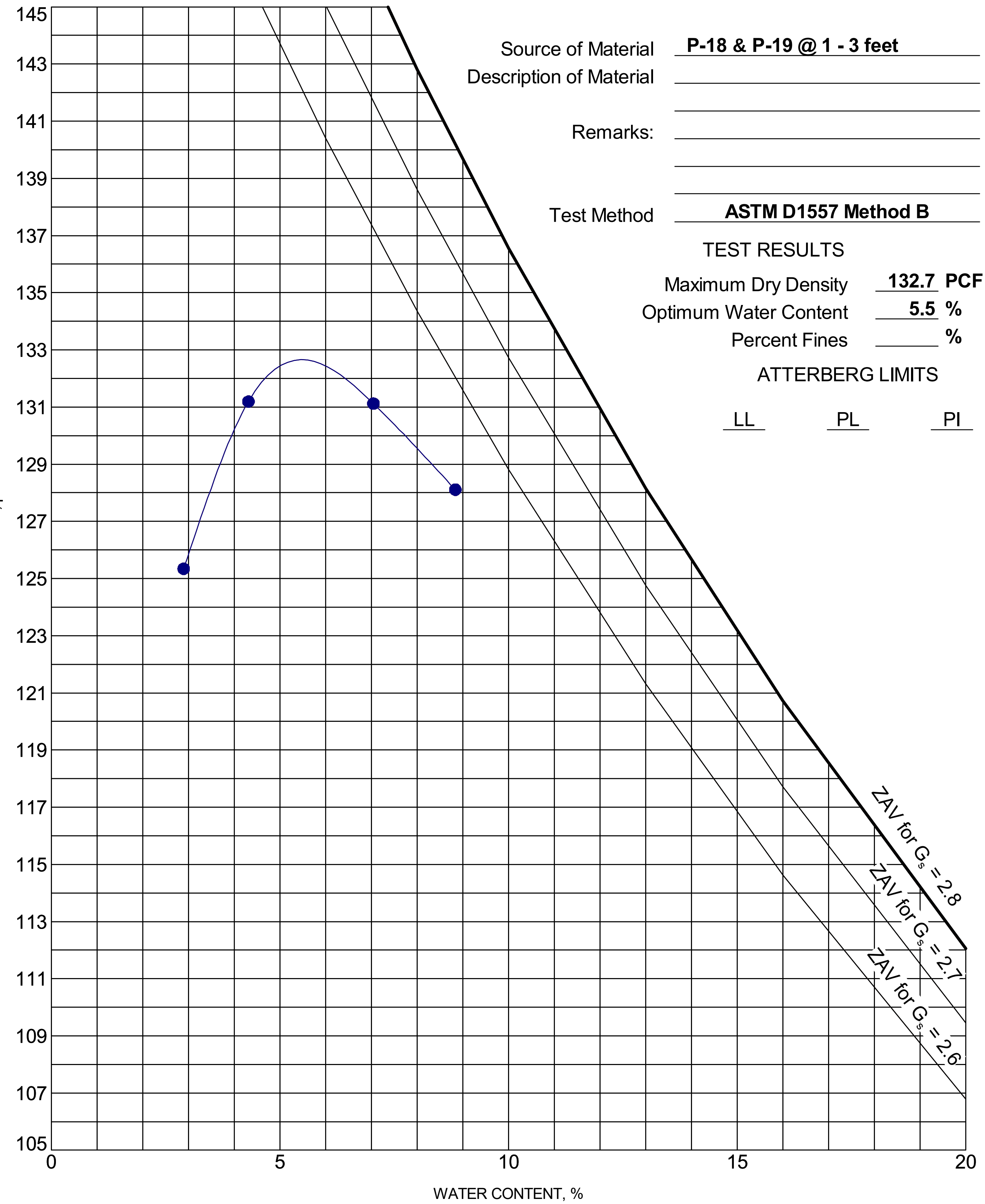


PROJECT: New Bedford Hauling Company Improvements	PROJECT NUMBER: J2225034
SITE: 1166 Shawmut Avenue New Bedford, Massachusetts	CLIENT: The Cambridge Companies, Inc. Griffith, Indiana

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: P-18 & P-19 @ 1 - 3 feet

Description of Material:

Remarks:

Test Method: ASTM D1557 Method B

TEST RESULTS

Maximum Dry Density: 132.7 PCF

Optimum Water Content: 5.5 %

Percent Fines: %

ATTERBERG LIMITS

LL	PL	PI

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

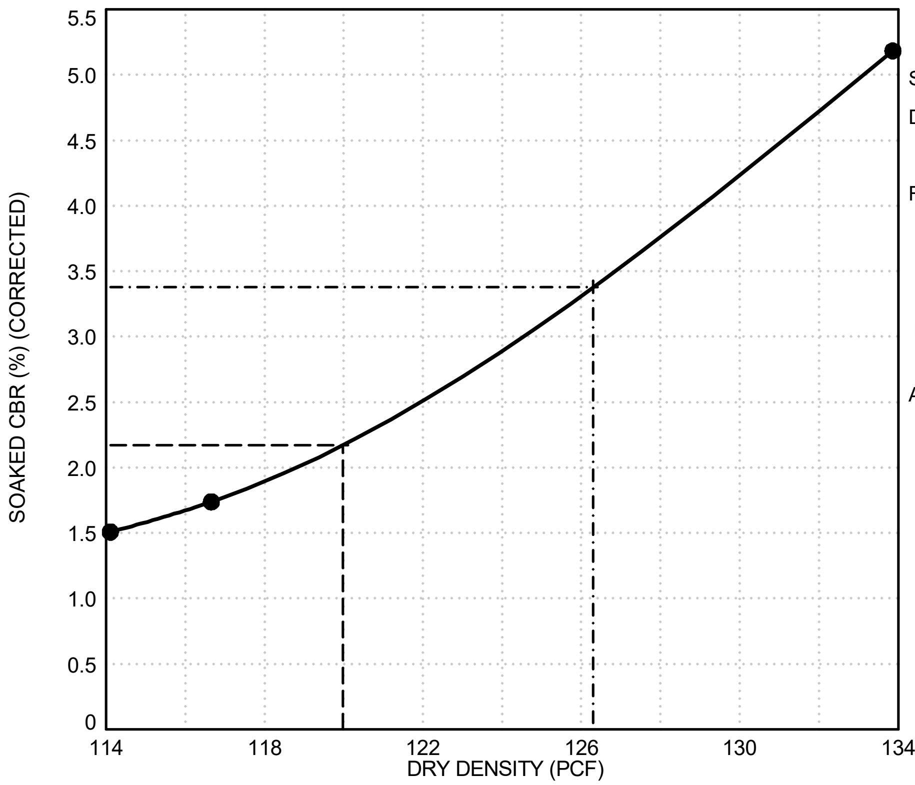
Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

CALIFORNIA BEARING RATIO

ASTM D1883-07[2]



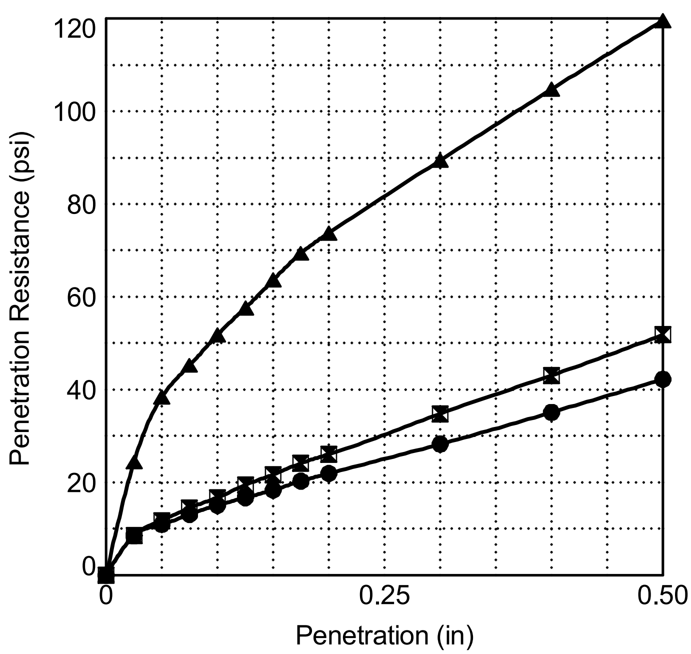
Source of Material: P-8 & P-9 (1-3')

Description of Material:

Remarks:

Percent Fines: %

Atterberg Limits: LL PL PI



Sample No.	1	2	3
Sample Condition	Soaked		
Compaction Method	ASTM D1557A		
Maximum Dry Density, (pcf)	126.3	126.3	126.3
Optimum Moisture Content, (%)	6.7	6.7	6.7
Dry Density before Soaking, (pcf)	114.11	116.66	133.87
Moisture Content, (%)			
After Compaction	6.5	6.5	6.5
Top 1" After Soaking	13.2	13.4	12.6
Surcharge,. (lbs)	10.00	10.00	10.00
Swell, (%)	0.02	0.02	0.02
Bearing Ratio, (%)	1.5	1.7	5.2

Dry Density @ 90% 114.11 pcf

Dry Density @ 92% 116.66 pcf

Dry Density @ 95% 133.87 pcf

CBR @ 90% Density 1.5

CBR @ 92% Density 1.7

CBR @ 95% Density 5.2

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue, New Bedford, Massachusetts

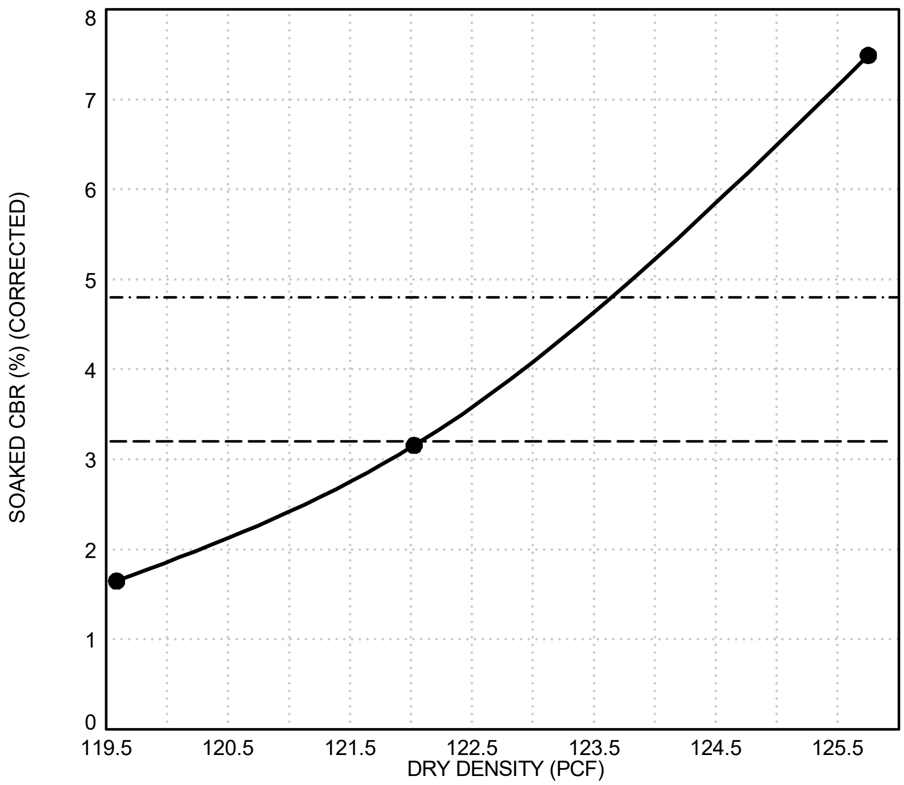
Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc., Griffith, Indiana

CALIFORNIA BEARING RATIO

ASTM D1883-07[2]



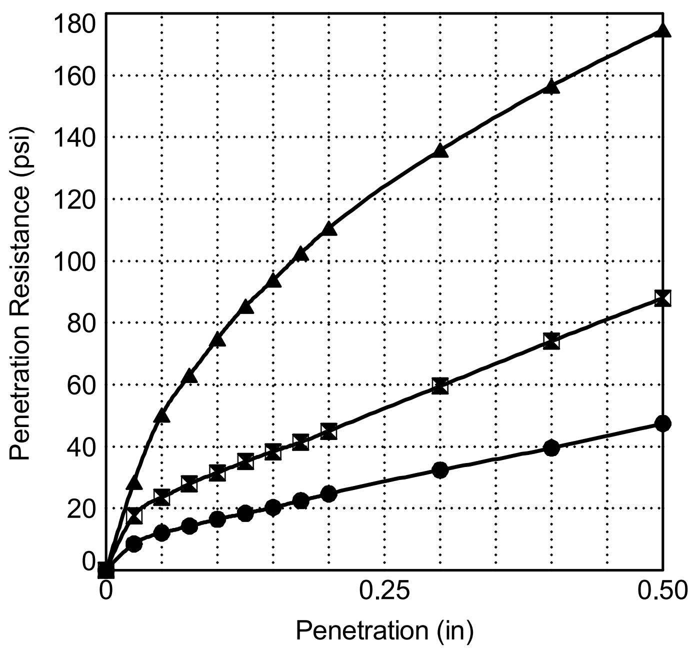
Source of Material P-19 & P-29 (1-3')

Description of Material

Remarks:

Percent Fines %

Atterberg Limits LL PL PI



Sample No.	1	2	3
Sample Condition	Soaked		
Compaction Method	ASTM 1557B		
Maximum Dry Density, (pcf)	132.7	132.7	132.7
Optimum Moisture Content, (%)	5.5	5.5	5.5
Dry Density before Soaking, (pcf)	119.59	122.03	125.75
Moisture Content, (%)			
After Compaction	5.7	5.7	5.7
Top 1" After Soaking	39.7	44.5	40.3
Surcharge,. (lbs)	10.00	10.00	10.00
Swell, (%)	0.87	0.09	0.04
Bearing Ratio, (%)	1.6	3.2	7.5

Dry Density @ 90% 119.59 pcf

Dry Density @ 92% 122.03 pcf

Dry Density @ 95% 125.75 pcf

CBR @ 90% Density 1.6

CBR @ 92% Density 3.2

CBR @ 95% Density 7.5

PROJECT: New Bedford Hauling Company Improvements

SITE: 1166 Shawmut Avenue
New Bedford, Massachusetts

Terracon
201 Hammer Mill Rd, Ste B
Rocky Hill, CT

PROJECT NUMBER: J2225034

CLIENT: The Cambridge Companies, Inc.
Griffith, Indiana

Terracon
Explore with us

Client

The Cambridge Companies, Inc.
Griffith, IN

Project

New Bedford Hauling Company Improvements
J2225034

Date Received: 8/12/2022 - 8/16/2022

Results from Corrosion Testing

Sample Location	P-2	P-21
Sample Depth (ft.)	0.0'-4.0'	0.0'-4.0'
pH Analysis, ASTM G 51	8.22	6.73
Water Soluble Sulfate (SO4), ASTM C 1580 (ppm)	5	10
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil
Chlorides, ASTM D 512, (ppm)	22	23
Red-Ox, ASTM G 200, (mV)	+472	+459
Total Salts, AWWA 2520 B, (mg/kg)	136	203
Resistivity (Saturated), ASTM G 57, (ohm-cm)	22000	14000

Analyzed By: ChrisAnne Ross
Field Geologist

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

New Bedford Hauling Company Improvements ■ New Bedford, Massachusetts

Terracon Project No. J2225034

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Standard Penetration Test	Water Initially Encountered	N — Standard Penetration Test Resistance (Blows/Ft.)
	Water Level After a Specified Period of Time	(HP) — Hand Penetrometer
	Water Level After a Specified Period of Time	(T) — Torvane
	Cave In Encountered	(DCP) — Dynamic Cone Penetrometer
	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	UC — Unconfined Compressive Strength
		(PID) — Photo-Ionization Detector
		(OVA) — Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \ge 4$ and $1 \le Cc \le 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or [Cc<1 or Cc>3.0] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \ge 6$ and $1 \le Cc \le 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [Cc<1 or Cc>3.0] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line		CL	Lean clay [K, L, M]
			$PI < 4$ or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\ge$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\ge$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\ge$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

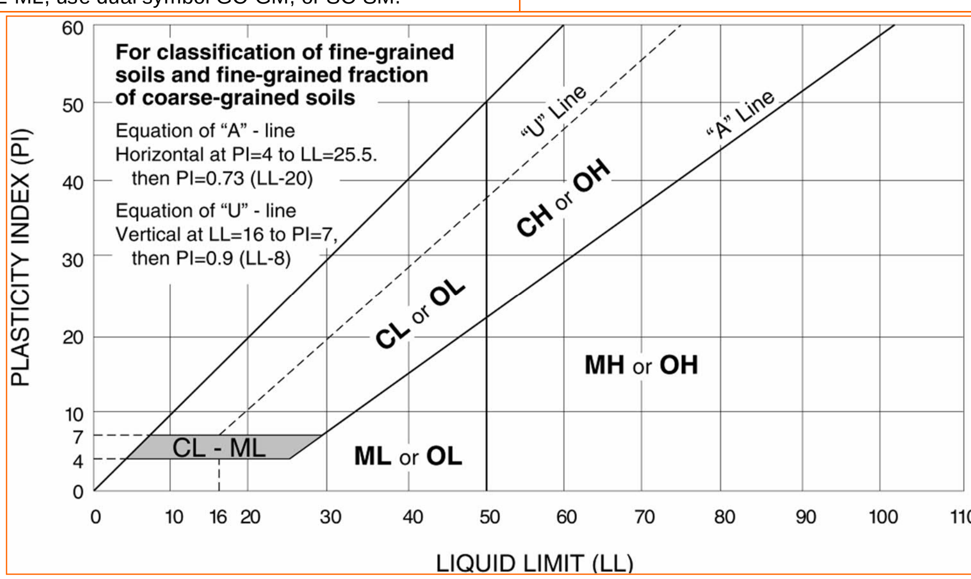
[M] If soil contains $\ge$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \ge 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

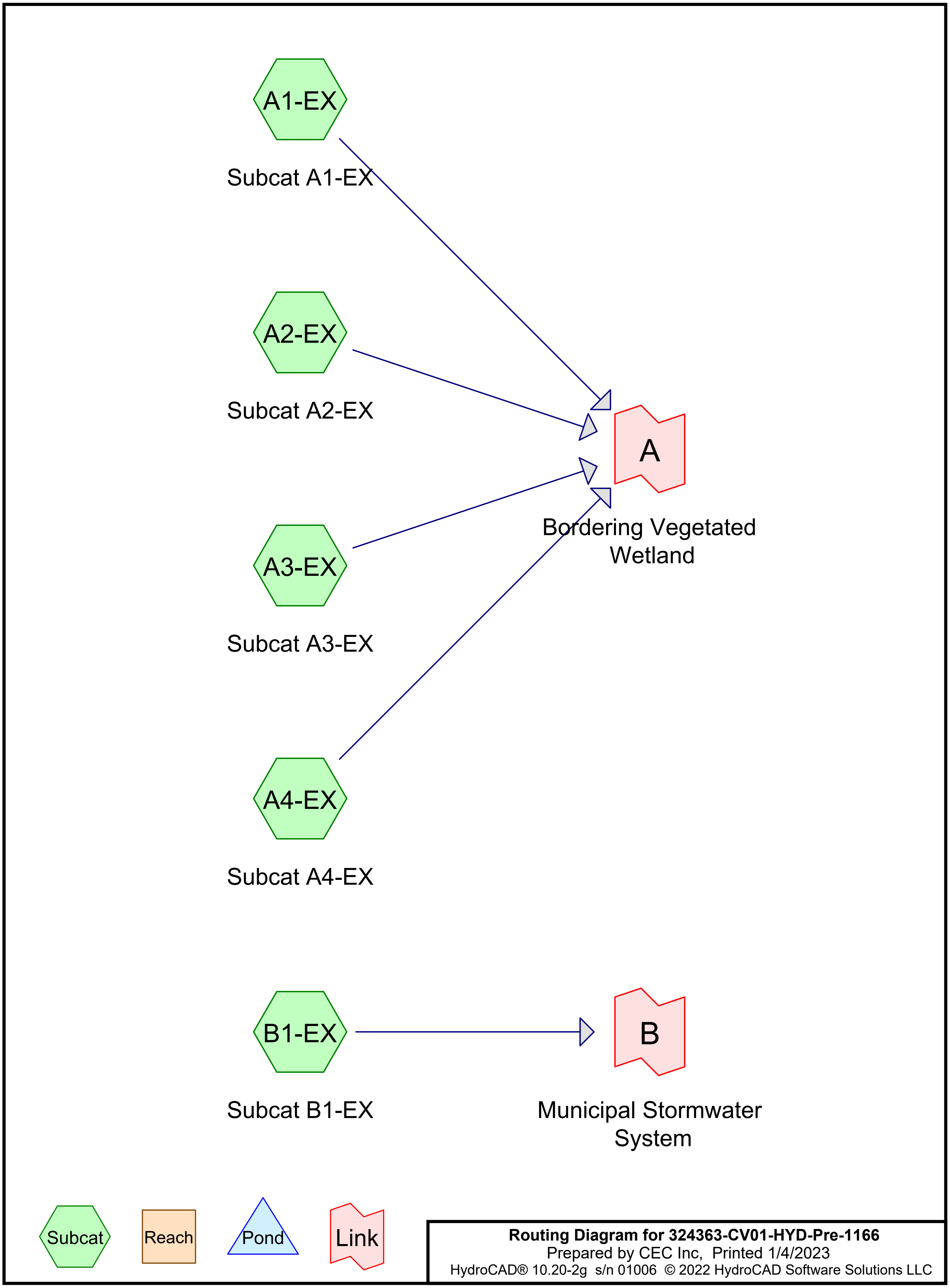


APPENDIX C

SUPPORTING CALCULATIONS

HydroCAD Drainage Analysis
TSS Calculations
Drainage Capacity Calculations
Water Quality Calculations
Recharge Calculations

HydroCAD Drainage Analysis



Routing Diagram for 324363-CV01-HYD-Pre-1166
Prepared by CEC Inc, Printed 1/4/2023
HydroCAD® 10.20-2g s/n 01006 © 2022 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.40	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.80	2
3	25-Year	Type III 24-hr		Default	24.00	1	5.60	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.207	80	>75% Grass cover, Good, HSG D (A1-EX, B1-EX)
0.222	96	Gravel surface, HSG D (A1-EX, A4-EX)
5.378	98	Paved parking, HSG D (A1-EX, A2-EX, A3-EX, A4-EX, B1-EX)
1.554	98	Roofs, HSG D (A1-EX, A2-EX, A3-EX, B1-EX)
1.528	77	Woods, Good, HSG D (A1-EX)
8.890	**94**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
8.890	HSG D	A1-EX, A2-EX, A3-EX, A4-EX, B1-EX
0.000	Other	
8.890		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.207	0.000	0.207	>75% Grass cover, Good	A1-EX, B1-EX
0.000	0.000	0.000	0.222	0.000	0.222	Gravel surface	A1-EX, A4-EX
0.000	0.000	0.000	5.378	0.000	5.378	Paved parking	A1-EX, A2-EX, A3-EX, A4-EX, B1-EX
0.000	0.000	0.000	1.554	0.000	1.554	Roofs	A1-EX, A2-EX, A3-EX, B1-EX
0.000	0.000	0.000	1.528	0.000	1.528	Woods, Good	A1-EX
0.000	**0.000**	**0.000**	**8.890**	**0.000**	**8.890**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A1-EX: Subcat A1-EX Runoff Area=4.903 ac 62.38% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=91 Runoff=13.49 cfs 0.999 af

Subcatchment A2-EX: Subcat A2-EX Runoff Area=0.609 ac 100.00% Impervious Runoff Depth>3.16"
Tc=6.0 min CN=98 Runoff=1.97 cfs 0.161 af

Subcatchment A3-EX: Subcat A3-EX Runoff Area=0.640 ac 100.00% Impervious Runoff Depth>3.16"
Tc=6.0 min CN=98 Runoff=2.07 cfs 0.169 af

Subcatchment A4-EX: Subcat A4-EX Runoff Area=0.779 ac 97.33% Impervious Runoff Depth>3.16"
Flow Length=404' Tc=7.5 min CN=98 Runoff=2.42 cfs 0.205 af

Subcatchment B1-EX: Subcat B1-EX Runoff Area=1.959 ac 95.30% Impervious Runoff Depth>3.05"
Flow Length=216' Tc=20.5 min CN=97 Runoff=4.30 cfs 0.497 af

Link A: Bordering Vegetated Wetland Inflow=19.91 cfs 1.534 af
Primary=19.91 cfs 1.534 af

Link B: Municipal Stormwater System Inflow=4.30 cfs 0.497 af
Primary=4.30 cfs 0.497 af

Total Runoff Area = 8.890 ac Runoff Volume = 2.031 af Average Runoff Depth = 2.74"
22.02% Pervious = 1.957 ac 77.98% Impervious = 6.933 ac

Summary for Subcatchment A1-EX: Subcat A1-EX

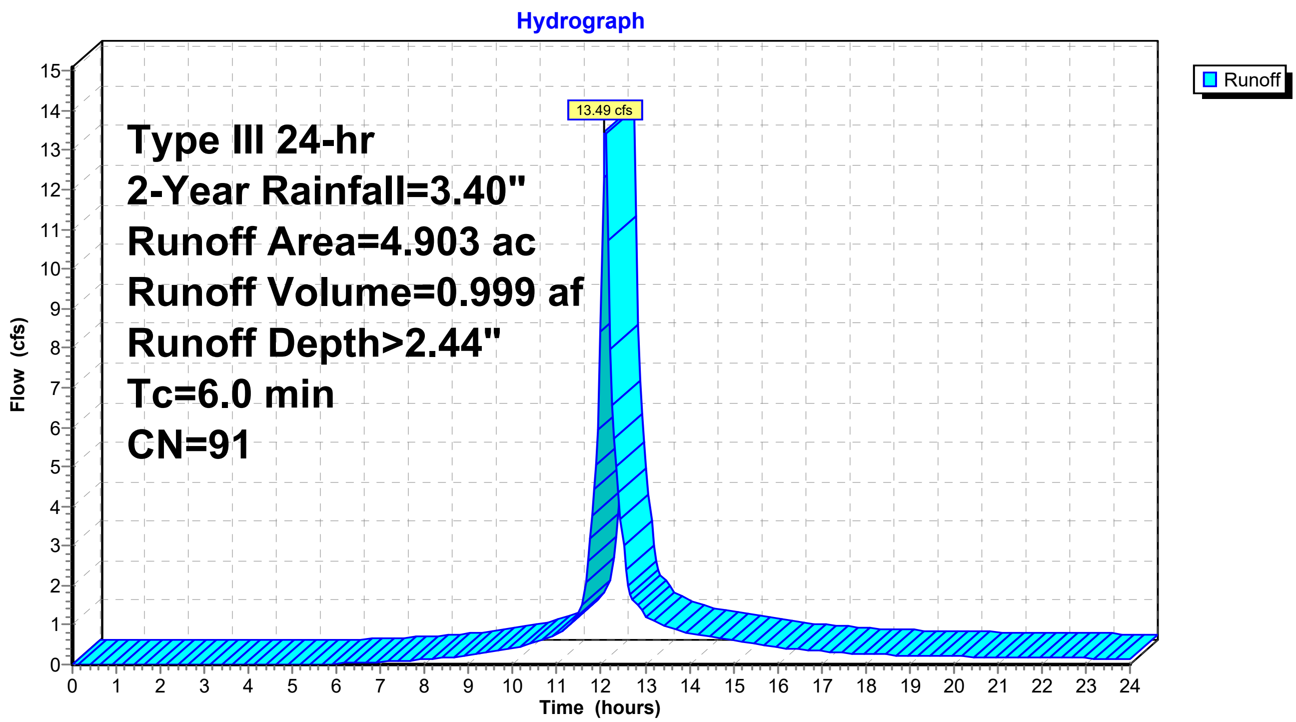
Runoff = 13.49 cfs @ 12.09 hrs, Volume= 0.999 af, Depth> 2.44"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.115	80	>75% Grass cover, Good, HSG D
0.201	96	Gravel surface, HSG D
2.940	98	Paved parking, HSG D
0.118	98	Roofs, HSG D
1.528	77	Woods, Good, HSG D
4.903	91	Weighted Average
1.844		37.62% Pervious Area
3.059		62.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A1-EX: Subcat A1-EX



Summary for Subcatchment A2-EX: Subcat A2-EX

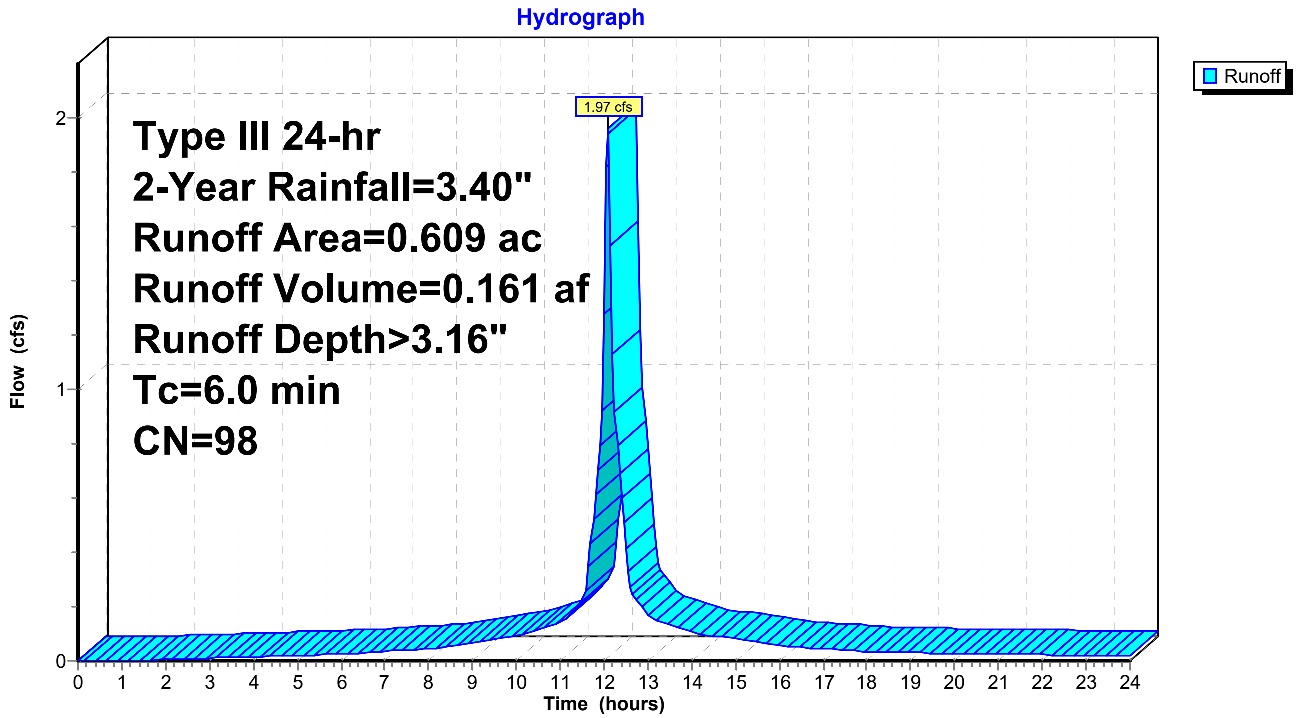
Runoff = 1.97 cfs @ 12.09 hrs, Volume= 0.161 af, Depth> 3.16"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.609	98	Roofs, HSG D
0.609	98	Weighted Average
0.609		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A2-EX: Subcat A2-EX



Summary for Subcatchment A3-EX: Subcat A3-EX

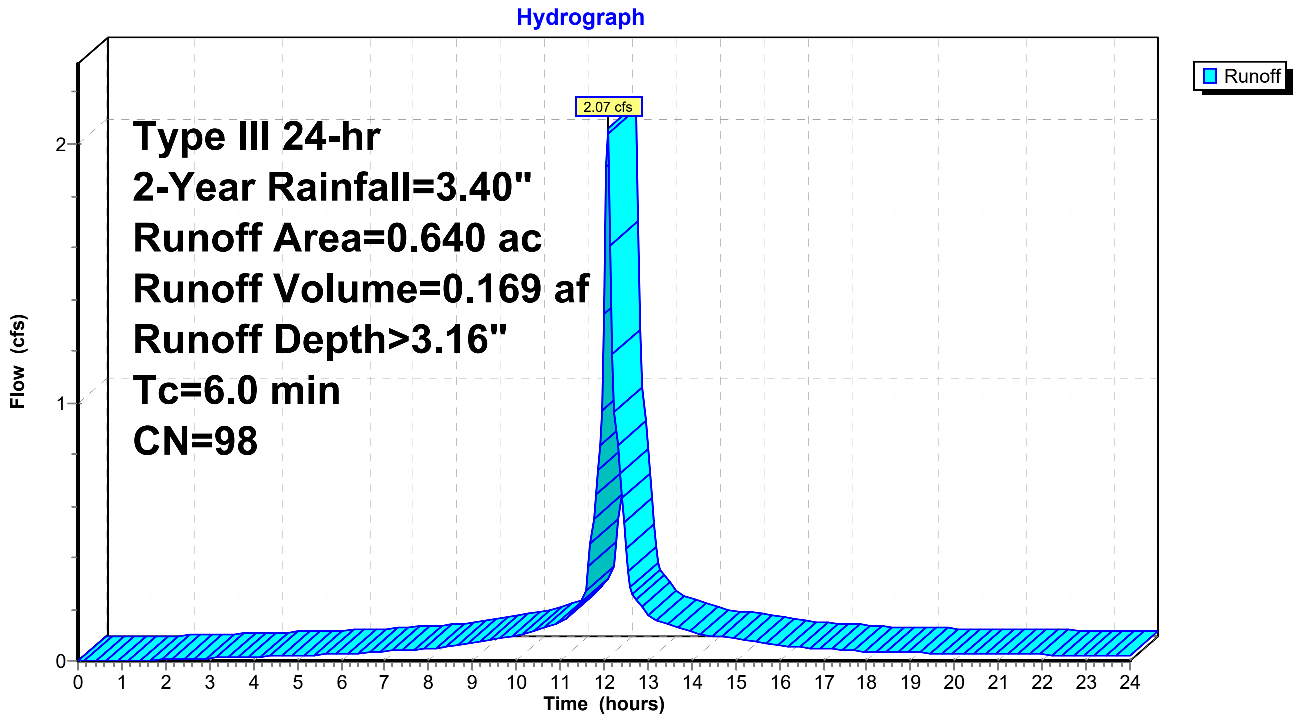
Runoff = 2.07 cfs @ 12.09 hrs, Volume= 0.169 af, Depth> 3.16"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.640	98	Roofs, HSG D
0.640	98	Weighted Average
0.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A3-EX: Subcat A3-EX



Summary for Subcatchment A4-EX: Subcat A4-EX

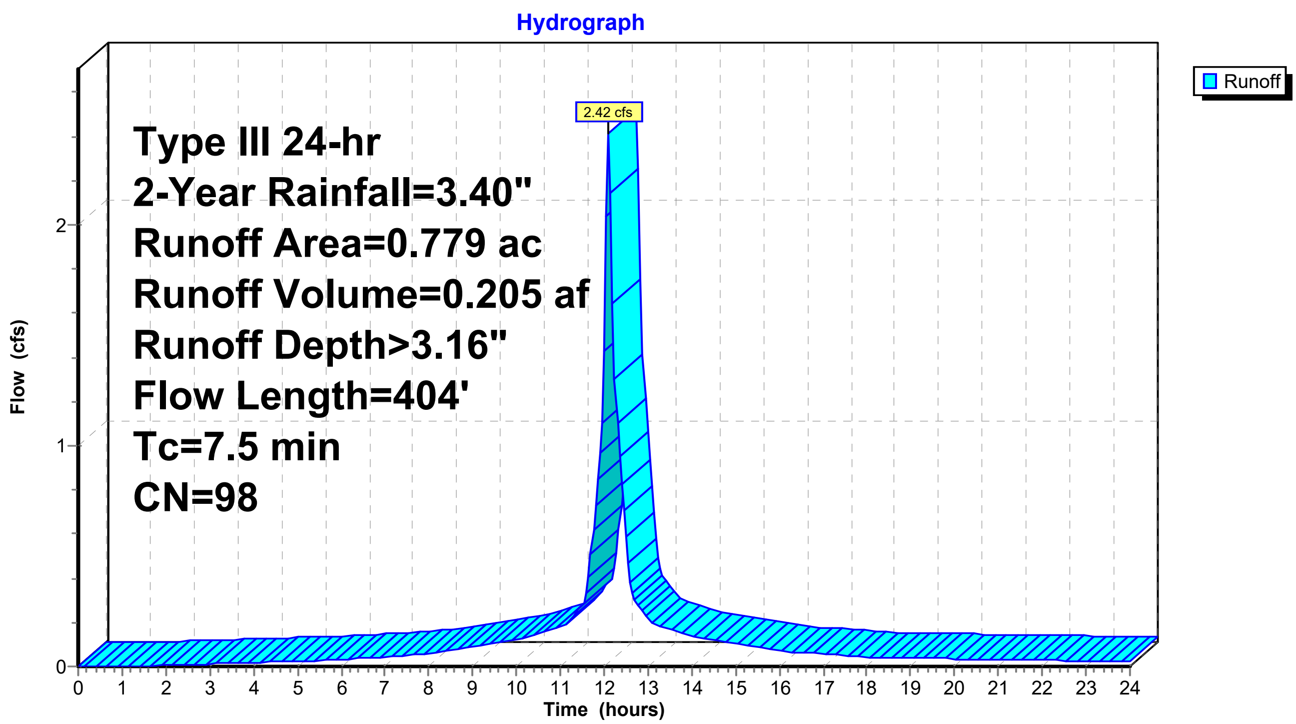
Runoff = 2.42 cfs @ 12.10 hrs, Volume= 0.205 af, Depth> 3.16"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.021	96	Gravel surface, HSG D
0.758	98	Paved parking, HSG D
0.779	98	Weighted Average
0.021		2.67% Pervious Area
0.758		97.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0080	0.23		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.7	190	0.0080	1.82		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	30	0.0033	1.17		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	134	0.0320	1.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.5	404	Total			

Subcatchment A4-EX: Subcat A4-EX



Summary for Subcatchment B1-EX: Subcat B1-EX

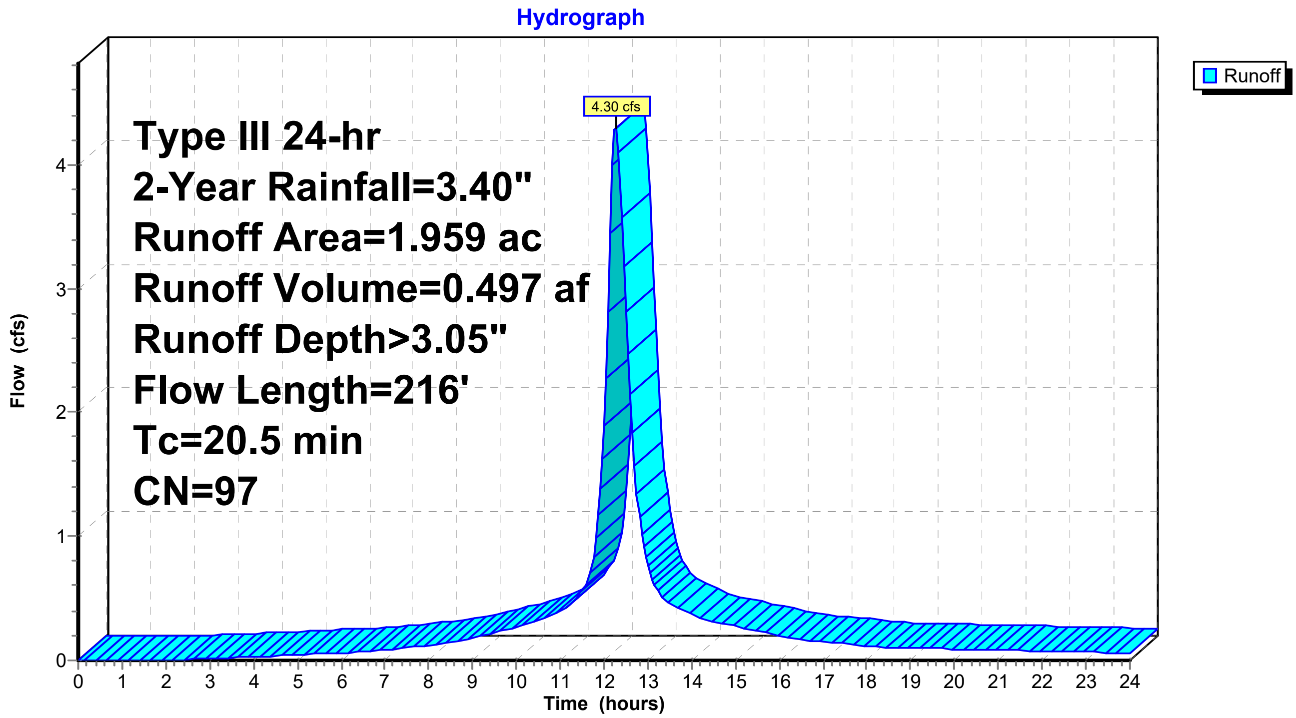
Runoff = 4.30 cfs @ 12.27 hrs, Volume= 0.497 af, Depth> 3.05"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.092	80	>75% Grass cover, Good, HSG D
1.680	98	Paved parking, HSG D
0.187	98	Roofs, HSG D
1.959	97	Weighted Average
0.092		4.70% Pervious Area
1.867		95.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	38	0.0140	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.1	12	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	26	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	117	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
20.5	216	Total			

Subcatchment B1-EX: Subcat B1-EX

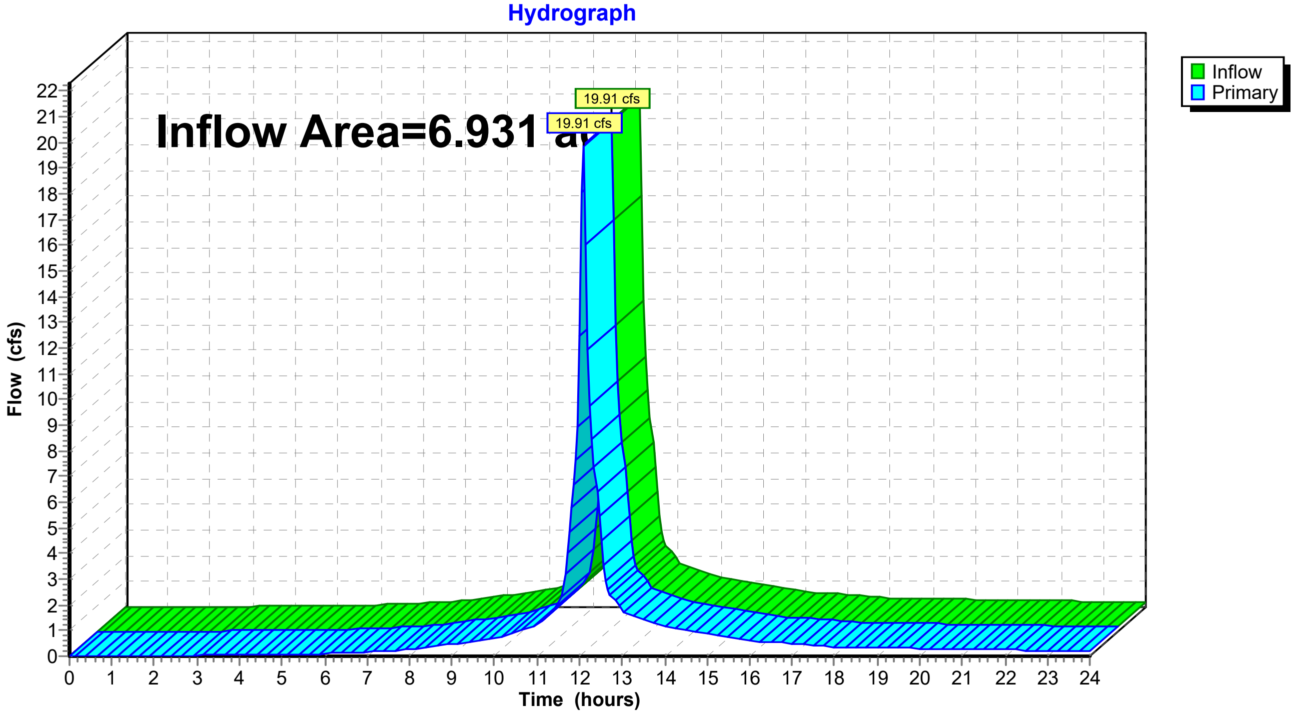


Summary for Link A: Bordering Vegetated Wetland

Inflow Area =	6.931 ac, 73.09% Impervious,	Inflow Depth > 2.66"	for 2-Year event
Inflow =	19.91 cfs @ 12.09 hrs,	Volume= 1.534 af	
Primary =	19.91 cfs @ 12.09 hrs,	Volume= 1.534 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

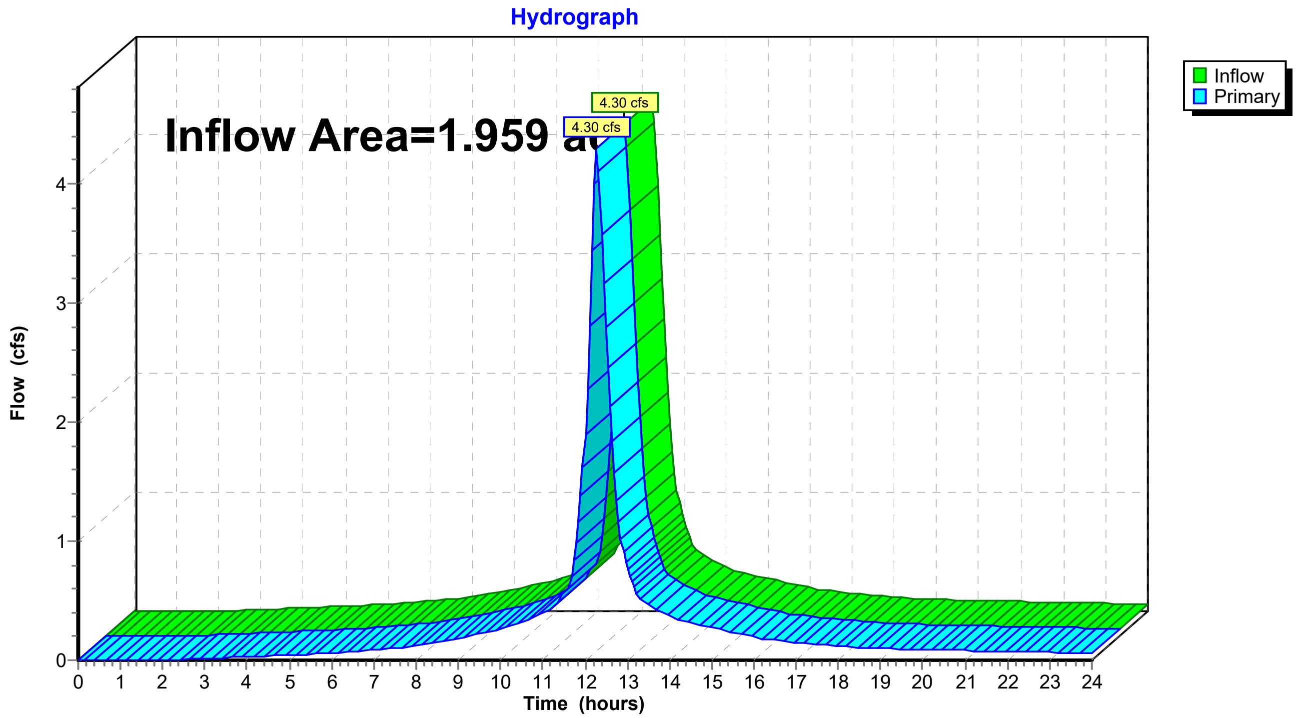


Summary for Link B: Municipal Stormwater System

Inflow Area = 1.959 ac, 95.30% Impervious, Inflow Depth > 3.05" for 2-Year event
Inflow = 4.30 cfs @ 12.27 hrs, Volume= 0.497 af
Primary = 4.30 cfs @ 12.27 hrs, Volume= 0.497 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-EX: Subcat A1-EX Runoff Area=4.903 ac 62.38% Impervious Runoff Depth>3.79"
Tc=6.0 min CN=91 Runoff=20.43 cfs 1.547 af

SubcatchmentA2-EX: Subcat A2-EX Runoff Area=0.609 ac 100.00% Impervious Runoff Depth>4.56"
Tc=6.0 min CN=98 Runoff=2.79 cfs 0.231 af

SubcatchmentA3-EX: Subcat A3-EX Runoff Area=0.640 ac 100.00% Impervious Runoff Depth>4.56"
Tc=6.0 min CN=98 Runoff=2.93 cfs 0.243 af

SubcatchmentA4-EX: Subcat A4-EX Runoff Area=0.779 ac 97.33% Impervious Runoff Depth>4.56"
Flow Length=404' Tc=7.5 min CN=98 Runoff=3.43 cfs 0.296 af

SubcatchmentB1-EX: Subcat B1-EX Runoff Area=1.959 ac 95.30% Impervious Runoff Depth>4.44"
Flow Length=216' Tc=20.5 min CN=97 Runoff=6.15 cfs 0.724 af

Link A: Bordering Vegetated Wetland Inflow=29.55 cfs 2.317 af
Primary=29.55 cfs 2.317 af

Link B: Municipal Stormwater System Inflow=6.15 cfs 0.724 af
Primary=6.15 cfs 0.724 af

Total Runoff Area = 8.890 ac Runoff Volume = 3.041 af Average Runoff Depth = 4.11"
22.02% Pervious = 1.957 ac 77.98% Impervious = 6.933 ac

Summary for Subcatchment A1-EX: Subcat A1-EX

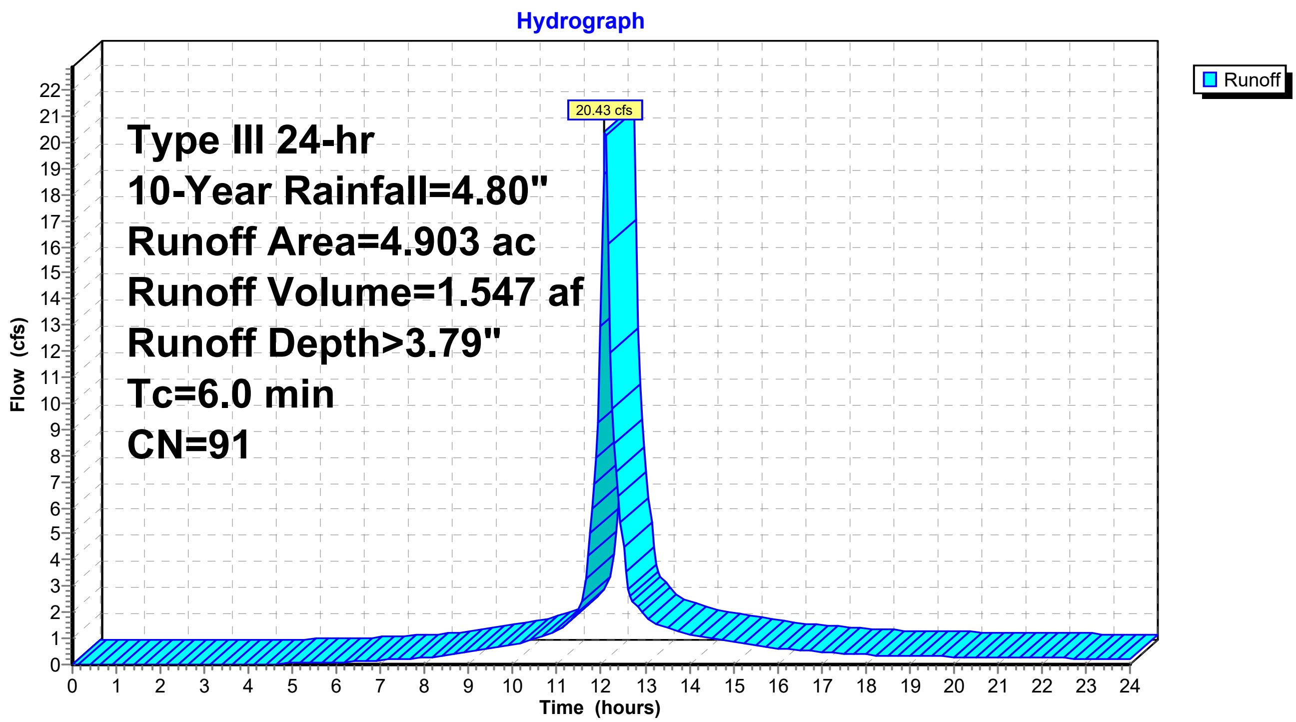
Runoff = 20.43 cfs @ 12.09 hrs, Volume= 1.547 af, Depth> 3.79"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.115	80	>75% Grass cover, Good, HSG D
0.201	96	Gravel surface, HSG D
2.940	98	Paved parking, HSG D
0.118	98	Roofs, HSG D
1.528	77	Woods, Good, HSG D
4.903	91	Weighted Average
1.844		37.62% Pervious Area
3.059		62.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A1-EX: Subcat A1-EX



Summary for Subcatchment A2-EX: Subcat A2-EX

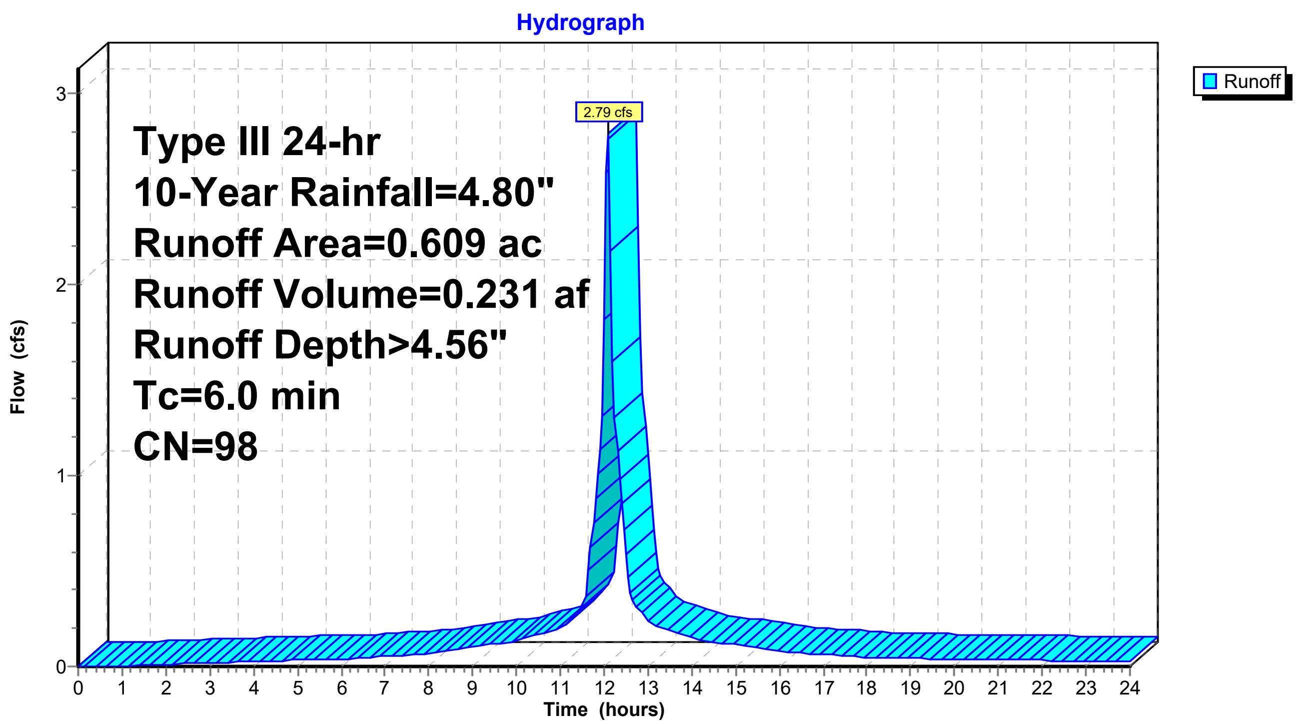
Runoff = 2.79 cfs @ 12.09 hrs, Volume= 0.231 af, Depth> 4.56"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.609	98	Roofs, HSG D
0.609	98	Weighted Average
0.609		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A2-EX: Subcat A2-EX



Summary for Subcatchment A3-EX: Subcat A3-EX

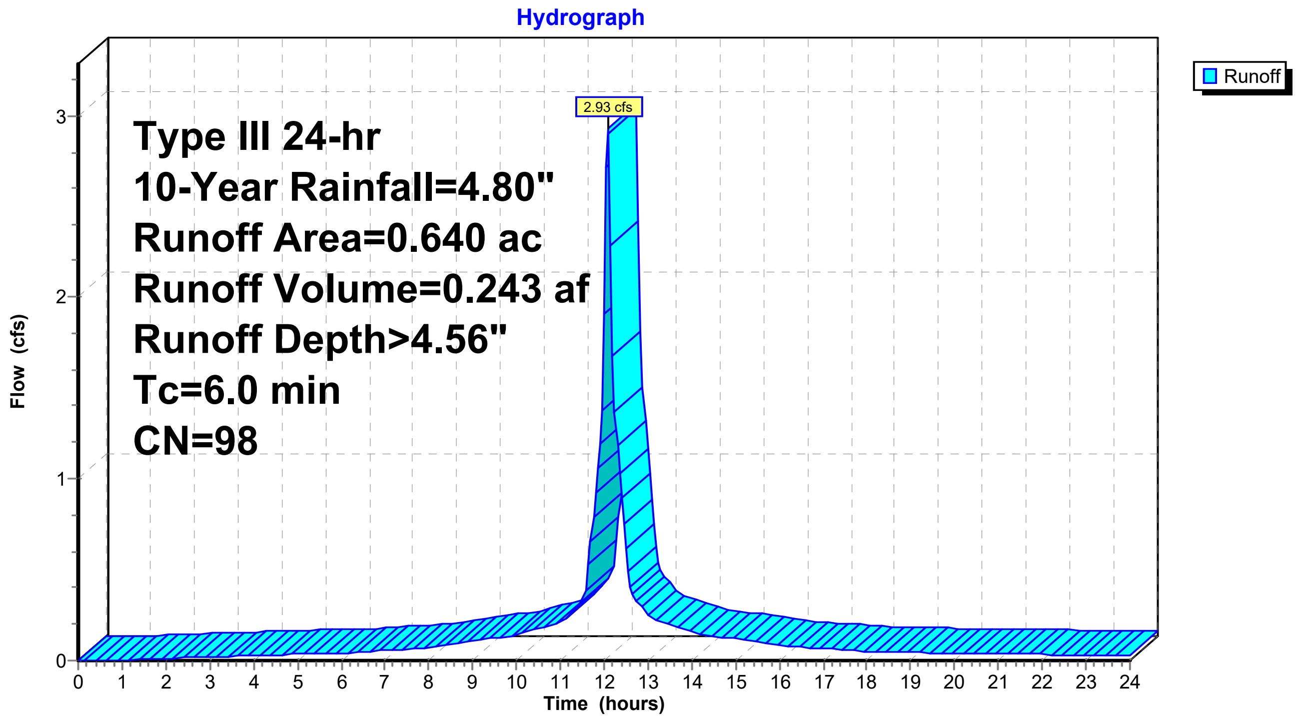
Runoff = 2.93 cfs @ 12.09 hrs, Volume= 0.243 af, Depth> 4.56"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.640	98	Roofs, HSG D
0.640	98	Weighted Average
0.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A3-EX: Subcat A3-EX



Summary for Subcatchment A4-EX: Subcat A4-EX

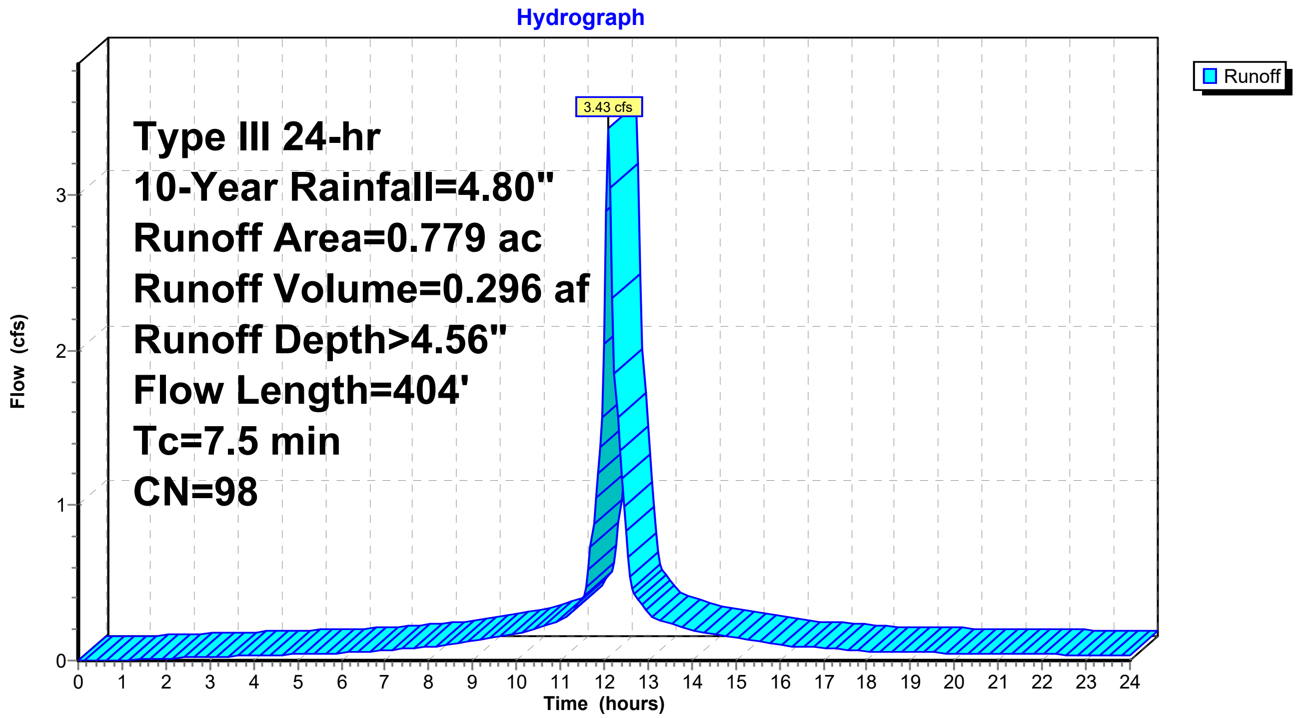
Runoff = 3.43 cfs @ 12.10 hrs, Volume= 0.296 af, Depth> 4.56"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.021	96	Gravel surface, HSG D
0.758	98	Paved parking, HSG D
0.779	98	Weighted Average
0.021		2.67% Pervious Area
0.758		97.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0080	0.23		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.7	190	0.0080	1.82		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	30	0.0033	1.17		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	134	0.0320	1.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.5	404	Total			

Subcatchment A4-EX: Subcat A4-EX



Summary for Subcatchment B1-EX: Subcat B1-EX

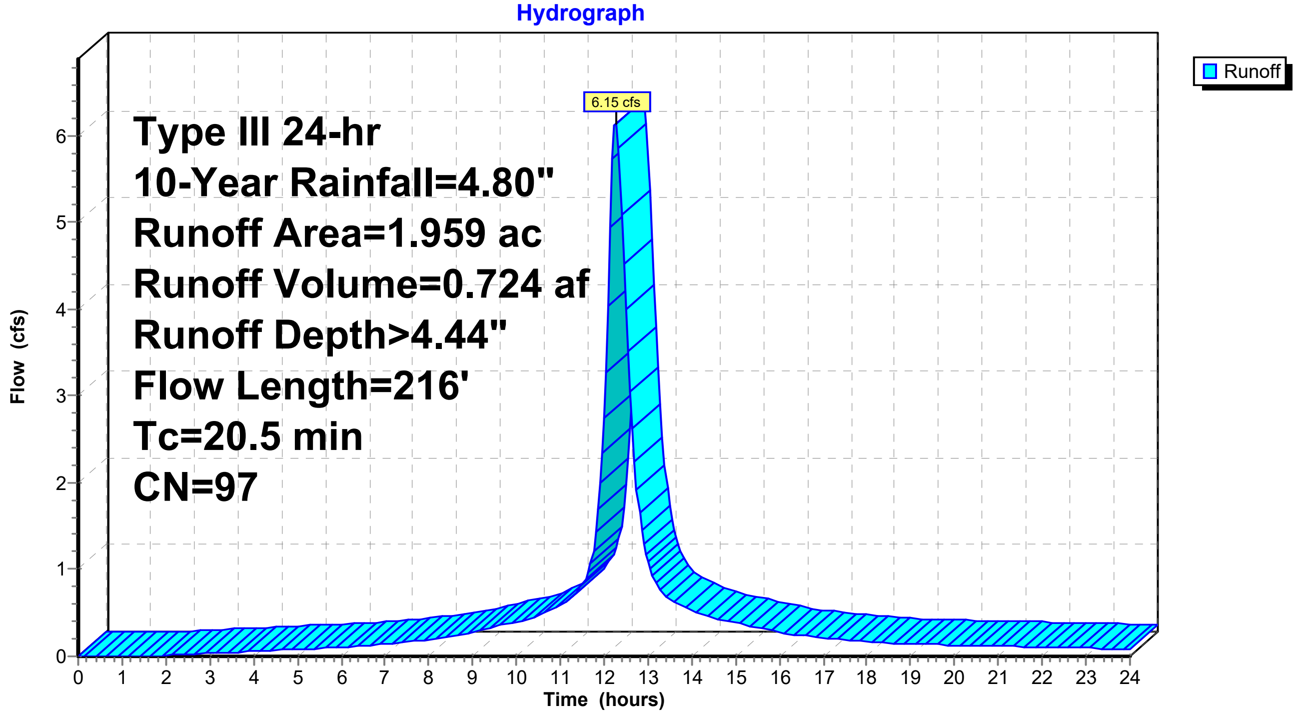
Runoff = 6.15 cfs @ 12.27 hrs, Volume= 0.724 af, Depth> 4.44"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.092	80	>75% Grass cover, Good, HSG D
1.680	98	Paved parking, HSG D
0.187	98	Roofs, HSG D
1.959	97	Weighted Average
0.092		4.70% Pervious Area
1.867		95.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	38	0.0140	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.1	12	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	26	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	117	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
20.5	216	Total			

