



HOWARD STEIN HUDSON

Engineers + Planners

## STORMWATER MANAGEMENT REPORT

# The Tantallon Proposed Multifamily Redevelopment Project 7 Tantallon Road

Andover, Massachusetts

Prepared by:

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## Existing Conditions

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The subject site is comprised of  $\pm$ .38 acres located in the General Business (GB) zoning district known as 7 Tantallon Road (Assessor's Map 35 Lots 5A & 6). This parcel is located to the east of the Shawsheen River and north of Haverhill Street. The site currently contains a vacant existing building on the western property edge that will be demolished and reconstructed. To the south is the Bank of New England. The property consists of mostly paved impervious surfaces with small areas of trees and grass surrounding the existing building and a small grass area surrounding the bank.

Site topography on the parcel shows that the site is relatively flat. On the western border, there are wetlands leading up to the Shawsheen River, where the topography begins to have a steeper slope.

Stormwater from the subject site currently flows off to two different locations. The majority of stormwater will cross the site from East to West and flow down the riverbank eventually making its way to the Shawsheen River (AP1). The remaining stormwater will overland flow to Haverhill Street and enter the street drainage (AP2).

Utilities exist within Tantallon Road; including water, sewer, gas, overhead electric, cable, and telephone which are accessible to the existing building and the adjacent parcel. The existing sewer main will be utilized pending a camera inspection determining it is feasible to use.



## Proposed Conditions

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The project proposes to improve the site with a multifamily residential building, sixty (60) total parking spaces, site utilities, drainage, landscaping, and lighting improvements. Access to the site is proposed through the existing one-way entrance and access easement off Haverhill Street through the abutting lot. The one-way exit is through Tantallon Road (a private way) and exits to Haverhill Street.

Sixty (60) total parking spaces are proposed in accordance with the dimensional standards of the Andover Zoning Bylaw. Adequate parking has been provided for both residents and visitors of the project location with 24 spaces at grade below the units and 36 spaces outside including two visitor spaces on an adjacent site for overnight use for the residents.

Site topography has been designed to mimic the existing conditions to the maximum extent practicable, while also allowing for the installation of curb to collect stormwater for adequate drainage design including increased TSS removal. Additionally, the proposed site grading provides increased flood storage when compared to the existing condition. Site topography on the parcel remains relatively flat except on the western border, where there is a steeper slope in the topography due to the wetlands bordering the site and the Shawsheen River.

Existing utilities within Tantallon Road will be utilized for the proposed building where they are determined to be in good condition. The existing water line has been determined to be unusable and will be replaced in kind with a new 8" CLDI water main. Electrical services will come off the infrastructure mains existing in Tantallon Road and the existing sewer main will be utilized pending a camera inspection determining if it is feasible to use.

A stormwater management system has been proposed as further outlined in the Hydrology section of this report.



# Zoning

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## General Business (GB)

| <u>Dimensional Requirements</u> | <u>Required</u> | <u>Proposed</u> |
|---------------------------------|-----------------|-----------------|
| Minimum Lot Area                | 48,000* sf      | 49,432 ± sf     |
| Minimum Front Yard (A)          | 152.3 ± ft      | 152.6 ± ft      |
| Minimum Side/Read Yard (B)      | 3 ± ft          | 4 ± ft          |
| Building Coverage (C)           | 66%             | 21% ft          |
| Maximum Stories                 | 4               | 4               |
| Maximum Building Height         | 50 ft           | 50 ± ft         |

\*2,000 square feet of lot area is required per dwelling unit. Twenty-four (24) units are proposed.

(A) In the General Business District, the front setback shall be the average front setback of existing buildings on the block.

(B) No building in a business district shall be erected or expanded within 15 feet of a building containing a residential use, regardless of the zoning district which said building containing a residential use is located.

(C) In a General Business District, an existing structure occupying more than 2/3 of the lot area shall not be expanded. New structures shall not exceed 2/3 of the lot area within the General Business District.



# Hydrology

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The parcel currently does not have a drainage infrastructure network, aside from the catch basins within Haverhill Street. The proposed project reduces the overall impervious onsite by 3,400± sf and therefore is considered a redevelopment project under the Massachusetts Stormwater Standards. All stormwater runoff from the existing site is currently directed to two main analysis points. The first analysis point AP1 is the Shawsheen River. This analysis point currently accepts much of the stormwater runoff associated with the property. A small portion of the site is directed to the drainage infrastructure within Haverhill Street and is identified as AP2.

The proposed project consists of a new drainage infrastructure network that is meant to capture and treat stormwater and direct to the analysis points while also decreasing the overall runoff and volume of stormwater runoff to these analysis points. A deep sump hooded catch basin to a CDS water quality unit is proposed to help with the removal of total suspended solids (TSS) prior to discharge. The water quality unit will treat runoff to the greatest extent practicable prior to discharge to the existing drainage infrastructure within Haverhill Street. This will vastly improve stormwater runoff treatment from what currently exists on site by providing treatment of paved surfaces where currently none exist. The only area of runoff that remains with limited treatment is that which flows overland directly to Haverhill Street.

# Stormwater Management Standards

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## Standard 1: No new untreated discharges

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The Massachusetts Stormwater Handbook requires that the project demonstrates that no new stormwater conveyances (e.g. outfalls) discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The proposed project proposed to upgrade and reuse the existing discharge to the Shawsheen River at the existing retaining wall.



## Standard 2: Post-development peak discharge rates not to exceed pre-development peak discharge rates.

Post-development peak discharge rates do not exceed the pre-development peak discharge rates for all storms. The proposed condition reduces rates and volumes, with exception of a slight increase in the 2-year storm event directed to Shawsheen River, by controlling the stormwater runoff within the stormwater management system and reducing the amount of impervious surface onsite.

| Storm Event                      | 2-year       | 10-year      | 25-year       | 100-year      |
|----------------------------------|--------------|--------------|---------------|---------------|
| Pre-development rates (cfs) AP1  | 3.24         | 6.04         | 7.81          | 10.52         |
| Volume (cf) to Shawsheen River   | 10,236       | 19,458       | 25,468        | 34,874        |
| Post-development rates (cfs) AP1 | 3.00         | 5.49         | 7.11          | 9.67          |
| Volume (cf) to Shawsheen River   | 10,254       | 18,747       | 24,379        | 33,313        |
| <b>Rate reductions (cfs)</b>     | <b>-0.24</b> | <b>-0.55</b> | <b>-0.70</b>  | <b>-0.85</b>  |
| <b>Volume Reductions (cf)</b>    | <b>18</b>    | <b>-711</b>  | <b>-1,089</b> | <b>-1,561</b> |
| Pre-development rates (cfs) AP2  | 0.02         | 0.10         | 0.16          | 0.26          |
| Volume (cf) to Haverhill Street  | 110          | 342          | 524           | 837           |
| Post-development rates (cfs) AP2 | 0.01         | 0.08         | 0.13          | 0.22          |
| Volume (cf) to Haverhill Street  | 78           | 268          | 422           | 693           |
| <b>Rate reductions (cfs)</b>     | <b>-0.01</b> | <b>-0.02</b> | <b>-0.03</b>  | <b>-0.04</b>  |
| <b>Volume Reductions (cf)</b>    | <b>-32</b>   | <b>-74</b>   | <b>-102</b>   | <b>-144</b>   |

## Standard 3: Minimize or eliminate loss of annual recharge to groundwater.

The site currently does not recharge stormwater or groundwater. All paved areas sheet flow offsite.

It is not feasible to provide recharge due to the large amount of existing utility infrastructure within Tantallon Road, there is no available space for subsurface drainage detention and recharge.

The proposal calls for the decrease in impervious areas on site and therefore provides additional vegetated areas to promote surface infiltration.

The standard has been met to the maximum extent practicable and has improved the existing conditions.



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## Standard 4: Stormwater management system to remove 80% of the average annual load of Total Suspended Solids (TSS)

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### TSS Removal Calculation – Treatment Train

#### Treatment Train #1 (to Shawsheen)

- Street Sweeping: 5% TSS Removal  
Initial TSS: 100%  
Amount Removed: 5%  
Amount Remaining:  $(100\% - 5\%) = 95\%$
- Deep Sump Hooded Catch Basin: 25% TSS Removal  
Initial TSS: 95%  
Amount Removed:  $(95\% \times 25\%) = 23.75\%$   
Amount Remaining:  $(95\% - 23.75\%) = 71.25\%$
- Contech CDS 2015-4 separator: 89.28% TSS Removal (See Appendix D for calculation)  
Initial TSS: 71.25%  
Amount Removed:  $(71.25\% \times 89.28\%) = 63.6\%$   
Amount Remaining:  $(71.25\% - 63.6\%) = 7.65\%$

**TSS Treatment Chain removes  $(100\% - 7.65\%) = 92.35\%$**

**Site impervious percentage = 74%**

#### Treatment Train #2 (to Haverhill Street)

- Street Sweeping: 5% TSS Removal  
Initial TSS: 100%  
Amount Removed: 5%  
Amount Remaining:  $(100\% - 5\%) = 95\%$

**TSS Treatment Chain removes  $(100\% - 95\%) = 5\%$**

**Site impervious percentage = 26%**



**Total TSS removal for the site = (92.35%) \* (74%) + (5%) \* (26%) = 69.6% TSS removal. This is a significant removal increase given that the existing site currently does not have any form of stormwater management in place at all to remove TSS from entering the Shawsheen River.**

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## **Standard 5: Land uses with higher potential pollutant loads**

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The development is not considered a land use that generally produces higher potential pollutant loads.

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## **Standard 6: Stormwater discharges to critical areas**

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The proposed stormwater system does not discharge to a critical area.

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## **Standard 7: Redevelopment projects**

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The project is considered a redevelopment project. Stormwater controls have been implemented to the maximum extent practicable in accordance with Section 7 of the Massachusetts Stormwater Handbook.

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## **Standard 8: Control construction-related impacts**

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The project will install erosion and sediment controls prior to any earthwork activity. Erosion control barriers will be placed down slope from the proposed construction to prevent erosion and sedimentation into the surrounding areas.

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## **Standard 9: Long-term operation and maintenance plan**

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See Appendix A for the operation and maintenance requirements of the stormwater management system.

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## **Standard 10: No illicit discharges**

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An illicit discharge compliance statement will be provided by the property owner under separate cover.



# Appendix A: Operation and Maintenance Plan

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## OPERATIONS AND MAINTENANCE PLAN

# The Tantallon Proposed Multifamily Redevelopment Project 7 Tantallon Road

Andover, Massachusetts

Prepared by:

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# Proposed Conditions

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## OPERATIONS AND MAINTENANCE PLAN

7 Tantallon Road – Andover, MA

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Signed:

NRJP, LLC

Neil Rosenberg



OPERATIONS AND MAINTENANCE PLAN  
7 Tantalum Road – Andover, MA  
March 2019  
Revised: October 2022

# CGP Pollution Prevention Requirements

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## 2.3 POLLUTION PREVENTION REQUIREMENTS<sup>47</sup>

You must implement pollution prevention controls in accordance with the following requirements to minimize the discharge of pollutants in stormwater and to prevent the discharge of pollutants from spilled or leaked materials from construction activities.

### 2.3.1 For equipment and vehicle fueling and maintenance:

- a. Provide an effective means of eliminating the discharge of spilled or leaked chemicals, including fuels and oils, from these activities;<sup>48</sup>
- b. If applicable, comply with the Spill Prevention Control and Countermeasures (SPCC) requirements in 40 CFR part 112 and Section 311 of the CWA;
- c. Ensure adequate supplies are available at all times to handle spills, leaks, and disposal of used liquids;
- d. Use drip pans and absorbents under or around leaky vehicles;
- e. Dispose of or recycle oil and oily wastes in accordance with other Federal, State, Tribal, or local requirements; and
- f. Clean up spills or contaminated surfaces immediately, using dry clean up measures (do not clean contaminated surfaces by hosing the area down), and eliminate the source of the spill to prevent a discharge or a continuation of an ongoing discharge.

### 2.3.2 For equipment and vehicle washing:

- a. Provide an effective means of minimizing the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of wash waters;<sup>49</sup>
- b. Ensure there is no discharge of soaps, solvents, or detergents in equipment and vehicle wash water; and
- c. For storage of soaps, detergents, or solvents, provide either (1) cover (e.g., *plastic sheeting, temporary roofs*) to minimize the exposure of these detergents to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.

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<sup>47</sup> Under this permit, you are not required to minimize exposure for any products or materials where the exposure to precipitation and to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).

<sup>48</sup> Examples of effective means include:

- Locating activities away from receiving waters, storm drain inlets, and constructed or natural site drainage feature so that stormwater coming into contact with these activities cannot reach waters of the U.S.;
- Providing secondary containment (e.g., *spill berms, dikes, spill containment pallets*) and cover where appropriate; and
- Having a spill kit available on site and ensuring personnel are available to respond expeditiously in the event of a leak or spill.

<sup>49</sup> Examples of effective means include locating activities away from receiving waters and storm drain inlets or constructed or natural site drainage features and directing wash waters to a sediment basin or sediment trap, using filtration devices, such as filter bags or sand filters, or using other similarly effective controls.

**2.3.3 For equipment and vehicle washing:**

- a. Provide an effective means of minimizing the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of wash waters;<sup>49</sup>
- b. Ensure there is no discharge of soaps, solvents, or detergents in equipment and vehicle wash water; and
- c. For storage of soaps, detergents, or solvents, provide either (1) cover (e.g., *plastic sheeting, temporary roofs*) to minimize the exposure of these detergents to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.

**2.3.4 For storage, handling, and disposal of building products, materials, and wastes:<sup>50</sup>**

- a. *For building materials and building products,<sup>51</sup> provide either (1) cover (e.g., plastic sheeting, temporary roofs) to minimize the exposure of these products to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.*

Exception: Minimization of exposure is not required in cases where the exposure to precipitation and to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).

- b. *For pesticides, herbicides, insecticides, fertilizers, and landscape materials:*
  - i. In storage areas, provide either (1) cover (e.g., *plastic sheeting, temporary roofs*) to minimize the exposure of these chemicals to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas; and
  - ii. Comply with all application and disposal requirements included on the registered pesticide, herbicide, insecticide, and fertilizer label (see also Part 2.3.5).
- c. *For diesel fuel, oil, hydraulic fluids, other petroleum products, and other chemicals:* The following requirements apply to the storage and handling of chemicals on your site. If you are already implementing controls as part of an SPCC or other spill prevention plan that meet or exceed the requirements of this Part, you may continue to do so and be considered in compliance with these provisions provided you reference the applicable parts of the SPCC or other plans in your SWPPP as required in Part 7.2.6b.viii.
  - i. If any chemical container has a storage capacity of less than 55 gallons:
    - (a) The containers must be water-tight, and must be kept closed, sealed, and secured when not being actively used;
    - (b) If stored outside, use a spill containment pallet or similar device to capture small leaks or spills; and

<sup>50</sup> Compliance with the requirements of this permit does not relieve compliance requirements with respect to Federal, State, or local laws and regulations governing the storage, handling, and disposal of solid, hazardous, or toxic wastes and materials.

<sup>51</sup> Examples of building materials and building products typically present at construction sites include asphalt sealants, copper flashing, roofing materials, adhesives, concrete admixtures, and gravel and mulch stockpiles.

- (c) Have a spill kit available on site that is in good working condition (i.e., not damaged, expired, or used up) and ensure personnel are available to respond immediately in the event of a leak or spill.
  - ii. If any chemical container has a storage capacity of 55 gallons or more:
    - (a) The containers must be water-tight, and must be kept closed, sealed, and secured when not being actively used;
    - (b) Store containers a minimum of 50 feet from receiving waters, constructed or natural site drainage features, and storm drain inlets. If infeasible due to site constraints, store containers as far away from these features as the site permits. If site constraints prevent you from storing containers 50 feet away from receiving waters or the other features identified, you must document in your SWPPP the specific reasons why the 50-foot setback is infeasible, and how you will store containers as far away as the site permits;
    - (c) Provide either (1) cover (e.g., temporary roofs) to minimize the exposure of these containers to precipitation and to stormwater, or (2) secondary containment (e.g., curbing, spill berms, dikes, spill containment pallets, double-wall, above-ground storage tank); and
    - (d) Have a spill kit available on site that is in good working condition (i.e., not damaged, expired, or used up) and ensure personnel are available to respond immediately in the event of a leak or spill. Additional secondary containment measures are listed at 40 CFR § 112.7(c)(1).
  - iii. Clean up spills immediately, using dry clean-up methods where possible, and dispose of used materials properly. You are prohibited from hosing the area down to clean surfaces or spills. Eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge.
- d. *For hazardous or toxic wastes:*<sup>52</sup>
- i. Separate hazardous or toxic waste from construction and domestic waste;
  - ii. Store waste in sealed containers, constructed of suitable materials to prevent leakage and corrosion, and labeled in accordance with applicable Resource Conservation and Recovery Act (RCRA) requirements and all other applicable Federal, State, Tribal, or local requirements;
  - iii. Store all outside containers within appropriately-sized secondary containment (e.g., *spill berms, dikes, spill containment pallets*) to prevent spills from being discharged, or provide a similarly effective means designed to prevent the discharge of pollutants from these areas (e.g., *storing chemicals in a covered area, having a spill kit available on site*);
  - iv. Dispose of hazardous or toxic waste in accordance with the manufacturer's recommended method of disposal and in compliance with Federal, State, Tribal, and local requirements;
  - v. Clean up spills immediately, using dry clean-up methods, and dispose of used materials properly. You are prohibited from hosing the area down to clean surfaces or spills. Eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge; and
  - vi. Follow all other Federal, State, Tribal, and local requirements regarding hazardous or toxic waste.

- e. *For construction and domestic wastes:*<sup>53</sup>
- i. Provide waste containers (e.g., *dumpster, trash receptacle*) of sufficient size and number to contain construction and domestic wastes;
    - (a) For waste containers with lids, keep waste container lids closed when not in use, and close lids at the end of the business day and during storm events. For waste containers without lids, provide either (1) *cover (e.g., a tarp, plastic sheeting, temporary roof)* to minimize exposure of wastes to precipitation, or (2) a similarly effective means designed to minimize the discharge of pollutants (e.g., *secondary containment*);
    - (b) On business days, clean up and dispose of waste in designated waste containers; and
    - (c) Clean up immediately if containers overflow, and if there is litter elsewhere on the site from escaped trash.
  - ii. Waste containers are not required for the waste remnant or unused portions of construction materials or final products that are covered by the exception in Part 2.2.3a provided that:
    - (a) These wastes are stored separately from other construction or domestic wastes addressed by Part 2.3.3e.i (i.e., wastes not covered by the exception in Part 2.3.3a). If the wastes are mixed, they must be stored in waste containers as required in Part 2.3.3e.i; and
    - (b) These wastes are stored in designated areas of the site, the wastes are described in the SWPPP (see Part 7.2.6b.ix), and identified in the site plan (see Part 7.2.4i).
  - f. *For sanitary waste*, position portable toilets so they are secure and will not be tipped or knocked over, and are located away from receiving waters, storm drain inlets, and constructed or natural site drainage features.

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<sup>52</sup> Examples of hazardous or toxic waste that may be present at construction sites include paints, caulks, sealants, fluorescent light ballasts, solvents, petroleum-based products, wood preservatives, additives, curing compounds, and acids.

<sup>53</sup> Examples of construction and domestic wastes include packaging materials, scrap construction materials, masonry products, timber, pipe and electrical cuttings, plastics, styrofoam, concrete, demolition debris; and other trash or discarded materials.

**2.3.5 For washing applicators and containers used for stucco, paint, concrete, form release oils, curing compounds, or other materials:**

- a. Direct wash water into a leak-proof container or leak-proof and lined pit designed so no overflows can occur due to inadequate sizing or precipitation;
- b. Handle washout or cleanout wastes as follows:
  - i. For liquid wastes:
    - (a) Do not dump liquid wastes or allow them to enter into constructed or natural site drainage features, storm inlets, or receiving waters;
    - (b) Do not allow liquid wastes to be disposed of through infiltration or to otherwise be disposed of on the ground;
    - (c) Comply with applicable State, Tribal, or local requirements for disposal
  - ii. Remove and dispose of hardened concrete waste consistent with your handling of other construction wastes in Part 2.3.3e; and
- c. Locate any washout or cleanout activities as far away as possible from receiving waters, constructed or natural site drainage features, and storm drain inlets, and, to the extent feasible, designate areas to be used for these activities and conduct such activities only in these areas.

**2.3.6 For the application of fertilizers:**

- a. Apply at a rate and in amounts consistent with manufacturer's specifications, or document in the SWPPP departures from the manufacturer specifications where appropriate in accordance with Part 7.2.6b.x;
- b. Apply at the appropriate time of year for your location, and preferably timed to coincide as closely as possible to the period of maximum vegetation uptake and growth;
- c. Avoid applying before heavy rains that could cause excess nutrients to be discharged;
- d. Never apply to frozen ground;
- e. Never apply to constructed or natural site drainage features; and
- f. Follow all other Federal, State, Tribal, and local requirements regarding fertilizer application.

**2.3.7 Emergency Spill Notification Requirements**

Discharges of toxic or hazardous substances from a spill or other release are prohibited, consistent with Part 1.3.5. Where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR part 110, 40 CFR part 117, or 40 CFR part 302 occurs during a 24-hour period, you must notify the National Response Center (NRC) at (800) 424-8802 or, in the Washington, DC metropolitan area, call (202) 267-2675 in accordance with the requirements of 40 CFR part 110, 40 CFR part 117, and 40 CFR part 302 as soon as you have knowledge of the release. You must also, within seven (7) calendar days of knowledge of the release, provide a description of the release, the circumstances leading to the release, and the date of the release. State, Tribal, or local requirements may necessitate additional reporting of spills or discharges to local emergency response, public health, or drinking water supply agencies.

## 2.4 CONSTRUCTION DEWATERING REQUIREMENTS

Comply with the following requirements to minimize the discharge of pollutants from dewatering<sup>54</sup> operations.

- 2.4.1 Route dewatering water through a sediment control (e.g., sediment trap or basin, pumped water filter bag) designed to prevent discharges with visual turbidity;<sup>55</sup>
- 2.4.2 Do not discharge visible floating solids or foam;
- 2.4.3 The discharge must not cause the formation of a visible sheen on the water surface, or visible oily deposits on the bottom or shoreline of the receiving water. Use an oil-water separator or suitable filtration device (such as a cartridge filter) designed to remove oil, grease, or other products if dewatering water is found to or expected to contain these materials;
- 2.4.4 To the extent feasible, use well-vegetated (e.g., grassy or wooded), upland areas of the site to infiltrate dewatering water before discharge.<sup>56</sup> You are prohibited from using receiving waters as part of the treatment area;
- 2.4.5 To prevent dewatering-related erosion and related sediment discharges:
  - a. Use stable, erosion-resistant surfaces (e.g., well-vegetated grassy areas, clean filter stone, geotextile underlayment) to discharge from dewatering controls;
  - b. Do not place dewatering controls, such as pumped water filter bags, on steep slopes (as defined in Appendix A); and
  - c. At all points where dewatering water is discharged, comply with the velocity dissipation requirements of Part 2.2.11.
- 2.4.6 For backwash water, either haul it away for disposal or return it to the beginning of the treatment process;
- 2.4.7 Replace and clean the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturer's specifications; and
- 2.4.8 Comply with dewatering-specific inspection requirements in Part 4.

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<sup>54</sup> "Dewatering" is defined in Appendix A as "the act of draining accumulated stormwater and/or ground water from building foundations, vaults, and trenches, or other similar points of accumulation."

<sup>55</sup> For the purposes of this permit, visual turbidity is present where there is a sediment plume in the discharge or the discharge appears cloudy, or opaque, or has a visible contrast that can be identified by an observer.

<sup>56</sup> See footnote 19.

### **3 WATER QUALITY-BASED EFFLUENT LIMITATIONS**

#### **3.1 GENERAL EFFLUENT LIMITATION TO MEET APPLICABLE WATER QUALITY STANDARDS**

Discharges must be controlled as necessary to meet applicable water quality standards. Discharges must also comply with any additional State or Tribal requirements that are in Part 9.

In the absence of information demonstrating otherwise, EPA expects that compliance with the conditions in this permit will result in stormwater discharges being controlled as necessary to meet applicable water quality standards. If at any time you become aware, or EPA determines, that discharges are not being controlled as necessary to meet applicable water quality standards, you must take corrective action as required in Parts 5.1 and 5.2, and document the corrective actions as required in Part 5.4.

EPA may insist that you install additional controls (to meet the narrative water quality-based effluent limit above) on a site-specific basis, or require you to obtain coverage under an individual permit, if information in your NOI or from other sources indicates that your discharges are not controlled as necessary to meet applicable water quality standards. This includes situations where additional controls are necessary to comply with a wasteload allocation in an EPA-established or approved TMDL.

If during your coverage under a previous permit, you were required to install and maintain stormwater controls specifically to meet the assumptions and requirements of an EPA-approved or established TMDL (for any parameter) or to otherwise control your discharge to meet water quality standards, you must continue to implement such controls as part of your coverage under this permit.

#### **3.2 WATER QUALITY-BASED CONDITIONS FOR SITES DISCHARGING TO CERTAIN IMPAIRED AND HIGH QUALITY RECEIVING WATERS**

For any portion of the site that discharges to a sediment or nutrient-impaired water or to a water that is identified by your State, Tribe, or EPA as Tier 2, Tier 2.5, or Tier 3 for antidegradation purposes,<sup>57</sup> you must comply with the inspection frequency specified in Part 4.3 and you must comply with the stabilization deadline specified in Part 2.2.14b.iii.<sup>58</sup>

If you discharge to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform you if any additional controls are necessary for your discharge to be controlled as necessary to meet water quality standards. These controls might include those necessary for your discharge to be consistent with the assumptions of any available wasteload allocation in any applicable TMDL. In addition, EPA may require you to apply for and obtain coverage under an individual NPDES permit.

<sup>57</sup> Refer to Appendix A for definitions of "impaired water" and "Tier 2," "Tier 2.5," and "Tier 3" waters. For assistance in determining whether your site discharges to impaired waters, EPA has developed a tool that is available at <https://www.epa.gov/npdes/epas-stormwater-discharge-mapping-tools>. For assistance in determining whether your site discharges to a Tier 2, 2.5, or 3 water, refer to the list of such waters at <https://www.epa.gov/npdes/construction-general-permit-resources-tools-and-templates>.

<sup>58</sup> If you qualify for any of the reduced inspection frequencies in Part 4.4, you may conduct inspections in

In addition, on a case-by-case basis, EPA may notify operators of new sites or operators of existing sites with increased discharges that additional analyses, stormwater controls, and/or other measures are necessary to comply with the applicable antidegradation requirements, or notify you that an individual permit application is necessary.

If you discharge to a water that is impaired for polychlorinated biphenyls (PCBs) and are engaging in demolition of any structure with at least 10,000 square feet of floor space built or renovated before January 1, 1980, you must:

- a.** Implement controls<sup>59</sup> to minimize the exposure of PCB-containing building materials, including paint, caulk, and pre-1980 fluorescent lighting fixtures, to precipitation and to stormwater; and
- b.** Ensure that disposal of such materials is performed in compliance with applicable State, Federal, and local laws.

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accordance with Part 4.4 for any portion of your site that discharges to a sensitive water.

<sup>59</sup> Examples of controls to minimize exposure of PCBs to precipitation and stormwater include separating work areas from non-work areas and selecting appropriate personal protective equipment and tools, constructing a containment area so that all dust or debris generated by the work remains within the protected area, and using tools that minimize dust and heat (<212°F). For additional information, refer to Part 2.3.3 of the CGP Fact Sheet.



















# Contech CDS Maintenance Guide

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## CDS<sup>®</sup> Inspection and Maintenance Guide

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## Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

## Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allow both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

## Cleaning

Cleaning of a CDS system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.



| CDS Model | Diameter |     | Distance from Water Surface to Top of Sediment Pile |     | Sediment Storage Capacity |                |
|-----------|----------|-----|---|-----|---------------------------|----------------|
|           | ft       | m   | ft  | m   | y <sup>3</sup>            | m <sup>3</sup> |
| CDS1515   | 3        | 0.9 | 3.0   | 0.9 | 0.5                       | 0.4            |
| CDS2015   | 4        | 1.2 | 3.0   | 0.9 | 0.9                       | 0.7            |
| CDS2015   | 5        | 1.3 | 3.0   | 0.9 | 1.3                       | 1.0            |
| CDS2020   | 5        | 1.3 | 3.5   | 1.1 | 1.3                       | 1.0            |
| CDS2025   | 5        | 1.3 | 4.0   | 1.2 | 1.3                       | 1.0            |
| CDS3020   | 6        | 1.8 | 4.0   | 1.2 | 2.1                       | 1.6            |
| CDS3025   | 6        | 1.8 | 4.0   | 1.2 | 2.1                       | 1.6            |
| CDS3030   | 6        | 1.8 | 4.6   | 1.4 | 2.1                       | 1.6            |
| CDS3035   | 6        | 1.8 | 5.0   | 1.5 | 2.1                       | 1.6            |
| CDS4030   | 8        | 2.4 | 4.6   | 1.4 | 5.6                       | 4.3            |
| CDS4040   | 8        | 2.4 | 5.7   | 1.7 | 5.6                       | 4.3            |
| CDS4045   | 8        | 2.4 | 6.2   | 1.9 | 5.6                       | 4.3            |
| CDS5640   | 10       | 3.0 | 6.3   | 1.9 | 8.7                       | 6.7            |
| CDS5653   | 10       | 3.0 | 7.7   | 2.3 | 8.7                       | 6.7            |
| CDS5668   | 10       | 3.0 | 9.3   | 2.8 | 8.7                       | 6.7            |
| CDS5678   | 10       | 3.0 | 10.3  | 3.1 | 8.7                       | 6.7            |

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities



**Support**

- Drawings and specifications are available at [www.contechstormwater.com](http://www.contechstormwater.com).
- Site-specific design support is available from our engineers.

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# Floor Drain Variance

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CHARLES D. BAKER  
GOVERNOR

KARYN E. POLITO  
LIEUTENANT GOVERNOR

JAY ASH  
SECRETARY OF HOUSING AND  
ECONOMIC DEVELOPMENT

Commonwealth of Massachusetts  
Division of Professional Licensure  
BOARD OF STATE EXAMINERS OF PLUMBERS  
AND GAS FITTERS

1000 Washington Street • Boston • Massachusetts • 02118

JOHN C. CHAPMAN  
UNDERSECRETARY OF  
CONSUMER AFFAIRS AND  
BUSINESS REGULATION

CHARLES BORSTEL  
COMMISSIONER DIVISION OF  
PROFESSIONAL LICENSURE

March 16, 2018

Mr. Kenneth R. Feyl  
1 Elm Square, 3<sup>rd</sup> Floor  
Andover, MA. 01810

Re: Variance PV128 – NRJP LLC – 7 Tantallon Rd. – Andover

Dear Mr. Feyl,

Please be advised on March 7, 2018 in the Board Meeting Room, 1000 Washington Street in Boston Massachusetts, the Board of the State Examiners of Plumbers and Gas Fitters deliberated on and voted to **Grant a variance from 248 CMR 10.09**. The Board voted to allow the following: ***To Install floor Drains tied into the existing storm system to be treated with the existing stormceptors.***

This variance decision is, based on the presentation, information and documentation provided by the applicant and is applicable to this end user and this site only. All other plumbing and gas fitting work if applicable shall comply with the rules and regulations of 248 CMR 3.00 through 10.00 and all other applicable statutes and codes.

Sincerely,  
For the Board,

Charles Kilb, Board Counsel  
Board of State Examiners of Plumbers and Gasfitters

Cc: Richard Danforth  
Plumbing and Gas Inspector





**OPERATIONS AND MAINTENANCE PLAN**

7 Tantallon Road – Andover, MA

March 2019

Revised: October 2022

# Maintenance Plan Sketch

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**HOWARD STEIN HUDSON**

114 Turnpike Road, Suite 2C  
Chelmsford, MA 01824  
www.hshassoc.com

PREPARED FOR:  
Neil Rosenberg  
7 Tantalion Road  
Andover, MA 01810

**THE TANTALLON  
PROPOSED MULTIFAMILY  
REDEVELOPMENT PROJECT  
7 TANTALLON ROAD  
ANDOVER, MA, 01810**

REVISIONS:

| NO | BY | DATE     | DESCRIPTION       |
|----|----|----------|-------------------|
| 1  | MB | 8/03/20  | ISSUED FOR REVIEW |
| 2  | MB | 8/17/22  | NOI SUBMISSION    |
| 3  | MB | 10/26/22 | REV PER COMMENTS  |
|    |    |          |                   |
|    |    |          |                   |
|    |    |          |                   |
|    |    |          |                   |
|    |    |          |                   |
|    |    |          |                   |
|    |    |          |                   |

SITE PLAN

**OPERATION AND  
MAINTENANCE  
PLAN**

DATE: 10-24-2017

PROJECT NUMBER: 17024

DESIGNED BY: TM

DRAWN BY: TM

CHECKED BY: KE

1

SHEET 1 OF 1

MAP 35 LOT 8  
20 HAVERHILL STREET  
LISA M. COX  
BOOK 11792 PAGE 190

MAP 35 LOT 7  
16 HAVERHILL STREET  
JPNR, LLC  
BOOK 7154 PAGE 329

EXISTING  
MULTI-TENANT  
OFFICE BUILDING

MAP 36 LOT 91  
16 BALMORAL STREET  
THE BALMORAL  
CONDOMINIUM COMPLEX

MAP 35 LOT 29  
56 YORK STREET  
NEW BRICKSTONE OFFICE, LLC  
BOOK 13994 PAGE 71

4 STORY  
APARTMENT BLDG  
24 UNITS  
1ST FLOOR PARKING  
24 SPACES  
(SEE ARCH PLANS FOR HC  
PARKING INSIDE)

MAP 35 LOT 5  
12 HAVERHILL STREET  
WINDHAM REALTY LLC  
BOOK 4168 PAGE 210

EXISTING  
BANK BUILDING

"VISITOR PARKING FOR  
THE TANTALLON  
M-F 5:00 PM TO 7:00 AM ONLY  
VIOLATORS WILL BE TOWED  
AT OWNERS EXPENSE"

PROP. GATE  
W/CLICK TO ACCESS  
LOCK FOR FIRE DEPT.  
TO BE ADDED TO EXIST. FENCE  
COORDINATE WITH  
ABUTTING PROPERTY OWNER

PAVED AREA TO BE  
STREET SWEEP  
SEE NOTE #7

100' INNER  
RIPARIAN ZONE

"STOP"  
"ONE-WAY  
DO NOT ENTER"

50' NO  
BUILD

PAVED AREA TO BE  
STREET SWEEP  
SEE NOTE #7

25' NO  
DISTURB

30'  
APPROXIMATE  
LOCATION  
EXISTING SEWER  
EASEMENT

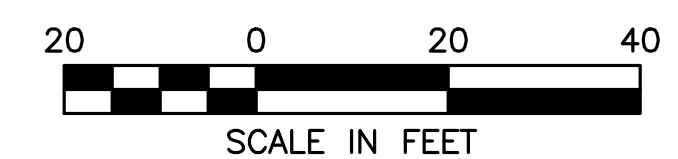
12" STRAW WATTLE  
EROSION CONTROL  
BARRIER

SILT FENCE BARRIER  
(INSTALL ADJACENT TO,  
AND DOWN GRADIENT OF  
STRAW WATTLE)

25' NO  
DISTURB

**SHAWSHEEN RIVER**

- NOTES:
- DMH-5 SHALL BE EQUIPPED WITH A BACKFLOW PREVENTION DEVICE. REFER TO DETAIL SHEET 4 OF 4 FOR ADDITIONAL INFORMATION.
  - DMH-4 AND DMH-6 SHALL BE EQUIPPED WITH A SUMP.
  - NO STORMWATER SHALL BE DISCHARGED THROUGH THE STORMWATER MANAGEMENT SYSTEM UNTIL OUTLET IS STABILIZED.
  - NO SALT, SAND, FERTILIZERS, PET WASTE, HAZARDOUS CHEMICALS, ETC., SHALL BE STORED IN THE GARAGE WHERE FLOOD WATERS COULD REACH.
  - THERE WILL BE NO VEHICLE WASHING PERMITTED ON SITE.
  - ALL SNOW SHALL BE DISPOSED OF OFF-SITE IN A MANNER CONSISTENT WITH LOCAL AND STATE REGULATIONS.
  - MECHANICAL STREET SWEEPING SHALL OCCUR ON ALL PAVED SURFACES (INCLUDING INSIDE THE GARAGE) ON AVERAGE TWELVE (12) TIMES A YEAR (PRIMARILY IN THE SPRING AND FALL) IN PERPETUITY.





# Appendix B: Erosion and Sediment Control Notes and General Construction Sequence

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## Erosion and Sediment Control Notes

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- 1) Erosion and sediment control measures must be installed prior to the start of construction and maintained and upgraded as necessary during construction by the contractor. It is the contractor's responsibility to inspect and install additional control measures as needed during construction.
- 2) All catch basins receiving drainage from the project site must be provided with a catch basin filter.
- 3) Stabilization of all re-graded and soil stockpile areas must be maintained during all phases of construction. Stockpiled material should be kept to a minimum for short periods of time and should consist of clean fill.
- 4) Sediment removed from erosion and sediment control devices must be properly removed and disposed. All damaged controls must be removed and replaced.
- 5) The contractor is responsible for implementing the erosion and sediment control plan. This includes the installation and maintenance of control measures, informing all parties engaged on the construction site of the requirements and objectives of the plan, and notifying the proper city agency of any transfer of this responsibility.
- 6) The contractor shall be responsible for controlling wind erosion and dust throughout the life of his contract. Dust control may include, but is not limited to, sprinkling of water on exposed soils and street sweeping adjacent roadways.
- 7) Final grading cannot be delayed. The contractor will prepare a detailed plan and approach for keeping the site stabilized. Once existing pavement is removed final grading, repaving, or immediate stabilization will commence with temporary vegetation. No mulch shall be used on site.
- 8) If a disturbed area will be exposed for greater than one-year, permanent grasses or other approved cover must be installed.
- 9) The contractor must keep on-site at all times additional silt fence and hay bales for the installation at the direction of the engineer or the city to mitigate any emergency condition.
- 10) The construction fencing and erosion and sediment controls as shown may not be practical during all stages of construction. Earthwork activity on-site must be done in a manner such that runoff is directed to a sediment control device such as the devices listed above, sediment traps, infiltration, or active treatment systems.
- 11) Demolition and construction debris must be properly contained and disposed of.