Subcatchment B1-EX: Subcat B1-EX

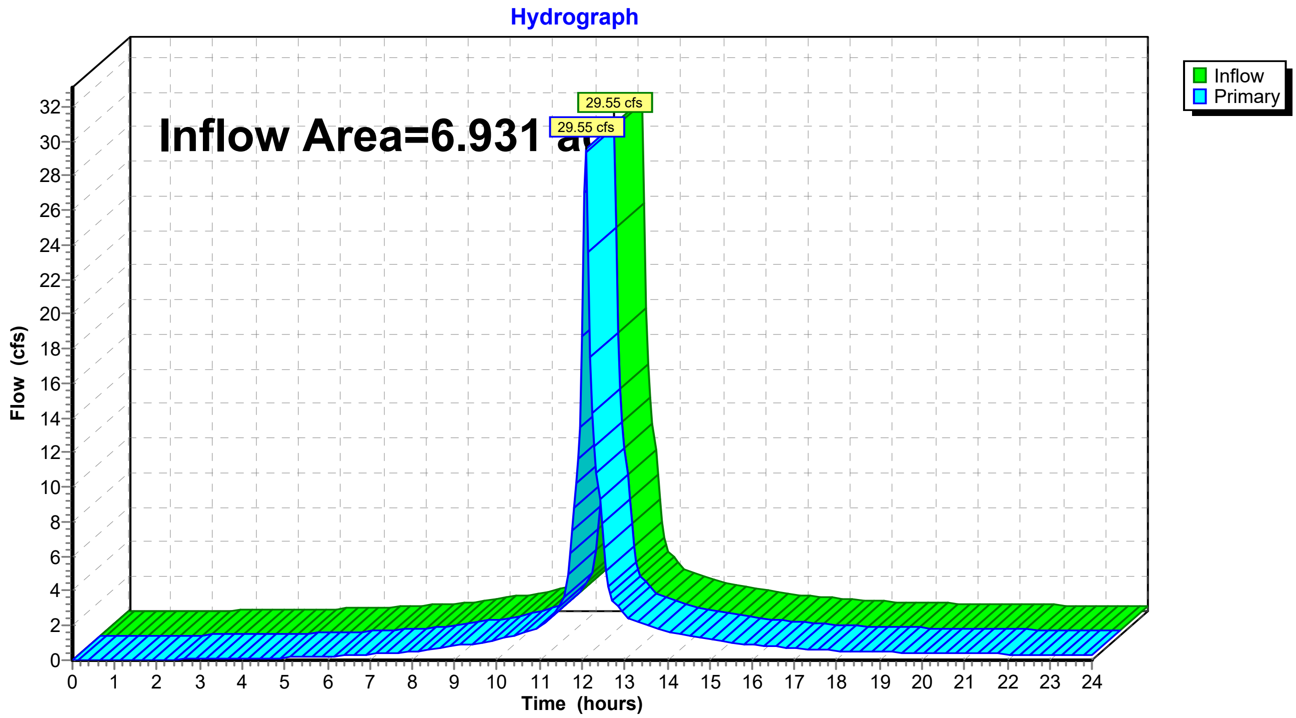


Summary for Link A: Bordering Vegetated Wetland

Inflow Area =	6.931 ac,	73.09% Impervious,	Inflow Depth > 4.01"	for 10-Year event
Inflow =	29.55 cfs @	12.09 hrs, Volume=	2.317 af	
Primary =	29.55 cfs @	12.09 hrs, Volume=	2.317 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

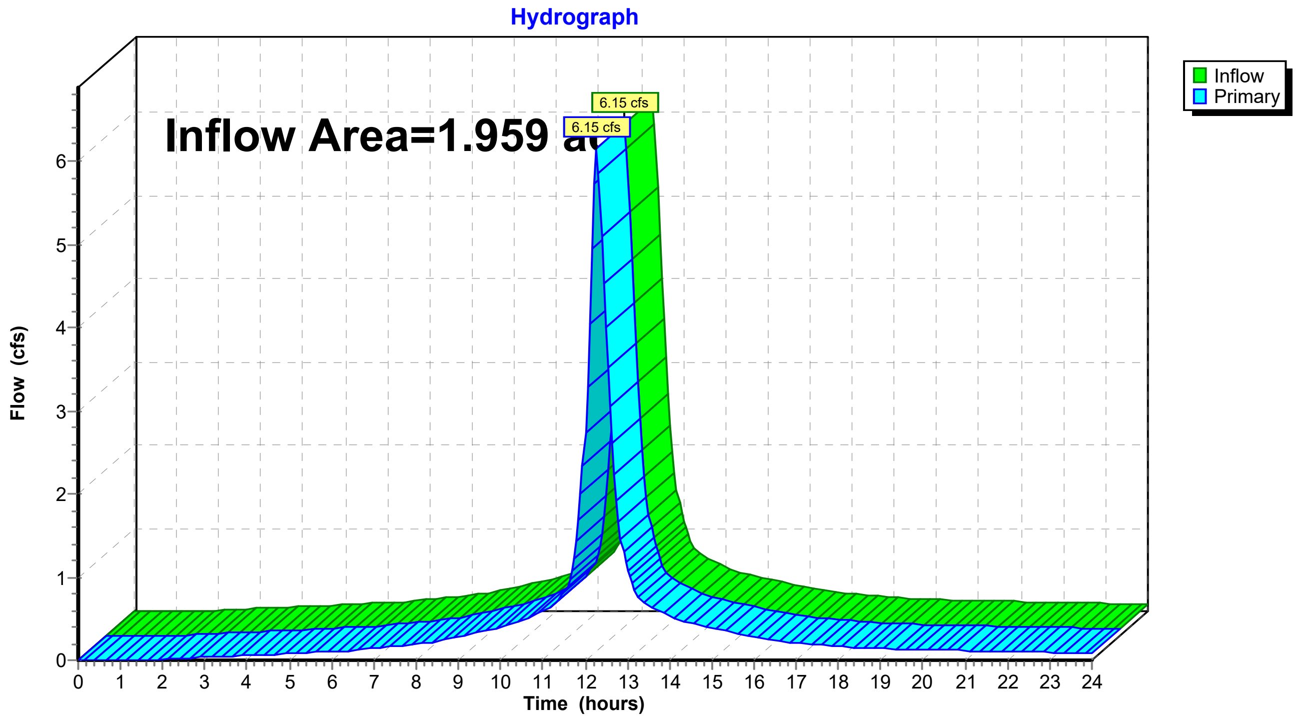


Summary for Link B: Municipal Stormwater System

Inflow Area = 1.959 ac, 95.30% Impervious, Inflow Depth > 4.44" for 10-Year event
Inflow = 6.15 cfs @ 12.27 hrs, Volume= 0.724 af
Primary = 6.15 cfs @ 12.27 hrs, Volume= 0.724 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-EX: Subcat A1-EX Runoff Area=4.903 ac 62.38% Impervious Runoff Depth>4.56"
Tc=6.0 min CN=91 Runoff=24.37 cfs 1.864 af

SubcatchmentA2-EX: Subcat A2-EX Runoff Area=0.609 ac 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=3.26 cfs 0.272 af

SubcatchmentA3-EX: Subcat A3-EX Runoff Area=0.640 ac 100.00% Impervious Runoff Depth>5.36"
Tc=6.0 min CN=98 Runoff=3.43 cfs 0.286 af

SubcatchmentA4-EX: Subcat A4-EX Runoff Area=0.779 ac 97.33% Impervious Runoff Depth>5.36"
Flow Length=404' Tc=7.5 min CN=98 Runoff=4.01 cfs 0.348 af

SubcatchmentB1-EX: Subcat B1-EX Runoff Area=1.959 ac 95.30% Impervious Runoff Depth>5.23"
Flow Length=216' Tc=20.5 min CN=97 Runoff=7.20 cfs 0.854 af

Link A: Bordering Vegetated Wetland Inflow=35.02 cfs 2.770 af
Primary=35.02 cfs 2.770 af

Link B: Municipal Stormwater System Inflow=7.20 cfs 0.854 af
Primary=7.20 cfs 0.854 af

Total Runoff Area = 8.890 ac Runoff Volume = 3.624 af Average Runoff Depth = 4.89"
22.02% Pervious = 1.957 ac 77.98% Impervious = 6.933 ac

Summary for Subcatchment A1-EX: Subcat A1-EX

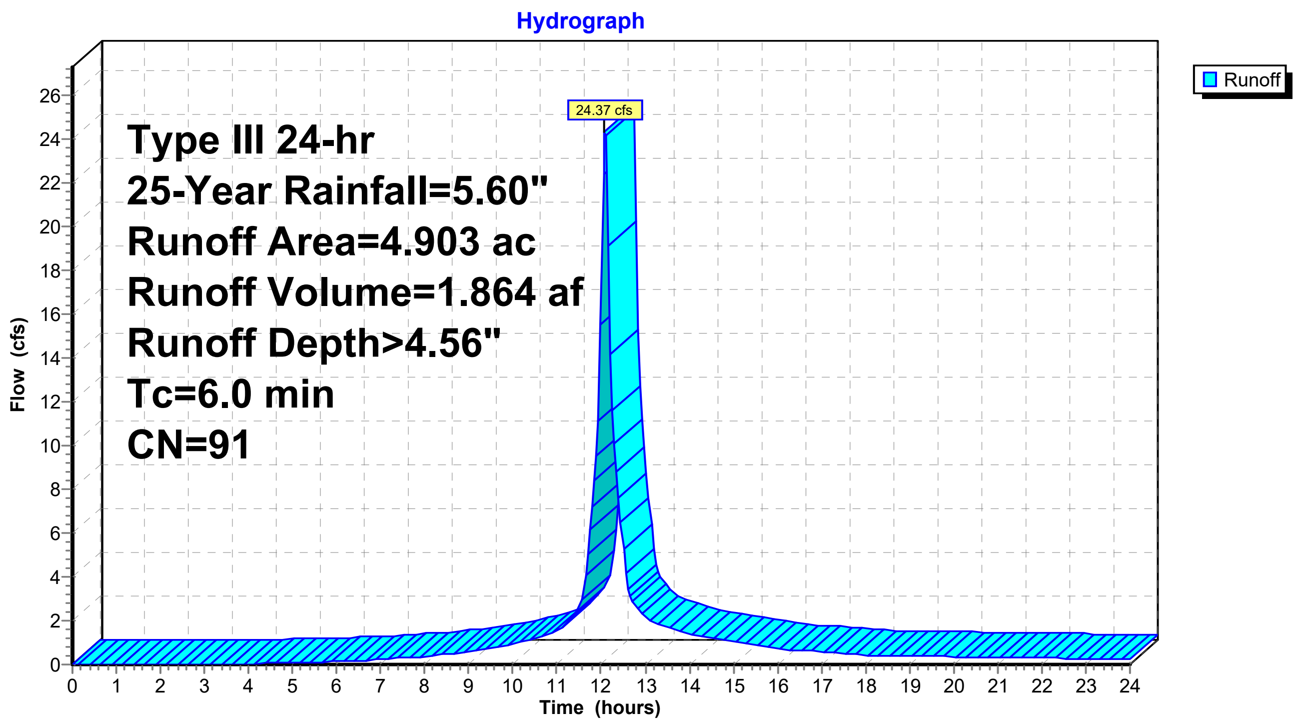
Runoff = 24.37 cfs @ 12.09 hrs, Volume= 1.864 af, Depth> 4.56"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.115	80	>75% Grass cover, Good, HSG D
0.201	96	Gravel surface, HSG D
2.940	98	Paved parking, HSG D
0.118	98	Roofs, HSG D
1.528	77	Woods, Good, HSG D
4.903	91	Weighted Average
1.844		37.62% Pervious Area
3.059		62.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A1-EX: Subcat A1-EX



Summary for Subcatchment A2-EX: Subcat A2-EX

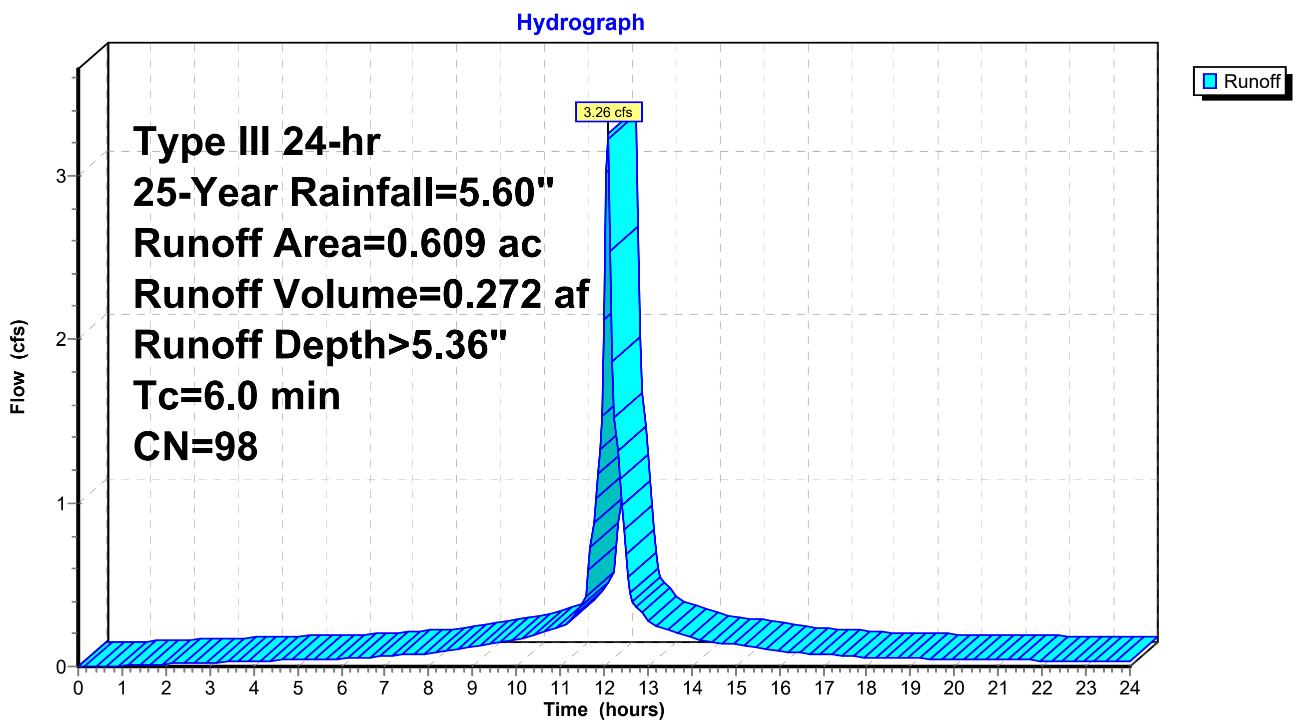
Runoff = 3.26 cfs @ 12.09 hrs, Volume= 0.272 af, Depth> 5.36"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.609	98	Roofs, HSG D
0.609	98	Weighted Average
0.609		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A2-EX: Subcat A2-EX



Summary for Subcatchment A3-EX: Subcat A3-EX

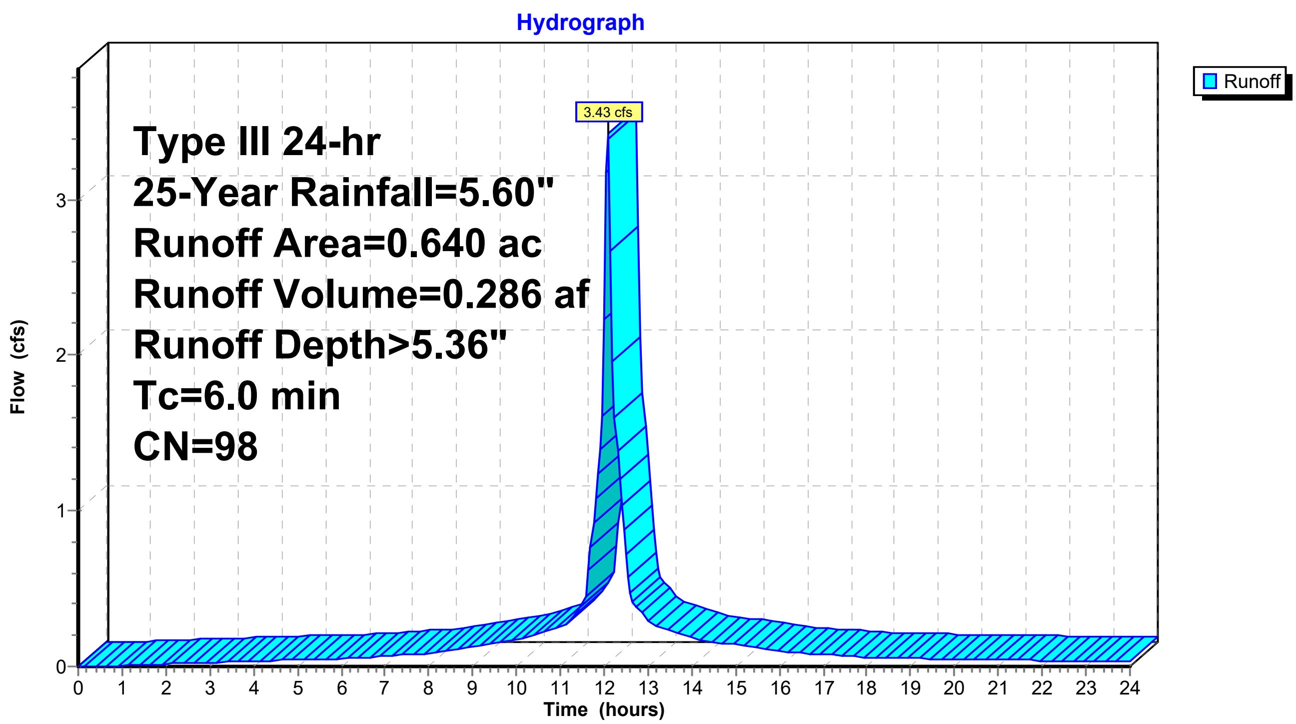
Runoff = 3.43 cfs @ 12.09 hrs, Volume= 0.286 af, Depth> 5.36"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.640	98	Roofs, HSG D
0.640	98	Weighted Average
0.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A3-EX: Subcat A3-EX



Summary for Subcatchment A4-EX: Subcat A4-EX

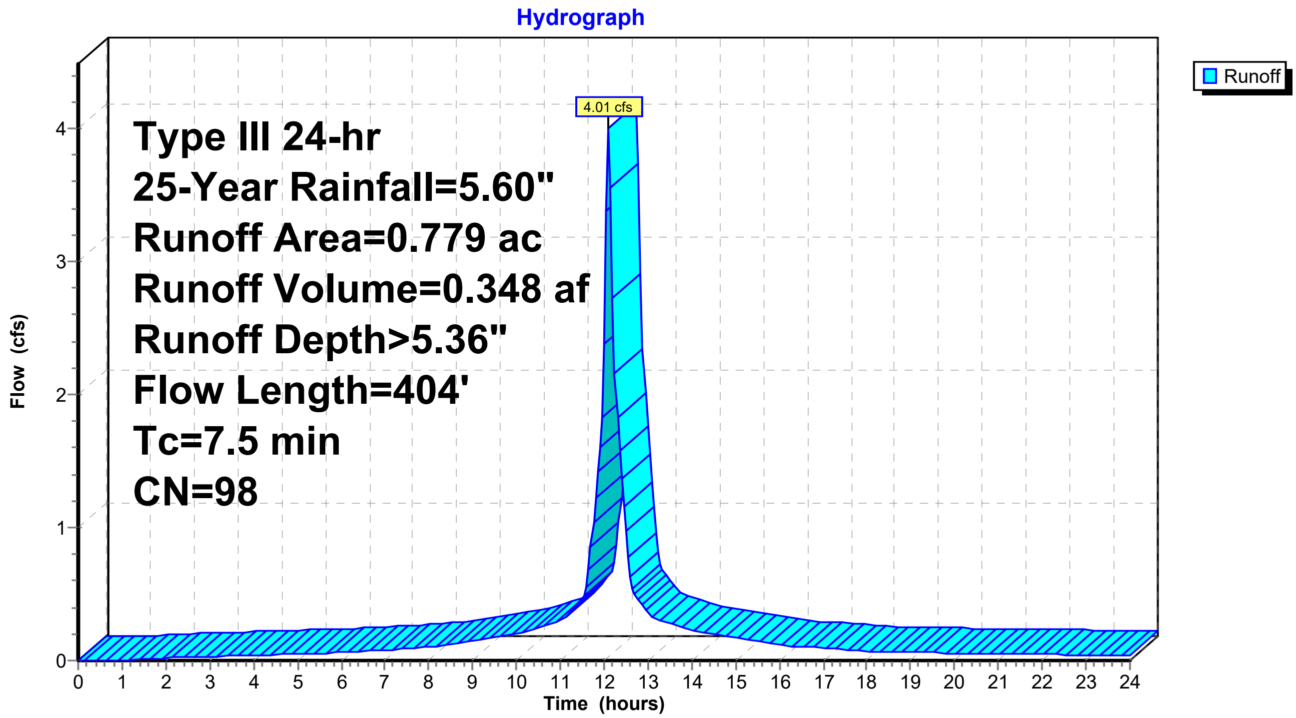
Runoff = 4.01 cfs @ 12.10 hrs, Volume= 0.348 af, Depth> 5.36"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.021	96	Gravel surface, HSG D
0.758	98	Paved parking, HSG D
0.779	98	Weighted Average
0.021		2.67% Pervious Area
0.758		97.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0080	0.23		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.7	190	0.0080	1.82		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	30	0.0033	1.17		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	134	0.0320	1.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.5	404	Total			

Subcatchment A4-EX: Subcat A4-EX



Summary for Subcatchment B1-EX: Subcat B1-EX

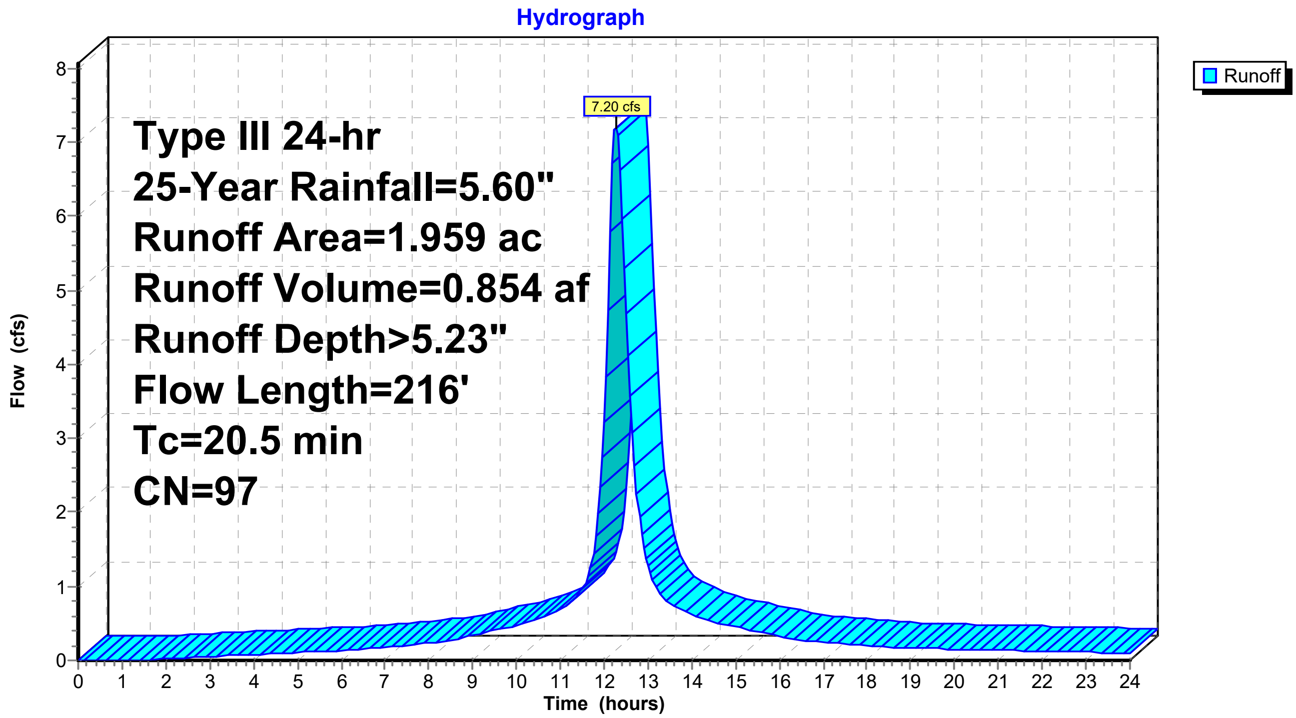
Runoff = 7.20 cfs @ 12.27 hrs, Volume= 0.854 af, Depth> 5.23"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.092	80	>75% Grass cover, Good, HSG D
1.680	98	Paved parking, HSG D
0.187	98	Roofs, HSG D
1.959	97	Weighted Average
0.092		4.70% Pervious Area
1.867		95.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	38	0.0140	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.1	12	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	26	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	117	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
20.5	216	Total			

Subcatchment B1-EX: Subcat B1-EX

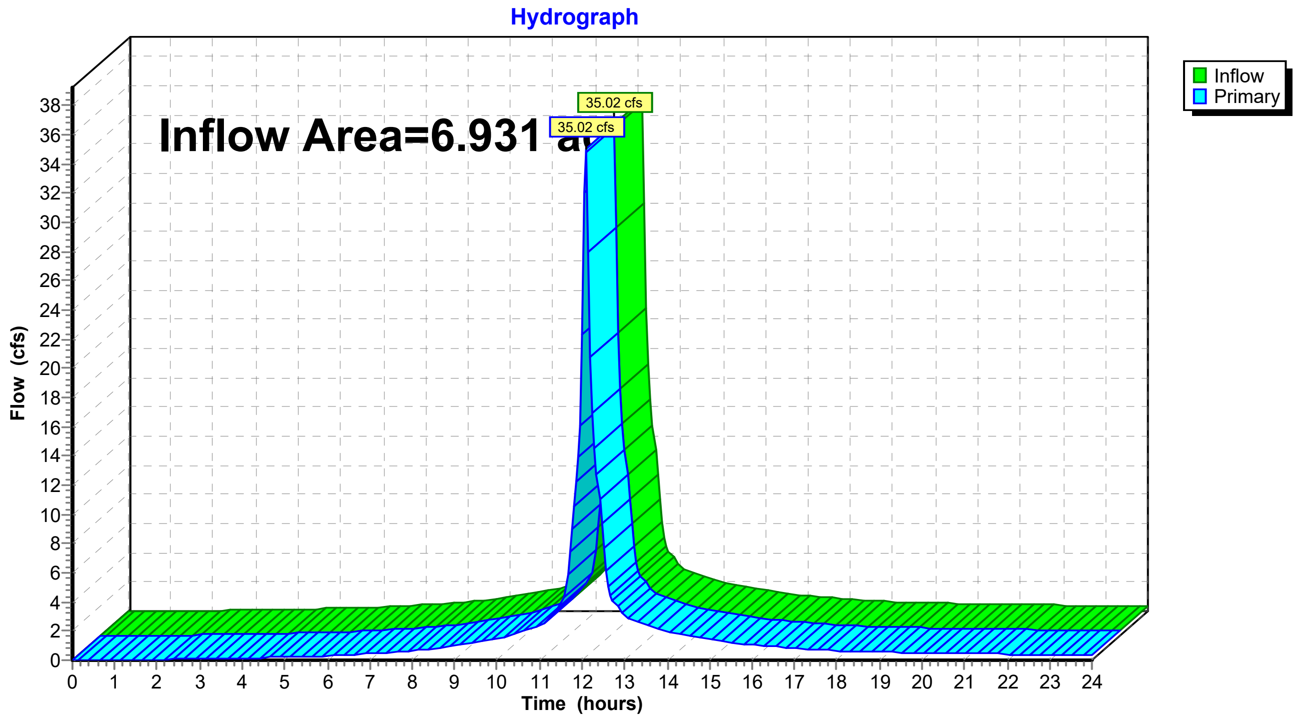


Summary for Link A: Bordering Vegetated Wetland

Inflow Area =	6.931 ac,	73.09% Impervious,	Inflow Depth > 4.80"	for 25-Year event	
Inflow =	35.02 cfs @	12.09 hrs,	Volume=	2.770 af	
Primary =	35.02 cfs @	12.09 hrs,	Volume=	2.770 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

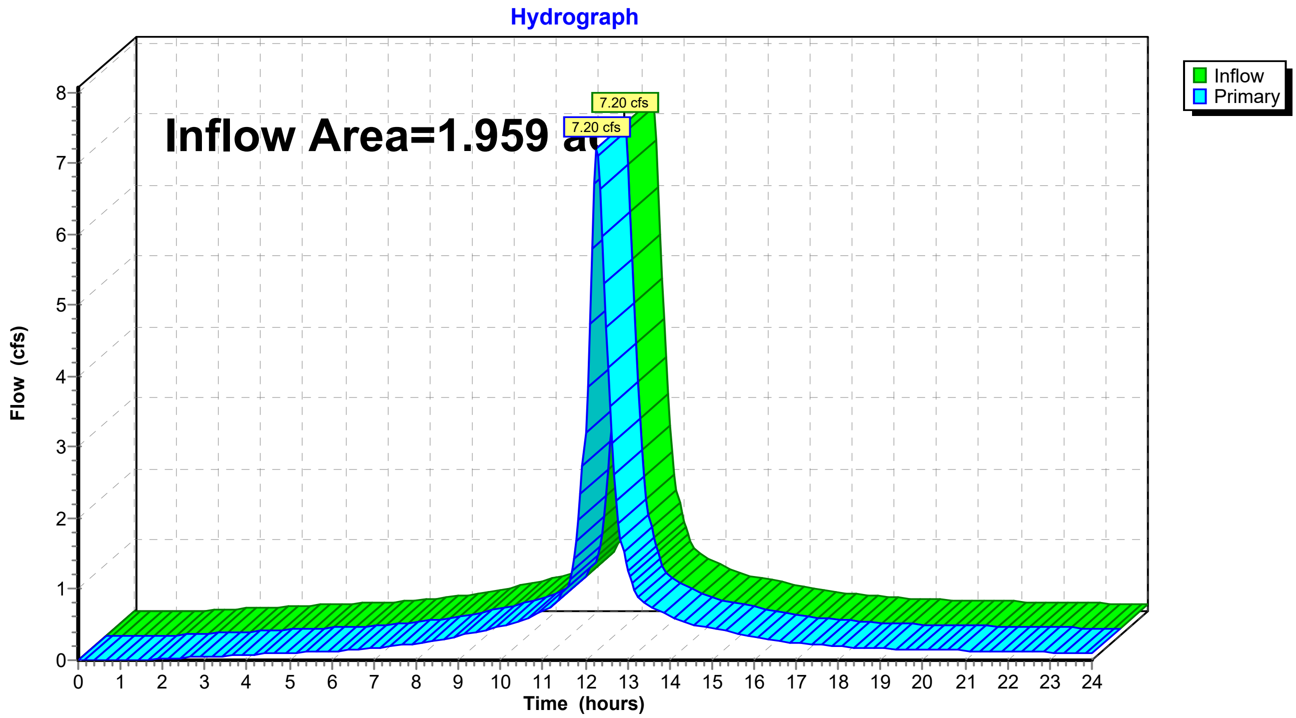


Summary for Link B: Municipal Stormwater System

Inflow Area =	1.959 ac, 95.30% Impervious,	Inflow Depth >	5.23"	for 25-Year event
Inflow =	7.20 cfs @ 12.27 hrs,	Volume=	0.854 af	
Primary =	7.20 cfs @ 12.27 hrs,	Volume=	0.854 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A1-EX: Subcat A1-EX Runoff Area=4.903 ac 62.38% Impervious Runoff Depth>5.93"
Tc=6.0 min CN=91 Runoff=31.21 cfs 2.425 af

Subcatchment A2-EX: Subcat A2-EX Runoff Area=0.609 ac 100.00% Impervious Runoff Depth>6.76"
Tc=6.0 min CN=98 Runoff=4.08 cfs 0.343 af

Subcatchment A3-EX: Subcat A3-EX Runoff Area=0.640 ac 100.00% Impervious Runoff Depth>6.76"
Tc=6.0 min CN=98 Runoff=4.29 cfs 0.360 af

Subcatchment A4-EX: Subcat A4-EX Runoff Area=0.779 ac 97.33% Impervious Runoff Depth>6.76"
Flow Length=404' Tc=7.5 min CN=98 Runoff=5.02 cfs 0.438 af

Subcatchment B1-EX: Subcat B1-EX Runoff Area=1.959 ac 95.30% Impervious Runoff Depth>6.62"
Flow Length=216' Tc=20.5 min CN=97 Runoff=9.04 cfs 1.081 af

Link A: Bordering Vegetated Wetland Inflow=44.55 cfs 3.567 af
Primary=44.55 cfs 3.567 af

Link B: Municipal Stormwater System Inflow=9.04 cfs 1.081 af
Primary=9.04 cfs 1.081 af

Total Runoff Area = 8.890 ac Runoff Volume = 4.648 af Average Runoff Depth = 6.27"
22.02% Pervious = 1.957 ac 77.98% Impervious = 6.933 ac

Summary for Subcatchment A1-EX: Subcat A1-EX

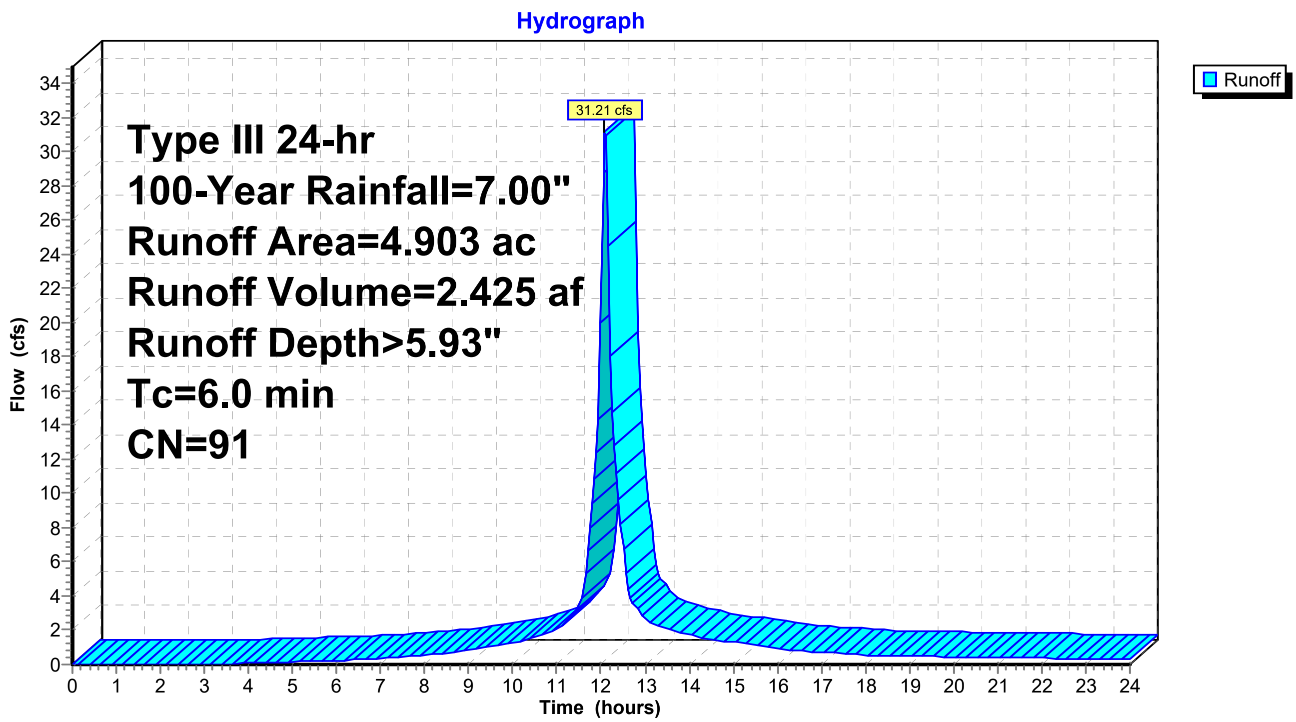
Runoff = 31.21 cfs @ 12.09 hrs, Volume= 2.425 af, Depth> 5.93"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.115	80	>75% Grass cover, Good, HSG D
0.201	96	Gravel surface, HSG D
2.940	98	Paved parking, HSG D
0.118	98	Roofs, HSG D
1.528	77	Woods, Good, HSG D
4.903	91	Weighted Average
1.844		37.62% Pervious Area
3.059		62.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A1-EX: Subcat A1-EX



Summary for Subcatchment A2-EX: Subcat A2-EX

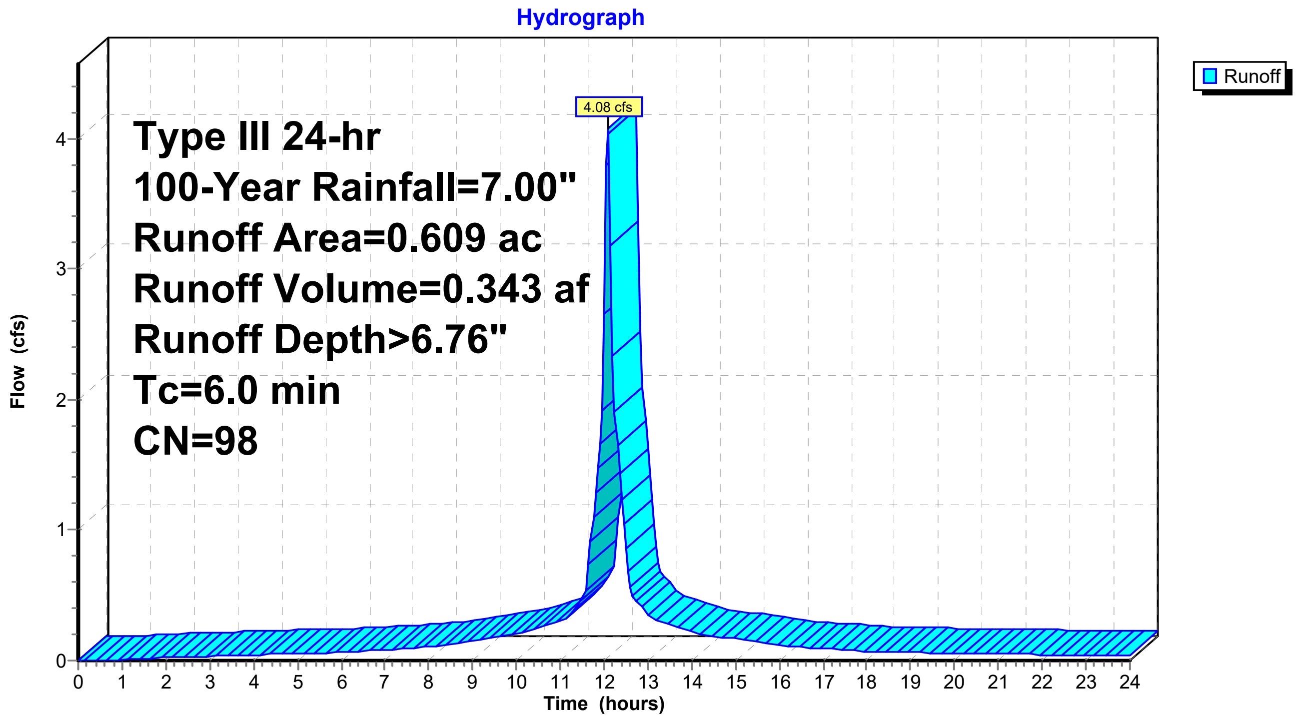
Runoff = 4.08 cfs @ 12.09 hrs, Volume= 0.343 af, Depth> 6.76"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.609	98	Roofs, HSG D
0.609	98	Weighted Average
0.609		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A2-EX: Subcat A2-EX



Summary for Subcatchment A3-EX: Subcat A3-EX

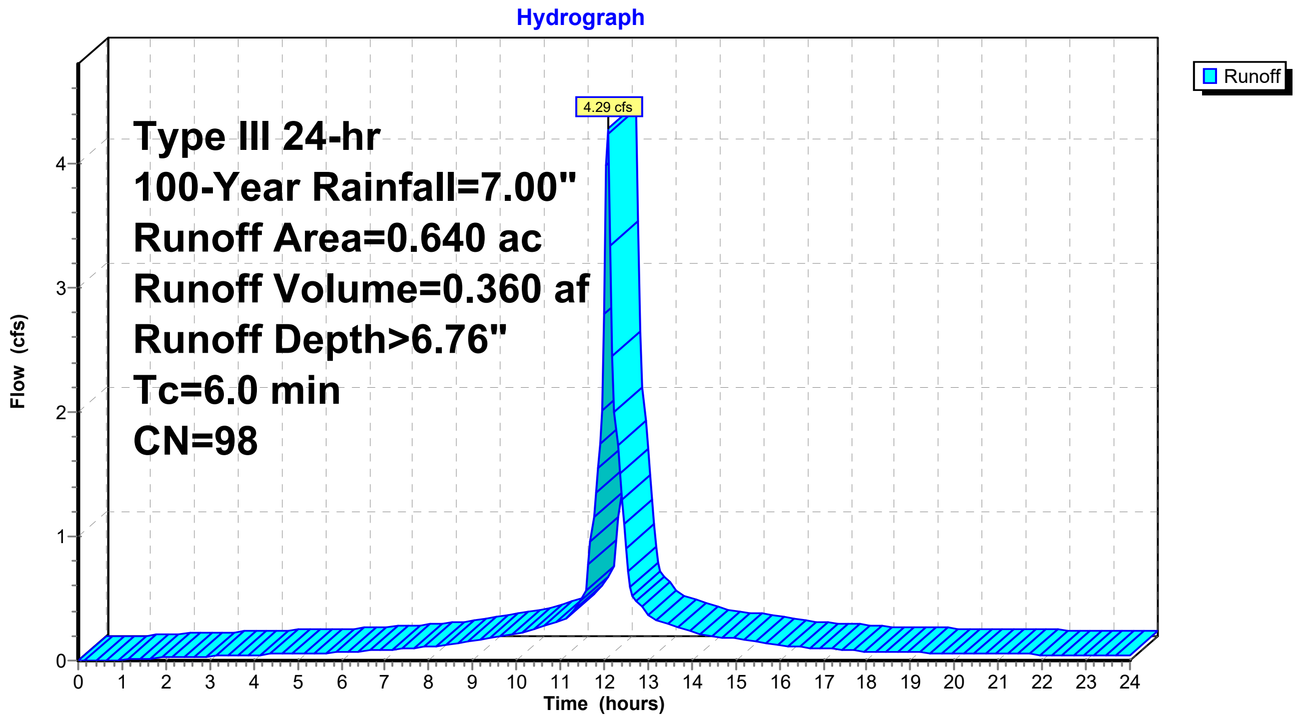
Runoff = 4.29 cfs @ 12.09 hrs, Volume= 0.360 af, Depth> 6.76"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.000	98	Paved parking, HSG D
0.640	98	Roofs, HSG D
0.640	98	Weighted Average
0.640		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A3-EX: Subcat A3-EX



Summary for Subcatchment A4-EX: Subcat A4-EX

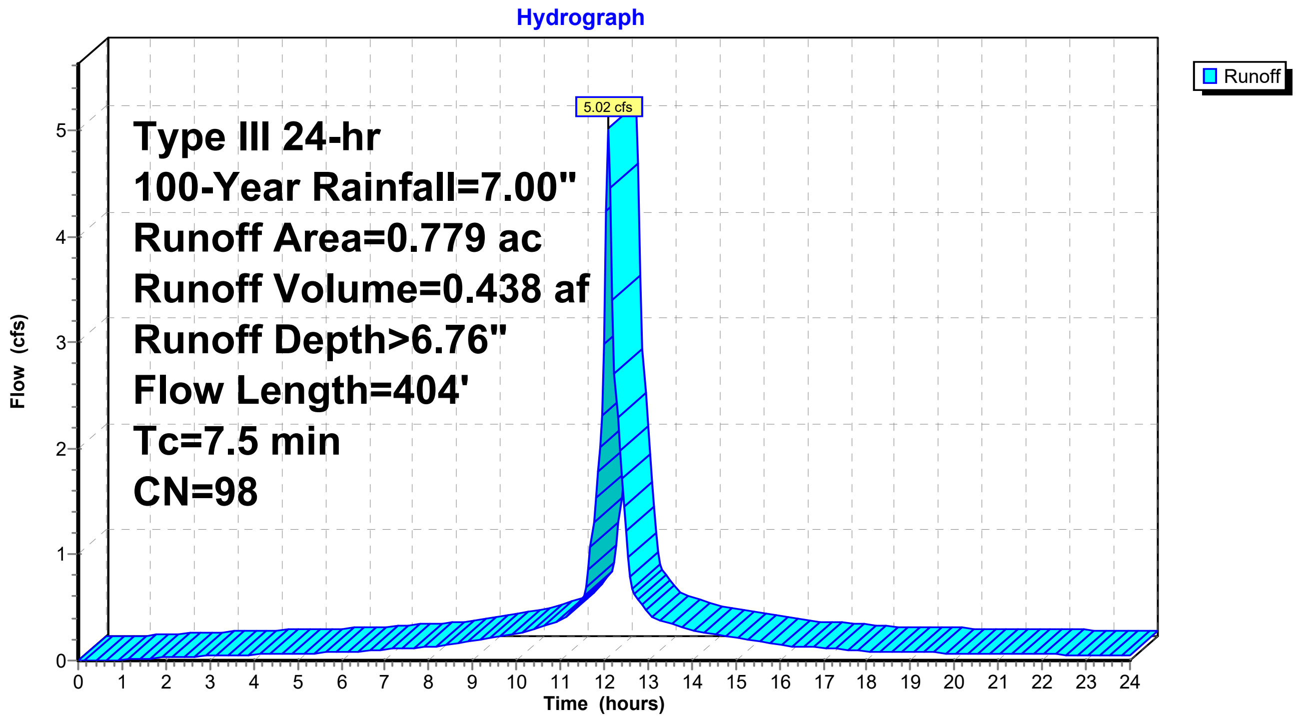
Runoff = 5.02 cfs @ 12.10 hrs, Volume= 0.438 af, Depth> 6.76"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.021	96	Gravel surface, HSG D
0.758	98	Paved parking, HSG D
0.779	98	Weighted Average
0.021		2.67% Pervious Area
0.758		97.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	50	0.0080	0.23		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.7	190	0.0080	1.82		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	30	0.0033	1.17		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	134	0.0320	1.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
7.5	404	Total			

Subcatchment A4-EX: Subcat A4-EX



Summary for Subcatchment B1-EX: Subcat B1-EX

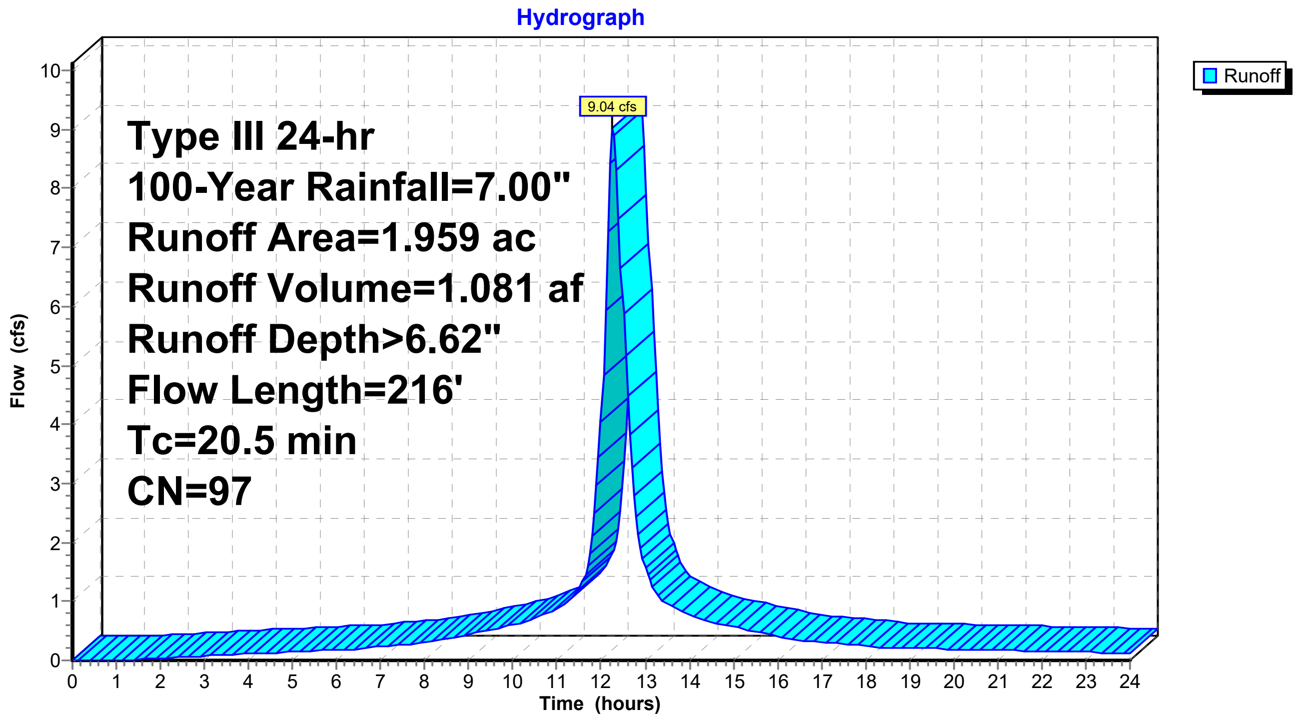
Runoff = 9.04 cfs @ 12.27 hrs, Volume= 1.081 af, Depth> 6.62"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.092	80	>75% Grass cover, Good, HSG D
1.680	98	Paved parking, HSG D
0.187	98	Roofs, HSG D
1.959	97	Weighted Average
0.092		4.70% Pervious Area
1.867		95.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6	38	0.0140	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.1	12	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	26	0.0047	1.39		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	117	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
20.5	216	Total			

Subcatchment B1-EX: Subcat B1-EX

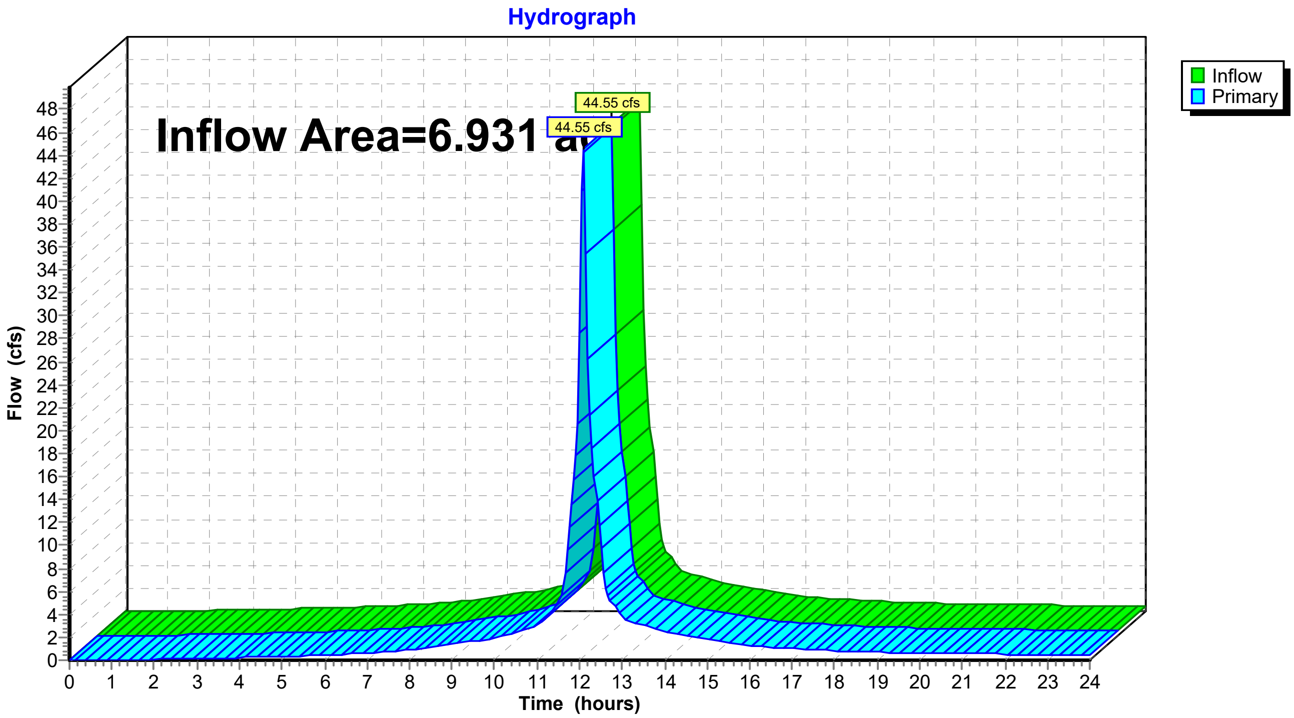


Summary for Link A: Bordering Vegetated Wetland

Inflow Area =	6.931 ac,	73.09% Impervious,	Inflow Depth > 6.18"	for 100-Year event
Inflow =	44.55 cfs @	12.09 hrs, Volume=	3.567 af	
Primary =	44.55 cfs @	12.09 hrs, Volume=	3.567 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

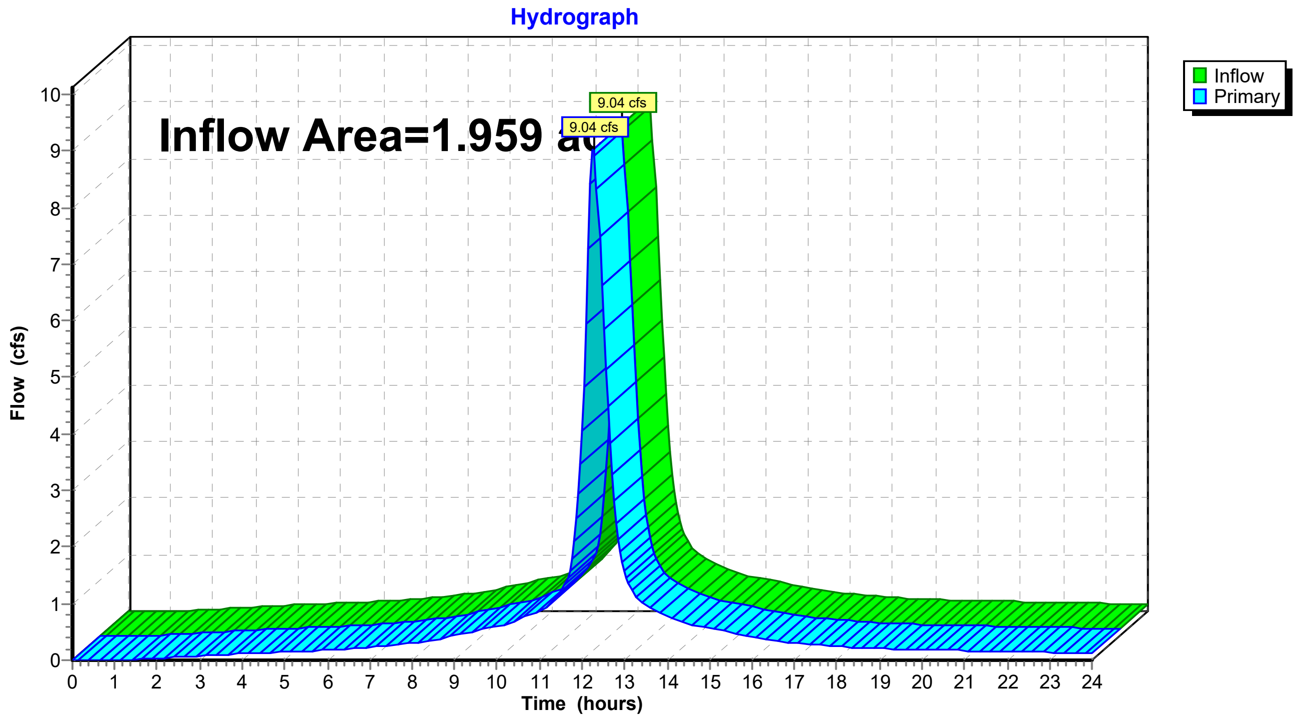


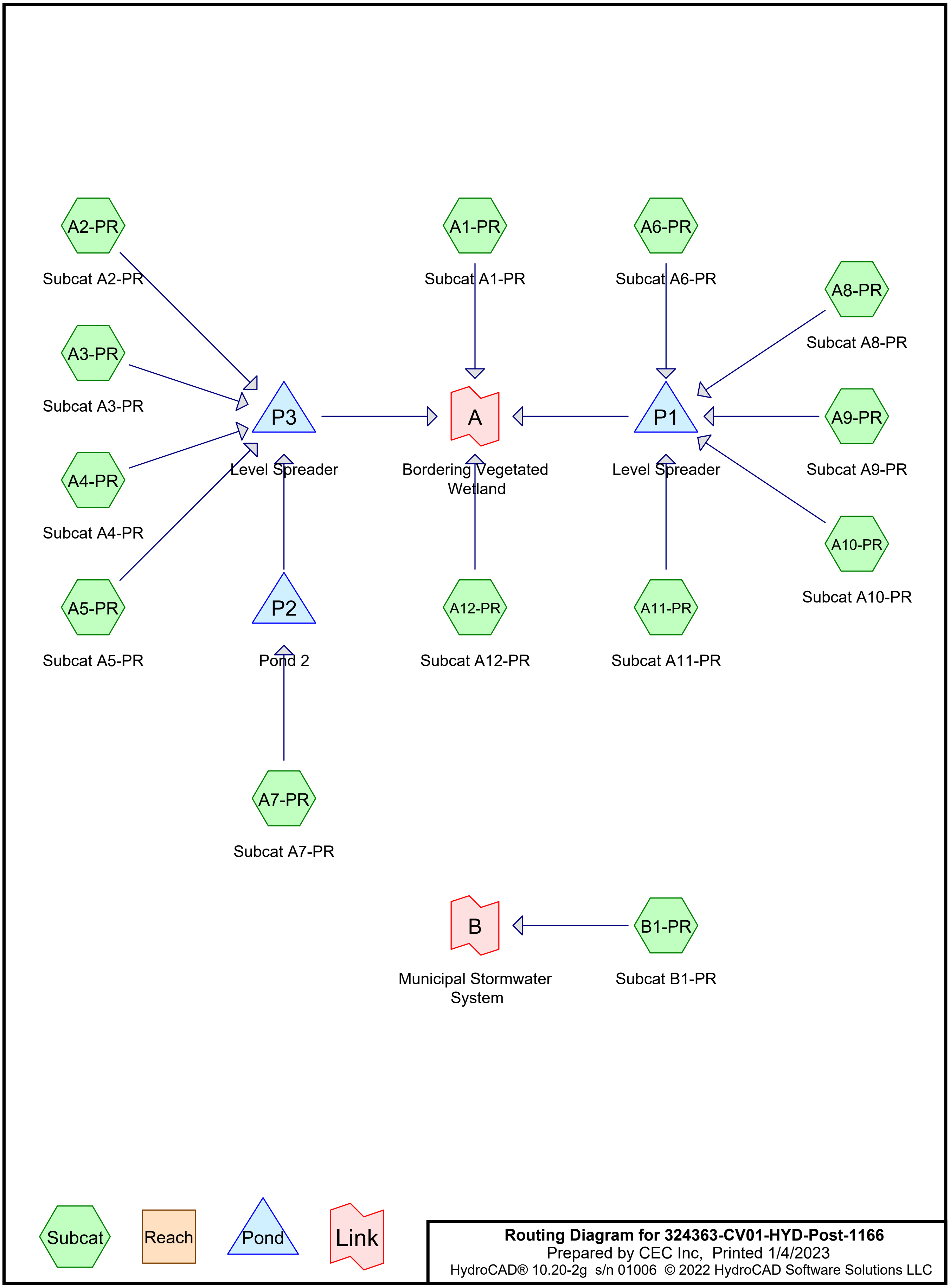
Summary for Link B: Municipal Stormwater System

Inflow Area =	1.959 ac,	95.30% Impervious,	Inflow Depth > 6.62"	for 100-Year event
Inflow =	9.04 cfs @	12.27 hrs, Volume=	1.081 af	
Primary =	9.04 cfs @	12.27 hrs, Volume=	1.081 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System





Routing Diagram for 324363-CV01-HYD-Post-1166
Prepared by CEC Inc, Printed 1/4/2023
HydroCAD® 10.20-2g s/n 01006 © 2022 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.40	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.80	2
3	25-Year	Type III 24-hr		Default	24.00	1	5.60	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.851	80	>75% Grass cover, Good, HSG D (A1-PR, A10-PR, A11-PR, A12-PR, A2-PR, A3-PR, A4-PR, A5-PR, A6-PR, A8-PR, A9-PR, B1-PR)
5.656	98	Paved parking, HSG D (A1-PR, A10-PR, A11-PR, A12-PR, A2-PR, A3-PR, A4-PR, A5-PR, A6-PR, A8-PR, A9-PR, B1-PR)
0.997	98	Roofs, HSG D (A1-PR, A10-PR, A3-PR, A7-PR, A8-PR, A9-PR, B1-PR)
0.153	98	Water Surface, HSG D (A12-PR, A2-PR, A4-PR)
1.234	77	Woods, Good, HSG D (A1-PR, A12-PR, B1-PR)
8.890	**93**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
8.890	HSG D	A1-PR, A10-PR, A11-PR, A12-PR, A2-PR, A3-PR, A4-PR, A5-PR, A6-PR, A7-PR, A8-PR, A9-PR, B1-PR
0.000	Other	
8.890		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.851	0.000	0.851	>75% Grass cover, Good	A1-PR, A10-PR, A11-PR, A12-PR, A2-PR, A3-PR, A4-PR, A5-PR, A6-PR, A8-PR, A9-PR, B1-PR
0.000	0.000	0.000	5.656	0.000	5.656	Paved parking	A1-PR, A10-PR, A11-PR, A12-PR, A2-PR, A3-PR, A4-PR, A5-PR, A6-PR, A8-PR, A9-PR, B1-PR
0.000	0.000	0.000	0.997	0.000	0.997	Roofs	A1-PR, A10-PR, A3-PR, A7-PR, A8-PR, A9-PR, B1-PR
0.000	0.000	0.000	0.153	0.000	0.153	Water Surface	A12-PR, A2-PR, A4-PR
0.000	0.000	0.000	1.234	0.000	1.234	Woods, Good	A1-PR, A12-PR, B1-PR
0.000	**0.000**	**0.000**	**8.890**	**0.000**	**8.890**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-PR: Subcat A1-PR Runoff Area=1.758 ac 35.89% Impervious Runoff Depth>1.93"
Flow Length=130' Slope=0.0105 '/' Tc=6.0 min CN=85 Runoff=3.90 cfs 0.282 af

SubcatchmentA10-PR: Subcat A10-PR Runoff Area=0.155 ac 87.77% Impervious Runoff Depth>2.94"
Flow Length=385' Tc=6.1 min CN=96 Runoff=0.48 cfs 0.038 af

SubcatchmentA11-PR: Subcat A11-PR Runoff Area=0.472 ac 96.62% Impervious Runoff Depth>3.05"
Flow Length=395' Tc=6.1 min CN=97 Runoff=1.50 cfs 0.120 af

SubcatchmentA12-PR: Subcat A12-PR Runoff Area=0.403 ac 14.89% Impervious Runoff Depth>1.70"
Tc=6.0 min CN=82 Runoff=0.79 cfs 0.057 af

SubcatchmentA2-PR: Subcat A2-PR Runoff Area=0.680 ac 84.85% Impervious Runoff Depth>2.84"
Flow Length=245' Tc=6.0 min CN=95 Runoff=2.08 cfs 0.161 af

SubcatchmentA3-PR: Subcat A3-PR Runoff Area=0.731 ac 93.23% Impervious Runoff Depth>3.05"
Flow Length=428' Tc=6.0 min CN=97 Runoff=2.33 cfs 0.186 af

SubcatchmentA4-PR: Subcat A4-PR Runoff Area=0.752 ac 84.99% Impervious Runoff Depth>2.83"
Flow Length=301' Tc=18.6 min CN=95 Runoff=1.65 cfs 0.177 af

SubcatchmentA5-PR: Subcat A5-PR Runoff Area=0.542 ac 96.68% Impervious Runoff Depth>3.05"
Flow Length=215' Tc=6.0 min CN=97 Runoff=1.73 cfs 0.138 af

SubcatchmentA6-PR: Subcat A6-PR Runoff Area=0.349 ac 100.00% Impervious Runoff Depth>3.16"
Flow Length=149' Tc=6.0 min CN=98 Runoff=1.13 cfs 0.092 af

SubcatchmentA7-PR: Subcat A7-PR Runoff Area=0.691 ac 100.00% Impervious Runoff Depth>3.16"
Flow Length=660' Tc=6.0 min CN=98 Runoff=2.23 cfs 0.182 af