- 12) Disposal of all demolished materials is the responsibility of the contractor and must be hauled off-site in accordance with all federal, state, and local requirements.
- 13) The contractor is responsible for the inspection of the slope along the Shawsheen River Reservoir. Any trash shall be removed, and erosion gullies repaired.
- 14) Vehicle washing shall be prohibited on site.
- 15) All catch basin spoils shall be disposed of in a manner consistent with all Local, State, and Federal regulations.

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## General Construction Sequence

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- 1) Install erosion and sediment controls prior to starting any earthworks activity.
- 2) Begin clearing, grubbing and demolition.
- 3) Begin utility installations.
- 4) Construct building foundation.
- 5) Install site furnishings.
- 6) Install landscaping.
- 7) Erosion and sediment controls shall be maintained until permanent cover is established.



# Appendix C: Flood Storage Calculations

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## Flood Storage Calculations - Pre- vs. Post-Development



Site Location: Tantallon Road, Andover, MA

*These calculations are updated to reflect the building shift outside the floodway. Storage inside the footprint of the proposed building has NOT been included.*

Date: 02/07/2020

**rev. 08/31/2022**

By: MB

Checked: KE

| Elevation | Pre-Development      |                                 | Post-Development     |                                 | Incremental Increase<br>(Decrease) (cf) | Cumulative Increase<br>(Decrease) (cf) |
|-----------|----------------------|---------------------------------|----------------------|---------------------------------|---|--|
|           | Storage Area<br>(sf) | Vol. Between<br>Elevations (cf) | Storage Area<br>(sf) | Vol. Between<br>Elevations (cf) |   |  |
| 29        | 7697                 |                                 | 7697                 |                                 |   |  |
|           |                      | 8113.5                          |                      | 8113.5                          | 0                                       | <b>0</b>                               |
| 30        | 8530                 |                                 | 8530                 |                                 |   |  |
|           |                      | 8948                            |                      | 8948                            | 0                                       | <b>0</b>                               |
| 31        | 9366                 |                                 | 9366                 |                                 |   |  |
|           |                      | 10089                           |                      | 10142.5                         | 53.5                                    | <b>53.5</b>                            |
| 32        | 10812                |                                 | 10919                |                                 |   |  |
|           |                      | 16080.5                         |                      | 16555                           | 474.5                                   | <b>528</b>                             |
| 33        | 21349                |                                 | 22191                |                                 |   |  |
|           |                      | 28790.5                         |                      | 30367                           | 1576.5                                  | <b>2104.5</b>                          |
| 34        | 36232                |                                 | 38543                |                                 |   |  |
|           |                      | 38254                           |                      | 39077.5                         | 823.5                                   | <b>2928</b>                            |
| 35        | 40276                |                                 | 39612                |                                 |   |  |
|           |                      | 40276                           |                      | 39612                           | -664                                    | <b>2264</b>                            |
| 36        | 40276                |                                 | 39612                |                                 |   |  |
|           |                      | 40276                           |                      | 39612                           | -664                                    | <b>1600</b>                            |
| 37        | 40276                |                                 | 39612                |                                 |   |  |
|           |                      | 40276                           |                      | 39612                           | -664                                    | <b>936</b>                             |
| 38        | 40276                |                                 | 39612                |                                 |   |  |

Post El. 34 Adjustment for Building:

|                                    |       |                               |
|------------------------------------|-------|-------------------------------|
| Contour area (SF)                  | 48887 |                               |
| Subtract: Building Footprint (SF)  | 10344 |                               |
| Subtract: Ground Above El. 34 (SF) | 0     | (LS area adj. to front entry) |
| Adjusted value for Post El. 34:    | 38543 |                               |



# Appendix D: Contech CDS Documentation

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The Tantalum

CDS-1

CDS 2015-4

**CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD**

| Rainfall Intensity <sup>1</sup> (in/hr)   | % Rainfall Volume <sup>1</sup> | Cumulative Rainfall Volume | Rainfall Volume Treated | Total Flowrate (cfs) | Treated Flowrate (cfs) | Operating Rate (%) | Removal Efficiency (%) | Incremental Removal (%) |
|---|--------------------------------|----------------------------|-------------------------|----------------------|------------------------|--------------------|------------------------|-------------------------|
| 0.0200  | 10.17%                         | 10.17%                     | 10.17%                  | 0.0184               | 0.0184                 | 2.63%              | 100.00%                | 10.17%                  |
| 0.0400  | 9.65%                          | 19.82%                     | 9.65%                   | 0.0368               | 0.0368                 | 5.26%              | 100.00%                | 9.65%                   |
| 0.0600  | 9.45%                          | 29.27%                     | 9.45%                   | 0.0553               | 0.0553                 | 7.90%              | 99.83%                 | 9.43%                   |
| 0.0800  | 7.74%                          | 37.01%                     | 7.74%                   | 0.0737               | 0.0737                 | 10.53%             | 99.30%                 | 7.69%                   |
| 0.1000  | 8.57%                          | 45.58%                     | 8.57%                   | 0.0921               | 0.0921                 | 13.16%             | 98.78%                 | 8.47%                   |
| 0.1200  | 6.30%                          | 51.88%                     | 6.30%                   | 0.1105               | 0.1105                 | 15.79%             | 98.25%                 | 6.19%                   |
| 0.1400  | 4.66%                          | 56.54%                     | 4.66%                   | 0.1290               | 0.1290                 | 18.43%             | 97.72%                 | 4.55%                   |
| 0.1600  | 4.64%                          | 61.18%                     | 4.64%                   | 0.1474               | 0.1474                 | 21.06%             | 97.20%                 | 4.51%                   |
| 0.1800  | 3.54%                          | 64.72%                     | 3.54%                   | 0.1658               | 0.1658                 | 23.69%             | 96.67%                 | 3.42%                   |
| 0.2000  | 4.34%                          | 69.06%                     | 4.34%                   | 0.1842               | 0.1842                 | 26.31%             | 96.15%                 | 4.17%                   |
| 0.2500  | 8.00%                          | 77.06%                     | 8.00%                   | 0.2303               | 0.2303                 | 32.90%             | 94.83%                 | 7.59%                   |
| 0.3000  | 5.59%                          | 82.65%                     | 5.59%                   | 0.2764               | 0.2764                 | 39.49%             | 93.51%                 | 5.23%                   |
| 0.3500  | 4.37%                          | 87.02%                     | 4.37%                   | 0.3224               | 0.3224                 | 46.06%             | 92.19%                 | 4.03%                   |
| 0.4000  | 2.53%                          | 89.55%                     | 2.53%                   | 0.3685               | 0.3685                 | 52.64%             | 90.88%                 | 2.30%                   |
| 0.4500  | 2.53%                          | 92.08%                     | 2.53%                   | 0.4145               | 0.4145                 | 59.21%             | 89.56%                 | 2.27%                   |
| 0.5000  | 1.38%                          | 93.46%                     | 1.38%                   | 0.4606               | 0.4606                 | 65.80%             | 88.24%                 | 1.22%                   |
| 0.7500  | 5.04%                          | 98.50%                     | 5.04%                   | 0.6909               | 0.6909                 | 98.70%             | 81.66%                 | 4.12%                   |
| 1.0000  | 1.01%                          | 99.51%                     | 0.77%                   | 0.9212               | 0.7000                 | 100.00%            | 61.85%                 | 0.62%                   |
| 1.5000  | 0.00%                          | 99.51%                     | 0.00%                   | 1.3818               | 0.7000                 | 100.00%            | 41.24%                 | 0.00%                   |
| 2.0000  | 0.00%                          | 99.51%                     | 0.00%                   | 1.8424               | 0.7000                 | 100.00%            | 30.93%                 | 0.00%                   |
| 3.0000  | 0.48%                          | 99.99%                     | 0.12%                   | 2.7636               | 0.7000                 | 100.00%            | 20.62%                 | 0.10%                   |
|   |                                |                            |                         |                      |                        |                    |                        | 95.73%                  |
| Removal Efficiency Adjustment <sup>2</sup> =  |                                |                            |                         |                      |                        |                    |                        | 6.45%                   |
| Predicted % Annual Rainfall Treated =   |                                |                            |                         |                      |                        |                    |                        | 92.94%                  |
| Predicted Net Annual Load Removal Efficiency =  |                                |                            |                         |                      |                        |                    |                        | 89.28%                  |
| <sup>1</sup> - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA |                                |                            |                         |                      |                        |                    |                        |                         |
| <sup>2</sup> - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes. |                                |                            |                         |                      |                        |                    |                        |                         |

**NJCAT TECHNOLOGY VERIFICATION**

**HIGH EFFICIENCY CONTINUOUS  
DEFLECTIVE SEPARATOR (CDS<sup>®</sup>)**

**CONTECH CONSTRUCTION PRODUCTS Inc.**

**January 2010**

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## **1. Introduction**

### **1.1 New Jersey Corporation for Advance 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 that the technology meets the regulatory intent and that there is a 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, 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 Interim Certification**

CONTECH Construction Products Inc. (CONTECH) is a leading provider of innovative, long-term, stormwater treatment solutions, offering a variety of products, maintenance, laboratory, and engineering support to meet stormwater treatment needs. CONTECH's patented product, the High Efficiency Continuous Deflective Separator (CDS<sup>®</sup>) unit is a Best Management Practice (BMP) designed to meet federal, state, and local requirements for treating stormwater runoff in compliance with the Clean Water Act. The High Efficiency CDS unit improves the quality of stormwater runoff before it enters receiving waterways through continuous deflective separation and settling to provide enhanced solids removal. (See Section 2 for an additional description of the technology.)

CDS Technologies, Inc., now CONTECH, received New Jersey Corporation for Advanced Technology (NJCAT) verification of claims for the CDS in June 2003. This verification was revised in December of 2004 and a Conditional Interim Certification was issued by NJDEP in January of 2005 for the High Efficiency CDS when used as a pre-treatment device. A major condition of this Conditional Interim Certification was the execution of a field evaluation in accordance with the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). Conditional Interim Certification was extended in August of 2007. A Project Plan for the Field Evaluation was completed in November of 2007, resulting in the commencement of monitoring activities.

## **1.3 Applicant Profile**

CONTECH offers a range of stormwater treatment products including filtration, hydrodynamic separation, volumetric separation, detention/retention, screening, oil/water separation, and flow control technologies. A knowledgeable team of 200 professionals across the U.S. provide the engineering and customer service support to determine a project's most appropriate stormwater treatment system that meets the requirements of the relevant permitting jurisdiction.

At CONTECH's state-of-the-art laboratories, engineers and scientists conduct ongoing research to further the understanding of non-point source pollution and develop practical product solutions. CONTECH helps its customers achieve their water quality goals by providing treatment technologies that remove a variety of pollutants from stormwater runoff. These stormwater treatment products are specifically designed to meet federal, state, and local regulations.

Former CONTECH subsidiaries Vortech (2004) and Stormwater Management, Inc. (2005) combined to form Stormwater360 (2006), and later became CONTECH Stormwater Solutions, Inc. a division of CONTECH Construction Products Inc. In December 2006, CDS Technologies, Inc. was added into CONTECH's product offerings.

CONTECH has four primary regional offices that service their customers.

**Ohio (Headquarters)**

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West Chester, OH 45069  
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**Maryland**

521 Progress Drive, Suite H  
Lithicum, MD 21090  
866-740-3318

**Maine**

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207-885-9830

**Oregon**

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866-400-3180

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Key managers of CONTECH are Rick Stepien – President CONTECH Marketing, James Lenhart – Chief Technical Officer, and Frank Birney – Vice President of Stormwater.

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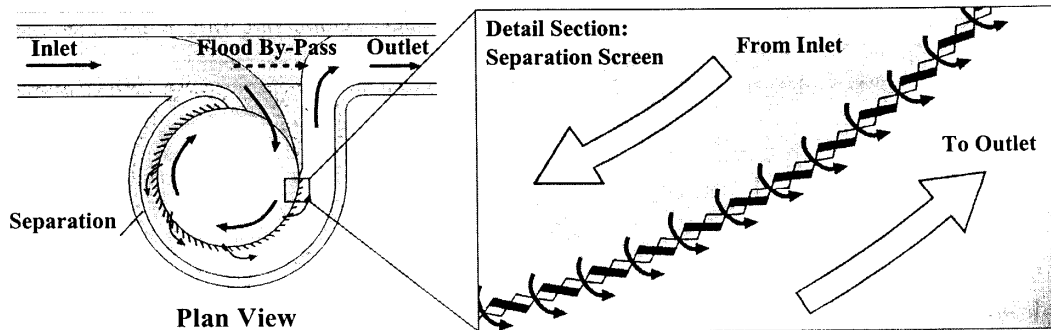
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**2. The High Efficiency CDS**

The High Efficiency CDS unit is typically comprised of a manhole that houses flow and screening controls designed around patented, continuous deflective separation technology. Stormwater runoff enters the High Efficiency CDS unit's diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed. The separation and containment chamber consist of a containment sump in the lower section and an upper separation section. Gross pollutants are separated within the chamber using a perforated plate allowing the filtered water to pass through to a volute return system and thence to the outlet pipe. The water and associated pollutants contained within the separation chamber are kept in continuous motion by the energy generated by the incoming flow. This has the effect of

preventing the separation plate from being blocked by the gross solids separated from the inflow. The heavier solids ultimately settle into the containment sump. Figure 1 is a schematic representation of the solid separation mechanism of the CDS technology.



**Figure 1 Schematic Representation of the CDS System**

The diversion of the stormwater and associated pollutants into a separation chamber overcomes problems associated with the direct filtration systems of conventional gross pollutant traps. The present design of the CDS system utilizes a simple solid diversion unit to divert flows into the separation chamber. The diversion unit is designed to divert all flows into the separation chamber as long as water levels are below the crest level of the diversion unit. As water levels exceed the crest of the diversion unit, some flows would by-pass the CDS system. The crest level of the diversion unit may be adjusted to suit individual installations.

The solid separation system consists of a large expanded stainless steel plate which acts as a filter screen with an outer volute outlet passage. The perforations in the separation screen are typically elongated in shape and are aligned with the longer axis in the vertical direction. The size of the elliptical holes can be specified according to performance requirements and typical width of the short axis ranges from 2.4 mm to 4.7 mm. The separation screen is installed in the unit such that the leading edge of each perforation extends into the flow within the containment chamber.

### *Operating Mechanism*

The essential operational function of the CDS unit is to ensure that the separation screen remains free from blocking by trapped material as the volume of pollutants trapped increases. All flows up to the unit's treatment design capacity enter the separation chamber. Swirl concentration and screen deflection forces direct floatables and solids to the center of the separation chamber, where floatables and neutrally buoyant debris larger than the screen apertures are trapped. Stormwater then moves through the separation screen, over the sediment weir, and exits the unit. The separation screen remains clog free due to continuous deflection. During flow events exceeding the design treatment capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants will not wash out. Once treated, stormwater is

directed to a collection pipe or discharged to an open channel drainage way. For more detailed information about the High Efficiency CDS unit visit [www.contechstormwater.com](http://www.contechstormwater.com).

The screen surface area is of the order of 40-45 times the pipe inlet area. Measurement of screen perforations indicates that the orifice area in the direction perpendicular to the plate is approximately 20% of the total plate area. The radial flow velocity through the screen is thus an order of magnitude less than the pipe inlet velocity. Gross solids are prevented from blocking the separation screen using the significantly higher tangential flow velocity compared to the radial velocity throughout the surface of the separation screen. The flow direction in the outer volute outlet system is opposite to that of the circular motion in the separation chamber.

Tangential velocity decreases along the separation screen as well as with depth and decreases from the screen to the center of the separation chamber. The radial velocity distribution is a direct reflection of the distribution of flow through the separation screen. Different inlet conditions can influence distribution of flow through the separation screen and optimization of the CDS unit configuration has been conducted to promote a radial velocity distribution which is consistent with the distribution of tangential velocities along the separation screen. Thus the ratio of tangential to radial velocities is maintained at a high level throughout the surface of the separation screen with both velocities decreasing with increasing distance from the inlet.

#### *Gross Solids Separation*

Solids entering the separation chamber can either be floating or settleable materials with those solids which are larger than the aperture size of the separation screen being prevented from passing through the screen. The trapped material is kept in motion within the separation chamber by the design of the unit which maintains the ratio of tangential to radial velocities necessary to promote the non-blocking mechanism throughout the surface of the separation screen. The settleable material ultimately settles into the containment sump. The floating material that enters the CDS unit (including organic matter which over time absorbs water and eventually sinks, e.g. leaf litter) remains within the separation chamber and circulates at the water surface until the water level drops and inflow ceases. The action of the inflow jet, the shaping of the screen and centrifugal effects tend to concentrate this floating material towards the center of the chamber away from the screen.

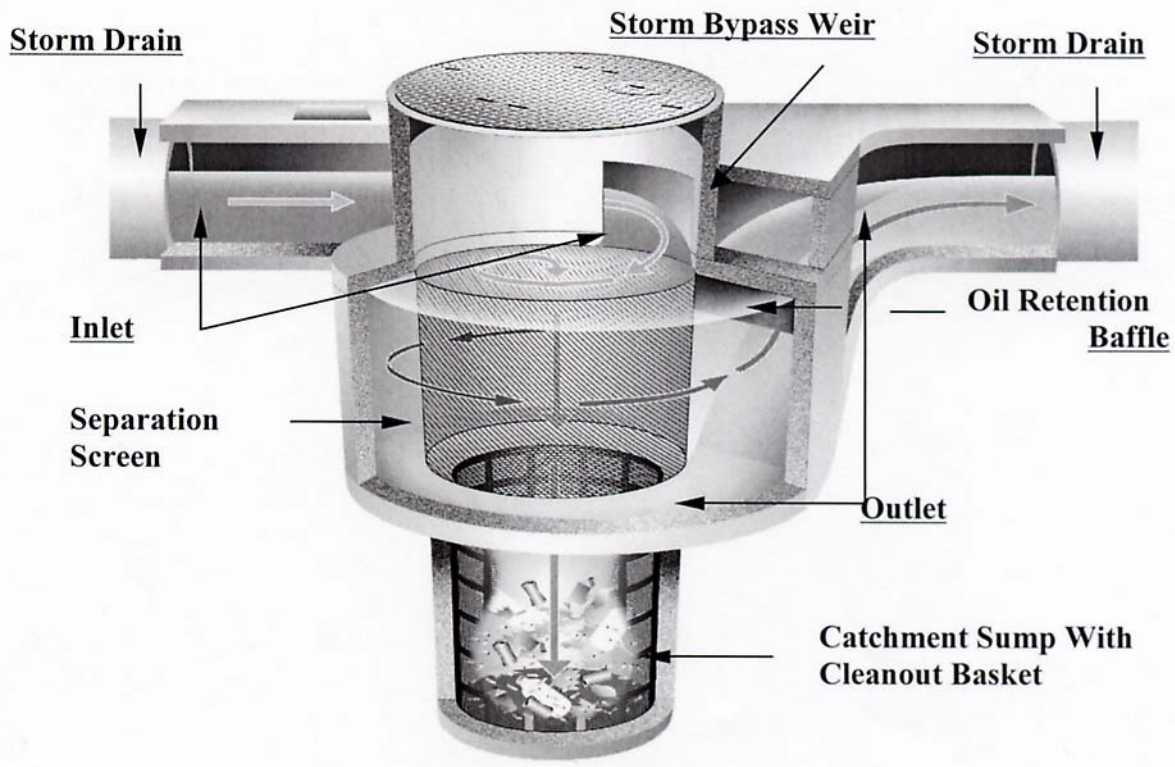
#### *Fine Solids Separation*

For solids which are smaller than the aperture size of the separation screen, trapping efficiency will be affected by the ability of the unit in keeping these solids away from the separation screen as they progressively settle into the containment chamber. The trajectory of these fine particles within the separation chamber is defined by the combined effect of fluid velocity within the chamber and the settling velocity of the particles. The likelihood for very fine particles to flow through the separation screen is higher than coarser particles owing to the trajectory of the former being more exposed to the separation screen. Both particle size and its settling velocity have a direct influence on the trapping efficiency of these particles by the CDS unit.

## *Oil and Grease Removal*

Oil and grease and other total petroleum hydrocarbons (TPHs) are primary water quality constituents of concern from many catchment areas, such as parking areas and highways. CDS units are equipped with a conventional oil baffle to capture and retain oil and grease and TPH pollutants as they are transported through the storm drain system during dry weather (gross spills) and wet weather flows.

There are three (3) types of configurations that CDS units are available in to meet the hydraulic and water quality needs of large and small projects. These treatment configurations can have either an internal or external bypass. Figure 2 provides an illustration of a typical off-line CDS unit.



**Figure 2 Schematic of an Off-Line CDS Unit**

### **3. Technology System Evaluation: Project Plan**

#### **3.1 Introduction**

CDS Technologies, Inc., now CONTECH, received New Jersey Corporation for Advanced Technology (NJCAT) verification of claims for the CDS in June 2003. This verification was

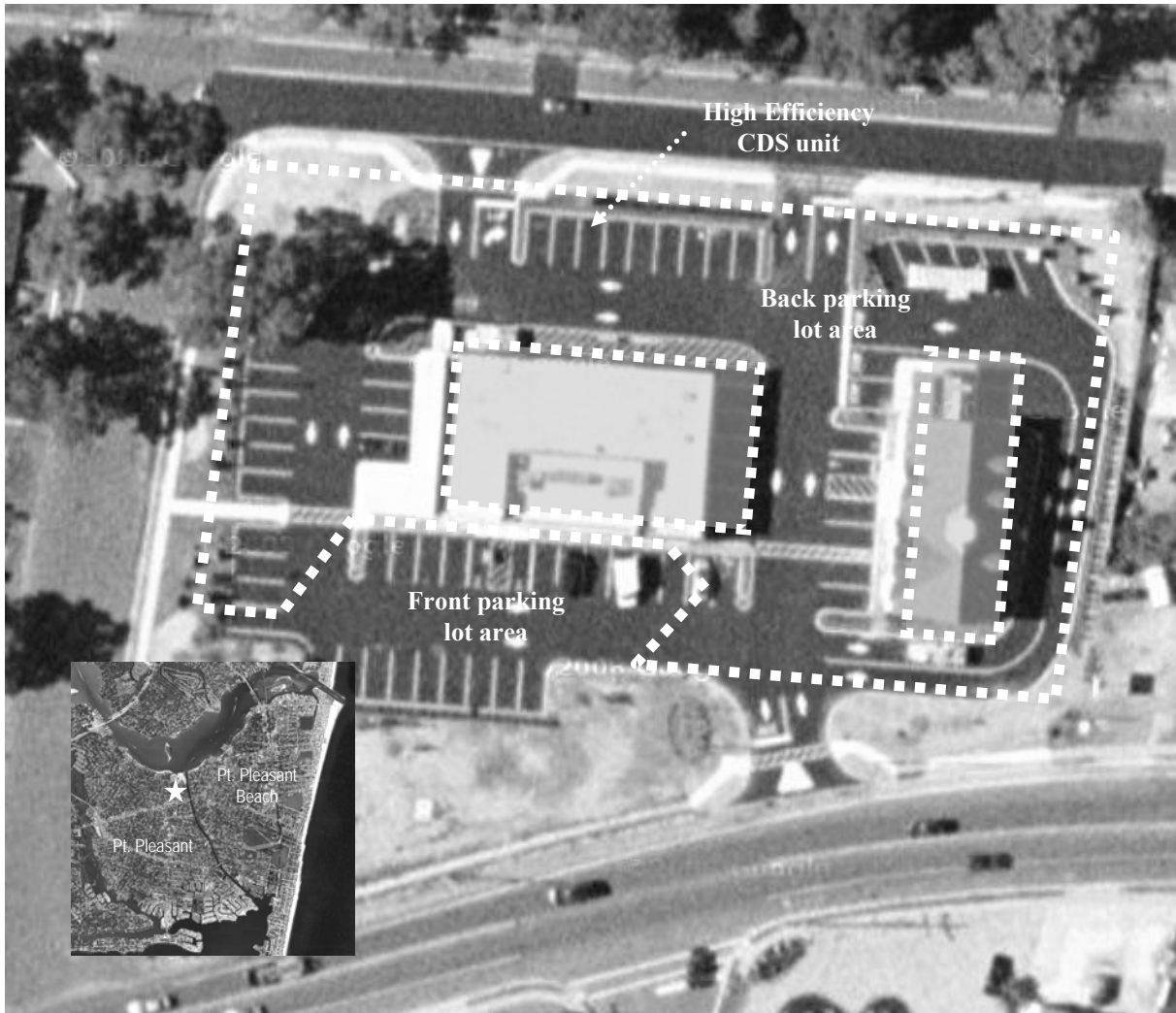
revised in December of 2004 and a Conditional Interim Certification (CIC) was issued by NJDEP on January of 2005 for the High Efficiency CDS for 50% TSS removal. A major condition of this Conditional Interim Certification was the execution of a field evaluation in accordance with the TARP Tier II Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). Conditional Interim Certification was extended in August of 2007. A Project Plan for the Field Evaluation was completed in November of 2007, resulting in the commencement of monitoring activities.

### **3.2 Site and System Description**

The Manasquan Savings Bank study site is located in the Borough of Point Pleasant, New Jersey (Lat: N 40.0834, Lon: W 74.07208) approximately 18 feet above sea level and is situated at the northeastern end of Ocean County, New Jersey. The site is located at the intersection of Route 88 and Herbertsville Road. A convenience store and bank currently occupy the site. Based on information provided by the specifying engineer the total drainage area of the site is 1.972 acres, 79% impervious. The contributing drainage area to the High Efficiency CDS installed on site is 0.90 acres. An aerial photo of the Manasquan Savings Bank study site is shown in Figure 3 and photographs of the study site are provided in Figures 4 and 5.

Stormwater runoff from the site is directed to a High Efficiency CDS unit model PMSU20\_25 (CDS2025) seen in Figure 6, before eventually discharging into the Manasquan River. The unit was installed during redevelopment of the site. The installation was allowed by NJDEP under the Conditional Interim Certification of the High Efficiency CDS. The High Efficiency CDS unit is designed in an on-line configuration with respect to the stormwater conveyance pipe system.

The water quality flow rate provided by the specifying engineer for the Manasquan Savings Bank study site is 1.4 cfs, based on the New Jersey Water Quality Design Storm of 1.25 inches over 2 hours. The Model 20\_25 High Efficiency CDS unit is rated to treat a maximum water quality flow rate of 1.6 cfs and a peak flow rate of 5.43 cfs. The next smallest CDS Model is only rated for a water quality flow of 1.1 cfs so the Model 20\_25 is appropriately sized for this site. Sizing is based on laboratory testing that serves as the basis of the CIC; the testing demonstrated a suspended solids removal rate of 73.7% or greater based on silica sand particles <100 $\mu$ m with a  $d_{50}$  of 63 $\mu$ m.



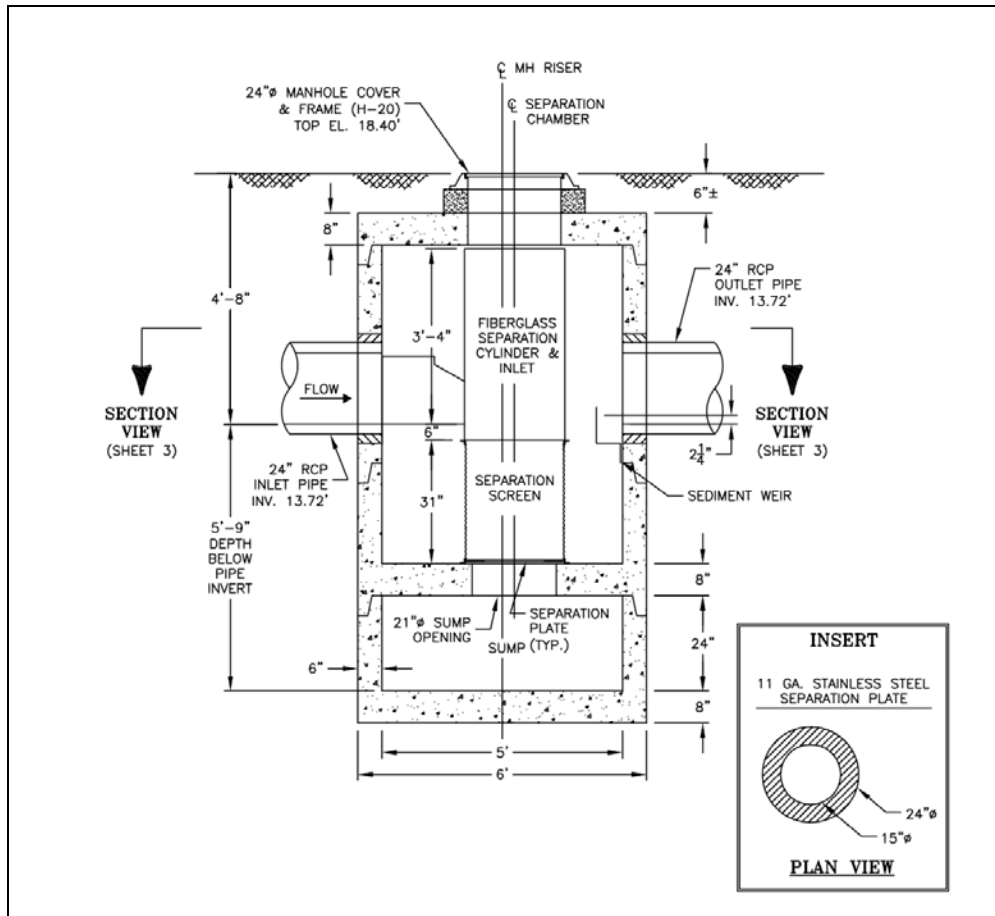
**Figure 3 Aerial view of Manasquan Savings Bank study site with drainage area outlined.**



**Figure 4 View of front parking lot area of Manasquan Savings Bank study site**



**Figure 5 View of back parking lot area of Manasquan Savings Bank study site**



**Figure 6 Elevation view of High Efficiency CDS unit installed at Manasquan Savings Bank study site**

### 3.3 Sampling Design

The equipment and sampling techniques used for this study are in accordance with the Project Plan (CONTECH, 2007) developed by CONTECH in consultation with NJDEP and NJCAT under the TARP Tier II Stormwater Protocol (TARP, 2003) and New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006). CONTECH personnel were responsible for the installation, operation, and maintenance of the sampling equipment. Sovereign Consulting was utilized for sample retrieval, system reset, and sample submittal activities. Water sample processing and analysis was performed by NJAL and Test America. A general overview of the methodology is provided.

A mobile monitoring unit (MMU) was provided, installed, maintained, and operated by CONTECH for sampling purposes. The MMU is a towable, fully enclosed, self-contained stormwater monitoring system specially designed and built by CONTECH for remote, extended-deployment stormwater monitoring. The design allows for remote control of sampling equipment, eliminates confined space entry requirements, and streamlines the sample pickup and data collection process. The MMU is shown in Figure 7.



**Figure 7 View of Mobile Monitoring Unit (MMU) installed at the Manasquan Savings Bank study site**

Influent and effluent samples were collected using individual ISCO 6712 Portable Automated Samplers configured for standard, individual, round, wide-mouth sample bottles with HDPE bottles in the 1 through 12 positions for discrete sample collection. The samplers were connected to individual 12VDC deep cycle power supplies recharged by a solar panel. The effluent sampler was equipped with an ISCO 750 Area Velocity Flow Module with a Low Profile Area Velocity Flow Sensor for flow analysis and effluent sample pacing. Sample pacing was based upon effluent flow readings by using a paired sampler configuration though the use of an ISCO SPA 1026 cable. Each sampler was also connected to an ISCO SPA 1489 Digital Cell Phone Modem to allow for remote communication and data access. Rainfall was analyzed with 0.01-in resolution with a Texas Electronics TR-4 tipping bucket-type rain gauge. The sample intake from each automated sampler pump was connected to a stainless steel sample strainer (9/16" diameter, 6" length, with multiple 1/4" openings) via a length of 3/8" ID Acutech Duality FEP/LDPE tubing. Sample strainers and the effluent flow sensor were mounted to the invert of the influent/effluent pipes using stainless steel spring rings.

The sample collection program input into each automated sampler was a two-part program developed to maximize the number of water quality samples collected as well as the coverage of the storm event. Influent and effluent sample collection programs were configured to collect two 500-mL aliquots per bottle spread between up to 12 1-L HDPE bottles. Samplers were

programmed to enable and start the sample collection program when flow conditions exceeded 5 gpm. Once enabled, the sampling equipment collected samples on a volume-paced basis allowing the specified pacing volume to pass before taking a sample. Pacing volumes were calculated for each storm event based on the predicted depth of precipitation in order to satisfy storm event coverage requirements.

Upon the collection of samples following a precipitation event, CONTECH personnel remotely communicated with the automated sampling equipment to confirm sample collection and dispatch personnel from Sovereign to retrieve the samples and reset the automated sampling equipment. Samples were delivered to NJAL by Sovereign using cold transport and accompanied by chain-of-custody documentation. At the direction of CONTECH personnel, sample bottles were combined by NJAL to create composite samples through identification of those bottles best representing the storm event based upon the storm event hydrograph. Selected sample bottles were thoroughly shaken and emptied into a cone splitter with a 2000 micron sieve on top to remove particles greater than 2000µm to ensure proper operation of the cone splitter (USGS, 1980).

**Table 1 Analytical methods used for analytical parameters of interest**

| <b>Parameter</b>                       | <b>Analytical Method</b> |
|--|--------------------------|
| Suspended Sediment Conc. (SSC)         | ASTM D3977               |
| Total Suspended Solids (TSS-SM)        | SM2540 D                 |
| Total Suspended Solids (TSS-EPA)       | EPA 160.2                |
| Total Volatile Suspended Solids (TVSS) | SM 2540G                 |
| Particle Size Distribution             | ASTM D4464               |

As per the Project Plan, the following quality control samples were used to assess the quality of both field sampling and analytical activities: equipment rinsate blanks, equipment field blanks, method blank, and duplicate analysis. Sample processing blank samples were not taken. Except for solids analyses that employ the use of the whole sample volume (SSC), all method blanks and duplicate analyses were handled by NJAL. Since solids analyses that employ the use of whole sample volume (SSC) consume the entire sample volume, replicate samples were prepared in place of duplicate samples and analyzed to allow the assessment of analytical accuracy. The results of equipment rinsate blanks, equipment blanks, and sample processing blanks are shown in Table 2 accompanied by associated decisions and action items for instances of detection.

**Table 2 Instances of contaminant detection in equipment rinsate blank and equipment field blank samples**

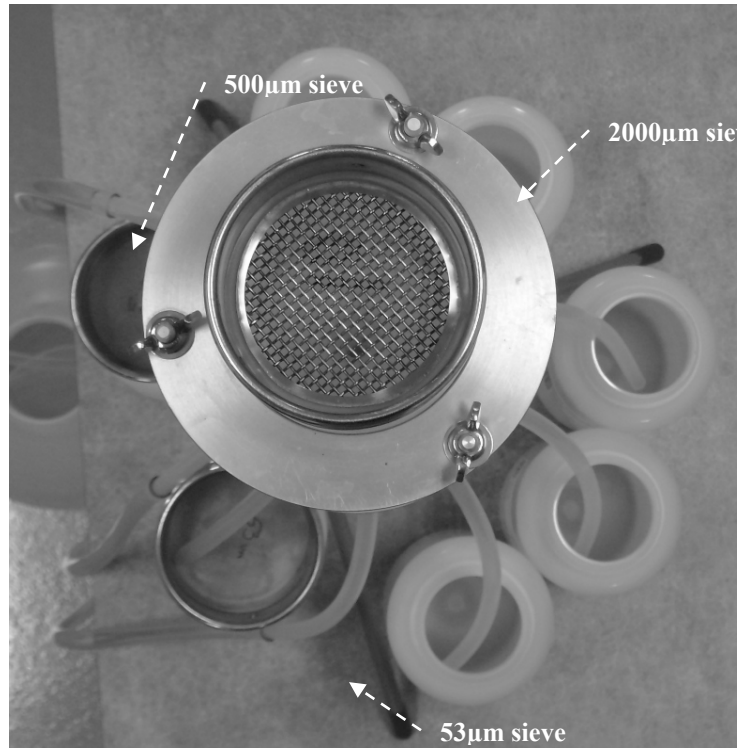
| Date     | Blank Type | Detections | Level (mg/L) | Action  | % of Sample Pairs Affected   |
|----------|------------|------------|--------------|---|--|
| 04/15/08 | Rinsate    |            |              | None  | 0  |
| 09/18/08 | Field      |            |              | None  | 0  |
| 01/29/08 | Field      | TVSS       | 0.9          | Disqualify TVSS results $\leq 4.5$ mg/L for events since last QC Blank. | TVSS(<50 $\mu$ m) 21%<br>TVSS(<500 $\mu$ m) 16%<br>TVSS(<2000 $\mu$ m) 5%<br>TVSS(>2000 $\mu$ m) 21% |

### 3.4 Particle Size Distribution and Residual Solids Assessment Methods

Two methods of evaluating influent particle size were used for this project. The first method, laser diffraction, was used in accordance with the TARP Tier II Protocol. The second method was a serial filtration process that was utilized for every storm event sampled. The serial filtration method is a direct measurement of particle size by mass whereas indirect methods such as Laser Diffraction and the electrical sensing zone method (Coulter Principle) convert counted data points into mass by way of assumptions regarding particle shape and density (CONTECH, 2004). For each storm event sampled, samples were poured through a 2000 $\mu$ m sieve prior to being split with a cone splitter as seen in Figure 6. Subsamples intended for SSC (<50 $\mu$ m) and SSC (<500 $\mu$ m) analysis were passed through 50 $\mu$ m and 500 $\mu$ m sieves respectively prior to analysis, as seen in Figure 8 and 9.