SubcatchmentA8-PR: Subcat A8-PR Runoff Area=0.414 ac 78.09% Impervious Runoff Depth>2.73"
Flow Length=568' Tc=25.3 min CN=94 Runoff=0.78 cfs 0.094 af

SubcatchmentA9-PR: Subcat A9-PR Runoff Area=0.205 ac 87.61% Impervious Runoff Depth>2.94"
Flow Length=500' Tc=6.1 min CN=96 Runoff=0.64 cfs 0.050 af

SubcatchmentB1-PR: Subcat B1-PR Runoff Area=1.738 ac 89.62% Impervious Runoff Depth>2.94"
Flow Length=50' Slope=0.0134 '/' Tc=23.6 min CN=96 Runoff=3.53 cfs 0.425 af

Pond P1: Level Spreader Peak Elev=64.24' Storage=7,818 cf Inflow=4.17 cfs 0.395 af
Outflow=2.99 cfs 0.213 af

Pond P2: Pond 2 Peak Elev=66.14' Storage=2,635 cf Inflow=2.23 cfs 0.182 af
Discarded=0.03 cfs 0.042 af Primary=2.11 cfs 0.087 af Outflow=2.15 cfs 0.129 af

Pond P3: Level Spreader Peak Elev=64.36' Storage=4,779 cf Inflow=9.32 cfs 0.749 af
Outflow=9.18 cfs 0.645 af

Link A: Bordering Vegetated Wetland
Inflow=13.85 cfs 1.198 af
Primary=13.85 cfs 1.198 af

Link B: Municipal Stormwater System
Inflow=3.53 cfs 0.425 af
Primary=3.53 cfs 0.425 af

Total Runoff Area = 8.890 ac Runoff Volume = 2.004 af Average Runoff Depth = 2.71"
23.45% Pervious = 2.084 ac 76.55% Impervious = 6.806 ac

Summary for Subcatchment A1-PR: Subcat A1-PR

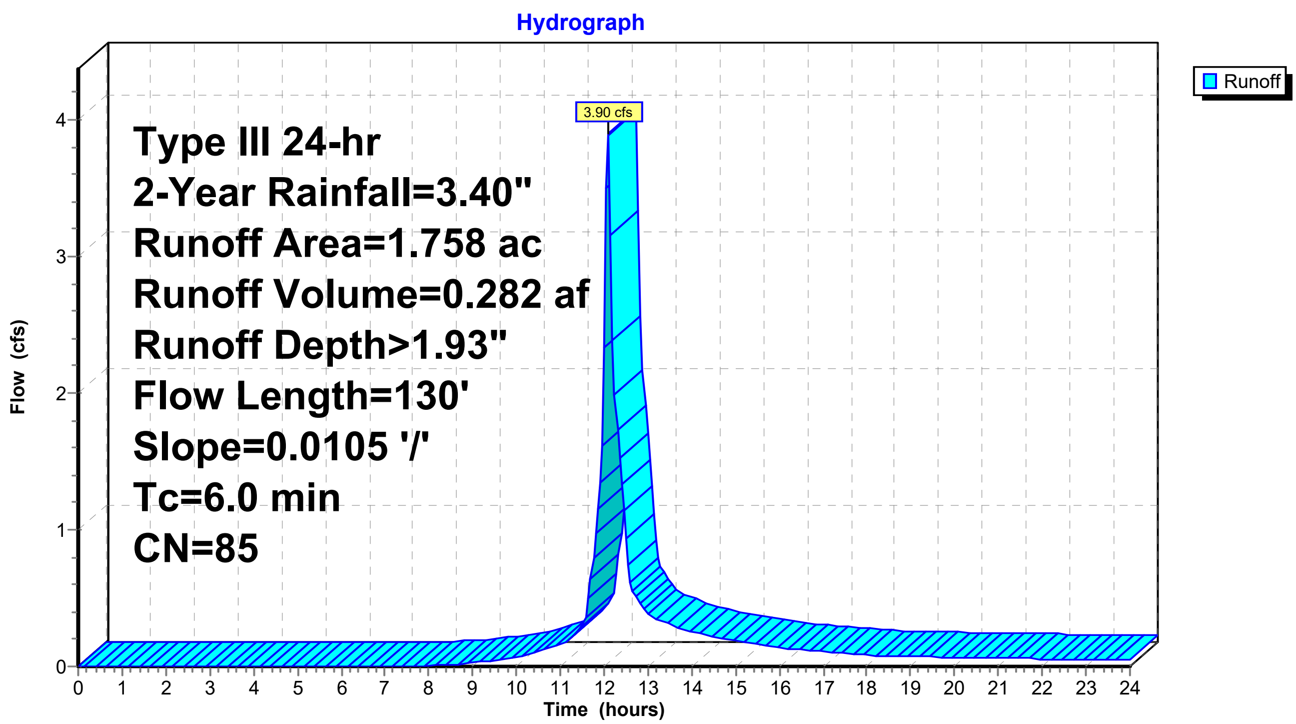
Runoff = 3.90 cfs @ 12.09 hrs, Volume= 0.282 af, Depth> 1.93"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.007	80	>75% Grass cover, Good, HSG D
0.027	80	>75% Grass cover, Good, HSG D
0.074	98	Paved parking, HSG D
0.438	98	Paved parking, HSG D
0.119	98	Roofs, HSG D
1.093	77	Woods, Good, HSG D
1.758	85	Weighted Average
1.127		64.11% Pervious Area
0.631		35.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0105	0.26		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	80	0.0105	2.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.8	130	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A1-PR: Subcat A1-PR



Summary for Subcatchment A10-PR: Subcat A10-PR

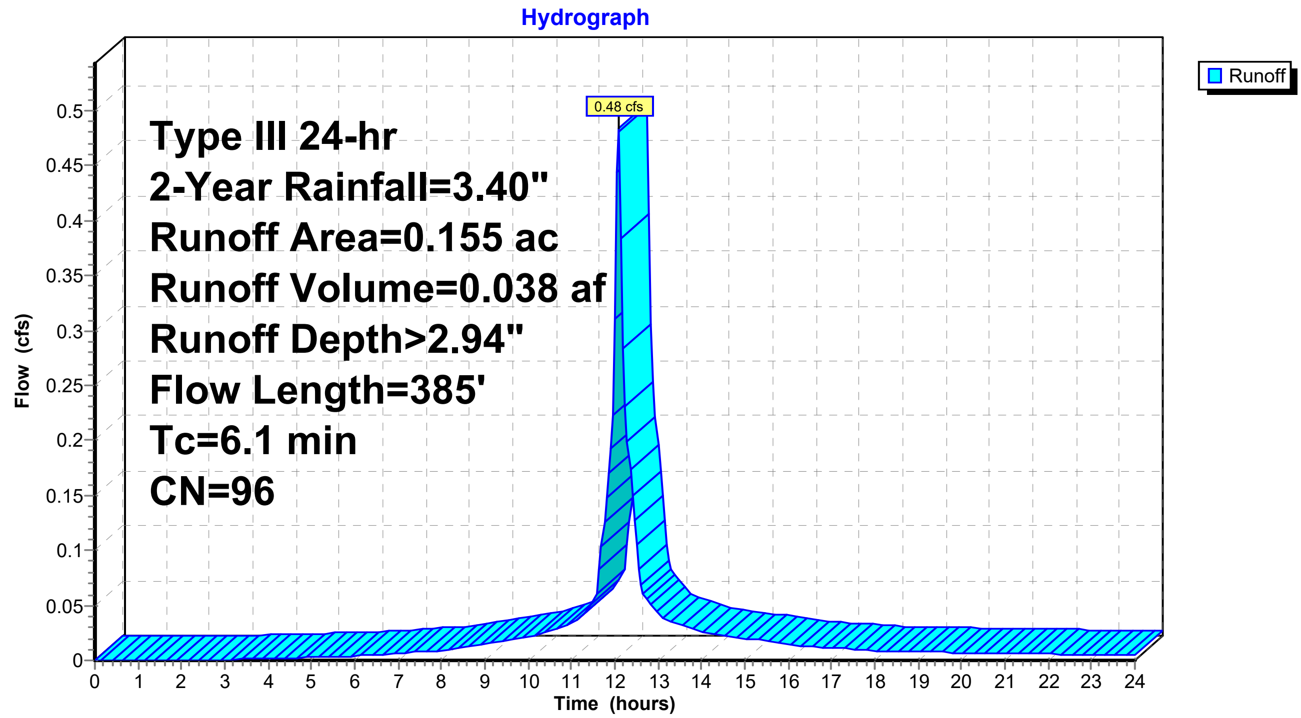
Runoff = 0.48 cfs @ 12.09 hrs, Volume= 0.038 af, Depth> 2.94"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.019	80	>75% Grass cover, Good, HSG D
0.136	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.155	96	Weighted Average
0.019		12.23% Pervious Area
0.136		87.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	12	0.2770	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
2.5	28	0.0060	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	55	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	385	Total			

Subcatchment A10-PR: Subcat A10-PR



Summary for Subcatchment A11-PR: Subcat A11-PR

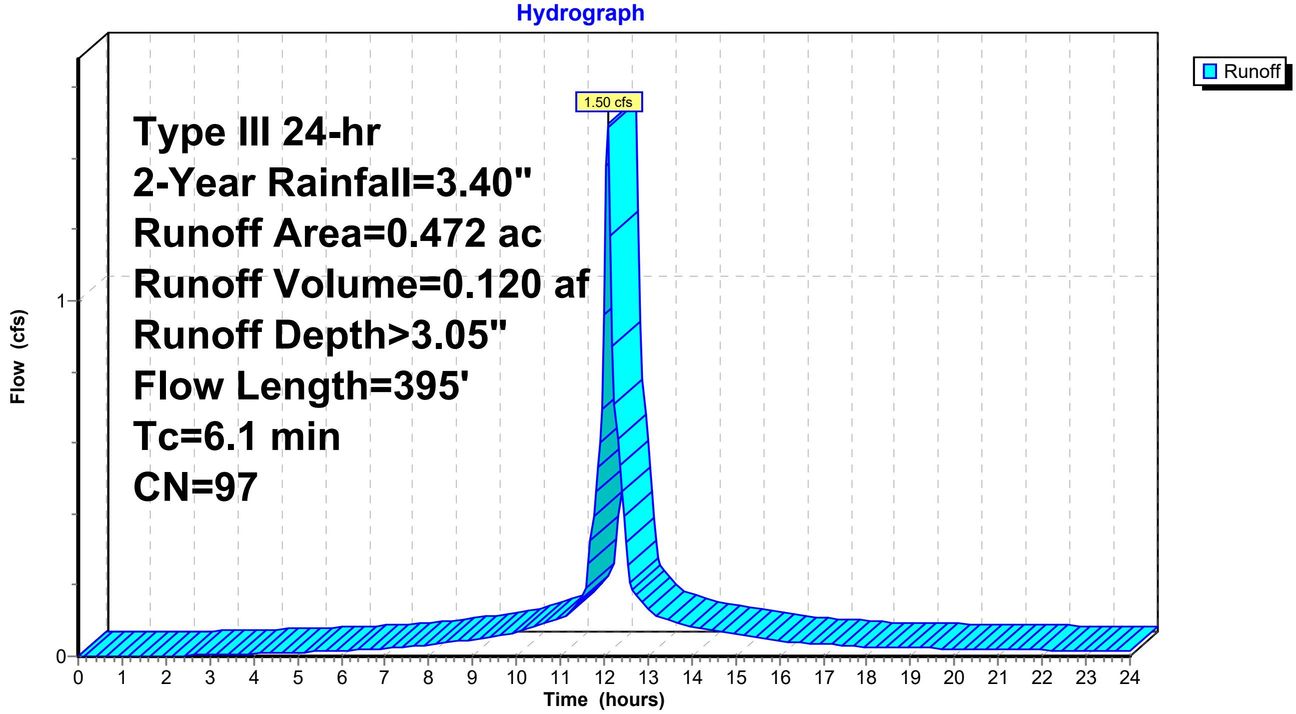
Runoff = 1.50 cfs @ 12.09 hrs, Volume= 0.120 af, Depth> 3.05"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.016	80	>75% Grass cover, Good, HSG D
0.456	98	Paved parking, HSG D
0.472	97	Weighted Average
0.016		3.38% Pervious Area
0.456		96.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	20	0.0140	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.1	15	0.0130	0.22		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.4	15	0.0081	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	32	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0069	1.69		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	106	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	395	Total			

Subcatchment A11-PR: Subcat A11-PR



Summary for Subcatchment A12-PR: Subcat A12-PR

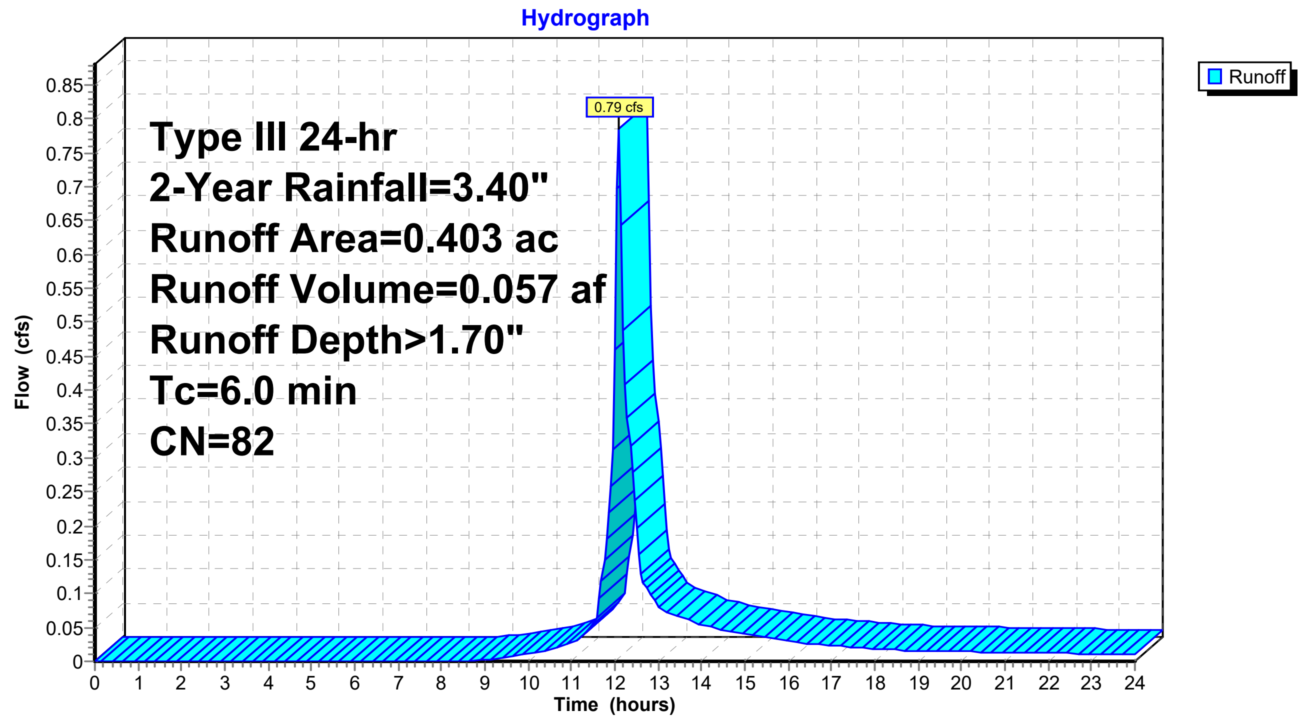
Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.057 af, Depth> 1.70"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.203	80	>75% Grass cover, Good, HSG D
0.000	98	Paved parking, HSG D
0.060	98	Water Surface, HSG D
0.140	77	Woods, Good, HSG D
0.403	82	Weighted Average
0.343		85.11% Pervious Area
0.060		14.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A12-PR: Subcat A12-PR



Summary for Subcatchment A2-PR: Subcat A2-PR

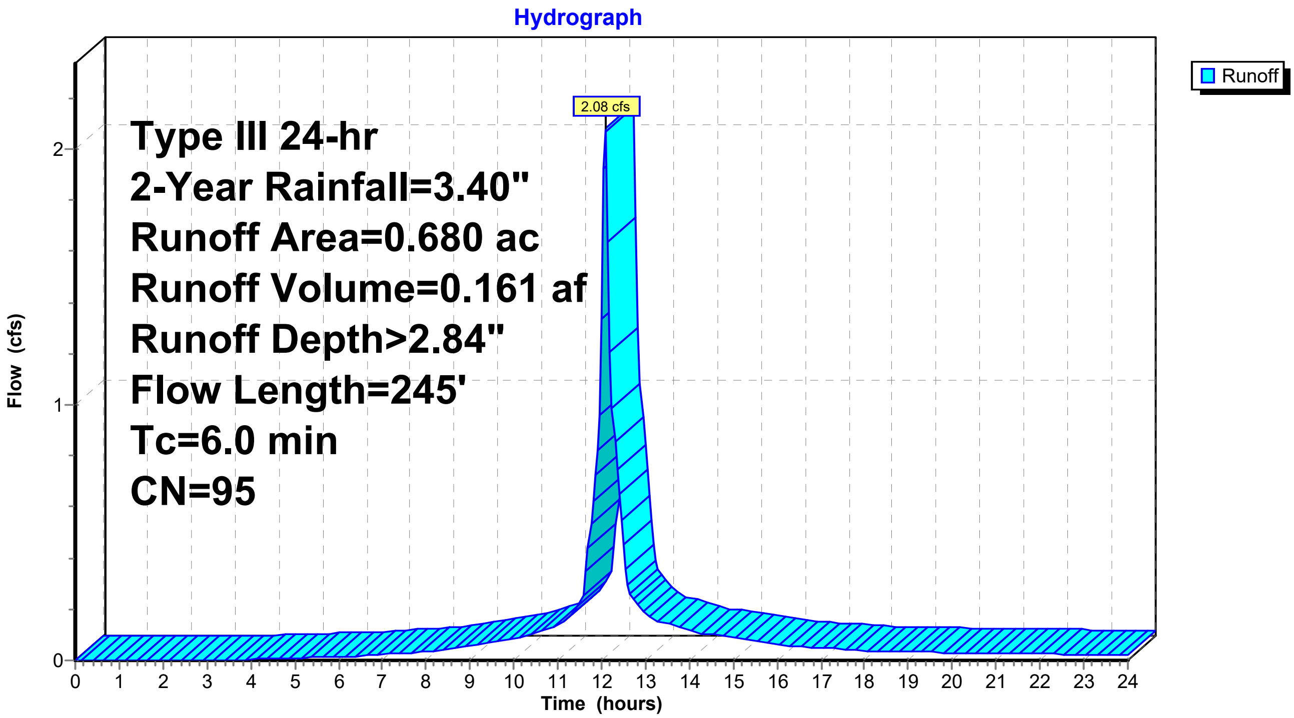
Runoff = 2.08 cfs @ 12.09 hrs, Volume= 0.161 af, Depth> 2.84"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.031	80	>75% Grass cover, Good, HSG D
0.072	80	>75% Grass cover, Good, HSG D
0.394	98	Paved parking, HSG D
0.128	98	Paved parking, HSG D
0.047	98	Water Surface, HSG D
0.008	98	Water Surface, HSG D
0.680	95	Weighted Average
0.103		15.15% Pervious Area
0.577		84.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	17	0.0259	0.30		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	33	0.0256	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	6	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	39	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	108	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.3	245	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A2-PR: Subcat A2-PR



Summary for Subcatchment A3-PR: Subcat A3-PR

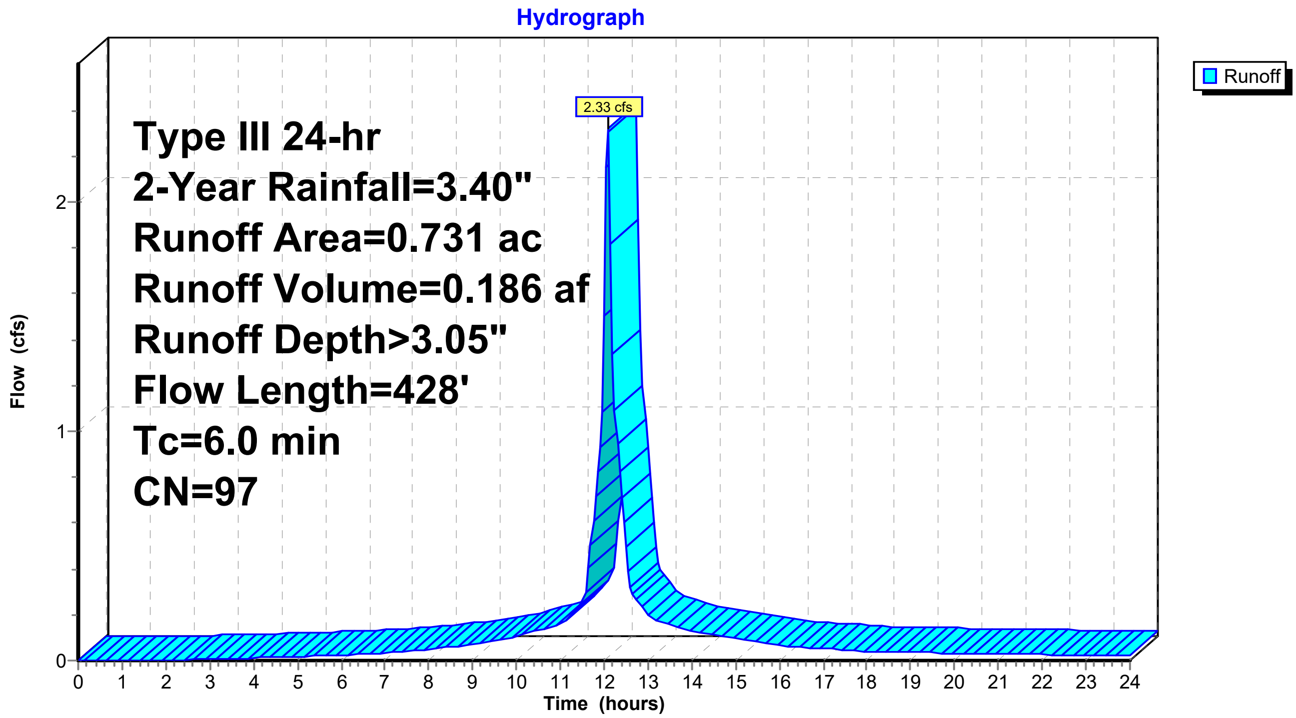
Runoff = 2.33 cfs @ 12.09 hrs, Volume= 0.186 af, Depth> 3.05"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.681	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.731	97	Weighted Average
0.049		6.77% Pervious Area
0.681		93.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	50	0.0208	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	100	0.0208	2.93		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	278	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
4.2	428	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A3-PR: Subcat A3-PR



Summary for Subcatchment A4-PR: Subcat A4-PR

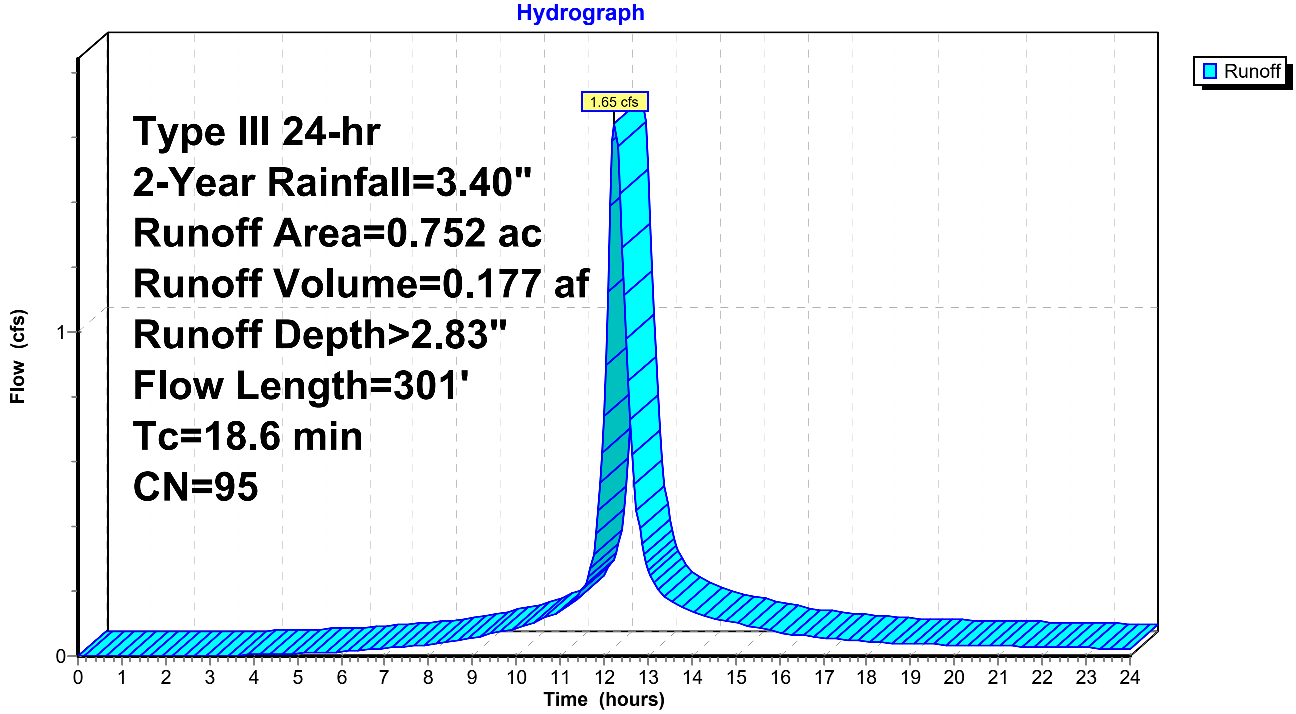
Runoff = 1.65 cfs @ 12.25 hrs, Volume= 0.177 af, Depth> 2.83"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.113	80	>75% Grass cover, Good, HSG D
0.601	98	Paved parking, HSG D
0.038	98	Water Surface, HSG D
0.752	95	Weighted Average
0.113		15.01% Pervious Area
0.639		84.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	25	0.0074	0.02		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	75	0.0074	1.75		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.6	178	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
18.6	301	Total			

Subcatchment A4-PR: Subcat A4-PR



Summary for Subcatchment A5-PR: Subcat A5-PR

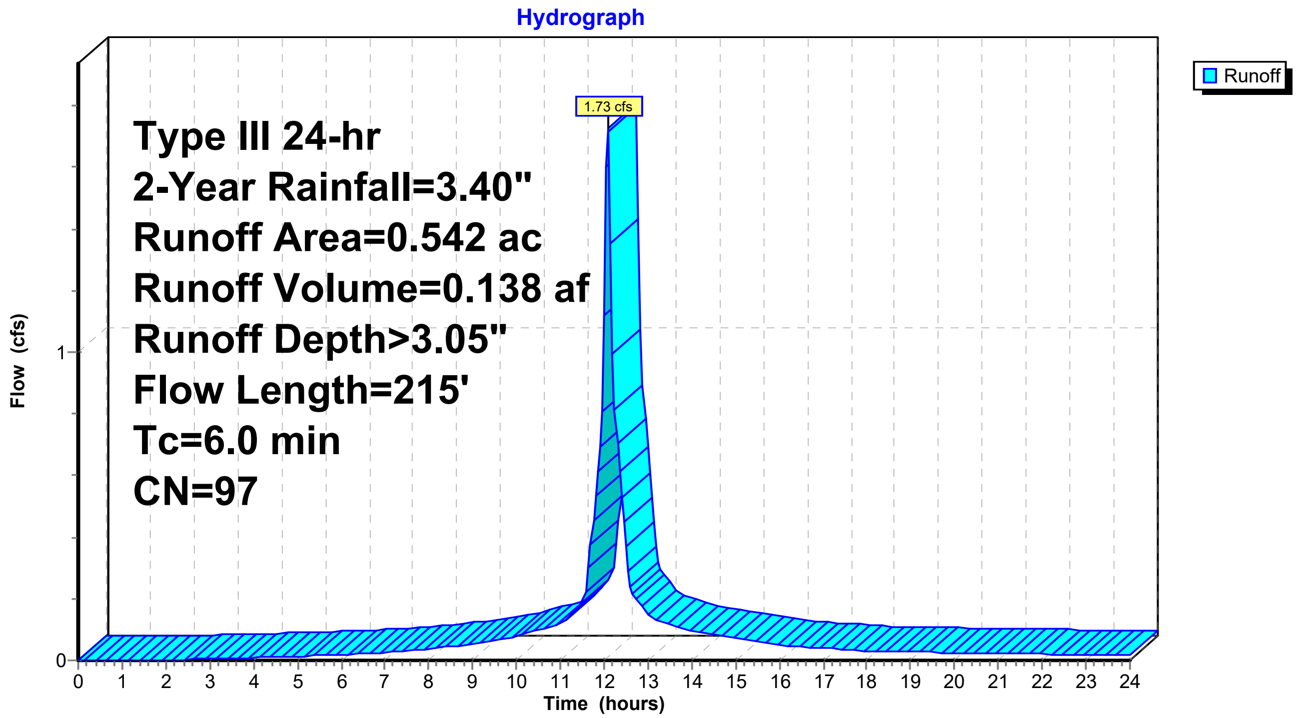
Runoff = 1.73 cfs @ 12.09 hrs, Volume= 0.138 af, Depth> 3.05"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.018	80	>75% Grass cover, Good, HSG D
0.524	98	Paved parking, HSG D
0.542	97	Weighted Average
0.018		3.32% Pervious Area
0.524		96.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	19	0.0230	0.29		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	31	0.0217	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	15	0.0217	2.99		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	49	0.0204	2.90		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0219	3.00		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	59	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.6	215	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A5-PR: Subcat A5-PR



Summary for Subcatchment A6-PR: Subcat A6-PR

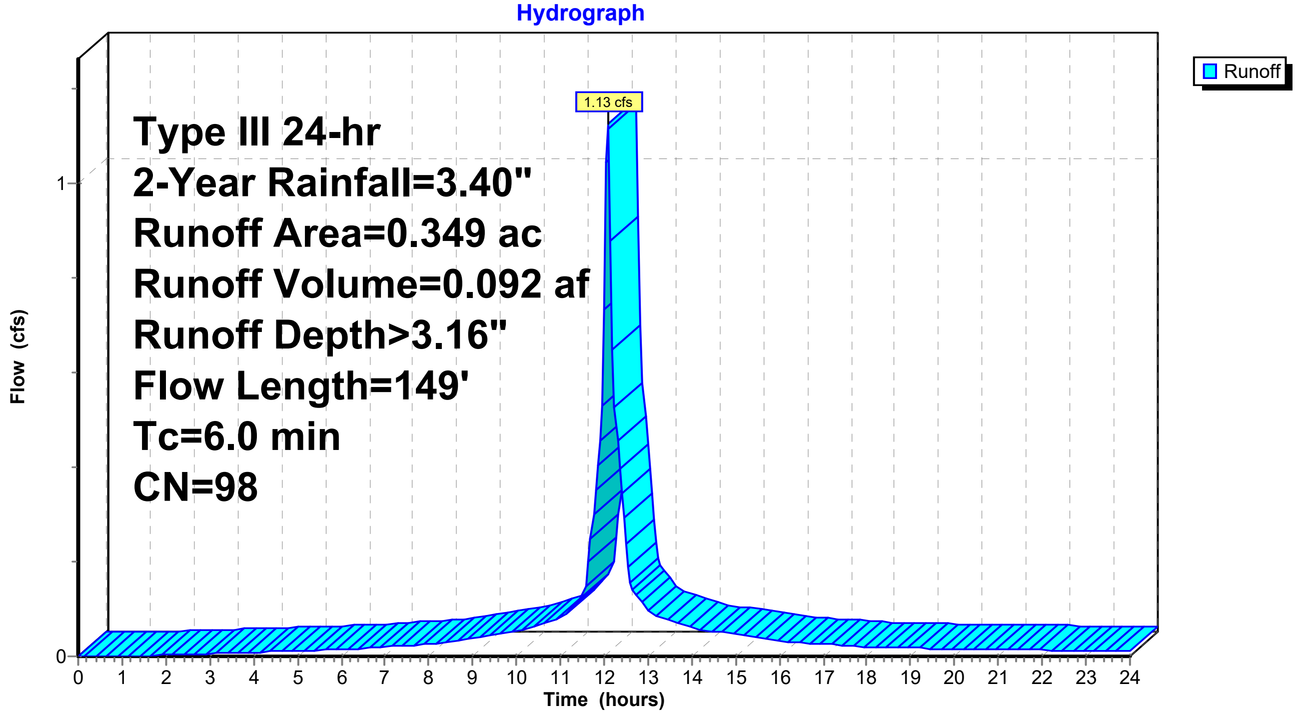
Runoff = 1.13 cfs @ 12.09 hrs, Volume= 0.092 af, Depth> 3.16"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.000	80	>75% Grass cover, Good, HSG D
0.349	98	Paved parking, HSG D
0.349	98	Weighted Average
0.000		0.00% Pervious Area
0.349		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	24	0.0417	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.2	26	0.0357	0.37		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	2	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	28	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.0364	3.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	34	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
2.6	149	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A6-PR: Subcat A6-PR



Summary for Subcatchment A7-PR: Subcat A7-PR

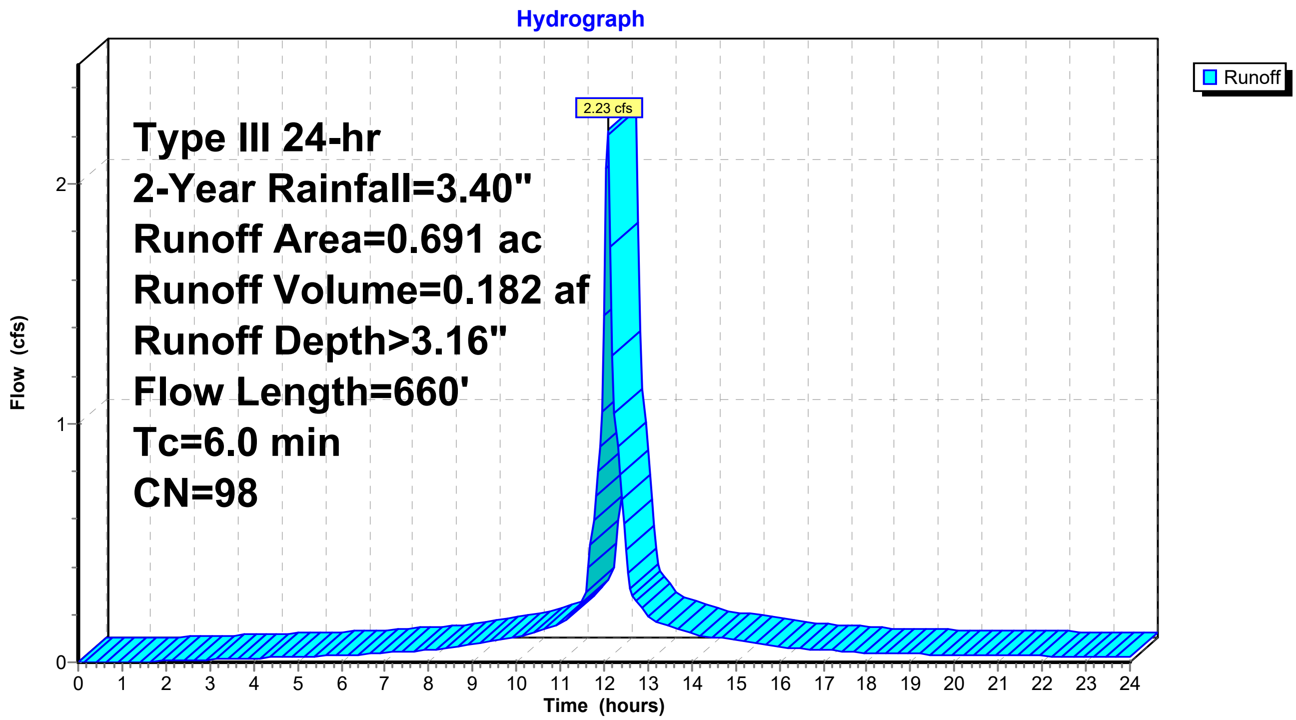
Runoff = 2.23 cfs @ 12.09 hrs, Volume= 0.182 af, Depth> 3.16"
Routed to Pond P2 : Pond 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.691	98	Roofs, HSG D
0.691		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	60	0.0200	0.35		**Sheet Flow, Roof Area** Smooth surfaces n= 0.011 P2= 0.25"
2.9	600	0.0050	3.47	2.73	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	660	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A7-PR: Subcat A7-PR



Summary for Subcatchment A8-PR: Subcat A8-PR

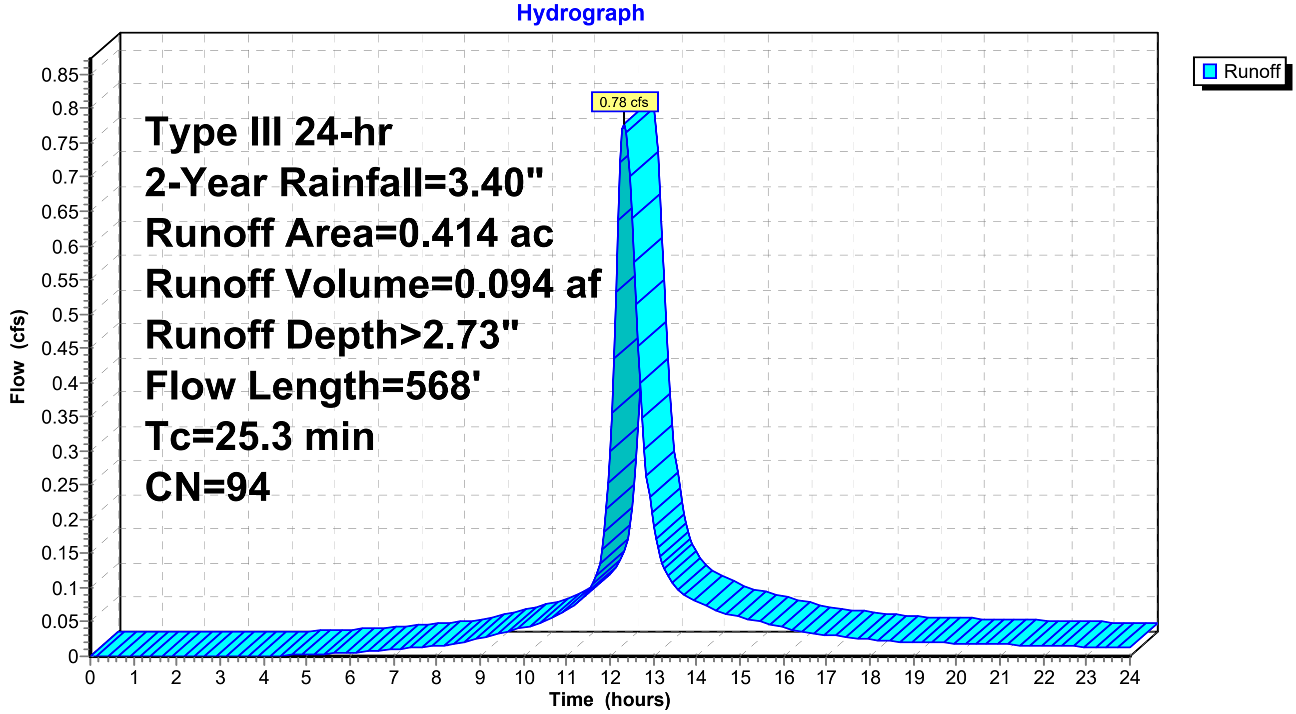
Runoff = 0.78 cfs @ 12.34 hrs, Volume= 0.094 af, Depth> 2.73"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.091	80	>75% Grass cover, Good, HSG D
0.323	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.414	94	Weighted Average
0.091		21.91% Pervious Area
0.323		78.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2	40	0.0100	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	10	0.0200	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	60	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	12	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	13	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.5	133	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
25.3	568	Total			

Subcatchment A8-PR: Subcat A8-PR



Summary for Subcatchment A9-PR: Subcat A9-PR

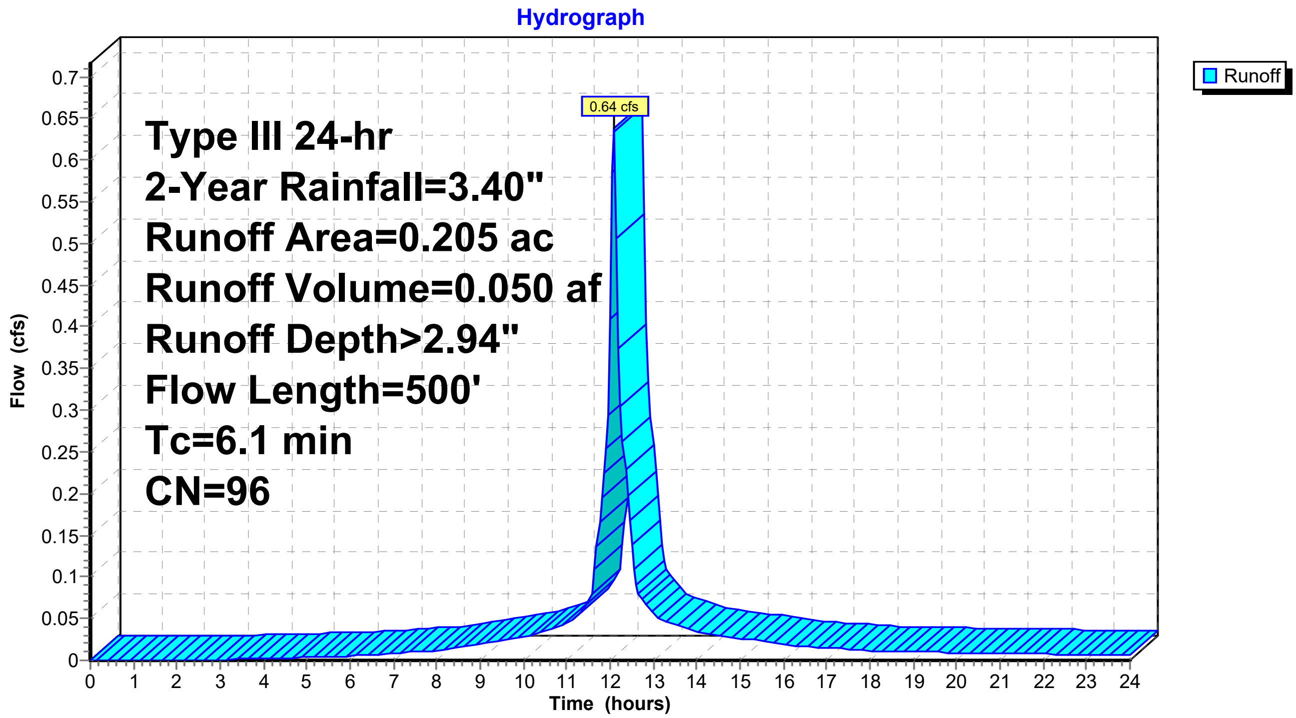
Runoff = 0.64 cfs @ 12.09 hrs, Volume= 0.050 af, Depth> 2.94"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.025	80	>75% Grass cover, Good, HSG D
0.179	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.205	96	Weighted Average
0.025		12.39% Pervious Area
0.179		87.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	12	0.2520	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
1.9	35	0.0200	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.2	30	0.0030	2.48	1.95	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.6	133	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	500	Total			

Subcatchment A9-PR: Subcat A9-PR



Summary for Subcatchment B1-PR: Subcat B1-PR

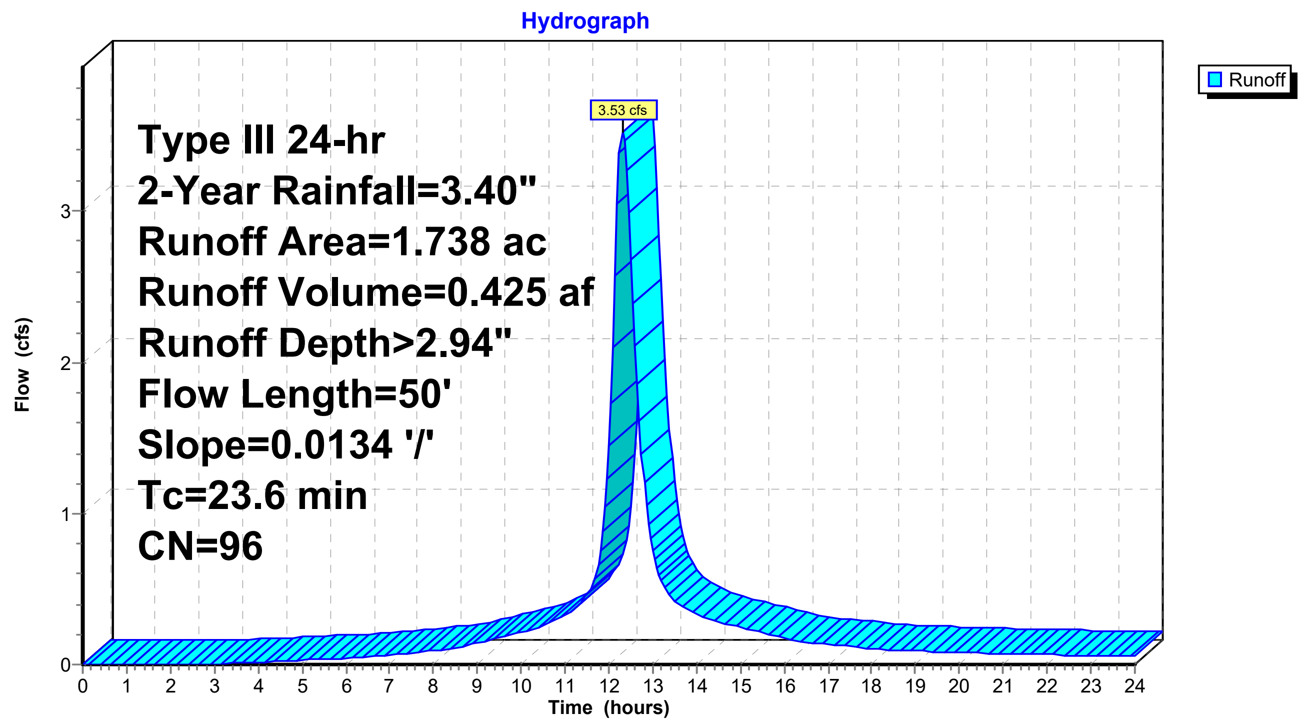
Runoff = 3.53 cfs @ 12.31 hrs, Volume= 0.425 af, Depth> 2.94"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.40"

Area (ac)	CN	Description
0.180	80	>75% Grass cover, Good, HSG D
1.371	98	Paved parking, HSG D
0.186	98	Roofs, HSG D
0.001	77	Woods, Good, HSG D
1.738	96	Weighted Average
0.180		10.38% Pervious Area
1.558		89.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.6	50	0.0134	0.04		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"

Subcatchment B1-PR: Subcat B1-PR



Summary for Pond P1: Level Spreader

Inflow Area = 1.596 ac, 90.54% Impervious, Inflow Depth > 2.97" for 2-Year event
Inflow = 4.17 cfs @ 12.09 hrs, Volume= 0.395 af
Outflow = 2.99 cfs @ 12.22 hrs, Volume= 0.213 af, Atten= 28%, Lag= 7.7 min
Primary = 2.99 cfs @ 12.22 hrs, Volume= 0.213 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.24' @ 12.20 hrs Surf.Area= 2,735 sf Storage= 7,818 cf

Plug-Flow detention time= 222.9 min calculated for 0.213 af (54% of inflow)
Center-of-Mass det. time= 109.3 min (881.7 - 772.4)

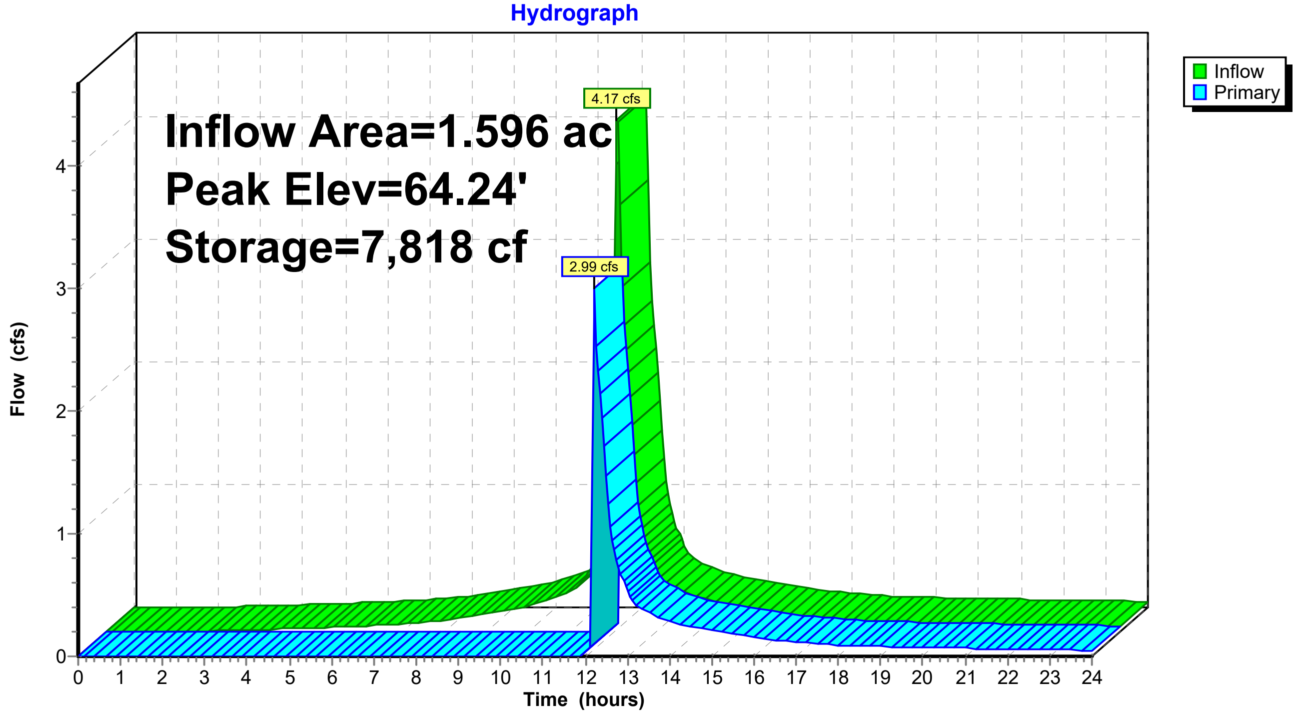
Volume	Invert	Avail.Storage	Storage Description
#1	59.00'	10,054 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
59.00	370	193.0	0	0	370
60.00	770	206.0	558	558	828
61.00	1,194	218.0	974	1,532	1,285
62.00	1,643	231.0	1,413	2,945	1,801
63.00	2,118	243.0	1,875	4,820	2,312
64.00	2,617	256.0	2,363	7,183	2,886
65.00	3,133	268.0	2,871	10,054	3,450

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**132.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=2.24 cfs @ 12.22 hrs HW=64.24' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 2.24 cfs @ 0.47 fps)

Pond P1: Level Spreader



Summary for Pond P2: Pond 2

Inflow Area = 0.691 ac,100.00% Impervious, Inflow Depth > 3.16" for 2-Year event
Inflow = 2.23 cfs @ 12.09 hrs, Volume= 0.182 af
Outflow = 2.15 cfs @ 12.10 hrs, Volume= 0.129 af, Atten= 4%, Lag= 1.1 min
Discarded = 0.03 cfs @ 12.10 hrs, Volume= 0.042 af
Primary = 2.11 cfs @ 12.10 hrs, Volume= 0.087 af
Routed to Pond P3 : Level Spreader

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 66.14' @ 12.10 hrs Surf.Area= 1,479 sf Storage= 2,635 cf

Plug-Flow detention time= 172.1 min calculated for 0.129 af (71% of inflow)
Center-of-Mass det. time= 79.6 min (834.3 - 754.7)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	4,091 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

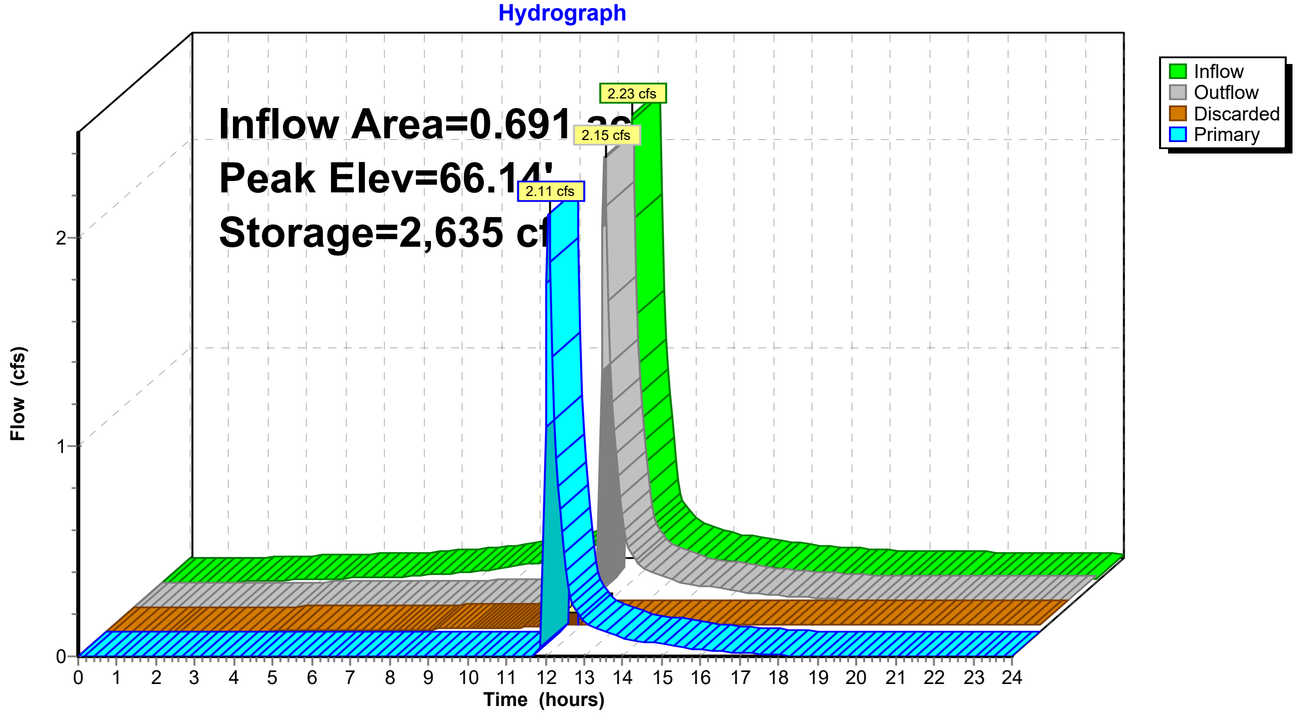
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	50	39.0	0	0	50
63.00	234	84.0	131	131	495
64.00	551	124.0	381	512	1,165
65.00	953	143.0	743	1,255	1,590
66.00	1,411	162.0	1,175	2,429	2,076
67.00	1,925	181.0	1,661	4,091	2,622

Device	Routing	Invert	Outlet Devices
#1	Primary	63.10'	**15.0" Round Culvert** L= 305.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 63.10' / 61.21' S= 0.0062 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	66.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.03 cfs @ 12.10 hrs HW=66.14' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=2.07 cfs @ 12.10 hrs HW=66.14' (Free Discharge)
└─**1=Culvert** (Passes 2.07 cfs of 6.29 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.07 cfs @ 1.23 fps)

Pond P2: Pond 2



Summary for Pond P3: Level Spreader

Inflow Area = 3.396 ac, 91.66% Impervious, Inflow Depth > 2.65" for 2-Year event
Inflow = 9.32 cfs @ 12.10 hrs, Volume= 0.749 af
Outflow = 9.18 cfs @ 12.10 hrs, Volume= 0.645 af, Atten= 2%, Lag= 0.3 min
Primary = 9.18 cfs @ 12.10 hrs, Volume= 0.645 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.36' @ 12.10 hrs Surf.Area= 1,747 sf Storage= 4,779 cf

Plug-Flow detention time= 95.3 min calculated for 0.644 af (86% of inflow)
Center-of-Mass det. time= 39.7 min (813.8 - 774.1)

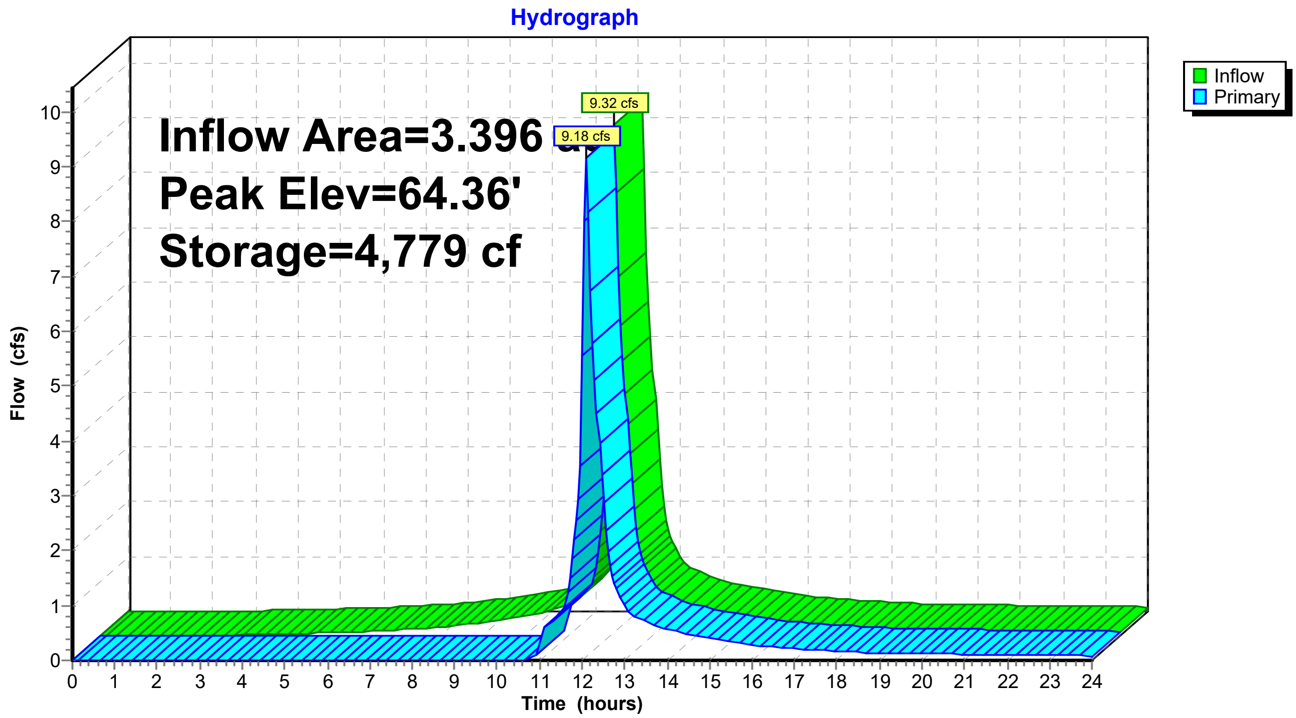
Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	5,961 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.00	524	113.0	0	0	524
61.00	763	125.0	640	640	781
62.00	1,026	138.0	891	1,531	1,083
63.00	1,314	150.0	1,167	2,698	1,393
64.00	1,628	163.0	1,468	4,166	1,753
65.00	1,967	176.0	1,795	5,961	2,142

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**59.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=9.08 cfs @ 12.10 hrs HW=64.36' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 9.08 cfs @ 0.94 fps)

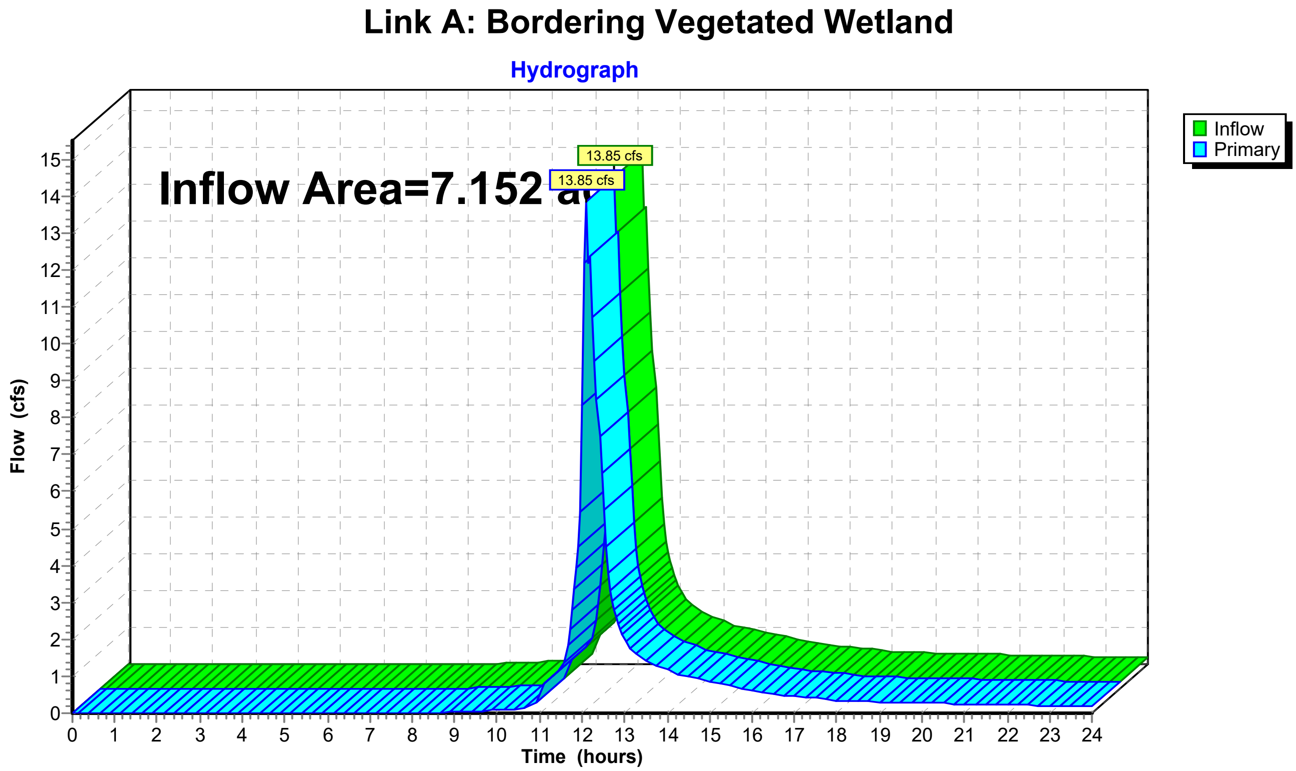
Pond P3: Level Spreader



Summary for Link A: Bordering Vegetated Wetland

Inflow Area = 7.152 ac, 73.38% Impervious, Inflow Depth > 2.01" for 2-Year event
Inflow = 13.85 cfs @ 12.10 hrs, Volume= 1.198 af
Primary = 13.85 cfs @ 12.10 hrs, Volume= 1.198 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

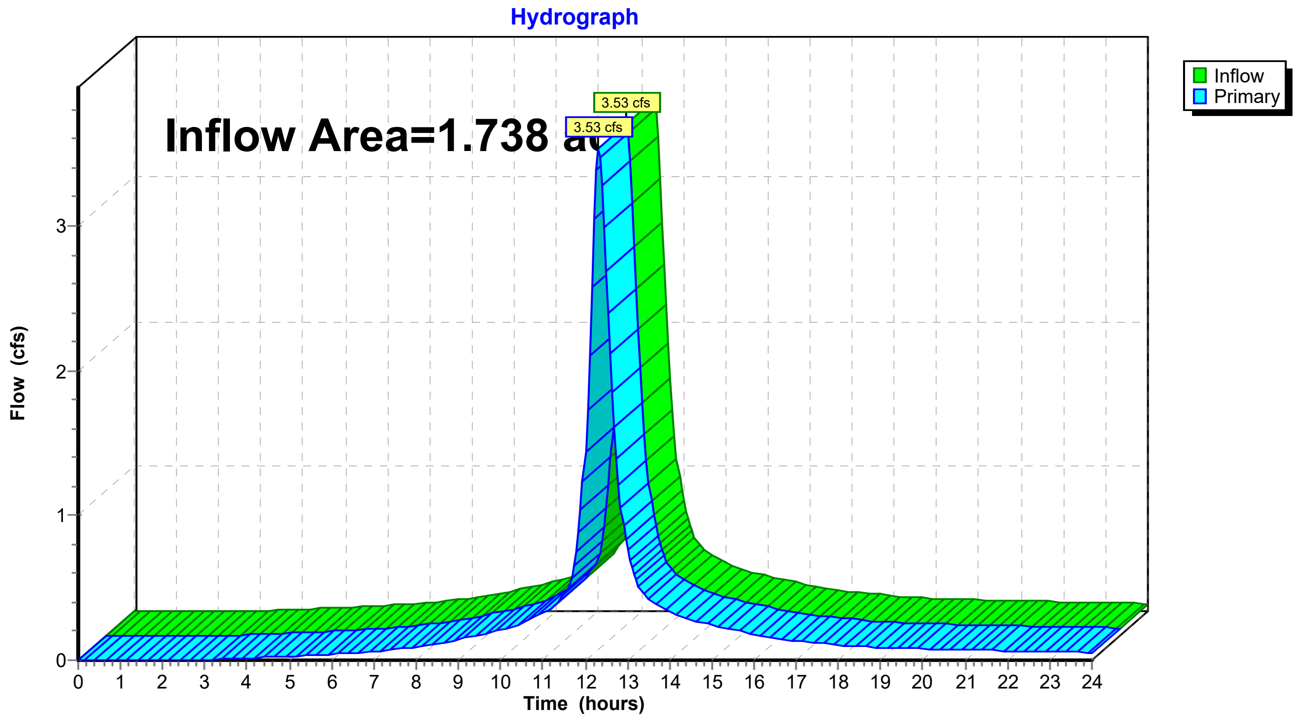


Summary for Link B: Municipal Stormwater System

Inflow Area =	1.738 ac,	89.62% Impervious,	Inflow Depth > 2.94"	for 2-Year event
Inflow =	3.53 cfs @	12.31 hrs, Volume=	0.425 af	
Primary =	3.53 cfs @	12.31 hrs, Volume=	0.425 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-PR: Subcat A1-PR Runoff Area=1.758 ac 35.89% Impervious Runoff Depth>3.18"
Flow Length=130' Slope=0.0105 '/' Tc=6.0 min CN=85 Runoff=6.37 cfs 0.466 af

SubcatchmentA10-PR: Subcat A10-PR Runoff Area=0.155 ac 87.77% Impervious Runoff Depth>4.33"
Flow Length=385' Tc=6.1 min CN=96 Runoff=0.70 cfs 0.056 af

SubcatchmentA11-PR: Subcat A11-PR Runoff Area=0.472 ac 96.62% Impervious Runoff Depth>4.44"
Flow Length=395' Tc=6.1 min CN=97 Runoff=2.14 cfs 0.175 af

SubcatchmentA12-PR: Subcat A12-PR Runoff Area=0.403 ac 14.89% Impervious Runoff Depth>2.90"
Tc=6.0 min CN=82 Runoff=1.34 cfs 0.097 af

SubcatchmentA2-PR: Subcat A2-PR Runoff Area=0.680 ac 84.85% Impervious Runoff Depth>4.22"
Flow Length=245' Tc=6.0 min CN=95 Runoff=3.03 cfs 0.239 af

SubcatchmentA3-PR: Subcat A3-PR Runoff Area=0.731 ac 93.23% Impervious Runoff Depth>4.45"
Flow Length=428' Tc=6.0 min CN=97 Runoff=3.32 cfs 0.271 af

SubcatchmentA4-PR: Subcat A4-PR Runoff Area=0.752 ac 84.99% Impervious Runoff Depth>4.21"
Flow Length=301' Tc=18.6 min CN=95 Runoff=2.39 cfs 0.264 af

SubcatchmentA5-PR: Subcat A5-PR Runoff Area=0.542 ac 96.68% Impervious Runoff Depth>4.45"
Flow Length=215' Tc=6.0 min CN=97 Runoff=2.47 cfs 0.201 af

SubcatchmentA6-PR: Subcat A6-PR Runoff Area=0.349 ac 100.00% Impervious Runoff Depth>4.56"
Flow Length=149' Tc=6.0 min CN=98 Runoff=1.60 cfs 0.133 af

SubcatchmentA7-PR: Subcat A7-PR Runoff Area=0.691 ac 100.00% Impervious Runoff Depth>4.56"
Flow Length=660' Tc=6.0 min CN=98 Runoff=3.17 cfs 0.263 af

SubcatchmentA8-PR: Subcat A8-PR Runoff Area=0.414 ac 78.09% Impervious Runoff Depth>4.10"
Flow Length=568' Tc=25.3 min CN=94 Runoff=1.15 cfs 0.141 af

SubcatchmentA9-PR: Subcat A9-PR Runoff Area=0.205 ac 87.61% Impervious Runoff Depth>4.33"
Flow Length=500' Tc=6.1 min CN=96 Runoff=0.92 cfs 0.074 af

SubcatchmentB1-PR: Subcat B1-PR Runoff Area=1.738 ac 89.62% Impervious Runoff Depth>4.32"
Flow Length=50' Slope=0.0134 '/' Tc=23.6 min CN=96 Runoff=5.09 cfs 0.626 af

Pond P1: Level Spreader Peak Elev=64.27' Storage=7,899 cf Inflow=5.99 cfs 0.579 af
Outflow=5.89 cfs 0.399 af

Pond P2: Pond 2 Peak Elev=66.18' Storage=2,692 cf Inflow=3.17 cfs 0.263 af
Discarded=0.04 cfs 0.046 af Primary=3.03 cfs 0.162 af Outflow=3.07 cfs 0.207 af

Pond P3: Level Spreader Peak Elev=64.41' Storage=4,859 cf Inflow=13.42 cfs 1.136 af
Outflow=13.25 cfs 1.033 af

Link A: Bordering Vegetated Wetland
Inflow=26.83 cfs 1.995 af
Primary=26.83 cfs 1.995 af

Link B: Municipal Stormwater System
Inflow=5.09 cfs 0.626 af
Primary=5.09 cfs 0.626 af

Total Runoff Area = 8.890 ac Runoff Volume = 3.005 af Average Runoff Depth = 4.06"
23.45% Pervious = 2.084 ac 76.55% Impervious = 6.806 ac

Summary for Subcatchment A1-PR: Subcat A1-PR

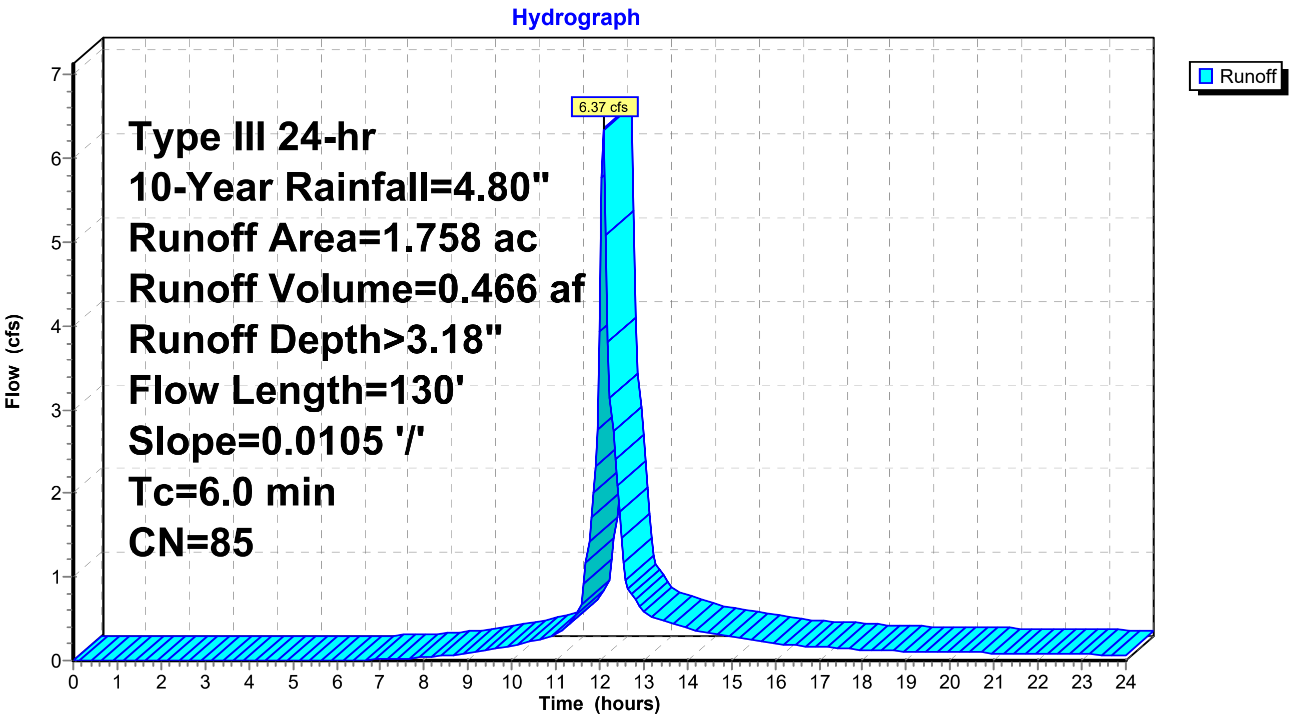
Runoff = 6.37 cfs @ 12.09 hrs, Volume= 0.466 af, Depth> 3.18"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.007	80	>75% Grass cover, Good, HSG D
0.027	80	>75% Grass cover, Good, HSG D
0.074	98	Paved parking, HSG D
0.438	98	Paved parking, HSG D
0.119	98	Roofs, HSG D
1.093	77	Woods, Good, HSG D
1.758	85	Weighted Average
1.127		64.11% Pervious Area
0.631		35.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0105	0.26		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	80	0.0105	2.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.8	130	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A1-PR: Subcat A1-PR



Summary for Subcatchment A10-PR: Subcat A10-PR

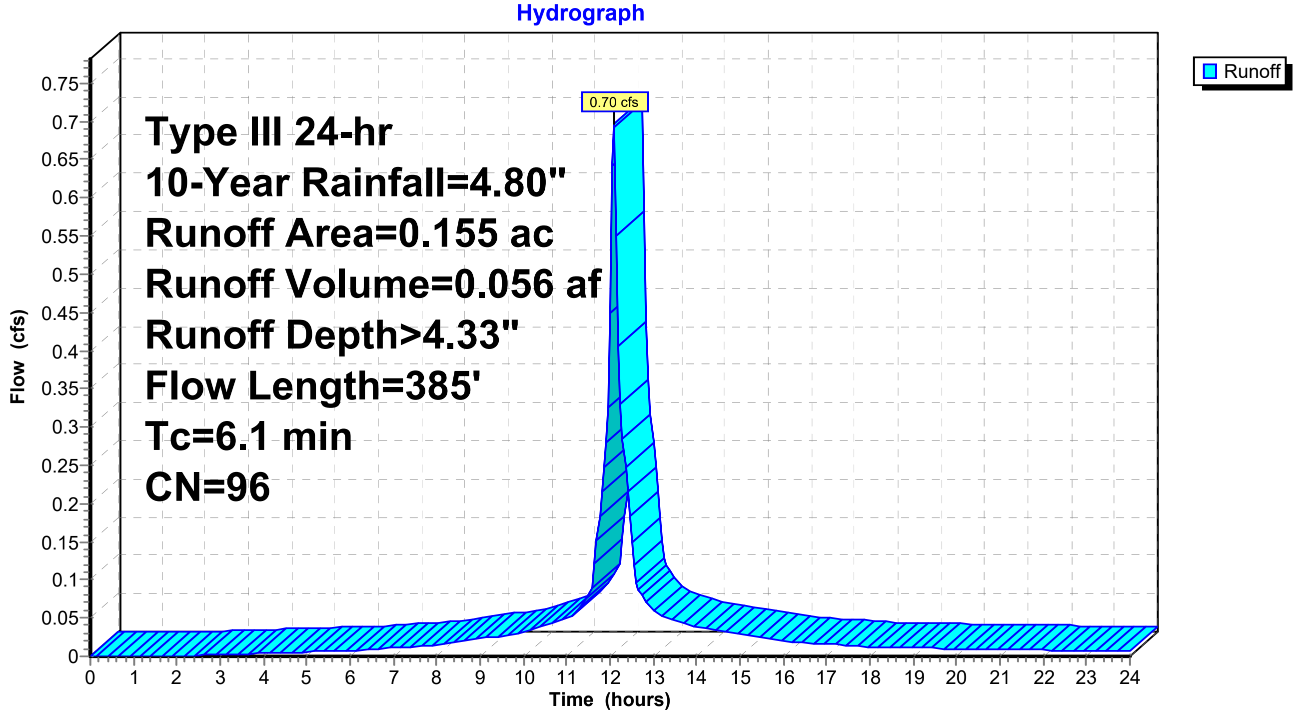
Runoff = 0.70 cfs @ 12.09 hrs, Volume= 0.056 af, Depth> 4.33"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.019	80	>75% Grass cover, Good, HSG D
0.136	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.155	96	Weighted Average
0.019		12.23% Pervious Area
0.136		87.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	12	0.2770	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
2.5	28	0.0060	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	55	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	385	Total			

Subcatchment A10-PR: Subcat A10-PR



Summary for Subcatchment A11-PR: Subcat A11-PR

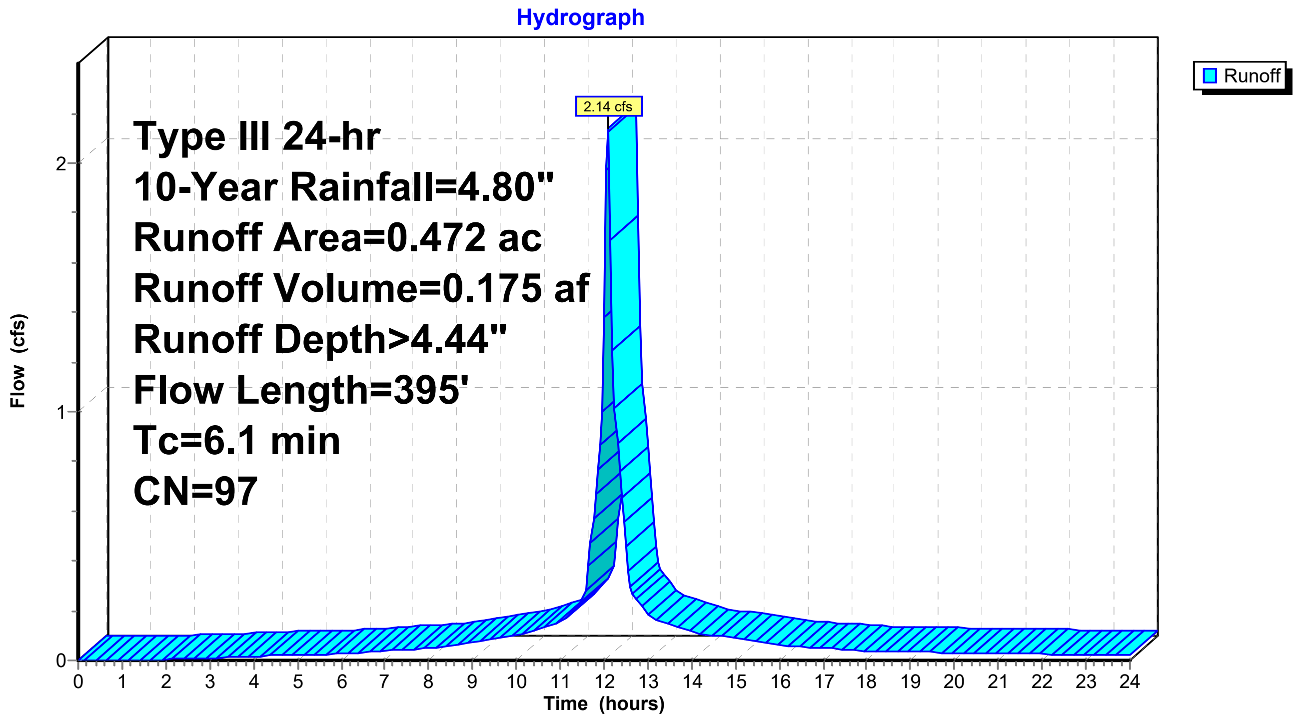
Runoff = 2.14 cfs @ 12.09 hrs, Volume= 0.175 af, Depth> 4.44"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.016	80	>75% Grass cover, Good, HSG D
0.456	98	Paved parking, HSG D
0.472	97	Weighted Average
0.016		3.38% Pervious Area
0.456		96.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	20	0.0140	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.1	15	0.0130	0.22		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.4	15	0.0081	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	32	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0069	1.69		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	106	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	395	Total			

Subcatchment A11-PR: Subcat A11-PR



Summary for Subcatchment A12-PR: Subcat A12-PR

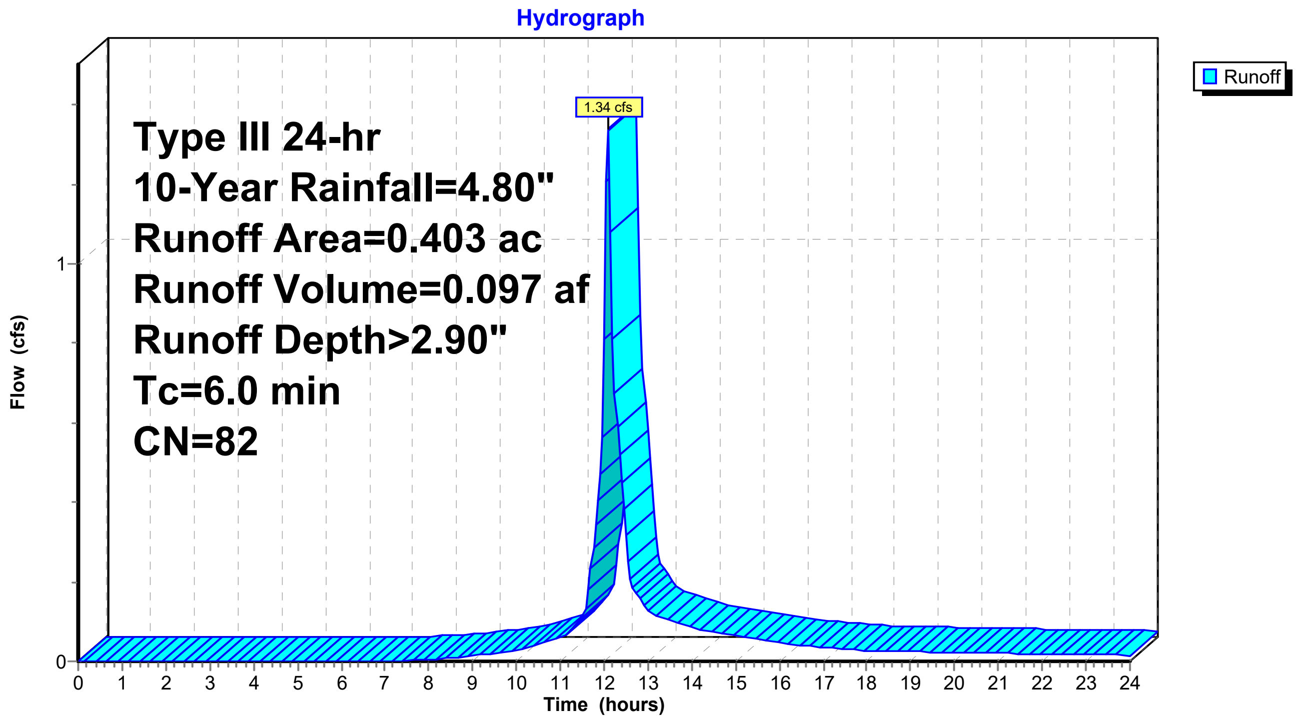
Runoff = 1.34 cfs @ 12.09 hrs, Volume= 0.097 af, Depth> 2.90"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.203	80	>75% Grass cover, Good, HSG D
0.000	98	Paved parking, HSG D
0.060	98	Water Surface, HSG D
0.140	77	Woods, Good, HSG D
0.403	82	Weighted Average
0.343		85.11% Pervious Area
0.060		14.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A12-PR: Subcat A12-PR



Summary for Subcatchment A2-PR: Subcat A2-PR

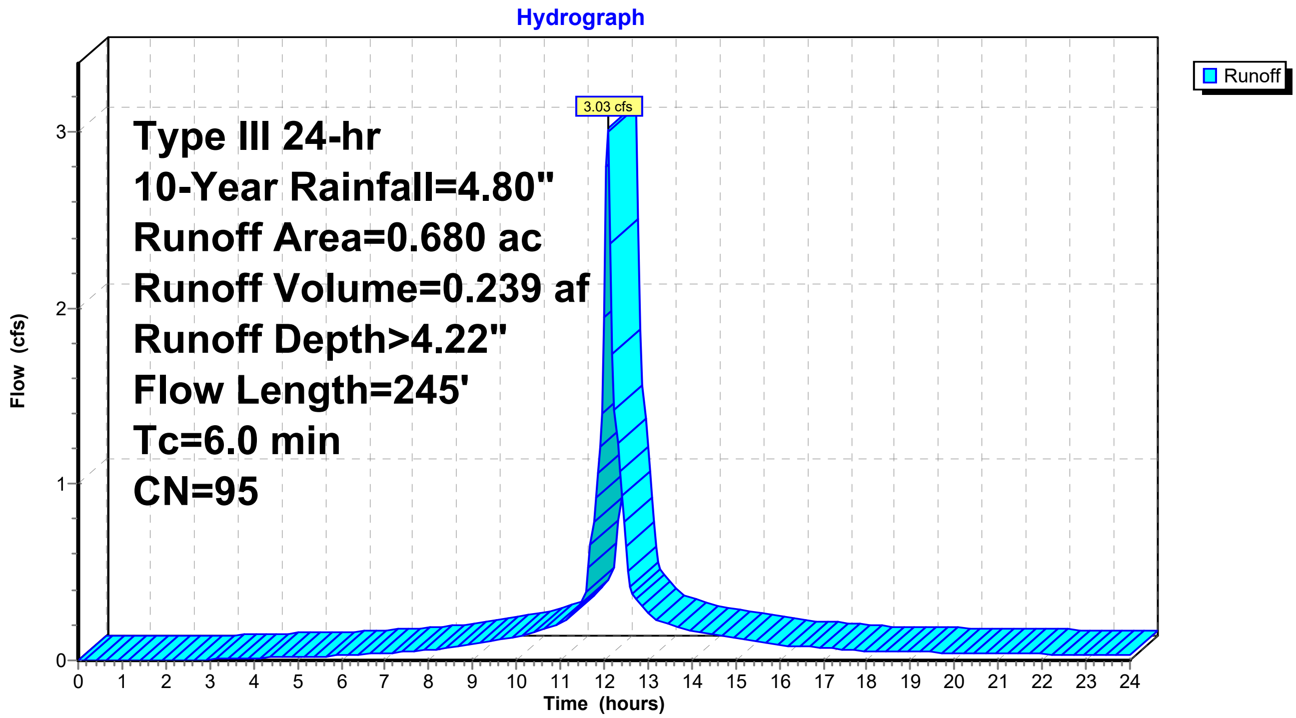
Runoff = 3.03 cfs @ 12.09 hrs, Volume= 0.239 af, Depth> 4.22"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.031	80	>75% Grass cover, Good, HSG D
0.072	80	>75% Grass cover, Good, HSG D
0.394	98	Paved parking, HSG D
0.128	98	Paved parking, HSG D
0.047	98	Water Surface, HSG D
0.008	98	Water Surface, HSG D
0.680	95	Weighted Average
0.103		15.15% Pervious Area
0.577		84.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	17	0.0259	0.30		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	33	0.0256	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	6	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	39	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	108	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.3	245	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A2-PR: Subcat A2-PR



Summary for Subcatchment A3-PR: Subcat A3-PR

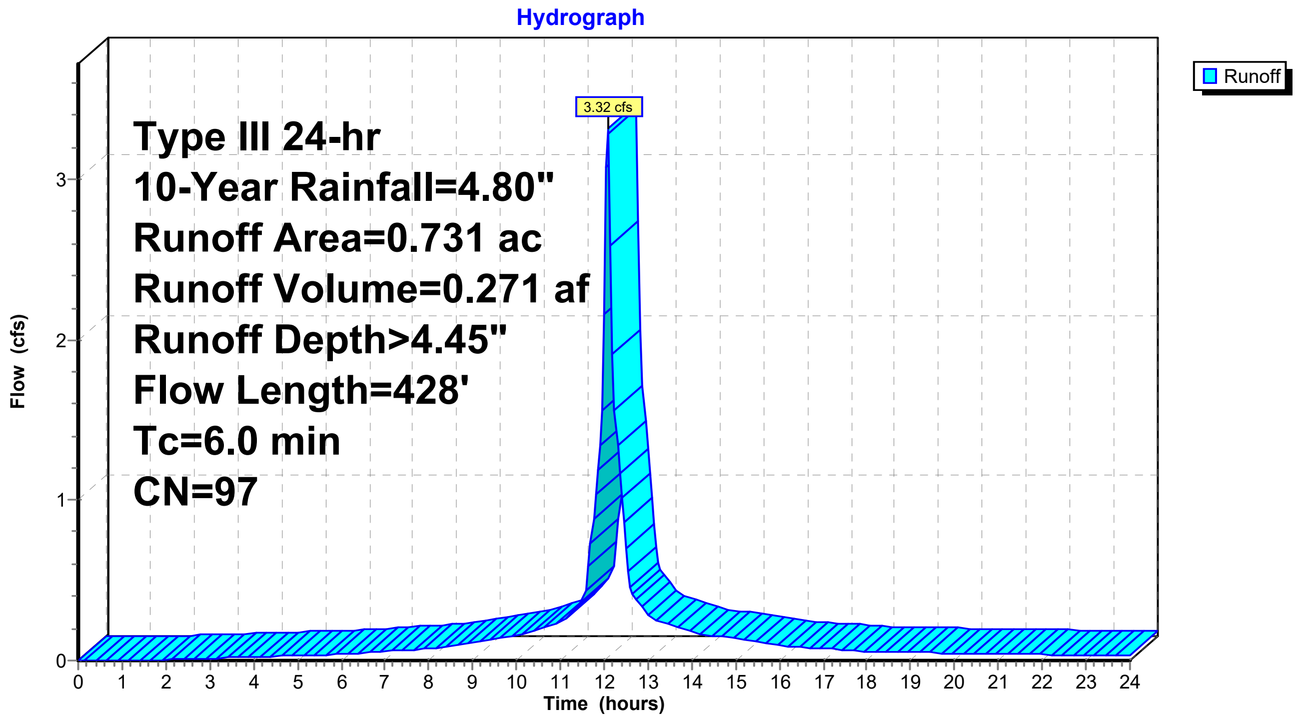
Runoff = 3.32 cfs @ 12.09 hrs, Volume= 0.271 af, Depth> 4.45"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.681	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.731	97	Weighted Average
0.049		6.77% Pervious Area
0.681		93.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	50	0.0208	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	100	0.0208	2.93		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	278	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
4.2	428	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A3-PR: Subcat A3-PR



Summary for Subcatchment A4-PR: Subcat A4-PR

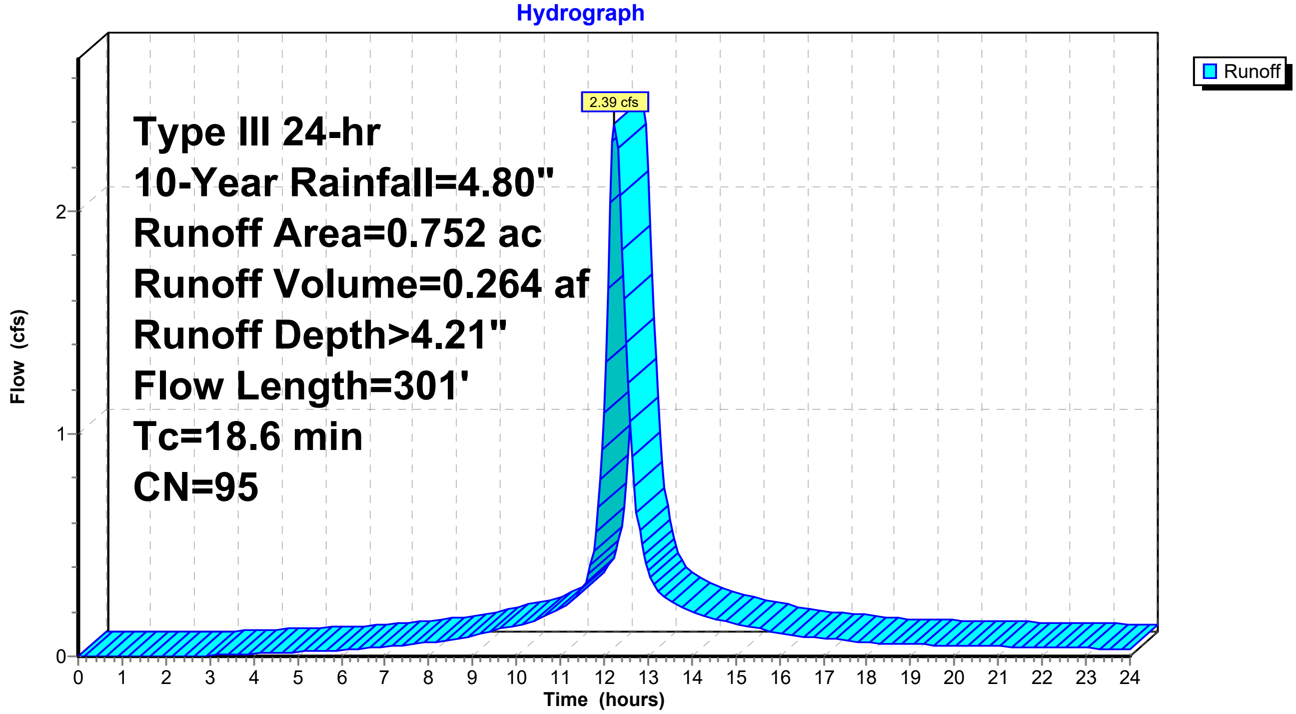
Runoff = 2.39 cfs @ 12.25 hrs, Volume= 0.264 af, Depth> 4.21"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.113	80	>75% Grass cover, Good, HSG D
0.601	98	Paved parking, HSG D
0.038	98	Water Surface, HSG D
0.752	95	Weighted Average
0.113		15.01% Pervious Area
0.639		84.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	25	0.0074	0.02		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	75	0.0074	1.75		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.6	178	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
18.6	301	Total			

Subcatchment A4-PR: Subcat A4-PR



Summary for Subcatchment A5-PR: Subcat A5-PR

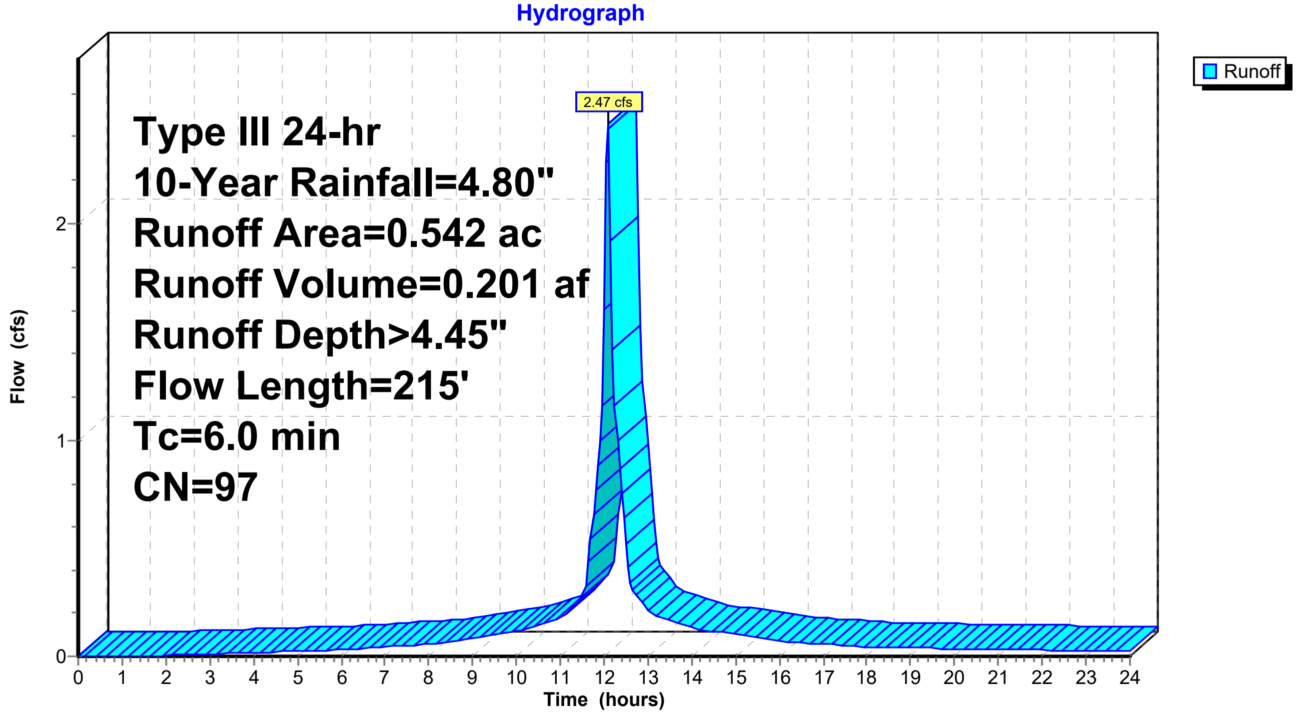
Runoff = 2.47 cfs @ 12.09 hrs, Volume= 0.201 af, Depth> 4.45"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.018	80	>75% Grass cover, Good, HSG D
0.524	98	Paved parking, HSG D
0.542	97	Weighted Average
0.018		3.32% Pervious Area
0.524		96.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	19	0.0230	0.29		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	31	0.0217	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	15	0.0217	2.99		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	49	0.0204	2.90		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0219	3.00		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	59	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.6	215	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A5-PR: Subcat A5-PR



Summary for Subcatchment A6-PR: Subcat A6-PR

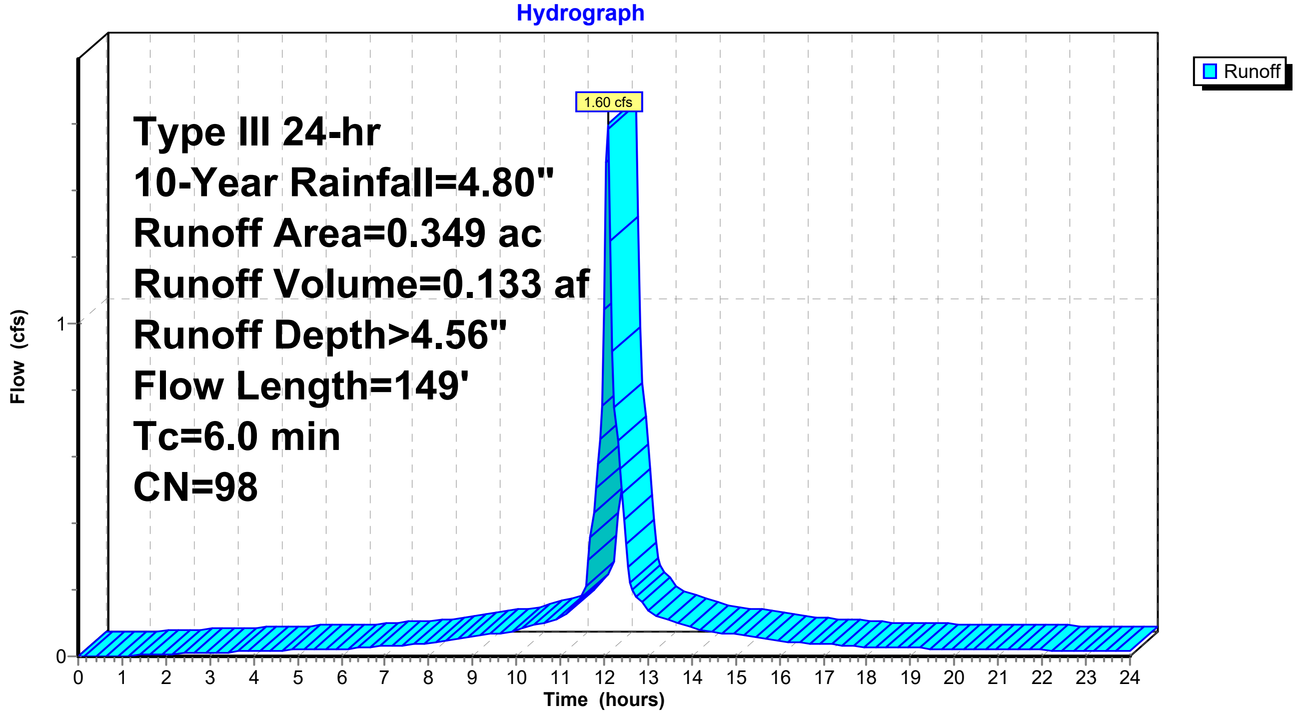
Runoff = 1.60 cfs @ 12.09 hrs, Volume= 0.133 af, Depth> 4.56"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.000	80	>75% Grass cover, Good, HSG D
0.349	98	Paved parking, HSG D
0.349	98	Weighted Average
0.000		0.00% Pervious Area
0.349		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	24	0.0417	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.2	26	0.0357	0.37		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	2	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	28	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.0364	3.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	34	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
2.6	149	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A6-PR: Subcat A6-PR



Summary for Subcatchment A7-PR: Subcat A7-PR

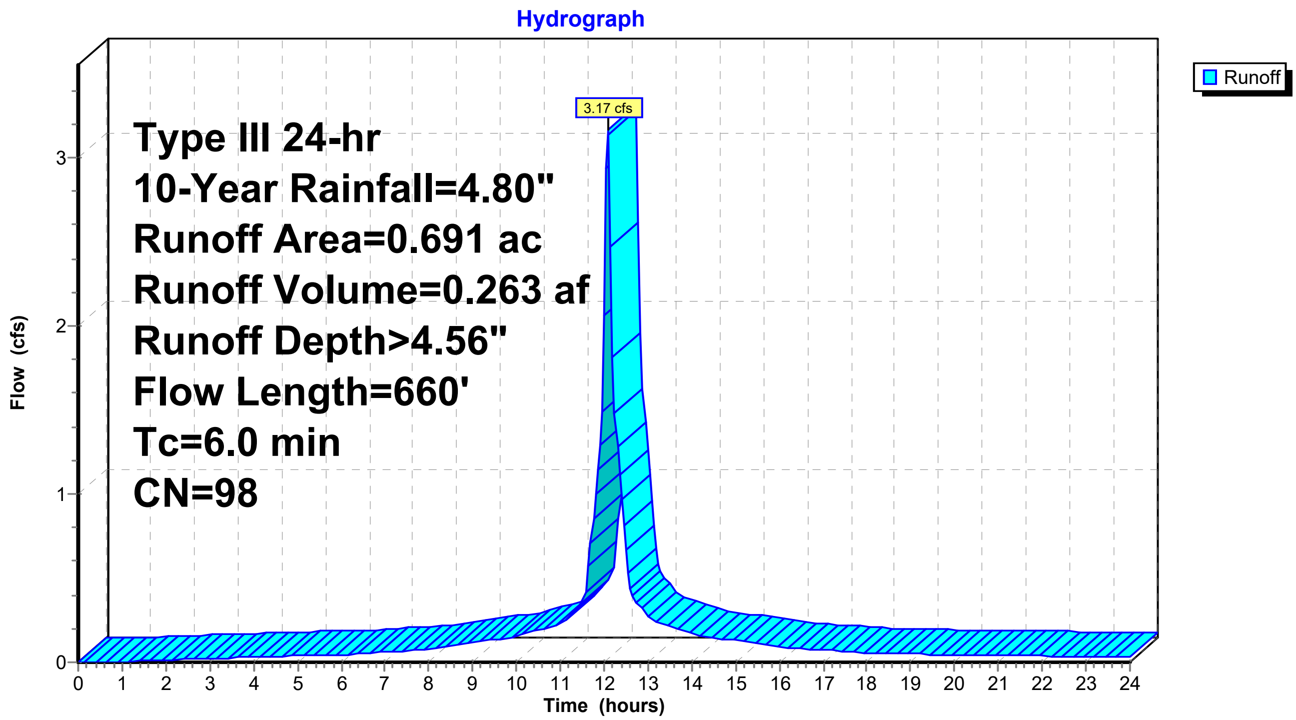
Runoff = 3.17 cfs @ 12.09 hrs, Volume= 0.263 af, Depth> 4.56"
Routed to Pond P2 : Pond 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.691	98	Roofs, HSG D
0.691		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	60	0.0200	0.35		**Sheet Flow, Roof Area** Smooth surfaces n= 0.011 P2= 0.25"
2.9	600	0.0050	3.47	2.73	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	660	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A7-PR: Subcat A7-PR



Summary for Subcatchment A8-PR: Subcat A8-PR

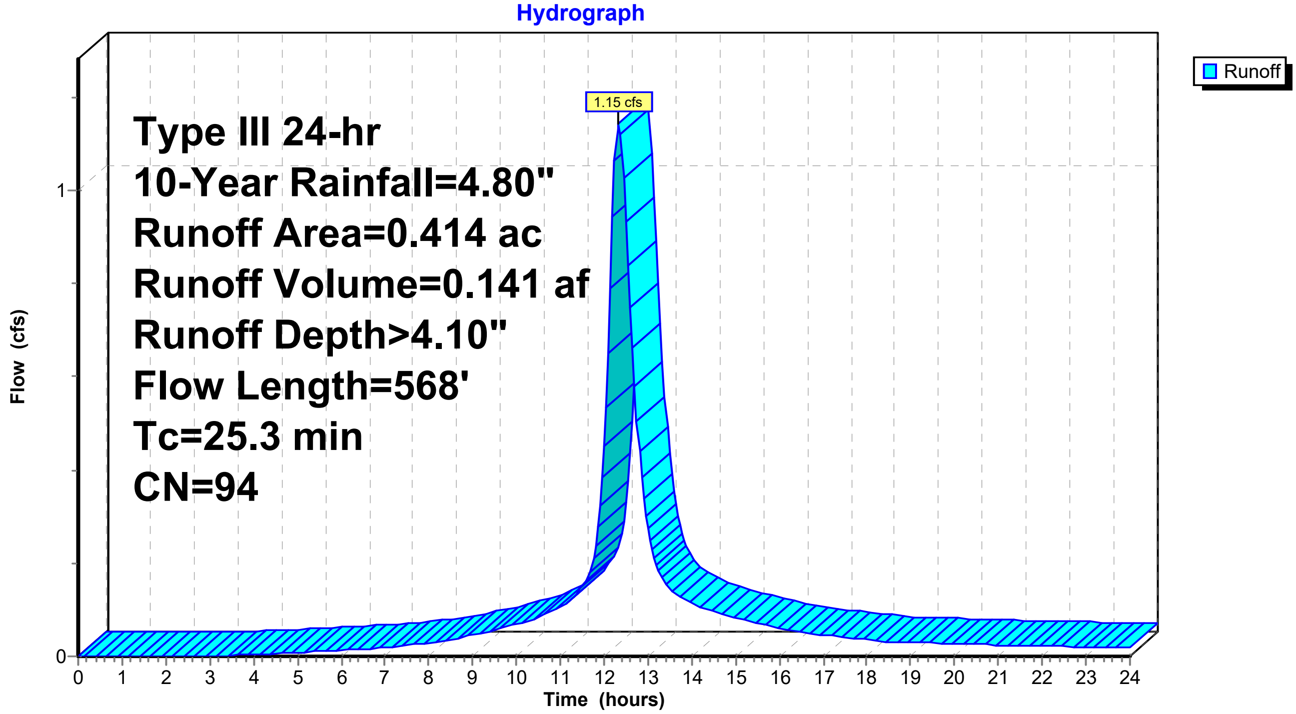
Runoff = 1.15 cfs @ 12.33 hrs, Volume= 0.141 af, Depth> 4.10"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.091	80	>75% Grass cover, Good, HSG D
0.323	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.414	94	Weighted Average
0.091		21.91% Pervious Area
0.323		78.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2	40	0.0100	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	10	0.0200	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	60	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	12	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	13	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.5	133	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
25.3	568	Total			

Subcatchment A8-PR: Subcat A8-PR



Summary for Subcatchment A9-PR: Subcat A9-PR

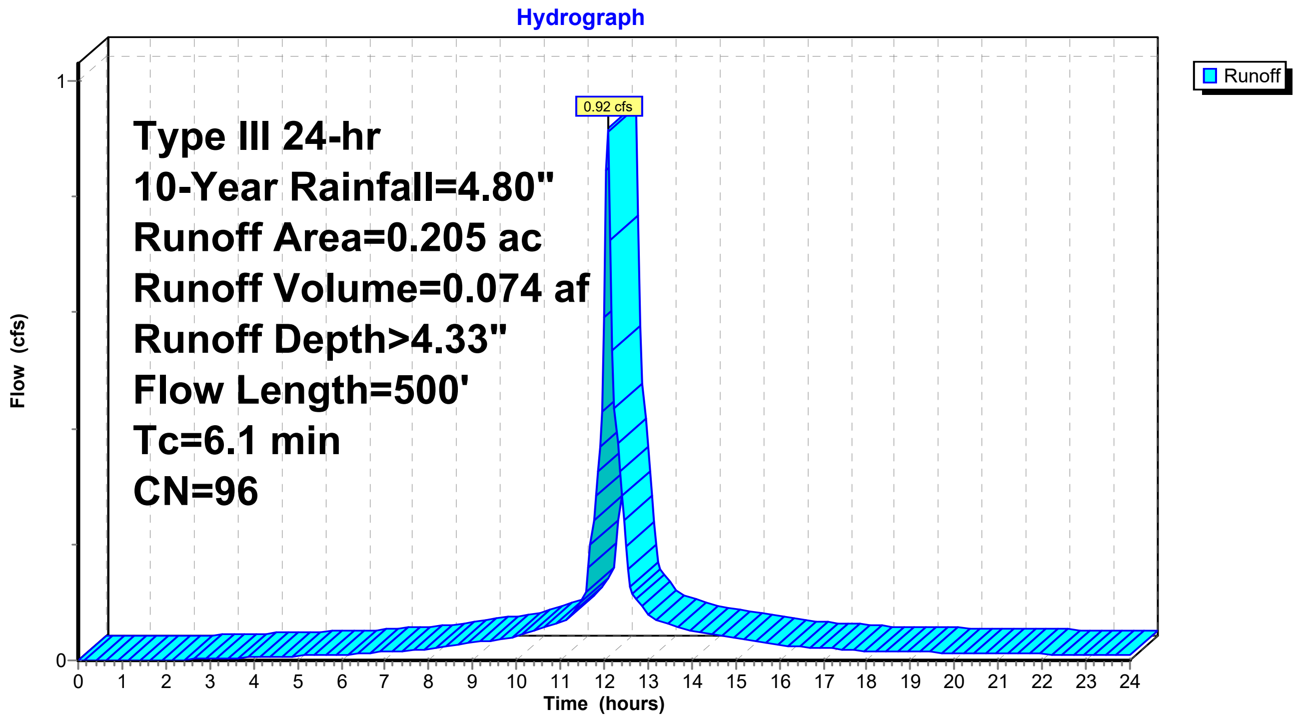
Runoff = 0.92 cfs @ 12.09 hrs, Volume= 0.074 af, Depth> 4.33"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.025	80	>75% Grass cover, Good, HSG D
0.179	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.205	96	Weighted Average
0.025		12.39% Pervious Area
0.179		87.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	12	0.2520	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
1.9	35	0.0200	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.2	30	0.0030	2.48	1.95	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.6	133	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	500	Total			

Subcatchment A9-PR: Subcat A9-PR



Summary for Subcatchment B1-PR: Subcat B1-PR

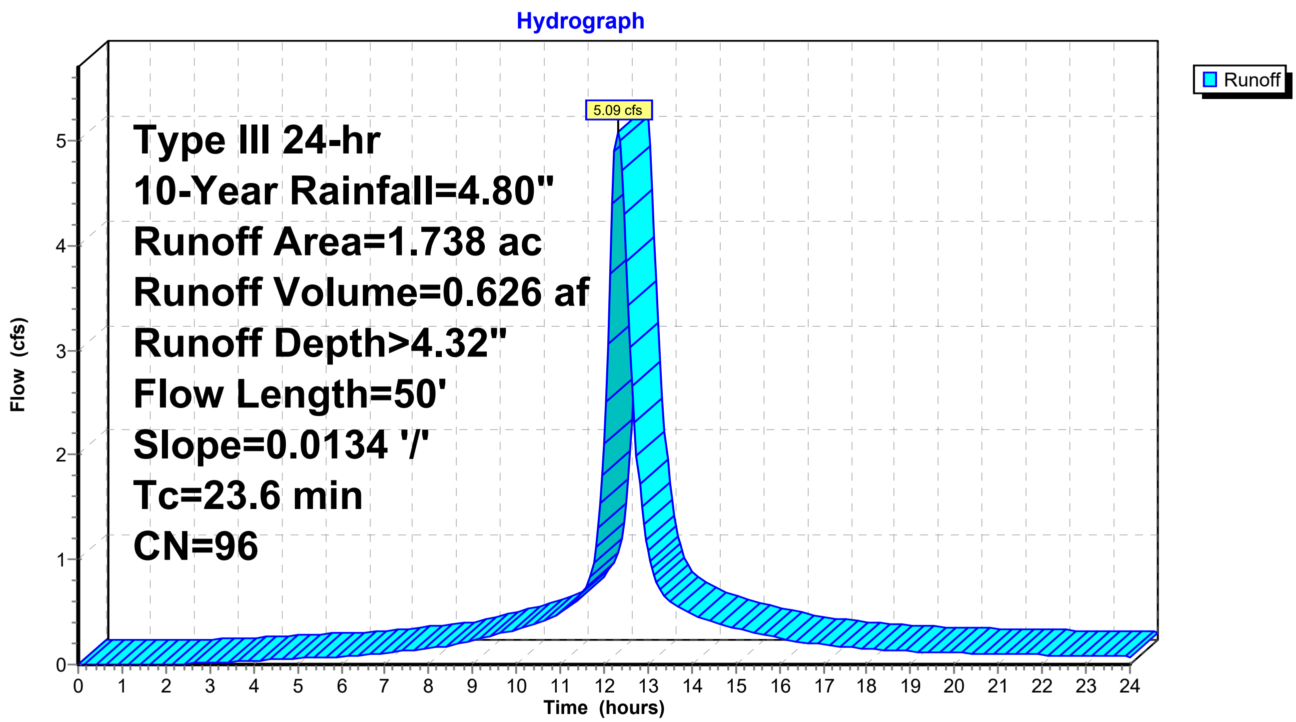
Runoff = 5.09 cfs @ 12.31 hrs, Volume= 0.626 af, Depth> 4.32"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.80"

Area (ac)	CN	Description
0.180	80	>75% Grass cover, Good, HSG D
1.371	98	Paved parking, HSG D
0.186	98	Roofs, HSG D
0.001	77	Woods, Good, HSG D
1.738	96	Weighted Average
0.180		10.38% Pervious Area
1.558		89.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.6	50	0.0134	0.04		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"

Subcatchment B1-PR: Subcat B1-PR



Summary for Pond P1: Level Spreader

Inflow Area = 1.596 ac, 90.54% Impervious, Inflow Depth > 4.35" for 10-Year event
Inflow = 5.99 cfs @ 12.09 hrs, Volume= 0.579 af
Outflow = 5.89 cfs @ 12.10 hrs, Volume= 0.399 af, Atten= 2%, Lag= 0.3 min
Primary = 5.89 cfs @ 12.10 hrs, Volume= 0.399 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.27' @ 12.10 hrs Surf.Area= 2,750 sf Storage= 7,899 cf

Plug-Flow detention time= 173.5 min calculated for 0.399 af (69% of inflow)
Center-of-Mass det. time= 79.5 min (843.7 - 764.2)

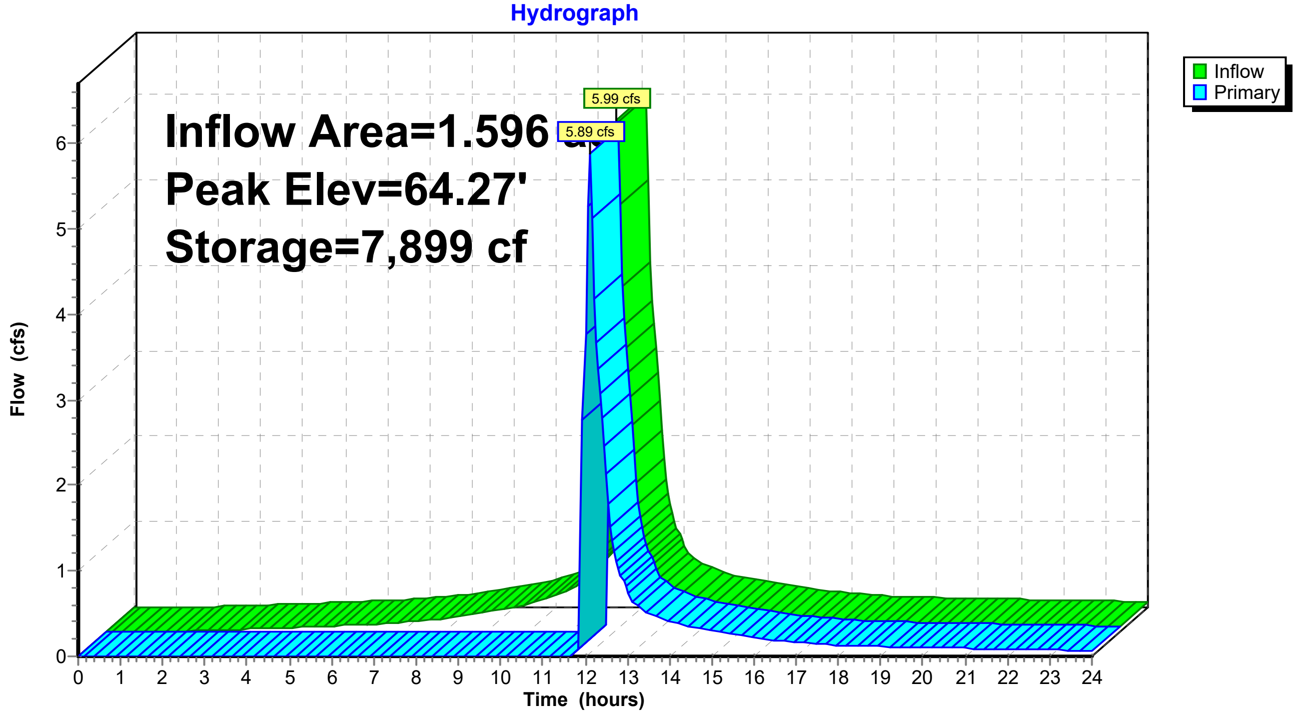
Volume	Invert	Avail.Storage	Storage Description
#1	59.00'	10,054 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
59.00	370	193.0	0	0	370
60.00	770	206.0	558	558	828
61.00	1,194	218.0	974	1,532	1,285
62.00	1,643	231.0	1,413	2,945	1,801
63.00	2,118	243.0	1,875	4,820	2,312
64.00	2,617	256.0	2,363	7,183	2,886
65.00	3,133	268.0	2,871	10,054	3,450

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**132.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=5.53 cfs @ 12.10 hrs HW=64.27' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 5.53 cfs @ 0.63 fps)

Pond P1: Level Spreader



Summary for Pond P2: Pond 2

Inflow Area = 0.691 ac,100.00% Impervious, Inflow Depth > 4.56" for 10-Year event
Inflow = 3.17 cfs @ 12.09 hrs, Volume= 0.263 af
Outflow = 3.07 cfs @ 12.10 hrs, Volume= 0.207 af, Atten= 3%, Lag= 0.9 min
Discarded = 0.04 cfs @ 12.10 hrs, Volume= 0.046 af
Primary = 3.03 cfs @ 12.10 hrs, Volume= 0.162 af
Routed to Pond P3 : Level Spreader

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 66.18' @ 12.10 hrs Surf.Area= 1,498 sf Storage= 2,692 cf

Plug-Flow detention time= 139.8 min calculated for 0.207 af (79% of inflow)
Center-of-Mass det. time= 60.7 min (808.9 - 748.3)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	4,091 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

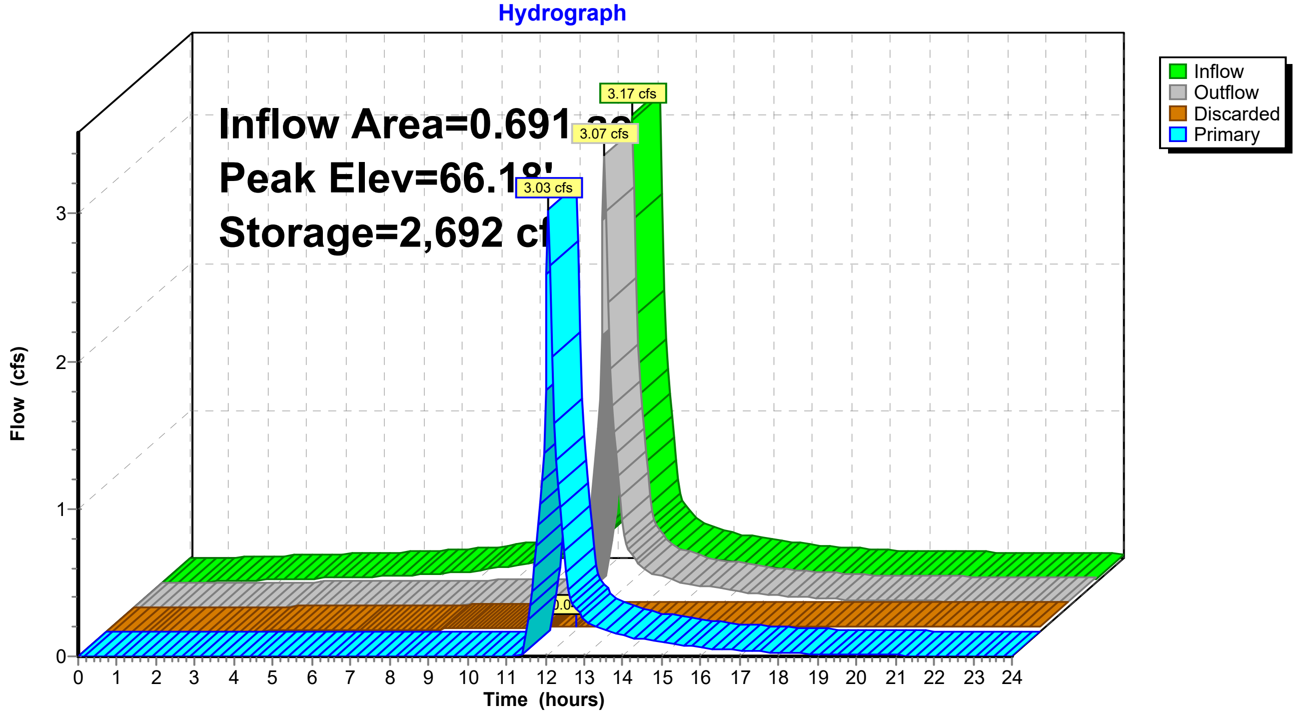
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	50	39.0	0	0	50
63.00	234	84.0	131	131	495
64.00	551	124.0	381	512	1,165
65.00	953	143.0	743	1,255	1,590
66.00	1,411	162.0	1,175	2,429	2,076
67.00	1,925	181.0	1,661	4,091	2,622

Device	Routing	Invert	Outlet Devices
#1	Primary	63.10'	**15.0" Round Culvert** L= 305.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 63.10' / 61.21' S= 0.0062 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	66.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 12.10 hrs HW=66.18' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=2.99 cfs @ 12.10 hrs HW=66.18' (Free Discharge)
└─**1=Culvert** (Passes 2.99 cfs of 6.32 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.99 cfs @ 1.39 fps)

Pond P2: Pond 2



Summary for Pond P3: Level Spreader

Inflow Area = 3.396 ac, 91.66% Impervious, Inflow Depth > 4.01" for 10-Year event
Inflow = 13.42 cfs @ 12.10 hrs, Volume= 1.136 af
Outflow = 13.25 cfs @ 12.10 hrs, Volume= 1.033 af, Atten= 1%, Lag= 0.2 min
Primary = 13.25 cfs @ 12.10 hrs, Volume= 1.033 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.41' @ 12.10 hrs Surf.Area= 1,763 sf Storage= 4,859 cf

Plug-Flow detention time= 74.8 min calculated for 1.031 af (91% of inflow)
Center-of-Mass det. time= 32.5 min (799.4 - 766.9)

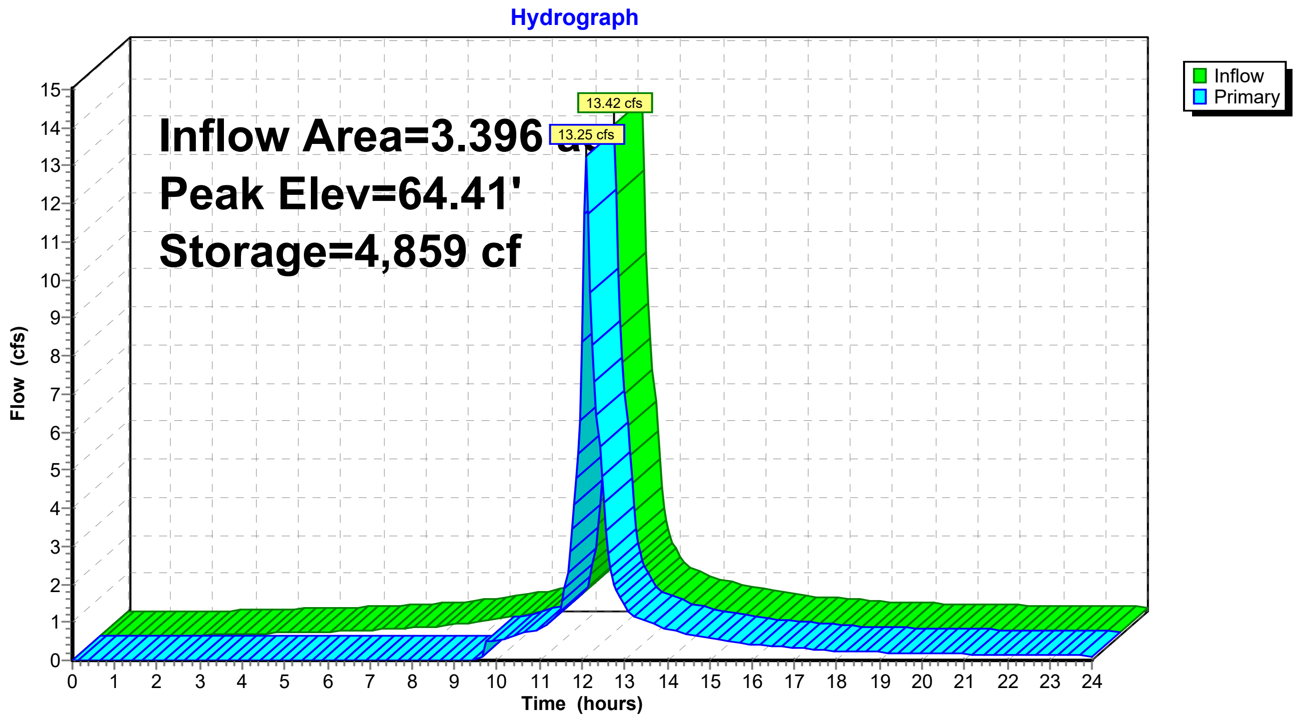
Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	5,961 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.00	524	113.0	0	0	524
61.00	763	125.0	640	640	781
62.00	1,026	138.0	891	1,531	1,083
63.00	1,314	150.0	1,167	2,698	1,393
64.00	1,628	163.0	1,468	4,166	1,753
65.00	1,967	176.0	1,795	5,961	2,142

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**59.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=13.20 cfs @ 12.10 hrs HW=64.41' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 13.20 cfs @ 1.07 fps)

Pond P3: Level Spreader

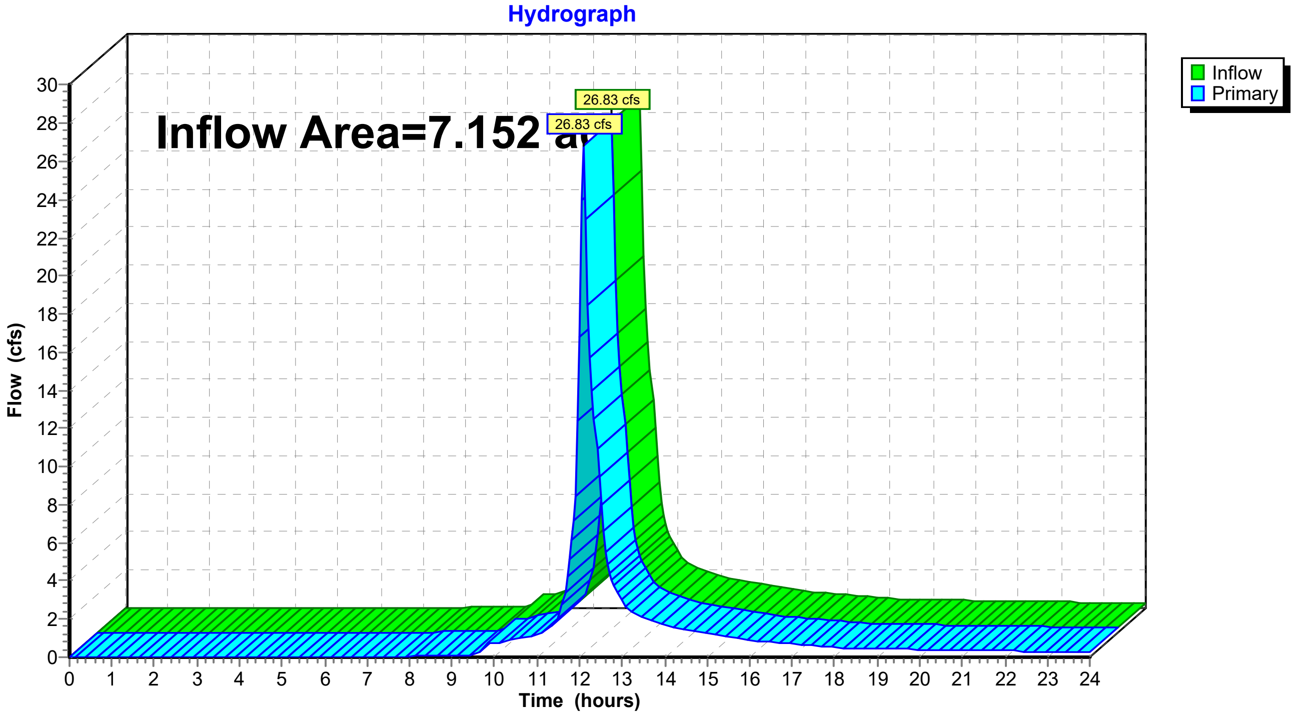


Summary for Link A: Bordering Vegetated Wetland

Inflow Area =	7.152 ac,	73.38% Impervious,	Inflow Depth > 3.35"	for 10-Year event
Inflow =	26.83 cfs @	12.10 hrs, Volume=	1.995 af	
Primary =	26.83 cfs @	12.10 hrs, Volume=	1.995 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