Results were obtained for SSC, SSC (>2000 $\mu$ m), SSC (<2000 $\mu$ m), SSC (<500 $\mu$ m), and SSC (<50 $\mu$ m). Results for SSC (>2000 $\mu$ m) and SSC were calculated. SSC (>2000 $\mu$ m) was calculated using the estimated volume of the sample used for the composite and the mass of material retained by the 2000 $\mu$ m sieve. SSC was equal to the sum of SSC (>2000 $\mu$ m) and SSC (<2000 $\mu$ m). The use of 2000 $\mu$ m and 50 $\mu$ m sieves to bracket the sand fraction is based upon the USDA particle size distribution system.

Residual solids captured by the system were assessed at the end of the monitoring phase of the project. The assessment involved the estimation of captured material found inside the system and the collection of a 20 liter composite sample of the residual solids. The composite sample of residual solids was homogenized by hand and representatively sampled for analysis. Subsamples were analyzed to determine moisture content, bulk density, and particle size distribution using hydrometer and sieve techniques. Results were used to characterize and determine the dry mass of captured residual solids.



**Figure 8** Top view of cone splitter apparatus prior sample splitting using sieves



**Figure 9** Side view of cone splitter apparatus prior to sample splitting using sieves

### 3.5 Precipitation Measurement

Rainfall was measured with a Texas Electronics TR-4 tipping bucket-type rain gauge. The rain gauge was connected to the ISCO 6712 programmed to record the total number of tips (0.01 inch per tip) every 5 minutes. A comparison of data collected during the monitoring period to data from a National Weather Service (NWS) cooperative station in Toms River, NJ (about 12 miles south of Point Pleasant) on a monthly basis indicated that the rain gauge was working properly during the monitoring period (Table 3). A comparison of the Toms River rain gauge monthly totals to monthly normal totals shows that rainfall in the area was below normal in October (2007), November (2007), January (2008), April (2008), June (2008), July (2008), August (2008), and October (2008). Rainfall was noticeably above normal in December (2007), February (2008) and September (2008).

**Table 3 Comparison of monthly rainfall data between National Weather Service (NWS) cooperative station in Toms River, NJ and Manasquan Savings Bank study site rain gage**

| Month            | MSB rain gage (in.) | NCDC Toms River rain gage (in.) | Percent of normal (%) | Monthly normal totals (1977-2000) |
|------------------|---------------------|---------------------------------|-----------------------|-----------------------------------|
| October (2007)   | --                  | 2.6                             | 73                    | 3.6                               |
| November (2007)  | 2.0                 | 1.9                             | 46                    | 4.1                               |
| December (2007)  | 6.1                 | 6.8                             | 167                   | 4.1                               |
| January (2008)   | 2.2                 | 2.6                             | 61                    | 4.2                               |
| February (2008)  | 5.3                 | 5.6                             | 168                   | 3.4                               |
| March (2008)     | 4.5                 | 4.8                             | 110                   | 4.3                               |
| April (2008)     | 2.2                 | 1.5                             | 37                    | 4.0                               |
| May (2008)       | 4.6                 | 4.9                             | 118                   | 4.2                               |
| June (2008)      | 3.8                 | 2.6                             | 73                    | 3.5                               |
| July (2008)      | 3.0                 | 3.2                             | 70                    | 4.6                               |
| August (2008)    | 1.3                 | 2.9                             | 58                    | 5.0                               |
| September (2008) | 3.9                 | 8.5                             | 214                   | 4.0                               |
| October (2008)   | 2.1                 | 1.6                             | 46                    | 3.6                               |
| November (2008)  | 5.0                 | 4.6                             | 114                   | 4.1                               |

A total of 19 qualifying storm events were successfully sampled during the monitoring period between January of 2008 and November of 2008. Collection of storm events commenced after the review and conditional approval of the Project Plan by project stake holders. Storm event durations ranged from 2.58 hours to 27.08 hours, rainfall depth for sampled events ranged from 0.31 to 3.20 inches, and 15 and 30 minute maximum intensities were 2.44 and 1.74 inches/hour respectively. Based on the drainage area provided by the specifying engineer of 0.90 acres the calculated total rainfall volume ranged from 7575 to 78,199 gallons (Table 4).

**Table 4 Rainfall and runoff statistics for sampled events at the Manasquan Savings Bank study site.**

| <b>Event ID</b> | <b>Duration of storm event (hours)</b> | <b>Total rainfall (in.)</b> | <b>P15 (in/hr)</b> | <b>P30 (in/hr)</b> | <b>Total rainfall volume (gal)</b> |
|-----------------|--|-----------------------------|--------------------|--------------------|------------------------------------|
| MSB011008       | 11.25                                  | 0.50                        | 0.16               | 0.52               | 12219                              |
| MSB011308       | 10.08                                  | 0.63                        | 0.32               | 0.46               | 15395                              |
| MSB011708       | 15.08                                  | 0.70                        | 0.24               | 0.30               | 17106                              |
| MSB020108       | 9.08                                   | 1.22                        | 0.40               | 0.62               | 29813                              |
| MSB040408       | 27.00                                  | 0.57                        | 0.24               | 0.24               | 13929                              |
| MSB050908       | 23.58                                  | 1.21                        | 0.36               | 0.40               | 29569                              |
| MSB051208       | 18.08                                  | 0.97                        | 0.28               | 0.38               | 23704                              |
| MSB052708       | 2.58                                   | 0.39                        | 0.52               | 0.66               | 9530                               |
| MSB053108       | 21.58                                  | 0.31                        | 0.52               | 0.26               | 7576                               |
| MSB060408       | 10.83                                  | 0.85                        | 0.64               | 0.90               | 20772                              |
| MSB061408       | 10.58                                  | 0.57                        | 1.12               | 0.56               | 13929                              |
| MSB061508       | 21.08                                  | 0.92                        | 2.44               | 1.74               | 22482                              |
| MSB070508       | 21.08                                  | 0.88                        | 0.80               | 0.88               | 21505                              |
| MSB072408       | 8.08                                   | 1.14                        | 1.44               | 0.80               | 27858                              |
| MSB081408       | 27.08                                  | 0.85                        | 0.76               | 0.46               | 20772                              |
| MSB092508       | 15.08                                  | 3.20                        | 1.40               | 1.38               | 78199                              |
| MSB111508       | 25.33                                  | 0.97                        | 0.28               | 0.26               | 23704                              |
| MSB112508       | 14.83                                  | 0.97                        | 0.16               | 0.30               | 23704                              |
| MSB113008       | 32.08                                  | 1.46                        | 0.36               | 0.50               | 35678                              |

### **3.6 Flow Measurement**

An ISCO 750 Area Velocity Flow Module with a Low Profile Area Velocity Flow Sensor was used to measure flow and pace sample collection. Level measurements were adjusted by applying corrections that reflected differences between recorded and measured water surface elevations in the effluent pipe where the ISCO flow sensor was installed. On average 78 percent of the calculated total rainfall volume was measured as runoff for the events monitored (Table 5).

**Table 5 Percentage of calculated rainfall runoff volumes measured at Manasquan Savings Bank study site**

| <b>Event ID</b> | <b>Event depth (in)</b> | <b>Influent volume (gal)</b> | <b>Total rainfall volume (gal)</b> | <b>Percent runoff (%)</b> |
|-----------------|-------------------------|------------------------------|------------------------------------|---------------------------|
| MSB011008       | 0.50                    | 8275                         | 12219                              | 68                        |
| MSB011308       | 0.63                    | 10530                        | 15395                              | 68                        |
| MSB011708       | 0.70                    | 9487                         | 17106                              | 55                        |
| MSB020108       | 1.22                    | 30508                        | 29813                              | 102                       |
| MSB040408       | 0.57                    | 4740                         | 13929                              | 34                        |
| MSB050908       | 1.21                    | 13134                        | 29569                              | 44                        |
| MSB051208       | 0.97                    | 10050                        | 23704                              | 42                        |
| MSB052708       | 0.39                    | 7915                         | 9530                               | 83                        |
| MSB053108       | 0.31                    | 10153                        | 7576                               | 134                       |
| MSB060408       | 0.85                    | 24003                        | 20772                              | 116                       |
| MSB061408       | 0.57                    | 13560                        | 13929                              | 97                        |
| MSB061508       | 0.92                    | 15465                        | 22482                              | 69                        |
| MSB070508       | 0.92                    | 24748                        | 22482                              | 110                       |
| MSB072408       | 1.14                    | 28963                        | 27858                              | 104                       |
| MSB081408       | 0.85                    | 19781                        | 20772                              | 95                        |
| MSB092508       | 3.20                    | 65868                        | 78199                              | 84                        |
| MSB111508       | 0.97                    | 15806                        | 23704                              | 67                        |
| MSB112508       | 0.97                    | 11707                        | 23704                              | 49                        |
| MSB113008       | 1.46                    | 24187                        | 35678                              | 68                        |

### **3.7 Stormwater Data Collection Requirements**

Of the 19 qualifying storm events sampled between January of 2008 and November of 2008: 1) the total rainfall was greater than 0.1 inch for all storm events sampled, 2) the minimum inter-event period was greater than 12 hours for all storm events sampled, 3) flow-weighted composite samples covered a minimum of 70% of total storm flow for all storm events sampled, 4) the average number of samples collected per storm event was 11, 5) the total sampled rainfall was 18.35 inches, 6) three events exceeded 75% of the design treatment capacity, and 6) TSS-SM, TSS-EPA, and SSC data were collected for all storm events sampled. All but two of the events qualified to strict interpretation of the stormwater data collection requirements as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003), Table 6. For the storm events in question, MSB040408 and MSB072408, less than 6 samples were collected but storm event coverage was greater than 90%. Considering the very small margin separating these events from qualification, they were deemed qualified based upon best professional judgment.

**Table 6 Stormwater data collection requirements results**

| <b>Event ID</b> | <b>Coverage (nearest 10%)</b> | <b>Number of samples</b> | <b>Event depth (in.)</b> | <b>Antecedent dry period (hr)</b> | <b>Influent volume (gal)</b> | <b>Peak flow (gpm)</b> | <b>Percent of hyd. design (%)</b> |
|-----------------|-------------------------------|--------------------------|--------------------------|-----------------------------------|------------------------------|------------------------|-----------------------------------|
| MSB011008       | 70                            | 6                        | 0.50                     | 734                               | 8275                         | 241                    | 34                                |
| MSB011308       | 70                            | 8                        | 0.63                     | 53                                | 10530                        | 162                    | 23                                |
| MSB011708       | 90                            | 9                        | 0.70                     | 64                                | 9487                         | 113                    | 16                                |
| MSB020108       | 80                            | 24                       | 1.22                     | 49                                | 30508                        | 209                    | 29                                |
| MSB040408       | >90                           | 5                        | 0.57                     | 45                                | 4740                         | 66                     | 9                                 |
| MSB050908       | 70                            | 9                        | 1.21                     | 235                               | 13134                        | 132                    | 18                                |
| MSB051208       | 80                            | 8                        | 0.97                     | 51                                | 10050                        | 103                    | 14                                |
| MSB052708       | 90                            | 9                        | 0.39                     | 12                                | 7915                         | 353                    | 49                                |
| MSB053108       | 90                            | 9                        | 0.31                     | 81                                | 10153                        | 238                    | 33                                |
| MSB060408       | >90                           | 22                       | 0.85                     | 69                                | 24003                        | 339                    | 47                                |
| MSB061408       | >90                           | 14                       | 0.57                     | 228                               | 13560                        | 436                    | 61                                |
| MSB061508       | >90                           | 9                        | 0.92                     | 12                                | 15465                        | 743                    | 103                               |
| MSB070508       | >90                           | 8                        | 0.92                     | 89.6                              | 24748                        | 363                    | 51                                |
| MSB072408       | >90                           | 5                        | 1.14                     | 84.8                              | 28963                        | 620                    | 86                                |
| MSB081408       | 90                            | 6                        | 0.85                     | 14.8                              | 19781                        | 349                    | 49                                |
| MSB092508       | >90                           | 21                       | 3.20                     | 304                               | 65868                        | 619                    | 86                                |
| MSB111508       | >90                           | 10                       | 0.97                     | 33                                | 15806                        | 145                    | 20                                |
| MSB112508       | >90                           | 8                        | 0.97                     | 212                               | 11707                        | 57                     | 8                                 |
| MSB113008       | >90                           | 14                       | 1.46                     | 114                               | 24187                        | 158                    | 22                                |

#### 4. Technology System Performance

##### 4.1 Data Analysis

Of the 19 storm events captured between January of 2008 and November of 2008, data verification and validation did not lead to the outright disqualification of any events due to obvious monitoring, handling, or analytical errors, or the substantial exceedance of the design operating parameters. However, some instances were encountered that suggested the disqualification or separation of select analytical results from the data set. Some monitoring error was encountered in the form of equipment contamination as discussed in the Sampling Design section. This suggests the disqualification of a portion of the Total Volatile Suspended Solids (TVSS) data as well as calculated parameters that utilize TVSS data according to Table 2. Disqualification of either an influent or effluent result resulted in the elimination of the paired data from the final data set. Event mean concentrations (EMCs) from influent and effluent samples are summarized in Table 7, 8, and 9.

**Table 7 Suspended Solids Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID  | TSS-SM<br>(<2000µm)<br>(mg/l) |          | TSS-EPA<br>(<2000µm)<br>(mg/l) |          | SSC<br>(mg/l) |          | SSC<br>(>2000µm)<br>(mg/l) |          | SSC<br>(<2000µm)<br>(mg/l) |          | SSC<br>(<500µm)<br>(mg/l) |          | SSC<br>(<50µm)<br>(mg/l) |          |
|-----------|-------------------------------|----------|--------------------------------|----------|---------------|----------|----------------------------|----------|----------------------------|----------|---------------------------|----------|--------------------------|----------|
|           | Influent                      | Effluent | Influent                       | Effluent | Influent      | Effluent | Influent                   | Effluent | Influent                   | Effluent | Influent                  | Effluent | Influent                 | Effluent |
| MSB011008 | 180.0                         | 40.0     | 130.0                          | 30.0     | 1360.0        | 40.3     | 367.0                      | 2.5      | 993.0                      | 40.3     | 397.0                     | 40.3     | 55.7                     | 26.9     |
| MSB011308 | 60.0                          | 10.0     | 50.0                           | 10.0     | 760.0         | 13.2     | 381.0                      | 4.1      | 379.0                      | 13.2     | 101.0                     | 13.0     | 26.2                     | 12.8     |
| MSB011708 | 60.0                          | 30.0     | 60.0                           | 40.0     | 178.0         | 36.5     | 25.5                       | 4.4      | 152.0                      | 36.5     | 81.1                      | 35.7     | 44.2                     | 35.5     |
| MSB020108 | 60.0                          | 50.0     | 60.0                           | 50.0     | 152.0         | 65.3     | 42.7                       | 11.1     | 109.0                      | 54.2     | 70.0                      | 43.4     | 56.6                     | 51.6     |
| MSB040408 | 310.0                         | 2.9      | 40.0                           | 10.0     | 341.0         | 2.4      | NT                         | NT       | 341.0                      | 2.4      | 99.7                      | 2.9      | 26.5                     | 2.9      |
| MSB050908 | 56                            | 21       | 48                             | 21       | 78.7          | 23.3     | 24.7                       | 0.2      | 54                         | 23.3     | 27.7                      | 23.8     | 4.8                      | 7.6      |
| MSB051208 | 41                            | 6        | 32                             | 8.7      | 50.6          | 9.3      | 15.7                       | 0.2      | 34.9                       | 9.3      | 10.2                      | 6.3      | 4.6                      | 3.7      |
| MSB052708 | 68                            | 32       | 60                             | 34.7     | 74.5          | 40.7     | 7                          | 2.4      | 67.5                       | 38.3     | 40.5                      | 29.6     | 14.3                     | 7.5      |
| MSB053108 | 154                           | 43.2     | 141                            | 41       | 188.5         | 41.1     | 27.7                       | 0.27     | 160.8                      | 40.8     | 60                        | 30.3     | 20.8                     | 12.8     |
| MSB060408 | 24.3                          | 9        | 23.3                           | 7.7      | 27.7          | 10.5     | 0.8                        | 0.6      | 26.9                       | 9.9      | 17.4                      | 5.3      | 6                        | 7.3      |
| MSB061408 | 718                           | 84       | 658                            | 51       | 710.7         | 74.7     | 25.2                       | 4.4      | 685.5                      | 70.3     | 508.6                     | 41.6     | 125.1                    | 32.8     |
| MSB061508 | 304                           | 40       | 298                            | 37       | 299.5         | 55.9     | 11                         | 0.1      | 288.5                      | 55.9     | 241                       | 29.5     | 72.6                     | 11.8     |
| MSB070508 | 271                           | 26       | 232                            | 25.5     | 241.9         | 30.3     | 3.9                        | 0.38     | 238                        | 29.9     | 158                       | 13.6     | 52.4                     | 6.8      |
| MSB072408 | 458.7                         | 46       | 427                            | 43.3     | 500           | 49.7     | 8.6                        | 6.71     | 491.1                      | 43       | 256.2                     | 24.2     | 74.4                     | 9.4      |
| MSB081408 | 657                           | 48       | 468.5                          | 41       | 598           | 42.5     | 55.2                       | 0.2      | 542.8                      | 42.3     | 271.2                     | 31.9     | 50                       | 14.2     |
| MSB092508 | 2259                          | 13.8     | 2075                           | 12.7     | 6995          | 22.5     | 845                        | 0.1      | 6150                       | 22.5     | 2558                      | 9.1      | 16.2                     | 4.7      |
| MSB111508 | 75.5                          | 25.1     | 46.6                           | 17       | 113           | 21.8     | 41.1                       | 0.1      | 71.9                       | 21.7     | 21.4                      | 9.3      | 11.6                     | 7.2      |
| MSB112508 | 29.4                          | 2.5      | 20.5                           | 2.5      | 38.9          | 3.8      | 14.2                       | 0.1      | 24.7                       | 3.7      | 9.2                       | 1.4      | ND                       | ND       |
| MSB113008 | 519                           | 16.8     | 348                            | 16.7     | 381.8         | 15.7     | 25.5                       | 0.1      | 356.3                      | 15.6     | 178.6                     | 7.6      | 56.1                     | 5.1      |
| Min       | 24.3                          | 2.5      | 20.5                           | 2.5      | 27.7          | 2.4      | 0.8                        | 0.1      | 24.7                       | 2.4      | 9.2                       | 1.4      | 4.6                      | 2.9      |
| Max       | 2259.0                        | 84.0     | 2075.0                         | 51.0     | 6995.0        | 74.7     | 845.0                      | 11.1     | 6150.0                     | 70.3     | 2558.0                    | 43.4     | 125.1                    | 51.6     |
| Median    | 154.0                         | 26.0     | 60.0                           | 25.5     | 241.9         | 30.3     | 25.4                       | 0.3      | 238.0                      | 29.9     | 99.7                      | 23.8     | 35.4                     | 8.5      |
| Mean      | 331.8                         | 28.8     | 274.6                          | 26.3     | 688.9         | 31.6     | 106.8                      | 2.1      | 587.7                      | 30.2     | 268.8                     | 21.0     | 39.9                     | 14.5     |

ND = Non-detect

NT = Not Tested

**Table 8 Total Volatile Suspended Solids Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID      | TVSS (>2000µm)<br>(mg/l) |            | TVSS (<2000µm)<br>(mg/l) |             | TVSS (<500µm)<br>(mg/l) |             | TVSS (<50µm)<br>(mg/l) |             | TVSS (mg/l)  |             |
|---------------|--------------------------|------------|--------------------------|-------------|-------------------------|-------------|------------------------|-------------|--------------|-------------|
|               | Influent                 | Effluent   | Influent                 | Effluent    | Influent                | Effluent    | Influent               | Effluent    | Influent     | Effluent    |
| MSB011008     | NT                       | NT         | 90.7                     | 17.3        | 46.5                    | 19.2        | 20.9                   | 11.5        | NT           | NT          |
| MSB011308     | NT                       | NT         | 41.1                     | 7.3         | 21.2                    | 7.2         | 12.2                   | 7.1         | NT           | NT          |
| MSB011708     | NT                       | NT         | 29.0                     | 15.1        | 23.8                    | 14.8        | 17.4                   | 14.7        | NT           | NT          |
| MSB020108     | NT                       | NT         | 25.9                     | 20.7        | 24.3                    | 16.8        | 21.1                   | 19.8        | NT           | NT          |
| MSB040408     | NT                       | NT         | 24.9                     | 2.4         | 19.9                    | 2.9         | 11.8                   | 2.9         | NT           | NT          |
| MSB050908     | 23.4                     | 0.2        | 35.4                     | 14.8        | 16.4                    | 12.7        | 5.1                    | 3.6         | 58.8         | 14.8        |
| MSB051208     | 14.4                     | 0.2        | 28                       | 9.3         | 8.8                     | 8.5         | 6.4                    | 5.2         | 42.4         | 9.3         |
| MSB052708     | 6.6                      | 2.3        | 40.3                     | 19.9        | 23                      | 15.6        | 6.6                    | 2.6         | 46.9         | 22.2        |
| MSB053108     | 9.6                      | 0.3        | 100.8                    | 22          | 30.1                    | 14.5        | 6.6                    | 6           | 110.4        | 22.3        |
| MSB060408     | 0.8                      | 0.6        | 13.9                     | 6.8         | 8.9                     | 3.4         | 3.2                    | 1.4         | 14.7         | 7.4         |
| MSB061408     | 22.9                     | 4          | 284.5                    | 32.8        | 207.6                   | 18          | 38.6                   | 12.4        | 307.4        | 36.8        |
| MSB061508     | 8.7                      | 0.1        | 119                      | 23.9        | 91.8                    | 10.7        | 20.2                   | 4.1         | 127.7        | 23.9        |
| MSB070508     | 3.5                      | 0.3        | 106                      | 11.9        | 58.3                    | 6.3         | 15.4                   | 2.7         | 109          | 12.2        |
| MSB072408     | 8.6                      | 5.7        | 220.2                    | 43          | 106.4                   | 24.2        | 23.6                   | 9.4         | 229          | 49          |
| MSB081408     | 39.6                     | 0.2        | 235.2                    | 13.2        | 94.4                    | 11.6        | 3.2                    | 6.1         | 274.8        | 13.4        |
| MSB092508     | QC DQ                    | QC DQ      | 67.2                     | 9.1         | QC DQ                   | QC DQ       | QC DQ                  | QC DQ       | 97.4         | 9.2         |
| MSB111508     | QC DQ                    | QC DQ      | 44.8                     | 10.9        | 10.3                    | 4.8         | QC DQ                  | QC DQ       | 69           | 11          |
| MSB112508     | QC DQ                    | QC DQ      | QC DQ                    | QC DQ       | QC DQ                   | QC DQ       | QC DQ                  | QC DQ       | 21           | 2.9         |
| MSB113008     | QC DQ                    | QC DQ      | 145.6                    | 6.2         | QC DQ                   | QC DQ       | QC DQ                  | QC DQ       | 171.1        | 6.3         |
| <b>Min</b>    | <b>0.8</b>               | <b>0.1</b> | <b>13.9</b>              | <b>2.4</b>  | <b>8.8</b>              | <b>2.9</b>  | <b>3.2</b>             | <b>1.4</b>  | <b>14.7</b>  | <b>2.9</b>  |
| <b>Max</b>    | <b>39.6</b>              | <b>5.7</b> | <b>284.5</b>             | <b>43.0</b> | <b>207.6</b>            | <b>24.2</b> | <b>38.6</b>            | <b>19.8</b> | <b>307.4</b> | <b>49.0</b> |
| <b>Median</b> | <b>9.2</b>               | <b>0.3</b> | <b>56.0</b>              | <b>14.0</b> | <b>24.1</b>             | <b>12.2</b> | <b>12.2</b>            | <b>6.0</b>  | <b>103.2</b> | <b>12.8</b> |
| <b>Mean</b>   | <b>13.8</b>              | <b>1.4</b> | <b>91.8</b>              | <b>15.9</b> | <b>49.5</b>             | <b>11.9</b> | <b>14.2</b>            | <b>7.3</b>  | <b>120.0</b> | <b>17.2</b> |

NT = Not Tested

QC DQ = Quality Control Disqualification

**Table 9 Calculated Parameters (mineral) Event Mean Concentrations (EMCs) for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID      | Coarse Solids<br>(mineral)<br>(material >2000um)<br>(mg/l) |            | Sand<br>(mineral)<br>(material 2000um to 50um)<br>(mg/l) |             | Silt<br>(mineral)<br>(material <50um)<br>(mg/l) |             |
|---------------|--|------------|--|-------------|---|-------------|
|               | Influent   | Effluent   | Influent   | Effluent    | Influent  | Effluent    |
| MSB011008     | NT   | NT         | 868.0  | 2.4         | 35.0  | 15.0        |
| MSB011308     | NT   | NT         | 324.0  | 1.8         | 14.0  | 6.0         |
| MSB011708     | NT   | NT         | 96.0   | 1.6         | 27.0  | 21.0        |
| MSB020108     | NT   | NT         | 48.0   | 1.4         | 36.0  | 32.0        |
| MSB040408     | NT   | NT         | 301.0  | 2.9         | 14.7  | 2.9         |
| MSB050908     | 1.3  | 0.2        | 19   | 4.5         | 1.7   | 4           |
| MSB051208     | 1.3  | 0.2        | 8.7  | 2.3         | ND  | ND          |
| MSB052708     | 0.4  | 0.1        | 19.5   | 13.5        | 7.7   | 4.9         |
| MSB053108     | 18.1   | 0.1        | 45.8   | 12          | 14.2  | 6.8         |
| MSB060408     | ND   | ND         | 10.2   | 0.6         | 2.8   | 5.9         |
| MSB061408     | 2.3  | 0.4        | 314.5  | 17.1        | 86.5  | 20.4        |
| MSB061508     | 2.3  | 0.1        | 117.1  | 24.3        | 52.4  | 7.7         |
| MSB070508     | ND   | ND         | 95   | 13.9        | 37  | 4.1         |
| MSB072408     | 0  | 1.01       | 220.1  | 0           | 50.8  | 0           |
| MSB081408     | 15.6   | 0.2        | 260.8  | 21          | 46.8  | 8.1         |
| MSB092508     | QC DQ  | QC DQ      | QC DQ  | QC DQ       | QC DQ   | QC DQ       |
| MSB111508     | QC DQ  | QC DQ      | 20.9   | 5.1         | QC DQ   | QC DQ       |
| MSB112508     | QC DQ  | QC DQ      | QC DQ  | QC DQ       | QC DQ   | QC DQ       |
| MSB113008     | QC DQ  | QC DQ      | QC DQ  | QC DQ       | QC DQ   | QC DQ       |
| <b>Min</b>    | <b>0.0</b>   | <b>0.1</b> | <b>8.7</b>   | <b>0.0</b>  | <b>1.7</b>                                      | <b>0.0</b>  |
| <b>Max</b>    | <b>18.1</b>  | <b>1.0</b> | <b>868.0</b>   | <b>24.3</b> | <b>86.5</b>                                     | <b>32.0</b> |
| <b>Median</b> | <b>1.8</b>   | <b>0.2</b> | <b>95.5</b>  | <b>3.7</b>  | <b>31.0</b>                                     | <b>6.4</b>  |
| <b>Mean</b>   | <b>5.2</b>   | <b>0.3</b> | <b>173.0</b>   | <b>7.8</b>  | <b>30.5</b>                                     | <b>9.9</b>  |

ND = Non-detect

NT = Not Tested

QC DQ = Quality Control Disqualification

Using SSC (<500  $\mu\text{m}$ ) and SSC (<50  $\mu\text{m}$ ) EMC results the percent of corresponding SSC (<2000  $\mu\text{m}$ ) EMC results was calculated. The calculated percentages of corresponding SSC (<2000 $\mu\text{m}$ ) EMC results indicates the portion of material that are less than 500  $\mu\text{m}$  and 50  $\mu\text{m}$  in size and are summarized in Table 13.

Using TVSS EMC results the percent of corresponding SSC results was calculated. The calculated percentages of corresponding SSC (<2000 $\mu\text{m}$ ) results indicate the portion of material that is less than 500  $\mu\text{m}$  and 50  $\mu\text{m}$  in size and are summarized in Table 14.

Appendix A details system performance on an individual storm basis (discrete removal efficiency) using the Washington State Department of Ecology “individual storm reduction in pollutant concentration” method (WADOE, 2002 method #1)—the performance of the system over the course of a single storm event based upon EMC. Hydrograph and rainfall data from the events are also shown in Appendix A.

In order to determine if data was normally or log-normally distributed the Kolmogorov-Smirnov test was used. EMCs for all parameters analyzed were tested. Influent EMCs for SSC (<50 $\mu\text{m}$ ), TVSS, TVSS (>2000 $\mu\text{m}$ ), TVSS (<50 $\mu\text{m}$ ), and Silt (mineral) were normally distributed. Effluent EMCs for SSC, TVSS, SSC (<2000 $\mu\text{m}$ ), SSC (<500 $\mu\text{m}$ ), TVSS (<2000 $\mu\text{m}$ ), TVSS (<500 $\mu\text{m}$ ), TVSS (<50 $\mu\text{m}$ ), TSS-SM (<2000 $\mu\text{m}$ ), and TSS-EPA (<2000 $\mu\text{m}$ ) were normally distributed. Influent EMCs for Sand (mineral), SSC, SSC (>2000 $\mu\text{m}$ ), SSC (<2000 $\mu\text{m}$ ), SSC (<500 $\mu\text{m}$ ), TVSS (<2000 $\mu\text{m}$ ), TVSS (<500 $\mu\text{m}$ ), and TSS-SM (<2000 $\mu\text{m}$ ) were log normally distributed. Effluent EMCs for Coarse Solids (mineral) and SSC (>2000 $\mu\text{m}$ ) were log-normally distributed.

Non-parametric statistical methods were used to evaluate correlations and differences between influent and effluent EMCs since influent and effluent EMCs were generally not from the same statistical distribution. To test for positive correlations between influent and effluent EMCs, the Spearman Rank Order Correlation test was used (USGS, 1991). To evaluate the significance of differences between influent and effluent EMCs, the Mann-Whitney Rank Sum Test was used (USGS, 1991). For the Mann-Whitney Rank Sum Test the null hypothesis was that the two samples were not drawn from populations with different medians. A significant difference between influent and effluent EMCs was concluded when  $P < 0.05$ .

Performance was calculated using the summation of loads (SOL) method. The SOL method defines the efficiency as a percentage based on the ratio of the summation of all incoming loads to the summation of all outlet loads. The SOL method assumes: 1) monitoring data accurately represents the actual entire total loads in and out of the BMP for a period long enough to overshadow any temporary storage or export of pollutants and 2) any significant storm events that were not monitored had a ratio of inlet to outlet loads similar to the storm events that were monitored (URS/ EPA 1999). Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study are summarized in Tables 10, 11, and 12.

Detectible concentrations were observed for all parameters analyzed except for SSC (<50 $\mu\text{m}$ ) for the MSB092508 event, Coarse Solids (mineral) for the MSB060408 and MSB070508 events, and Silt (mineral) for the MSB051208 event. For values that were reported as non-detect no substitutions were made for statistical testing or calculation of event loads.

**Table 10 Suspended Solids Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID              | TSS-SM<br>(<2000µm)<br>(kg) |             | TSS-EPA<br>(<2000µm)<br>(kg) |             | SSC<br>(kg)   |             | SSC<br>(>2000µm)<br>(kg) |            | SSC<br>(<2000µm)<br>(kg) |             | SSC<br>(<500µm)<br>(kg) |             | SSC<br>(<50µm)<br>(kg) |             |
|-----------------------|-----------------------------|-------------|------------------------------|-------------|---------------|-------------|--------------------------|------------|--------------------------|-------------|-------------------------|-------------|------------------------|-------------|
|                       | Influent                    | Effluent    | Influent                     | Effluent    | Influent      | Effluent    | Influent                 | Effluent   | Influent                 | Effluent    | Influent                | Effluent    | Influent               | Effluent    |
| MSB011008             | 5.6                         | 1.3         | 4.1                          | 0.9         | 42.6          | 1.3         | 11.5                     | 0.1        | 31.1                     | 1.3         | 12.4                    | 1.3         | 1.7                    | 0.8         |
| MSB011308             | 2.4                         | 0.4         | 2.0                          | 0.4         | 30.3          | 0.5         | 15.2                     | 0.2        | 15.1                     | 0.5         | 4.0                     | 0.5         | 1.0                    | 0.5         |
| MSB011708             | 2.2                         | 1.1         | 2.2                          | 1.4         | 6.4           | 1.3         | 0.9                      | 0.2        | 5.5                      | 1.3         | 2.9                     | 1.3         | 1.6                    | 1.3         |
| MSB020108             | 6.9                         | 5.8         | 6.9                          | 5.8         | 17.6          | 7.5         | 4.9                      | 1.3        | 12.6                     | 6.3         | 8.1                     | 5.0         | 6.5                    | 6.0         |
| MSB040408             | 5.6                         | 0.1         | 0.7                          | 0.2         | 6.1           | 0.0         | NT                       | NT         | 6.1                      | 0.0         | 1.8                     | 0.1         | 0.5                    | 0.1         |
| MSB050908             | 2.8                         | 1.0         | 2.4                          | 1.0         | 3.9           | 1.2         | 1.2                      | 0.0        | 2.7                      | 1.2         | 1.4                     | 1.2         | 0.2                    | 0.4         |
| MSB051208             | 1.6                         | 0.2         | 1.2                          | 0.3         | 1.9           | 0.4         | 0.6                      | 0.0        | 1.3                      | 0.4         | 0.4                     | 0.2         | 0.2                    | 0.1         |
| MSB052708             | 2.0                         | 1.0         | 1.8                          | 1.0         | 2.2           | 1.2         | 0.2                      | 0.1        | 2.0                      | 1.1         | 1.2                     | 0.9         | 0.4                    | 0.2         |
| MSB053108             | 5.9                         | 1.7         | 5.4                          | 1.6         | 7.2           | 1.6         | 1.1                      | 0.0        | 6.2                      | 1.6         | 2.3                     | 1.2         | 0.8                    | 0.5         |
| MSB060408             | 2.2                         | 0.8         | 2.1                          | 0.7         | 2.5           | 1.0         | 0.1                      | 0.1        | 2.4                      | 0.9         | 1.6                     | 0.5         | 0.5                    | 0.7         |
| MSB061408             | 36.9                        | 4.3         | 33.8                         | 2.6         | 36.5          | 3.8         | 1.3                      | 0.2        | 35.2                     | 3.6         | 26.1                    | 2.1         | 6.4                    | 1.7         |
| MSB061508             | 17.8                        | 2.3         | 17.4                         | 2.2         | 17.5          | 3.3         | 0.6                      | 0.0        | 16.9                     | 3.3         | 14.1                    | 1.7         | 4.2                    | 0.7         |
| MSB070508             | 25.4                        | 2.4         | 21.7                         | 2.4         | 22.7          | 2.8         | 0.4                      | 0.0        | 22.3                     | 2.8         | 14.8                    | 1.3         | 4.9                    | 0.6         |
| MSB072408             | 50.3                        | 5.0         | 46.8                         | 4.7         | 54.8          | 5.4         | 0.9                      | 0.7        | 53.8                     | 4.7         | 28.1                    | 2.7         | 8.2                    | 1.0         |
| MSB081408             | 49.2                        | 3.6         | 35.1                         | 3.1         | 44.8          | 3.2         | 4.1                      | 0.0        | 40.6                     | 3.2         | 20.3                    | 2.4         | 3.7                    | 1.1         |
| MSB092508             | 563.2                       | 3.4         | 517.3                        | 3.2         | 1743.9        | 5.6         | 210.7                    | 0.0        | 1533.3                   | 5.6         | 637.7                   | 2.3         | 4.0                    | 1.2         |
| MSB111508             | 4.5                         | 1.5         | 2.8                          | 1.0         | 6.8           | 1.3         | 2.5                      | 0.0        | 4.3                      | 1.3         | 1.3                     | 0.6         | 0.7                    | 0.4         |
| MSB112508             | 1.3                         | 0.1         | 0.9                          | 0.1         | 1.7           | 0.2         | 0.6                      | 0.0        | 1.1                      | 0.2         | 0.4                     | 0.1         | ND                     | ND          |
| MSB113008             | 47.5                        | 1.5         | 31.9                         | 1.5         | 35.0          | 1.4         | 2.3                      | 0.0        | 32.6                     | 1.4         | 16.4                    | 0.7         | 5.1                    | 0.5         |
| <b>Total</b>          | <b>833.2</b>                | <b>37.6</b> | <b>736.5</b>                 | <b>34.2</b> | <b>2084.4</b> | <b>43.0</b> | <b>259.2</b>             | <b>2.9</b> | <b>1825.1</b>            | <b>40.6</b> | <b>795.3</b>            | <b>25.8</b> | <b>50.9</b>            | <b>17.7</b> |
| <b>SOL Efficiency</b> | <b>95</b>                   |             | <b>95</b>                    |             | <b>98</b>     |             | <b>99</b>                |            | <b>98</b>                |             | <b>97</b>               |             | <b>65</b>              |             |

ND = Non-detect  
 NT = Not Tested

**Table 11 Total Volatile Suspended Solids Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID              | TVSS (>2000µm)<br>(kg) |            | TVSS (<2000µm)<br>(kg) |             | TVSS (<500µm)<br>(kg) |             | TVSS (<50µm)<br>(kg) |            | TVSS (kg)    |             |
|-----------------------|------------------------|------------|------------------------|-------------|-----------------------|-------------|----------------------|------------|--------------|-------------|
|                       | Influent               | Effluent   | Influent               | Effluent    | Influent              | Effluent    | Influent             | Effluent   | Influent     | Effluent    |
| MSB011008             | NT                     | NT         | 2.8                    | 0.5         | 1.5                   | 0.6         | 0.7                  | 0.4        | NT           | NT          |
| MSB011308             | NT                     | NT         | 1.6                    | 0.3         | 0.8                   | 0.3         | 0.5                  | 0.3        | NT           | NT          |
| MSB011708             | NT                     | NT         | 1.0                    | 0.5         | 0.9                   | 0.5         | 0.6                  | 0.5        | NT           | NT          |
| MSB020108             | NT                     | NT         | 3.0                    | 2.4         | 2.8                   | 1.9         | 2.4                  | 2.3        | NT           | NT          |
| MSB040408             | NT                     | NT         | 0.4                    | 0.0         | 0.4                   | 0.1         | 0.2                  | 0.1        | NT           | NT          |
| MSB050908             | 1.2                    | 0.0        | 1.8                    | 0.7         | 0.8                   | 0.6         | 0.3                  | 0.2        | 2.9          | 0.7         |
| MSB051208             | 0.5                    | 0.0        | 1.1                    | 0.4         | 0.3                   | 0.3         | 0.2                  | 0.2        | 1.6          | 0.4         |
| MSB052708             | 0.2                    | 0.1        | 1.2                    | 0.6         | 0.7                   | 0.5         | 0.2                  | 0.1        | 1.4          | 0.7         |
| MSB053108             | 0.4                    | 0.0        | 3.9                    | 0.8         | 1.2                   | 0.6         | 0.3                  | 0.2        | 4.2          | 0.9         |
| MSB060408             | 0.1                    | 0.1        | 1.3                    | 0.6         | 0.8                   | 0.3         | 0.3                  | 0.1        | 1.3          | 0.7         |
| MSB061408             | 1.2                    | 0.2        | 14.6                   | 1.7         | 10.7                  | 0.9         | 2.0                  | 0.6        | 15.8         | 1.9         |
| MSB061508             | 0.5                    | 0.0        | 7.0                    | 1.4         | 5.4                   | 0.6         | 1.2                  | 0.2        | 7.5          | 1.4         |
| MSB070508             | 0.3                    | 0.0        | 9.9                    | 1.1         | 5.5                   | 0.6         | 1.4                  | 0.3        | 10.2         | 1.1         |
| MSB072408             | 0.9                    | 0.6        | 24.1                   | 4.7         | 11.7                  | 2.7         | 2.6                  | 1.0        | 25.1         | 5.4         |
| MSB081408             | 3.0                    | 0.0        | 17.6                   | 1.0         | 7.1                   | 0.9         | 0.2                  | 0.5        | 20.6         | 1.0         |
| MSB092508             | QC DQ                  | QC DQ      | 16.8                   | 2.3         | QC DQ                 | QC DQ       | QC DQ                | QC DQ      | 24.3         | 2.3         |
| MSB111508             | QC DQ                  | QC DQ      | 2.7                    | 0.7         | 0.6                   | 0.3         | QC DQ                | QC DQ      | 4.1          | 0.7         |
| MSB112508             | QC DQ                  | QC DQ      | QC DQ                  | QC DQ       | QC DQ                 | QC DQ       | QC DQ                | QC DQ      | 0.9          | 0.1         |
| MSB113008             | QC DQ                  | QC DQ      | 13.3                   | 0.6         | QC DQ                 | QC DQ       | QC DQ                | QC DQ      | 15.7         | 0.6         |
| <b>Total</b>          | <b>8.3</b>             | <b>1.0</b> | <b>124.1</b>           | <b>20.3</b> | <b>51.0</b>           | <b>11.6</b> | <b>13.1</b>          | <b>6.9</b> | <b>135.7</b> | <b>17.7</b> |
| <b>SOL Efficiency</b> | <b>88</b>              |            | <b>84</b>              |             | <b>77</b>             |             | <b>47</b>            |            | <b>87</b>    |             |

NT = Not Tested  
QC DQ = Quality Control Disqualification

**Table 12 Calculated Parameters (mineral) Event Sum of Loads (SOL) Efficiency Calculations for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID              | Coarse Solids<br>(mineral)<br>(kg) |            | Sand<br>(mineral)<br>(kg) |            | Silt<br>(mineral)<br>(kg) |            |
|-----------------------|------------------------------------|------------|---------------------------|------------|---------------------------|------------|
|                       | Influent                           | Effluent   | Influent                  | Effluent   | Influent                  | Effluent   |
| MSB011008             | NT                                 | NT         | 27.2                      | 0.1        | 1.1                       | 0.5        |
| MSB011308             | NT                                 | NT         | 12.9                      | 0.1        | 0.6                       | 0.2        |
| MSB011708             | NT                                 | NT         | 3.4                       | 0.1        | 1.0                       | 0.8        |
| MSB020108             | NT                                 | NT         | 5.5                       | 0.2        | 4.2                       | 3.7        |
| MSB040408             | NT                                 | NT         | 5.4                       | 0.1        | 0.3                       | 0.1        |
| MSB050908             | 0.1                                | 0.0        | 0.9                       | 0.2        | 0.1                       | 0.2        |
| MSB051208             | 0.0                                | 0.0        | 0.3                       | 0.1        | ND                        | ND         |
| MSB052708             | 0.0                                | 0.0        | 0.6                       | 0.4        | 0.2                       | 0.1        |
| MSB053108             | 0.7                                | 0.0        | 1.8                       | 0.5        | 0.5                       | 0.3        |
| MSB060408             | ND                                 | ND         | 0.9                       | 0.1        | 0.3                       | 0.5        |
| MSB061408             | 0.1                                | 0.0        | 16.1                      | 0.9        | 4.4                       | 1.0        |
| MSB061508             | 0.1                                | 0.0        | 6.9                       | 1.4        | 3.1                       | 0.5        |
| MSB070508             | ND                                 | ND         | 8.9                       | 1.3        | 3.5                       | 0.4        |
| MSB072408             | 0.0                                | 0.1        | 24.1                      | 0.0        | 5.6                       | 0.0        |
| MSB081408             | 1.2                                | 0.0        | 19.5                      | 1.6        | 3.5                       | 0.6        |
| MSB092508             | QC DQ                              | QC DQ      | QC DQ                     | QC DQ      | QC DQ                     | QC DQ      |
| MSB111508             | QC DQ                              | QC DQ      | 1.3                       | 0.3        | QC DQ                     | QC DQ      |
| MSB112508             | QC DQ                              | QC DQ      | QC DQ                     | QC DQ      | QC DQ                     | QC DQ      |
| MSB113008             | QC DQ                              | QC DQ      | QC DQ                     | QC DQ      | QC DQ                     | QC DQ      |
| <b>Total</b>          | <b>2.2</b>                         | <b>0.2</b> | <b>135.8</b>              | <b>7.1</b> | <b>28.2</b>               | <b>8.8</b> |
| <b>SOL Efficiency</b> | <b>92</b>                          |            | <b>95</b>                 |            | <b>69</b>                 |            |

ND = Non-detect  
 NT = Not Tested  
 QC DQ = Quality Control Disqualification

**Table 13 Calculated percentages of material less than 500  $\mu\text{m}$  and 50  $\mu\text{m}$  for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID      | SSC (<500- $\mu\text{m}$ ) (mg/l)/<br>SSC (<2000- $\mu\text{m}$ ) (mg/l) |             | SSC (<50- $\mu\text{m}$ ) (mg/l)/<br>SSC (<2000- $\mu\text{m}$ ) (mg/l) |             |
|---------------|--|-------------|---|-------------|
|               | Influent   | Effluent    | Influent  | Effluent    |
| MSB011008     | 40%  | 100%        | 6%  | 67%         |
| MSB011308     | 27%  | 98%         | 7%  | 97%         |
| MSB011708     | 53%  | 98%         | 29%   | 97%         |
| MSB020108     | 64%  | 80%         | 52%   | 95%         |
| MSB040408     | 29%  | 121%        | 8%  | 125%        |
| MSB050908     | 51%  | 102%        | 9%  | 33%         |
| MSB051208     | 29%  | 68%         | 13%   | 40%         |
| MSB052708     | 60%  | 77%         | 21%   | 20%         |
| MSB053108     | 37%  | 74%         | 13%   | 31%         |
| MSB060408     | 65%  | 54%         | 22%   | 74%         |
| MSB061408     | 74%  | 59%         | 18%   | 47%         |
| MSB061508     | 84%  | 53%         | 25%   | 21%         |
| MSB070508     | 66%  | 45%         | 22%   | 23%         |
| MSB072408     | 52%  | 56%         | 15%   | 22%         |
| MSB081408     | 50%  | 75%         | 9%  | 34%         |
| MSB092508     | 42%  | 40%         | 0%  | 21%         |
| MSB111508     | 30%  | 43%         | 16%   | 33%         |
| MSB112508     | 37%  | 38%         | ND  | ND          |
| MSB113008     | 50%  | 49%         | 16%   | 33%         |
| <b>Min</b>    | <b>27%</b>   | <b>38%</b>  | <b>0%</b>   | <b>20%</b>  |
| <b>Max</b>    | <b>84%</b>   | <b>121%</b> | <b>52%</b>  | <b>125%</b> |
| <b>Median</b> | <b>50%</b>   | <b>68%</b>  | <b>15%</b>  | <b>33%</b>  |
| <b>Mean</b>   | <b>50%</b>   | <b>70%</b>  | <b>17%</b>  | <b>51%</b>  |

ND = Non-detect

**Table 14 Calculated percentages of combustible materials that are assumed to be organic in nature for the 19 events sampled at the Manasquan Savings Bank study site**

| Event ID      | TVSS (<2000-um) (mg/l)<br>/ SSC (<2000-um) (mg/l) |             | TVSS (<500-um) (mg/l)<br>/ SSC (<500-um) (mg/l) |             | TVSS (<50-um) (mg/l)<br>/ SSC (<50-um) (mg/l) |             | TVSS (>2000-um) (mg/l)<br>/ SSC (>2000-um) (mg/l) |             | TVSS (mg/l) / SSC(mg/l) |             |
|---------------|---|-------------|---|-------------|---|-------------|---|-------------|-------------------------|-------------|
|               | Influent  | Effluent    | Influent  | Effluent    | Influent                                      | Effluent    | Influent  | Effluent    | Influent                | Effluent    |
| MSB011008     | 9%  | 43%         | 12%   | 48%         | 38%   | 43%         | NT  | NT          | NT                      | NT          |
| MSB011308     | 11%   | 56%         | 21%   | 56%         | 47%   | 56%         | NT  | NT          | NT                      | NT          |
| MSB011708     | 19%   | 41%         | 29%   | 41%         | 39%   | 41%         | NT  | NT          | NT                      | NT          |
| MSB020108     | 24%   | 38%         | 35%   | 39%         | 37%   | 38%         | NT  | NT          | NT                      | NT          |
| MSB040408     | 7%  | 100%        | 20%   | 100%        | 45%   | 100%        | NT  | NT          | NT                      | NT          |
| MSB050908     | 66%   | 64%         | 59%   | 53%         | 106%  | 47%         | 95%   | 100%        | 75%                     | 64%         |
| MSB051208     | 80%   | 100%        | 86%   | 135%        | 139%  | 141%        | 92%   | 100%        | 84%                     | 100%        |
| MSB052708     | 60%   | 52%         | 57%   | 53%         | 46%   | 35%         | 94%   | 96%         | 63%                     | 55%         |
| MSB053108     | 63%   | 54%         | 50%   | 48%         | 32%   | 47%         | 35%   | 111%        | 59%                     | 54%         |
| MSB060408     | 52%   | 69%         | 51%   | 64%         | 53%   | 19%         | 100%  | 100%        | 53%                     | 70%         |
| MSB061408     | 42%   | 47%         | 41%   | 43%         | 31%   | 38%         | 91%   | 91%         | 43%                     | 49%         |
| MSB061508     | 41%   | 43%         | 38%   | 36%         | 28%   | 35%         | 79%   | 100%        | 43%                     | 43%         |
| MSB070508     | 45%   | 40%         | 37%   | 46%         | 29%   | 40%         | 90%   | 79%         | 45%                     | 40%         |
| MSB072408     | 45%   | 100%        | 42%   | 100%        | 32%   | 100%        | 100%  | 85%         | 46%                     | 99%         |
| MSB081408     | 43%   | 31%         | 35%   | 36%         | 6%  | 43%         | 72%   | 100%        | 46%                     | 32%         |
| MSB092508     | 1%  | 40%         | QC DQ   | QC DQ       | QC DQ   | QC DQ       | QC DQ   | QC DQ       | 1%                      | 41%         |
| MSB111508     | 62%   | 50%         | 48%   | 52%         | QC DQ   | QC DQ       | QC DQ   | QC DQ       | 61%                     | 50%         |
| MSB112508     | QC DQ   | QC DQ       | QC DQ   | QC DQ       | QC DQ   | QC DQ       | QC DQ   | QC DQ       | 54%                     | 76%         |
| MSB113008     | 41%   | 40%         | QC DQ   | QC DQ       | QC DQ   | QC DQ       | QC DQ   | QC DQ       | 45%                     | 40%         |
| <b>Min</b>    | <b>1%</b>   | <b>31%</b>  | <b>12%</b>                                      | <b>36%</b>  | <b>6%</b>                                     | <b>19%</b>  | <b>35%</b>  | <b>79%</b>  | <b>1%</b>               | <b>32%</b>  |
| <b>Max</b>    | <b>80%</b>  | <b>100%</b> | <b>86%</b>                                      | <b>135%</b> | <b>139%</b>                                   | <b>141%</b> | <b>100%</b>                                       | <b>111%</b> | <b>84%</b>              | <b>100%</b> |
| <b>Median</b> | <b>42%</b>  | <b>48%</b>  | <b>39%</b>                                      | <b>50%</b>  | <b>38%</b>                                    | <b>43%</b>  | <b>91%</b>  | <b>100%</b> | <b>50%</b>              | <b>52%</b>  |
| <b>Mean</b>   | <b>39%</b>  | <b>56%</b>  | <b>41%</b>                                      | <b>59%</b>  | <b>47%</b>                                    | <b>55%</b>  | <b>85%</b>  | <b>96%</b>  | <b>51%</b>              | <b>58%</b>  |

NT = Not Tested

QC DQ = Quality Control Disqualification

## 4.2 Test Results

Based on the use of the Spearman Rank Order correlation, test positive correlations ( $P < 0.05$ ) were determined between influent and effluent EMCs for TVSS, SSC ( $< 50\mu\text{m}$ ), TVSS ( $< 500\mu\text{m}$ ), TVSS ( $< 50\mu\text{m}$ ), and TSS-EPA ( $< 2000\mu\text{m}$ ). The concentration of influent and effluent sample pairs tended to increase together.

Based on the use of the Mann-Whitney Rank Sum test the difference in the median values between the influent and effluent EMCs is greater than would be expected by chance; there is a statistically significant difference ( $P < 0.05$ ) for all parameters analyzed.

### *Suspended Solids Parameters*

Influent EMCs for TSS-SM ( $< 2000\mu\text{m}$ ) ranged from 24.3 mg/l to 2259.0 mg/l with a median of 154.0 mg/l and a mean of 331.8 mg/l. Corresponding effluent EMCs ranged from 2.5 mg/l to 84.0 mg/l with a median of 26.0 mg/l and a mean of 28.8 mg/l. Total event loadings for the study were 833.2 kg at the influent and 37.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for SSC ( $< 2000\mu\text{m}$ ) ranged from 24.7 mg/l to 6150.0 mg/l with a median of 238.0 mg/l and a mean of 587.7 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 70.3 mg/l with a median of 29.9 mg/l and a mean of 30.2 mg/l. Total event loadings for the study were 1825.1 kg at the influent and 40.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 98 %.

In general, the relationship between TSS-SM ( $< 2000\mu\text{m}$ ) and SSC ( $< 2000\mu\text{m}$ ) was determined to be positive based on the linear regression results for both influent ( $R^2 = 0.9$ ) and effluent ( $R^2 = 0.91$ ) EMCs. The ratio of TSS-SM ( $< 2000\mu\text{m}$ ) to SSC ( $< 2000\mu\text{m}$ ) EMCs ranged from 0.2 to 1.5 with a median of 1.0 for the influent compared to a range from 0.6 to 1.2 with a median of 0.9 for the effluent.

Influent EMCs for TSS-EPA ( $< 2000\mu\text{m}$ ) ranged from 20.5 mg/l to 2075.0 mg/l with a median of 60.0 mg/l and a mean of 274.6 mg/l. Corresponding effluent EMCs ranged from 2.5 mg/l to 51.0 mg/l with a median of 25.5 mg/l and a mean of 26.3 mg/l. Total event loadings for the study were 736.5 kg at the influent and 34.2 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for SSC ranged from 27.7 mg/l to 6995.0 mg/l with a median of 241.9 mg/l and a mean of 688.9 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 74.7 mg/l with a median of 30.3 mg/l and a mean of 31.6 mg/l. Total event loadings for the study were 2084.4 kg at the influent and 43.0 kg at the effluent sampling location, resulting in an overall removal efficiency of 98%.

Influent EMCs for SSC ( $> 2000\mu\text{m}$ ) ranged from 0.8 mg/l to 845.0 mg/l with a median of 25.4 mg/l and a mean of 106.8 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 11.1 mg/l with a median of 0.3 mg/l and a mean of 2.1 mg/l. Total event loadings for the study were 259.2

kg at the influent and 2.9 kg at the effluent sampling location, resulting in an overall removal efficiency of 99%.

Influent EMCs for SSC (<500µm) ranged from 9.2 mg/l to 2558.0 mg/l with a median of 99.7 mg/l and a mean of 268.8 mg/l. Corresponding effluent EMCs ranged from 1.4 mg/l to 43.4 mg/l with a median of 23.8 mg/l and a mean of 21.0 mg/l. Total event loadings for the study were 795.3 kg at the influent and 25.8 kg at the effluent sampling location, resulting in an overall removal efficiency of 97%. For each storm event the percent of SSC (<2000 µm) represented by SSC (<500 µm) was calculated. Influent and effluent median percentages of SSC (<2000µm) were 50% and 68% respectively. The percentage of corresponding SSC (<2000µm) results indicates the portion of material that are less than 500µm in size.

Influent EMCs for SSC (<50µm) ranged from 4.6 mg/l to 125.1 mg/l with a median of 35.4 mg/l and a mean of 39.9 mg/l. Corresponding effluent EMCs ranged from 2.9 mg/l to 51.6 mg/l with a median of 8.5 mg/l and a mean of 14.5 mg/l. Total event loadings for the study were 50.9 kg at the influent and 17.7 kg at the effluent sampling location, resulting in an overall removal efficiency of 65 %. For each storm event the percent of SSC (<2000 µm) represented by SSC (<50 µm) was calculated. Influent and effluent median percentages of SSC (<2000µm) were 15% and 33% respectively. The percentage of corresponding SSC (<2000µm) results indicates the portion of materials that are less than 50µm in size.

#### *Volatile Suspended Solids Parameters*

Influent EMCs for TVSS (>2000µm) ranged from 0.8 mg/l and 39.6 mg/l with a median of 9.2 mg/l and a mean of 13.8 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 5.7 mg/l with a median of 0.3 mg/l and a mean of 1.4 mg/l. Total event loadings for the study were 8.3 kg at the influent and 1.0 kg at the effluent sampling location, resulting in an overall removal efficiency of 88%. For each storm event the percent of SSC (>2000 µm) represented by TVSS (>2000µm) was calculated. Influent and effluent median percentages of SSC (>2000µm) were 91% and 100% respectively. Percentage of corresponding SSC (>2000µm) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS ranged from 14.7 mg/l and 307.4 mg/l with a median of 103.2 mg/l and a mean of 120.0 mg/l. Corresponding effluent EMCs ranged from 2.9 mg/l to 49.0 mg/l with a median of 12.8 mg/l and a mean of 17.2 mg/l. Total event loadings for the study were 135.7 kg at the influent and 17.7 kg at the effluent sampling location, resulting in an overall removal efficiency of 87%. For each storm event the percent of SSC represented by TVSS was calculated. Influent and effluent median percentages of SSC were 50% and 52% respectively. Percentage of corresponding SSC results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<2000µm) ranged from 284.5 mg/l and 13.9 mg/l with a median of 56.0 mg/l and a mean of 91.8 mg/l. Corresponding effluent EMCs ranged from 2.4 mg/l to 43.0 mg/l with a median of 14.0 mg/l and a mean of 15.9 mg/l. Total event loadings for the study were 124.1 kg at the influent and 20.3 kg at the effluent sampling location, resulting in an overall removal efficiency of 84%. For each storm event the percent of SSC (<2000 µm) represented by

TVSS (<2000 $\mu$ m) was calculated. Influent and effluent median percentages of SSC (<2000 $\mu$ m) were 42% and 48% respectively. Percentage of corresponding SSC (<2000 $\mu$ m) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<500 $\mu$ m) ranged from 207.6 mg/l and 8.8 mg/l with a median of 24.1 mg/l and a mean of 49.5 mg/l. Corresponding effluent EMCs ranged from 24.2 mg/l to 2.9 mg/l with a median of 12.2 mg/l and a mean of 11.9 mg/l. Total event loadings for the study were 51.0 kg at the influent and 11.6 kg at the effluent sampling location, resulting in an overall removal efficiency of 77%. For each storm event the percent of SSC (<500  $\mu$ m) represented by TVSS (<500  $\mu$ m) was calculated. Influent and effluent median percentages of SSC (<500 $\mu$ m) were 39% and 50% respectively. Percentage of corresponding SSC (<500 $\mu$ m) results indicates the percent of combustible materials that are assumed to be organic in nature.

Influent EMCs for TVSS (<50 $\mu$ m) ranged from 3.2 mg/l and 38.6 mg/l with a median of 12.2 mg/l and a mean of 14.2 mg/l. Corresponding effluent EMCs ranged from 1.4 mg/l to 19.8 mg/l with a median of 6.0 mg/l and a mean of 7.3 mg/l. Total event loadings for the study were 13.1 kg at the influent and 6.9 kg at the effluent sampling location, resulting in an overall removal efficiency of 47%. For each storm event the percent of SSC (<50  $\mu$ m) represented by TVSS (<50  $\mu$ m) was calculated. Influent and effluent median percentages of SSC (<50 $\mu$ m) were 38% and 43% respectively. Percentage of corresponding SSC (<50 $\mu$ m) results indicates the percent of combustible materials that are assumed to be organic in nature.

#### *Additional Parameters*

Influent EMCs for Coarse Solids (mineral) ranged from 0.00 mg/l and 18.1 mg/l with a median of 1.8 mg/l and a mean of 5.2 mg/l. Corresponding effluent EMCs ranged from 0.1 mg/l to 1.0 mg/l with a median 0.2 mg/l and a mean of 0.3 mg/l. Total event loadings for the study were 2.2 kg at the influent and 0.2 kg at the effluent sampling location, resulting in an overall removal efficiency of 92%.

Influent EMCs for Sand (mineral) ranged from 8.7 mg/l and 868.0 mg/l with a median of 95.5 mg/l and a mean of 173.0 mg/l. Corresponding effluent EMCs ranged from 0.0 mg/l to 24.3 mg/l with a median of 3.7 mg/l and a mean of 7.8 mg/l. Total event loadings for the study were 135.8 kg at the influent and 7.1 kg at the effluent sampling location, resulting in an overall removal efficiency of 95%.

Influent EMCs for Silt (mineral) ranged from 1.7 mg/l and 86.5 mg/l with a median of 31.0 mg/l and a mean of 30.5 mg/l. Corresponding effluent EMCs ranged from 0.0 mg/l to 32.0 mg/l with a median of 6.4 mg/l and a mean of 9.9 mg/l. Total event loadings for the study were 28.2 kg at the influent and 8.8 kg at the effluent sampling location, resulting in an overall removal efficiency of 69%.

### **4.3 System Maintenance and Residual Solids Assessment Results**

Inspection of the CDS system in April 2008 revealed that a substantial volume of leaf litter had accumulated in the separation chamber. A vactor truck was contracted to remove this material

from the separation chamber on April, 15, 2008. Upon removal of the leaf litter it was determined that the remainder of the system did not require maintenance. At the conclusion of the monitoring period in January 2009 a vactor truck was contracted to remove all contents from the CDS system. Prior to this maintenance event on January 13, 2009 samples were collected from the separation chamber, sediment sump and annulus area for evaluation. In order to safely enter the system a vactor truck was used to dewater the system. Following the dewatering of the system, multiple sediment samples were collected of materials contained in the system and depth measurements taken. Sediment samples were combined into a composite sample. Subsamples were then collected from this composite and analyzed for bulk density and particle size distribution. Prior to particle size distribution analysis the subsample was passed through a 2000 $\mu\text{m}$  sieve in an effort to isolate soil separates. Particle size analysis of materials <2000 $\mu\text{m}$  revealed that the total solids portion of materials contained in the system had a sand texture (USDA classification).

The mass of materials contained in the system was estimated using depth measurements and bulk density results. The mass of materials contained in the system included material removed during both the maintenance inspection performed on April 15, 2008 and final maintenance performed on January 13, 2009. The estimated total dry mass of materials contained in the system, after dewatering, was approximately 1300 kg (2860 lbs). Approximately 8% of the of the mass was located in the annulus area outside of the separation chamber, approximately 51% of the mass was located in the treatment chamber, and approximately 41% of the mass was located in the sump of the unit. The accuracy of the estimated mass of materials contained in the system should be considered limited, due to the non uniform distribution of materials contained in the system as well as the unaccounted for material removed by the vactor truck during the dewatering process.

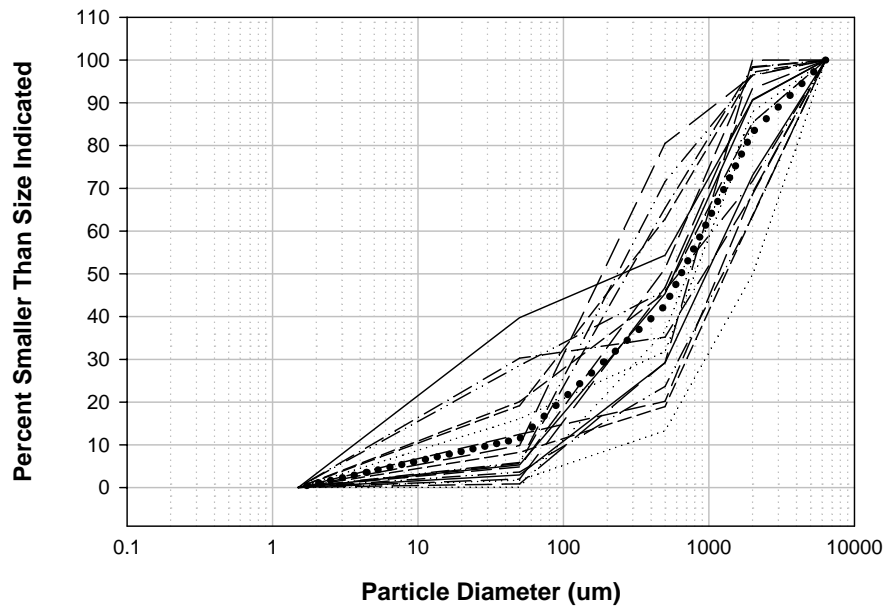
*Particle Size Distribution Analysis Results*

The particle size distribution (PSD) results obtained using the Laser Diffraction method are summarized in Table 15. Results suggest the average  $d_{50}$  is greater than 100 $\mu\text{m}$  for both influent and effluent sampling locations for all three events submitted for analysis. These results are supported by the observed (TSS-EPA, TSS-SM, and SSC<2000 $\mu\text{m}$ ) removal efficiency of greater than 90%, which suggests the presence of a substantial mass of coarse solids and a  $d_{50}$  greater than 100 $\mu\text{m}$ .

**Table 15 Particle size distribution analysis results using ASTM D4464 for events sampled at the Manasquan Savings Bank study site**

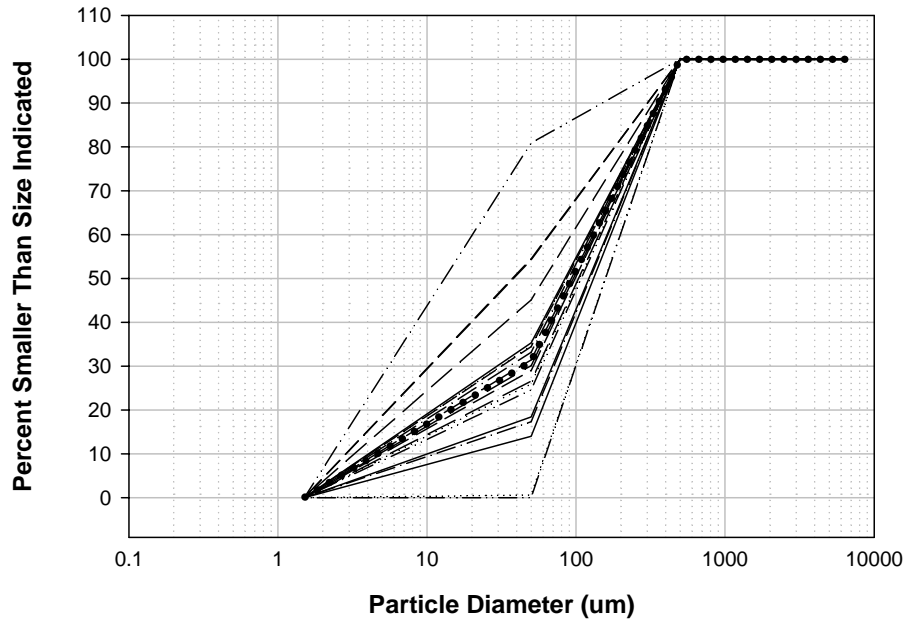
| Event ID   | SAND     |          | SILT     |          | CLAY     |          | $d_{50}$ |          |
|------------|----------|----------|----------|----------|----------|----------|----------|----------|
|            | Influent | Effluent | Influent | Effluent | Influent | Effluent | Influent | Effluent |
| MSB051208A | 99.17    | 97.82    | 0.83     | 2.18     | 0.00     | 0.00     | 1315.63  | 1163.59  |
| MSB061408A | 50.49    | 66.54    | 47.11    | 31.67    | 2.40     | 1.80     | 76.38    | 392.77   |
| MSB111508A | 76.93    | 67.47    | 22.11    | 31.15    | 0.96     | 1.38     | 582.00   | 412.15   |
| Median     | 76.93    | 67.47    | 22.11    | 31.15    | 0.96     | 1.38     | 582.00   | 412.15   |
| Mean       | 75.53    | 77.28    | 23.35    | 21.67    | 1.12     | 1.06     | 658.00   | 656.17   |

Influent particle size distribution (PSD) obtained using the serial filtration method covering the 6350 $\mu\text{m}$  to 1.5 $\mu\text{m}$  particle size range suggests that the average  $d_{50}$  is greater than 100 $\mu\text{m}$  for all of the events captured to date, as shown in Figure 10. The upper size limit of 6350 $\mu\text{m}$  is approximately equal to the sample strainer opening. It is assumed that particles larger than the opening will not be sampled. The lower size limit of 1.5 $\mu\text{m}$  is equal to the pore size of filters used by the analytical laboratory for solids analysis. Serial filtration particle size distribution results are also supported by observed solids (TSS-EPA, TSS-SM, and SSC <2000 $\mu\text{m}$  removal efficiency rates of greater than 90%, which suggests the presence of a substantial mass of coarse solids and a  $d_{50}$  greater than 100 $\mu\text{m}$ .



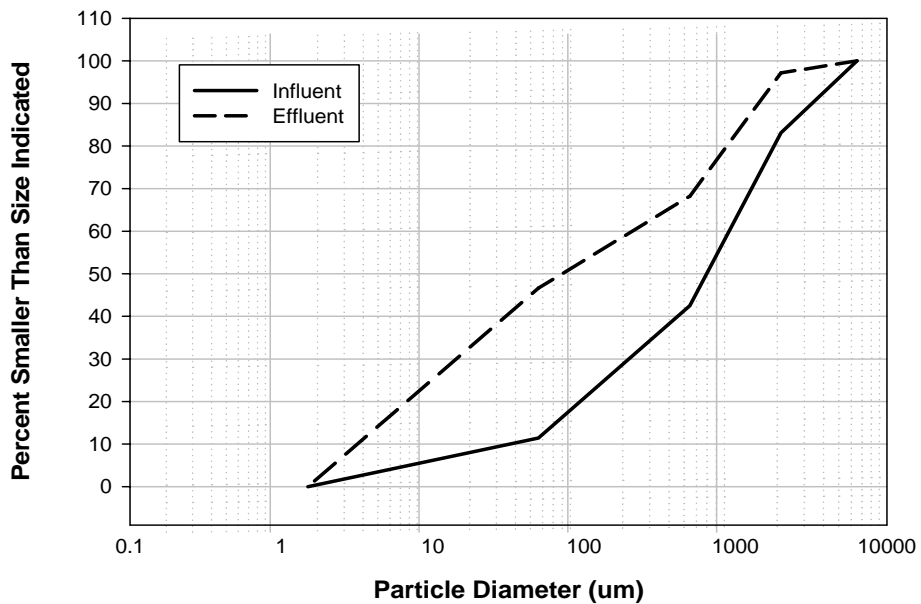
**Figure 10 Influent particle size distribution generated using serial filtration covering 6350 $\mu\text{m}$  to 1.5 $\mu\text{m}$  particle size range; dashed line represents mean particle size distribution**

Influent particle size distribution (PSD) obtained using the serial filtration method covering the 500 $\mu\text{m}$  to 1.5 $\mu\text{m}$  particle size range reflect an average  $d_{50}$  that is less than 100 $\mu\text{m}$  for all the events captured to date, as seen in Figure 11.



**Figure 11 Influent PSD generated using serial filtration covering 500µm to 1.5µm particle size range; dashed line represents mean particle size distribution**

Influent and effluent mean particle size distributions were compared using data obtained using serial filtration covering the 6350µm to 1.5µm particle size range, as seen in Figure 12. Plotted results indicate that the  $d_{50}$  values were greater than 100µm for the influent sampling location and less than 100µm at the effluent sampling location.



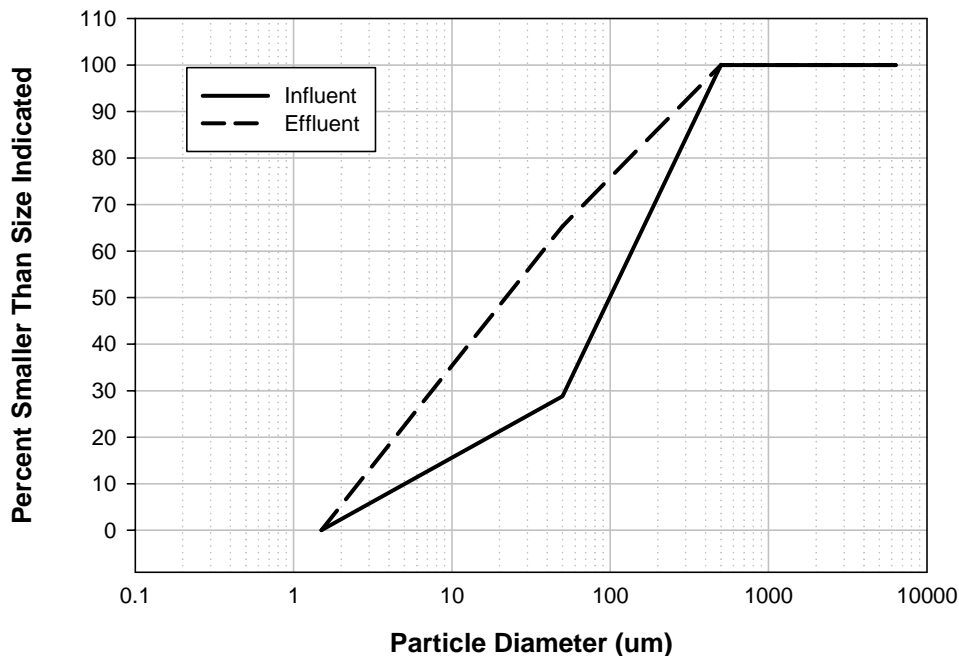
**Figure 12 Comparison of mean influent and effluent particle size distributions generated using serial filtration covering 6350µm to 1.5µm particle size range**

Influent and effluent mean particle size distributions were compared using data obtained using serial filtration covering the 500 $\mu\text{m}$  to 1.5 $\mu\text{m}$  particle size range, as seen in Figure 13. Plotted results indicate that the  $d_{50}$  values were less than 100 $\mu\text{m}$  for both the influent sampling location and the effluent sampling location.

#### 4.4 Summary

Between January of 2008 and November of 2008, 19 storm events were monitored and were determined to meet the storm data collection requirements as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003). Total rainfall depth for qualified events was 18.35 inches and three events exceeded 75% of the design treatment capacity, thus satisfying TARP Tier II and NJDEP completeness criteria.

Significant reductions for suspended solids loads were observed between influent and effluent sampling locations: SSC (<2000 $\mu\text{m}$ ) 98%, TSS-SM (<2000 $\mu\text{m}$ ) 95%, TSS-EPA (<2000 $\mu\text{m}$ ) 95%, SSC (<500 $\mu\text{m}$ ) 97%, and SSC (<50 $\mu\text{m}$ ) 65%. The positive capture of solids by the system was verified as part of the residual solids assessment during both the maintenance inspection as well as the final maintenance. Comparison of the estimated mass of material contained in the system to calculated loads using water quality results was determined to be within the realm of expectations for the study.



**Figure 13 Comparison of mean influent and effluent particle size distributions generated using serial filtration covering 500 $\mu\text{m}$  to 1.5 $\mu\text{m}$  particle size range**

## 5. Performance Claim Verification

Given that the performance standard is based on TSS-SM, and TSS-SM removal efficiency results for this study are associated with suspended solids with a  $d_{50}$  greater than  $100\mu\text{m}$ , the review of additional data was required to further understand removal efficiency results. In general, removal efficiency results in excess of 90% are not typical for a flow through gravity separation technology but are within the realm of expected performance associated with observed influent TSS-SM EMCs with a  $d_{50}$  greater than  $100\mu\text{m}$ . In an effort to isolate suspended sediment removal efficiency based on specific particle size ranges, SSC samples were sieved prior to analysis. The particle size ranges that were isolated for this study include  $6350\mu\text{m}$  to  $1.5\mu\text{m}$ ,  $2000\mu\text{m}$  to  $1.5\mu\text{m}$ ,  $500\mu\text{m}$  to  $1.5\mu\text{m}$ , and  $50\mu\text{m}$  to  $1.5\mu\text{m}$ .