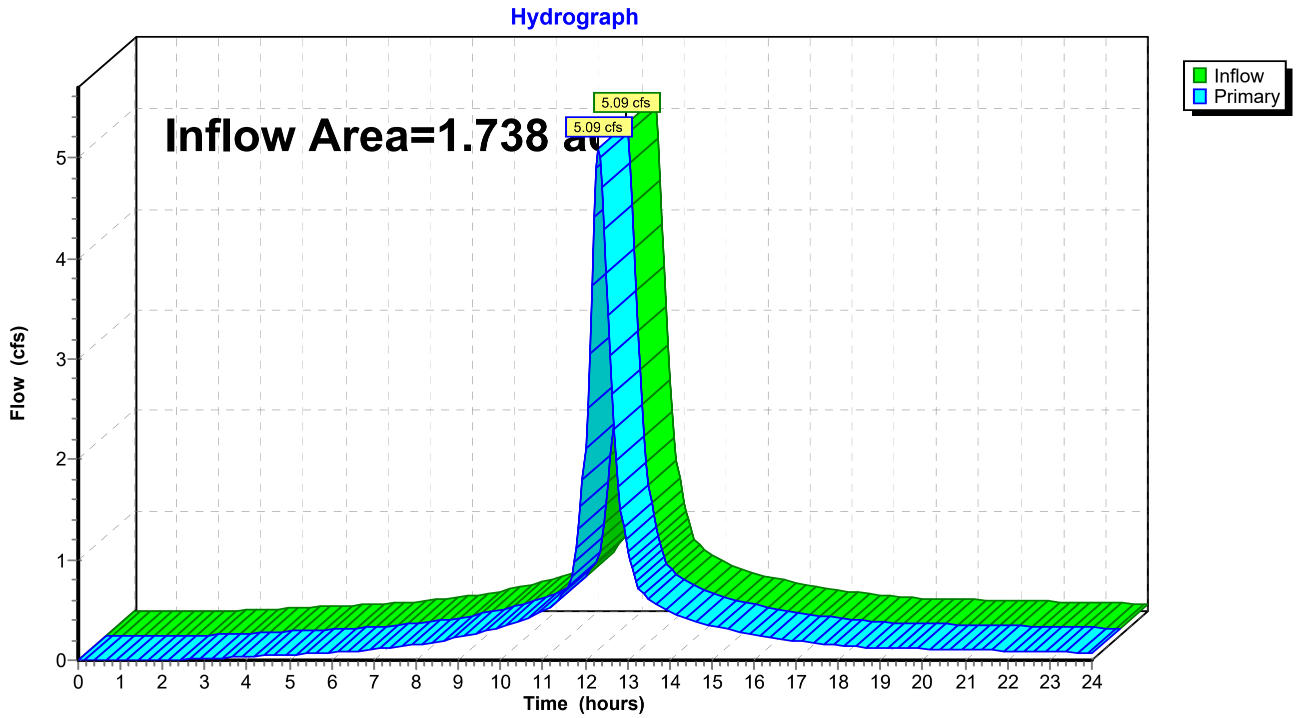


Summary for Link B: Municipal Stormwater System

Inflow Area = 1.738 ac, 89.62% Impervious, Inflow Depth > 4.32" for 10-Year event
Inflow = 5.09 cfs @ 12.31 hrs, Volume= 0.626 af
Primary = 5.09 cfs @ 12.31 hrs, Volume= 0.626 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-PR: Subcat A1-PR Runoff Area=1.758 ac 35.89% Impervious Runoff Depth>3.92"
Flow Length=130' Slope=0.0105 '/' Tc=6.0 min CN=85 Runoff=7.79 cfs 0.575 af

SubcatchmentA10-PR: Subcat A10-PR Runoff Area=0.155 ac 87.77% Impervious Runoff Depth>5.13"
Flow Length=385' Tc=6.1 min CN=96 Runoff=0.82 cfs 0.066 af

SubcatchmentA11-PR: Subcat A11-PR Runoff Area=0.472 ac 96.62% Impervious Runoff Depth>5.24"
Flow Length=395' Tc=6.1 min CN=97 Runoff=2.51 cfs 0.206 af

SubcatchmentA12-PR: Subcat A12-PR Runoff Area=0.403 ac 14.89% Impervious Runoff Depth>3.62"
Tc=6.0 min CN=82 Runoff=1.66 cfs 0.121 af

SubcatchmentA2-PR: Subcat A2-PR Runoff Area=0.680 ac 84.85% Impervious Runoff Depth>5.01"
Flow Length=245' Tc=6.0 min CN=95 Runoff=3.56 cfs 0.284 af

SubcatchmentA3-PR: Subcat A3-PR Runoff Area=0.731 ac 93.23% Impervious Runoff Depth>5.24"
Flow Length=428' Tc=6.0 min CN=97 Runoff=3.89 cfs 0.319 af

SubcatchmentA4-PR: Subcat A4-PR Runoff Area=0.752 ac 84.99% Impervious Runoff Depth>5.00"
Flow Length=301' Tc=18.6 min CN=95 Runoff=2.82 cfs 0.313 af

SubcatchmentA5-PR: Subcat A5-PR Runoff Area=0.542 ac 96.68% Impervious Runoff Depth>5.24"
Flow Length=215' Tc=6.0 min CN=97 Runoff=2.89 cfs 0.237 af

SubcatchmentA6-PR: Subcat A6-PR Runoff Area=0.349 ac 100.00% Impervious Runoff Depth>5.36"
Flow Length=149' Tc=6.0 min CN=98 Runoff=1.87 cfs 0.156 af

SubcatchmentA7-PR: Subcat A7-PR Runoff Area=0.691 ac 100.00% Impervious Runoff Depth>5.36"
Flow Length=660' Tc=6.0 min CN=98 Runoff=3.70 cfs 0.309 af

SubcatchmentA8-PR: Subcat A8-PR Runoff Area=0.414 ac 78.09% Impervious Runoff Depth>4.88"
Flow Length=568' Tc=25.3 min CN=94 Runoff=1.35 cfs 0.169 af

SubcatchmentA9-PR: Subcat A9-PR Runoff Area=0.205 ac 87.61% Impervious Runoff Depth>5.13"
Flow Length=500' Tc=6.1 min CN=96 Runoff=1.08 cfs 0.087 af

SubcatchmentB1-PR: Subcat B1-PR Runoff Area=1.738 ac 89.62% Impervious Runoff Depth>5.11"
Flow Length=50' Slope=0.0134 '/' Tc=23.6 min CN=96 Runoff=5.98 cfs 0.741 af

Pond P1: Level Spreader Peak Elev=64.28' Storage=7,926 cf Inflow=7.02 cfs 0.685 af
Outflow=6.90 cfs 0.506 af

Pond P2: Pond 2 Peak Elev=66.20' Storage=2,723 cf Inflow=3.70 cfs 0.309 af
Discarded=0.04 cfs 0.047 af Primary=3.55 cfs 0.206 af Outflow=3.59 cfs 0.253 af

Pond P3: Level Spreader Peak Elev=64.43' Storage=4,898 cf Inflow=15.75 cfs 1.359 af
Outflow=15.55 cfs 1.256 af

Link A: Bordering Vegetated Wetland
Inflow=31.89 cfs 2.458 af
Primary=31.89 cfs 2.458 af

Link B: Municipal Stormwater System
Inflow=5.98 cfs 0.741 af
Primary=5.98 cfs 0.741 af

Total Runoff Area = 8.890 ac Runoff Volume = 3.583 af Average Runoff Depth = 4.84"
23.45% Pervious = 2.084 ac 76.55% Impervious = 6.806 ac

Summary for Subcatchment A1-PR: Subcat A1-PR

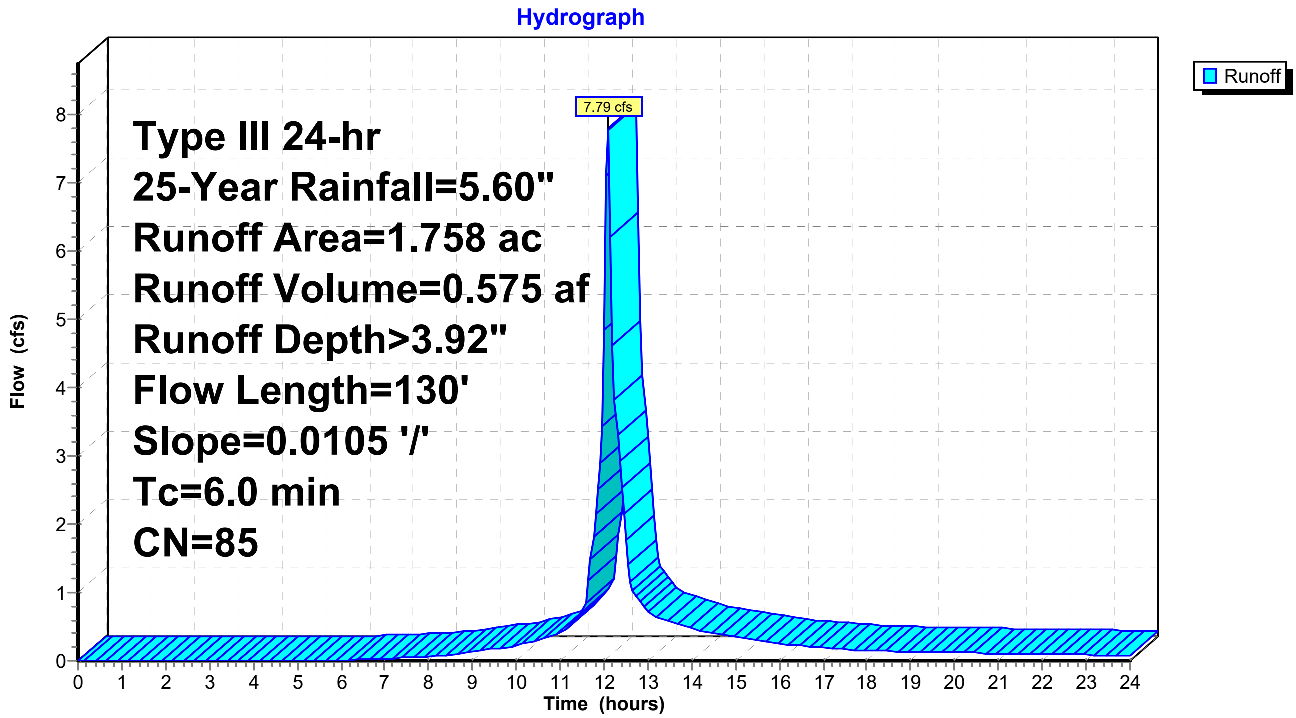
Runoff = 7.79 cfs @ 12.09 hrs, Volume= 0.575 af, Depth> 3.92"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.007	80	>75% Grass cover, Good, HSG D
0.027	80	>75% Grass cover, Good, HSG D
0.074	98	Paved parking, HSG D
0.438	98	Paved parking, HSG D
0.119	98	Roofs, HSG D
1.093	77	Woods, Good, HSG D
1.758	85	Weighted Average
1.127		64.11% Pervious Area
0.631		35.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0105	0.26		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	80	0.0105	2.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.8	130	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A1-PR: Subcat A1-PR



Summary for Subcatchment A10-PR: Subcat A10-PR

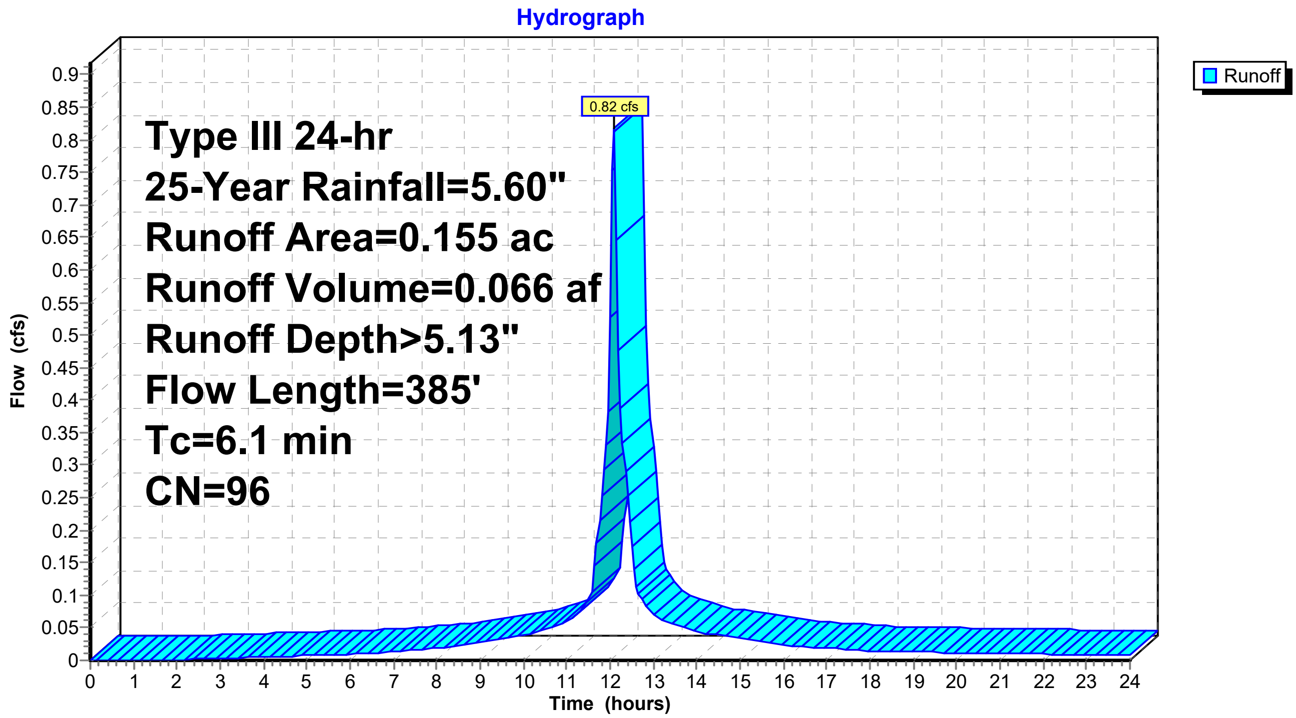
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.066 af, Depth> 5.13"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.019	80	>75% Grass cover, Good, HSG D
0.136	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.155	96	Weighted Average
0.019		12.23% Pervious Area
0.136		87.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	12	0.2770	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
2.5	28	0.0060	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	55	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	385	Total			

Subcatchment A10-PR: Subcat A10-PR



Summary for Subcatchment A11-PR: Subcat A11-PR

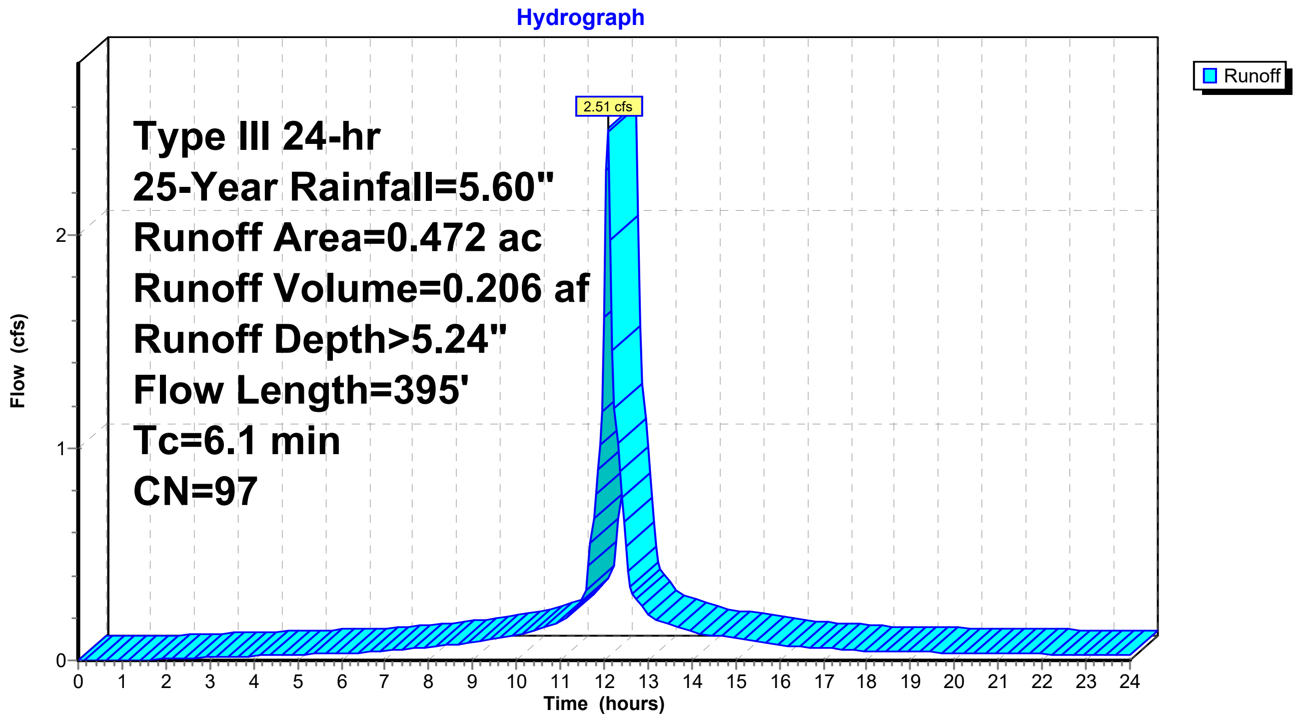
Runoff = 2.51 cfs @ 12.09 hrs, Volume= 0.206 af, Depth> 5.24"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.016	80	>75% Grass cover, Good, HSG D
0.456	98	Paved parking, HSG D
0.472	97	Weighted Average
0.016		3.38% Pervious Area
0.456		96.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	20	0.0140	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.1	15	0.0130	0.22		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.4	15	0.0081	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	32	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0069	1.69		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	106	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	395	Total			

Subcatchment A11-PR: Subcat A11-PR



Summary for Subcatchment A12-PR: Subcat A12-PR

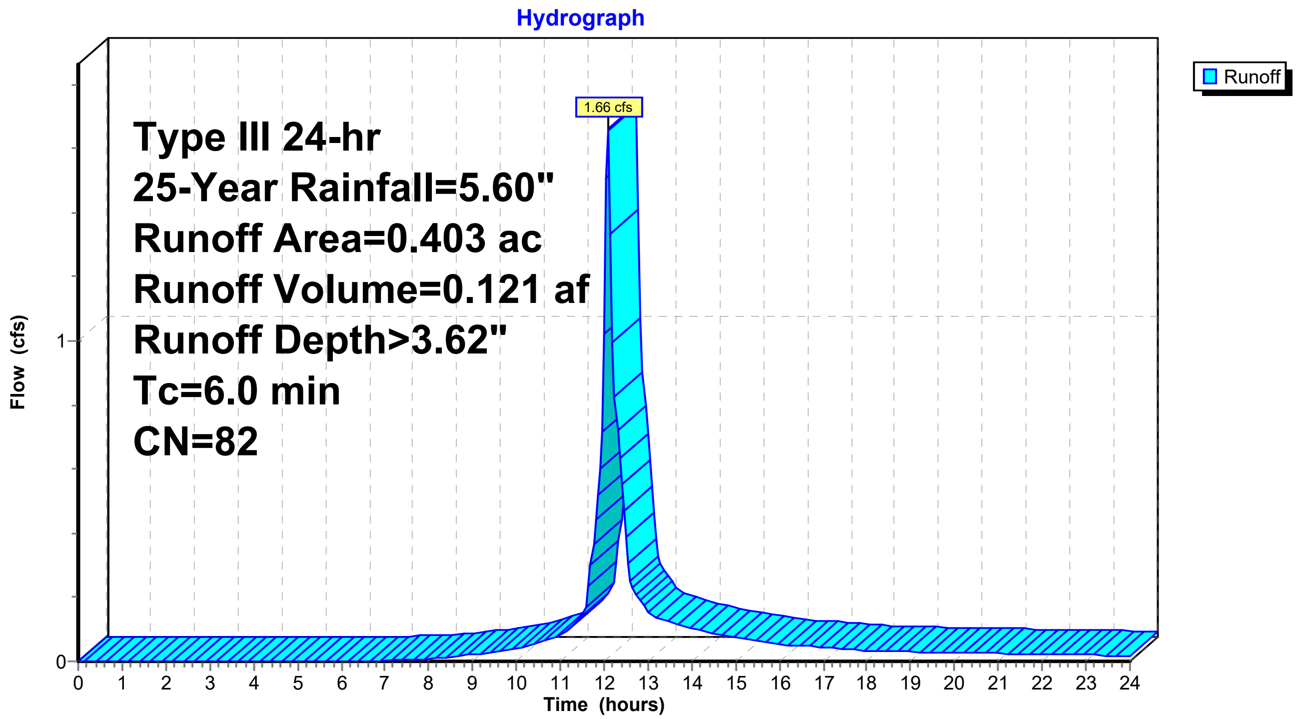
Runoff = 1.66 cfs @ 12.09 hrs, Volume= 0.121 af, Depth> 3.62"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.203	80	>75% Grass cover, Good, HSG D
0.000	98	Paved parking, HSG D
0.060	98	Water Surface, HSG D
0.140	77	Woods, Good, HSG D
0.403	82	Weighted Average
0.343		85.11% Pervious Area
0.060		14.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A12-PR: Subcat A12-PR



Summary for Subcatchment A2-PR: Subcat A2-PR

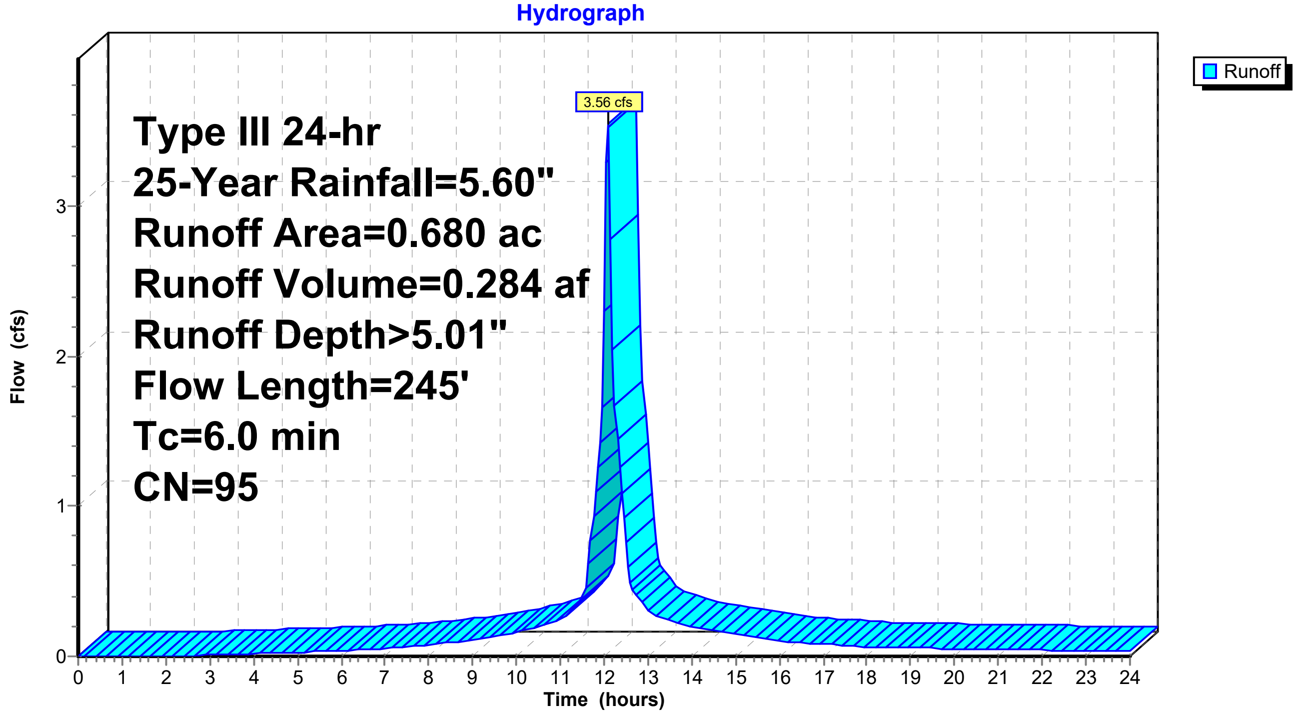
Runoff = 3.56 cfs @ 12.09 hrs, Volume= 0.284 af, Depth> 5.01"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.031	80	>75% Grass cover, Good, HSG D
0.072	80	>75% Grass cover, Good, HSG D
0.394	98	Paved parking, HSG D
0.128	98	Paved parking, HSG D
0.047	98	Water Surface, HSG D
0.008	98	Water Surface, HSG D
0.680	95	Weighted Average
0.103		15.15% Pervious Area
0.577		84.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	17	0.0259	0.30		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	33	0.0256	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	6	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	39	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	108	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.3	245	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A2-PR: Subcat A2-PR



Summary for Subcatchment A3-PR: Subcat A3-PR

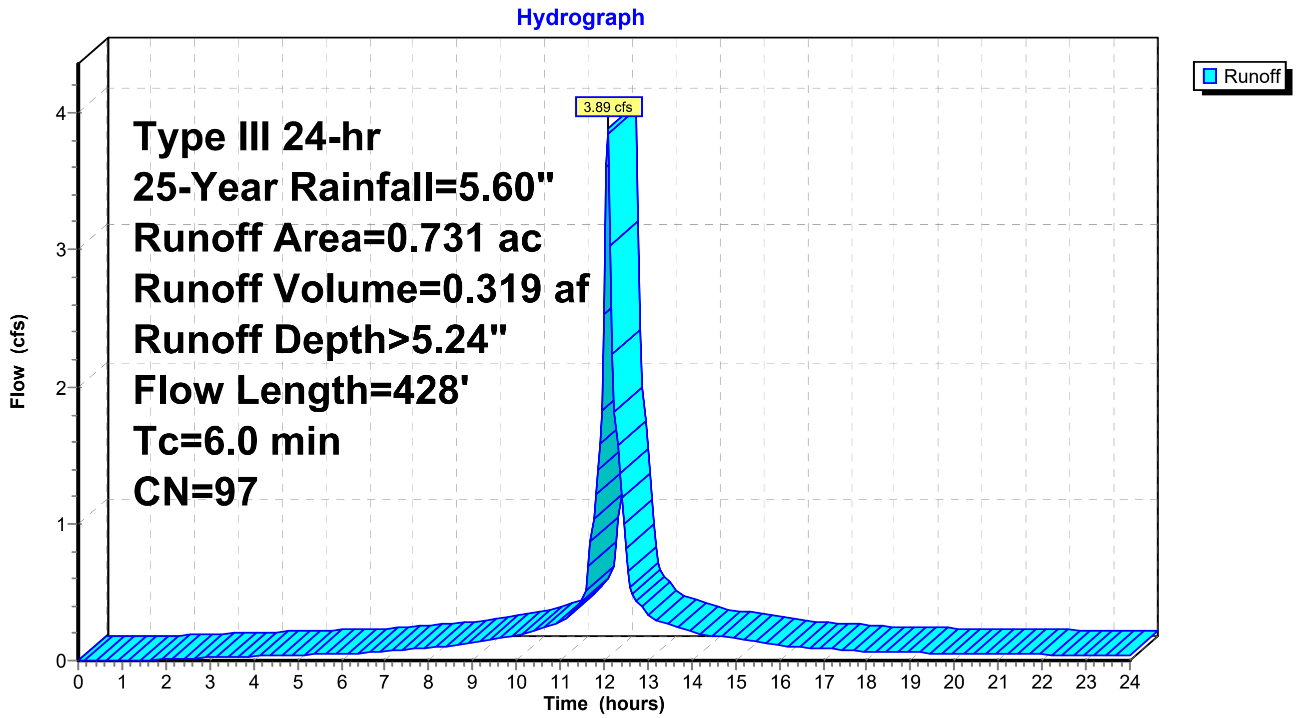
Runoff = 3.89 cfs @ 12.09 hrs, Volume= 0.319 af, Depth> 5.24"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.681	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.731	97	Weighted Average
0.049		6.77% Pervious Area
0.681		93.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	50	0.0208	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	100	0.0208	2.93		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	278	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
4.2	428	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A3-PR: Subcat A3-PR



Summary for Subcatchment A4-PR: Subcat A4-PR

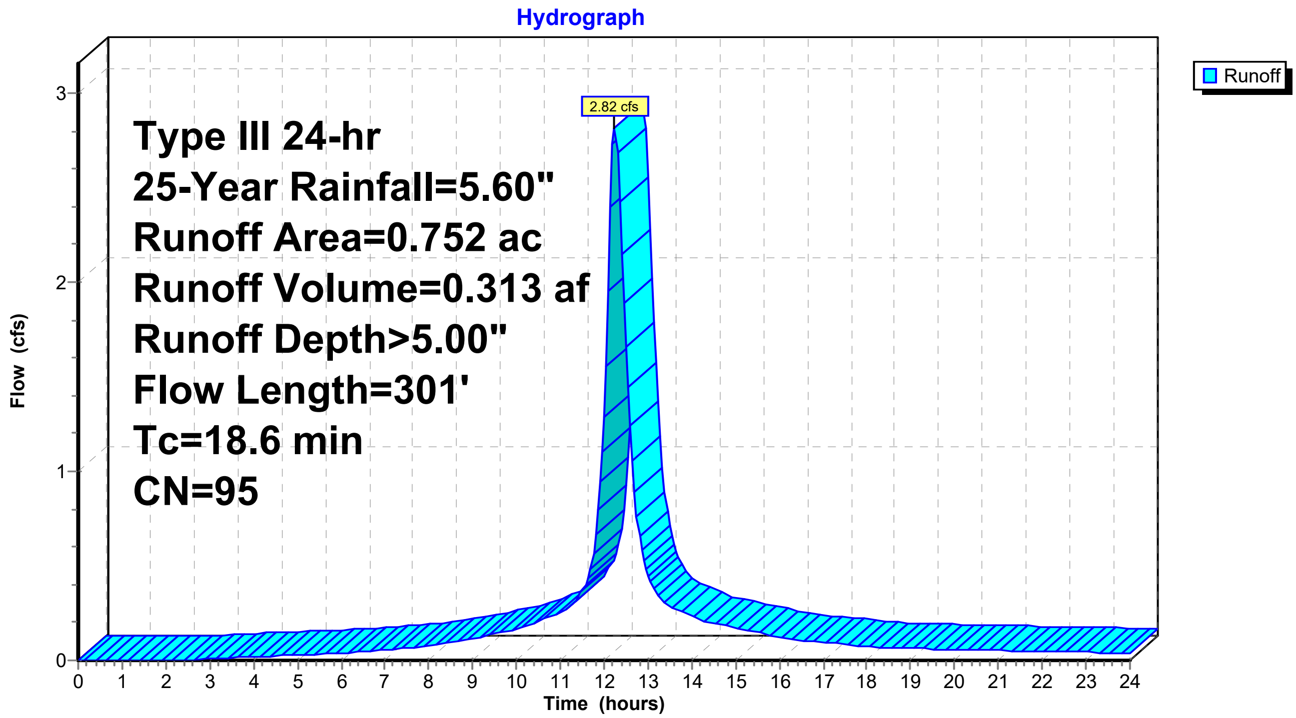
Runoff = 2.82 cfs @ 12.25 hrs, Volume= 0.313 af, Depth> 5.00"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.113	80	>75% Grass cover, Good, HSG D
0.601	98	Paved parking, HSG D
0.038	98	Water Surface, HSG D
0.752	95	Weighted Average
0.113		15.01% Pervious Area
0.639		84.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	25	0.0074	0.02		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	75	0.0074	1.75		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.6	178	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
18.6	301	Total			

Subcatchment A4-PR: Subcat A4-PR



Summary for Subcatchment A5-PR: Subcat A5-PR

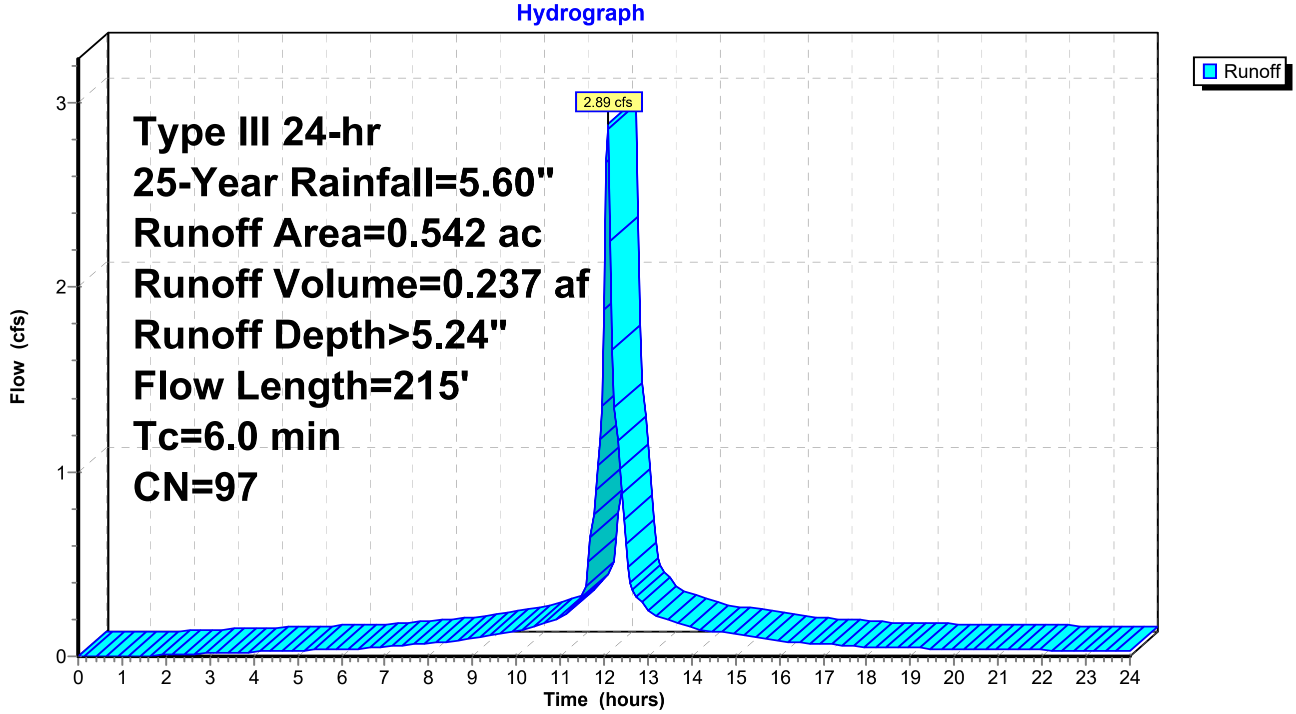
Runoff = 2.89 cfs @ 12.09 hrs, Volume= 0.237 af, Depth> 5.24"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.018	80	>75% Grass cover, Good, HSG D
0.524	98	Paved parking, HSG D
0.542	97	Weighted Average
0.018		3.32% Pervious Area
0.524		96.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	19	0.0230	0.29		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	31	0.0217	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	15	0.0217	2.99		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	49	0.0204	2.90		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0219	3.00		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	59	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.6	215	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A5-PR: Subcat A5-PR



Summary for Subcatchment A6-PR: Subcat A6-PR

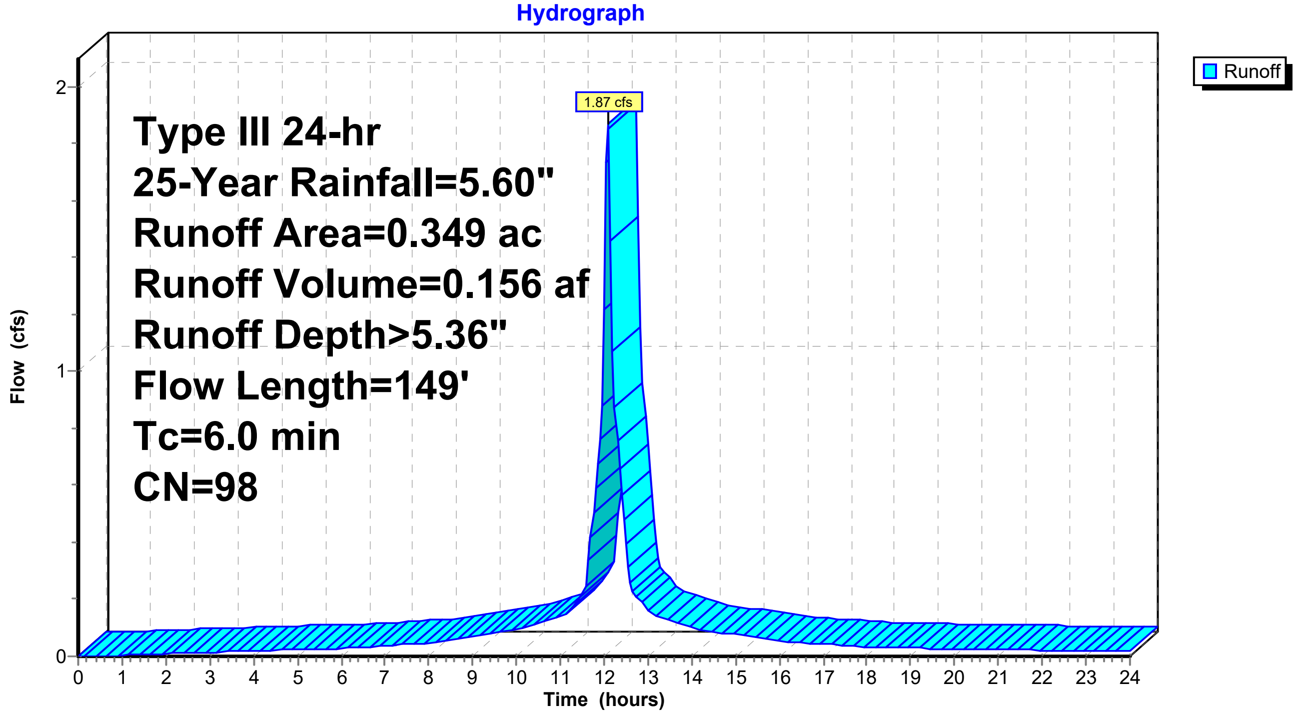
Runoff = 1.87 cfs @ 12.09 hrs, Volume= 0.156 af, Depth> 5.36"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.000	80	>75% Grass cover, Good, HSG D
0.349	98	Paved parking, HSG D
0.349	98	Weighted Average
0.000		0.00% Pervious Area
0.349		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	24	0.0417	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.2	26	0.0357	0.37		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	2	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	28	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.0364	3.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	34	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
2.6	149	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A6-PR: Subcat A6-PR



Summary for Subcatchment A7-PR: Subcat A7-PR

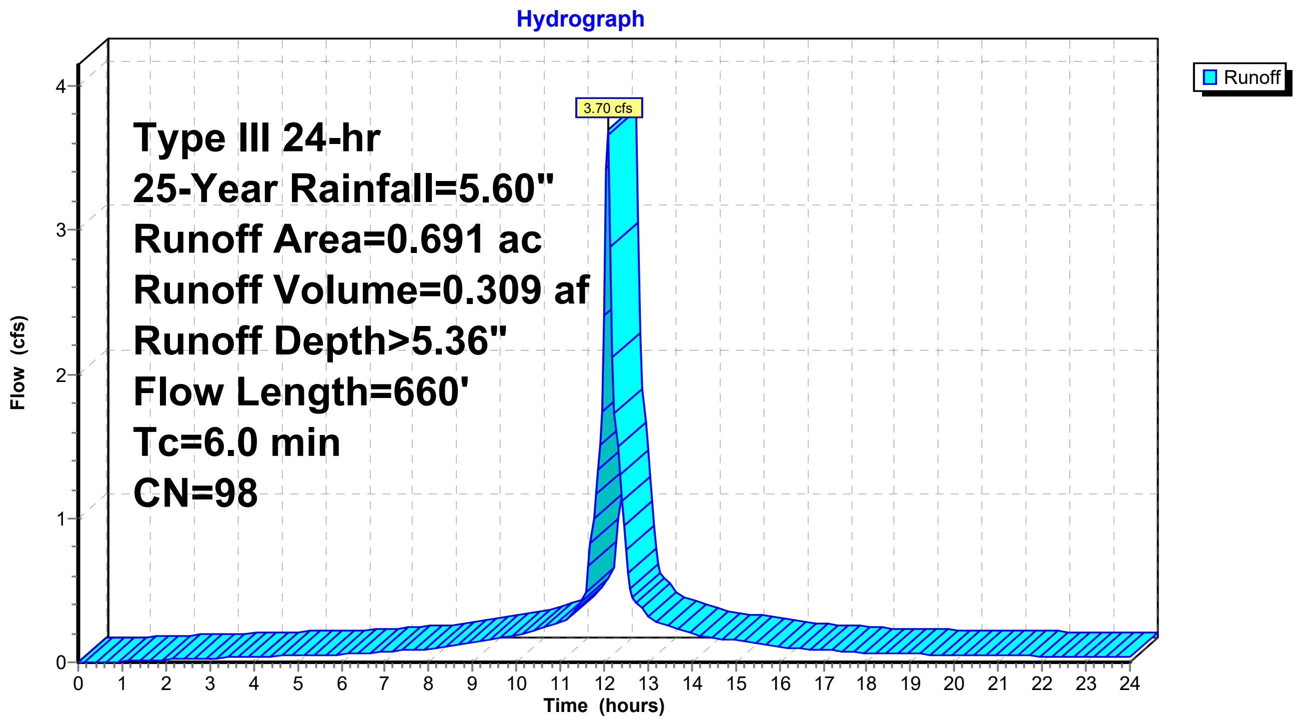
Runoff = 3.70 cfs @ 12.09 hrs, Volume= 0.309 af, Depth> 5.36"
Routed to Pond P2 : Pond 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.691	98	Roofs, HSG D
0.691		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	60	0.0200	0.35		**Sheet Flow, Roof Area** Smooth surfaces n= 0.011 P2= 0.25"
2.9	600	0.0050	3.47	2.73	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	660	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A7-PR: Subcat A7-PR



Summary for Subcatchment A8-PR: Subcat A8-PR

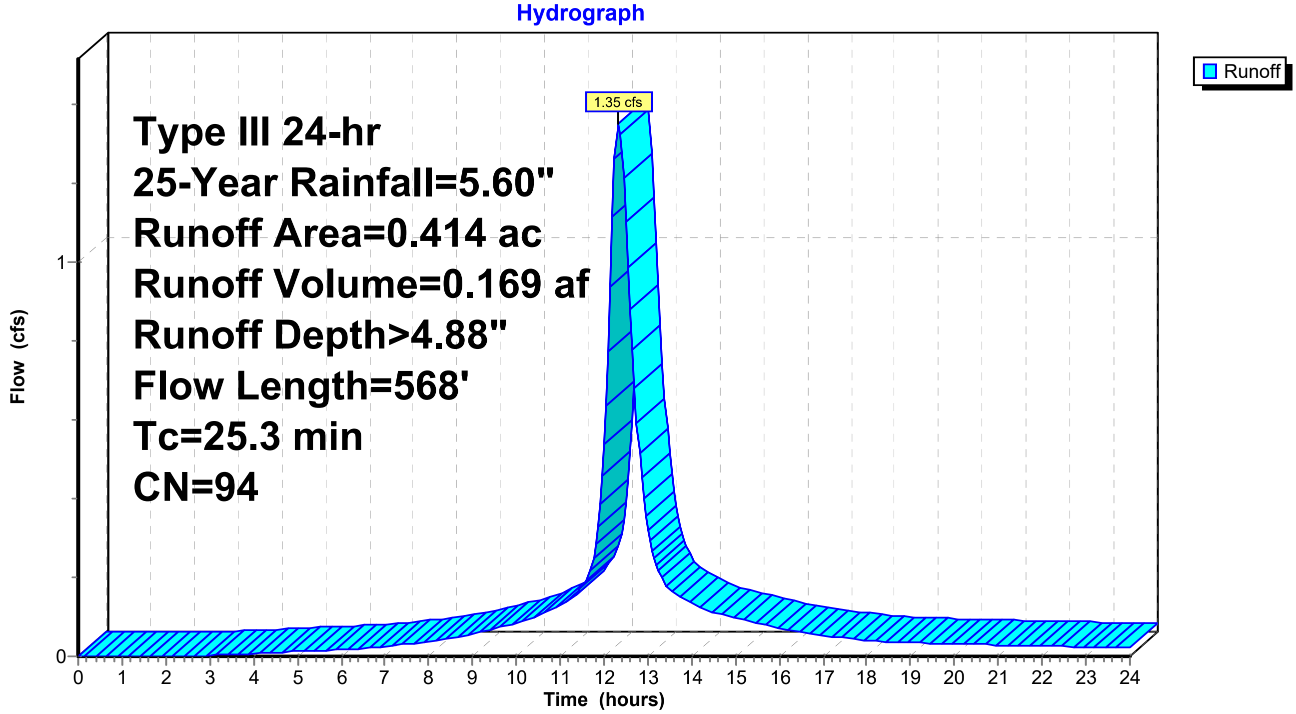
Runoff = 1.35 cfs @ 12.33 hrs, Volume= 0.169 af, Depth> 4.88"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.091	80	>75% Grass cover, Good, HSG D
0.323	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.414	94	Weighted Average
0.091		21.91% Pervious Area
0.323		78.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2	40	0.0100	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	10	0.0200	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	60	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	12	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	13	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.5	133	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
25.3	568	Total			

Subcatchment A8-PR: Subcat A8-PR



Summary for Subcatchment A9-PR: Subcat A9-PR

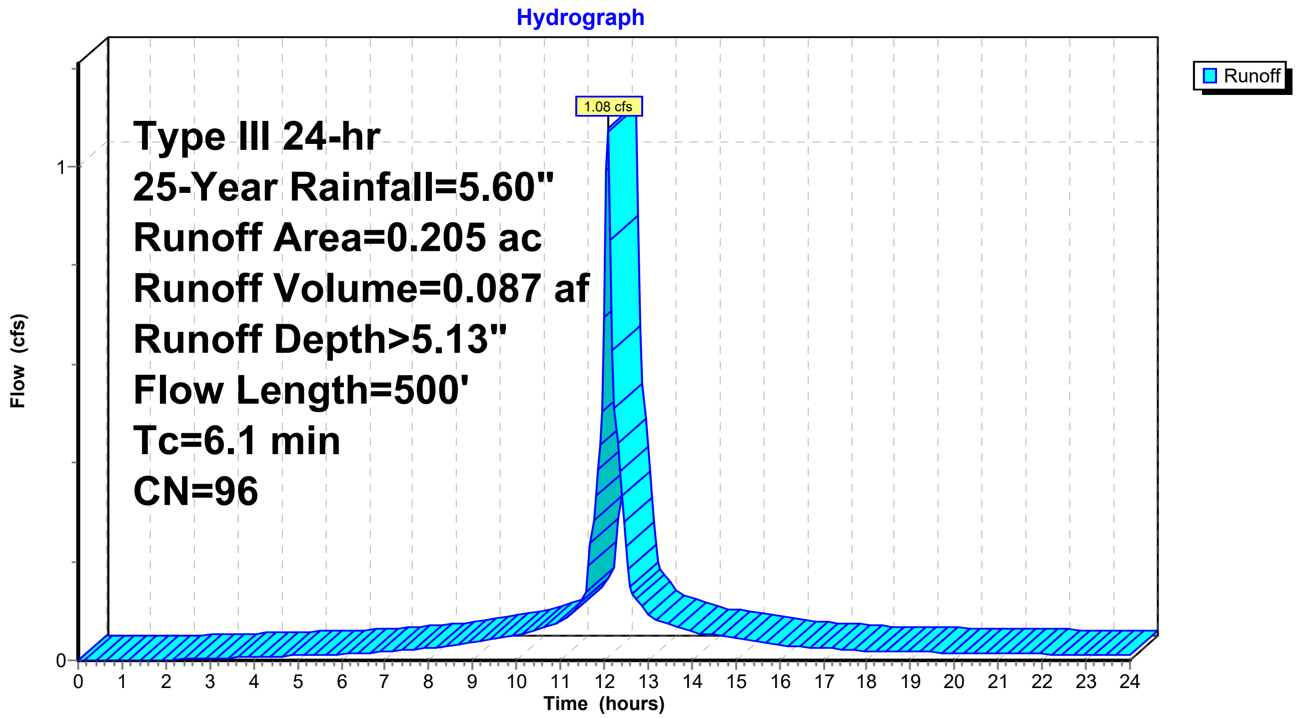
Runoff = 1.08 cfs @ 12.09 hrs, Volume= 0.087 af, Depth> 5.13"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.025	80	>75% Grass cover, Good, HSG D
0.179	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.205	96	Weighted Average
0.025		12.39% Pervious Area
0.179		87.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	12	0.2520	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
1.9	35	0.0200	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.2	30	0.0030	2.48	1.95	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.6	133	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	500	Total			

Subcatchment A9-PR: Subcat A9-PR



Summary for Subcatchment B1-PR: Subcat B1-PR

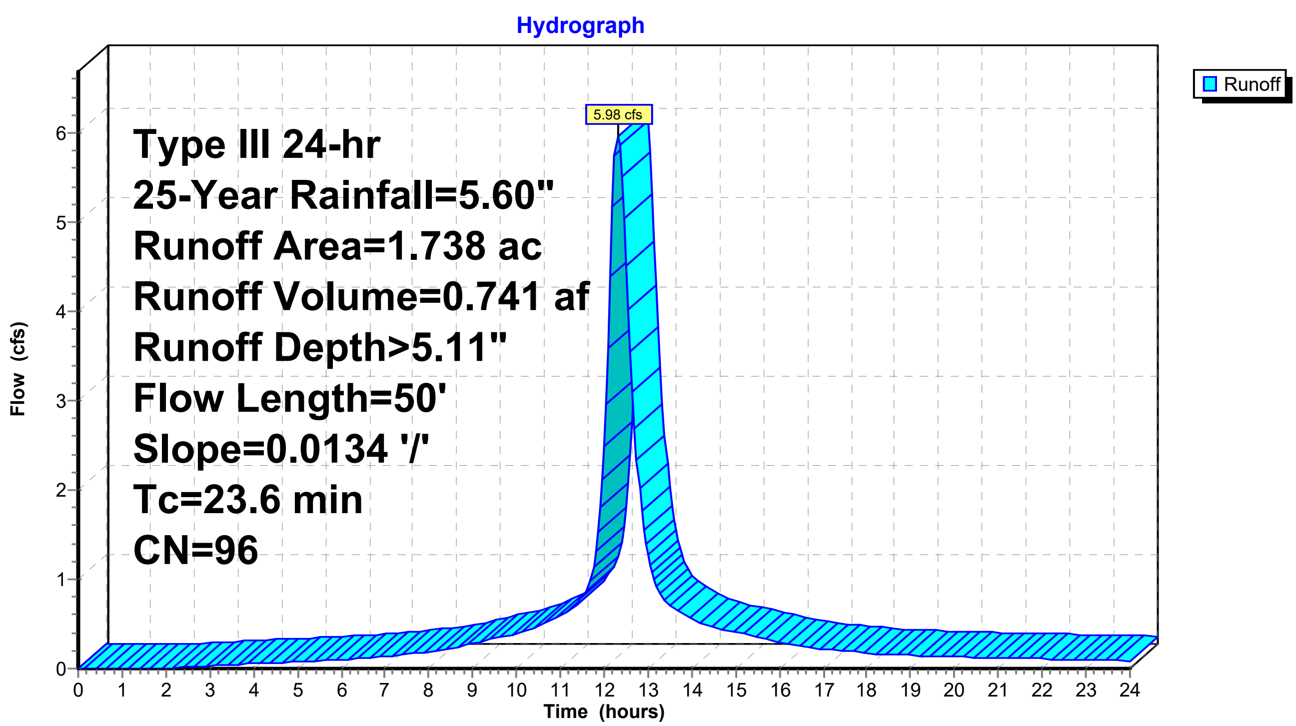
Runoff = 5.98 cfs @ 12.31 hrs, Volume= 0.741 af, Depth> 5.11"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.60"

Area (ac)	CN	Description
0.180	80	>75% Grass cover, Good, HSG D
1.371	98	Paved parking, HSG D
0.186	98	Roofs, HSG D
0.001	77	Woods, Good, HSG D
1.738	96	Weighted Average
0.180		10.38% Pervious Area
1.558		89.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.6	50	0.0134	0.04		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"

Subcatchment B1-PR: Subcat B1-PR



Summary for Pond P1: Level Spreader

Inflow Area = 1.596 ac, 90.54% Impervious, Inflow Depth > 5.15" for 25-Year event
Inflow = 7.02 cfs @ 12.09 hrs, Volume= 0.685 af
Outflow = 6.90 cfs @ 12.10 hrs, Volume= 0.506 af, Atten= 2%, Lag= 0.3 min
Primary = 6.90 cfs @ 12.10 hrs, Volume= 0.506 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.28' @ 12.10 hrs Surf.Area= 2,755 sf Storage= 7,926 cf

Plug-Flow detention time= 159.1 min calculated for 0.506 af (74% of inflow)
Center-of-Mass det. time= 72.4 min (833.3 - 760.9)

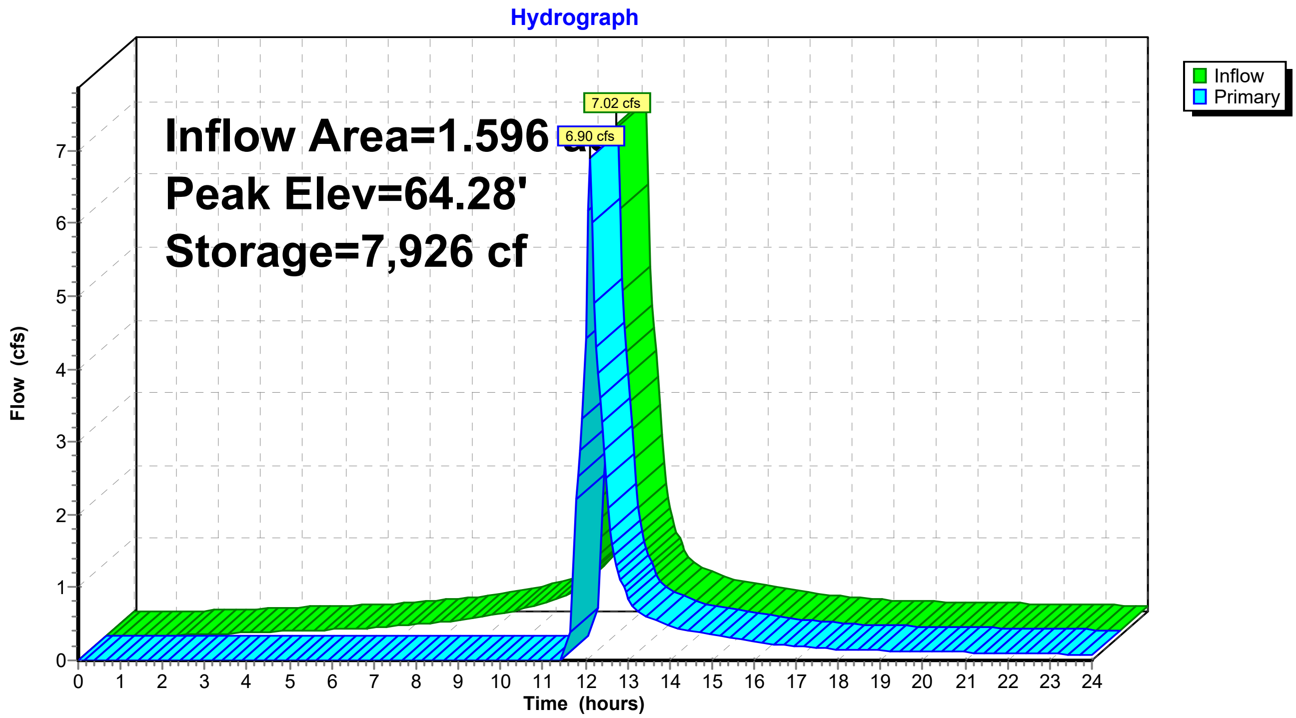
Volume	Invert	Avail.Storage	Storage Description
#1	59.00'	10,054 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
59.00	370	193.0	0	0	370
60.00	770	206.0	558	558	828
61.00	1,194	218.0	974	1,532	1,285
62.00	1,643	231.0	1,413	2,945	1,801
63.00	2,118	243.0	1,875	4,820	2,312
64.00	2,617	256.0	2,363	7,183	2,886
65.00	3,133	268.0	2,871	10,054	3,450

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**132.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=6.75 cfs @ 12.10 hrs HW=64.28' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 6.75 cfs @ 0.67 fps)

Pond P1: Level Spreader



Summary for Pond P2: Pond 2

Inflow Area = 0.691 ac,100.00% Impervious, Inflow Depth > 5.36" for 25-Year event
Inflow = 3.70 cfs @ 12.09 hrs, Volume= 0.309 af
Outflow = 3.59 cfs @ 12.10 hrs, Volume= 0.253 af, Atten= 3%, Lag= 0.9 min
Discarded = 0.04 cfs @ 12.10 hrs, Volume= 0.047 af
Primary = 3.55 cfs @ 12.10 hrs, Volume= 0.206 af
Routed to Pond P3 : Level Spreader

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 66.20' @ 12.10 hrs Surf.Area= 1,508 sf Storage= 2,723 cf

Plug-Flow detention time= 129.4 min calculated for 0.253 af (82% of inflow)
Center-of-Mass det. time= 56.7 min (802.5 - 745.8)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	4,091 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

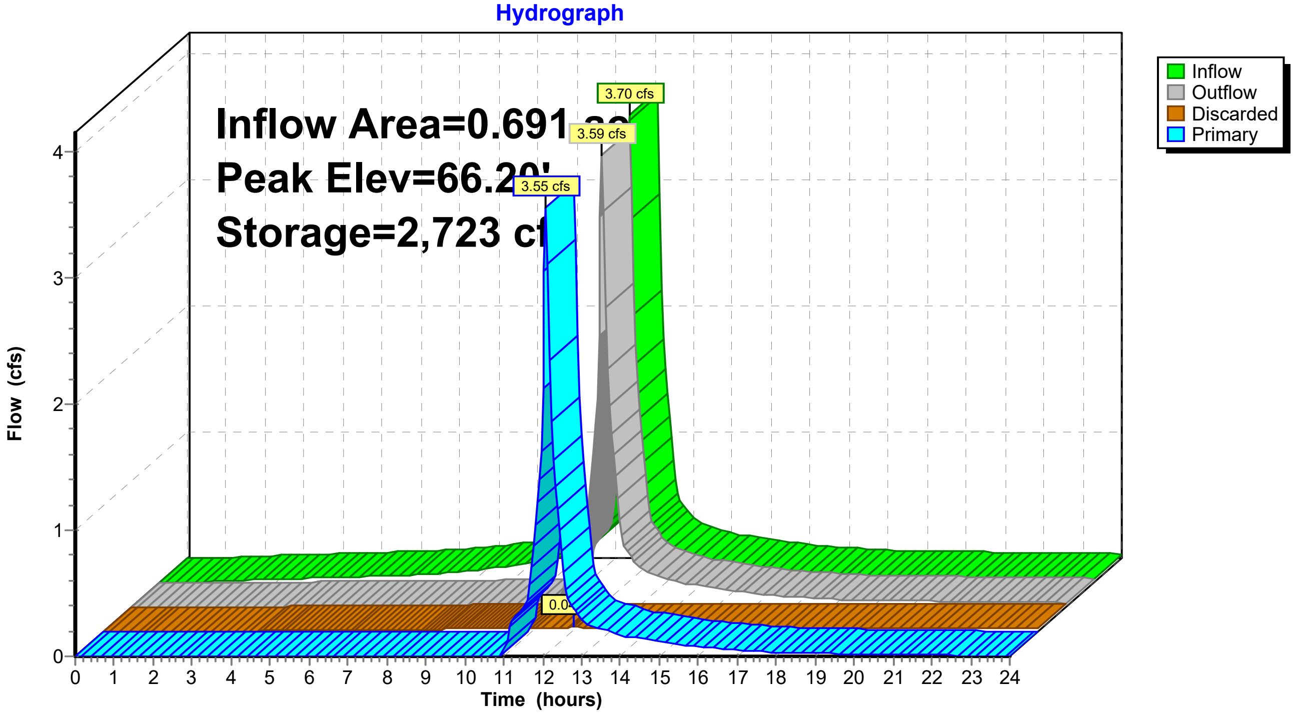
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	50	39.0	0	0	50
63.00	234	84.0	131	131	495
64.00	551	124.0	381	512	1,165
65.00	953	143.0	743	1,255	1,590
66.00	1,411	162.0	1,175	2,429	2,076
67.00	1,925	181.0	1,661	4,091	2,622

Device	Routing	Invert	Outlet Devices
#1	Primary	63.10'	**15.0" Round Culvert** L= 305.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 63.10' / 61.21' S= 0.0062 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	66.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 12.10 hrs HW=66.20' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=3.53 cfs @ 12.10 hrs HW=66.20' (Free Discharge)
└─**1=Culvert** (Passes 3.53 cfs of 6.34 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 3.53 cfs @ 1.47 fps)

Pond P2: Pond 2



Summary for Pond P3: Level Spreader

Inflow Area = 3.396 ac, 91.66% Impervious, Inflow Depth > 4.80" for 25-Year event
Inflow = 15.75 cfs @ 12.10 hrs, Volume= 1.359 af
Outflow = 15.55 cfs @ 12.10 hrs, Volume= 1.256 af, Atten= 1%, Lag= 0.2 min
Primary = 15.55 cfs @ 12.10 hrs, Volume= 1.256 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.43' @ 12.10 hrs Surf.Area= 1,770 sf Storage= 4,898 cf

Plug-Flow detention time= 67.7 min calculated for 1.256 af (92% of inflow)
Center-of-Mass det. time= 29.7 min (793.9 - 764.3)

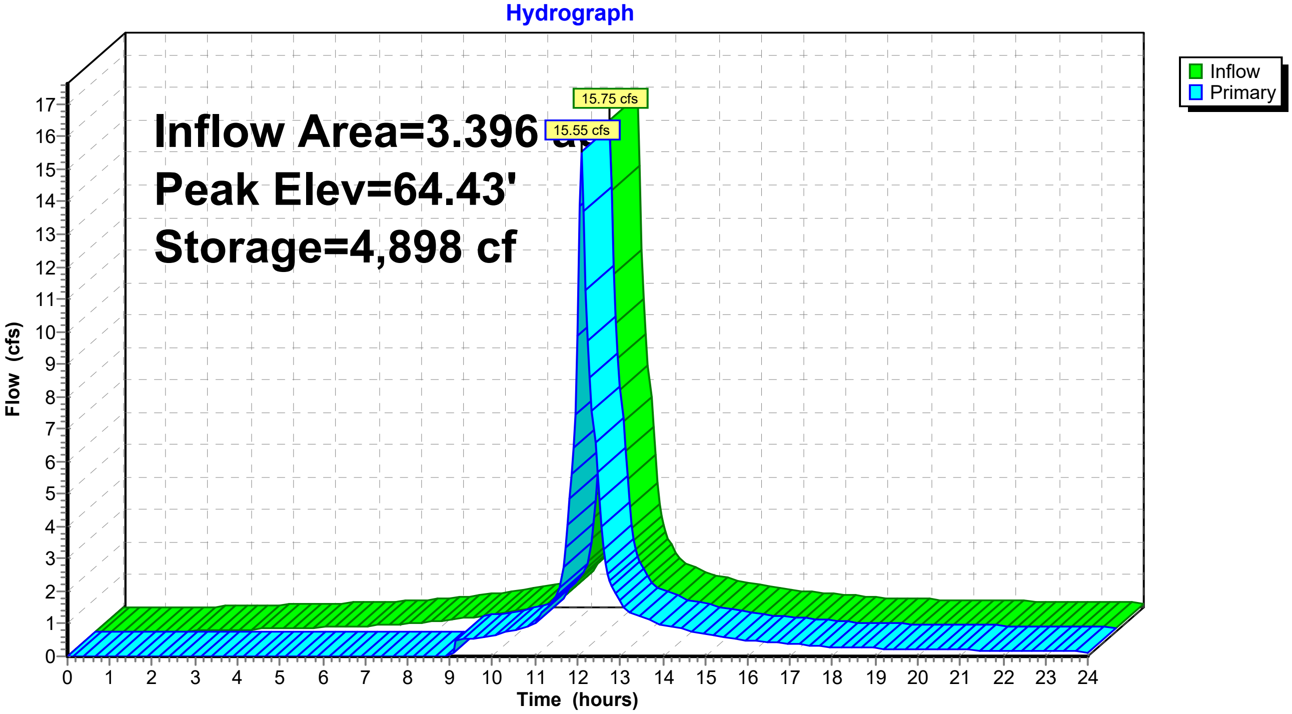
Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	5,961 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.00	524	113.0	0	0	524
61.00	763	125.0	640	640	781
62.00	1,026	138.0	891	1,531	1,083
63.00	1,314	150.0	1,167	2,698	1,393
64.00	1,628	163.0	1,468	4,166	1,753
65.00	1,967	176.0	1,795	5,961	2,142

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**59.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=15.43 cfs @ 12.10 hrs HW=64.43' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 15.43 cfs @ 1.13 fps)

Pond P3: Level Spreader

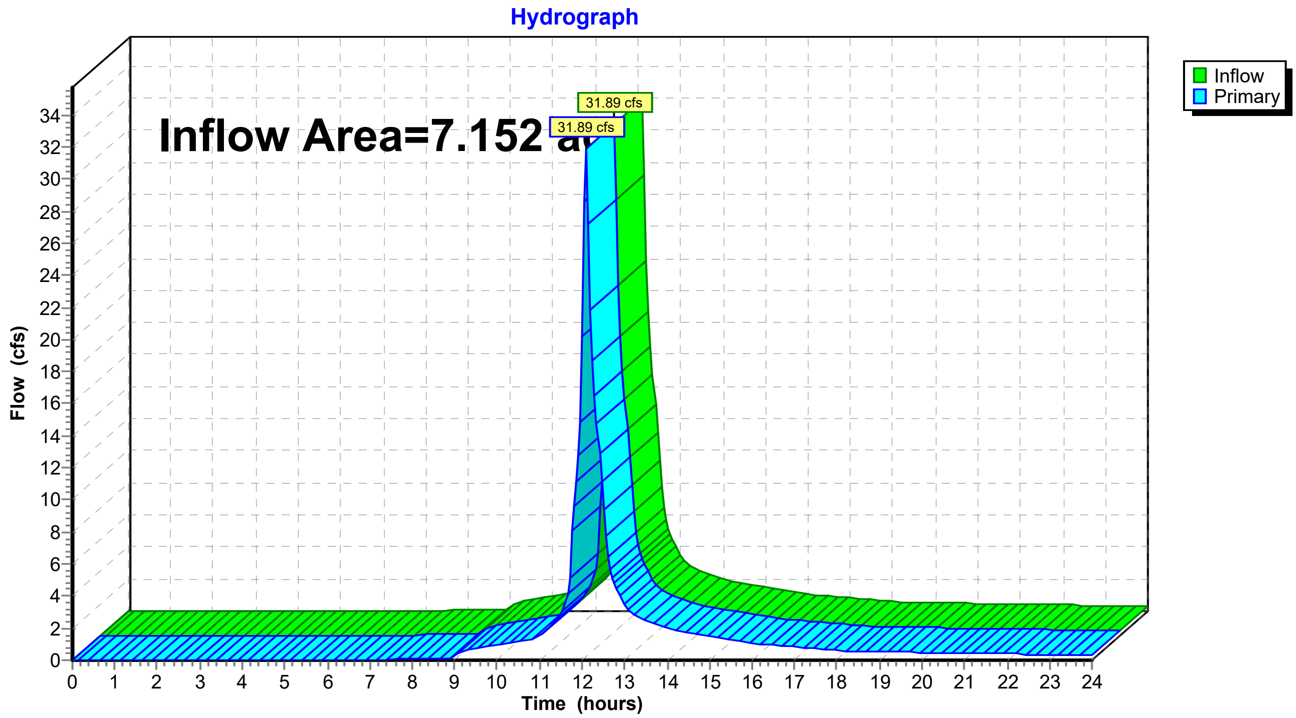


Summary for Link A: Bordering Vegetated Wetland

Inflow Area = 7.152 ac, 73.38% Impervious, Inflow Depth > 4.12" for 25-Year event
Inflow = 31.89 cfs @ 12.10 hrs, Volume= 2.458 af
Primary = 31.89 cfs @ 12.10 hrs, Volume= 2.458 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Bordering Vegetated Wetland

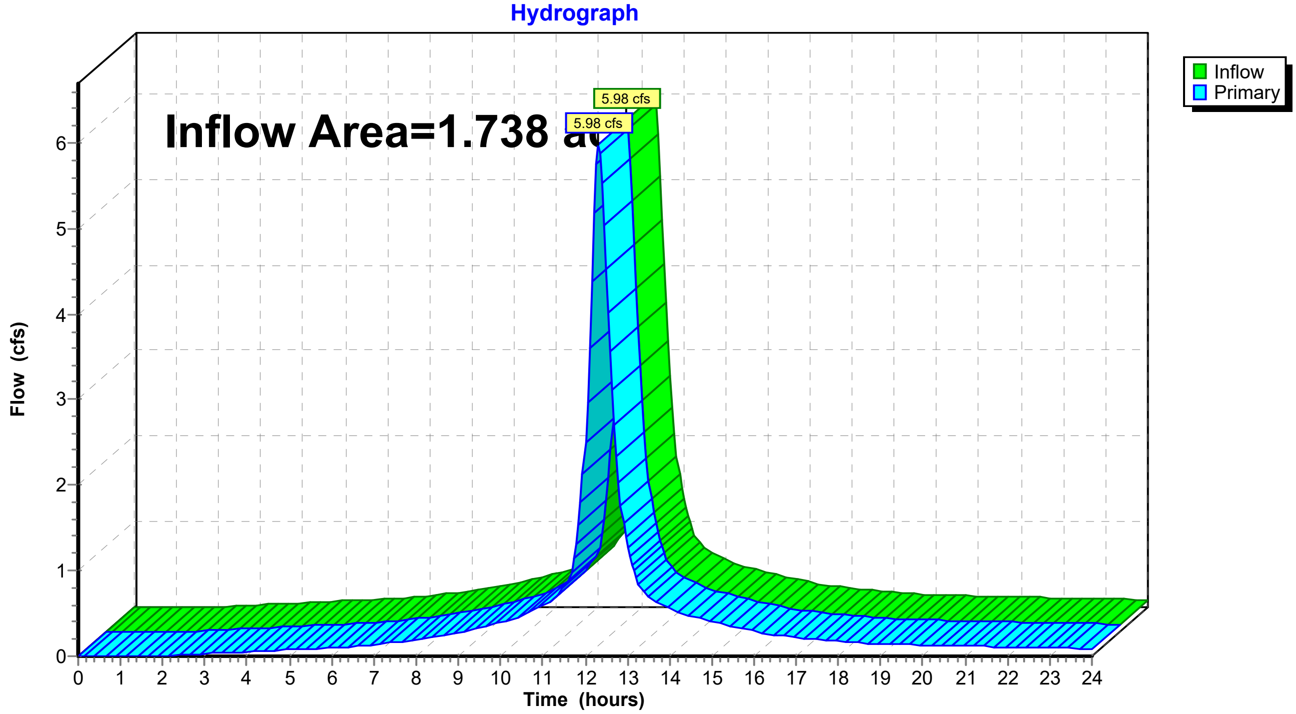


Summary for Link B: Municipal Stormwater System

Inflow Area =	1.738 ac,	89.62% Impervious,	Inflow Depth > 5.11"	for 25-Year event
Inflow =	5.98 cfs @	12.31 hrs, Volume=	0.741 af	
Primary =	5.98 cfs @	12.31 hrs, Volume=	0.741 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link B: Municipal Stormwater System



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentA1-PR: Subcat A1-PR Runoff Area=1.758 ac 35.89% Impervious Runoff Depth>5.25"
Flow Length=130' Slope=0.0105 '/' Tc=6.0 min CN=85 Runoff=10.29 cfs 0.769 af

SubcatchmentA10-PR: Subcat A10-PR Runoff Area=0.155 ac 87.77% Impervious Runoff Depth>6.52"
Flow Length=385' Tc=6.1 min CN=96 Runoff=1.03 cfs 0.084 af

SubcatchmentA11-PR: Subcat A11-PR Runoff Area=0.472 ac 96.62% Impervious Runoff Depth>6.64"
Flow Length=395' Tc=6.1 min CN=97 Runoff=3.15 cfs 0.261 af

SubcatchmentA12-PR: Subcat A12-PR Runoff Area=0.403 ac 14.89% Impervious Runoff Depth>4.91"
Tc=6.0 min CN=82 Runoff=2.24 cfs 0.165 af

SubcatchmentA2-PR: Subcat A2-PR Runoff Area=0.680 ac 84.85% Impervious Runoff Depth>6.40"
Flow Length=245' Tc=6.0 min CN=95 Runoff=4.49 cfs 0.363 af

SubcatchmentA3-PR: Subcat A3-PR Runoff Area=0.731 ac 93.23% Impervious Runoff Depth>6.64"
Flow Length=428' Tc=6.0 min CN=97 Runoff=4.88 cfs 0.404 af

SubcatchmentA4-PR: Subcat A4-PR Runoff Area=0.752 ac 84.99% Impervious Runoff Depth>6.39"
Flow Length=301' Tc=18.6 min CN=95 Runoff=3.56 cfs 0.400 af

SubcatchmentA5-PR: Subcat A5-PR Runoff Area=0.542 ac 96.68% Impervious Runoff Depth>6.64"
Flow Length=215' Tc=6.0 min CN=97 Runoff=3.62 cfs 0.300 af

SubcatchmentA6-PR: Subcat A6-PR Runoff Area=0.349 ac 100.00% Impervious Runoff Depth>6.76"
Flow Length=149' Tc=6.0 min CN=98 Runoff=2.34 cfs 0.197 af

SubcatchmentA7-PR: Subcat A7-PR Runoff Area=0.691 ac 100.00% Impervious Runoff Depth>6.76"
Flow Length=660' Tc=6.0 min CN=98 Runoff=4.64 cfs 0.389 af

SubcatchmentA8-PR: Subcat A8-PR Runoff Area=0.414 ac 78.09% Impervious Runoff Depth>6.27"
Flow Length=568' Tc=25.3 min CN=94 Runoff=1.71 cfs 0.216 af

SubcatchmentA9-PR: Subcat A9-PR Runoff Area=0.205 ac 87.61% Impervious Runoff Depth>6.52"
Flow Length=500' Tc=6.1 min CN=96 Runoff=1.36 cfs 0.111 af

SubcatchmentB1-PR: Subcat B1-PR Runoff Area=1.738 ac 89.62% Impervious Runoff Depth>6.50"
Flow Length=50' Slope=0.0134 '/' Tc=23.6 min CN=96 Runoff=7.52 cfs 0.942 af

Pond P1: Level Spreader Peak Elev=64.29' Storage=7,960 cf Inflow=8.82 cfs 0.870 af
Outflow=8.70 cfs 0.692 af

Pond P2: Pond 2 Peak Elev=66.23' Storage=2,773 cf Inflow=4.64 cfs 0.389 af
Discarded=0.04 cfs 0.049 af Primary=4.46 cfs 0.284 af Outflow=4.50 cfs 0.334 af

Pond P3: Level Spreader Peak Elev=64.47' Storage=4,962 cf Inflow=19.82 cfs 1.751 af
Outflow=19.57 cfs 1.647 af

Link A: Bordering Vegetated Wetland Inflow=40.76 cfs 3.273 af
Primary=40.76 cfs 3.273 af

Link B: Municipal Stormwater System Inflow=7.52 cfs 0.942 af
Primary=7.52 cfs 0.942 af

Total Runoff Area = 8.890 ac Runoff Volume = 4.602 af Average Runoff Depth = 6.21"
23.45% Pervious = 2.084 ac 76.55% Impervious = 6.806 ac

Summary for Subcatchment A1-PR: Subcat A1-PR

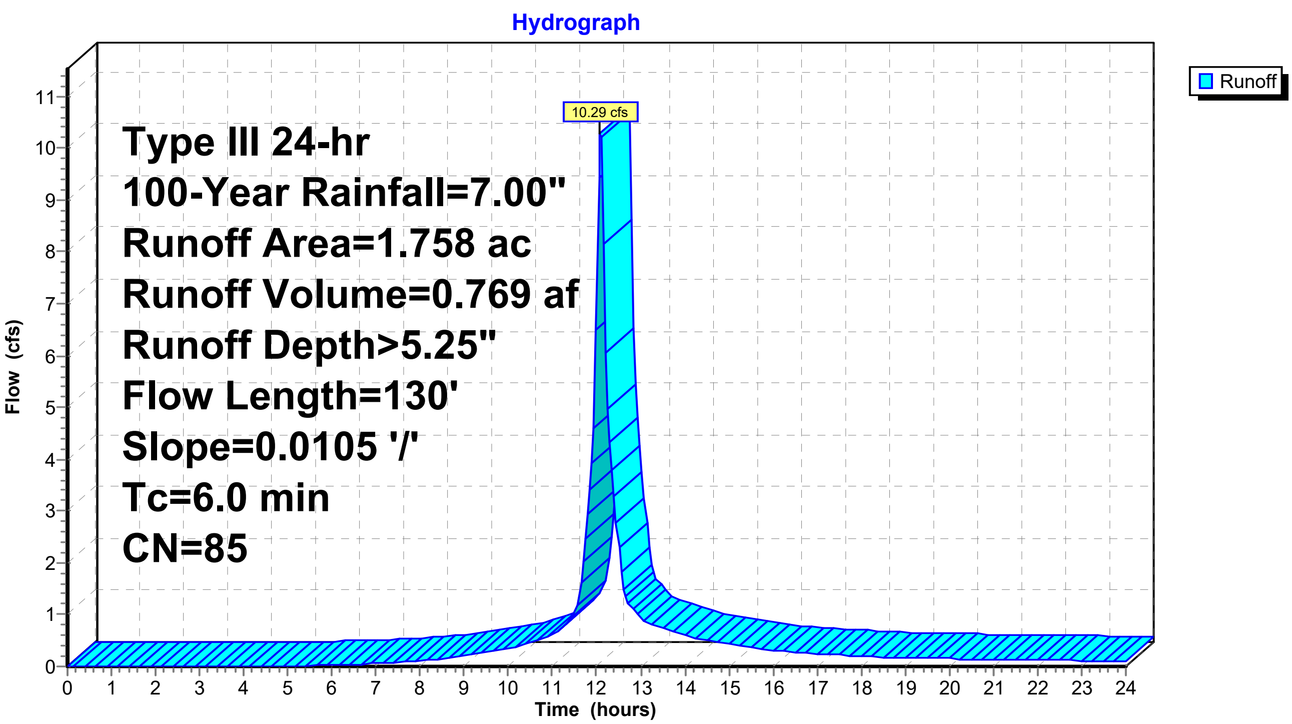
Runoff = 10.29 cfs @ 12.09 hrs, Volume= 0.769 af, Depth> 5.25"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.007	80	>75% Grass cover, Good, HSG D
0.027	80	>75% Grass cover, Good, HSG D
0.074	98	Paved parking, HSG D
0.438	98	Paved parking, HSG D
0.119	98	Roofs, HSG D
1.093	77	Woods, Good, HSG D
1.758	85	Weighted Average
1.127		64.11% Pervious Area
0.631		35.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0105	0.26		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	80	0.0105	2.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.8	130	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A1-PR: Subcat A1-PR



Summary for Subcatchment A10-PR: Subcat A10-PR

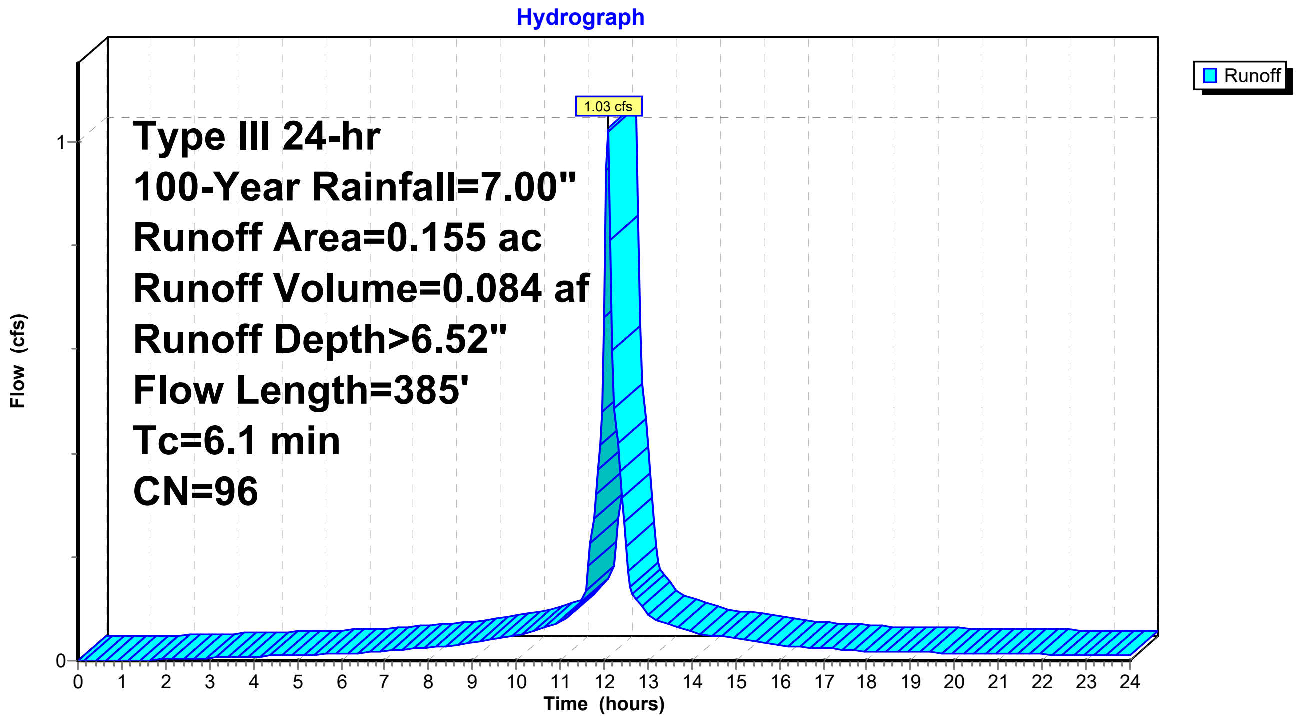
Runoff = 1.03 cfs @ 12.09 hrs, Volume= 0.084 af, Depth> 6.52"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.019	80	>75% Grass cover, Good, HSG D
0.136	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.155	96	Weighted Average
0.019		12.23% Pervious Area
0.136		87.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	12	0.2770	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
2.5	28	0.0060	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	55	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	385	Total			

Subcatchment A10-PR: Subcat A10-PR



Summary for Subcatchment A11-PR: Subcat A11-PR

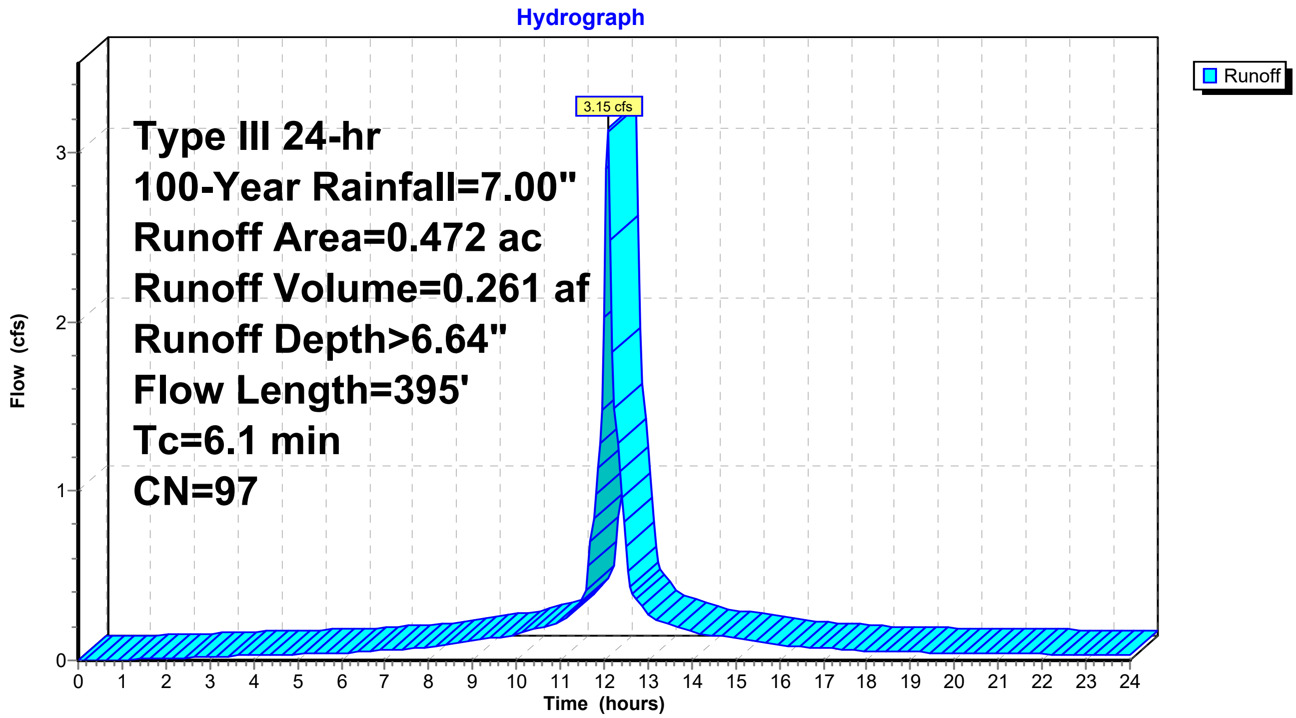
Runoff = 3.15 cfs @ 12.09 hrs, Volume= 0.261 af, Depth> 6.64"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.016	80	>75% Grass cover, Good, HSG D
0.456	98	Paved parking, HSG D
0.472	97	Weighted Average
0.016		3.38% Pervious Area
0.456		96.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	20	0.0140	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.1	15	0.0130	0.22		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.4	15	0.0081	0.18		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.3	32	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0081	1.83		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	52	0.0069	1.69		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	106	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	395	Total			

Subcatchment A11-PR: Subcat A11-PR



Summary for Subcatchment A12-PR: Subcat A12-PR

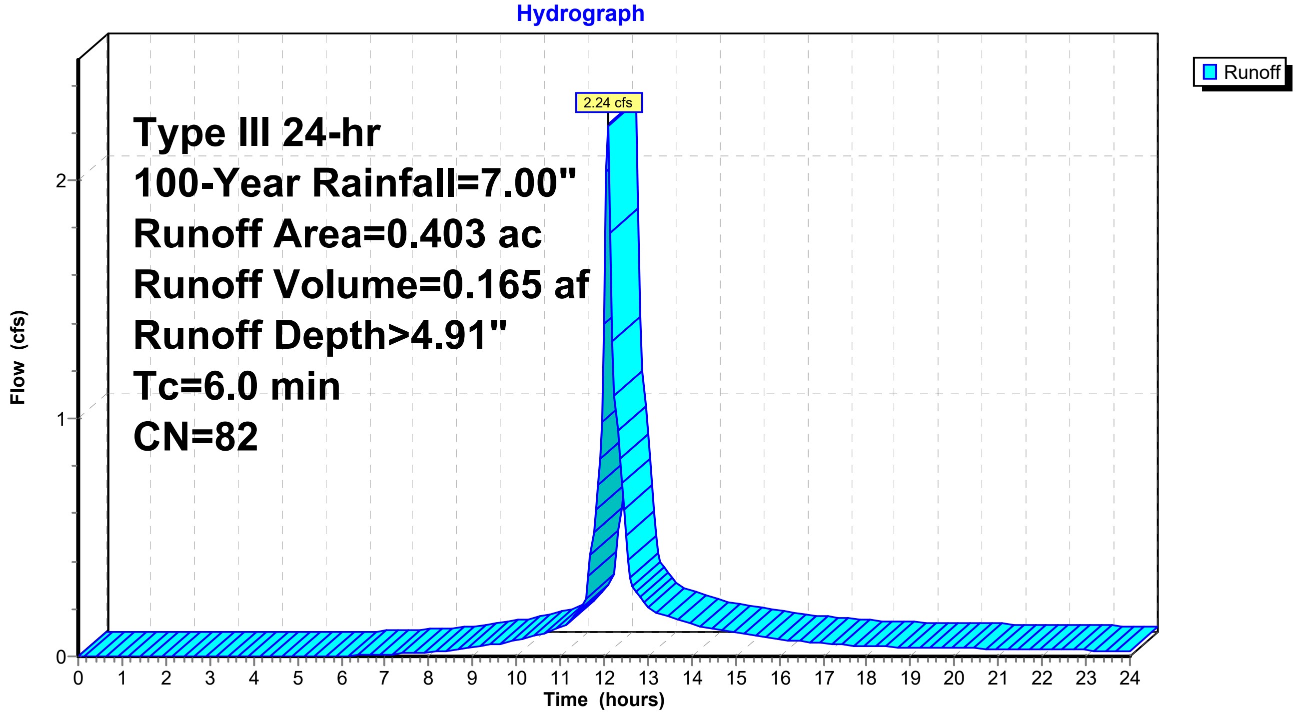
Runoff = 2.24 cfs @ 12.09 hrs, Volume= 0.165 af, Depth> 4.91"
Routed to Link A : Bordering Vegetated Wetland

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.203	80	>75% Grass cover, Good, HSG D
0.000	98	Paved parking, HSG D
0.060	98	Water Surface, HSG D
0.140	77	Woods, Good, HSG D
0.403	82	Weighted Average
0.343		85.11% Pervious Area
0.060		14.89% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment A12-PR: Subcat A12-PR



Summary for Subcatchment A2-PR: Subcat A2-PR

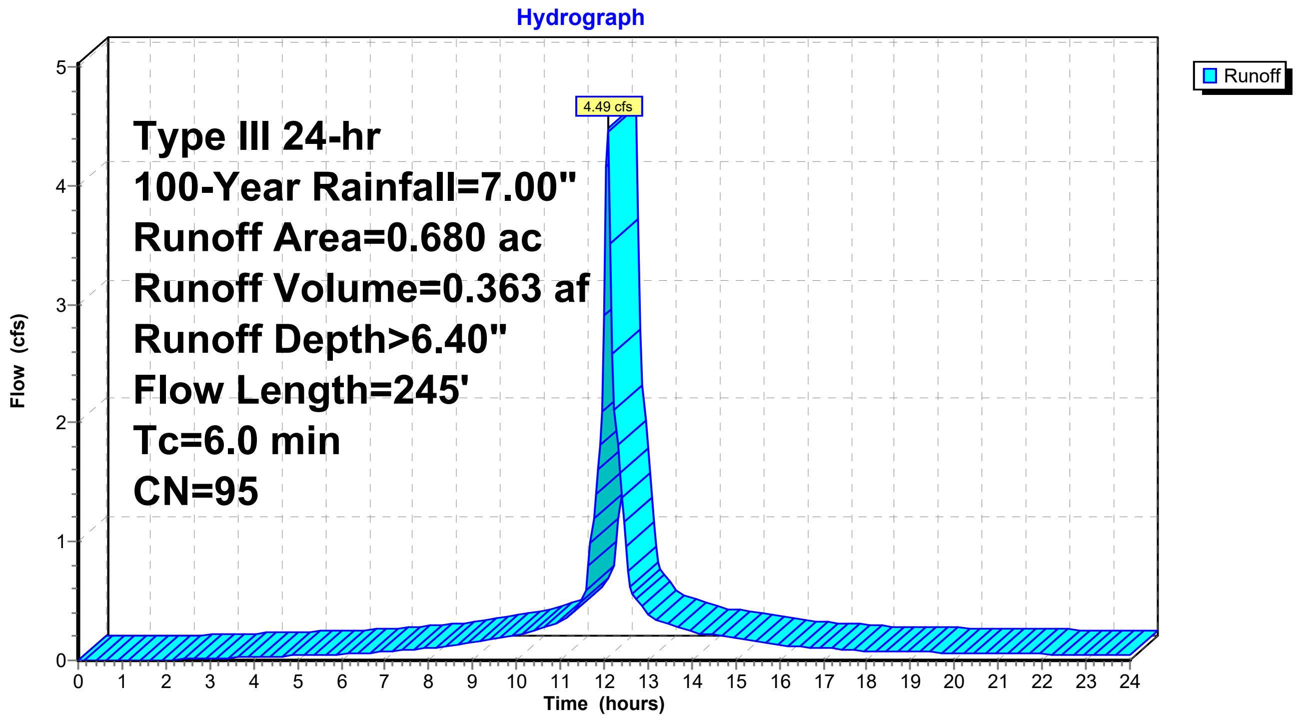
Runoff = 4.49 cfs @ 12.09 hrs, Volume= 0.363 af, Depth> 6.40"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.031	80	>75% Grass cover, Good, HSG D
0.072	80	>75% Grass cover, Good, HSG D
0.394	98	Paved parking, HSG D
0.128	98	Paved parking, HSG D
0.047	98	Water Surface, HSG D
0.008	98	Water Surface, HSG D
0.680	95	Weighted Average
0.103		15.15% Pervious Area
0.577		84.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	17	0.0259	0.30		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	33	0.0256	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	6	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	39	0.0256	3.25		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.4	108	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.3	245	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A2-PR: Subcat A2-PR



Summary for Subcatchment A3-PR: Subcat A3-PR

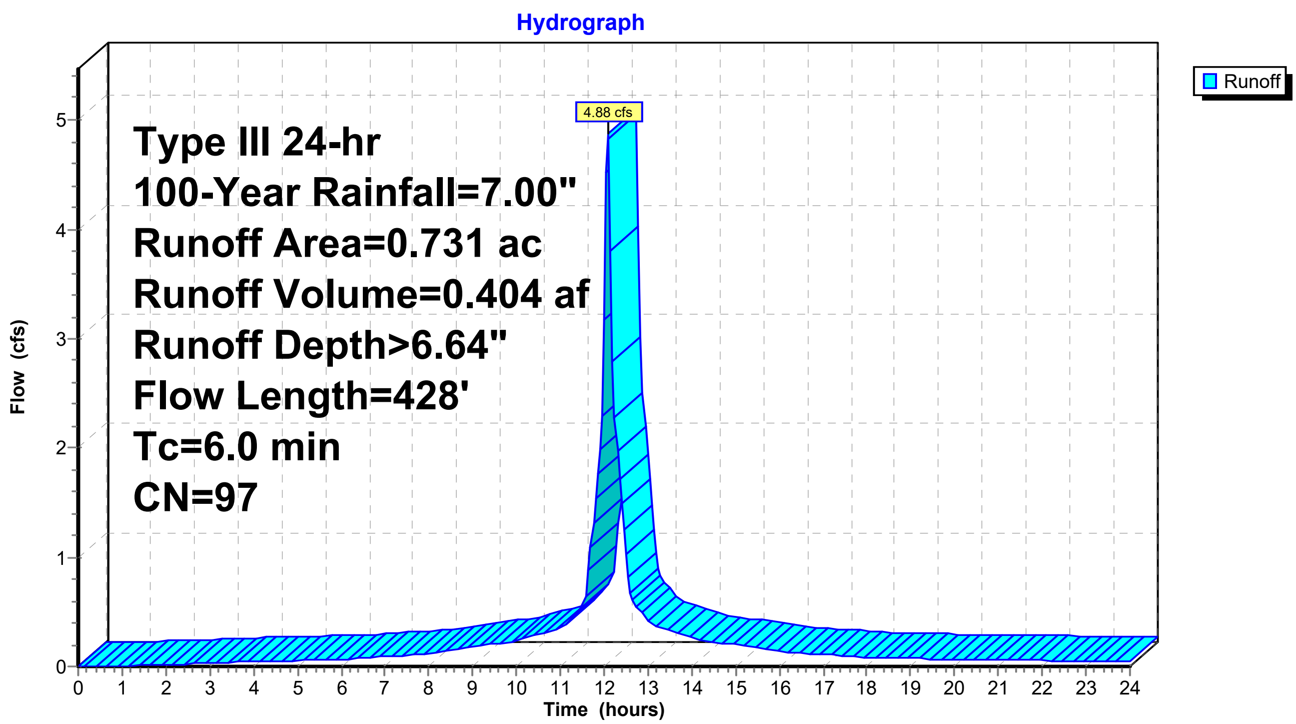
Runoff = 4.88 cfs @ 12.09 hrs, Volume= 0.404 af, Depth> 6.64"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.049	80	>75% Grass cover, Good, HSG D
0.681	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.731	97	Weighted Average
0.049		6.77% Pervious Area
0.681		93.23% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	50	0.0208	0.34		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.6	100	0.0208	2.93		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	278	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
4.2	428	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A3-PR: Subcat A3-PR



Summary for Subcatchment A4-PR: Subcat A4-PR

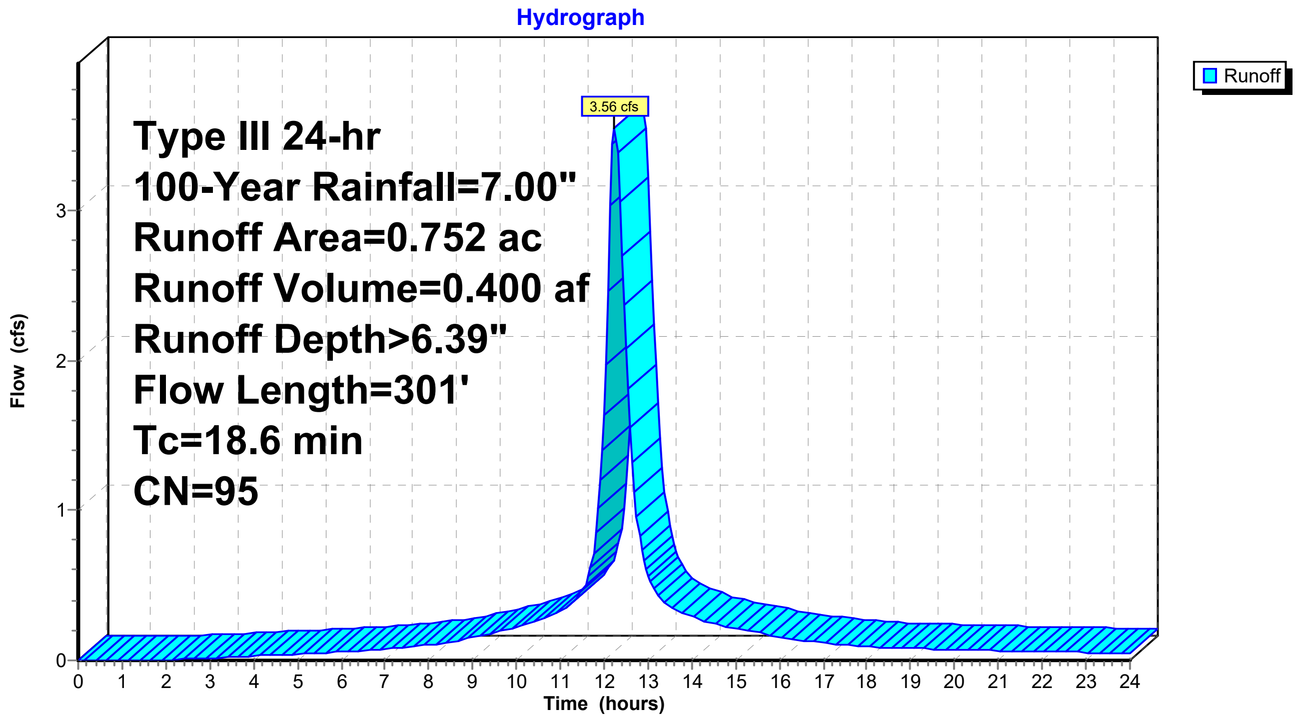
Runoff = 3.56 cfs @ 12.24 hrs, Volume= 0.400 af, Depth> 6.39"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.113	80	>75% Grass cover, Good, HSG D
0.601	98	Paved parking, HSG D
0.038	98	Water Surface, HSG D
0.752	95	Weighted Average
0.113		15.01% Pervious Area
0.639		84.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	25	0.0074	0.02		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	75	0.0074	1.75		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	23	0.0050	4.20	7.43	**Pipe Channel, RCP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.6	178	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
18.6	301	Total			

Subcatchment A4-PR: Subcat A4-PR



Summary for Subcatchment A5-PR: Subcat A5-PR

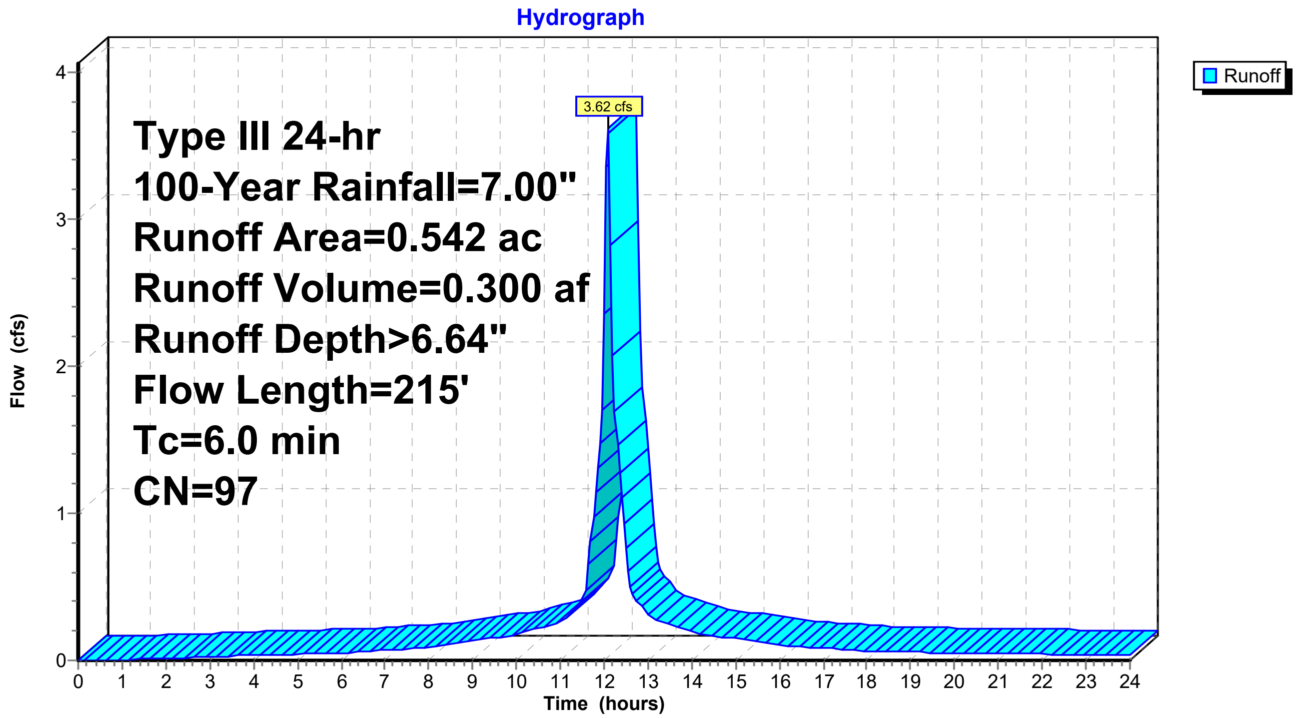
Runoff = 3.62 cfs @ 12.09 hrs, Volume= 0.300 af, Depth> 6.64"
Routed to Pond P3 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.018	80	>75% Grass cover, Good, HSG D
0.524	98	Paved parking, HSG D
0.542	97	Weighted Average
0.018		3.32% Pervious Area
0.524		96.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	19	0.0230	0.29		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.6	31	0.0217	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	15	0.0217	2.99		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	49	0.0204	2.90		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	16	0.0219	3.00		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	59	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.1	26	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
3.6	215	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A5-PR: Subcat A5-PR



Summary for Subcatchment A6-PR: Subcat A6-PR

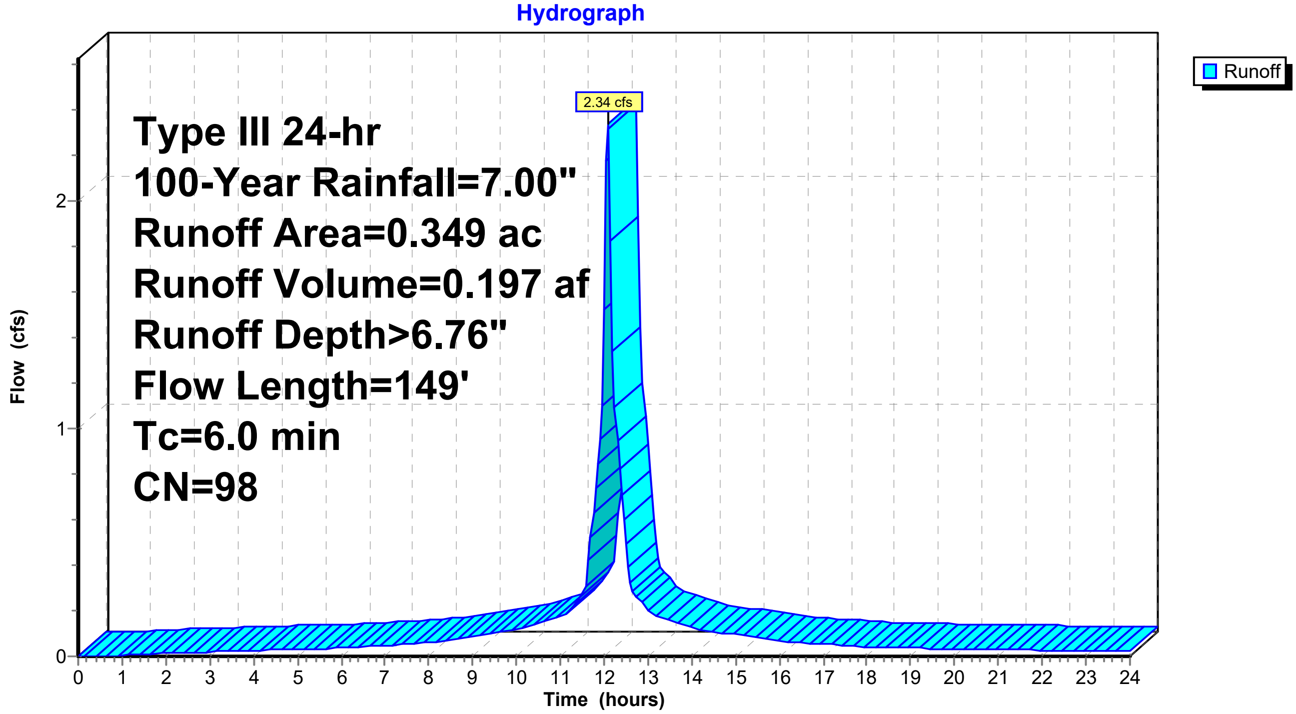
Runoff = 2.34 cfs @ 12.09 hrs, Volume= 0.197 af, Depth> 6.76"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.000	80	>75% Grass cover, Good, HSG D
0.349	98	Paved parking, HSG D
0.349	98	Weighted Average
0.000		0.00% Pervious Area
0.349		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	24	0.0417	0.39		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
1.2	26	0.0357	0.37		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.0	2	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	28	0.0357	3.84		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.0	11	0.0364	3.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.2	34	0.0050	3.21	2.52	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
2.6	149	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A6-PR: Subcat A6-PR



Summary for Subcatchment A7-PR: Subcat A7-PR

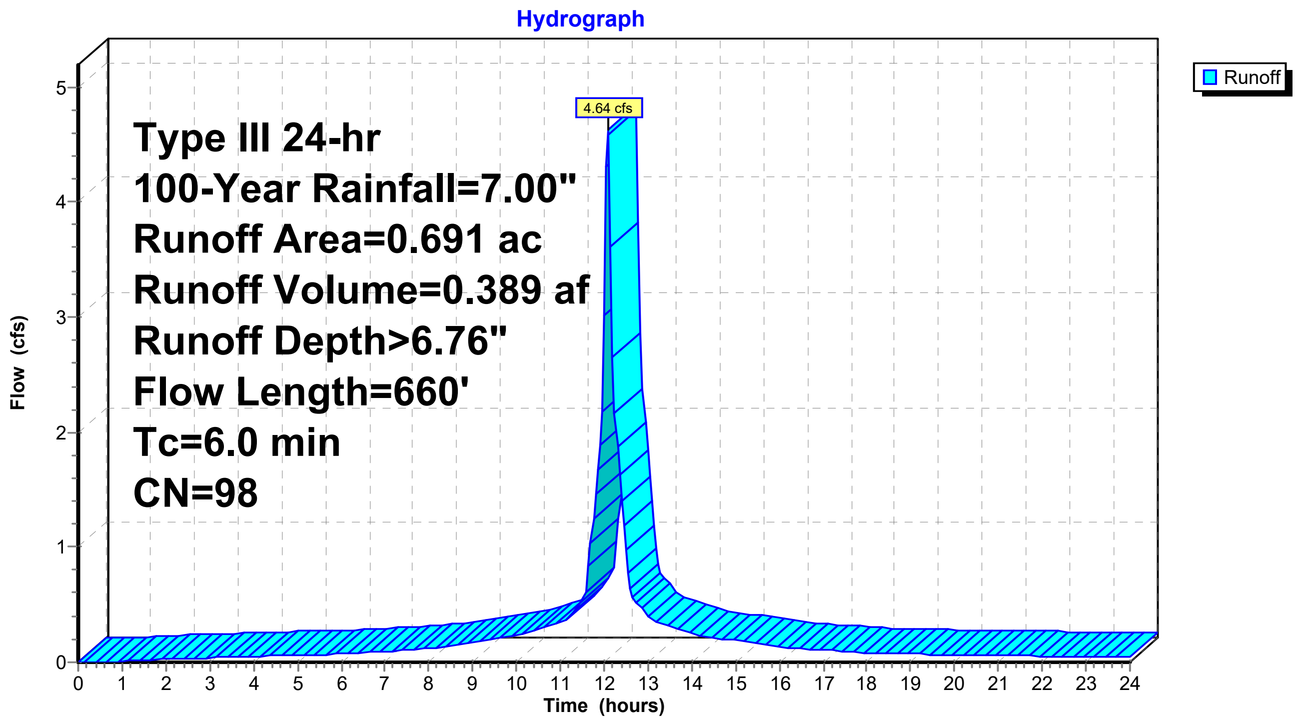
Runoff = 4.64 cfs @ 12.09 hrs, Volume= 0.389 af, Depth> 6.76"
Routed to Pond P2 : Pond 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.691	98	Roofs, HSG D
0.691		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.9	60	0.0200	0.35		**Sheet Flow, Roof Area** Smooth surfaces n= 0.011 P2= 0.25"
2.9	600	0.0050	3.47	2.73	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
5.8	660	Total, Increased to minimum Tc = 6.0 min			

Subcatchment A7-PR: Subcat A7-PR



Summary for Subcatchment A8-PR: Subcat A8-PR

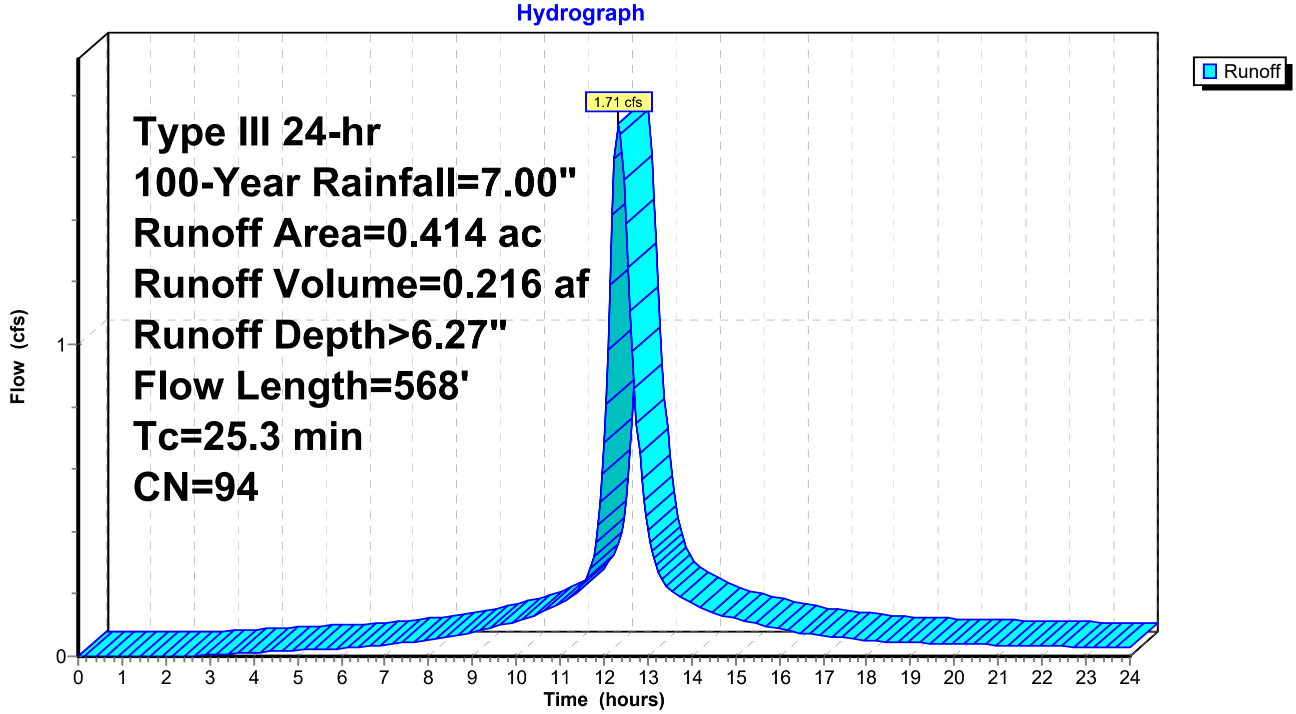
Runoff = 1.71 cfs @ 12.33 hrs, Volume= 0.216 af, Depth> 6.27"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.091	80	>75% Grass cover, Good, HSG D
0.323	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.414	94	Weighted Average
0.091		21.91% Pervious Area
0.323		78.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2	40	0.0100	0.03		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
0.7	10	0.0200	0.24		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.5	60	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	12	0.0100	2.03		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	13	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.5	133	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
25.3	568	Total			

Subcatchment A8-PR: Subcat A8-PR



Summary for Subcatchment A9-PR: Subcat A9-PR

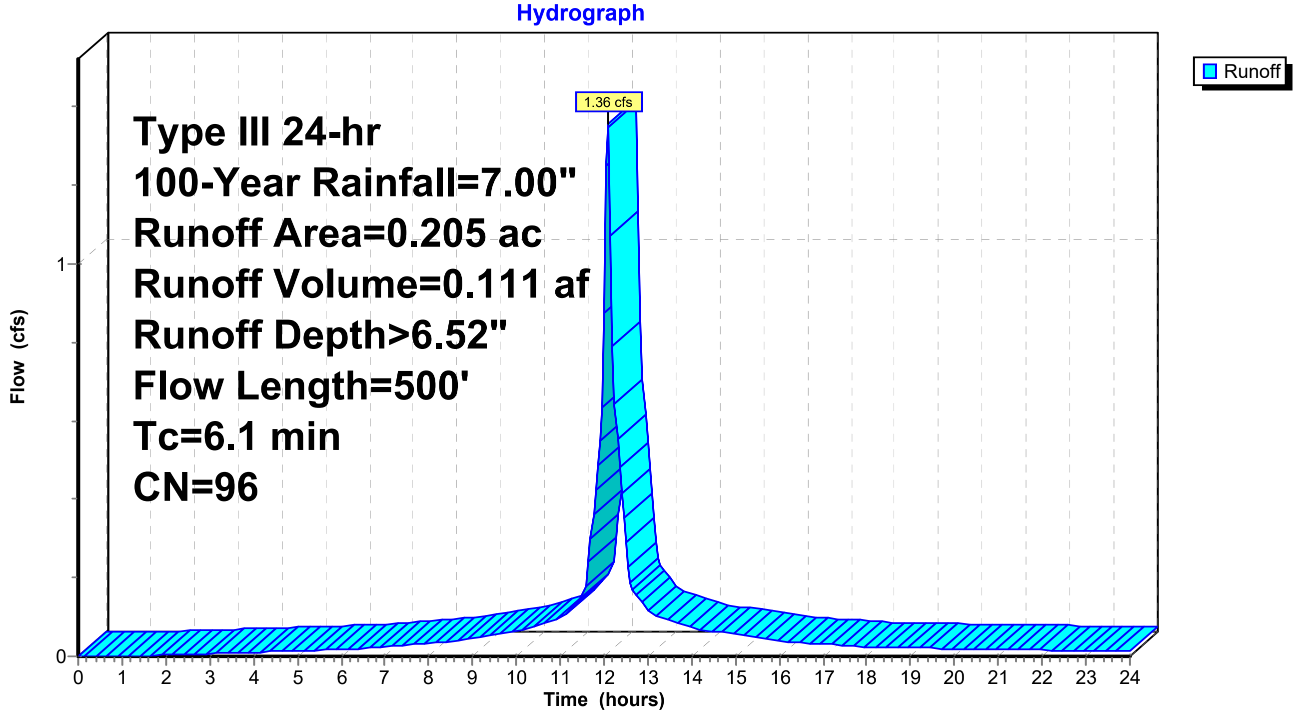
Runoff = 1.36 cfs @ 12.09 hrs, Volume= 0.111 af, Depth> 6.52"
Routed to Pond P1 : Level Spreader

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.025	80	>75% Grass cover, Good, HSG D
0.179	98	Paved parking, HSG D
0.000	98	Roofs, HSG D
0.205	96	Weighted Average
0.025		12.39% Pervious Area
0.179		87.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	12	0.2520	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"
1.9	35	0.0200	0.31		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 0.25"
0.2	30	0.0030	2.48	1.95	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.6	133	0.0050	3.72	4.57	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.7	187	0.0050	4.20	7.43	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
0.3	79	0.0050	5.09	16.00	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
0.1	24	0.0080	6.44	20.23	**Pipe Channel,** 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013 Corrugated PE, smooth interior
6.1	500	Total			

Subcatchment A9-PR: Subcat A9-PR



Summary for Subcatchment B1-PR: Subcat B1-PR

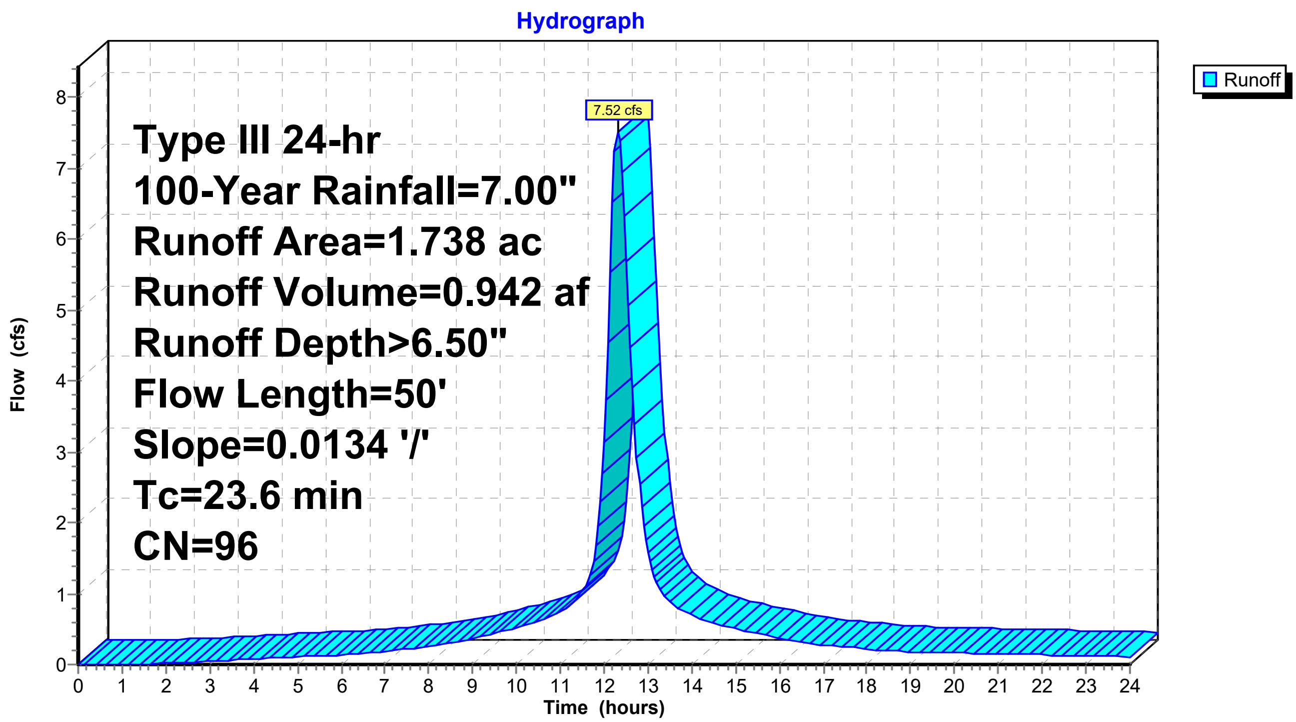
Runoff = 7.52 cfs @ 12.31 hrs, Volume= 0.942 af, Depth> 6.50"
Routed to Link B : Municipal Stormwater System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.00"

Area (ac)	CN	Description
0.180	80	>75% Grass cover, Good, HSG D
1.371	98	Paved parking, HSG D
0.186	98	Roofs, HSG D
0.001	77	Woods, Good, HSG D
1.738	96	Weighted Average
0.180		10.38% Pervious Area
1.558		89.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.6	50	0.0134	0.04		**Sheet Flow,** Grass: Short n= 0.150 P2= 0.25"

Subcatchment B1-PR: Subcat B1-PR



Summary for Pond P1: Level Spreader

Inflow Area = 1.596 ac, 90.54% Impervious, Inflow Depth > 6.54" for 100-Year event
Inflow = 8.82 cfs @ 12.09 hrs, Volume= 0.870 af
Outflow = 8.70 cfs @ 12.10 hrs, Volume= 0.692 af, Atten= 1%, Lag= 0.2 min
Primary = 8.70 cfs @ 12.10 hrs, Volume= 0.692 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.29' @ 12.10 hrs Surf.Area= 2,761 sf Storage= 7,960 cf

Plug-Flow detention time= 140.1 min calculated for 0.691 af (79% of inflow)
Center-of-Mass det. time= 64.5 min (821.1 - 756.5)

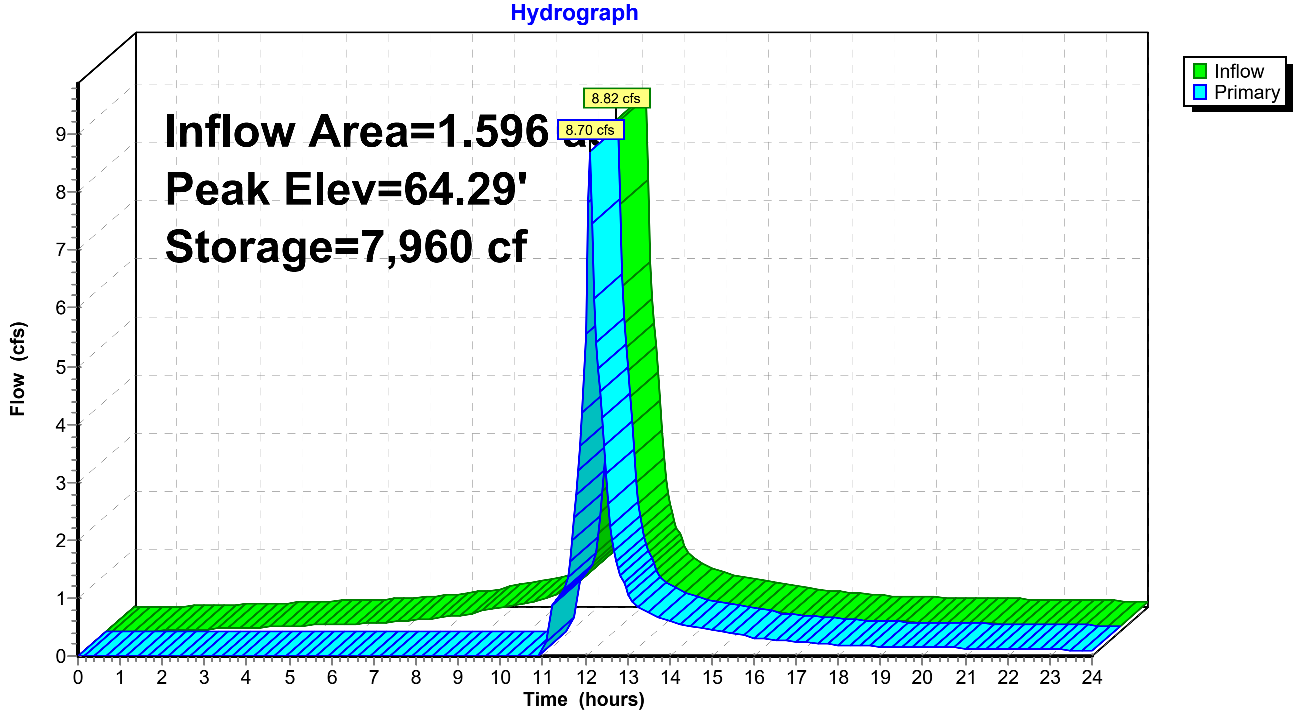
Volume	Invert	Avail.Storage	Storage Description
#1	59.00'	10,054 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
59.00	370	193.0	0	0	370
60.00	770	206.0	558	558	828
61.00	1,194	218.0	974	1,532	1,285
62.00	1,643	231.0	1,413	2,945	1,801
63.00	2,118	243.0	1,875	4,820	2,312
64.00	2,617	256.0	2,363	7,183	2,886
65.00	3,133	268.0	2,871	10,054	3,450

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**132.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=8.45 cfs @ 12.10 hrs HW=64.29' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 8.45 cfs @ 0.73 fps)

Pond P1: Level Spreader



Summary for Pond P2: Pond 2

Inflow Area = 0.691 ac,100.00% Impervious, Inflow Depth > 6.76" for 100-Year event
Inflow = 4.64 cfs @ 12.09 hrs, Volume= 0.389 af
Outflow = 4.50 cfs @ 12.10 hrs, Volume= 0.334 af, Atten= 3%, Lag= 0.8 min
Discarded = 0.04 cfs @ 12.10 hrs, Volume= 0.049 af
Primary = 4.46 cfs @ 12.10 hrs, Volume= 0.284 af
Routed to Pond P3 : Level Spreader

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 66.23' @ 12.10 hrs Surf.Area= 1,524 sf Storage= 2,773 cf

Plug-Flow detention time= 115.2 min calculated for 0.334 af (86% of inflow)
Center-of-Mass det. time= 51.7 min (794.2 - 742.5)

Volume	Invert	Avail.Storage	Storage Description
#1	62.00'	4,091 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

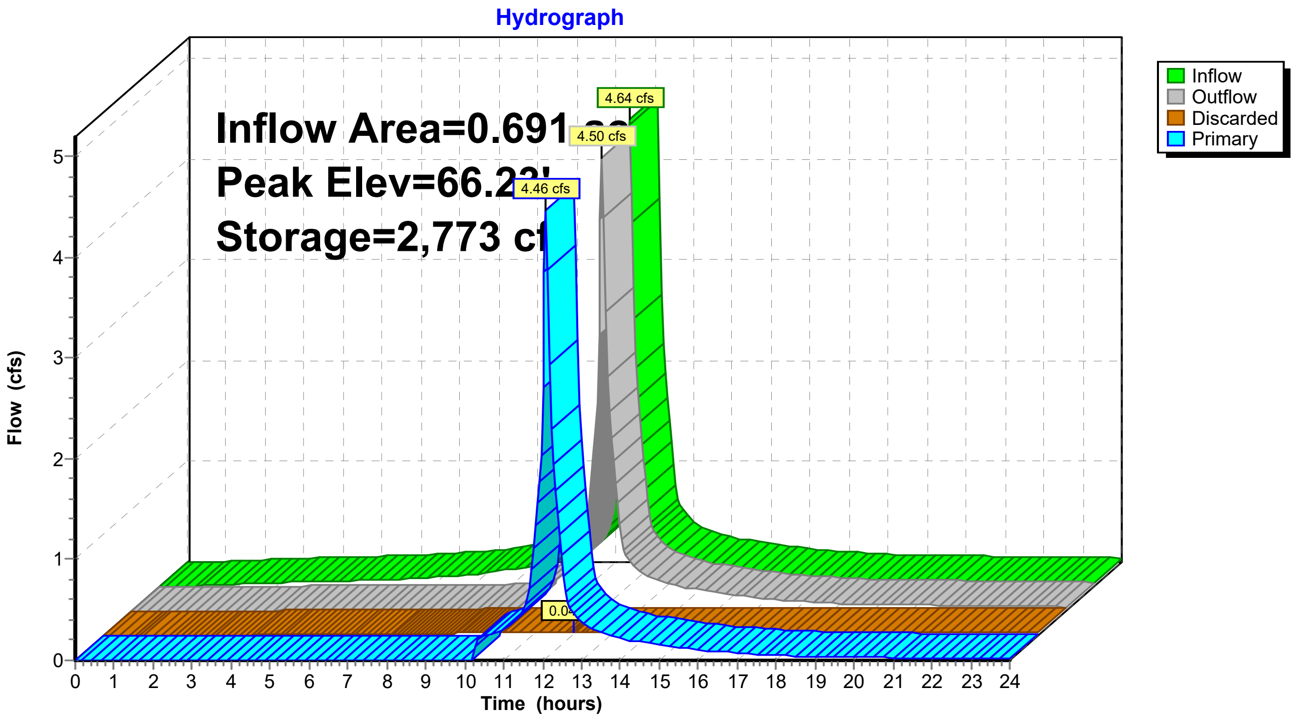
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
62.00	50	39.0	0	0	50
63.00	234	84.0	131	131	495
64.00	551	124.0	381	512	1,165
65.00	953	143.0	743	1,255	1,590
66.00	1,411	162.0	1,175	2,429	2,076
67.00	1,925	181.0	1,661	4,091	2,622

Device	Routing	Invert	Outlet Devices
#1	Primary	63.10'	**15.0" Round Culvert** L= 305.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 63.10' / 61.21' S= 0.0062 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	66.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	62.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 12.10 hrs HW=66.23' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=4.44 cfs @ 12.10 hrs HW=66.23' (Free Discharge)
└─**1=Culvert** (Passes 4.44 cfs of 6.37 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.44 cfs @ 1.58 fps)

Pond P2: Pond 2



Summary for Pond P3: Level Spreader

Inflow Area = 3.396 ac, 91.66% Impervious, Inflow Depth > 6.19" for 100-Year event
Inflow = 19.82 cfs @ 12.10 hrs, Volume= 1.751 af
Outflow = 19.57 cfs @ 12.10 hrs, Volume= 1.647 af, Atten= 1%, Lag= 0.2 min
Primary = 19.57 cfs @ 12.10 hrs, Volume= 1.647 af
Routed to Link A : Bordering Vegetated Wetland