The isolation of suspended solids removal efficiency based on particles  $500\mu\text{m}$  to  $1.5\mu\text{m}$  with  $d_{50}$  less than  $100\mu\text{m}$  and particles between  $50\mu\text{m}$  and  $1.5\mu\text{m}$  with a  $d_{50}$  less than  $50\mu\text{m}$  resulted in an overall removal efficiency of 97% and 65% respectively. The use of these results is proposed to confirm favorable removal of solids and in order to satisfy the site qualification requirements ( $d_{50} < 100\mu\text{m}$ ) as per New Jersey Tier II Stormwater Test Requirements—Amendments to TARP Tier II Protocol (NJDEP, 2006) and the NJDEP interpretation of TARP (2003). Additionally, these results demonstrate performance greater than 60% removal (65%  $\text{SSC} < 50\mu\text{m}$ ) of suspended solids with a  $d_{50}$  less than  $50\mu\text{m}$ . Past research has concluded that when coarse particles are not present results obtained with the SSC method differ very little from results obtained using the TSS method (Gray et al 2000, Guo 2006), so results of the  $\text{SSC} < 50\mu\text{m}$  analysis are expected to be representative of TSS results.

Focusing on finer solids fractions also reduces the potential for bias towards the sampling of coarse mineral solids using accepted sampling techniques. Finer mineral particles smaller than  $50\mu\text{m}$  (Silt (mineral)) are generally expected to be more or less uniformly distributed throughout the water column. In addition to SSC, removal efficiency based on mineral particles smaller than  $50\mu\text{m}$  was isolated. Silt (mineral) results were calculated by subtracting the volatile suspended solids results (TVSS ( $< 50\mu\text{m}$ )) composed of combustible materials assumed to be organic in nature from the suspended solids results (SSC ( $< 50\mu\text{m}$ )). Removal efficiency based on Silt (Mineral) results resulted in an overall removal efficiency of 69%.

Recognizing the potential of a limited number of storm events to dominate sum of loads performance efficiency calculations, storm events with TSS-SM ( $< 2000\mu\text{m}$ ) EMCs less than  $500\text{mg/l}$  were segregated from the data set and evaluated. Significant reductions for suspended solids loads were observed between influent and effluent sampling locations:  $\text{SSC} (< 2000\mu\text{m})$  85%, TSS-SM ( $< 2000\mu\text{m}$ ) 82%, TSS-EPA ( $< 2000\mu\text{m}$ ) 80%,  $\text{SSC} (< 500\mu\text{m})$  81%,  $\text{SSC} (< 50\mu\text{m})$  58%, and Silt (mineral) 65%.

The primary purpose of this project was to document High Efficiency CDS system performance with respect to suspended solids removal and quantify performance in accordance with the TARP Protocol for Stormwater Best Management Practice Demonstrations and NJDEP Tier II monitoring requirements.

The High Efficiency CDS unit model PMSU20\_25 (CDS2025) installed online at the Manasquan Savings Bank study site sized based on the New Jersey Water Quality Design Storm to treat a maximum water quality flow rate of 1.6 cfs and a peak flow of 5.43 cfs demonstrated significant suspended solids removal including greater than 60% removal of suspended solids with a  $d_{50}$  less than 50 $\mu$ m. The CDS2025 also demonstrated the ability to remove greater than 80% of stormwater solids when the influent particle size distribution is predominantly sand sized particles (50-2000 microns).

## 6. Net Environmental Benefit

The High Efficiency CDS unit requires no input of raw material, has no moving parts and therefore uses no water or energy other than that provided by stormwater runoff. During the 11-month monitoring period the mass of materials captured and retained by the High Efficiency CDS unit was approximately 1300 kg (2860 lbs). This material would otherwise have been released to the environment during runoff producing rain events.

## 7. References

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## **APPENDIX A**

### **INDIVIDUAL STORM REPORTS**

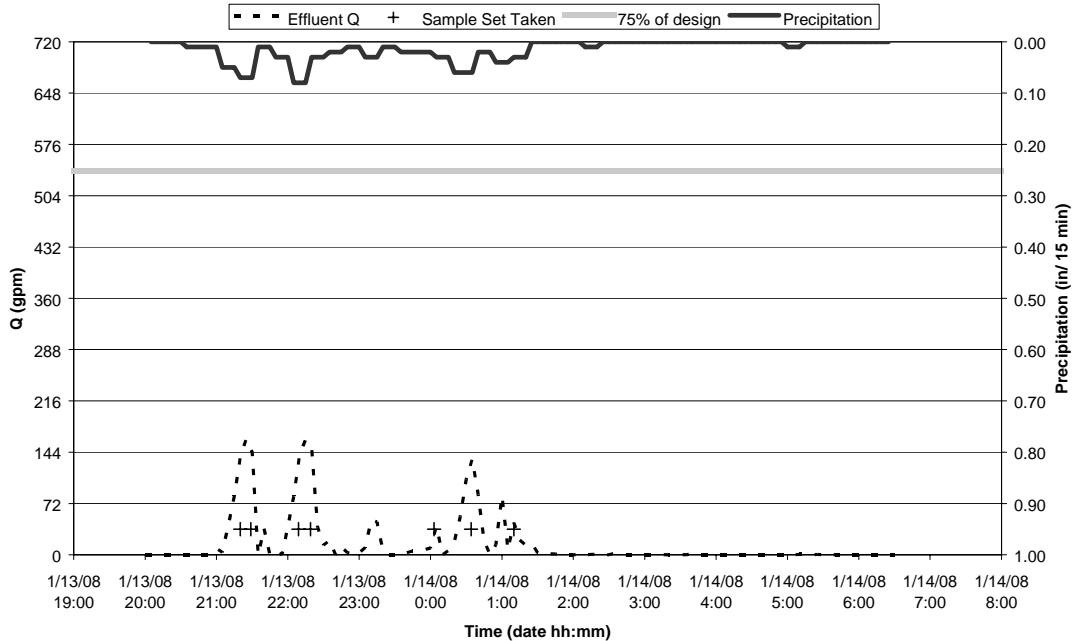
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 01/13/08  
 Date of Last Maintenance: 10/29/07  
 Antecedent Conditions: 53 hours since last rain event, 0.11"

### Hydrology

Total Precipitation (in): 0.63  
 Peak Flow (gpm): 162 (23% of design)  
 Total Runoff Volume (gal): 10530  
 Vol. Coverage (nearest 10%): 70

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                | Concentrations (mg/L) |              |      | Discrete Removal |            |
|---------------------|--------------------------|-----------------------|--------------|------|------------------|------------|
|                     |                          | Influent EMC          | Effluent EMC | MRL  | Dup. RPD         | Efficiency |
| IN: 8 (3.2-L)       | <u>Sand (mineral)</u>    | 324                   | ND           | 1.79 | 20%              | 99%        |
| EFF: 8              | <u>Silt (mineral)</u>    | 14                    | 6            | 1.75 | 20%              | 60%        |
|                     | <u>SSC (&gt;2000-um)</u> | 381                   | ND           | 4.08 | 20%              | 99%        |
|                     | <u>SSC</u>               | 760                   | 13.2         | 4.08 | 20%              | 98%        |
|                     | SSC (<2000-um)           | 379                   | 13.2         | 1.79 | 24.3%            | 97%        |
|                     | SSC (<500-um)            | 101                   | 13.0         | 1.77 | 24.3%            | 87%        |
|                     | SSC (<50-um)             | 26.2                  | 12.8         | 1.75 | 24.3%            | 51%        |
|                     | TVSS (>2000-um)          | 41.1                  | 7.33         | 1.79 | 20%              | 82%        |
|                     | TVSS (<500-um)           | 21.2                  | 7.22         | 1.77 | 20%              | 66%        |
|                     | TVSS (<50-um)            | 12.2                  | 7.13         | 1.75 | 20%              | 42%        |
|                     | TSS (SM)                 | 60.0                  | 10.0         | 10.0 | 20%              | 83%        |
|                     | TSS (EPA)                | 50.0                  | 10.0         | 10.0 | 20%              | 80%        |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results. A single influent and effluent aliquot from 01/10/2008 (not displayed) was included in the composite due to overlap between events and their corresponding sample bottles on account of the "stacked" sampling approach.

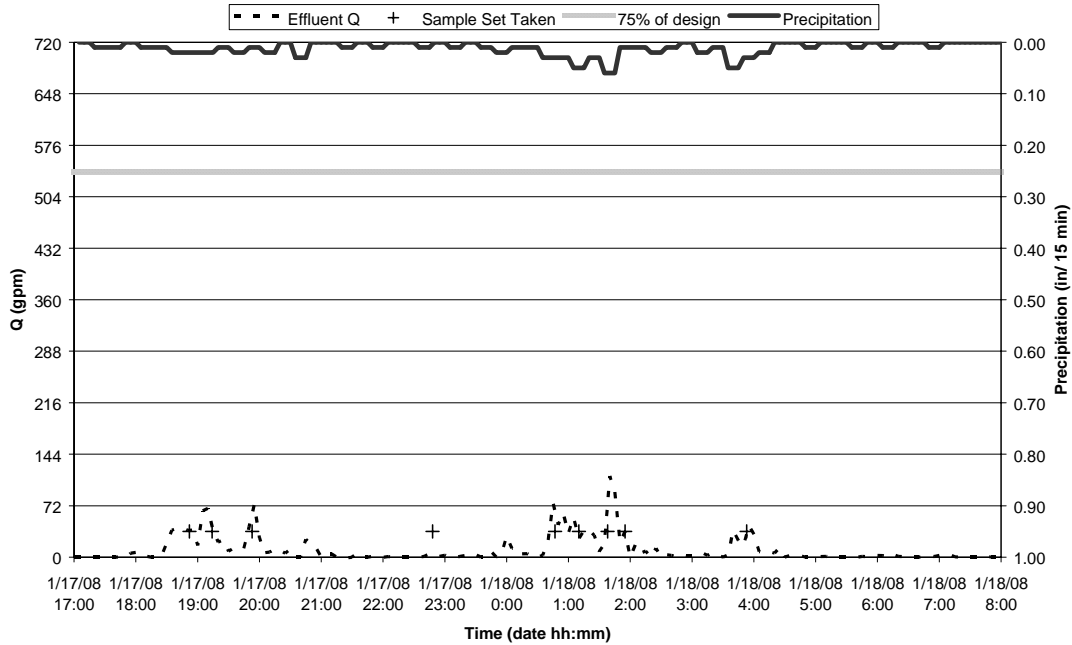
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 01/17/08  
 Date of Last Maintenance: 10/29/07  
 Antecedent Conditions: 64 hours since last rain event, 0.09"

### Hydrology

Total Precipitation (in): 0.70  
 Peak Flow (gpm): 113 (16% of design)  
 Total Runoff Volume (gal): 9487  
 Vol. Coverage (nearest 10%): 90

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                | Concentrations (mg/L) |              |      | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------|-----------------------|--------------|------|----------|-----------------------------|
|                     |                          | Influent EMC          | Effluent EMC | MRL  |          |                             |
| IN: 9 (3.6-L)       | <u>Sand (mineral)</u>    | 96                    | ND           | 1.61 | 20%      | 98%                         |
| EFF: 9              | <u>Silt (mineral)</u>    | 27                    | 21           | 1.58 | 20%      | 22%                         |
|                     | <u>SSC (&gt;2000-um)</u> | 25.5                  | ND           | 4.37 | 20%      | 83%                         |
|                     | SSC                      | 178                   | 36.5         | 4.37 | 20%      | 79%                         |
|                     | SSC (<2000-um)           | 152                   | 36.5         | 1.61 | 15.8%    | 76%                         |
|                     | SSC (<500-um)            | 81.1                  | 35.7         | 1.59 | 15.8%    | 56%                         |
|                     | SSC (<50-um)             | 44.2                  | 35.5         | 1.58 | 15.8%    | 20%                         |
|                     | TVSS (<2000-um)          | 29.0                  | 15.1         | 1.61 | 20%      | 48%                         |
|                     | TVSS (<500-um)           | 23.8                  | 14.8         | 1.59 | 20%      | 38%                         |
|                     | TVSS (<50-um)            | 17.4                  | 14.7         | 1.58 | 20%      | undeterminable              |
|                     | TSS (SM)                 | 60.0                  | 30.0         | 10.0 | 20%      | 50%                         |
|                     | TSS (EPA)                | 60.0                  | 40.0         | 10.0 | 20%      | 33%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

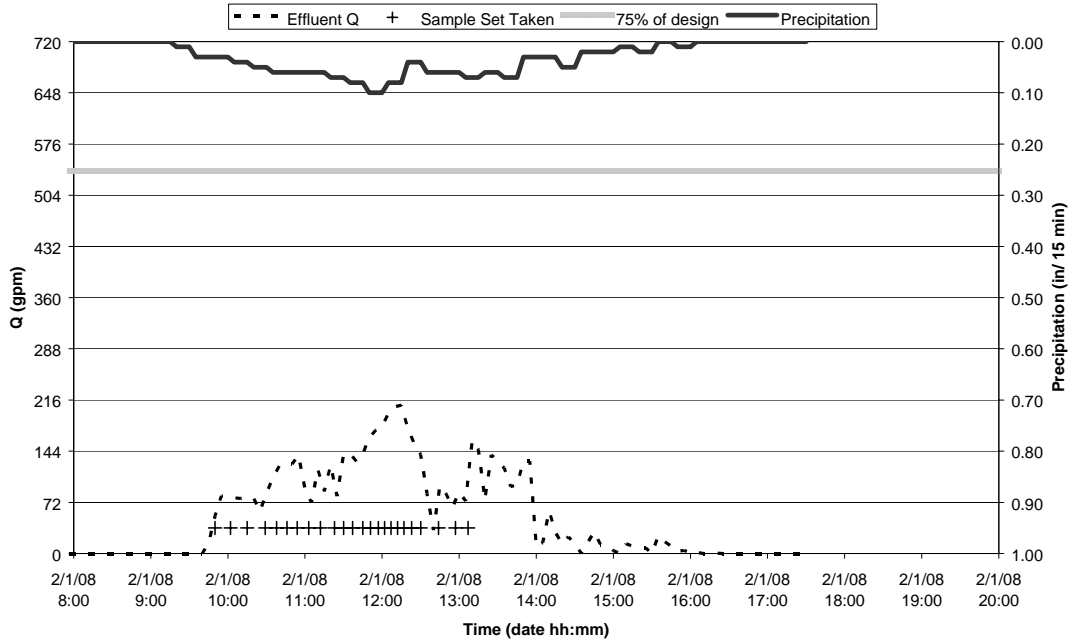
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 02/01/2008  
 Date of Last Maintenance: 10/29/07  
 Antecedent Conditions: 49 hours since last rain event, 0.05"

### Hydrology

Total Precipitation (in): 1.22  
 Peak Flow (gpm): 209 (29% of design)  
 Total Runoff Volume (gal): 30508  
 Vol. Coverage (nearest 10%): 80

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter       | Concentrations (mg/L) |              |      | Dup. RPD | Discrete Removal Efficiency |
|---------------------|-----------------|-----------------------|--------------|------|----------|-----------------------------|
|                     |                 | Influent EMC          | Effluent EMC | MRL  |          |                             |
| IN: 24 (9.1-L)      | Sand (mineral)  | 48                    | ND           | 1.43 | 20%      | 97%                         |
| EFF: 24             | Silt (mineral)  | 36                    | 32           | 1.32 | 20%      | undeterminable              |
|                     | SSC (>2000-um)  | 42.7                  | ND           | 11.1 | 20%      | 74%                         |
|                     | SSC             | 152                   | 65.3         | 11.1 | 20%      | 57%                         |
|                     | SSC (<2000-um)  | 109                   | 54.2         | 1.18 | 5.7%     | 50%                         |
|                     | SSC (<500-um)   | 70.0                  | 43.4         | 1.43 | 5.7%     | 38%                         |
|                     | SSC (<50-um)    | 56.6                  | 51.6         | 1.32 | 5.7%     | 9%                          |
|                     | TVSS (<2000-um) | 25.9                  | 20.7         | 1.18 | 20%      | 20%                         |
|                     | TVSS (<500-um)  | 24.3                  | 16.8         | 1.43 | 20%      | 31%                         |
|                     | TVSS (<50-um)   | 21.1                  | 19.8         | 1.32 | 20%      | undeterminable              |
|                     | TSS (SM)        | 60.0                  | 50.0         | 10.0 | 20%      | undeterminable              |
|                     | TSS (EPA)       | 60.0                  | 50.0         | 10.0 | 20%      | undeterminable              |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

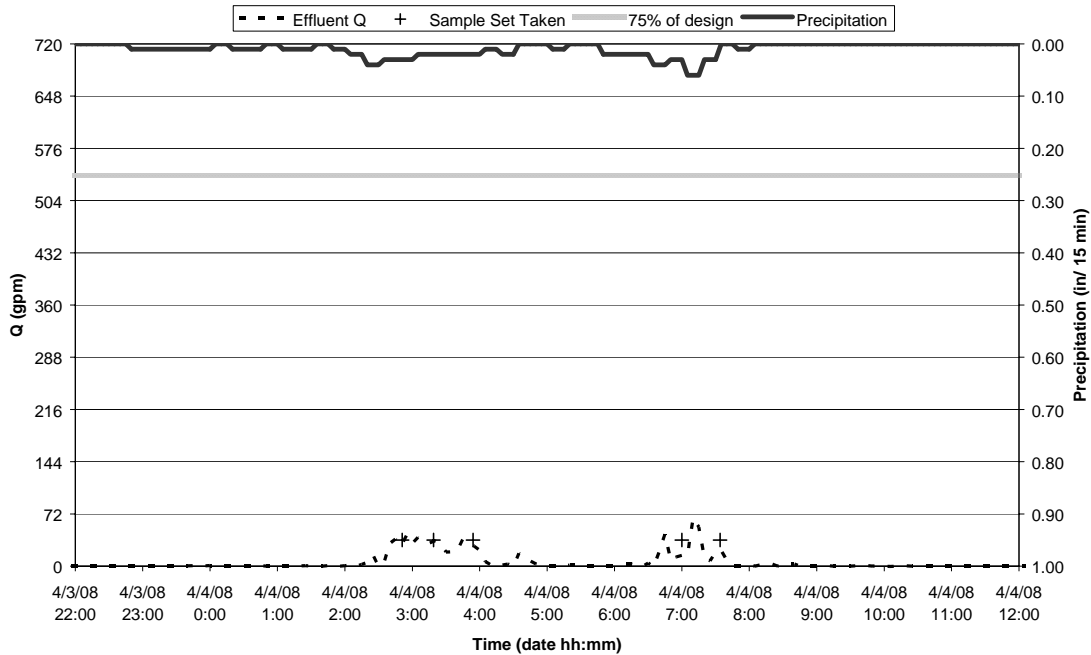
**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 04/04/08  
 Date of Last Maintenance: 10/29/07  
 Antecedent Conditions: 45 hours since last rain event, 0.06"

**Hydrology**

Total Precipitation (in): 0.57  
 Peak Flow (gpm): 66(9% of design)  
 Total Runoff Volume (gal): 4740  
 Vol. Coverage (nearest 10%): >90%

**Event Hydrograph**



**Analytical**

| Number of Aliquots: | Parameter                | Concentrations (mg/L) |              |      | Discrete Removal |            |
|---------------------|--------------------------|-----------------------|--------------|------|------------------|------------|
|                     |                          | Influent EMC          | Effluent EMC | MRL  | Dup. RPD         | Efficiency |
| IN: 5 (2.5-L)       | <u>Sand (mineral)</u>    | 301                   | ND           | 2.85 | 20%              | 99%        |
| EFF: 5              | <u>Silt (mineral)</u>    | 14.7                  | ND           | 2.94 | 20%              | 80%        |
|                     | <u>SSC (&gt;2000-um)</u> | NT                    | NT           | ---  | ---              | ---        |
|                     | SSC                      | 341                   | 2.36         | 2.8  | 20%              | 99%        |
|                     | SSC (<2000-um)           | 341                   | 2.36         | 2.77 | 20%              | 99%        |
|                     | SSC (<500-um)            | 99.7                  | ND           | 2.85 | 20%              | 97%        |
|                     | SSC (<50-um)             | 26.5                  | ND           | 2.94 | 20%              | 89%        |
|                     | TVSS (<2000-um)          | 24.9                  | 2.36         | 2.77 | 20%              | 91%        |
|                     | TVSS (<500-um)           | 19.9                  | ND           | 2.85 | 20%              | 86%        |
|                     | TVSS (<50-um)            | 11.8                  | ND           | 2.94 | 20%              | 75%        |
|                     | TSS (SM)                 | 310                   | ND           | 2.87 | 0.00%            | 99%        |
|                     | TSS (EPA)                | 40.0                  | 10.0         | 10.0 | 0.00%            | 75%        |

**Notes**

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot)

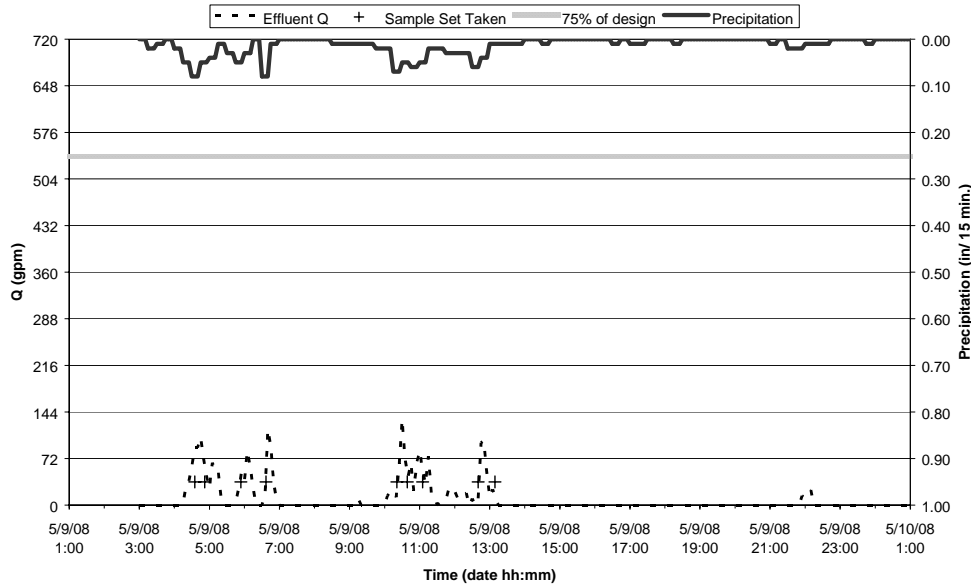
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 05/09/08  
 Date of Last Maintenance: 4/15/08  
 Antecedent Conditions: 235 hours since last rain event, 0.62"

### Hydrology

Total Precipitation (in): 1.21  
 Peak Flow (gpm): 132 (18% of design)  
 Total Runoff Volume (gal): 13134  
 Vol. Coverage (nearest 10%): 70

Event Hydrograph



### Analytical

| Number of Aliquots:<br>IN: 9 (4.5-L)<br>EFF: 9 | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|--|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|  |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
|  | <u>Coarse Solids (mineral)</u> | 1.3                   | ND           | 0.2 | 20%      | 85%                         |
|  | <u>Sand (mineral)</u>          | 19                    | 4.5          | 1.7 | 20%      | 76%                         |
|  | <u>Silt (mineral)</u>          | ND                    | 4.0          | 1.7 | 20%      | release                     |
|  | SSC                            | 78.7                  | 23.3         | 1.7 | 10%      | 70%                         |
|  | <u>TVSS</u>                    | 58.8                  | 14.8         | 1.7 | 20%      | 75%                         |
|  | SSC (>2000-um)                 | 24.7                  | ND           | 0.2 | 10%      | 99%                         |
|  | SSC (<2000-um)                 | 54.0                  | 23.3         | 1.7 | 10%      | 57%                         |
|  | SSC (<500-um)                  | 27.7                  | 23.8         | 1.7 | 10%      | 14%                         |
|  | SSC (<50-um)                   | 4.8                   | 7.6          | 1.7 | 10%      | release                     |
|  | TVSS(>2000-um)                 | 23.4                  | ND           | 0.2 | 20%      | 99%                         |
|  | TVSS (<2000-um)                | 35.4                  | 14.8         | 1.7 | 20%      | 58%                         |
|  | TVSS (<500-um)                 | 16.4                  | 12.7         | 1.7 | 20%      | 23%                         |
|  | TVSS (<50-um)                  | 5.1                   | 3.6          | 1.7 | 20%      | 29%                         |
|  | TSS (SM)                       | 56.0                  | 21.0         | 5.0 | 20%      | 63%                         |
|  | TSS (EPA)                      | 48.0                  | 21.0         | 5.0 | 20%      | 56%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

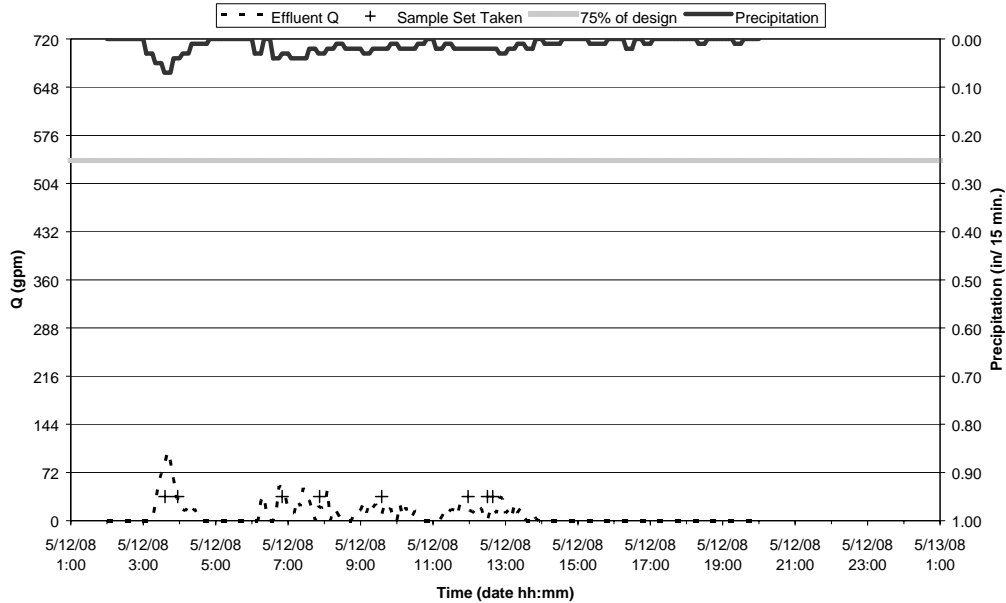
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 05/12/08  
 Date of Last Maintenance: 4/15/08  
 Antecedent Conditions: 51 hours since last rain event, 1.21"

### Hydrology

Total Precipitation (in): 0.97  
 Peak Flow (gpm): 103 (14% of design)  
 Total Runoff Volume (gal): 10050  
 SF Vol. Coverage (nearest 10%): 80

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                        | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|----------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                  | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 8 (8-L)         | <u>Coarse Material (mineral)</u> | 1.3                   | ND           | 0.2 | 20%      | 85%                         |
| EFF: 8              | <u>Sand (mineral)</u>            | 8.7                   | ND           | 2.3 | 20%      | 74%                         |
|                     | <u>Silt (mineral)</u>            | ND                    | ND           | 2.3 | 20%      | undeterminable              |
|                     | <u>SSC</u>                       | 50.6                  | 9.3          | 2.3 | 8%       | 82%                         |
|                     | <u>TVSS</u>                      | 42.4                  | 9.3          | 2.3 | 20%      | 78%                         |
|                     | SSC (>2000-um)                   | 15.7                  | ND           | 0.2 | 8%       | 99%                         |
|                     | SSC (<2000-um)                   | 34.9                  | 9.3          | 2.3 | 8%       | 73%                         |
|                     | SSC (<500-um)                    | 10.2                  | 6.3          | 2.3 | 8%       | 38%                         |
|                     | SSC (<50-um)                     | 4.6                   | 3.7          | 2.3 | 8%       | 20%                         |
|                     | TVSS(>2000-um)                   | 14.4                  | ND           | 0.2 | 20%      | 99%                         |
|                     | TVSS (<2000-um)                  | 28                    | 9.3          | 2.3 | 20%      | 67%                         |
|                     | TVSS (<500-um)                   | 8.8                   | 8.5          | 2.3 | 20%      | undeterminable              |
|                     | TVSS (<50-um)                    | 6.4                   | 5.2          | 2.3 | 20%      | 19%                         |
|                     | TSS (SM)                         | 41.0                  | 6.0          | 5.0 | 20%      | 85%                         |
|                     | TSS (EPA)                        | 32.0                  | 8.7          | 5.0 | 20%      | 73%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

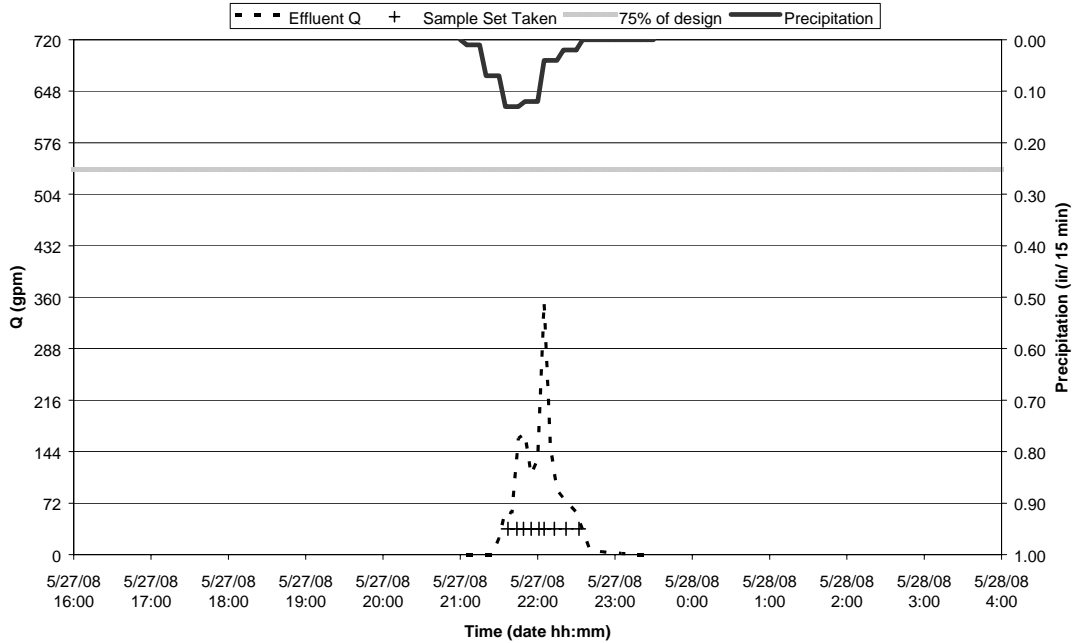
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 05/27/08  
 Date of Last Maintenance: 4/15/08  
 Antecedent Conditions: 12 hours since last rain event, 0.04"

### Hydrology

Total Precipitation (in): 0.39  
 Peak Flow (gpm): 353 (49% of design)  
 Total Runoff Volume (gal): 7915  
 Vol. Coverage (nearest 10%): >90

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                        | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|----------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                  | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 9 (8.5-L)       | <u>Coarse Material (mineral)</u> | 0.4                   | 0.1          | 0.1 | 20%      | 75%                         |
| EFF: 9              | <u>Sand (mineral)</u>            | 19.5                  | 13.5         | 1.4 | 20%      | 31%                         |
|                     | <u>Silt (mineral)</u>            | 7.7                   | 4.9          | 1.4 | 20%      | 36%                         |
|                     | <u>SSC</u>                       | 74.5                  | 40.7         | 1.4 | 20%      | 45%                         |
|                     | <u>TVSS</u>                      | 46.9                  | 22.2         | 1.4 | 20%      | 53%                         |
|                     | SSC (>2000-um)                   | 7.0                   | 2.4          | 0.1 | 14%      | 66%                         |
|                     | SSC (<2000-um)                   | 67.5                  | 38.3         | 1.4 | 14%      | 43%                         |
|                     | SSC (<500-um)                    | 40.5                  | 29.6         | 1.4 | 14%      | 27%                         |
|                     | SSC (<50-um)                     | 14.3                  | 7.5          | 1.4 | 14%      | 48%                         |
|                     | TVSS(>2000-um)                   | 6.6                   | 2.3          | 0.1 | 20%      | 65%                         |
|                     | TVSS (<2000-um)                  | 40.3                  | 19.9         | 1.4 | 20%      | 51%                         |
|                     | TVSS (<500-um)                   | 23.0                  | 15.6         | 1.4 | 20%      | 32%                         |
|                     | TVSS (<50-um)                    | 6.6                   | 2.6          | 1.4 | 20%      | 61%                         |
|                     | TSS (SM)                         | 68.0                  | 32.0         | 5.0 | 4.3%     | 53%                         |
|                     | TSS (EPA)                        | 60.0                  | 34.7         | 6.3 | 12.5%    | 42%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

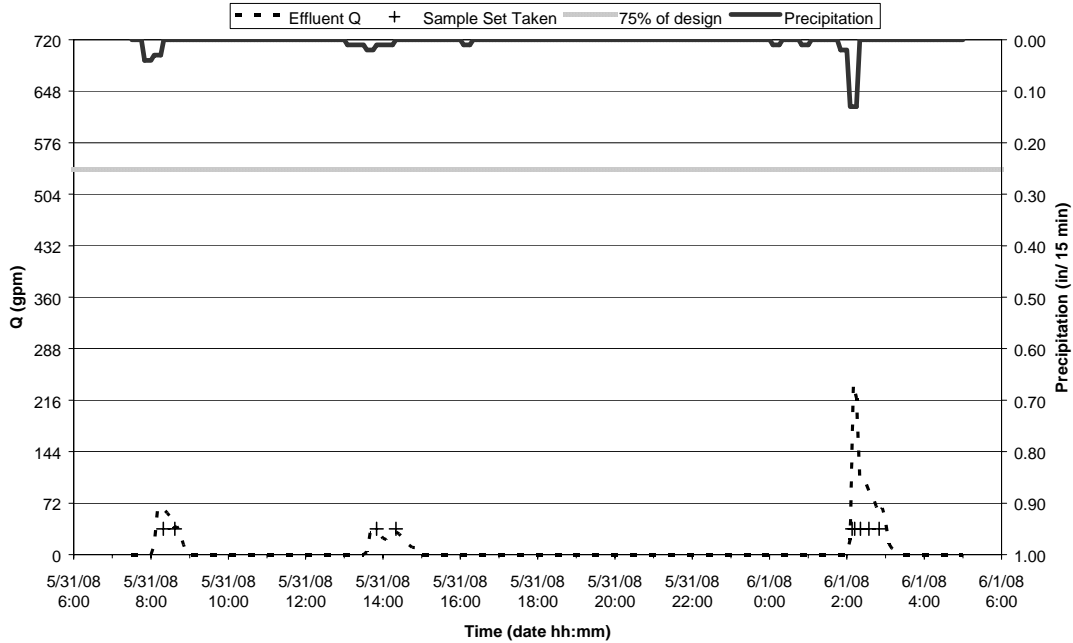
**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 05/31/08  
 Date of Last Maintenance: 4/15/08  
 Antecedent Conditions: 81.4 hours since last rain event, 0.39"

**Hydrology**

Total Precipitation (in): 0.31  
 Peak Flow (gpm): 238 (33% of design)  
 Total Runoff Volume (gal): 10153  
 Vol. Coverage (nearest 10%): 90

**Event Hydrograph**



**Analytical**

| Number of Aliquots: | Parameter                        | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|----------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                  | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 9 (8.5-L)       | <u>Coarse Material (mineral)</u> | 18.1                  | ND           | 0.1 | 20%      | 99%                         |
| EFF: 9              | <u>Sand (mineral)</u>            | 45.8                  | 12.0         | 1.4 | 20%      | 74%                         |
|                     | <u>Silt (mineral)</u>            | 14.2                  | 6.8          | 1.4 | 20%      | 52%                         |
|                     | <u>SSC</u>                       | 188.5                 | 41.1         | 1.4 | 14%      | 78%                         |
|                     | <u>TVSS</u>                      | 110.4                 | 22.3         | 1.4 | 20%      | 80%                         |
|                     | SSC (>2000-um)                   | 27.7                  | 0.27         | 0.1 | 14%      | 99%                         |
|                     | SSC (<2000-um)                   | 160.8                 | 40.8         | 1.4 | 14%      | 75%                         |
|                     | SSC (<500-um)                    | 60.0                  | 30.3         | 1.4 | 14%      | 50%                         |
|                     | SSC (<50-um)                     | 20.8                  | 12.8         | 1.4 | 14%      | 38%                         |
|                     | TVSS(>2000-um)                   | 9.6                   | 0.3          | 0.1 | 20%      | 97%                         |
|                     | TVSS (<2000-um)                  | 100.8                 | 22.0         | 1.4 | 20%      | 78%                         |
|                     | TVSS (<500-um)                   | 30.1                  | 14.5         | 1.4 | 20%      | 52%                         |
|                     | TVSS (<50-um)                    | 6.6                   | 6.0          | 1.4 | 20%      | undeterminable              |
|                     | TSS (SM)                         | 154.0                 | 43.2         | 5.0 | 0.7%     | 72%                         |
|                     | TSS (EPA)                        | 141.0                 | 41.0         | 5.0 | 24.1%    | 71%                         |

**Notes**

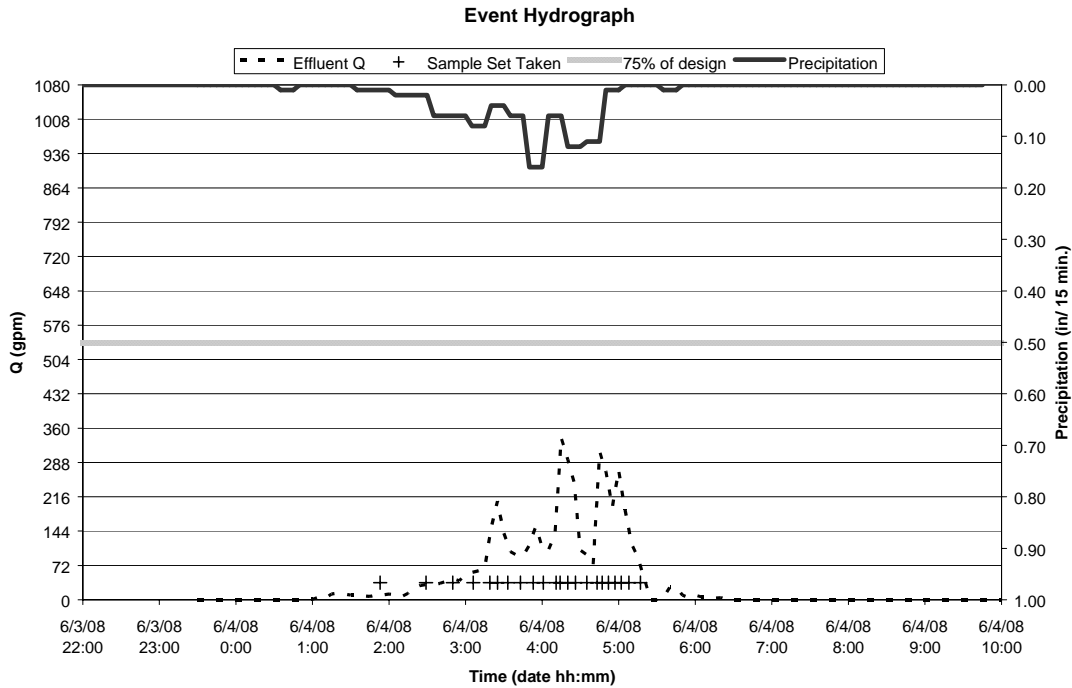
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 06/04/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 69 hours since last rain event, 0.17 "