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 64.47' @ 12.10 hrs Surf.Area= 1,782 sf Storage= 4,962 cf

Plug-Flow detention time= 57.6 min calculated for 1.647 af (94% of inflow)
Center-of-Mass det. time= 25.8 min (786.4 - 760.6)

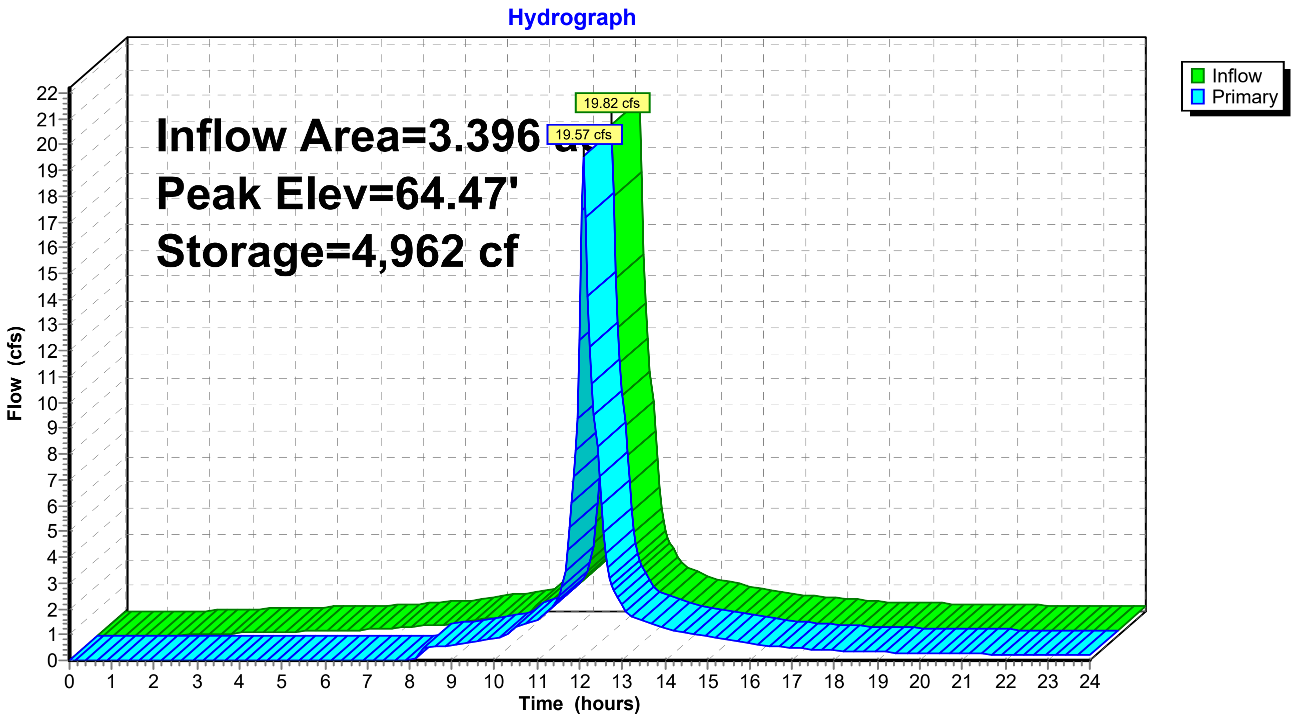
Volume	Invert	Avail.Storage	Storage Description
#1	60.00'	5,961 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
60.00	524	113.0	0	0	524
61.00	763	125.0	640	640	781
62.00	1,026	138.0	891	1,531	1,083
63.00	1,314	150.0	1,167	2,698	1,393
64.00	1,628	163.0	1,468	4,166	1,753
65.00	1,967	176.0	1,795	5,961	2,142

Device	Routing	Invert	Outlet Devices
#1	Primary	64.20'	**59.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=19.43 cfs @ 12.10 hrs HW=64.47' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 19.43 cfs @ 1.24 fps)

Pond P3: Level Spreader

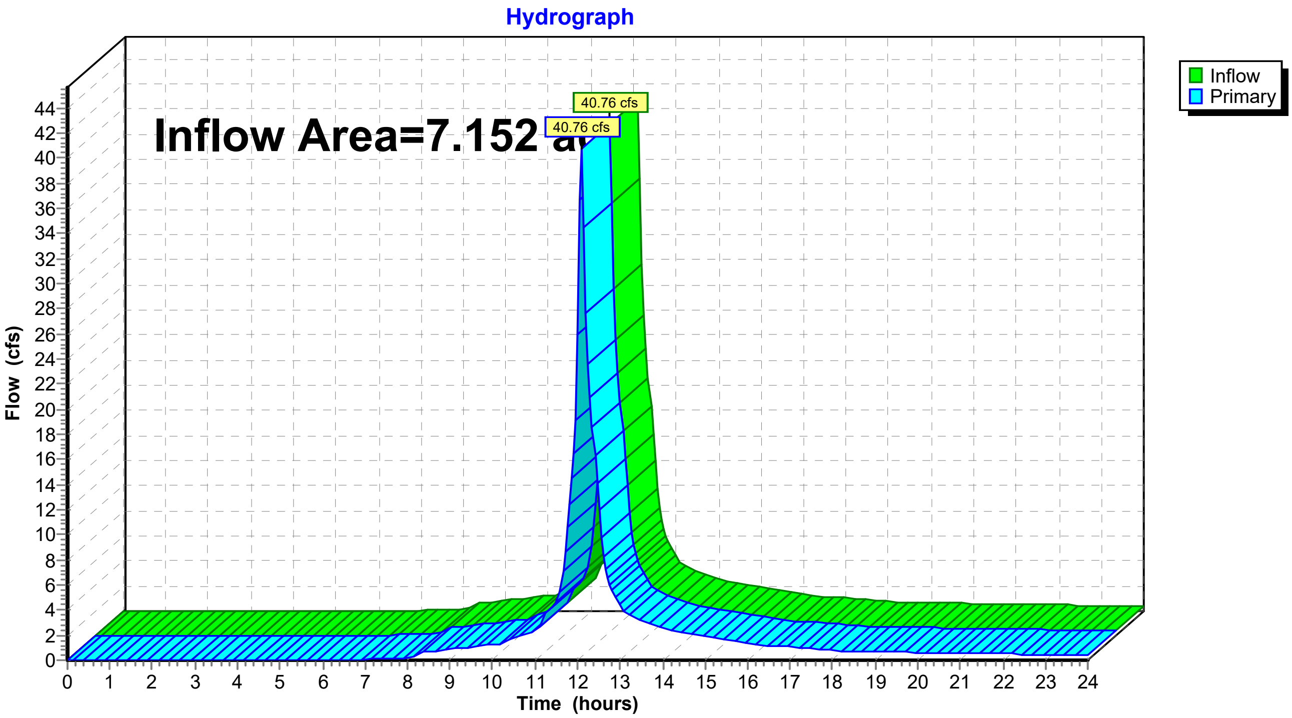


Summary for Link A: Bordering Vegetated Wetland

Inflow Area = 7.152 ac, 73.38% Impervious, Inflow Depth > 5.49" for 100-Year event
Inflow = 40.76 cfs @ 12.09 hrs, Volume= 3.273 af
Primary = 40.76 cfs @ 12.09 hrs, Volume= 3.273 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

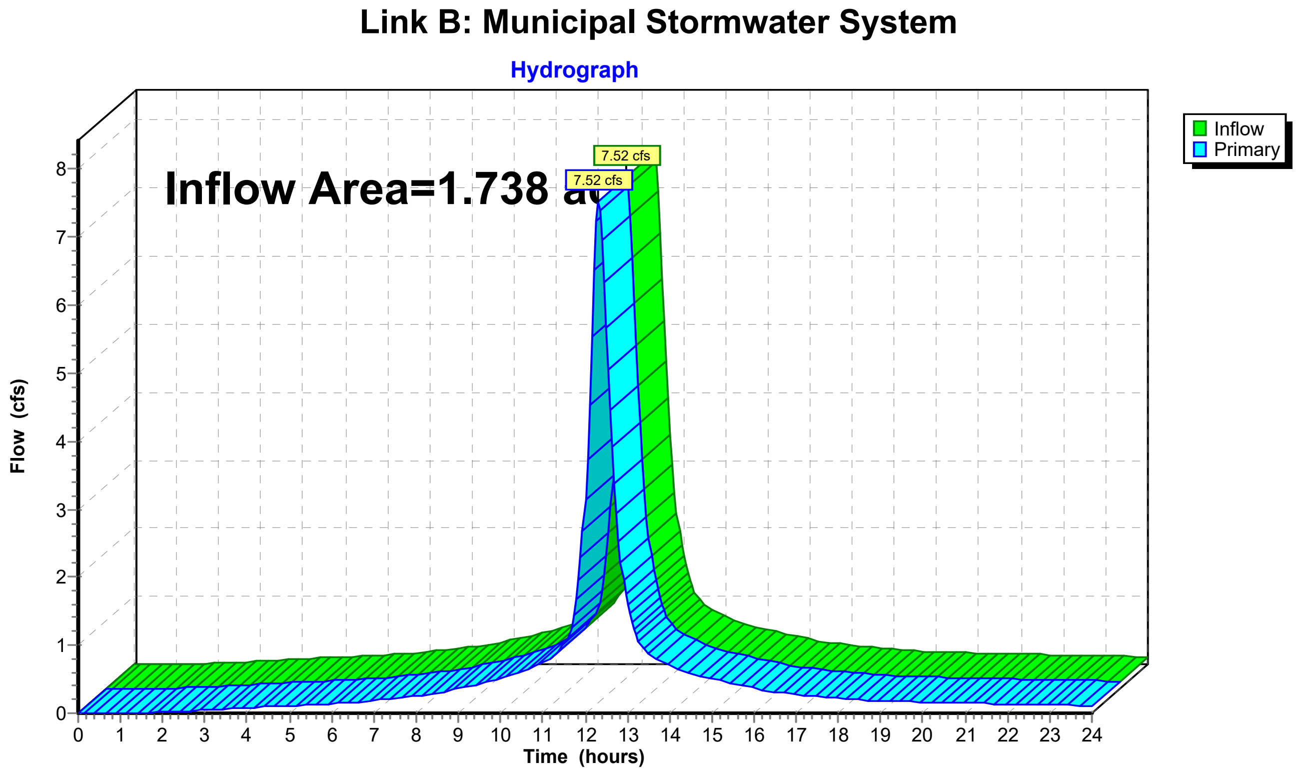
Link A: Bordering Vegetated Wetland



Summary for Link B: Municipal Stormwater System

Inflow Area =	1.738 ac,	89.62% Impervious,	Inflow Depth > 6.50"	for 100-Year event
Inflow =	7.52 cfs @	12.31 hrs, Volume=	0.942 af	
Primary =	7.52 cfs @	12.31 hrs, Volume=	0.942 af, Atten= 0%, Lag= 0.0 min	

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



TSS Calculations

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: Subcatchment A6-PR, A8-PR, A9-PR, A10-PR, A11-PR

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary WQU (StormTech STC900)	**0.80**	**0.75**	**0.60**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Total TSS Removal = **85%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **New Bedford Hauling**
Prepared By: **KLP**
Date: **1/3/2023**

*Equals remaining load from previous BMP (E) which enters the BMP

*** Stormtech Isolator Row conservatively assumed to provide a minimum of 25% TSS removal*

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: Subcatchment A7-PR

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Proprietary WQU (StormTech STC450i)	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **New Bedford Hauling**

Prepared By: **KLP**

Date: **1/3/2023**

*Equals remaining load from previous BMP (E) which enters the BMP

*** Stormtech Isolator Row conservatively assumed to provide a minimum of 25% TSS removal*

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: Subcatchment A2-PR, A3-PR, A5-PR

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary WQU (StormTech STC900)	**0.80**	**0.75**	**0.60**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**
	0.00	**0.15**	**0.00**	**0.15**

Total TSS Removal = **85%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **New Bedford Hauling**
Prepared By: **KLP**
Date: **1/3/2023**

*Equals remaining load from previous BMP (E) which enters the BMP

*** Stormtech Isolator Row conservatively assumed to provide a minimum of 25% TSS removal*

Drainage Capacity Calculations

	Project Name:	New Bedford Hauling				Date:	1/3/2023		**Storm Drainage Calculations**
	Project Location:	1166 Shawmut Avenue, New Bedford			Calculated by:		KLP		
	Project Number:	324-365			Checked by:		KPS		

	LOCATION		**DESIGN**					**CAPACITY**		**PROFILE**					**NOTES**
DESCRIPTION	FROM	TO	Q	V	n	PIPE	SLOPE	Q full	V full	LENGTH	FALL	RIM	INV	INV	
			cfs	fps		SIZE		ft^3/s	ft/s	ft	ft		UPPER	LOWER	
	A3	A2	4.5	4.0	0.012	18	0.005	8.0	4.5	108	0.54	64.64	60.90	60.36	100% of subcatchment A2-PR
	A4	A2	3.6	3.8	0.012	15	0.005	4.9	4.0	59	0.29	64.65	60.65	60.36	100% of subcatchment A5-PR
	A5	A2	4.9	4.0	0.012	18	0.005	8.0	4.6	278	1.39	64.88	61.75	60.36	100% of subcatchment A3-PR
	A2	A1	13.0	5.3	0.012	24	0.005	17.4	5.5	26	0.13	-	60.26	60.13	Subcatchment A2-PR, A3-PR and A5-PR via A2
	A8	A7	3.6	3.7	0.012	18	0.005	7.9	4.5	23	0.11	65.71	62.58	62.47	100% of subcatchment A4-PR
	A9	A7	4.6	4.2	0.012	15	0.005	5.0	4.0	128	0.64	66.00	63.10	62.46	Outflow from Pond 2
	A7	A6	8.2	4.6	0.012	24	0.005	17.2	5.5	178	0.88	66.64	62.09	61.21	Subcatchment A4-PR and Pond 2 via A7
	B11	B9	1.7	3.1	0.012	15	0.005	4.9	4.0	128	0.63	65.88	62.48	61.85	100% of subcatchment A8-PR
	B10	B9	1.4	2.3	0.013	12	0.003	2.0	2.5	30	0.09	65.57	61.94	61.85	100% of subcatchment A9-PR
	B9	B6	3.1	3.6	0.012	15	0.005	4.9	4.0	133	0.66	67.07	61.72	61.06	Subcatchment A8-PR and A9-PR via B9
	B8	B6	1.0	2.7	0.012	12	0.005	2.8	3.5	55	0.28	65.92	61.46	61.18	100% of subcatchment A10-PR
	B6	B4	4.1	3.9	0.012	18	0.005	8.1	4.6	187	0.95	66.64	60.93	59.98	Subcatchment A8-PR, A9-PR and A10-PR via B6
	B5	B4	3.2	3.6	0.012	15	0.005	5.0	4.0	106	0.53	64.64	60.51	59.98	100% of subcatchment A11-PR
	B4	B2	7.3	4.4	0.012	24	0.005	17.4	5.5	79	0.40	66.20	59.98	59.58	Subcatchment A8-PR, A9-PR, A10-PR, and A11-PR via B4
	B3	B2	2.3	3.5	0.012	12	0.005	2.7	3.5	34	0.17	64.60	59.75	59.58	100% of subcatchment A6-PR
	B2	B1	9.6	5.5	0.012	24	0.007	21.1	6.7	24	0.18	65.14	59.33	59.15	Subcatchment A8-PR, A9-PR, A10-PR, A11-PR, and A6-PR via B2
	RD-1	FES-1	2.3	3.7	0.012	12	0.006	3.0	3.8	34	0.20	-	63.20	63.00	50% of subcatchment A7-PR
	RD-2	FES-2	2.3	3.6	0.012	12	0.005	2.8	3.6	28	0.15	-	63.30	63.15	50% of subcatchment A7-PR

Water Quality Calculations

Water Quality Volume Flow Rate Calculations

Project Name:	New Bedford Hauling	Date:	12/28/2022
Project Location:	1228, 1200 and 1166 Shawmut Avenue	Calculated By:	KLP
Project Number:	324-365	Checked By:	KPS

Structure Name: WQU-A2 Description: Stormceptor STC 900
Subcatchment: A2-PR, A3-PR, A5-PR

Total Drainage Area:	85,073	sq ft
	1.95	ac
Total Impervious Area:	77,537	sq ft
	1.78	ac

** Roof Areas are considred clean and are not subject to WQV calculation*

Runoff Depth to be Treated: 1.0 inches

Required Water Quality Volume:	**6,461**	**cf**
	0.148	ac ft

FLOW RATE CONVERSION

$$Q = (qu)(A)(WQV)$$

Where:

Q = flow rate associated with the depth of runoff, in cfs
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Given:

1-acre = 0.0015625 mi^2
6 minute = 0.01 hours
qu (**1**-inch) = **774** csm/in

Calculation:

qu= **774**
A= 1.78 ac
WQV= 1.0 in

Required Water Quality Flow Rate:	**2.15**	**cfs**

STC 900 will provide 80% TSS Removal Efficiency for tributary area - see attached documentation

(Based on Manufacturer's sizing. See attached documentation.)

* Flow rate conversion based on the Massachusetts Department of Environmental Protection Wetlands Program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

Brief Stormceptor Sizing Report - New Bedford Hauling

Project Information & Location			
Project Name	New Bedford Hauling	**Project Number**	324-365
City	New Bedford	**State/ Province**	Massachusetts
Country	United States of America	**Date**	1/4/2023
Designer Information		**EOR Information (optional)**	
Name	Kay Pascua	**Name**	
Company	Civil & Environmental Consultants, Inc.	**Company**	
Phone #	774-501-2176	**Phone #**	
Email	kpascua@cecinc.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	New Bedford Hauling
Target TSS Removal (%)	80
TSS Removal (%) Provided	84
Recommended Stormceptor Model	STC 900

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	76
STC 900	84
STC 1200	84
STC 1800	84
STC 2400	88
STC 3600	88
STC 4800	91
STC 6000	91
STC 7200	93
STC 11000	95
STC 13000	95
STC 16000	96

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Sizing Details

Drainage Area	
Total Area (acres)	1.95
Imperviousness %	91.2

Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	2.15

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Water Quality Volume Flow Rate Calculations

Project Name:	New Bedford Hauling	Date:	12/28/2022
Project Location:	1228, 1200 and 1166 Shawmut Avenue	Calculated By:	KLP
Project Number:	324-365	Checked By:	KPS

Structure Name: WQU-A8 Description: Stormceptor STC 450i
Subcatchment: A4-PR

Total Drainage Area:	32,757	sq ft
	0.75	ac
Total Impervious Area:	27,835	sq ft
	0.64	ac

** Roof Areas are considred clean and are not subject to WQV calculation*

Runoff Depth to be Treated: 1.0 inches

Required Water Quality Volume:	**2,320**	**cf**
	0.053	ac ft

FLOW RATE CONVERSION

$$Q = (qu)(A)(WQV)$$

Where:

Q = flow rate associated with the depth of runoff, in cfs
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Given:

1-acre = 0.0015625 mi^2
6 minute = 0.01 hours
qu (**1**-inch) = **774** csm/in

Calculation:

qu= **774**
A= 0.64 ac
WQV= 1.0 in

Required Water Quality Flow Rate:	**0.77**	**cfs**

STC 450i will provide 80% TSS Removal Efficiency for tributary area - see attached documentation

(Based on Manufacturer's sizing. See attached documentation.)

* Flow rate conversion based on the Massachusetts Department of Environmental Protection Wetlands Program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

Brief Stormceptor Sizing Report - New Bedford Hauling

Project Information & Location			
Project Name	New Bedford Hauling	**Project Number**	324-365
City	New Bedford	**State/ Province**	Massachusetts
Country	United States of America	**Date**	1/4/2023
Designer Information		**EOR Information (optional)**	
Name	Kay Pascua	**Name**	
Company	Civil & Environmental Consultants, Inc.	**Company**	
Phone #	774-501-2176	**Phone #**	
Email	kpascua@cecinc.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	New Bedford Hauling
Target TSS Removal (%)	80
TSS Removal (%) Provided	87
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	87
STC 900	92
STC 1200	92
STC 1800	93
STC 2400	95
STC 3600	95
STC 4800	96
STC 6000	97
STC 7200	97
STC 11000	98
STC 13000	98
STC 16000	99

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Sizing Details

Drainage Area	
Total Area (acres)	0.75
Imperviousness %	85.3

Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	0.77

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Water Quality Volume Flow Rate Calculations

Project Name:	New Bedford Hauling	Date:	12/28/2022
Project Location:	1228, 1200 and 1166 Shawmut Avenue	Calculated By:	KLP
Project Number:	324-365	Checked By:	KPS

Structure Name: WQU-B2 Description: Stormceptor STC 900

Subcatchment: A6-PR, A8-PR, A9-PR, A10-PR, and A11-PR

Total Drainage Area:	69,478	sq ft
	1.60	ac
Total Impervious Area:	62,901	sq ft
	1.44	ac

** Roof Areas are considred clean and are not subject to WQV calculation*

Runoff Depth to be Treated:	1.0	inches

Required Water Quality Volume:	**5,242**	**cf**
	0.120	ac ft

FLOW RATE CONVERSION

$$Q = (qu)(A)(WQV)$$

Where:

Q = flow rate associated with the depth of runoff, in cfs
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Given:

1-acre =	0.0015625	mi^2
6 minute =	0.01	hours
qu (**1**-inch) =	**774**	csm/in

Calculation:

qu=	**774**	
A=	1.44	ac
WQV=	1.0	in

Required Water Quality Flow Rate:	**1.75**	**cfs**

STC 900 will provide 80% TSS Removal Efficiency for tributary area - see attached documentation

(Based on Manufacturer's sizing. See attached documentation.)

* Flow rate conversion based on the Massachusetts Department of Environmental Protection Wetlands Program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

Brief Stormceptor Sizing Report - New Bedford Hauling

Project Information & Location			
Project Name	New Bedford Hauling	**Project Number**	324-365
City	New Bedford	**State/ Province**	Massachusetts
Country	United States of America	**Date**	1/4/2023
Designer Information		**EOR Information (optional)**	
Name	Kay Pascua	**Name**	
Company	Civil & Environmental Consultants, Inc.	**Company**	
Phone #	774-501-2176	**Phone #**	
Email	kpascua@cecinc.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	New Bedford Hauling
Target TSS Removal (%)	80
TSS Removal (%) Provided	85
Recommended Stormceptor Model	STC 900

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	78
STC 900	85
STC 1200	86
STC 1800	86
STC 2400	89
STC 3600	90
STC 4800	92
STC 6000	93
STC 7200	94
STC 11000	96
STC 13000	96
STC 16000	97

Sizing Details

Drainage Area	
Total Area (acres)	1.60
Imperviousness %	90.0

Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	
Water Quality Flow Rate (CFS)	1.75

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

OK-110		
Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

• Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
• Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
• For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Recharge Calculations

Groundwater Recharge Calculations

Project Name:	New Bedford Hauling	Date:	1/4/2023
Project Location:	1228, 1200, and 1166 Shawmut Avenue	Calculated By:	KLP
Project Number:	324-365	Checked By:	KPS

Existing Conditions Impervious Area

Hydrologic Soil Group	Area (sq ft)	Area (acres)	Recharge Depth (in)	Volume (cu ft)
A	0	0.00	0.60	0.0
B	0	0.00	0.35	0.0
C	0	0.00	0.25	0.0
D	301,958	6.93	0.10	2516.3
TOTAL	**301,958**	**6.93**		**2,516**

Proposed Conditions Impervious Area

Hydrologic Soil Group	Area (sq ft)	Area (acres)	Recharge Depth (in)	Volume (cu ft)
A	0	0.00	0.60	0.0
B	0	0.00	0.35	0.0
C	0	0.00	0.25	0.0
D	289,805	6.65	0.10	2415.0
TOTAL	**289,805**	**6.65**		**2,415**

Net Required Recharge Volume: -101 cu ft

***No regulatory recharge requirement due to reduction in impervious areas**

Provided Recharge Volume

Subcatchment A7-PR	2,429 cf	*Infiltration Basin*
TOTAL	2,429 cf	

Total Provided 2,429 cu ft

Groundwater Recharge Calculations

Project Name:	New Bedford Hauling	Date:	1/4/2023
Project Location:	1228, 1200, and 1166 Shawmut Avenue	Calculated By:	KLP
Project Number:	324-365	Checked By:	KPS

Stormwater BMP: Subcatchment A7-PR

Description: Infiltration Basin

Provided Recharge Volume

Bottom of Basin:	62.00	ft	
Outlet Elevation:	66.00	ft	
*** Volume Provided:	0.06	ac ft	
	2,429	cu ft	*** (See attached HydroCAD output)

Total Provided Recharge Volume: 2,429 cu ft

72-hour Drawdown Calculation

Provided Recharge Volume:	2,429	cu ft	
Saturated Hydraulic Conductivity:	1.02	in / hr	(Rawls Rate for Sandy Loam (HSG B) was used)
Bottom Area:	1,411	sq ft	

Drawdown Time: 20.3 hours

Stage-Area-Storage for Pond P2: Pond 2

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
62.00	50	0	64.60	779	909
62.05	56	3	64.65	800	949
62.10	62	6	64.70	821	989
62.15	69	9	64.75	842	1,031
62.20	76	13	64.80	864	1,073
62.25	83	16	64.85	886	1,117
62.30	91	21	64.90	908	1,162
62.35	99	26	64.95	930	1,208
62.40	107	31	65.00	953	1,255
62.45	116	36	65.05	974	1,303
62.50	125	42	65.10	995	1,352
62.55	134	49	65.15	1,016	1,403
62.60	144	56	65.20	1,037	1,454
62.65	154	63	65.25	1,059	1,506
62.70	165	71	65.30	1,081	1,560
62.75	175	80	65.35	1,103	1,614
62.80	186	89	65.40	1,125	1,670
62.85	198	98	65.45	1,148	1,727
62.90	210	109	65.50	1,171	1,785
62.95	222	119	65.55	1,194	1,844
63.00	234	131	65.60	1,217	1,904
63.05	247	143	65.65	1,241	1,966
63.10	260	155	65.70	1,264	2,028
63.15	273	169	65.75	1,288	2,092
63.20	287	183	65.80	1,312	2,157
63.25	301	197	65.85	1,337	2,223
63.30	315	213	65.90	1,361	2,291
63.35	330	229	65.95	1,386	2,360
63.40	345	246	66.00	1,411	2,429
63.45	360	263	66.05	1,435	2,501
63.50	376	282	66.10	1,459	2,573
63.55	392	301	66.15	1,483	2,647
63.60	408	321	66.20	1,507	2,721
63.65	425	342	66.25	1,532	2,797
63.70	442	363	66.30	1,557	2,874
63.75	459	386	66.35	1,582	2,953
63.80	477	409	66.40	1,607	3,033
63.85	495	434	66.45	1,632	3,114
63.90	513	459	66.50	1,658	3,196
63.95	532	485	66.55	1,684	3,279
64.00	551	512	66.60	1,710	3,364
64.05	569	540	66.65	1,736	3,450
64.10	586	569	66.70	1,762	3,538
64.15	604	599	66.75	1,789	3,627
64.20	623	629	66.80	1,816	3,717
64.25	641	661	66.85	1,843	3,808
64.30	660	694	66.90	1,870	3,901
64.35	679	727	66.95	1,897	3,995
64.40	699	761	67.00	**1,925**	**4,091**
64.45	718	797			
64.50	738	833			
64.55	759	871			

APPENDIX D

Illicit Discharge Statement
NJCAT Stormceptor Test Results
Manufacturer's O&M Manual

Illicit Discharge Statement

Illicit Discharge Compliance Statement

Responsibility:

The Owner is responsible for ultimate compliance with all provisions of the Massachusetts Stormwater Management Policy, the USEPA NPDES Construction General Permit and responsible for identifying and eliminating illicit discharges (as defined by the USEPA).

Engineer's Compliance Statement:

The attached reports, plans and calculations meet the requirements of Standard 10 of the Massachusetts Stormwater Handbook regarding illicit discharges to the stormwater management system. No detectable illicit discharges exist on the site, to the best of my knowledge.

Included with this statement are site plans, drawn to scale, that identify the location of systems for conveying stormwater on the site and show that these systems do not allow entry of any illicit discharges into the stormwater management system. The plans also show systems for conveying wastewater and show that there are no connections between the stormwater and wastewater systems.

For a redevelopment project (if applicable), all actions taken to identify and remove illicit discharges, including without limitation, visual screening, dye or smoke testing, and the removal of any sources of illicit discharges to the stormwater management system are documented and included with this statement.

NJCAT Stormceptor Test Results

FINAL

NJCAT TECHNOLOGY VERIFICATION

Stormceptor®

September 9, 2004

June 2010 Addendum to this report starts on page 31

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1. Introduction

1.1 New Jersey Corporation for Advanced Technology (NJCAT) Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization;
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated;
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state; and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program), the New Jersey Department of Environmental Protection (NJDEP) and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies the net beneficial environmental effect of the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter into reciprocal environmental technology agreements concerning the evaluation and verification protocols with the United States Environmental Protection Agency (USEPA), other local required or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the Energy and Environment Technology Verification Program.

1.2 Technology Verification Report

In August 2003, the Stormceptor® Group of Companies (12 Madison Avenue, Toronto, Canada, M5R 2S1) submitted a formal request for participation in the NJCAT Technology Verification Program. The technology proposed – The Stormceptor® System, Oil and Sediment Separator – is a patented water quality improvement device applicable for treatment of stormwater in a variety of development situations. The Stormceptor® concept was developed in the late 1980's with the first patent filed in 1990. The original application of the technology was for spills capture, containment and detection in industrial areas. The first unit was sold in 1992. Since then, the Stormceptor® concept has evolved as field monitoring and on-going research present new opportunities to improve the Stormceptor® product line and environmental awareness regarding stormwater quality control increased.

Through research and field application, the technology has been refined to separate oil and sediment from stormwater runoff as well as capturing oil spills during dry weather conditions. The request (after pre-screening by NJCAT staff personnel in accordance with the technology assessment guidelines) was accepted into the verification program. This verification report covers the evaluation based upon the performance claims of the vendor, Stormceptor® Group of Companies (see Section 4). The verification report differs from typical NJCAT verification reports in that final verification of the Stormceptor® System (and subsequent NJDEP certification of the technology) awaits completed field testing that meets the full requirements of the Technology Acceptance and Reciprocity Partnership (TARP) – Stormwater Best Management Practice Tier II Protocol for Interstate Reciprocity for stormwater treatment technology. This verification report is intended to evaluate the Stormceptor® System initial performance claim for the technology based primarily on carefully conducted laboratory studies. This claim is expected to be modified and expanded following completion of the TARP required field-testing.

In August 2003, the Stormceptor® Corporation in association with Rinker Materials™, Hydro Conduit Division, submitted a Verification Acceptance to NJCAT's verification program for review and approval. After this initial submittal, a meeting was held with Stormceptor® representatives, NJCAT and NJDEP to discuss the preliminary review of the verification package and NJDEP's recently released draft Total Suspended Solids (TSS) laboratory testing procedure. Based upon this meeting and subsequent discussions, the Stormceptor® Corporation decided to conduct additional laboratory tests in accordance with NJDEP's draft TSS laboratory testing procedure. A laboratory testing protocol was developed by the Stormceptor® Corporation and submitted to NJCAT and NJDEP for their review and comment. In June 2004, the Stormceptor® Corporation submitted a Full Scale Laboratory Evaluation of Stormceptor® Model STC 900 for removal of TSS (Applying NJDEP particle size distribution (PSD) & Weight Factor). This project included the evaluation of these assembled reports, company manuals, literature, and laboratory testing reports to verify that the Stormceptor® System meets the performance claims of Stormceptor® Corporation.

1.3 Technology Description

1.3.1 Technology Status

In 1990 Congress established deadlines and priorities for USEPA to require permits for discharges of stormwater that is not mixed or contaminated with household or industrial wastewater. Phase I regulations established that a NPDES (National Pollutant Discharge Elimination System) permit is required for stormwater discharge from municipalities with a separate storm sewer system that serves a population greater than 100,000 and certain defined industrial activities. To receive a NPDES permit, the municipality or specific industry has to develop a stormwater management plan and identify Best Management Practices (BMPs) for stormwater treatment and discharge. BMPs are measures, systems, processes or controls that reduce pollutants at the source to prevent the pollution of stormwater runoff discharge from the site. Phase II stormwater discharges include all discharges composed entirely of stormwater, except those specifically classified as Phase I discharge.

The nature of pollutants emanating from differing land uses is very diverse. Stormceptor® Corporation has developed a hydrodynamic source control device for the capture and retention of free and floating oils, grease, hydrocarbons, petroleum products, and total suspended solids. Sorbed contaminants that are transported by the fine uspended solids such as nutrients, heavy metals, and hydrocarbon and petroleum products are removed from stormwater, thus improving water quality. The Stormceptor® System is a vertically oriented cylindrical structure manufactured from concrete and fiber reinforced plastic (fiberglass) insert. A weir and orifice plate on the fiberglass insert controls flow rates and operational velocities, which are minimized in order to facilitate the capture of fine suspended solids and hydrocarbons, and retaining it over a range of subsequent hydrological conditions. Between maintenance events, pollutants accumulate within the system and are therefore removed from the natural environment. These pollutants may otherwise become a human health hazard, an aesthetic issue or may be cycled within the food chain or water table even if trapped in a land based treatment system. Maintenance is performed above ground by a vacuum truck and without interference from internal components.

General

The patented Stormceptor® System is a pollution prevention technology that removes hydrocarbons and fine sediment from stormwater runoff and provides oil spill control from entering downstream ponds, lakes and rivers. The technology follows the philosophy of treating pollution at its source. Treating pollution at the source is the preferred methodology for water quality improvement because treatment effectiveness decreases with dilution as drainage area increases.

Storm sewers are designed to convey a specific flow determined from a design event. The design event is typically the event with the highest flow that may be encountered for a return period, measured in years. Typical design storms are based on the 2 year, 5 year, or 10 year return storms and are characterized by rainfall depth, rain duration, time distribution of rainfall, and the spatial distribution of rainfall. These design principles can be impractical when they are applied for stormwater quality. By definition, *design storms occur infrequently* and *typically* *account for a very small fraction of the annual rainfall volume*. Designing for stormwater quality using principles for sizing sewers becomes impracticable and uneconomical in that BMPs would have to be designed to contain a large volume of runoff created by a design storm which would in turn be used on a very infrequent basis. For this reason, the Stormceptor® System is designed intentionally to treat the *majority* of the total annual rainfall volume and only a portion of the peak flow volumes. Small frequently occurring events make up the majority of rainfall events in North America as observed from continuous historical rainfall data. By treating the small frequent events to a high degree and bypassing a portion of the infrequent high flows scouring of previously capture hydrocarbons and fine sediment is minimized and a high level of long term efficiency can be achieved. The weir and orifice plate feature on the Stormceptor® System achieves control of flow rates and operational velocities entering the treatment chamber, thus facilitating conditions necessary for capture of fine suspended solids and hydrocarbons, and retention of these pollutants even under peak flow events. The Stormceptor® System performance is based on the long-term removal average of TSS loading over the complete range of hydrological conditions including infrequent peak rainfall events. The sizing methodology of the Stormceptor® System includes the analysis of the actual hydrology of the site from geographic continuous long-term historical data to determine the TSS removal performance of each Stormceptor® model over the long-term.

1.3.2 Specific Applicability

Stormceptor® is a water quality improvement device applicable for treatment of stormwater in a variety of development situations including:

- stormwater quality retrofits for existing development;
- pretreatment of natural BMPs;
- industrial and commercial parking lots;
- automobile service stations;
- airports;
- areas susceptible to spills of material lighter than water (bus depots, transfer stations, etc.);
- new residential developments (as part of a treatment train); and
- re-development in the urban core.

1.3.3 Range of Contaminant Characteristics

Storm*ceptor*® Systems have been shown to capture a wide range of pollutants of concern. These include: free and floating oils; grease; hydrocarbons; petroleum products; and total suspended solids. Sorbed contaminants that are transported by the fine suspended solids such as nutrients, heavy metals, and hydrocarbon and petroleum products may also be removed from stormwater.

1.3.4 Range of Site Characteristics

The Stormceptor® System is designed to accommodate a wide range of flows and volumes (see Table 1). The Stormceptor® System is manufactured in 12 different sizes using precast concrete base, barrel and cap sections ranging from 4 ft (1200 mm) to 12 ft (3600 mm) in diameter. The 6 ft (1800 mm) insert divides the tank into two components, an upper and lower chamber. The key benefit of the system is a built-in bypass that prevents high flows from entering the lower chamber (storage chamber) to prevent stored contaminants from being flushed out.

Table 1. Stormceptor ® System Standard Sizes

Stormceptor® Models					
Model	Design Capacity [a] (gpm)	Orifice Diameter (inches)	Sediment Capacity [b] (ft^3)	Oil Capacity (US Gal.)	Total Holding Capacity (US Gal.)
STC 450	127	6	9	86	470
STC 900	285	6	19	251	952
STC 1200	285	6	25	251	1234
STC 1800	285	6	37	251	1833
STC 2400	475	8	49	840	2462
STC 3600	475	8	75	840	3715
STC 4800	793	10	101	909	5059
STC 6000	793	10	123	909	6136
STC 7200	1110	12	149	1059	7420
STC 11000**s**	1585	10	224	2797	11194
STC 13000**s**	1585	10	268	2797	13348
STC 16000**s**	2219	12	319	3055	15918

Notes:
a –Water quality treatment is the intent of the Stormceptor® design, therefore the use of this design capacity for single event design storm sizing (e.g. Rational Method) is not appropriate. The Stormceptor® Corporation recommends using the Stormcepto*r*® Sizing Program version 4.0.0 to properly select a Stormceptor® unit.
b – Sediment capacity prior to recommended maintenance.
s – These are series units which consist of two structures installed in series that are designed to operate in parallel. The sediment, oil and total holding capacity are based on both structures combined.

1.3.5 Material Overview, Handling and Safety

To clean out the Stormceptor® System, oil is removed through the 6 in. (150 mm) inspection/cleanout port, and sediment is removed through the 24 in. (610 mm) diameter riser pipe. Alternatively, oil could be removed from the 24 in. (610 mm) opening if water is first removed from the lower chamber in order to lower the oil level below the riser pipe.

The depth of sediment can be measured from the surface of the Stormceptor® unit with a dipstick tube equipped with a ball valve. A vacuum truck is generally the most convenient and efficient method to remove the sediment from the Stormceptor® unit. Solids recovered from the Stormceptor® System can typically be land filled or disposed of at a waste water treatment plant. It is possible that there may be some specific land use activities that create contaminated solids, which will be captured in the system. Such material would have to be handled and disposed of in accordance with hazardous waste management requirements.

1.4 Project Description

This project included the evaluation of assembled reports, company manuals, literature, and laboratory testing reports to verify that the Stormceptor® System meets the performance claims of Stormceptor ® Corporation.

1.5 Key Contacts

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2. Evaluation of the Applicant

2.1 Corporate History

The Stormceptor® concept was developed in the late 1980's with the first patent filed in 1990. The original application of the technology was for spills capture, containment and detection in industrial areas. The first unit was sold in 1992. Since then, the Stormceptor® concept has evolved as field monitoring and on-going research present new opportunities to improve the Stormceptor® product line and environmental awareness regarding stormwater quality control increased.

2.2 Organization and Management

The Stormceptor® Group of Companies (SGC) is a group of companies that design, engineer, patent, and market stormwater treatment equipment. Stormceptor® Group of Companies is comprised of three separate companies including:

- **Stormceptor® Corporation** in the United States;
- **Stormceptor® Canada, Inc.** in Canada; and
- **X-Ceptor™ International** in the remainder of the world.

These companies own and license the patented Stormceptor® System technology. Since 1992, over 10,000 units have been installed worldwide through a network of licensed manufacturers (affiliates).

2.3 Operating Experience with the Proposed Technology

The Stormceptor® System was designed and developed in the laboratory and has been tested in numerous field studies and other laboratory studies. Since 1990, the Stormceptor® group of companies and its affiliates have allocated over $1,000,000 (US) towards field monitoring in a continuing effort to define the operating characteristics of the product. All the Stormceptor® monitoring is completed by engineering consultants and follows a monitoring protocol based on flow proportional monitoring upstream and downstream of the Stormceptor® system.

2.4 Patents

Currently, 22 patents and applications relating to the original system and improvements upon it are filed in nine countries around the world including the United States, Canada, Australia, New Zealand, Malaysia, Indonesia, Korea, China, and Japan.

In the United States Stormceptor® Corporation holds six patents including the following:

Improved Separator Tank Construction:	US Patent no 4,985,148
Enhanced Separator Tank:	US Patent no 5,725,760
Submerged Pipe Separator Tank:	US Patent no 5,753,115
Tank Interceptor:	US Patent no 5,498,331
Catchbasin Interceptor:	US Patent no 5,849,181
Separator Tank:	US Patent no 6,068,765
Apparatus for Water at Low & High Feed Rates:	US Patent no 6,371,690

2.5 Technical Resources, Staff and Capital Equipment

Stormceptor® Corporation works in partnership with its affiliated companies to provide its customers with solutions to unique situations throughout the design process. Rinker Materials™-Hydro Conduit is a successful established company with 50 operations across the United Sates that has been in operation for over forty years. The Stormceptor® Corporation has been providing stormwater quality solutions for over 12 years.

Technical Resources
Technical assistance is provided by local Rinker Materials – Hydro Conduit representatives in the state of New Jersey. The Rinker Materials™-Hydro Conduit head office in Houston, Texas is available to provide assistance as well as the Stormceptor® Corporation office in Toronto, Canada.

Stormceptor® Corporation operates a full scale laboratory facility in Ontario Canada, to conduct research on new innovative treatment methods, as well as development of the current product line. If necessary, this facility is available to analyze and simulate individual site-specific issues as well. Stormceptor® Corporation also organizes bi-annual technical meetings with the technical representatives of its worldwide affiliate companies. These meeting are useful in sharing technical expertise and solutions between various geographic and regulatory environments.

The Stormceptor® System is widely used around the world. For Stormceptor® units specified in the State of New Jersey, the concrete portion of the Stormceptor® system is manufactured locally in New England, while the fiberglass insert is manufactured in Ontario, Canada.

For a given project, the Stormceptor® unit is typically sized by a consulting engineer using the publicly available Stormceptor® Sizing Program v 4.0.0. Site details, along with unit size are then forwarded to the local Rinker Materials™-Hydro Conduit facility for development of construction drawings. Drawings are forwarded to the contractor for confirmation of layout. After confirmation from the contractor, the final product is delivered onsite along with installation instructions. The amount of lead time required for ordering a unit is approximately 2 to 4 weeks.

3. Treatment System Description

Figure 1 shows parts that make up the Stormceptor® System. The Stormceptor® System is a vertically oriented cylindrical structure manufactured from concrete and fiber reinforced plastic, designed to remove hydrocarbons and fine sediment from stormwater.

It is comprised of precast concrete circular riser and slab components which make up the tank and a fiberglass disk partition, also referred to as the "fiberglass insert". A fiberglass insert is mounted inside the precast chamber and functions to achieve the following:

1. Separates the chamber into two components: an upper chamber and a lower chamber;
2. A weir on the fiberglass insert allows head build-up to a maximum of 9 inches (229 mm) which drives flows (up to the treatment capacity of the unit) through the orifice plate and into the lower chamber. The remainder of the high flows will overflow the weir and bypass the system under infrequently occurring large storm events;
3. The orifice plate controls the flow rate and velocities entering the lower chamber. High flows and velocities need to be minimized in order to prevent re-suspension, loss of fine suspended solids material, and emulsification of collected hydrocarbons; and
4. The separation between chambers allows a portion of the infrequent high flows that over tops the weir to bypass the system thus preventing re-suspension or the scour of previously deposited material.

Stormwater flows into the Stormceptor® System through the upper chamber via the storm sewer pipe. Low flows are diverted into the lower chamber by a weir and drop tee arrangement (See Figure 2). The drop tee is constructed with two holes directing the water to follow the inside circumference of the unit to maximize detention time. Water flows up through the riser pipe based on the head at the inlet weir, and is discharged back into the upper chamber downstream of the weir. The downstream section of the upper chamber is connected to the outlet sewer pipe.

Oil and floatables with a specific gravity less than water will rise in the lower chamber and become trapped since the outlet pipe is submerged. Sediment will settle to the bottom of the lower chamber by gravity. The circular design of the lower chamber is critical to prevent turbulent eddy currents and to promote settling. The Stormceptor® System does not remove dissolved and emulsified pollutants from water.

During high flow conditions, a portion of the stormwater that exceeds the treatment capacity, in the upper chamber will overflow the weir and be conveyed to the outlet sewer directly (See Figure 3). Water that overflows the weir decreases the head differential between the inlet and outlet pipe whereby ensuring that excessive high flows and velocities will not be forced into the lower chamber, which could scour or re-suspend the settled material. The high flow internal bypass is an integral part of the Stormceptor®.

Installation

The installation of the Stormceptor® System should conform in general to state and local specifications. Top soil that is removed during the excavation for the Stormceptor® unit should be stockpiled in designated areas and should not be mixed with subsoil or other materials. Topsoil stockpiles and the general site preparation for the installation of the Stormceptor® unit should conform to local specifications.

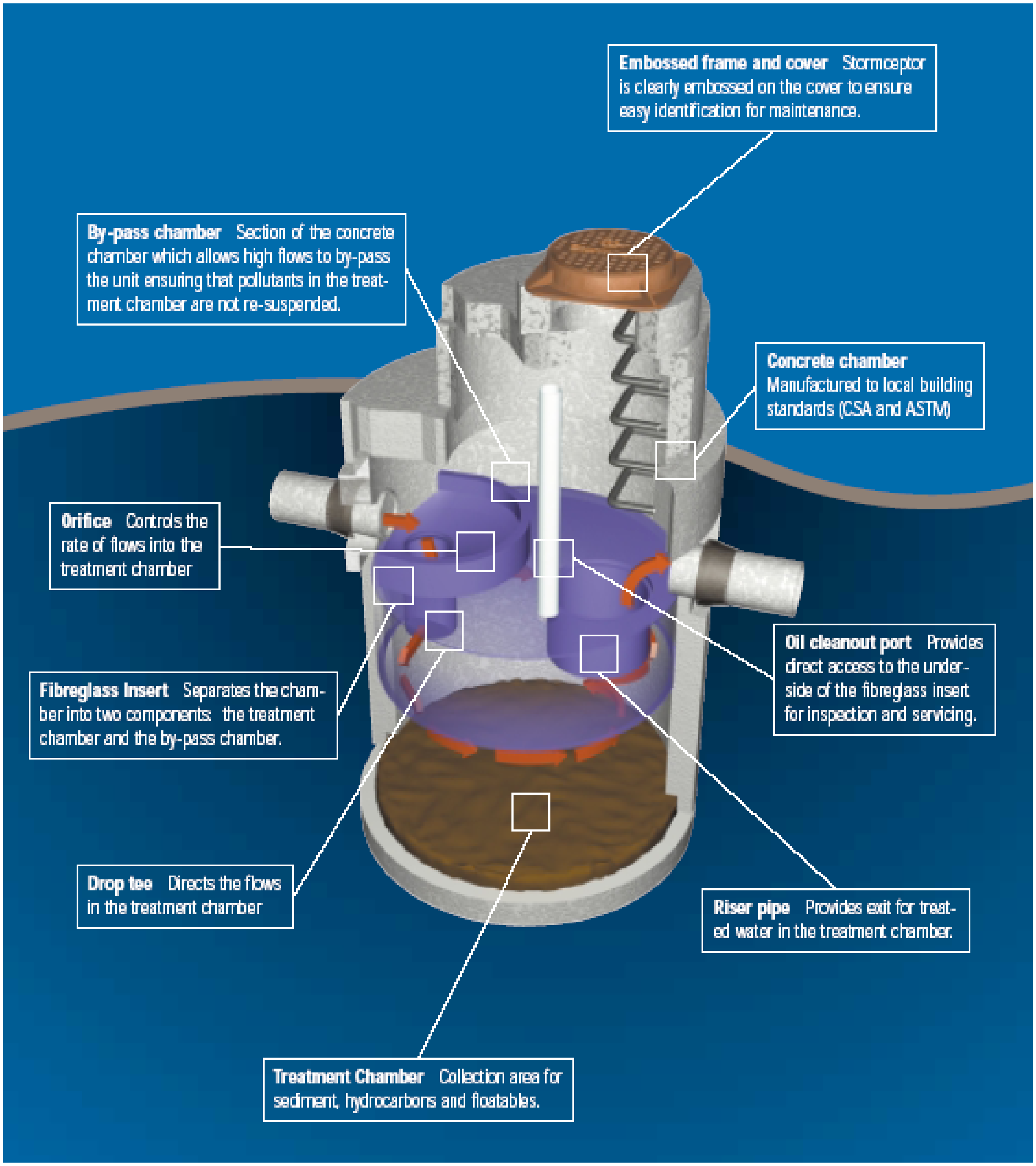

Figure 1. Stormceptor® System Components

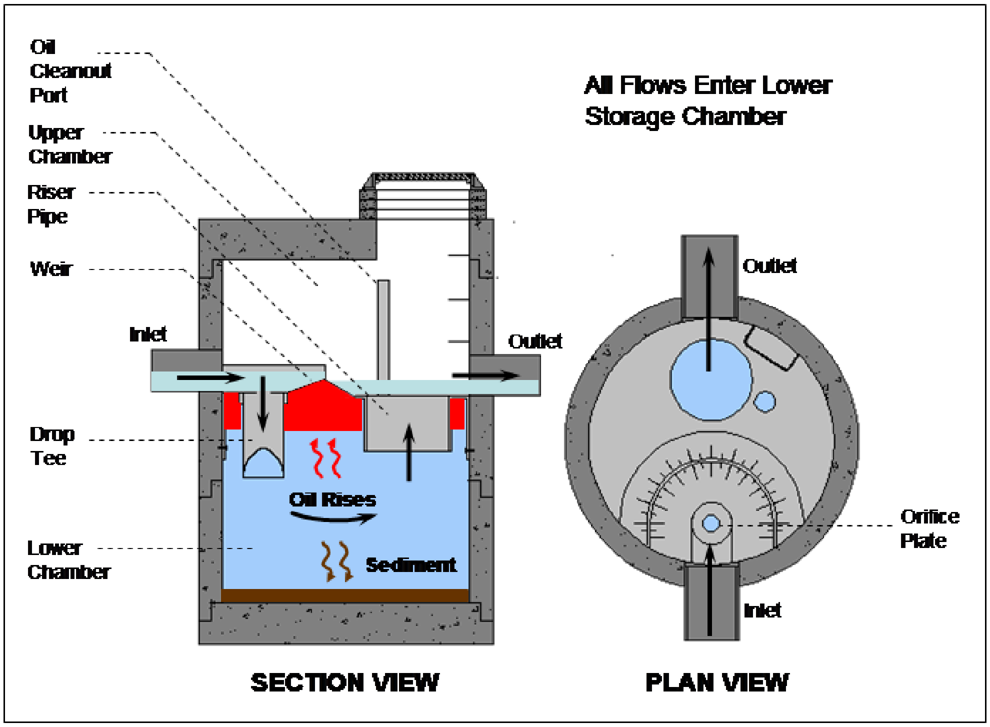

Figure 2. Stormceptor® Operation during Average Flow Conditions

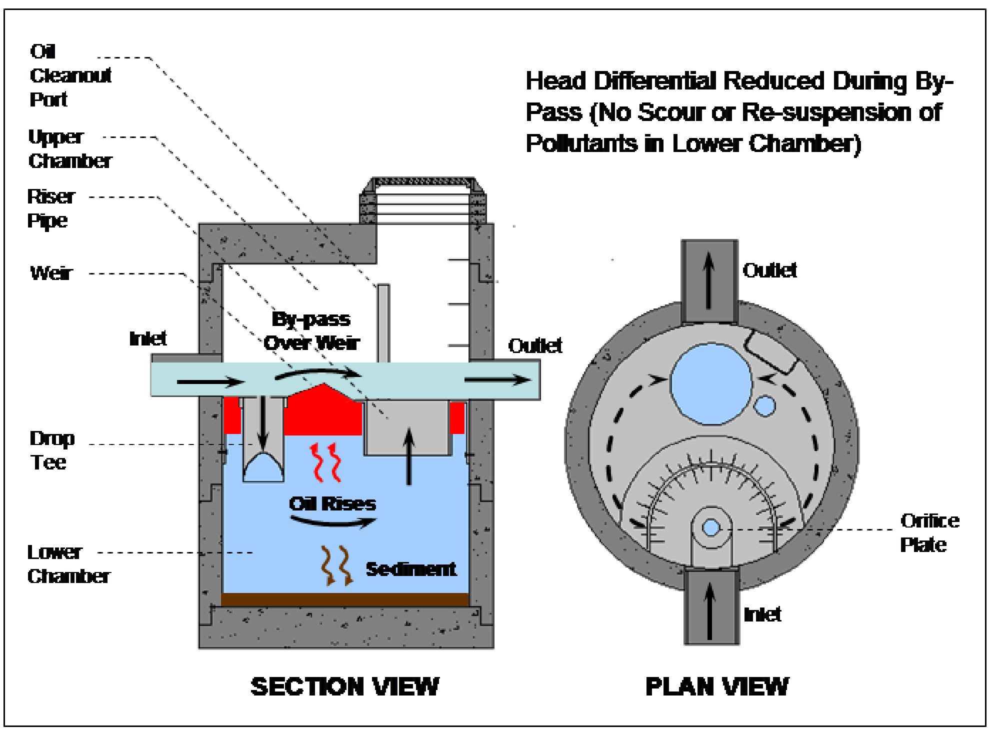

Figure 3. Stormceptor® Operation during High Flow Conditions

Stormceptor® units should not be installed on frozen ground. Excavation should extend a minimum of 12 inches from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required. Areas with a high water table may require continuous de-watering to ensure that the excavation is stable and free of water.

Backfilling
Backfill material should conform to provincial or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300 mm) in depth and compacted to local specifications.

Stormceptor® Construction Sequence
Rinker Materials™ provides a detailed site specific installation instruction at the time of order to the installer.

The instructions detail the stacking sequence of each precast component and identify the specific depths from the inlet pipe to the bottom of the base. Only the site specific installation instruction should be used for installation purposes. The concrete Stormceptor® unit is installed in sections in the following sequence:

1. aggregate base
2. base slab
3. lower chamber section
4. upper chamber section
5. assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate)
6. remainder of upper chamber
7. frame and access cover

The precast base should be placed level at the specified elevation. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with rubber gaskets, should be installed in accordance with Rinker Materials™ recommendations for precast concrete.

Adjustment of the Stormceptor® unit can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary.

The timing for installation of a Stormceptor® unit ranges from 2 to 6 hours, depending on the unit size and site conditions.

All Stormceptor® units are manufactured according to ASTM C-478 (Specification for Precast Reinforced Concrete Manhole Sections) and designed for an AASHTO HS-20 live load (units can be designed to meet other live loads, for example Aircraft loading).

All Stormceptor® units utilize a rubber gasket to form a watertight seal at all the joints. The joint is designed according to ASTM C-443 (Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets) and takes into consideration gasket deformation and fully out-of-round and off-centered product.

All Stormceptor® units have been checked for buoyancy based on the combination of the following design assumptions:

A. The elevation of the water table is at the finished grade.
B. A total depth of 8.0 feet (2.44 m) is assumed from the inlet invert elevation to the finished grade elevation.
C. The lower chamber is empty.

4. Technical Performance Claim

Claim: The Stormceptor® System Model STC 900 provides 75% "Bulk TSS" removal efficiency (as per NJDEP treatment efficiency calculation methodology) for laboratory simulated stormwater runoff with an average influent concentration of 295 mg/L and an average d_{50} particle size of 97 microns. TSS removal testing was conducted with sediment pre-loaded in the lower chamber to 50% sediment capacity for the STC 900.

5. Technical System Performance

The Stormceptor® System STC 900 has been tested in a full-scale hydraulic laboratory. The laboratory tests were completed for NJDEP recommended PSD with gradations ranging from 1 to 1,000 microns. Tests were performed with TSS influent concentrations ranging from 100 to 300 mg/L at various increments of the operating rate (i.e., 25%, 50%, 75%, 100%, and 125%). The operating rate of the STC 900 is 0.63 cubic feet per second (cfs) or 283 gallons per minute (gpm) or 18 litres per second. In addition to specific testing, Stormceptor® has developed the Stormceptor® Sizing Model that estimates long term TSS removal efficiencies based on site information, local precipitation patterns and laboratory performance data. The Stormceptor® System has been tested extensively in the field by Stormceptor® staff as well as independent researchers (Applied Hydrology Associates, 2003; Associated Earth Sciences, Inc., 2001; Pollutech Environmental Limited, 2001; Waschbusch, 1999; Winkler, 1997)

5.1 Laboratory Studies

Stormceptor® Corporation conducted laboratory testing to evaluate the TSS removal efficiency of the STC 900 systems under the NJDEP TSS protocol. This section provides details of the laboratory system setup, particulars on the initial sediment loading in the lower chamber and the procedures followed in the test.

System Description

A schematic of the laboratory layout is illustrated in Figure 4. All the tanks are filled with water prior to system startup. While the lower chamber of the Stormceptor® unit is full of water (and 50% of recommended sediment capacity before recommended servicing), the Stand Pipe, Plunge Pool and Storage Tank (all of which are open tanks) are filled with water to the invert of the inlet or outlet pipes. A ball valve located between the pump and stand pipe is adjusted to achieve the desired flow rate for the system. Approximately 10 ft or 3m upstream of the Stormceptor® unit, an area velocity flow logger is installed to measure the depth of flow, velocity and flow rate of the influent water.

Water is pumped to the stand pipe and overflows into the plunge pool, where partial pipe flow similar to what is observed in gravity sewers begins to occur. Water exits the plunge pool (a cylindrical tank) through a 15 in. (381 mm) internal diameter PVC pipe directed to the Storm*ceptor*® unit.

A slurry mixture, contained in a 65 gallon cone-bottom tank (0.25 m^3), is introduced to the partial pipe flow near the plunge pool exit pipe via a peristaltic pump. Sediment in the batch slurry mixture is kept in suspension using a mixer and a diaphragm pump. The diaphragm pump draws from the bottom of the cone bottom tank and pumps the slurry back into the top and side of the slurry tank. Turbulent flow within a portion of this 15.8 ft (4.8 m) long pipe provides mixing of the slurry/water mixture prior to entering the Stormceptor® unit.

The semi-circular weir on the Stormceptor® insert directs the flow to the lower chamber through an orifice plate and drop tee arrangement. The semi-circular weir and orifice plate restrict the quantity of flow entering the lower chamber up to the operating rate. The drop tee channels the flow around the inside circumference of the lower chamber. The head differential between the inlet and outlet of the unit allows water to exit the bottom chamber through a riser pipe. Automatic samplers are placed at the inlet and outlet pipes of the Stormceptor® unit to collect influent and effluent samples, respectively. Water exiting the STC 900 is channeled via a 42.5 in. (1080 mm) diameter half pipe, modified with a circular insert designed to simulate a 15 in. (375 mm) outlet pipe. This pipe feeds effluent into the storage tank. A 10 ft (3 m) diameter, 1-µm filter bag covers the storage tank and functions to filter out sediment that may be in the effluent prior to re-circulating back into the system from the storage tank.

Initial Sediment in STC 900

The total sediment capacity of the STC 900, which is based on the depth when servicing or maintenance of the unit is recommended, is determined by calculating 15% of the total depth of the lower chamber. For the STC 900, the actual total depth of the lower chamber is 5 ft 6” (1.7 m). At 15% of the total depth, the depth is approximately 10 in. (244 mm). As such, the depth of 10 in. (244 mm) is referred to as “100% sediment capacity” of the unit (See Figure 5). At 50% sediment capacity (See Figure 6), the depth of sediment in the lower chamber is approximately 5 in. (122 mm).

All the TSS tests and one scour test were conducted with the lower chamber of the STC 900 initially loaded with 50% of the sediment capacity. For the second scour test, the treatment chamber was filled to 100% of the sediment capacity (the recommended depth before servicing). Both scour tests were conducted at an operating rate of 125%.

While the NJDEP did not specify the particle gradation required in the lower chamber prior to testing, the same particle gradation required for the influent PSD was assumed for initial sediment loading. As a result, the sediment placed in the lower chamber consisted of 50% SIL-CO-SIL® 250 and 50% Mason Sand.

The actual sediment in the bottom of the chamber was measured by finding the distance from the top of the tank to the top of the sediment pile and subtracting it from the total height of the tank. The volume of sediment was then calculated using the average sediment depth determined and the diameter of the tank.

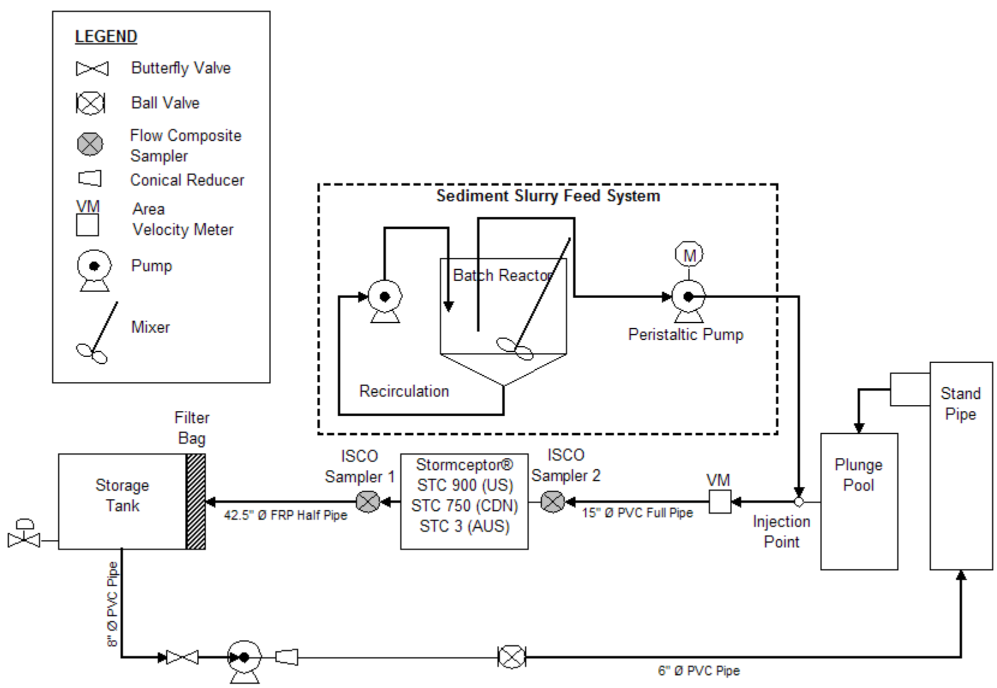

Figure 4. Process Flow Diagram of Laboratory Configuration

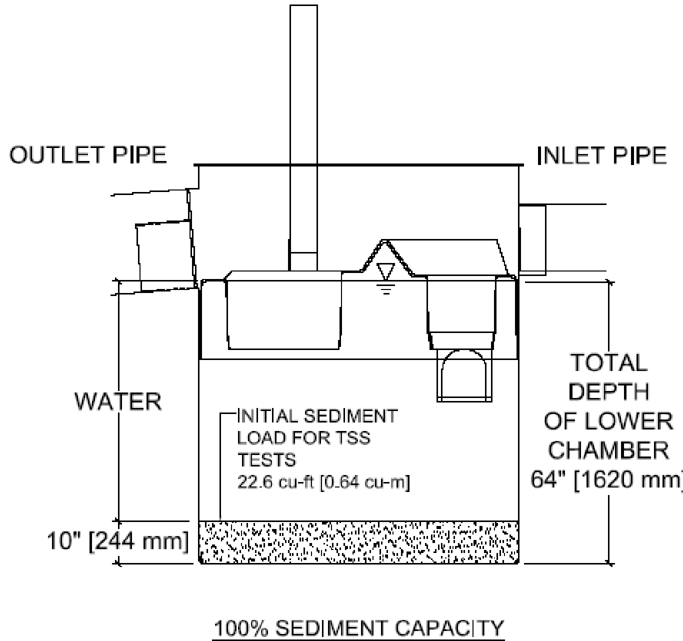

Figure 5. Theoretical Initial Sediment Depth of 100% in the Lower Chamber

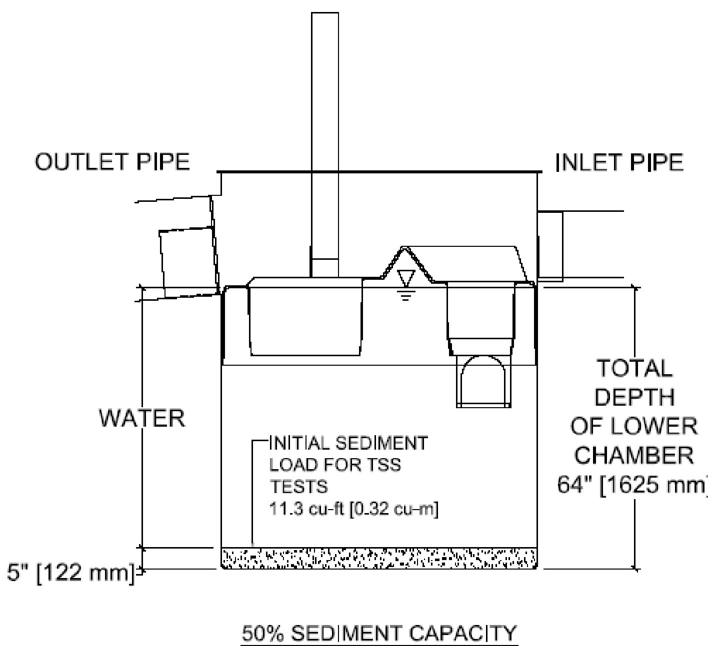

Figure 6. Theoretical Initial Sediment Depth of 50% in the Lower Chamber

Procedure

The test procedure followed in this test was approved by NJCAT and by the NJDEP. The test procedure was written in accordance to the NJDEP Protocol. During the test preparation, the protocol was updated to reflect the change in the number of samples to be collected. The main test methodology remained the same. The protocol followed for the testing can be found in the Stormceptor® TSS removal laboratory testing protocol dated April 12, 2004 as discussed below.

Note that the only deviation from the Stormceptor® protocol occurred at the 25% operating rate where one additional field blank was taken at the end of the run for a total of four field blanks. This was taken to ensure that there was no additional background loading due to recirculation of water through the Stormceptor® unit. One blank is allocated for internal laboratory analysis and the remainder is for external laboratory testing.

Quality Control Summary

The following is a summary of quality control measures followed:

Field Blanks	Background concentrations were measured by collecting three field blanks in the influent pipe prior to sediment injection for external laboratory analysis. The measured field blanks represented TSS concentrations already existing in the water due to recirculation. Grab samples were taken at the inlet pipe of the STC 900.
Initial Setup Condition	To prevent sample contamination from previous runs, a clean system must exist prior to the start of each run. To ensure each run started with a clean system, the inlet/outlet pipes and the surfaces of the insert were sprayed down to remove any material from the previous test run.
Sediment Source	Sil-Co-Sil® 250 and Mason sand (supplied by Lafarge Canada, Inc.) were used for the experiment. Sediment from each source was not sieved prior to use. The particle size distribution for the Sil-Co-Sil® 250 ranges from 0.1 µm to 212 µm (note that the 0.1 µm is based on measured samples completed by Maxxam Analytics, Inc. obtained from the test runs). The particle size distribution for the Mason sand ranges from 75 µm to 2,360 µm.
Sediment Slurry Mix	Through systematic testing, it was determined that a 40/60 ratio of Sil-Co-Sil® 250/Mason Sand mix would provide a particle size distribution representative of that prescribed in the NJDEP Protocol, when the peristaltic pump operates at a constant speed of 1.59 US gallons per minute (gpm) or 6.0 litres per minute for all runs. To ensure that the PSD was within range of the target NJDEP PSD, sediment slurry from each run was taken for external laboratory analysis to verify the quality of the run. The PSD from the inlet and outlet automatic samplers were also analyzed to better determine what was happening during each run. The sediment slurry was mixed in a 65 gal. cylindrical (0.25 m^3)cone-bottom tank with a 0.5 horsepower (hp) mixer. Slurry was drawn from the bottom of the tank via a 42 gpm (150 L/s) capacity diaphragm pump (operated at 25 pounds per square inch or 172 kilo Pascals) and re-circulated back into the top of the slurry tank directed to the inside wall. Prior to sediment injection to the system, sediment slurry samples were collected for external TSS and PSD analysis. At the end of the run, another slurry sample was taken to verify the slurry concentration through TSS analysis.

Sediment Metering	Sediment slurry was drawn from the bottom third of the slurry tank via a flexible hose from a peristaltic pump. The peristaltic pump discharged at a rate of 1.59 gpm (6 L/min). A flexible hose was anchored by a stainless steel rod inside the slurry tank to restrict movement and to maintain a consistent depth in the tank. The other end of the flexible tube was placed into the top of the inlet pipe located approximately 3 ft (0.91 m) away from the plunge pool. The peristaltic pump was calibrated using a graduated cylinder and stop watch.
Gravity Flow in Storm Sewer Conditions	To best simulate field conditions, the laboratory testing system is set-up to represent uniform normal flow conditions under the action of gravity in storm sewers. Water is pumped from the storage tank to the stand pipe via pressure flow using a 7.5 hp Armstrong Series 4380 pump through 6 in. (150 mm) diameter PVC pipe. Water is then directed into a stand pipe that is open to the atmosphere. Water overflows the stand pipe into a plunge pool that acts similar to a maintenance hole, and diverts water into the influent pipe simulating normal flow conditions that exist within pipe line systems in the field. Water then flows into the Stormceptor® unit via a 14.8 ft (4.5 m) long, 15 in. (375 mm) I.D. PVC inlet pipe, partially full under the action of gravity in accordance with empirical formulas such as Manning's Equation or Colebrook White.
Flow Calibration, Regulation and Measurement	Calibration of flows is achieved by measuring the depth of flow upstream of the area velocity probe and comparing it to the area velocity flow logger depth readings. Flow Link 4® is the ISCO software used to display the readings from the low profile velocity meter. The area velocity flow logger is set to display measurements for flow at increments of 5 seconds. For the purpose of ensuring that flow readings are consistent, depth of flow, velocity and flow rates are recorded with each sample bottle that is taken. A ball valve located between the centrifugal pump and stand pipe is used to regulate the flow rate for the system. The ball valve is open or closed until the target flow rate is reached. Once the target flow rate is achieved, the system is left to run for a minimum of 5 minutes to ensure that the flow rates have stabilized.
Sample Collection	Influent and effluent samples are collected using automatic samplers (ISCO). The automatic samplers are pre-programmed to collect 500 mL water samples every minute for a total of 12 samples per automatic sampler at the end of each individual test run. The samplers are pre-programmed to purge the tubing before and after each sample is drawn to prevent contamination. Sampling from the effluent automatic sampler is initiated once the detention time for the unit is reached. The detention time is a function of the operating rate and varies depending on the operating rate of the individual test runs. At the end of the run, 10 samples from each automatic sampler were emptied into clean 500 mL plastic sample bottles provided by the external analytical laboratory for TSS analysis. While one out of the ten samples was dedicated for internal laboratory analysis, the remaining 9 samples were sent out to an external laboratory for TSS analysis. The final two 500 mL samples were combined in a 1 L container for particle size distribution analysis. To ensure that all solid particles are properly transferred to the new labeled jars, the sample bottles are vigorously agitated to ensure suspension of particles. This step may be repeated if, through visual observation, sediment is still adhered to the transfer bottles. All samples are carefully labeled and placed in a cooler prior to shipping to an external laboratory for analysis.

Sample Handling and Transport	Samples are stored in a cooler maintained at a temperature of 39 degree Fahrenheit (^oF). A chain of custody is completed to document travel designation, receipt time, sample numbers and IDs submitted and type of analysis to be performed for each respective sample. All chain of custodies were signed by the receiving personnel to verify receipt.
Independent Laboratory Analysis	TSS analysis was performed by an external laboratory (AMEC Earth & Environmental Limited (AMEC), accredited by the Ontario Ministry of the Environment). APHA method 2540D (modified) was used, where the whole sample was analyzed. PSD analysis of the slurry, influent and effluent samples was performed by an external laboratory (Maxxam Analytics Inc., accredited by the Ontario Ministry of the Environment). Due to the nature of PSD analysis, the samples were sent out by Maxxam Analytics Inc. to their laboratory in Alberta. The instrument used to perform PSD analysis on the sediment/water samples was a Malvern Mastersizer 2000. It is used to measure particles in an aqueous suspension by diffracting a laser beam.

TSS vs. SSC

In the preparation of the protocol for this study, the Stormceptor® Corporation reviewed laboratory tests for the determination of the total suspended solids concentration of the water samples to determine the most appropriate testing methodology. There are currently two recognized types of tests being used in the stormwater industry including:

1) APHA Method 2540 D, a traditional TSS test, where only a sub-sample of the overall sample for suspended solids content is tested; and
2) ASTM D 3977-97 (Re-approved 2002), “Suspended-Sediment Concentration (SSC)” test where the entire sample volume is tested.

The APHA Method 2540 D TSS protocol requires that a 500 mL sample be agitated to homogenize the slurry. A 50 mL sub-sample is then drawn and filtered to find the “total suspended sediment” concentration. In the case of analysis of sediment and water, maintaining a homogeneous mixture is difficult to achieve as particle dispersion is dependent on particle size and weight. As a result, extraction of a representative sample is unlikely to be achieved.

Conversely, the SSC method uses the entire sample submitted to the laboratory for testing. By analyzing the entire sample, potential for error from agitation and sub-sample extraction is eliminated.

Storm*ceptor*® regards the SSC or “Bulk TSS” method as a more accurate indicator of the actual concentration of suspended solids of a given sample since the entire sample is used for analysis. These methods eliminate multiplying errors that can result from taking sub-samples; therefore, “Bulk TSS” analysis is the preferred method for suspended solids measurement.

For the purpose of the Storm*ceptor*® testing program, a local laboratory that was familiar with the ASTM D 3977-97 (Re-approved 2002) could not be sourced. As an alternative, a government licensed laboratory that could provide a "modified" TSS test as per APHA Method 2540 D procedures was selected. This modified APHA Method 2540 D was termed as "Bulk TSS" test and analyzes TSS using the entire sample volume submitted.

It is important to note that the NJDEP TSS removal criterion for stormwater management systems is based upon TSS, not SSC or "Bulk TSS". Through the definition of their draft TSS laboratory testing procedure, NJDEP has defined a particle size distribution that ranges from 1 to 1,000 microns, therefore defining TSS as particles smaller than 1,000 microns. Since the Stormceptor® Corporation used the NJDEP recommended particle size distribution in their laboratory experiments, an argument can be made that the use of SSC or "Bulk TSS" would be appropriate for determining a system removal efficiency for TSS, since only TSS (as defined by NJDEP) were present in the experiment. If the particle size distribution used in the experiments contain particles greater in size than 1,000 microns, these larger particles would have resulted in higher influent SSC concentrations, translating into higher removal efficiencies. Although precautions should be taken in conducting field verification studies where the influent to the system may contain particles larger than 1,000 microns, the Stormceptor® approach yields a good representation of the removal efficiency of the STC 900 system.

5.2 Verification Procedures

All the data provided to NJCAT were reviewed to fully understand the capabilities of the Stormceptor® System. To verify the Stormceptor® claim, the Stormceptor® laboratory data were reviewed and compared to the draft NJDEP TSS laboratory testing procedure.

Claim: The Stormceptor® System Model STC 900 provides 75% "Bulk TSS" removal efficiency (as per NJDEP treatment efficiency calculation methodology) for laboratory simulated stormwater runoff with an average influent concentration of 295 mg/L and an average d_{50} particle size of 97 microns. TSS removal testing was conducted with sediment pre-loaded in the lower chamber to 50% sediment capacity for the STC 900.

5.2.1 NJDEP Recommended TSS Laboratory Testing Procedure

The NJDEP has prepared a draft TSS laboratory testing procedure to help guide vendors as they prepare to test their stormwater treatment systems prior to applying for NJCAT verification. The testing procedure has three components:

1. Particle size distribution
2. Full scale laboratory testing requirements
3. Measuring treatment efficiency

1. <u>Particle size distribution:</u>

The following particle size distribution will be utilized to evaluate a manufactured treatment system (See Table 2) using a natural/commercial soil representing United States Department of Agriculture (USDA) definition of a sandy loam material. This hypothetical distribution was selected as it represents the various particles that would be associated with typical stormwater runoff from a post construction site.

2. Full Scale lab test requirements
    A. At a minimum, complete a total of 15 test runs including three (3) tests each at a constant flow rate of 25, 50, 75, 100, and 125 percent of the treatment flow rate. These tests should be operated with initial sediment loading of 50% of the unit's capture capacity.
    B. The three tests for each treatment flow rate will be conducted for influent concentrations of 100, 200, and 300 mg/L.
    C. For an online system, complete two tests at the maximum hydraulic operating rate. Utilizing clean water, the tests will be operated with initial sediment loading at 50% and 100% of the unit's capture capacity. These tests will be utilized to check the potential for TSS re-suspension and washout.
    D. The test runs should be conducted at a temperature between 73-79 degrees Fahrenheit (°F) or colder.

3. Measuring treatment efficiency
    A. Calculate the individual removal efficiency for the 15 test runs.
    B. Average the three test runs for each operating rate.
    C. The average percent removal efficiency will then be multiplied by a specified weight factor (See Table 5) for that particular operating rate.
    D. The results of the 5 numbers will then be summed to obtain the theoretical annual TSS load removal efficiency of the system.

Table 2. Particle Size Distribution

Particle Size (microns)	Sandy loam (percent by mass)
500-1,000 (coarse sand)	5.0
250-500 (medium sand)	5.0
100-250 (fine sand)	30.0
50-100 (very fine sand)	15.0
2-50 (silt)	(8-50 µm, 25%) (2-8 µm, 15%)*
1-2 (clay)	5.0

Notes:
1. Recommended density of particles ≤2.65 g/cm3

*The 8 µm diameter is the boundary between very fine silt and fine silt according to the definition of American Geophysical Union. The reference for this division/classification is: Lane, E. W., et al. (1947). "Report of the Subcommittee on Sediment Terminology," Transactions of the American Geophysical Union, Vol. 28, No. 6, pp. 936-938.

Table 3. Weight Factors for different Treatment Operating Rates

Treatment operating rate	Weight factor
25%	.25
50%	.30
75%	.20
100%	.15
125%	.10

Notes:
Weight factors were based upon the average annual distribution of runoff volumes in New Jersey and the assumed similarity with the distribution of runoff peaks. This runoff volume distribution was based upon accepted computation methods for small storm hydrology and a statistical analysis of 52 years of daily rainfall data at 92 rainfall gages.

5.2.2 Laboratory Testing

The results of the laboratory testing that were performed by the Stormceptor® Group are presented in Table 4. Testing was performed for three influent TSS target concentrations of 100, 200 and 300 mg/L. These tests were performed at various increments of the operating rate (i.e., 25%, 50%, 75%, 100%, and 125%). The NJDEP weighting factors were applied to the test results to generate weighted average removal efficiency. Based upon the data presented in Table 4, the removal efficiency of the system is 75%, thereby verifying the Stormceptor® Claim.

To confirm these results, a mass balance was completed. Results of the mass balance and NJDEP weight factors are listed in Tables 5 and 6.

The influent mass was determined by first calculating the average slurry concentration (in mg/L), which was measured at the beginning and at the end of the run, and multiplying it by the injection rate (in L/min) to determine the mass flow rate (in mg/min). This mass flow rate was then multiplied by the duration (in min.) that the slurry was being injected. The average of the initial slurry sample (SL1) and final slurry sample (SL4) was used to estimate the average suspended solids concentration injected during the course of the run.

In between test runs, the slurry tank was cleaned and refilled with water and new sediment. During the cleaning process, the remaining sediment in the slurry tank was not measured. In hindsight, the remaining sediment in the slurry tank should have been measured to help verify the mass of sediment injected. As a result, the average of the two slurry concentrations (SL1 and SL4) was used to estimate the total amount of sediment injected.

The effluent mass was determined by measuring the dry mass of the sediment in the filter bags. Filter bags were numbered, for identification purposes, and the dry weight recorded prior to use. After every test, the filter bag was removed from the outlet storage tank and left to dry at room temperature. Once the filter bag was dried, it was weighed and the mass of dry sediment was determined after allowing for the initial mass of the filter bag.

There were some problems with determining the mass balance due to the inability to completely dry the sampling bags and the high variability of slurry TSS concentration as measured at the beginning and the end of the experiment. At times, the slurry TSS concentration as measured at the end of the experiment was 50% of the concentration measured at the beginning of the experiment. Even though there are some questions to the accuracy of the mass balance calculation, the results do support the results from the calculated efficiency based upon samples collected by the automatic sampler of the influent and effluent (See Table 4).

During the laboratory experiments, Stormceptor® measured the particle size distribution of the slurry mix and the influent taken by the automatic sampler. The average d_{50} of the slurry mix was measured to be 47 microns while the average d_{50} of the influent was measured to be 97 microns. Stormceptor® suggests that this difference in average d_{50} particle size results from the inlet automatic sampler and sediment slurry samples taken at the beginning of the run may be due to the automatic samplers extracting a greater proportion of coarser material than what is actually present within the flow. It is postulated that the coarser material, being heavier, may have a tendency to travel closer to the bottom of the pipe due to their weight and size, despite the turbulent flow that exists in the inlet pipe. Data have not been presented by Stormceptor® to validate this hypothesis. The average d_{50} of the NJDEP particle size distribution is approximately 67 microns, slightly lower than the average d_{50} measured at the inlet during the Stormceptor® laboratory experiments. Additional analyses may be needed to determine if the hypothesis put forth by Stormceptor® (i.e., that the automatic sampler did not collect a truly representative sample due to coarser material travel near the bottom of the inlet pipe) is valid.

Table 4. Summary of Automatic Sampler TSS Concentrations and Removal Efficiencies

Operating Rate	Influent Target: 100 mg/L			Influent Target: 200 mg/L			Influent Target: 300 mg/L			Overall Ave. Removal Efficiency %	NJCAT Weight Factor	NJCAT Weighted Ave. Removal Efficiency %
	Ave. Inlet Conc. mg/L	Ave. Outlet Conc. mg/L	Ave. Removal Efficiency %	Ave. Inlet Conc. mg/L	Ave. Outlet Conc. mg/L	Ave. Removal Efficiency %	Ave. Inlet Conc. mg/L	Ave. Outlet Conc. mg/L	Ave. Removal Efficiency %			
25%	203	25	88%	355	50	86%	599	79	87%	87%	0.25	22%
50%	129	34	74%	218	68	69%	416	106	75%	72%	0.30	22%
75%	147	42	71%	266	85	68%	381	135	65%	68%	0.20	14%
100%	187	31	83%	303	90	70%	425	148	65%	73%	0.15	11%
125%	98	16	84%	223	114	49%	486	108	78%	70%	0.10	7%
Overall Ave.	153	30	80%	273	82	68%	461	115	74%			**75%**

Table 5. Mass Balance Results

Operating Rate	Mass In lbs (kg)	Mass Out Lbs (kg)	Mass Balance Performance (%)
25%	6.26 (2.84)	1.59 (0.72)	75%
50%	18.82 (8.54)	4.63 (2.10)	75%
75%	22.36 (10.14)	6.61 (3.00)	70%
100%	24.425 (11.08)	8.95 (4.06)	63%
125%	42.907 (19.46)	11.95 (5.42)	72%

Table 6. NJDEP Weighted Mass Balance Performance

Treatment Operating Rate	NJDEP Weight Factor	Average % Removal: Mass Balance	NJCAT Weighted Avg. Removal:
25%	0.25	75%	18.8%
50%	0.30	75%	22.5%
75%	0.20	70%	14.0%
100%	0.15	63%	9.5%
125%	0.10	72%	7.2%
Total			72%

5.2.3 Field Studies

Based upon the earlier Stormceptor® submittal of field testing, several of the data points were represented of reasonable influent TSS concentration and reasonable flow rates. The Como Park study (Rinker Materials, 2002) met these conditions on two days: August 7, 1998 and August 27, 1998. The influent TSS concentrations were 318 and 196 mg/l, respectively and the peak flow rate was approximately 68% of the operating rate. The TSS removals for these events were 81.4 and 70.4, respectively. The only other relevant data point was collected during the Greenwood Village study (Applied Hydrology Associates, 2003) on August 6, 2002 where influent TSS concentration was 122 mg/l and the peak flow was 23% of the operating rate. This system achieved a 77% TSS removal rate.

These field data generally support the removal efficiency that was measured in the laboratory experiment.

5.2.4 Scour Test

The Stormceptor® unit was tested to check the potential for TSS re-suspension. The scour test was performed at 125% of the operating rate and with initial sediment loading of 50% and 100% in the lower chamber of the Stormceptor® unit. Attempt was made to eliminate or reduce the background concentration in the recirculating water by draining and cleaning the storage reservoir, plunge pool and stand pipe, and replacing it with "clean water". In doing so, an average background concentration of 59 mg/L and 21 mg/L was observed for the 50% and 100% initial sediment loaded scour test, respectively. This is expected as some fine particles cannot be filtered out by the 1 µm filter bag and therefore recirculates through the system.

Table 7 summarizes the results from the scour tests performed at 125% of the operating rate. The adjusted outlet TSS concentration was -3 mg/L when the lower chamber contained 50% of its sediment capacity; thus, indicating that no scouring occurs when the unit is 50% full of sediment. It also confirms that some removal is still achieved at 125% of the operating rate.

Minimal TSS concentration in the outlet was observed in the 100% sediment capacity scour test, where the average outlet concentration was 3.3 mg/L. While this suggests that slight re-suspension of material can occur when the unit is at maximum sediment capacity, it also confirms that maintenance is important when the sediment capacity is reached.

The Stormceptor testing protocol for scouring was approved by NJDEP and NJCAT prior to testing. Based upon the data generated under this protocol, the scour test suggests that the system does not resuspend particles that have already been collected.

Table 7. Scour Test TSS Results

Scour Test at 125% Operating Rate			
Sediment Capacity in Storm*ceptor*® Unit	**Average Inlet Concentration**	**Average Outlet Concentration**	**Adjusted Outlet Concentration**
50%	59 mg/L	56 mg/L	-3 mg/L
100%	21 mg/L	25 mg/L	3.3 mg/L

5.3 Inspection and Maintenance

The Stormceptor® System requires minimal routine maintenance. However, it is important that the system be inspected at regular intervals and cleaned when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more on site activities than the size of the unit (i.e., heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping will slow accumulation).

5.3.1 Inspection

The Stormceptor® unit should be inspected at least once every six months using a dipstick or a similar device to measure the sediment depth and oil level contained in the lower chamber of the unit. Once the sediment depth reaches the recommended levels as indicated by the Stormceptor® model numbers presented in Table 8, the units should be serviced. If any large presence of oil is measured, the oil should be removed and properly disposed. It should be noted that maintenance frequency can vary with site conditions and therefore it is recommended that frequency of maintenance be increased or reduced based on local site conditions.

The depth of oil in the Stormceptor® unit can be determined by inserting a dipstick in the:

- 150 mm (6 in.) oil inspection /cleanout pipe ("disc" design");
- 914 mm (36 in.) central access way ("spool" design); or
- 100 mm (4 in.) cleanout pipe ("Inlet" design).

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor® via a dipstick tube equipped with a ball valve (sludge judge). This tube would be inserted in the:

- central opening ("spool" design);
- 610 mm (24 in.) opening ("disc" design); or
- 100 mm (4 in.) cleanout pipe ("inlet" design).

Stormceptor® maintenance is performed as follows:

- "spool" design: through the large central 914 mm (36 in.) diameter opening for both the oil and sediment.
- "disc" design: oil is removed through the 150 mm (6 in.) oil inspection/cleanout pipe and sediment is removed through the 610 mm (24 in.) diameter outlet riser pipe. Alternatively, oil could be removed from the 610 mm (24 in.) opening if water is removed from the lower chamber to lower the oil level to the level of the drop pipes.
- "inlet" design: oil is removed from the 100 mm (4 in.) oil/inspection cleanout pipe and sediment is removed though the 305 mm (12 in.) inlet drop pipe.

5.3.2 Maintenance

Once the sediment depth has reached the recommended depth for maintenance, the Stormceptor® unit should be serviced. A vacuum truck company licensed for solid waste disposal should be contracted to clean out the unit. Without any inspection, as a rule of thumb, the Stormceptor® unit should be serviced a minimum of once per year.

The oil should be removed first and contained separately from any water or sediment removed from the system. Oil is removed by pumping or skimming the top of the water through the oil cleanout port. Once the oil is removed, the water and sediment may be removed from the unit through the riser pipe. Where available, a secondary containment tank may be used to hold the water until the sediment is removed from the Stormceptor® unit. Once the sediment is removed, the water may be introduced back into the lower chamber of the Stormceptor® unit. Any petroleum waste products collected in a Stormceptor® due to oil, chemical or fuel spills should be removed by a licensed waste management company.

Table 8. Sediment Depths Indicating Requirement for Servicing

Model	**Sediment Depth (mm)**
STC 450	200 (8 in.)
STC 900	200 (8 in.)
STC 1200	250 (10 in.)
STC 1800	375 (15 in.)
STC 2400	300 (12 in.)
STC 3600	425 (17 in.)
STC 4800	375 (15 in.)
STC 6000	450 (18 in.)
STC 7200	375 (15 in.)
STC 11000**s**	375 (15 in.)
STC 13000**s**	450 (18 in.)
STC 16000**s**	375 (15 in.)

5.3.3 Solids Disposal

Solids recovered from the Stormceptor® System can typically be land filled or disposed of at a waste water treatment plant.

5.3.4 Damage Due to Lack of Maintenance

It is unlikely that the Stormceptor® System will become damaged due to lack of maintenance since there are no fragile internal parts. However, adhering to a regular maintenance plan ensures optimal performance of the system.

6. Technical Evaluation Analysis

6.1 Verification of Performance Claims

Based on the evaluation of the results from laboratory studies, sufficient data is available to support the Stormceptor® Claim: The Stormceptor® System Model STC 900 provides 75% "Bulk TSS" removal efficiency (as per NJDEP treatment efficiency calculation methodology) for laboratory simulated stormwater runoff with an average influent concentration of 295 mg/L and an average d_{50} particle size of 97 microns. TSS removal testing was conducted with sediment pre-loaded in the lower chamber to 50% sediment capacity for the STC 900.

6.2 Limitations

6.2.1 Factors Causing Under-Performance

If the Stormceptor® System is designed and installed correctly, there is minimal possibility of failure. There are no moving parts to bind or break, nor are there parts that are particularly susceptible to wear or corrosion. Lack of maintenance may cause the system to operate at a reduced efficiency, and it is possible that eventually the system will become totally filled with sediment.

6.2.2 Pollutant Transformation and Release

The Stormceptor® System will not increase the net pollutant load to the downstream environment. However, pollutants may be transformed within the unit. For example, organic matter may decompose and release nitrogen in the form of nitrogen gas or nitrate. These processes are similar to those in wetlands but probably occur at slower rates in the Stormceptor® System due to the absence of light and mixing by wind, thermal inputs and biological activity. Accumulated sediment should not be lost from the system at or under the design flow rate.

6.2.3 Sensitivity to Heavy Sediment Loading

Heavy loads of sediment will increase the needed maintenance frequency.

6.2.4 Mosquitoes

Although the Stormceptor® System is a self contained unit, the design does incorporate standing water in the lower chamber, which can be a breeding site for mosquitoes. Although no information has been presented by Stormceptor® in their submittal to NJCAT to address this concern, a flap valve can be installed at the terminal end of the outlet pipe to prevent mosquitoes from entering the unit from the downstream side.

7. Net Environmental Benefit

The NJDEP encourages the development of innovative environmental technologies (IET) and has established a performance partnership between their verification/certification process and NJCAT's third party independent technology verification program. The NJDEP, in the IET data and technology verification/certification process, will work with any company that can demonstrate a net beneficial effect (NBE) irrespective of the operational status, class or stage of an IET. The NBE is calculated as a mass balance of the IET in terms of its inputs of raw materials, water and energy use and its outputs of air emissions, wastewater discharges, and solid waste residues. Overall the IET should demonstrate a significant reduction of the impacts to the environment when compared to baseline conditions for the same or equivalent inputs and outputs.

Once Stormceptor® Systems have been verified and granted interim approval use within the State of New Jersey, the Stormceptor® Corporation will then proceed to install and monitor systems in the field for the purpose of achieving goals set by the Tier II Protocol and final certification. At that time a net environmental benefit evaluation will be completed. However, it should be noted that the Stormceptor® technology requires no input of raw material, has no moving parts, and therefore, uses no water or energy.

8. References

Applied Hydrology Associates, (2003). The Effects of Backwater on Stormceptor® Treatment Systems, Denver Colorado, dated September 2003.

Associated Earth Sciences, Inc., (2001). SeaTac Stormceptor® Performance Monitoring Report, SeaTac, Washington, Project No. KB98618A, dated April 23, 2001.

Patel, M., (2003). Draft Total Suspended Solids Laboratory Testing Procedures, dated December 23, 2003, New Jersey Department of Environmental Protection, Office of Innovative Technology and Market Development.

Patriquin, T., (2004) Letter to Rhea Weinberg Brekke, NJCAT, Performance Claim (Amendment No. 3) dated June 2, 2004.

Pollutech Environmental Limited, (2001). Performance Claim Evaluation of the Stormceptor® Group of Companies Stormceptor® System, Final Report for the Environmental Technology Verification Program, dated February 2001.

Rinker Materials, (2002). Stormceptor® Monitoring Study Como Park, St. Paul, Minnesota, dated February 2002.

Stormceptor® Corporation, (2003). Tier 1 Submission Verification Acceptance Report, dated August 2003, prepared for New Jersey Corporation for Advanced Technology.

Stormceptor® Corporation, (2003). Amendment to Performance Claim: Tier 1 Submission Verification Acceptance Report, dated December 2003, prepared for New Jersey Corporation for Advanced Technology.

Stormceptor® Group of Companies, (2004). Full Scale Laboratory Evaluation of Stormceptor® Model STC900 for Removal of TSS (Applying NJDEP PSD & Weight Factor) dated June 2004, prepared for New Jersey Corporation for Advanced Technology.

Waschbusch, R.J., (1999). Evaluation of the Effectiveness of an Urban Stormwater Treatment Unit in Madison, Wisconsin, 1996-7, United States Geological Survey (USGS) Water Resources Investigations Report 99-4195.

Winkler, E., (1997). Technology Assessment Report - Stormceptor® CRS New England Pipe, Center for Energy Efficiency and Renewable Energy, University of Massachusetts Amherst, dated December 1997.

Applied Hydrology Associates, Associated Earth Sciences, Inc., Pollutech Environmental Limited, Waschbusch, Winkler

NJCAT TECHNOLOGY VERIFICATION ADDENDUM REPORT

Stormceptor® STC

Imbrium Systems Corporation

June 2010

1. Introduction

NJCAT published a Technology Verification Report on the Stormceptor® STC hydrodynamic separator manufactured by the Stormceptor® Corporation (now Imbrium Systems Corporation) in September 2004. Since that time Imbrium Systems along with Rinker Materials™-Hydro Conduit, its New Jersey representative, has continued performance testing of the Stormceptor STC line. In 2008 Rinker Materials contracted with the Department of Environmental Engineering Sciences, University of Florida, Gainesville, FL 32611 for testing at the department's Stormwater Unit Operations and Processes (UOPs) Laboratory. In addition to particulate removal efficiency testing, scour tests were conducted to demonstrate the Stormceptor® STC's ability to retain captured sediment at flows greatly exceeding the water quality design flow.

In 2009 the New Jersey Department of Environmental Protection (NJDEP) published a laboratory protocol for testing manufactured hydrodynamic sedimentation devices (NJDEP 2009) that contained procedures to enable manufactured treatment device (MTD) vendors to demonstrate their technology's ability to retain captured sediment and hence be installed on-line. Since the scour testing conducted at the University of Florida (UF) exceeded the NJDEP 2009 protocol test requirements, Imbrium Systems has submitted the UF test report in support of their claim that the Stormceptor® STC qualifies for on-line installation.

2. Technical Performance Claim

Claim – The Stormceptor® STC450i tested at 565% of the Maximum Treatment Flow Rate (MTFR) with 100% of the maximum sediment storage volume loaded with NJDEP particle size diameter (d50 = 67 µm) sediment had effluent concentrations <10 mg/l.

3. Technical System Performance

3.1 Laboratory Testing

The testing of the Stormceptor® STC450i was conducted at the UOPs laboratory facility. The site has a footprint area of approximately 9,000 ft^2 and consists of a 40 by 60 feet concrete pad under roof. There is a two-story 20 by 20 feet tower building used as a multipurpose stormwater laboratory. There is a data acquisition room, 10 by 6 feet within the concrete pad, with A/C control for collecting the data during each run. The site is also provided with two 12,000-gallon potable water tanks fed by a pressured municipal water supply line and power (3-phase, 208-volt, 200-amps). The water supplied for the process was at a temperature of 28° C (± 3°C). Mx UltraMag electromagnetic flow meters measure flow rates. A CR3000 Micrologger, manufactured by Campell Scientific Inc., is used as the real-time data monitoring and data collection unit. An YSI 600 OMS Sonde (YSI Inc.) multi-parameter water quality monitoring probe equipped with a 6136 Turbidity Sensor provided in-situ measurement of turbidity.

The inside diameter of the STC450i unit is 48 inches. The surface area of the unit is 1810 in^2. The sediment chamber volume is 108,520 in^3, which is equal to 470 gallons. The Maximum Treatment Flow Rate of the STC450i is 0.283 ft^3/s. This unit has an internal bypass which accommodates overflow in the influent when there is a high flow rate, and protects previously captured pollutants. This bypass allows the excess influent volume to discharge to the effluent side of the STC450i insert, without disrupting the treatment or re-suspending previously captured pollutants. For the influent potable water pumped into the unit, an 8" diameter separate hard-plumbed PVC pipe was used.

3.2 Particle Size Distribution (PSD)

The New Jersey Particle Size Distribution (NJPSD) specified for sediment removal efficiency testing was used for preloading the sediment storage volume. This was more conservative than the protocol requirement that only material consistent with the particle distribution for particles 50 microns and greater in the NJPSD be utilized. A combination of four different particle gradations of silica sand particles were chosen for the study; 20/40 Oilfrac, #1 Dry, OK 110 and Sil-Co-Sil 106 were all used to prepare the NJPSD gradation as required by the NJDEP hydrodynamic separator lab testing protocol (NJDEP 2009). The particle size of each silica sand (or silt) gradation supplied by US Silica Company was combined to create the NJPSD (labeled as NJCAT) gradation as shown in Figure 1.

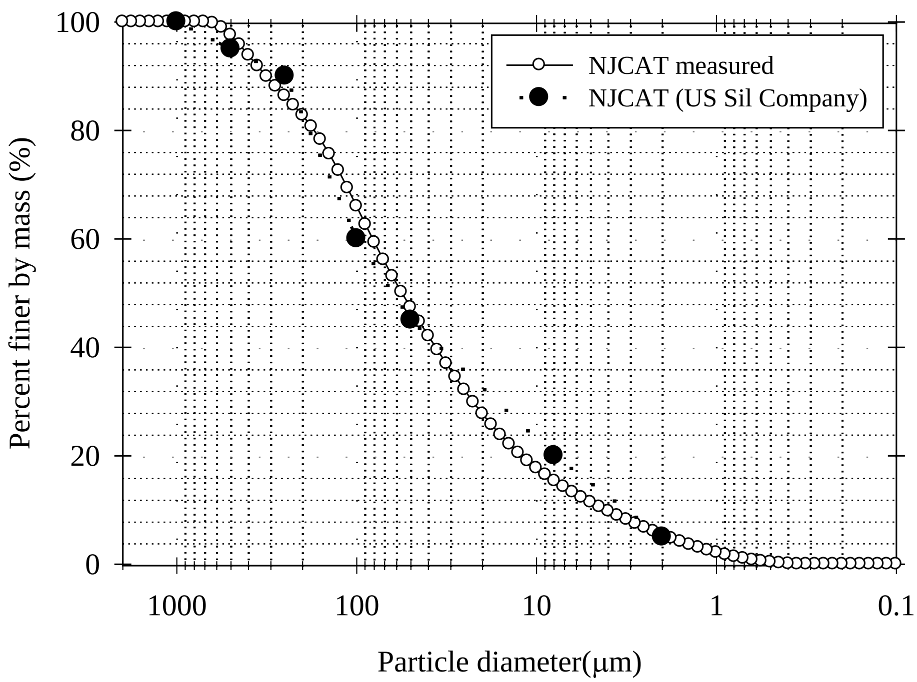

Figure 1 NJPSD target PSD with measured PSD for influent particle mixture consisting of 4 different silica gradations with predetermined mass ratio.

3.3 Scour Test Procedures

Scour testing was carried out at 1.6 cfs (565% of the maximum treatment flow rate (MTFR) of 0.283 cfs), at 50% and 100% of sediment depth in the lower chamber of the STC450i. It was observed that any flow above 0.32 cfs bypassed directly over to the effluent side of the unit without flowing into the unit.

The potential for re-suspension and washout of preloaded NJPSD in the STC450i was examined for two sets of parameters:

1. Flow rate of 565% of the MTFR, and

2. Preload sediment in the unit for 5 inches and 10 inches of depth. These are manufacturer-specified depths for 50% and 100% sediment capacity, and are within the range of approximately 15% of the volume in the lower chamber.

For the 50% sediment depth preloading set-up (5”), the entire surface area of the lower chamber (1810 in²) was filled with a 2 inch deposit of NJPSD gradation, using a movable insert (false-floor) raised up 3 inches from the bottom. For the 100% sediment depth preloading set-up (10”), the entire surface area of the lower chamber (1810 in²) was filled with an NJPSD gradation. This 100% run utilized the movable insert, raised up 8” from the bottom, to create a 2 inch NJPSD deposit. (Note: The NJDEP protocol specifies that “a false bottom may first be placed in the sedimentation chamber at a level below the 50% maximum sediment storage volume level and then covered with sufficient material as specified above to achieve 50% of the maximum sediment storage volume. In doing so, however, the level of the false bottom must be at least 12 inches below the 50% maximum sediment storage volume level or at the 40% maximum sediment storage level, whichever level is lower.” This was not done in this testing since it had been conducted prior to the protocol being issued. However, as described in Section 3.4, Verification Procedures, this did not impact the results.)

Once the STC450i was pre-filled with NJPSD gradation sediment, the STC450i was filled with potable water at a very low flow rate to minimize any re-suspension prior to starting the actual test. An additional 20 minutes of quiescent settling time was allowed to ensure that any remaining particulate matter was settled prior to conducting the scour testing.

The procedure followed to evaluate scouring from the STC450i is as follows: The flow monitoring was set at 1.6 cfs (718 gpm) which is 565% of the MTFR (0.283 cfs) and the YSI units were deployed at the inlet and the outlet of the STC450i and activated to record the influent and effluent turbidity. The test was started at “time 0”, which represents the time at which the desired steady state flow was achieved. Effluent sampling began instantaneously at “time 0” and a total of 21 individual samples were taken in ~1-L volume duplicates, at consistent sampling intervals calculated based on the flow rate being tested. The total duration of the experimental run was 10 minutes. The effluent samples were then transported to the laboratory, where lab analyses were conducted on the effluent samples. The YSI units were removed and the data was downloaded in the data acquisition room.

The lab analyses consisted of SSC analysis (ASTM 1999) and PSD analysis with a Malvern Mastersizer. SSC analysis was carried out by filtering the entire volume (10 L) of replicate composite samples through a prepared and pre weighed nominal 1.0 µm fiberglass filters as specified in the ASTM test method. The filters were then dried in the oven at 105 degree Celsius overnight, cooled in the desiccators, weighed and summed to obtain the total SSC. The concentration was calculated by dividing the SSC collected by the volume filtered.

The intensity of scouring was expressed as scouring rate (g/min) while the magnitude of scouring can be evaluated by effluent concentration (mg/l).

3.4 Verification Procedures

All the data provided to NJCAT were reviewed to fully understand the capabilities of the STC450i. For both the 5-inch (50 percent of sediment capacity) and 10-inch (100 percent of sediment capacity) tests, the influent was clean potable water (SSC ~ 0 mg/L). The mean effluent SSC was measured to be 5.9 mg/L and 6.1 mg/L for 50 percent and 100 percent sediment capacity, respectively.

The difference in the scouring rate between 50% and 100% of sediment capacity was not significant; (13.55 g/min and 14.27 g/min respectively based on measured effluent SSC). The plots of effluent concentration as a function of sediment loading in Figure 2 illustrate scour test results at the constant flow rate of 565 percent of the MTFR (718 gpm; 1.6 cfs)). Results did not show any significant difference between 50% and 100% of sediment preload. The PSD results in Figure 3 illustrate that 90% of scour particles were fine particles with sizes smaller than 25 μm which would not have been present had the 2009 NJDEP protocol been followed.

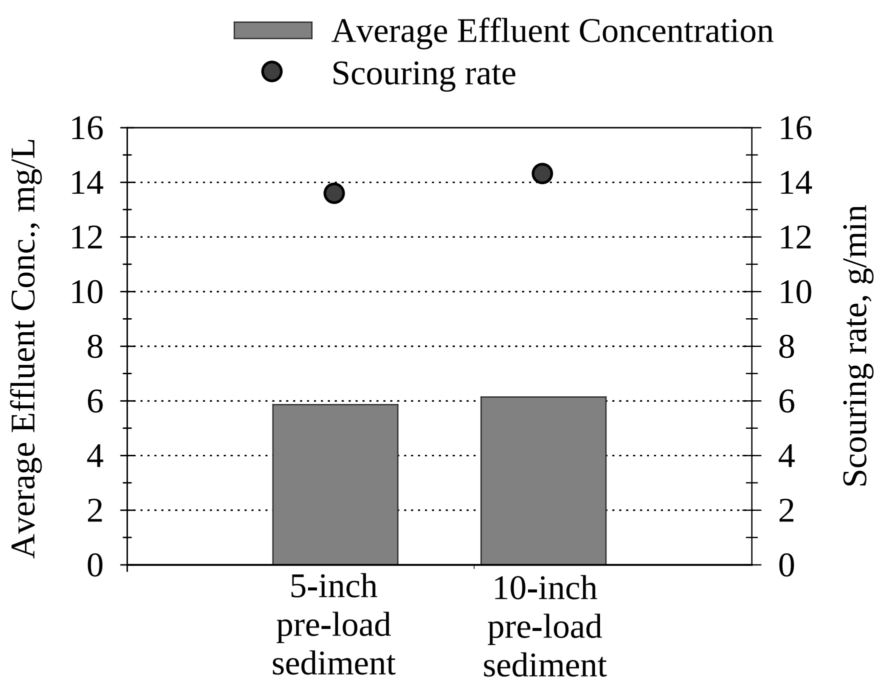

Figure 2 **Scour test results for the STC450i at 565 % of MTFR (718 gpm) at 5-inch and 10-inch of NJPSD sediment pre-loaded conditions.**

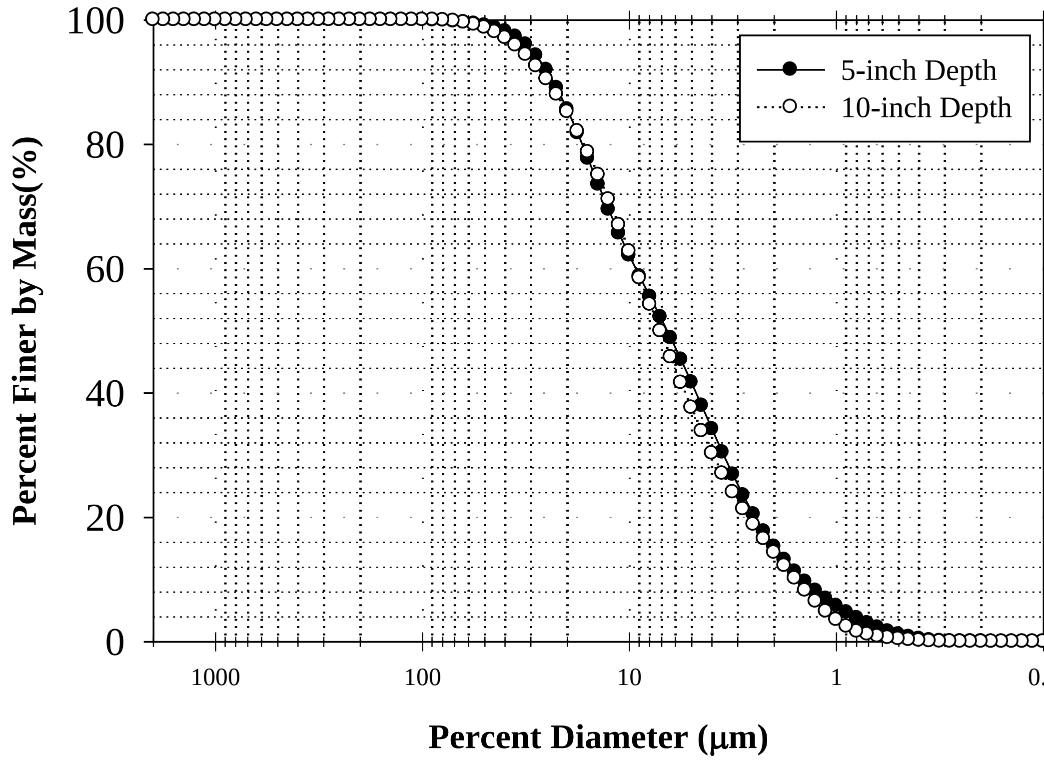

Figure 3 **Scour tests of particle gradations for 5-inch pre-loaded sediment and 10-inch pre-loaded sediment**

4. Verification of Performance Claim

Imbrium Systems Corp. completed scour testing of the Stormceptor STC450i prior to the issuance of the NJDEP 2009 Protocol for Manufactured Hydrodynamic Sedimentation Devices. Consequently their scour test conditions are different than those specified in the protocol. However, since the testing conditions exceed the requirements in the 15 December 2009 protocol the results may be considered conservative. The differences between the NJDEP scour test protocol and the Imbrium scour testing are shown in Table 1.

The Imbrium scour test results clearly show that the Stormceptor® STC450i has the capability to retain collected sediments under flows that are greater than 500% of the unit's MTFR. The measured effluent concentration at this condition was <10 mg/l qualifying the unit to be installed on-line.

Table 1 Comparison between NJDEP Scour Test Protocol and Imbrium Scour Test Procedures

Requirement	Protocol	Imbrium Test	Comment
Preloaded Sediment PSD	Particles 50 microns and greater in NJPSD	Utilized NJPSD (d50 = 67µm)	Conservative. Effluent PSD (d90 ~ 25µm) suggests that the material re-suspended and scoured in test would not have been present with 12-09-09 protocol.
False Bottom	Must be at least 12 in below 50% maximum sediment storage (MSS) volume level or at the 40% MSS, whichever is lower	8 inch is the marketed maintenance storage level. Sediment depths evaluated were 5 in and 10 in using a false bottom and a 2 in layer of NJCAT sediment.	Results showed that the maximum sediment lost during the 10 minute scour run was 0.0018 inch (10 in depth) confirming that the 2-in sediment depth was more than sufficient.
Clear Water Run	Water flow at 200% of the selected MTFR for 15 min or until volume of water equal to 5X MTD's MSS volume to demonstrate <10% sediment removed	Not done	Sediment (NJPSD) removal during scour testing confirms that <<10% of preloaded sediment would have been removed. (<0.1% removed) so requirement met.
Scour Test	200% of MTFR	565% of MTFR	Conservative
Run Time	30 min or 10X MSS volume, whichever is greater	10 min; 15X MSS volume	Run time less than 30 min. Exceeded 10X MSS volume
Samples	Minimum of 6 samples	21 samples in duplicate	Met protocol
Effluent Concentration	< 10 mg/L	6.1 mg/L for 10 in depth	Criterion met for more stringent initial PSD loading.
Samples tested	TSS	SSC	SSC is a more conservative metric vs. TSS when measuring scour (mg/l)

5. References

ASTM (1999) Standard Test Method for Determining Sediment Concentration in Water Samples, Annual Book of Standards, Water and Environmental Technology, *ASTM D 3977-97*, Vol. 11.02, p 389-394.

NJDEP (2009). Protocol for Manufactured Hydrodynamic Sedimentation Devices for Total Suspended Solids based on Laboratory Analysis. Dated August 5, 2009, Revised December 9, 2009.

University of Florida (2008). Multi-Phase Physical Model Testing of a Stormceptor® STC 450i – Final report. Submitted to Rinker Materials (20 December 2008)

Manufacturer's O&M Manual

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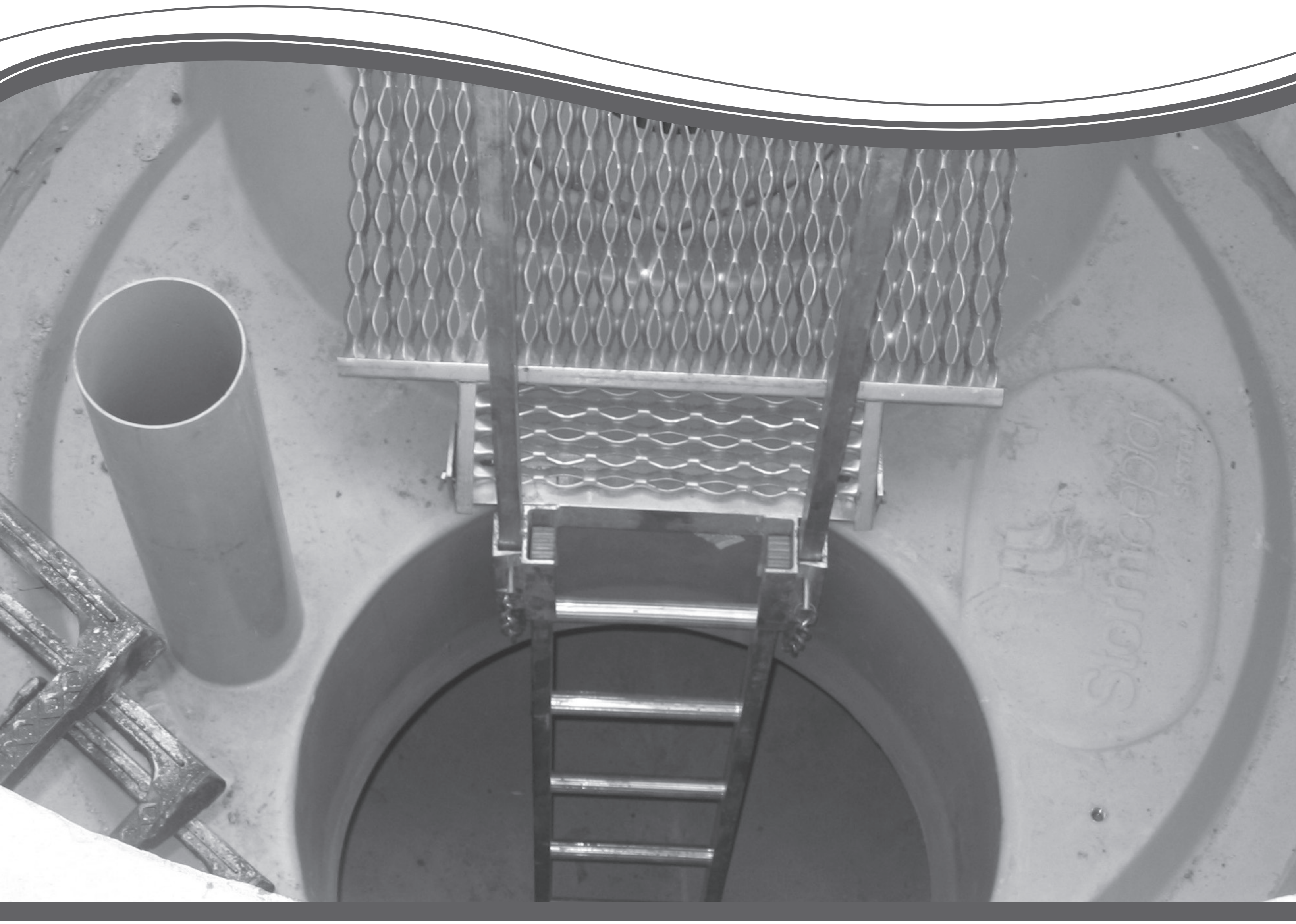
Stormceptor® STC
Operation and Maintenance Guide



Stormceptor® STC

Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	Inlet Unit STC 450i	In-Line Unit STC 900 to STC 7200	Series* STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

OPERATION AND MAINTENANCE GUIDE
Table of Content

1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18” (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

v_{SC} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_S = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft^3 (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

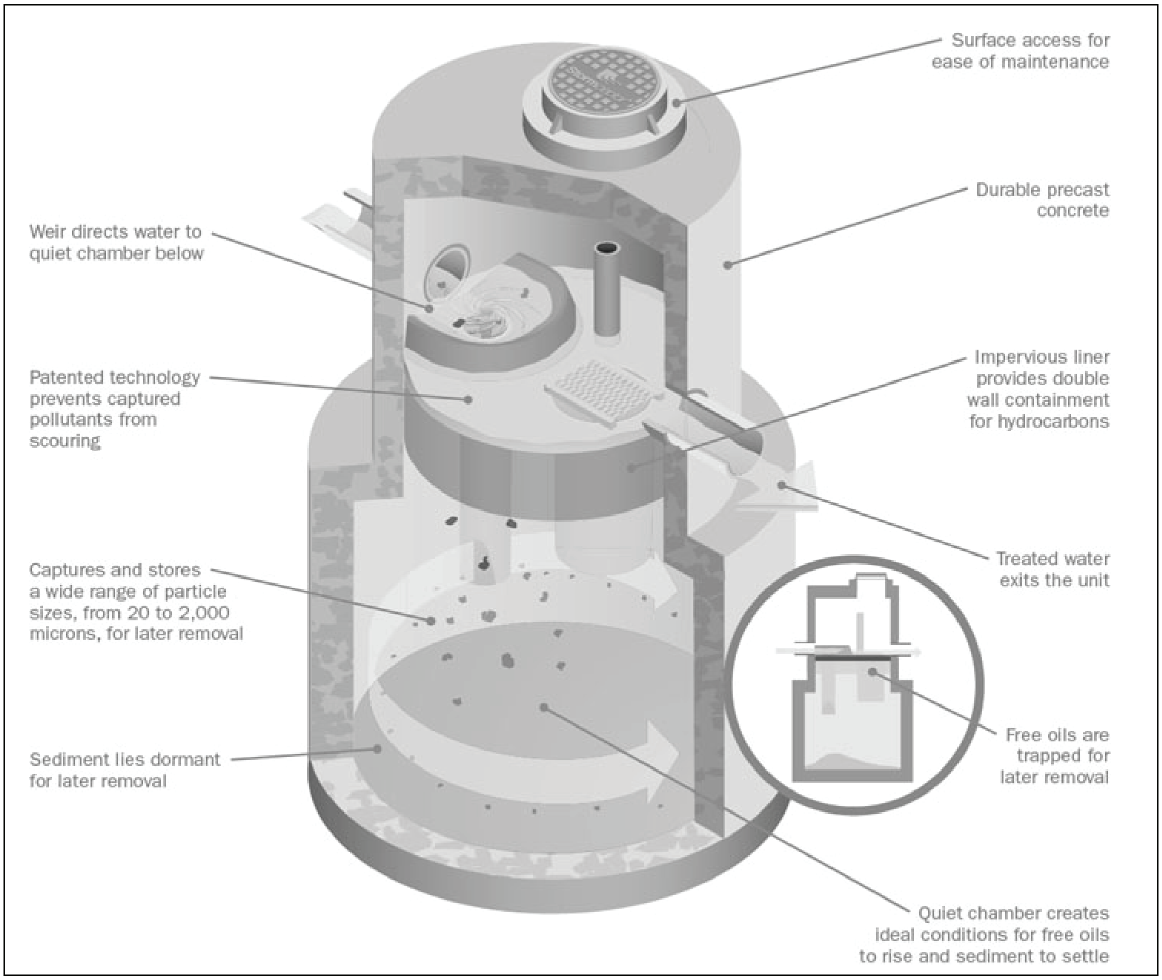


Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

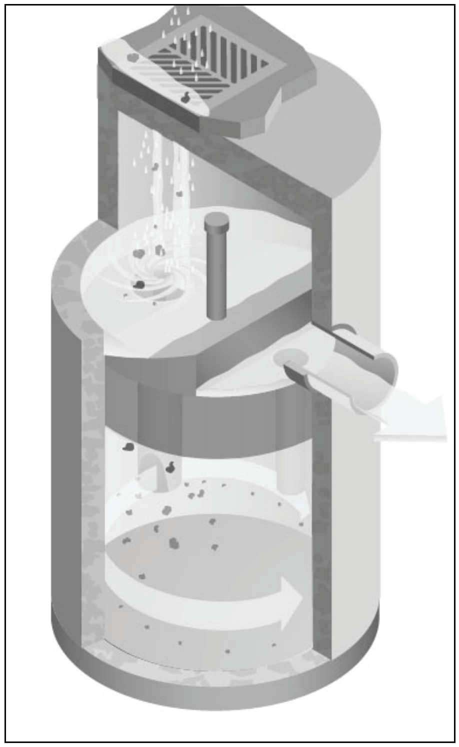


Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

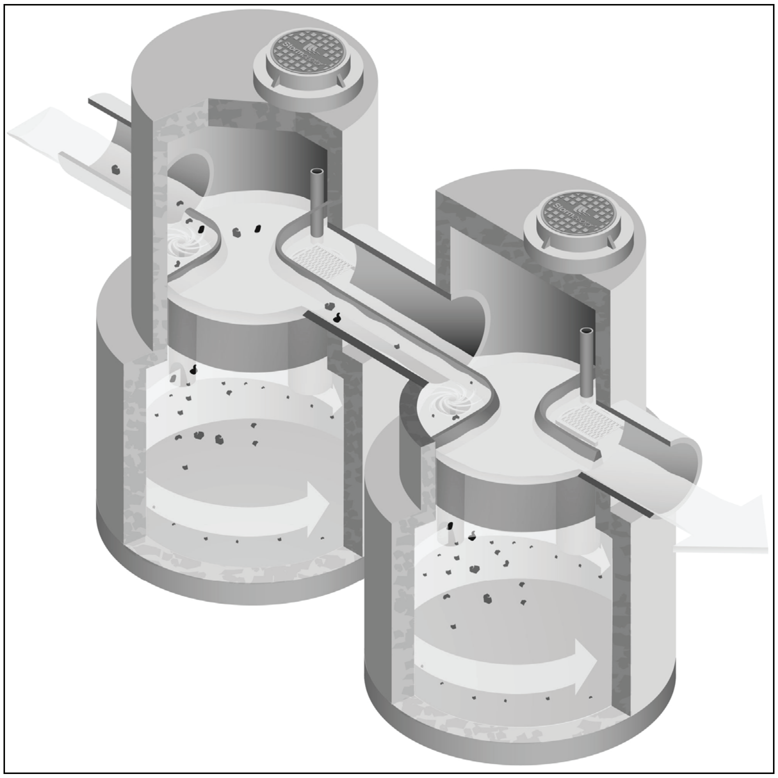


Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
    » The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
    » The distribution of TSS with the hydrology is properly and accurately considered in the sizing
    » Particle size distribution is properly considered in the sizing
    » The sizing can be optimized for TSS removal
    » The cost benefit of alternate TSS removal criteria can be easily assessed
    » The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

‘Spill Capture’ describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit’s available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

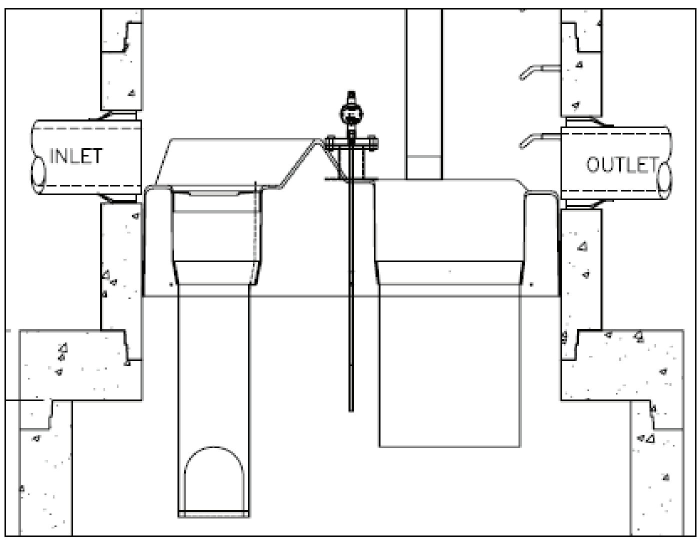


Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

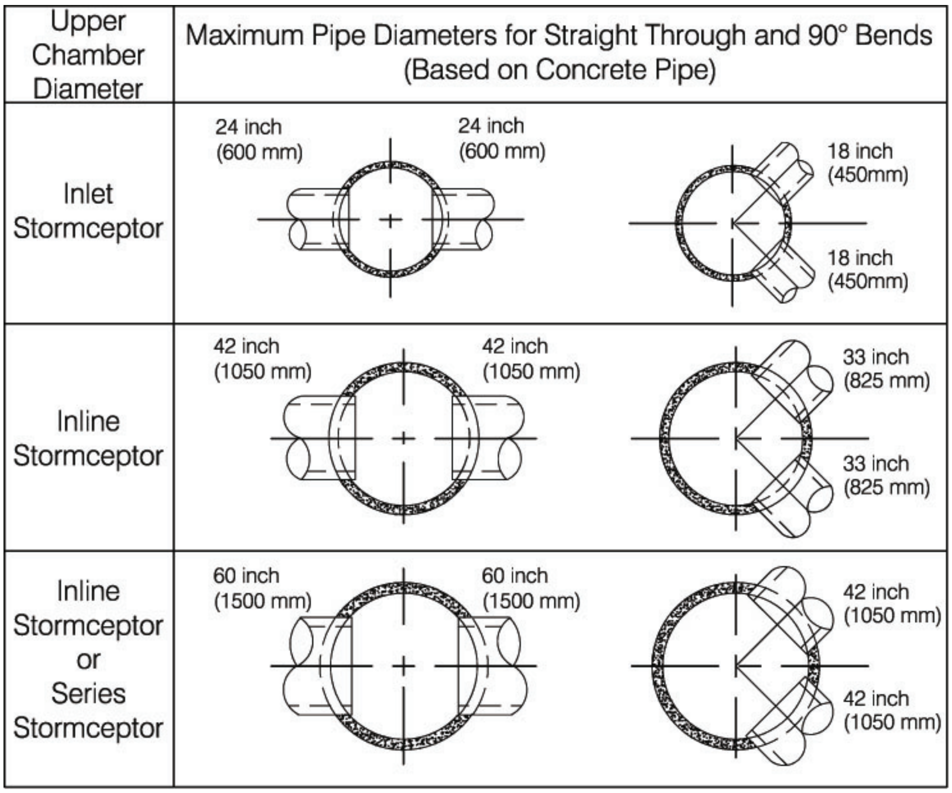


Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

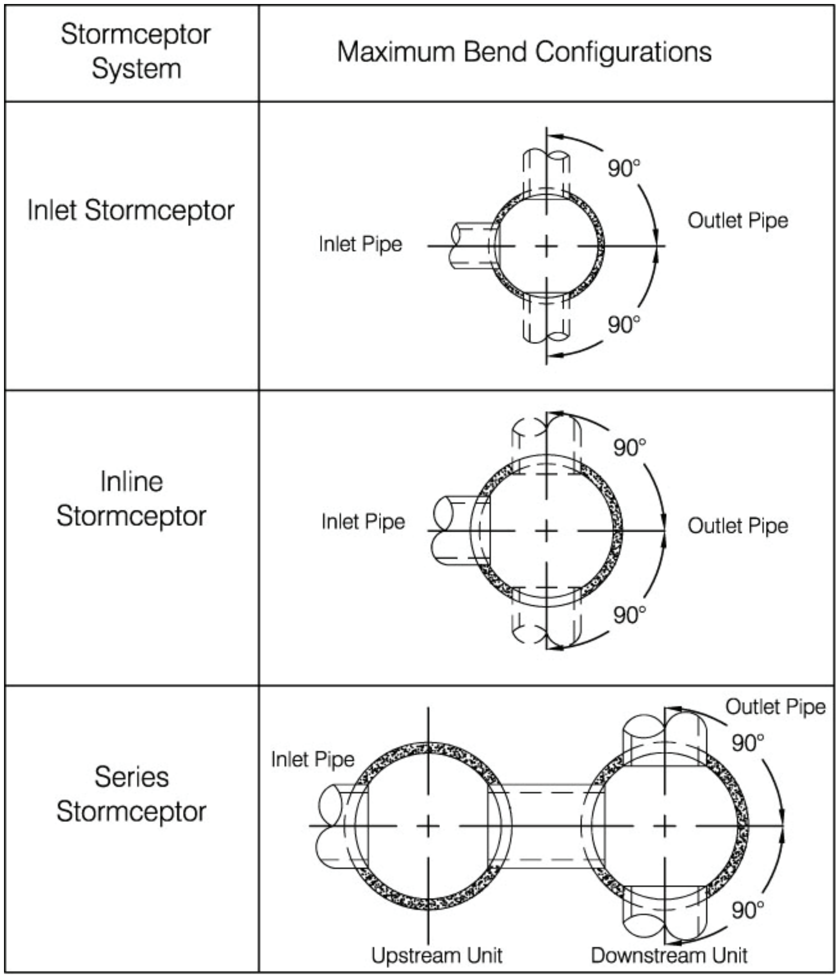


Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

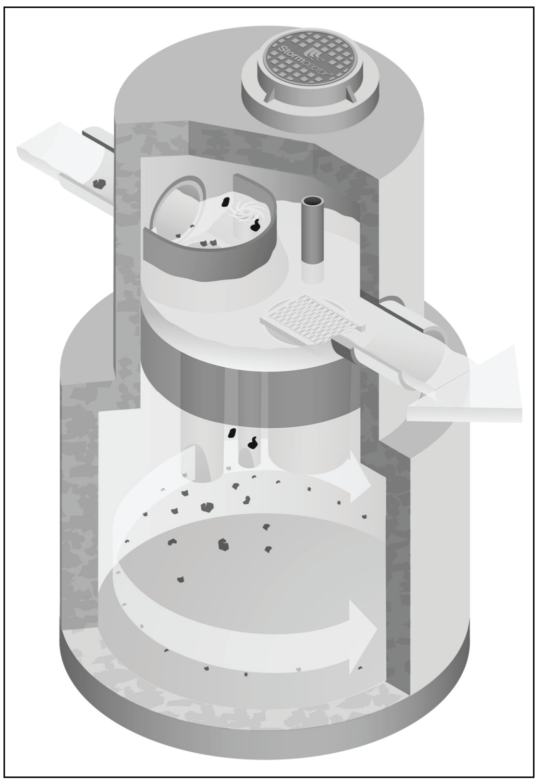


Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between "approved alternatives". The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system's performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product's performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system's design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit’s total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

Drawings and specifications are available at www.ContechES.com.

Site-specific design support is available from our engineers.

Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater, and earth stabilization products. For information, visit www.ContechES.com or call 800.338.1122

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