**Hydrology**

Total Precipitation (in): 0.85  
 Peak Flow (gpm): 339 (47% of design)  
 Total Runoff Volume (gal): 24003  
 Vol. Coverage (nearest 10%): >90%



**Analytical**

| Number of Aliquots: | Parameter                        | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|----------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                  | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 22 (11-L)       | <u>Coarse Material (mineral)</u> | ND                    | ND           | 0.1 | 20%      | undeterminable              |
| EFF: 22 (11-L)      | <u>Sand (mineral)</u>            | 10.2                  | ND           | 0.6 | 20%      | 94%                         |
|                     | <u>Silt (mineral)</u>            | 2.8                   | 5.9          | 0.6 | 20%      | release                     |
|                     | <u>SSC</u>                       | 27.7                  | 10.5         | 0.6 | 5.7%     | 62%                         |
|                     | <u>TVSS</u>                      | 14.7                  | 7.4          | 0.6 | 20%      | 50%                         |
|                     | SSC (>2000-um)                   | 0.8                   | 0.6          | 0.1 | 5.7%     | 25%                         |
|                     | SSC (<2000-um)                   | 26.9                  | 9.9          | 0.6 | 5.7%     | 63%                         |
|                     | SSC (<500-um)                    | 17.4                  | 5.3          | 0.6 | 5.7%     | 70%                         |
|                     | SSC (<50-um)                     | 6.0                   | 7.3          | 0.6 | 5.7%     | release                     |
|                     | TVSS(>2000-um)                   | 0.8                   | 0.6          | 0.1 | 20%      | 25%                         |
|                     | TVSS (<2000-um)                  | 13.9                  | 6.8          | 0.6 | 20%      | 51%                         |
|                     | TVSS (<500-um)                   | 8.9                   | 3.4          | 0.6 | 20%      | 62%                         |
|                     | TVSS (<50-um)                    | 3.2                   | 1.4          | 0.6 | 20%      | 56%                         |
|                     | TSS (SM)                         | 24.3                  | 9.0          | 2.5 | 22.6%    | 63%                         |
|                     | TSS (EPA)                        | 23.3                  | 7.7          | 2.5 | 6.4%     | 67%                         |

**Notes**

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

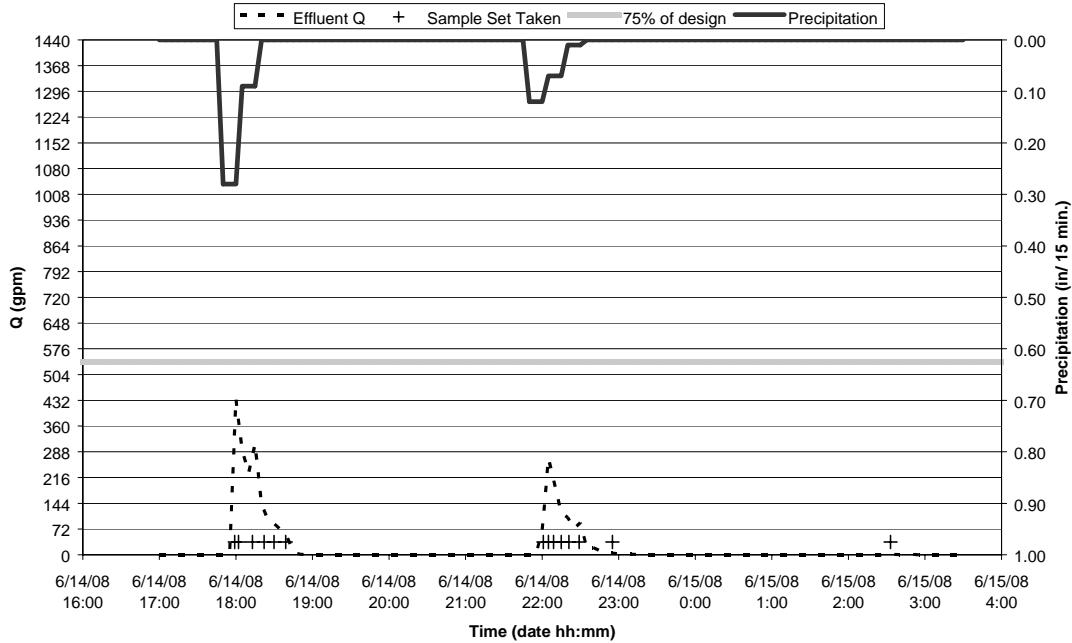
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 06/14/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 228 hours since last rain event, 1.55"

### Hydrology

Total Precipitation (in): 0.57  
 Peak Flow (gpm): 436(61% of design)  
 Total Runoff Volume (gal): 13560  
 Vol. Coverage (nearest 10%): >90%

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |      | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|------|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL  |          |                             |
| IN: 14 (7000-mL)    | <u>Coarse Solids (mineral)</u> | 2.30                  | 0.40         | 0.1  | 20%      | 83%                         |
| EFF: 14 (7000-mL)   | <u>Sand (mineral)</u>          | 314.5                 | 17.1         | 1.1  | 20%      | 95%                         |
|                     | <u>Silt (mineral)</u>          | 86.5                  | 20.4         | 1.1  | 20%      | 76%                         |
|                     | <u>SSC</u>                     | 710.7                 | 74.7         | 1.1  | 6.9%     | 89%                         |
|                     | <u>TVSS</u>                    | 307.4                 | 36.8         | 1.1  | 20%      | 88%                         |
|                     | SSC (>2000-um)                 | 25.2                  | 4.4          | 0.1  | 6.9%     | 83%                         |
|                     | SSC (<2000-um)                 | 685.5                 | 70.3         | 1.1  | 6.9%     | 90%                         |
|                     | SSC (<500-um)                  | 508.6                 | 41.6         | 1.1  | 6.9%     | 92%                         |
|                     | SSC (<50-um)                   | 125.1                 | 32.8         | 1.1  | 6.9%     | 74%                         |
|                     | TVSS(>2000-um)                 | 22.9                  | 4.0          | 0.1  | 20%      | 83%                         |
|                     | TVSS (<2000-um)                | 284.5                 | 32.8         | 1.1  | 20%      | 88%                         |
|                     | TVSS (<500-um)                 | 207.6                 | 18.0         | 1.1  | 20%      | 91%                         |
|                     | TVSS (<50-um)                  | 38.6                  | 12.4         | 1.1  | 20%      | 68%                         |
|                     | TSS (SM)                       | 718.0                 | 84.0         | 20.0 | 1.1%     | 88%                         |
|                     | TSS (EPA)                      | 658.0                 | 51.0         | 20.0 | 3.0%     | 92%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

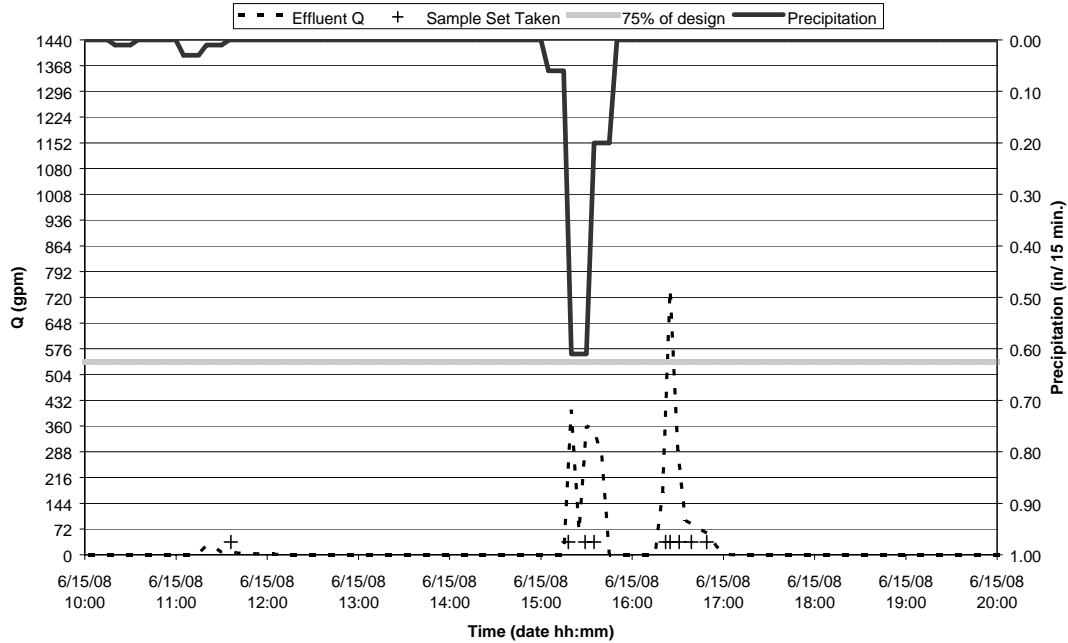
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 06/15/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 12 hours since last rain event, 0.57"

### Hydrology

Total Precipitation (in): 0.92  
 Peak Flow (gpm): 743 (103% of design)  
 Total Runoff Volume (gal): 15465  
 Vol. Coverage (nearest 10%): >90%

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |      | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|------|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL  |          |                             |
| IN: 9 (4500-mL)     | <u>Coarse Solids (mineral)</u> | 2.3                   | ND           | 0.1  | 20%      | 96%                         |
| EFF: 9 (4500-mL)    | <u>Sand (mineral)</u>          | 117.1                 | 24.3         | 1.1  | 20%      | 79%                         |
|                     | <u>Silt (mineral)</u>          | 52.4                  | 7.7          | 1.1  | 20%      | 85%                         |
|                     | <u>SSC</u>                     | 299.5                 | 55.9         | 1.1  | 10.0%    | 81%                         |
|                     | <u>TVSS</u>                    | 127.7                 | 23.9         | 1.1  | 20%      | 81%                         |
|                     | SSC (>2000-um)                 | 11.0                  | ND           | 0.1  | 10.0%    | 99%                         |
|                     | SSC (<2000-um)                 | 288.5                 | 55.9         | 1.1  | 10.0%    | 81%                         |
|                     | SSC (<500-um)                  | 241.0                 | 29.5         | 1.1  | 10.0%    | 88%                         |
|                     | SSC (<50-um)                   | 72.6                  | 11.8         | 1.1  | 10.0%    | 84%                         |
|                     | TVSS(>2000-um)                 | 8.7                   | ND           | 0.1  | 20%      | 99%                         |
|                     | TVSS (<2000-um)                | 119                   | 23.9         | 1.1  | 20%      | 80%                         |
|                     | TVSS (<500-um)                 | 91.8                  | 10.7         | 1.1  | 20%      | 88%                         |
|                     | TVSS (<50-um)                  | 20.2                  | 4.1          | 1.1  | 20%      | 80%                         |
|                     | TSS (SM)                       | 304.0                 | 40.0         | 10.0 | 1.1%     | 87%                         |
|                     | TSS (EPA)                      | 298.0                 | 37.0         | 10.0 | 3.0%     | 88%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

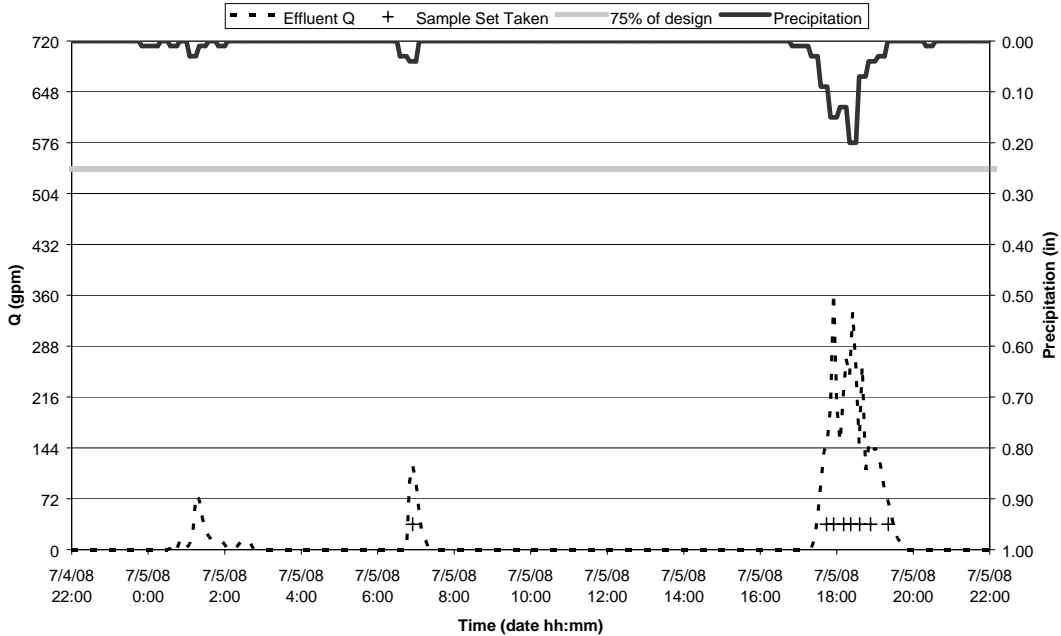
**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 07/05/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 89.6 hours since last rain event, 0.06"

**Hydrology**

Total Precipitation (in): 0.92  
 Peak Flow (gpm): 363 (51% of design)  
 Total Runoff Volume (gal): 24748  
 Vol. Coverage (nearest 10%): >90%

**Event Hydrograph**



**Analytical**

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 8 (4000-mL)     | <u>Coarse Solids (mineral)</u> | ND                    | ND           | 0.1 | 20%      | undeterminable              |
| EFF: 8 (4000-mL)    | <u>Sand (mineral)</u>          | 95                    | 13.9         | 1.4 | 20%      | 85%                         |
|                     | <u>Silt (mineral)</u>          | 37.0                  | 4.1          | 1.4 | 20%      | 89%                         |
|                     | <u>SSC</u>                     | 241.9                 | 30.3         | 1.4 | 4.1%     | 87%                         |
|                     | <u>TVSS</u>                    | 109                   | 12.2         | 1.4 | 20%      | 89%                         |
|                     | SSC (>2000-um)                 | 3.9                   | 0.38         | 0.1 | 4.1%     | 90%                         |
|                     | SSC (<2000-um)                 | 238                   | 29.9         | 1.4 | 4.1%     | 87%                         |
|                     | SSC (<500-um)                  | 158                   | 13.6         | 1.4 | 4.1%     | 91%                         |
|                     | SSC (<50-um)                   | 52.4                  | 6.8          | 1.4 | 4.1%     | 87%                         |
|                     | TVSS(>2000-um)                 | 3.5                   | 0.3          | 0.1 | 20%      | 91%                         |
|                     | TVSS (<2000-um)                | 106                   | 11.9         | 1.4 | 20%      | 89%                         |
|                     | TVSS (<500-um)                 | 58.3                  | 6.3          | 1.4 | 20%      | 89%                         |
|                     | TVSS (<50-um)                  | 15.4                  | 2.7          | 1.4 | 20%      | 82%                         |
|                     | TSS (SM)                       | 271                   | 26.0         | 5.0 | 4.9%     | 90%                         |
|                     | TSS (EPA)                      | 232                   | 25.5         | 5.0 | 3.0%     | 89%                         |

**Notes**

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

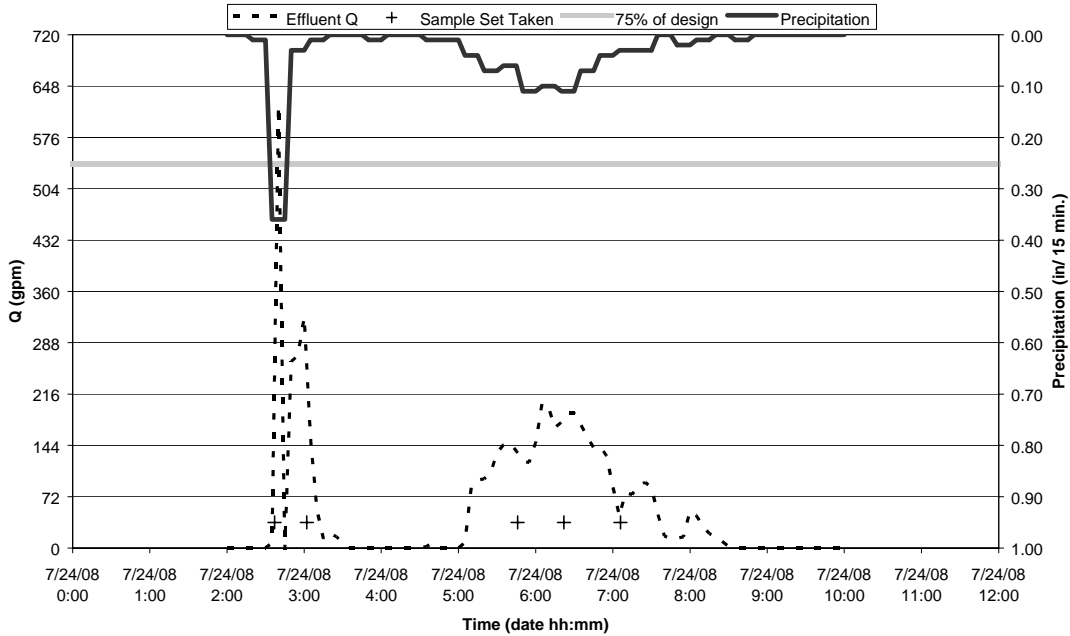
**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 07/24/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 84.8 hours since last rain event, 0.24"

**Hydrology**

Total Precipitation (in): 1.14  
 Peak Flow (gpm): 620 (86% of design)  
 Total Runoff Volume (gal): 28963  
 Vol. Coverage (nearest 10%): >90%

**Event Hydrograph**



**Analytical**

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 5 (2500-mL)     | <u>Coarse Solids (mineral)</u> | 0.0                   | 1.01         | 0.2 | 20%      | release                     |
| EFF: 5 (2500-mL)    | <u>Sand (mineral)</u>          | 220.1                 | 0.0          | 2.5 | 20%      | 100%                        |
|                     | <u>Silt (mineral)</u>          | 50.8                  | 0.0          | 2.5 | 20%      | 100%                        |
|                     | <u>SSC</u>                     | 500                   | 49.7         | 2.5 | 1.3%     | 90%                         |
|                     | <u>TVSS</u>                    | 229                   | 49           | 1.4 | 20%      | 79%                         |
|                     | SSC (>2000-um)                 | 8.6                   | 6.71         | 0.2 | 1.3%     | 22%                         |
|                     | SSC (<2000-um)                 | 491.1                 | 43.0         | 2.5 | 1.3%     | 91%                         |
|                     | SSC (<500-um)                  | 256.2                 | 24.2         | 2.5 | 1.3%     | 91%                         |
|                     | SSC (<50-um)                   | 74.4                  | 9.4          | 2.5 | 1.3%     | 87%                         |
|                     | TVSS(>2000-um)                 | 8.6                   | 5.7          | 0.2 | 20%      | 34%                         |
|                     | TVSS (<2000-um)                | 220.2                 | 43.0         | 2.5 | 20%      | 80%                         |
|                     | TVSS (<500-um)                 | 106.4                 | 24.2         | 2.5 | 20%      | 77%                         |
|                     | TVSS (<50-um)                  | 23.6                  | 9.4          | 2.5 | 20%      | 60%                         |
|                     | TSS (SM)                       | 458.7                 | 46.0         | 5.0 | 2.3%     | 90%                         |
|                     | TSS (EPA)                      | 427.0                 | 43.3         | 6.7 | 6.6%     | 90%                         |

**Notes**

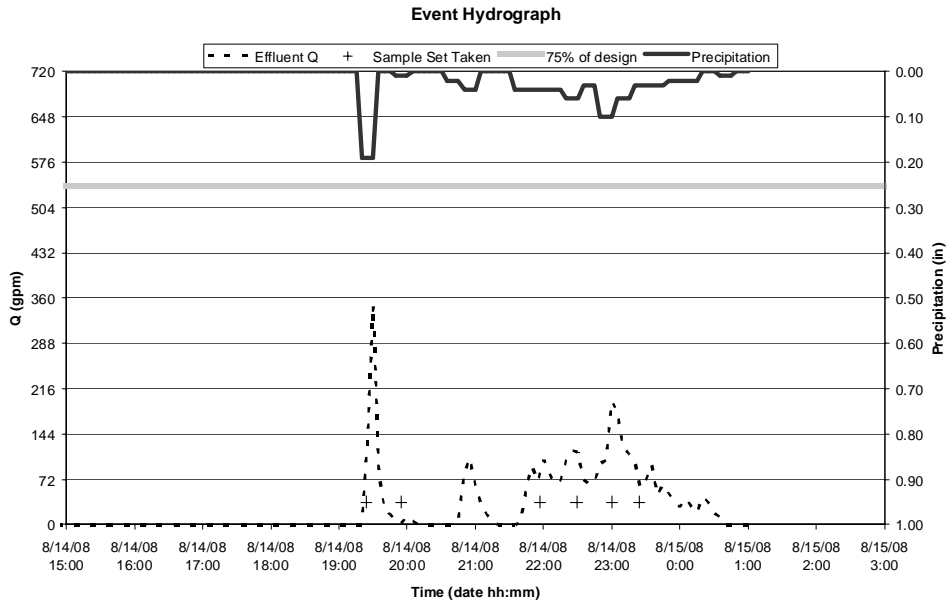
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 08/14/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 14.8 hours since last rain event, 0.08"

### Hydrology

Total Precipitation (in): 0.85  
 Peak Flow (gpm): 349 (49% of design)  
 Total Runoff Volume (gal): 19781  
 Vol. Coverage (nearest 10%): 90



### Analytical

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Discrete Removal |            |
|---------------------|--------------------------------|-----------------------|--------------|-----|------------------|------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL | Dup. RPD         | Efficiency |
| IN: 6 (3000-mL)     | <u>Coarse Solids (mineral)</u> | 15.6                  | ND           | 0.2 | 20%              | 99%        |
| EFF: 6 (3000-mL)    | <u>Sand (mineral)</u>          | 260.8                 | 21.0         | 1.6 | 20%              | 92%        |
|                     | <u>Silt (mineral)</u>          | 46.8                  | 8.1          | 1.6 | 20%              | 83%        |
|                     | SSC                            | 598.0                 | 42.5         | 1.6 | 10.0%            | 93%        |
|                     | TVSS                           | 274.8                 | 13.4         | 1.6 | 20%              | 95%        |
|                     | SSC (>2000-um)                 | 55.2                  | ND           | 0.2 | 10.0%            | 100%       |
|                     | SSC (<2000-um)                 | 542.8                 | 42.3         | 1.6 | 10.0%            | 92%        |
|                     | SSC (<500-um)                  | 271.2                 | 31.9         | 1.6 | 10.0%            | 88%        |
|                     | SSC (<50-um)                   | 50.0                  | 14.2         | 1.6 | 10.0%            | 72%        |
|                     | TVSS(>2000-um)                 | 39.6                  | ND           | 0.2 | 20%              | 99%        |
|                     | TVSS (<2000-um)                | 235.2                 | 13.2         | 1.6 | 20%              | 94%        |
|                     | TVSS (<500-um)                 | 94.4                  | 11.6         | 1.6 | 20%              | 88%        |
|                     | TVSS (<50-um)                  | 3.2                   | 6.1          | 1.6 | 20%              | release    |
|                     | TSS (SM)                       | 657.0                 | 48.0         | 4.0 | 4.1%             | 93%        |
|                     | TSS (EPA)                      | 468.5                 | 41.0         | 4.0 | 16.9%            | 91%        |

### Notes

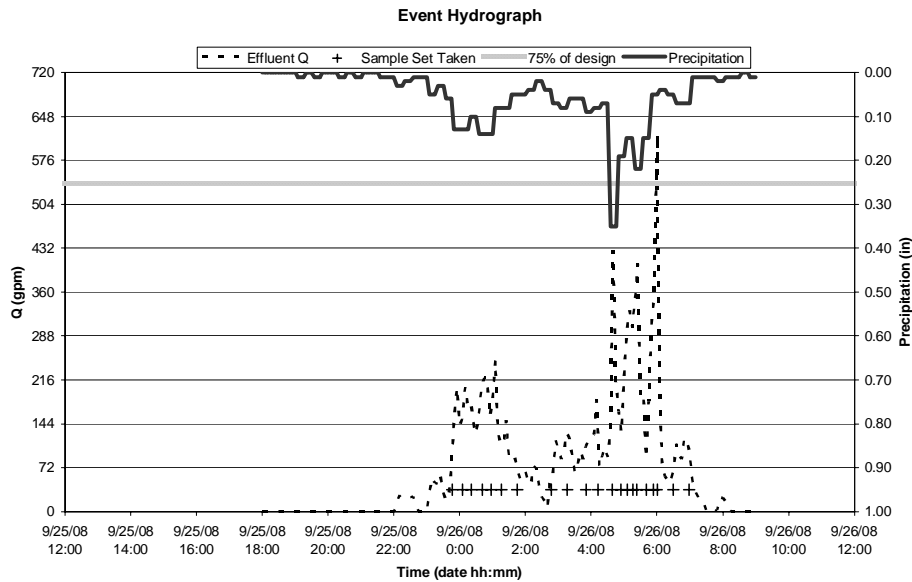
Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 09/25/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 304 hours since last rain event, 0.68"

**Hydrology**

Total Precipitation (in): 3.20  
 Peak Flow (gpm): 619 (86% of design)  
 Total Runoff Volume (gal): 65868  
 Vol. Coverage (nearest 10%): >90



**Analytical**

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 21 (10500-mL)   | <u>Coarse Solids (mineral)</u> | 815                   | ND           | 0.1 | 20%      | 100%                        |
| EFF: 21 (10500-mL)  | <u>Sand (mineral)</u>          | 6071                  | 10.5         | 1.0 | 20%      | 100%                        |
|                     | <u>Silt (mineral)</u>          | 11.8                  | 2.9          | 1.0 | 20%      | 75%                         |
|                     | <u>SSC</u>                     | 6995                  | 22.5         | 1.0 | 20%      | 100%                        |
|                     | <u>TVSS</u>                    | 97.4                  | 9.2          | 1.0 | 20%      | 91%                         |
|                     | SSC (>2000-um)                 | 845                   | ND           | 0.1 | 20%      | 100%                        |
|                     | SSC (<2000-um)                 | 6150                  | 22.5         | 1.0 | 20%      | 100%                        |
|                     | SSC (<500-um)                  | 2558                  | 9.1          | 1.0 | 20%      | 100%                        |
|                     | SSC (<50-um)                   | 16.2                  | 4.7          | 1.0 | 20%      | 71%                         |
|                     | TVSS(>2000-um)                 | 30.2                  | ND           | 0.1 | 20%      | 100%                        |
|                     | TVSS (<2000-um)                | 67.2                  | 9.1          | 1.0 | 20%      | 86%                         |
|                     | TVSS (<500-um)                 | 25.0                  | 3.6          | 1.0 | 20%      | 86%                         |
|                     | TVSS (<50-um)                  | 4.4                   | 1.8          | 1.0 | 20%      | 59%                         |
|                     | TSS (SM)                       | 2259                  | 13.8         | 5.0 | 14.5%    | 99%                         |
|                     | TSS (EPA)                      | 2075                  | 12.7         | 5.0 | 2.4%     | 99%                         |

**Notes**

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

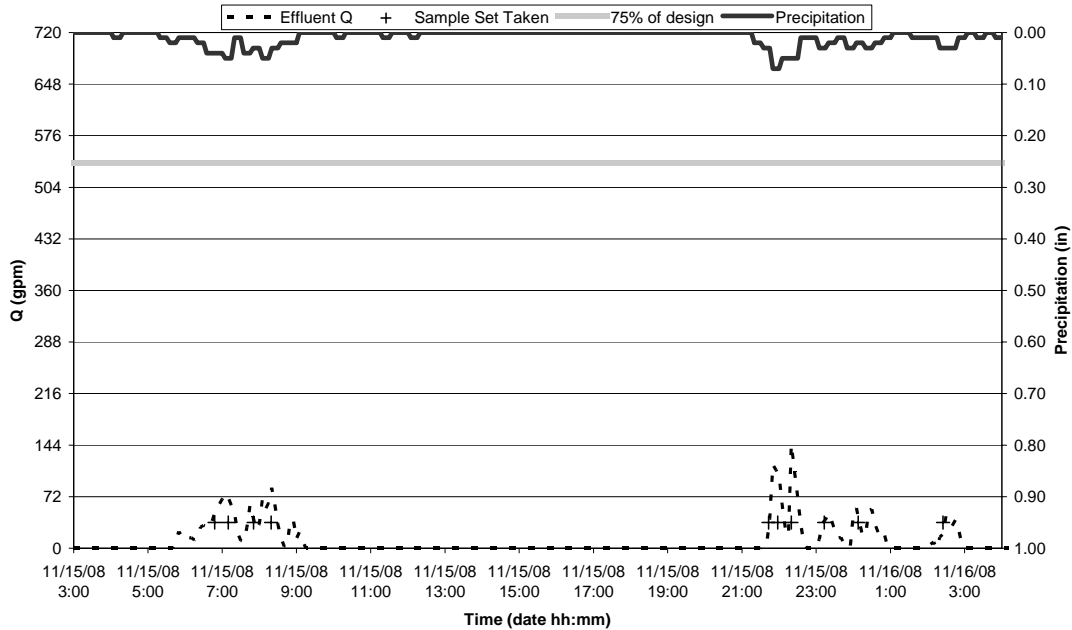
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 11/15/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 33 hours since last rain event, 0.57"

### Hydrology

Total Precipitation (in): 0.97  
 Peak Flow (gpm): 145 (20% of design)  
 Total Runoff Volume (gal): 15806  
 Vol. Coverage (nearest 10%): >90%

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 10 (5000-mL)    | <u>Coarse Solids (mineral)</u> | 16.9                  | ND           | 0.1 | 20%      | 99%                         |
| EFF: 10 (5000-mL)   | Sand (mineral)                 | 20.9                  | 5.1          | 1.0 | 20%      | 76%                         |
|                     | Silt (mineral)                 | 6.2                   | 5.7          | 1.0 | 20%      | undeterminable              |
|                     | SSC                            | 113                   | 21.8         | 1.0 | 27.7%    | 81%                         |
|                     | TVSS                           | 69.0                  | 11.0         | 1.0 | 20%      | 84%                         |
|                     | SSC (>2000-um)                 | 41.1                  | ND           | 0.1 | 27.7%    | 100%                        |
|                     | SSC (<2000-um)                 | 71.9                  | 21.7         | 1.0 | 27.7%    | 70%                         |
|                     | SSC (<500-um)                  | 21.4                  | 9.3          | 1.0 | 27.7%    | 57%                         |
|                     | SSC (<50-um)                   | 11.6                  | 7.2          | 1.0 | 27.7%    | 38%                         |
|                     | TVSS(>2000-um)                 | 24.2                  | 0.1          | 0.1 | 20%      | 100%                        |
|                     | TVSS (<2000-um)                | 44.8                  | 10.9         | 2.2 | 20%      | 76%                         |
|                     | TVSS (<500-um)                 | 10.3                  | 4.8          | 2.1 | 20%      | 53%                         |
|                     | TVSS (<50-um)                  | 5.4                   | 1.5          | 1.0 | 20%      | 72%                         |
|                     | TSS (SM)                       | 75.5                  | 25.1         | 5.0 | 5.7%     | 67%                         |
|                     | TSS (EPA)                      | 46.6                  | 17.0         | 5.0 | 9.0%     | 64%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

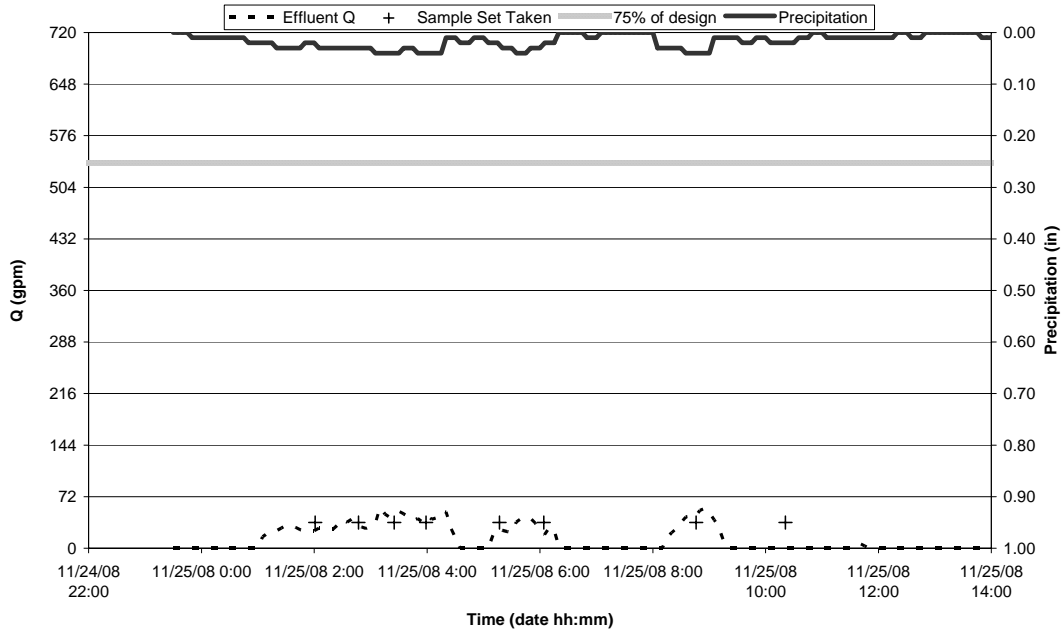
### General Information

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 11/25/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 212 hours since last rain event, 0.53"

### Hydrology

Total Precipitation (in): 0.97  
 Peak Flow (gpm): 57 (8% of design)  
 Total Runoff Volume (gal): 11707  
 Vol. Coverage (nearest 10%): >90%

Event Hydrograph



### Analytical

| Number of Aliquots: | Parameter                      | Concentrations (mg/L) |              |     | Dup. RPD | Discrete Removal Efficiency |
|---------------------|--------------------------------|-----------------------|--------------|-----|----------|-----------------------------|
|                     |                                | Influent EMC          | Effluent EMC | MRL |          |                             |
| IN: 8 (4000-mL)     | <u>Coarse Solids (mineral)</u> | 2.6                   | ND           | 0.1 | 20%      | 96%                         |
| EFF: 8 (4000-mL)    | Sand (mineral)                 | 15.3                  | ND           | 1.4 | 20%      | 91%                         |
|                     | Silt (mineral)                 | ND                    | ND           | 1.4 | 20%      | undeterminable              |
|                     | SSC                            | 38.9                  | 3.8          | 1.4 | 8.5%     | 90%                         |
|                     | TVSS                           | 21.0                  | 2.9          | 1.4 | 20%      | 86%                         |
|                     | SSC (>2000-um)                 | 14.2                  | ND           | 0.1 | 8.5%     | 99%                         |
|                     | SSC (<2000-um)                 | 24.7                  | 3.7          | 1.4 | 8.5%     | 85%                         |
|                     | SSC (<500-um)                  | 9.2                   | ND           | 1.4 | 8.5%     | 85%                         |
|                     | SSC (<50-um)                   | ND                    | ND           | 1.4 | 8.5%     | undeterminable              |
|                     | TVSS(>2000-um)                 | 11.6                  | ND           | 0.1 | 20%      | 99%                         |
|                     | TVSS (<2000-um)                | 9.4                   | 2.8          | 1.4 | 20%      | 70%                         |
|                     | TVSS (<500-um)                 | 5.0                   | ND           | 1.4 | 20%      | 72%                         |
|                     | TVSS (<50-um)                  | 1.4                   | ND           | 1.4 | 20%      | undeterminable              |
|                     | TSS (SM)                       | 29.4                  | 2.5          | 2.5 | 20%      | 91%                         |
|                     | TSS (EPA)                      | 20.5                  | ND           | 2.5 | 20%      | 88%                         |

### Notes

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.

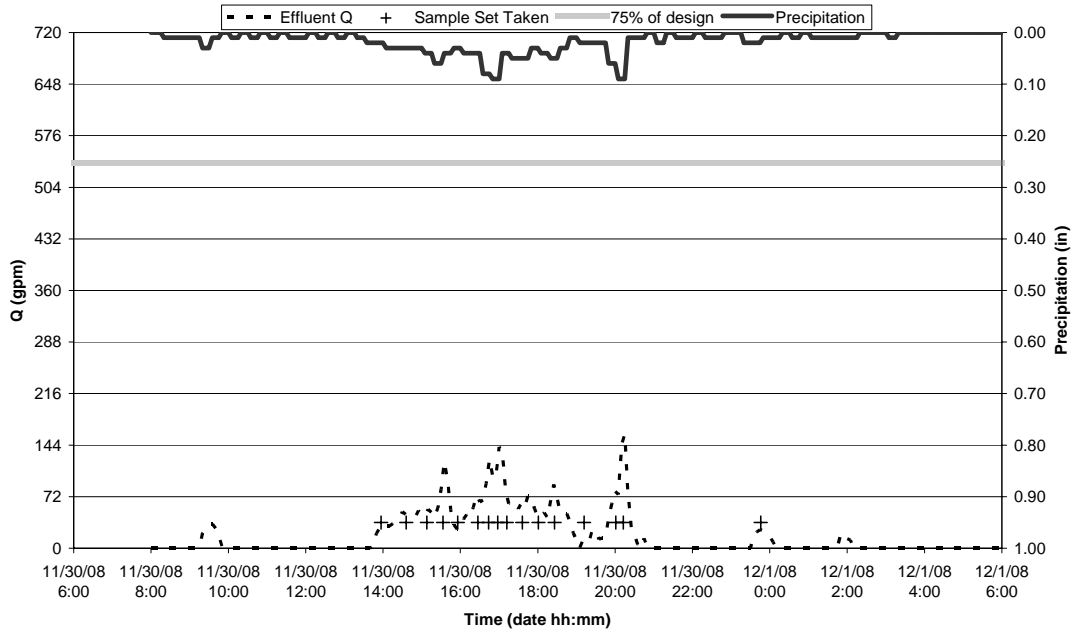
**General Information**

Site: Manasquan Savings Bank, (31378), Point Pleasant, NJ  
 System Description: CDS PMSU20\_25HE (40.5 ft<sup>2</sup> sediment storage capacity, design 1.6 cfs)  
 Event Date: 11/30/08  
 Date of Last Maintenance: 04/15/08  
 Antecedent Conditions: 14 days since last rain event, 0.97"

**Hydrology**

Total Precipitation (in): 1.46  
 Peak Flow (gpm): 158(22% of design)  
 Total Runoff Volume (gal): 24187  
 Vol. Coverage (nearest 10%): >90%

**Event Hydrograph**



**Analytical**

| Number of Aliquots:<br>IN: 14(7000-mL)<br>EFF: 14(7000-mL) | Parameter                      | Concentrations (mg/L) |              |      | Dup. RPD | Discrete Removal Efficiency |
|--|--------------------------------|-----------------------|--------------|------|----------|-----------------------------|
|  |                                | Influent EMC          | Effluent EMC | MRL  |          |                             |
|  | <u>Coarse Solids (mineral)</u> | ND                    | ND           | 0.1  | 20%      | undeterminable              |
|  | <u>Sand (mineral)</u>          | 170.1                 | 7.0          | 1.4  | 20%      | 96%                         |
|  | <u>Silt (mineral)</u>          | 40.6                  | 2.4          | 1.4  | 20%      | 94%                         |
|  | <u>SSC</u>                     | 381.8                 | 15.7         | 1.4  | 11.1%    | 96%                         |
|  | <u>TVSS</u>                    | 171.1                 | 6.3          | 1.4  | 20%      | 96%                         |
|  | SSC (>2000-um)                 | 25.5                  | ND           | 0.1  | 11.1%    | 100%                        |
|  | SSC (<2000-um)                 | 356.3                 | 15.6         | 1.4  | 11.1%    | 96%                         |
|  | SSC (<500-um)                  | 178.6                 | 7.6          | 1.4  | 11.1%    | 96%                         |
|  | SSC (<50-um)                   | 56.1                  | 5.1          | 1.4  | 11.1%    | 91%                         |
|  | TVSS(>2000-um)                 | 25.5                  | ND           | 0.1  | 20%      | 100%                        |
|  | TVSS (<2000-um)                | 145.6                 | 6.2          | 1.4  | 20%      | 96%                         |
|  | TVSS (<500-um)                 | 66.5                  | 4.4          | 1.4  | 20%      | 93%                         |
|  | TVSS (<50-um)                  | 15.5                  | 2.7          | 1.4  | 20%      | 83%                         |
|  | TSS (SM)                       | 519.0                 | 16.8         | 10.0 | 20%      | 97%                         |
|  | TSS (EPA)                      | 348.0                 | 16.7         | 10.0 | 0%       | 95%                         |

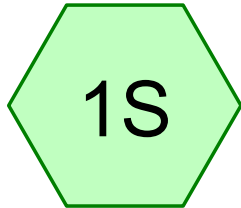
**Notes**

Peak flow and total runoff volume based on effluent flow measurements. Shaded RPD values defaulted to 20% standard due to QC complications. All samples passed through a 2000-um sieve prior to splitting. Underlined parameters are calculated: SSC defined as sum of SSC (>2000-um) and SSC (<2000-um); Coarse Solids defined as >2000-um; Sand defined as between 2000-um and 50-um; Silt defined as <50-um; SSC (>2000-um) calculated using estimated volume of sample used for composite (visual estimate of actual aliquot volume) and mass of material retained by the 2000-um sieve; mineral fraction determined through subtraction of volatile from total results.



# Appendix E: HydroCAD

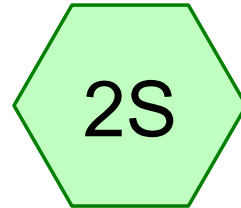
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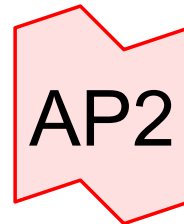
Area to Shawsheen River



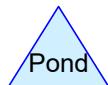
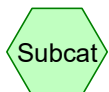
Offsite Shawsheen River Wetlands



Area to Haverhill Street



Offsite Haverhill Street



# 17024 PRE-DRAINAGE

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## 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   | 3.14           | 2   |
| 2      | 10-Year    | Type III 24-hr |       | Default | 24.00            | 1   | 4.97           | 2   |
| 3      | 25-Year    | Type III 24-hr |       | Default | 24.00            | 1   | 6.12           | 2   |
| 4      | 100-Year   | Type III 24-hr |       | Default | 24.00            | 1   | 7.89           | 2   |

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## Area Listing (all nodes)

| Area<br>(sq-ft) | CN        | Description<br>(subcatchment-numbers)  |
|-----------------|-----------|--|
| 5,408           | 39        | >75% Grass cover, Good, HSG A (1S, 2S) |
| 1,641           | 30        | Brush, Good, HSG A (1S)                |
| 43,316          | 98        | Paved parking, HSG A (1S, 2S)          |
| 12,934          | 98        | Roofs, HSG A (1S)                      |
| 5,624           | 30        | Woods, Good, HSG A (1S)                |
| <b>68,923</b>   | <b>86</b> | <b>TOTAL AREA</b>                      |

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## Soil Listing (all nodes)

| Area<br>(sq-ft) | Soil<br>Group | Subcatchment<br>Numbers |
|-----------------|---------------|-------------------------|
| 68,923          | HSG A         | 1S, 2S                  |
| 0               | HSG B         |                         |
| 0               | HSG C         |                         |
| 0               | HSG D         |                         |
| 0               | Other         |                         |
| <b>68,923</b>   |               | <b>TOTAL AREA</b>       |

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## Ground Covers (all nodes)

| HSG-A<br>(sq-ft) | HSG-B<br>(sq-ft) | HSG-C<br>(sq-ft) | HSG-D<br>(sq-ft) | Other<br>(sq-ft) | Total<br>(sq-ft) | Ground<br>Cover           |
|------------------|------------------|------------------|------------------|------------------|------------------|---------------------------|
| 5,408            | 0                | 0                | 0                | 0                | 5,408            | >75% Grass<br>cover, Good |
| 1,641            | 0                | 0                | 0                | 0                | 1,641            | Brush, Good               |
| 43,316           | 0                | 0                | 0                | 0                | 43,316           | Paved parking             |
| 12,934           | 0                | 0                | 0                | 0                | 12,934           | Roofs                     |
| 5,624            | 0                | 0                | 0                | 0                | 5,624            | Woods, Good               |
| <b>68,923</b>    | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>68,923</b>    | <b>TOTAL AREA</b>         |

**17024 PRE-DRAINAGE**

Type III 24-hr 2-Year Rainfall=3.14"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment1S: Area to Shawsheen** Runoff Area=66,027 sf 83.45% Impervious Runoff Depth>1.86"  
Tc=6.0 min CN=87 Runoff=3.24 cfs 10,236 cf

**Subcatchment2S: Area to Haverhill Street** Runoff Area=2,896 sf 39.81% Impervious Runoff Depth>0.45"  
Tc=6.0 min CN=62 Runoff=0.02 cfs 110 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=3.24 cfs 10,236 cf  
Primary=3.24 cfs 10,236 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.02 cfs 110 cf  
Primary=0.02 cfs 110 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 10,346 cf Average Runoff Depth = 1.80"**  
**18.39% Pervious = 12,673 sf 81.61% Impervious = 56,250 sf**

# 17024 PRE-DRAINAGE

Type III 24-hr 2-Year Rainfall=3.14"

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## Summary for Subcatchment 1S: Area to Shawsheen River

Runoff = 3.24 cfs @ 12.09 hrs, Volume= 10,236 cf, Depth> 1.86"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 42,163    | 98 | Paved parking, HSG A          |
| 12,934    | 98 | Roofs, HSG A                  |
| 3,665     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 1,641     | 30 | Brush, Good, HSG A            |
| 66,027    | 87 | Weighted Average              |
| 10,930    |    | 16.55% Pervious Area          |
| 55,097    |    | 83.45% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description   |
|----------|---------------|---------------|-------------------|----------------|---------------|
| 6.0      |               |               |                   |                | Direct Entry, |

## Summary for Subcatchment 2S: Area to Haverhill Street

Runoff = 0.02 cfs @ 12.12 hrs, Volume= 110 cf, Depth> 0.45"

Routed to Link AP2 : Offsite Haverhill Street

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,153     | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,896     | 62 | Weighted Average              |
| 1,743     |    | 60.19% Pervious Area          |
| 1,153     |    | 39.81% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description   |
|----------|---------------|---------------|-------------------|----------------|---------------|
| 6.0      |               |               |                   |                | Direct Entry, |

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,027 sf, 83.45% Impervious, Inflow Depth > 1.86" for 2-Year event

Inflow = 3.24 cfs @ 12.09 hrs, Volume= 10,236 cf

Primary = 3.24 cfs @ 12.09 hrs, Volume= 10,236 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

*Type III 24-hr 2-Year Rainfall=3.14"*

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**Summary for Link AP2: Offsite Haverhill Street**

Inflow Area = 2,896 sf, 39.81% Impervious, Inflow Depth > 0.45" for 2-Year event  
Inflow = 0.02 cfs @ 12.12 hrs, Volume= 110 cf  
Primary = 0.02 cfs @ 12.12 hrs, Volume= 110 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

Type III 24-hr 10-Year Rainfall=4.97"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment1S: Area to Shawsheen** Runoff Area=66,027 sf 83.45% Impervious Runoff Depth>3.54"  
Tc=6.0 min CN=87 Runoff=6.04 cfs 19,458 cf

**Subcatchment2S: Area to Haverhill Street** Runoff Area=2,896 sf 39.81% Impervious Runoff Depth>1.42"  
Tc=6.0 min CN=62 Runoff=0.10 cfs 342 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=6.04 cfs 19,458 cf  
Primary=6.04 cfs 19,458 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.10 cfs 342 cf  
Primary=0.10 cfs 342 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 19,800 cf Average Runoff Depth = 3.45"**  
**18.39% Pervious = 12,673 sf 81.61% Impervious = 56,250 sf**

# 17024 PRE-DRAINAGE

Type III 24-hr 10-Year Rainfall=4.97"

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## Summary for Subcatchment 1S: Area to Shawsheen River

Runoff = 6.04 cfs @ 12.09 hrs, Volume= 19,458 cf, Depth> 3.54"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 42,163    | 98 | Paved parking, HSG A          |
| 12,934    | 98 | Roofs, HSG A                  |
| 3,665     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 1,641     | 30 | Brush, Good, HSG A            |
| 66,027    | 87 | Weighted Average              |
| 10,930    |    | 16.55% Pervious Area          |
| 55,097    |    | 83.45% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description   |
|----------|---------------|---------------|-------------------|----------------|---------------|
| 6.0      |               |               |                   |                | Direct Entry, |

## Summary for Subcatchment 2S: Area to Haverhill Street

Runoff = 0.10 cfs @ 12.10 hrs, Volume= 342 cf, Depth> 1.42"

Routed to Link AP2 : Offsite Haverhill Street

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,153     | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,896     | 62 | Weighted Average              |
| 1,743     |    | 60.19% Pervious Area          |
| 1,153     |    | 39.81% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description   |
|----------|---------------|---------------|-------------------|----------------|---------------|
| 6.0      |               |               |                   |                | Direct Entry, |

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,027 sf, 83.45% Impervious, Inflow Depth > 3.54" for 10-Year event

Inflow = 6.04 cfs @ 12.09 hrs, Volume= 19,458 cf

Primary = 6.04 cfs @ 12.09 hrs, Volume= 19,458 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

*Type III 24-hr 10-Year Rainfall=4.97"*

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**Summary for Link AP2: Offsite Haverhill Street**

Inflow Area = 2,896 sf, 39.81% Impervious, Inflow Depth > 1.42" for 10-Year event  
Inflow = 0.10 cfs @ 12.10 hrs, Volume= 342 cf  
Primary = 0.10 cfs @ 12.10 hrs, Volume= 342 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

Type III 24-hr 25-Year Rainfall=6.12"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment1S: Area to Shawsheen**      Runoff Area=66,027 sf   83.45% Impervious   Runoff Depth>4.63"  
Tc=6.0 min   CN=87   Runoff=7.81 cfs   25,468 cf

**Subcatchment2S: Area to Haverhill Street**      Runoff Area=2,896 sf   39.81% Impervious   Runoff Depth>2.17"  
Tc=6.0 min   CN=62   Runoff=0.16 cfs   524 cf

**Link AP1: Offsite Shawsheen River Wetlands**      Inflow=7.81 cfs   25,468 cf  
Primary=7.81 cfs   25,468 cf

**Link AP2: Offsite Haverhill Street**      Inflow=0.16 cfs   524 cf  
Primary=0.16 cfs   524 cf

**Total Runoff Area = 68,923 sf   Runoff Volume = 25,992 cf   Average Runoff Depth = 4.53"**  
**18.39% Pervious = 12,673 sf   81.61% Impervious = 56,250 sf**

**17024 PRE-DRAINAGE**

Type III 24-hr 25-Year Rainfall=6.12"

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**Summary for Subcatchment 1S: Area to Shawsheen River**

Runoff = 7.81 cfs @ 12.09 hrs, Volume= 25,468 cf, Depth&gt; 4.63"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 42,163    | 98 | Paved parking, HSG A          |
| 12,934    | 98 | Roofs, HSG A                  |
| 3,665     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 1,641     | 30 | Brush, Good, HSG A            |
| 66,027    | 87 | Weighted Average              |
| 10,930    |    | 16.55% Pervious Area          |
| 55,097    |    | 83.45% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 2S: Area to Haverhill Street**

Runoff = 0.16 cfs @ 12.10 hrs, Volume= 524 cf, Depth&gt; 2.17"

Routed to Link AP2 : Offsite Haverhill Street

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,153     | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,896     | 62 | Weighted Average              |
| 1,743     |    | 60.19% Pervious Area          |
| 1,153     |    | 39.81% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Link AP1: Offsite Shawsheen River Wetlands**

Inflow Area = 66,027 sf, 83.45% Impervious, Inflow Depth &gt; 4.63" for 25-Year event

Inflow = 7.81 cfs @ 12.09 hrs, Volume= 25,468 cf

Primary = 7.81 cfs @ 12.09 hrs, Volume= 25,468 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## 17024 PRE-DRAINAGE

Type III 24-hr 25-Year Rainfall=6.12"

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### Summary for Link AP2: Offsite Haverhill Street

Inflow Area = 2,896 sf, 39.81% Impervious, Inflow Depth > 2.17" for 25-Year event  
Inflow = 0.16 cfs @ 12.10 hrs, Volume= 524 cf  
Primary = 0.16 cfs @ 12.10 hrs, Volume= 524 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

Type III 24-hr 100-Year Rainfall=7.89"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment1S: Area to Shawsheen** Runoff Area=66,027 sf 83.45% Impervious Runoff Depth>6.34"  
Tc=6.0 min CN=87 Runoff=10.52 cfs 34,874 cf

**Subcatchment2S: Area to Haverhill Street** Runoff Area=2,896 sf 39.81% Impervious Runoff Depth>3.47"  
Tc=6.0 min CN=62 Runoff=0.26 cfs 837 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=10.52 cfs 34,874 cf  
Primary=10.52 cfs 34,874 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.26 cfs 837 cf  
Primary=0.26 cfs 837 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 35,711 cf Average Runoff Depth = 6.22"**  
**18.39% Pervious = 12,673 sf 81.61% Impervious = 56,250 sf**

# 17024 PRE-DRAINAGE

Type III 24-hr 100-Year Rainfall=7.89"

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## Summary for Subcatchment 1S: Area to Shawsheen River

Runoff = 10.52 cfs @ 12.09 hrs, Volume= 34,874 cf, Depth> 6.34"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 42,163    | 98 | Paved parking, HSG A          |
| 12,934    | 98 | Roofs, HSG A                  |
| 3,665     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 1,641     | 30 | Brush, Good, HSG A            |
| 66,027    | 87 | Weighted Average              |
| 10,930    |    | 16.55% Pervious Area          |
| 55,097    |    | 83.45% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

## Summary for Subcatchment 2S: Area to Haverhill Street

Runoff = 0.26 cfs @ 12.10 hrs, Volume= 837 cf, Depth> 3.47"

Routed to Link AP2 : Offsite Haverhill Street

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,153     | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,896     | 62 | Weighted Average              |
| 1,743     |    | 60.19% Pervious Area          |
| 1,153     |    | 39.81% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,027 sf, 83.45% Impervious, Inflow Depth > 6.34" for 100-Year event

Inflow = 10.52 cfs @ 12.09 hrs, Volume= 34,874 cf

Primary = 10.52 cfs @ 12.09 hrs, Volume= 34,874 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PRE-DRAINAGE**

Type III 24-hr 100-Year Rainfall=7.89"

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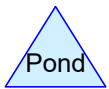
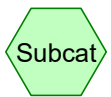
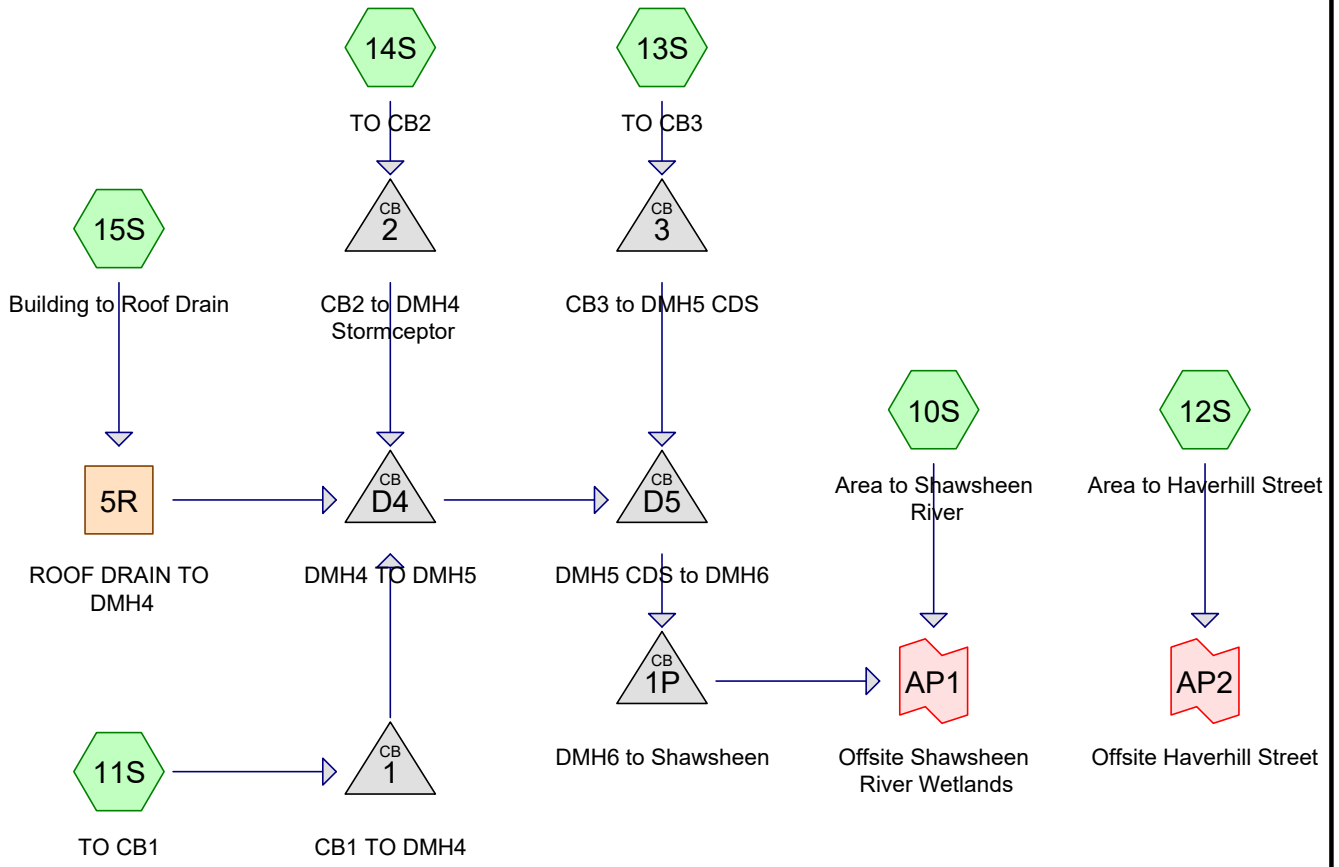
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**Summary for Link AP2: Offsite Haverhill Street**

Inflow Area = 2,896 sf, 39.81% Impervious, Inflow Depth > 3.47" for 100-Year event  
Inflow = 0.26 cfs @ 12.10 hrs, Volume= 837 cf  
Primary = 0.26 cfs @ 12.10 hrs, Volume= 837 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



**Routing Diagram for 17024 PR-DRAINAGE\_1**  
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## 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   | 3.14           | 2   |
| 2      | 10-Year    | Type III 24-hr |       | Default | 24.00            | 1   | 4.97           | 2   |
| 3      | 25-Year    | Type III 24-hr |       | Default | 24.00            | 1   | 6.12           | 2   |
| 4      | 100-Year   | Type III 24-hr |       | Default | 24.00            | 1   | 7.89           | 2   |

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## Area Listing (all nodes)

| Area<br>(sq-ft) | CN        | Description<br>(subcatchment-numbers)                   |
|-----------------|-----------|---|
| 10,481          | 39        | >75% Grass cover, Good, HSG A (10S, 11S, 12S, 13S, 14S) |
| 39,222          | 98        | Paved parking, HSG A (10S, 11S, 12S, 13S, 14S)          |
| 13,596          | 98        | Roofs, HSG A (13S, 14S, 15S)                            |
| 5,624           | 30        | Woods, Good, HSG A (10S)                                |
| <b>68,923</b>   | <b>83</b> | <b>TOTAL AREA</b>                                       |

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## Soil Listing (all nodes)

| Area<br>(sq-ft) | Soil<br>Group | Subcatchment<br>Numbers      |
|-----------------|---------------|------------------------------|
| 68,923          | HSG A         | 10S, 11S, 12S, 13S, 14S, 15S |
| 0               | HSG B         |                              |
| 0               | HSG C         |                              |
| 0               | HSG D         |                              |
| 0               | Other         |                              |
| <b>68,923</b>   |               | <b>TOTAL AREA</b>            |

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**Ground Covers (all nodes)**

| HSG-A<br>(sq-ft) | HSG-B<br>(sq-ft) | HSG-C<br>(sq-ft) | HSG-D<br>(sq-ft) | Other<br>(sq-ft) | Total<br>(sq-ft) | Ground<br>Cover           |
|------------------|------------------|------------------|------------------|------------------|------------------|---------------------------|
| 10,481           | 0                | 0                | 0                | 0                | 10,481           | >75% Grass<br>cover, Good |
| 39,222           | 0                | 0                | 0                | 0                | 39,222           | Paved parking             |
| 13,596           | 0                | 0                | 0                | 0                | 13,596           | Roofs                     |
| 5,624            | 0                | 0                | 0                | 0                | 5,624            | Woods, Good               |
| <b>68,923</b>    | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>68,923</b>    | <b>TOTAL AREA</b>         |

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## Pipe Listing (all nodes)

| Line# | Node Number | In-Invert (feet) | Out-Invert (feet) | Length (feet) | Slope (ft/ft) | n     | Width (inches) | Diam/Height (inches) | Inside-Fill (inches) |
|-------|-------------|------------------|-------------------|---------------|---------------|-------|----------------|----------------------|----------------------|
| 1     | 5R          | 29.77            | 29.15             | 31.0          | 0.0200        | 0.013 | 0.0            | 10.0                 | 0.0                  |
| 2     | 1           | 28.72            | 28.15             | 114.0         | 0.0050        | 0.013 | 0.0            | 12.0                 | 0.0                  |
| 3     | 1P          | 24.74            | 24.54             | 11.0          | 0.0182        | 0.013 | 0.0            | 18.0                 | 0.0                  |
| 4     | 2           | 27.85            | 27.39             | 31.0          | 0.0148        | 0.013 | 0.0            | 15.0                 | 0.0                  |
| 5     | 3           | 28.85            | 28.66             | 19.0          | 0.0100        | 0.013 | 0.0            | 15.0                 | 0.0                  |
| 6     | D4          | 27.28            | 26.70             | 117.0         | 0.0050        | 0.012 | 0.0            | 18.0                 | 0.0                  |
| 7     | D5          | 26.59            | 25.09             | 100.0         | 0.0150        | 0.013 | 0.0            | 18.0                 | 0.0                  |

**17024 PR-DRAINAGE\_1**

Type III 24-hr 2-Year Rainfall=3.14"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 10S: Area to Shawsheen** Runoff Area=20,799 sf 45.00% Impervious Runoff Depth>0.49"  
 Tc=6.0 min CN=63 Runoff=0.19 cfs 853 cf

**Subcatchment 11S: TO CB1** Runoff Area=3,917 sf 87.08% Impervious Runoff Depth>2.11"  
 Tc=6.0 min CN=90 Runoff=0.22 cfs 689 cf

**Subcatchment 12S: Area to Haverhill Street** Runoff Area=2,649 sf 34.20% Impervious Runoff Depth>0.35"  
 Tc=6.0 min CN=59 Runoff=0.01 cfs 78 cf

**Subcatchment 13S: TO CB3** Runoff Area=11,724 sf 92.20% Impervious Runoff Depth>2.39"  
 Tc=6.0 min CN=93 Runoff=0.71 cfs 2,332 cf

**Subcatchment 14S: TO CB2** Runoff Area=19,490 sf 92.29% Impervious Runoff Depth>2.39"  
 Tc=6.0 min CN=93 Runoff=1.19 cfs 3,876 cf

**Subcatchment 15S: Building to Roof** Runoff Area=10,344 sf 100.00% Impervious Runoff Depth>2.91"  
 Tc=6.0 min CN=98 Runoff=0.71 cfs 2,505 cf

**Reach 5R: ROOF DRAIN TO DMH4** Avg. Flow Depth=0.27' Max Vel=4.59 fps Inflow=0.71 cfs 2,505 cf  
 10.0" Round Pipe n=0.013 L=31.0' S=0.0200 '/' Capacity=3.10 cfs Outflow=0.71 cfs 2,505 cf

**Pond 1: CB1 TO DMH4** Peak Elev=28.99' Inflow=0.22 cfs 689 cf  
 12.0" Round Culvert n=0.013 L=114.0' S=0.0050 '/' Outflow=0.22 cfs 689 cf

**Pond 1P: DMH6 to Shawsheen** Peak Elev=25.59' Inflow=2.82 cfs 9,401 cf  
 18.0" Round Culvert n=0.013 L=11.0' S=0.0182 '/' Outflow=2.82 cfs 9,401 cf

**Pond 2: CB2 to DMH4 Stormceptor** Peak Elev=28.41' Inflow=1.19 cfs 3,876 cf  
 15.0" Round Culvert n=0.013 L=31.0' S=0.0148 '/' Outflow=1.19 cfs 3,876 cf

**Pond 3: CB3 to DMH5 CDS** Peak Elev=29.28' Inflow=0.71 cfs 2,332 cf  
 15.0" Round Culvert n=0.013 L=19.0' S=0.0100 '/' Outflow=0.71 cfs 2,332 cf

**Pond D4: DMH4 TO DMH5** Peak Elev=28.04' Inflow=2.11 cfs 7,070 cf  
 18.0" Round Culvert n=0.012 L=117.0' S=0.0050 '/' Outflow=2.11 cfs 7,070 cf

**Pond D5: DMH5 CDS to DMH6** Peak Elev=27.38' Inflow=2.82 cfs 9,401 cf  
 18.0" Round Culvert n=0.013 L=100.0' S=0.0150 '/' Outflow=2.82 cfs 9,401 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=3.00 cfs 10,254 cf  
 Primary=3.00 cfs 10,254 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.01 cfs 78 cf  
 Primary=0.01 cfs 78 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 10,332 cf Average Runoff Depth = 1.80"**  
**23.37% Pervious = 16,105 sf 76.63% Impervious = 52,818 sf**

**17024 PR-DRAINAGE\_1**

Type III 24-hr 2-Year Rainfall=3.14"

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**Summary for Subcatchment 10S: Area to Shawsheen River**

Runoff = 0.19 cfs @ 12.12 hrs, Volume= 853 cf, Depth&gt; 0.49"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 5,816     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 9,359     | 98 | Paved parking, HSG A          |
| 20,799    | 63 | Weighted Average              |
| 11,440    |    | 55.00% Pervious Area          |
| 9,359     |    | 45.00% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 11S: TO CB1**

Runoff = 0.22 cfs @ 12.09 hrs, Volume= 689 cf, Depth&gt; 2.11"

Routed to Pond 1 : CB1 TO DMH4

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,411     | 98 | Paved parking, HSG A          |
| 506       | 39 | >75% Grass cover, Good, HSG A |
| 3,917     | 90 | Weighted Average              |
| 506       |    | 12.92% Pervious Area          |
| 3,411     |    | 87.08% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 12S: Area to Haverhill Street**

Runoff = 0.01 cfs @ 12.16 hrs, Volume= 78 cf, Depth&gt; 0.35"

Routed to Link AP2 : Offsite Haverhill Street

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=3.14"

**17024 PR-DRAINAGE\_1**

Type III 24-hr 2-Year Rainfall=3.14"

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| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 906       | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,649     | 59 | Weighted Average              |
| 1,743     |    | 65.80% Pervious Area          |
| 906       |    | 34.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 13S: TO CB3**

Runoff = 0.71 cfs @ 12.09 hrs, Volume= 2,332 cf, Depth> 2.39"  
 Routed to Pond 3 : CB3 to DMH5 CDS

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 9,155     | 98 | Paved parking, HSG A          |
| 1,655     | 98 | Roofs, HSG A                  |
| 914       | 39 | >75% Grass cover, Good, HSG A |
| 11,724    | 93 | Weighted Average              |
| 914       |    | 7.80% Pervious Area           |
| 10,810    |    | 92.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 14S: TO CB2**

Runoff = 1.19 cfs @ 12.09 hrs, Volume= 3,876 cf, Depth> 2.39"  
 Routed to Pond 2 : CB2 to DMH4 Stormceptor

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=3.14"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 16,391    | 98 | Paved parking, HSG A          |
| 1,502     | 39 | >75% Grass cover, Good, HSG A |
| 1,597     | 98 | Roofs, HSG A                  |
| 19,490    | 93 | Weighted Average              |
| 1,502     |    | 7.71% Pervious Area           |
| 17,988    |    | 92.29% Impervious Area        |

**17024 PR-DRAINAGE\_1**

Type III 24-hr 2-Year Rainfall=3.14"

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| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

**Summary for Subcatchment 15S: Building to Roof Drain**

Runoff = 0.71 cfs @ 12.09 hrs, Volume= 2,505 cf, Depth> 2.91"  
Routed to Reach 5R : ROOF DRAIN TO DMH4

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=3.14"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 10,344    | 98 | Roofs, HSG A            |
| 10,344    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

**Summary for Reach 5R: ROOF DRAIN TO DMH4**

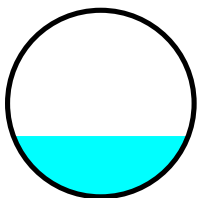
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 10,344 sf, 100.00% Impervious, Inflow Depth > 2.91" for 2-Year event  
Inflow = 0.71 cfs @ 12.09 hrs, Volume= 2,505 cf  
Outflow = 0.71 cfs @ 12.09 hrs, Volume= 2,505 cf, Atten= 0%, Lag= 0.1 min  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 4.59 fps, Min. Travel Time= 0.1 min  
Avg. Velocity = 1.53 fps, Avg. Travel Time= 0.3 min

Peak Storage= 5 cf @ 12.09 hrs  
Average Depth at Peak Storage= 0.27' , Surface Width= 0.78'  
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.10 cfs

10.0" Round Pipe  
n= 0.013 Corrugated PE, smooth interior  
Length= 31.0' Slope= 0.0200 '/'  
Inlet Invert= 29.77', Outlet Invert= 29.15'



# 17024 PR-DRAINAGE\_1

Type III 24-hr 2-Year Rainfall=3.14"

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## Summary for Pond 1: CB1 TO DMH4

Inflow Area = 3,917 sf, 87.08% Impervious, Inflow Depth > 2.11" for 2-Year event  
Inflow = 0.22 cfs @ 12.09 hrs, Volume= 689 cf  
Outflow = 0.22 cfs @ 12.09 hrs, Volume= 689 cf, Atten= 0%, Lag= 0.0 min  
Primary = 0.22 cfs @ 12.09 hrs, Volume= 689 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 28.99' @ 12.09 hrs  
Flood Elev= 31.52'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 28.72' | <b>12.0" Round Culvert</b> L= 114.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.72' / 28.15' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=0.21 cfs @ 12.09 hrs HW=28.98' TW=28.03' (Dynamic Tailwater)  
↑1=Culvert (Barrel Controls 0.21 cfs @ 1.92 fps)

## Summary for Pond 1P: DMH6 to Shawsheen

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 2.48" for 2-Year event  
Inflow = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf  
Outflow = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf, Atten= 0%, Lag= 0.0 min  
Primary = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf  
Routed to Link AP1 : Offsite Shawsheen River Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 25.59' @ 12.09 hrs  
Flood Elev= 33.60'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 24.74' | <b>18.0" Round Culvert</b> L= 11.0' Ke= 0.500<br>Inlet / Outlet Invert= 24.74' / 24.54' S= 0.0182 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=2.76 cfs @ 12.09 hrs HW=25.58' TW=0.00' (Dynamic Tailwater)  
↑1=Culvert (Barrel Controls 2.76 cfs @ 3.90 fps)

## Summary for Pond 2: CB2 to DMH4 Stormceptor

Inflow Area = 19,490 sf, 92.29% Impervious, Inflow Depth > 2.39" for 2-Year event  
Inflow = 1.19 cfs @ 12.09 hrs, Volume= 3,876 cf  
Outflow = 1.19 cfs @ 12.09 hrs, Volume= 3,876 cf, Atten= 0%, Lag= 0.0 min  
Primary = 1.19 cfs @ 12.09 hrs, Volume= 3,876 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

# 17024 PR-DRAINAGE\_1

Type III 24-hr 2-Year Rainfall=3.14"

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Peak Elev= 28.41' @ 12.10 hrs

Flood Elev= 31.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 27.85' | <b>15.0" Round Culvert</b> L= 31.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.85' / 27.39' S= 0.0148 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.07 cfs @ 12.09 hrs HW=28.40' TW=28.03' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 1.07 cfs @ 3.04 fps)

## Summary for Pond 3: CB3 to DMH5 CDS

Inflow Area = 11,724 sf, 92.20% Impervious, Inflow Depth > 2.39" for 2-Year event  
Inflow = 0.71 cfs @ 12.09 hrs, Volume= 2,332 cf  
Outflow = 0.71 cfs @ 12.09 hrs, Volume= 2,332 cf, Atten= 0%, Lag= 0.0 min  
Primary = 0.71 cfs @ 12.09 hrs, Volume= 2,332 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 29.28' @ 12.09 hrs

Flood Elev= 32.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 28.85' | <b>15.0" Round Culvert</b> L= 19.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.85' / 28.66' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=0.70 cfs @ 12.09 hrs HW=29.27' TW=27.36' (Dynamic Tailwater)

↑**1=Culvert** (Barrel Controls 0.70 cfs @ 2.83 fps)

## Summary for Pond D4: DMH4 TO DMH5

Inflow Area = 33,751 sf, 94.05% Impervious, Inflow Depth > 2.51" for 2-Year event  
Inflow = 2.11 cfs @ 12.09 hrs, Volume= 7,070 cf  
Outflow = 2.11 cfs @ 12.09 hrs, Volume= 7,070 cf, Atten= 0%, Lag= 0.0 min  
Primary = 2.11 cfs @ 12.09 hrs, Volume= 7,070 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 28.04' @ 12.10 hrs

Flood Elev= 32.81'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 27.28' | <b>18.0" Round Culvert</b> L= 117.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.28' / 26.70' S= 0.0050 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.98 cfs @ 12.09 hrs HW=28.03' TW=27.36' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 1.98 cfs @ 3.30 fps)

# 17024 PR-DRAINAGE\_1

Type III 24-hr 2-Year Rainfall=3.14"

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## Summary for Pond D5: DMH5 CDS to DMH6

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 2.48" for 2-Year event  
Inflow = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf  
Outflow = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf, Atten= 0%, Lag= 0.0 min  
Primary = 2.82 cfs @ 12.09 hrs, Volume= 9,401 cf  
Routed to Pond 1P : DMH6 to Shawsheen

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 27.38' @ 12.09 hrs  
Flood Elev= 33.76'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 26.59' | <b>18.0" Round Culvert</b> L= 100.0' Ke= 0.500<br>Inlet / Outlet Invert= 26.59' / 25.09' S= 0.0150 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=2.76 cfs @ 12.09 hrs HW=27.36' TW=25.58' (Dynamic Tailwater)  
↑1=Culvert (Inlet Controls 2.76 cfs @ 3.00 fps)

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,274 sf, 78.33% Impervious, Inflow Depth > 1.86" for 2-Year event  
Inflow = 3.00 cfs @ 12.09 hrs, Volume= 10,254 cf  
Primary = 3.00 cfs @ 12.09 hrs, Volume= 10,254 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Summary for Link AP2: Offsite Haverhill Street

Inflow Area = 2,649 sf, 34.20% Impervious, Inflow Depth > 0.35" for 2-Year event  
Inflow = 0.01 cfs @ 12.16 hrs, Volume= 78 cf  
Primary = 0.01 cfs @ 12.16 hrs, Volume= 78 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PR-DRAINAGE\_1**

Type III 24-hr 10-Year Rainfall=4.97"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 10S: Area to Shawsheen** Runoff Area=20,799 sf 45.00% Impervious Runoff Depth>1.49"  
 Tc=6.0 min CN=63 Runoff=0.77 cfs 2,579 cf

**Subcatchment 11S: TO CB1** Runoff Area=3,917 sf 87.08% Impervious Runoff Depth>3.84"  
 Tc=6.0 min CN=90 Runoff=0.38 cfs 1,255 cf

**Subcatchment 12S: Area to Haverhill Street** Runoff Area=2,649 sf 34.20% Impervious Runoff Depth>1.22"  
 Tc=6.0 min CN=59 Runoff=0.08 cfs 268 cf

**Subcatchment 13S: TO CB3** Runoff Area=11,724 sf 92.20% Impervious Runoff Depth>4.17"  
 Tc=6.0 min CN=93 Runoff=1.21 cfs 4,070 cf

**Subcatchment 14S: TO CB2** Runoff Area=19,490 sf 92.29% Impervious Runoff Depth>4.17"  
 Tc=6.0 min CN=93 Runoff=2.01 cfs 6,766 cf

**Subcatchment 15S: Building to Roof** Runoff Area=10,344 sf 100.00% Impervious Runoff Depth>4.73"  
 Tc=6.0 min CN=98 Runoff=1.13 cfs 4,078 cf

**Reach 5R: ROOF DRAIN TO DMH4** Avg. Flow Depth=0.35' Max Vel=5.22 fps Inflow=1.13 cfs 4,078 cf  
 10.0" Round Pipe n=0.013 L=31.0' S=0.0200 ' /' Capacity=3.10 cfs Outflow=1.13 cfs 4,077 cf

**Pond 1: CB1 TO DMH4** Peak Elev=29.08' Inflow=0.38 cfs 1,255 cf  
 12.0" Round Culvert n=0.013 L=114.0' S=0.0050 ' /' Outflow=0.38 cfs 1,255 cf

**Pond 1P: DMH6 to Shawsheen** Peak Elev=25.92' Inflow=4.73 cfs 16,168 cf  
 18.0" Round Culvert n=0.013 L=11.0' S=0.0182 ' /' Outflow=4.73 cfs 16,168 cf

**Pond 2: CB2 to DMH4 Stormceptor** Peak Elev=28.65' Inflow=2.01 cfs 6,766 cf  
 15.0" Round Culvert n=0.013 L=31.0' S=0.0148 ' /' Outflow=2.01 cfs 6,766 cf

**Pond 3: CB3 to DMH5 CDS** Peak Elev=29.43' Inflow=1.21 cfs 4,070 cf  
 15.0" Round Culvert n=0.013 L=19.0' S=0.0100 ' /' Outflow=1.21 cfs 4,070 cf

**Pond D4: DMH4 TO DMH5** Peak Elev=28.32' Inflow=3.52 cfs 12,098 cf  
 18.0" Round Culvert n=0.012 L=117.0' S=0.0050 ' /' Outflow=3.52 cfs 12,098 cf

**Pond D5: DMH5 CDS to DMH6** Peak Elev=27.66' Inflow=4.73 cfs 16,168 cf  
 18.0" Round Culvert n=0.013 L=100.0' S=0.0150 ' /' Outflow=4.73 cfs 16,168 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=5.49 cfs 18,747 cf  
 Primary=5.49 cfs 18,747 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.08 cfs 268 cf  
 Primary=0.08 cfs 268 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 19,016 cf Average Runoff Depth = 3.31"**  
**23.37% Pervious = 16,105 sf 76.63% Impervious = 52,818 sf**

**17024 PR-DRAINAGE\_1**

Type III 24-hr 10-Year Rainfall=4.97"

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**Summary for Subcatchment 10S: Area to Shawsheen River**

Runoff = 0.77 cfs @ 12.10 hrs, Volume= 2,579 cf, Depth&gt; 1.49"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 5,816     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 9,359     | 98 | Paved parking, HSG A          |
| 20,799    | 63 | Weighted Average              |
| 11,440    |    | 55.00% Pervious Area          |
| 9,359     |    | 45.00% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 11S: TO CB1**

Runoff = 0.38 cfs @ 12.09 hrs, Volume= 1,255 cf, Depth&gt; 3.84"

Routed to Pond 1 : CB1 TO DMH4

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,411     | 98 | Paved parking, HSG A          |
| 506       | 39 | >75% Grass cover, Good, HSG A |
| 3,917     | 90 | Weighted Average              |
| 506       |    | 12.92% Pervious Area          |
| 3,411     |    | 87.08% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 12S: Area to Haverhill Street**

Runoff = 0.08 cfs @ 12.11 hrs, Volume= 268 cf, Depth&gt; 1.22"

Routed to Link AP2 : Offsite Haverhill Street

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=4.97"

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| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 906       | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,649     | 59 | Weighted Average              |
| 1,743     |    | 65.80% Pervious Area          |
| 906       |    | 34.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 13S: TO CB3**

Runoff = 1.21 cfs @ 12.09 hrs, Volume= 4,070 cf, Depth> 4.17"  
 Routed to Pond 3 : CB3 to DMH5 CDS

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 9,155     | 98 | Paved parking, HSG A          |
| 1,655     | 98 | Roofs, HSG A                  |
| 914       | 39 | >75% Grass cover, Good, HSG A |
| 11,724    | 93 | Weighted Average              |
| 914       |    | 7.80% Pervious Area           |
| 10,810    |    | 92.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 14S: TO CB2**

Runoff = 2.01 cfs @ 12.09 hrs, Volume= 6,766 cf, Depth> 4.17"  
 Routed to Pond 2 : CB2 to DMH4 Stormceptor

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=4.97"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 16,391    | 98 | Paved parking, HSG A          |
| 1,502     | 39 | >75% Grass cover, Good, HSG A |
| 1,597     | 98 | Roofs, HSG A                  |
| 19,490    | 93 | Weighted Average              |
| 1,502     |    | 7.71% Pervious Area           |
| 17,988    |    | 92.29% Impervious Area        |

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| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

## Summary for Subcatchment 15S: Building to Roof Drain

Runoff = 1.13 cfs @ 12.09 hrs, Volume= 4,078 cf, Depth> 4.73"  
Routed to Reach 5R : ROOF DRAIN TO DMH4

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=4.97"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 10,344    | 98 | Roofs, HSG A            |
| 10,344    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

## Summary for Reach 5R: ROOF DRAIN TO DMH4

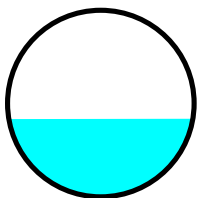
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 10,344 sf, 100.00% Impervious, Inflow Depth > 4.73" for 10-Year event  
Inflow = 1.13 cfs @ 12.09 hrs, Volume= 4,078 cf  
Outflow = 1.13 cfs @ 12.09 hrs, Volume= 4,077 cf, Atten= 0%, Lag= 0.1 min  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 5.22 fps, Min. Travel Time= 0.1 min  
Avg. Velocity = 1.77 fps, Avg. Travel Time= 0.3 min

Peak Storage= 7 cf @ 12.09 hrs  
Average Depth at Peak Storage= 0.35' , Surface Width= 0.82'  
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.10 cfs

10.0" Round Pipe  
n= 0.013 Corrugated PE, smooth interior  
Length= 31.0' Slope= 0.0200 '/'  
Inlet Invert= 29.77', Outlet Invert= 29.15'



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Type III 24-hr 10-Year Rainfall=4.97"

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## Summary for Pond 1: CB1 TO DMH4

Inflow Area = 3,917 sf, 87.08% Impervious, Inflow Depth > 3.84" for 10-Year event  
Inflow = 0.38 cfs @ 12.09 hrs, Volume= 1,255 cf  
Outflow = 0.38 cfs @ 12.09 hrs, Volume= 1,255 cf, Atten= 0%, Lag= 0.0 min  
Primary = 0.38 cfs @ 12.09 hrs, Volume= 1,255 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 29.08' @ 12.09 hrs  
Flood Elev= 31.52'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 28.72' | <b>12.0" Round Culvert</b> L= 114.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.72' / 28.15' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=0.37 cfs @ 12.09 hrs HW=29.07' TW=28.30' (Dynamic Tailwater)  
↑1=Culvert (Barrel Controls 0.37 cfs @ 2.25 fps)

## Summary for Pond 1P: DMH6 to Shawsheen

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 4.27" for 10-Year event  
Inflow = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf  
Outflow = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf, Atten= 0%, Lag= 0.0 min  
Primary = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf  
Routed to Link AP1 : Offsite Shawsheen River Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 25.92' @ 12.09 hrs  
Flood Elev= 33.60'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 24.74' | <b>18.0" Round Culvert</b> L= 11.0' Ke= 0.500<br>Inlet / Outlet Invert= 24.74' / 24.54' S= 0.0182 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=4.61 cfs @ 12.09 hrs HW=25.90' TW=0.00' (Dynamic Tailwater)  
↑1=Culvert (Barrel Controls 4.61 cfs @ 4.34 fps)

## Summary for Pond 2: CB2 to DMH4 Stormceptor

Inflow Area = 19,490 sf, 92.29% Impervious, Inflow Depth > 4.17" for 10-Year event  
Inflow = 2.01 cfs @ 12.09 hrs, Volume= 6,766 cf  
Outflow = 2.01 cfs @ 12.09 hrs, Volume= 6,766 cf, Atten= 0%, Lag= 0.0 min  
Primary = 2.01 cfs @ 12.09 hrs, Volume= 6,766 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

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Peak Elev= 28.65' @ 12.11 hrs

Flood Elev= 31.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 27.85' | <b>15.0" Round Culvert</b> L= 31.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.85' / 27.39' S= 0.0148 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.69 cfs @ 12.09 hrs HW=28.62' TW=28.30' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 1.69 cfs @ 3.04 fps)

## Summary for Pond 3: CB3 to DMH5 CDS

Inflow Area = 11,724 sf, 92.20% Impervious, Inflow Depth > 4.17" for 10-Year event  
Inflow = 1.21 cfs @ 12.09 hrs, Volume= 4,070 cf  
Outflow = 1.21 cfs @ 12.09 hrs, Volume= 4,070 cf, Atten= 0%, Lag= 0.0 min  
Primary = 1.21 cfs @ 12.09 hrs, Volume= 4,070 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 29.43' @ 12.09 hrs

Flood Elev= 32.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 28.85' | <b>15.0" Round Culvert</b> L= 19.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.85' / 28.66' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.18 cfs @ 12.09 hrs HW=29.42' TW=27.64' (Dynamic Tailwater)

↑**1=Culvert** (Barrel Controls 1.18 cfs @ 3.17 fps)

## Summary for Pond D4: DMH4 TO DMH5

Inflow Area = 33,751 sf, 94.05% Impervious, Inflow Depth > 4.30" for 10-Year event  
Inflow = 3.52 cfs @ 12.09 hrs, Volume= 12,098 cf  
Outflow = 3.52 cfs @ 12.09 hrs, Volume= 12,098 cf, Atten= 0%, Lag= 0.0 min  
Primary = 3.52 cfs @ 12.09 hrs, Volume= 12,098 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 28.32' @ 12.10 hrs

Flood Elev= 32.81'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 27.28' | <b>18.0" Round Culvert</b> L= 117.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.28' / 26.70' S= 0.0050 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=3.24 cfs @ 12.09 hrs HW=28.30' TW=27.64' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 3.24 cfs @ 3.58 fps)

# 17024 PR-DRAINAGE\_1

Type III 24-hr 10-Year Rainfall=4.97"

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## Summary for Pond D5: DMH5 CDS to DMH6

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 4.27" for 10-Year event  
Inflow = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf  
Outflow = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf, Atten= 0%, Lag= 0.0 min  
Primary = 4.73 cfs @ 12.09 hrs, Volume= 16,168 cf  
Routed to Pond 1P : DMH6 to Shawsheen

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 27.66' @ 12.09 hrs  
Flood Elev= 33.76'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 26.59' | <b>18.0" Round Culvert</b> L= 100.0' Ke= 0.500<br>Inlet / Outlet Invert= 26.59' / 25.09' S= 0.0150 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=4.61 cfs @ 12.09 hrs HW=27.64' TW=25.90' (Dynamic Tailwater)  
↑1=Culvert (Inlet Controls 4.61 cfs @ 3.49 fps)

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,274 sf, 78.33% Impervious, Inflow Depth > 3.39" for 10-Year event  
Inflow = 5.49 cfs @ 12.09 hrs, Volume= 18,747 cf  
Primary = 5.49 cfs @ 12.09 hrs, Volume= 18,747 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Summary for Link AP2: Offsite Haverhill Street

Inflow Area = 2,649 sf, 34.20% Impervious, Inflow Depth > 1.22" for 10-Year event  
Inflow = 0.08 cfs @ 12.11 hrs, Volume= 268 cf  
Primary = 0.08 cfs @ 12.11 hrs, Volume= 268 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PR-DRAINAGE\_1**

Type III 24-hr 25-Year Rainfall=6.12"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 10S: Area to Shawsheen** Runoff Area=20,799 sf 45.00% Impervious Runoff Depth>2.26"  
 Tc=6.0 min CN=63 Runoff=1.21 cfs 3,914 cf

**Subcatchment 11S: TO CB1** Runoff Area=3,917 sf 87.08% Impervious Runoff Depth>4.96"  
 Tc=6.0 min CN=90 Runoff=0.49 cfs 1,619 cf

**Subcatchment 12S: Area to Haverhill Street** Runoff Area=2,649 sf 34.20% Impervious Runoff Depth>1.91"  
 Tc=6.0 min CN=59 Runoff=0.13 cfs 422 cf

**Subcatchment 13S: TO CB3** Runoff Area=11,724 sf 92.20% Impervious Runoff Depth>5.30"  
 Tc=6.0 min CN=93 Runoff=1.52 cfs 5,176 cf

**Subcatchment 14S: TO CB2** Runoff Area=19,490 sf 92.29% Impervious Runoff Depth>5.30"  
 Tc=6.0 min CN=93 Runoff=2.52 cfs 8,604 cf

**Subcatchment 15S: Building to Roof** Runoff Area=10,344 sf 100.00% Impervious Runoff Depth>5.88"  
 Tc=6.0 min CN=98 Runoff=1.39 cfs 5,067 cf

**Reach 5R: ROOF DRAIN TO DMH4** Avg. Flow Depth=0.39' Max Vel=5.52 fps Inflow=1.39 cfs 5,067 cf  
 10.0" Round Pipe n=0.013 L=31.0' S=0.0200 '/' Capacity=3.10 cfs Outflow=1.39 cfs 5,067 cf

**Pond 1: CB1 TO DMH4** Peak Elev=29.12' Inflow=0.49 cfs 1,619 cf  
 12.0" Round Culvert n=0.013 L=114.0' S=0.0050 '/' Outflow=0.49 cfs 1,619 cf

**Pond 1P: DMH6 to Shawsheen** Peak Elev=26.11' Inflow=5.91 cfs 20,465 cf  
 18.0" Round Culvert n=0.013 L=11.0' S=0.0182 '/' Outflow=5.91 cfs 20,465 cf

**Pond 2: CB2 to DMH4 Stormceptor** Peak Elev=28.79' Inflow=2.52 cfs 8,604 cf  
 15.0" Round Culvert n=0.013 L=31.0' S=0.0148 '/' Outflow=2.52 cfs 8,604 cf

**Pond 3: CB3 to DMH5 CDS** Peak Elev=29.51' Inflow=1.52 cfs 5,176 cf  
 15.0" Round Culvert n=0.013 L=19.0' S=0.0100 '/' Outflow=1.52 cfs 5,176 cf

**Pond D4: DMH4 TO DMH5** Peak Elev=28.49' Inflow=4.40 cfs 15,290 cf  
 18.0" Round Culvert n=0.012 L=117.0' S=0.0050 '/' Outflow=4.40 cfs 15,290 cf

**Pond D5: DMH5 CDS to DMH6** Peak Elev=27.83' Inflow=5.91 cfs 20,465 cf  
 18.0" Round Culvert n=0.013 L=100.0' S=0.0150 '/' Outflow=5.91 cfs 20,465 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=7.11 cfs 24,379 cf  
 Primary=7.11 cfs 24,379 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.13 cfs 422 cf  
 Primary=0.13 cfs 422 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 24,802 cf Average Runoff Depth = 4.32"**  
**23.37% Pervious = 16,105 sf 76.63% Impervious = 52,818 sf**

**17024 PR-DRAINAGE\_1**

Type III 24-hr 25-Year Rainfall=6.12"

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**Summary for Subcatchment 10S: Area to Shawsheen River**

Runoff = 1.21 cfs @ 12.10 hrs, Volume= 3,914 cf, Depth&gt; 2.26"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 5,816     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 9,359     | 98 | Paved parking, HSG A          |
| 20,799    | 63 | Weighted Average              |
| 11,440    |    | 55.00% Pervious Area          |
| 9,359     |    | 45.00% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 11S: TO CB1**

Runoff = 0.49 cfs @ 12.09 hrs, Volume= 1,619 cf, Depth&gt; 4.96"

Routed to Pond 1 : CB1 TO DMH4

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,411     | 98 | Paved parking, HSG A          |
| 506       | 39 | >75% Grass cover, Good, HSG A |
| 3,917     | 90 | Weighted Average              |
| 506       |    | 12.92% Pervious Area          |
| 3,411     |    | 87.08% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 12S: Area to Haverhill Street**

Runoff = 0.13 cfs @ 12.10 hrs, Volume= 422 cf, Depth&gt; 1.91"

Routed to Link AP2 : Offsite Haverhill Street

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=6.12"

**17024 PR-DRAINAGE\_1**

Type III 24-hr 25-Year Rainfall=6.12"

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| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 906       | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,649     | 59 | Weighted Average              |
| 1,743     |    | 65.80% Pervious Area          |
| 906       |    | 34.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 13S: TO CB3**

Runoff = 1.52 cfs @ 12.09 hrs, Volume= 5,176 cf, Depth> 5.30"  
 Routed to Pond 3 : CB3 to DMH5 CDS

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 9,155     | 98 | Paved parking, HSG A          |
| 1,655     | 98 | Roofs, HSG A                  |
| 914       | 39 | >75% Grass cover, Good, HSG A |
| 11,724    | 93 | Weighted Average              |
| 914       |    | 7.80% Pervious Area           |
| 10,810    |    | 92.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 14S: TO CB2**

Runoff = 2.52 cfs @ 12.09 hrs, Volume= 8,604 cf, Depth> 5.30"  
 Routed to Pond 2 : CB2 to DMH4 Stormceptor

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=6.12"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 16,391    | 98 | Paved parking, HSG A          |
| 1,502     | 39 | >75% Grass cover, Good, HSG A |
| 1,597     | 98 | Roofs, HSG A                  |
| 19,490    | 93 | Weighted Average              |
| 1,502     |    | 7.71% Pervious Area           |
| 17,988    |    | 92.29% Impervious Area        |

**17024 PR-DRAINAGE\_1**

Type III 24-hr 25-Year Rainfall=6.12"

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| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

**Summary for Subcatchment 15S: Building to Roof Drain**

Runoff = 1.39 cfs @ 12.09 hrs, Volume= 5,067 cf, Depth> 5.88"  
Routed to Reach 5R : ROOF DRAIN TO DMH4

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=6.12"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 10,344    | 98 | Roofs, HSG A            |
| 10,344    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

**Summary for Reach 5R: ROOF DRAIN TO DMH4**

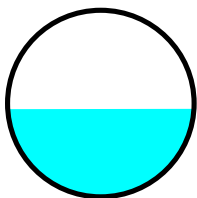
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 10,344 sf, 100.00% Impervious, Inflow Depth > 5.88" for 25-Year event  
Inflow = 1.39 cfs @ 12.09 hrs, Volume= 5,067 cf  
Outflow = 1.39 cfs @ 12.09 hrs, Volume= 5,067 cf, Atten= 0%, Lag= 0.1 min  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Max. Velocity= 5.52 fps, Min. Travel Time= 0.1 min  
Avg. Velocity = 1.89 fps, Avg. Travel Time= 0.3 min

Peak Storage= 8 cf @ 12.09 hrs  
Average Depth at Peak Storage= 0.39' , Surface Width= 0.83'  
Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.10 cfs

10.0" Round Pipe  
n= 0.013 Corrugated PE, smooth interior  
Length= 31.0' Slope= 0.0200 '/'  
Inlet Invert= 29.77', Outlet Invert= 29.15'



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Type III 24-hr 25-Year Rainfall=6.12"

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## Summary for Pond 1: CB1 TO DMH4

Inflow Area = 3,917 sf, 87.08% Impervious, Inflow Depth > 4.96" for 25-Year event  
Inflow = 0.49 cfs @ 12.09 hrs, Volume= 1,619 cf  
Outflow = 0.49 cfs @ 12.09 hrs, Volume= 1,619 cf, Atten= 0%, Lag= 0.0 min  
Primary = 0.49 cfs @ 12.09 hrs, Volume= 1,619 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 29.12' @ 12.09 hrs

Flood Elev= 31.52'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 28.72' | <b>12.0" Round Culvert</b> L= 114.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.72' / 28.15' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=0.47 cfs @ 12.09 hrs HW=29.12' TW=28.46' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 0.47 cfs @ 2.38 fps)

## Summary for Pond 1P: DMH6 to Shawsheen

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 5.40" for 25-Year event  
Inflow = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf  
Outflow = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf, Atten= 0%, Lag= 0.0 min  
Primary = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf  
Routed to Link AP1 : Offsite Shawsheen River Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 26.11' @ 12.09 hrs

Flood Elev= 33.60'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 24.74' | <b>18.0" Round Culvert</b> L= 11.0' Ke= 0.500<br>Inlet / Outlet Invert= 24.74' / 24.54' S= 0.0182 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=5.76 cfs @ 12.09 hrs HW=26.09' TW=0.00' (Dynamic Tailwater)

↑**1=Culvert** (Barrel Controls 5.76 cfs @ 4.56 fps)

## Summary for Pond 2: CB2 to DMH4 Stormceptor

Inflow Area = 19,490 sf, 92.29% Impervious, Inflow Depth > 5.30" for 25-Year event  
Inflow = 2.52 cfs @ 12.09 hrs, Volume= 8,604 cf  
Outflow = 2.52 cfs @ 12.09 hrs, Volume= 8,604 cf, Atten= 0%, Lag= 0.0 min  
Primary = 2.52 cfs @ 12.09 hrs, Volume= 8,604 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

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Type III 24-hr 25-Year Rainfall=6.12"

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Peak Elev= 28.79' @ 12.12 hrs

Flood Elev= 31.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 27.85' | <b>15.0" Round Culvert</b> L= 31.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.85' / 27.39' S= 0.0148 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=2.02 cfs @ 12.09 hrs HW=28.76' TW=28.46' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 2.02 cfs @ 2.97 fps)

## Summary for Pond 3: CB3 to DMH5 CDS

Inflow Area = 11,724 sf, 92.20% Impervious, Inflow Depth > 5.30" for 25-Year event  
Inflow = 1.52 cfs @ 12.09 hrs, Volume= 5,176 cf  
Outflow = 1.52 cfs @ 12.09 hrs, Volume= 5,176 cf, Atten= 0%, Lag= 0.0 min  
Primary = 1.52 cfs @ 12.09 hrs, Volume= 5,176 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 29.51' @ 12.09 hrs

Flood Elev= 32.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 28.85' | <b>15.0" Round Culvert</b> L= 19.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.85' / 28.66' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.48 cfs @ 12.09 hrs HW=29.50' TW=27.81' (Dynamic Tailwater)

↑**1=Culvert** (Barrel Controls 1.48 cfs @ 3.32 fps)

## Summary for Pond D4: DMH4 TO DMH5

Inflow Area = 33,751 sf, 94.05% Impervious, Inflow Depth > 5.44" for 25-Year event  
Inflow = 4.40 cfs @ 12.09 hrs, Volume= 15,290 cf  
Outflow = 4.40 cfs @ 12.09 hrs, Volume= 15,290 cf, Atten= 0%, Lag= 0.0 min  
Primary = 4.40 cfs @ 12.09 hrs, Volume= 15,290 cf  
Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 28.49' @ 12.10 hrs

Flood Elev= 32.81'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 27.28' | <b>18.0" Round Culvert</b> L= 117.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.28' / 26.70' S= 0.0050 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=3.99 cfs @ 12.09 hrs HW=28.46' TW=27.81' (Dynamic Tailwater)

↑**1=Culvert** (Outlet Controls 3.99 cfs @ 3.68 fps)

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Type III 24-hr 25-Year Rainfall=6.12"

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## Summary for Pond D5: DMH5 CDS to DMH6

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 5.40" for 25-Year event  
Inflow = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf  
Outflow = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf, Atten= 0%, Lag= 0.0 min  
Primary = 5.91 cfs @ 12.09 hrs, Volume= 20,465 cf  
Routed to Pond 1P : DMH6 to Shawsheen

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 27.83' @ 12.09 hrs

Flood Elev= 33.76'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 26.59' | <b>18.0" Round Culvert</b> L= 100.0' Ke= 0.500<br>Inlet / Outlet Invert= 26.59' / 25.09' S= 0.0150 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=5.76 cfs @ 12.09 hrs HW=27.81' TW=26.09' (Dynamic Tailwater)

↑1=Culvert (Inlet Controls 5.76 cfs @ 3.75 fps)

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,274 sf, 78.33% Impervious, Inflow Depth > 4.41" for 25-Year event  
Inflow = 7.11 cfs @ 12.09 hrs, Volume= 24,379 cf  
Primary = 7.11 cfs @ 12.09 hrs, Volume= 24,379 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Summary for Link AP2: Offsite Haverhill Street

Inflow Area = 2,649 sf, 34.20% Impervious, Inflow Depth > 1.91" for 25-Year event  
Inflow = 0.13 cfs @ 12.10 hrs, Volume= 422 cf  
Primary = 0.13 cfs @ 12.10 hrs, Volume= 422 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PR-DRAINAGE\_1**

Type III 24-hr 100-Year Rainfall=7.89"

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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 Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 10S: Area to Shawsheen** Runoff Area=20,799 sf 45.00% Impervious Runoff Depth>3.58"  
 Tc=6.0 min CN=63 Runoff=1.95 cfs 6,203 cf

**Subcatchment 11S: TO CB1** Runoff Area=3,917 sf 87.08% Impervious Runoff Depth>6.69"  
 Tc=6.0 min CN=90 Runoff=0.65 cfs 2,185 cf

**Subcatchment 12S: Area to Haverhill Street** Runoff Area=2,649 sf 34.20% Impervious Runoff Depth>3.14"  
 Tc=6.0 min CN=59 Runoff=0.22 cfs 693 cf

**Subcatchment 13S: TO CB3** Runoff Area=11,724 sf 92.20% Impervious Runoff Depth>7.05"  
 Tc=6.0 min CN=93 Runoff=1.98 cfs 6,887 cf

**Subcatchment 14S: TO CB2** Runoff Area=19,490 sf 92.29% Impervious Runoff Depth>7.05"  
 Tc=6.0 min CN=93 Runoff=3.30 cfs 11,449 cf

**Subcatchment 15S: Building to Roof** Runoff Area=10,344 sf 100.00% Impervious Runoff Depth>7.65"  
 Tc=6.0 min CN=98 Runoff=1.80 cfs 6,591 cf

**Reach 5R: ROOF DRAIN TO DMH4** Avg. Flow Depth=0.46' Max Vel=5.88 fps Inflow=1.80 cfs 6,591 cf  
 10.0" Round Pipe n=0.013 L=31.0' S=0.0200 '/' Capacity=3.10 cfs Outflow=1.80 cfs 6,590 cf

**Pond 1: CB1 TO DMH4** Peak Elev=29.20' Inflow=0.65 cfs 2,185 cf  
 12.0" Round Culvert n=0.013 L=114.0' S=0.0050 '/' Outflow=0.65 cfs 2,185 cf

**Pond 1P: DMH6 to Shawsheen** Peak Elev=26.41' Inflow=7.73 cfs 27,110 cf  
 18.0" Round Culvert n=0.013 L=11.0' S=0.0182 '/' Outflow=7.73 cfs 27,110 cf

**Pond 2: CB2 to DMH4 Stormceptor** Peak Elev=29.03' Inflow=3.30 cfs 11,449 cf  
 15.0" Round Culvert n=0.013 L=31.0' S=0.0148 '/' Outflow=3.30 cfs 11,449 cf

**Pond 3: CB3 to DMH5 CDS** Peak Elev=29.63' Inflow=1.98 cfs 6,887 cf  
 15.0" Round Culvert n=0.013 L=19.0' S=0.0100 '/' Outflow=1.98 cfs 6,887 cf

**Pond D4: DMH4 TO DMH5** Peak Elev=28.77' Inflow=5.74 cfs 20,224 cf  
 18.0" Round Culvert n=0.012 L=117.0' S=0.0050 '/' Outflow=5.74 cfs 20,224 cf

**Pond D5: DMH5 CDS to DMH6** Peak Elev=28.16' Inflow=7.73 cfs 27,110 cf  
 18.0" Round Culvert n=0.013 L=100.0' S=0.0150 '/' Outflow=7.73 cfs 27,110 cf

**Link AP1: Offsite Shawsheen River Wetlands** Inflow=9.67 cfs 33,313 cf  
 Primary=9.67 cfs 33,313 cf

**Link AP2: Offsite Haverhill Street** Inflow=0.22 cfs 693 cf  
 Primary=0.22 cfs 693 cf

**Total Runoff Area = 68,923 sf Runoff Volume = 34,006 cf Average Runoff Depth = 5.92"**  
**23.37% Pervious = 16,105 sf 76.63% Impervious = 52,818 sf**

# 17024 PR-DRAINAGE\_1

Type III 24-hr 100-Year Rainfall=7.89"

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## Summary for Subcatchment 10S: Area to Shawsheen River

Runoff = 1.95 cfs @ 12.10 hrs, Volume= 6,203 cf, Depth> 3.58"

Routed to Link AP1 : Offsite Shawsheen River Wetlands

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 5,816     | 39 | >75% Grass cover, Good, HSG A |
| 5,624     | 30 | Woods, Good, HSG A            |
| 9,359     | 98 | Paved parking, HSG A          |
| 20,799    | 63 | Weighted Average              |
| 11,440    |    | 55.00% Pervious Area          |
| 9,359     |    | 45.00% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

## Summary for Subcatchment 11S: TO CB1

Runoff = 0.65 cfs @ 12.09 hrs, Volume= 2,185 cf, Depth> 6.69"

Routed to Pond 1 : CB1 TO DMH4

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,411     | 98 | Paved parking, HSG A          |
| 506       | 39 | >75% Grass cover, Good, HSG A |
| 3,917     | 90 | Weighted Average              |
| 506       |    | 12.92% Pervious Area          |
| 3,411     |    | 87.08% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

## Summary for Subcatchment 12S: Area to Haverhill Street

Runoff = 0.22 cfs @ 12.10 hrs, Volume= 693 cf, Depth> 3.14"

Routed to Link AP2 : Offsite Haverhill Street

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=7.89"

**17024 PR-DRAINAGE\_1**

Type III 24-hr 100-Year Rainfall=7.89"

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| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 906       | 98 | Paved parking, HSG A          |
| 1,743     | 39 | >75% Grass cover, Good, HSG A |
| 2,649     | 59 | Weighted Average              |
| 1,743     |    | 65.80% Pervious Area          |
| 906       |    | 34.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 13S: TO CB3**

Runoff = 1.98 cfs @ 12.09 hrs, Volume= 6,887 cf, Depth> 7.05"  
 Routed to Pond 3 : CB3 to DMH5 CDS

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 9,155     | 98 | Paved parking, HSG A          |
| 1,655     | 98 | Roofs, HSG A                  |
| 914       | 39 | >75% Grass cover, Good, HSG A |
| 11,724    | 93 | Weighted Average              |
| 914       |    | 7.80% Pervious Area           |
| 10,810    |    | 92.20% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | <b>Direct Entry,</b> |

**Summary for Subcatchment 14S: TO CB2**

Runoff = 3.30 cfs @ 12.09 hrs, Volume= 11,449 cf, Depth> 7.05"  
 Routed to Pond 2 : CB2 to DMH4 Stormceptor

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=7.89"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 16,391    | 98 | Paved parking, HSG A          |
| 1,502     | 39 | >75% Grass cover, Good, HSG A |
| 1,597     | 98 | Roofs, HSG A                  |
| 19,490    | 93 | Weighted Average              |
| 1,502     |    | 7.71% Pervious Area           |
| 17,988    |    | 92.29% Impervious Area        |

# 17024 PR-DRAINAGE\_1

Type III 24-hr 100-Year Rainfall=7.89"

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| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

## Summary for Subcatchment 15S: Building to Roof Drain

Runoff = 1.80 cfs @ 12.09 hrs, Volume= 6,591 cf, Depth> 7.65"  
 Routed to Reach 5R : ROOF DRAIN TO DMH4

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=7.89"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 10,344    | 98 | Roofs, HSG A            |
| 10,344    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | <b>Direct Entry,</b> |

## Summary for Reach 5R: ROOF DRAIN TO DMH4

[52] Hint: Inlet/Outlet conditions not evaluated

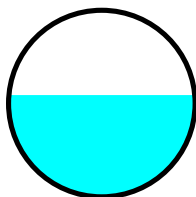
[90] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 10,344 sf, 100.00% Impervious, Inflow Depth > 7.65" for 100-Year event  
 Inflow = 1.80 cfs @ 12.09 hrs, Volume= 6,591 cf  
 Outflow = 1.80 cfs @ 12.09 hrs, Volume= 6,590 cf, Atten= 0%, Lag= 0.1 min  
 Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
 Max. Velocity= 5.88 fps, Min. Travel Time= 0.1 min  
 Avg. Velocity = 2.05 fps, Avg. Travel Time= 0.3 min

Peak Storage= 9 cf @ 12.09 hrs  
 Average Depth at Peak Storage= 0.46' , Surface Width= 0.83'  
 Bank-Full Depth= 0.83' Flow Area= 0.5 sf, Capacity= 3.10 cfs

10.0" Round Pipe  
 n= 0.013 Corrugated PE, smooth interior  
 Length= 31.0' Slope= 0.0200 '/'  
 Inlet Invert= 29.77', Outlet Invert= 29.15'



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Type III 24-hr 100-Year Rainfall=7.89"

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## Summary for Pond 1: CB1 TO DMH4

Inflow Area = 3,917 sf, 87.08% Impervious, Inflow Depth > 6.69" for 100-Year event  
Inflow = 0.65 cfs @ 12.09 hrs, Volume= 2,185 cf  
Outflow = 0.65 cfs @ 12.09 hrs, Volume= 2,185 cf, Atten= 0%, Lag= 0.0 min  
Primary = 0.65 cfs @ 12.09 hrs, Volume= 2,185 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 29.20' @ 12.11 hrs  
Flood Elev= 31.52'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 28.72' | <b>12.0" Round Culvert</b> L= 114.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.72' / 28.15' S= 0.0050 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=0.54 cfs @ 12.09 hrs HW=29.19' TW=28.72' (Dynamic Tailwater)  
↑1=Culvert (Outlet Controls 0.54 cfs @ 2.17 fps)

## Summary for Pond 1P: DMH6 to Shawsheen

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 7.15" for 100-Year event  
Inflow = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf  
Outflow = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf, Atten= 0%, Lag= 0.0 min  
Primary = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf  
Routed to Link AP1 : Offsite Shawsheen River Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 26.41' @ 12.09 hrs  
Flood Elev= 33.60'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 24.74' | <b>18.0" Round Culvert</b> L= 11.0' Ke= 0.500<br>Inlet / Outlet Invert= 24.74' / 24.54' S= 0.0182 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=7.53 cfs @ 12.09 hrs HW=26.37' TW=0.00' (Dynamic Tailwater)  
↑1=Culvert (Barrel Controls 7.53 cfs @ 4.87 fps)

## Summary for Pond 2: CB2 to DMH4 Stormceptor

Inflow Area = 19,490 sf, 92.29% Impervious, Inflow Depth > 7.05" for 100-Year event  
Inflow = 3.30 cfs @ 12.09 hrs, Volume= 11,449 cf  
Outflow = 3.30 cfs @ 12.09 hrs, Volume= 11,449 cf, Atten= 0%, Lag= 0.0 min  
Primary = 3.30 cfs @ 12.09 hrs, Volume= 11,449 cf  
Routed to Pond D4 : DMH4 TO DMH5

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

**17024 PR-DRAINAGE\_1**

Type III 24-hr 100-Year Rainfall=7.89"

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Peak Elev= 29.03' @ 12.13 hrs

Flood Elev= 31.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 27.85' | <b>15.0" Round Culvert</b> L= 31.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.85' / 27.39' S= 0.0148 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=2.36 cfs @ 12.09 hrs HW=28.96' TW=28.72' (Dynamic Tailwater)↑**1=Culvert** (Outlet Controls 2.36 cfs @ 2.72 fps)**Summary for Pond 3: CB3 to DMH5 CDS**

Inflow Area = 11,724 sf, 92.20% Impervious, Inflow Depth > 7.05" for 100-Year event  
 Inflow = 1.98 cfs @ 12.09 hrs, Volume= 6,887 cf  
 Outflow = 1.98 cfs @ 12.09 hrs, Volume= 6,887 cf, Atten= 0%, Lag= 0.0 min  
 Primary = 1.98 cfs @ 12.09 hrs, Volume= 6,887 cf  
 Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 29.63' @ 12.09 hrs

Flood Elev= 32.95'

| Device | Routing | Invert | Outlet Devices   |
|--------|---------|--------|--|
| #1     | Primary | 28.85' | <b>15.0" Round Culvert</b> L= 19.0' Ke= 0.500<br>Inlet / Outlet Invert= 28.85' / 28.66' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.93 cfs @ 12.09 hrs HW=29.61' TW=28.12' (Dynamic Tailwater)↑**1=Culvert** (Barrel Controls 1.93 cfs @ 3.52 fps)**Summary for Pond D4: DMH4 TO DMH5**

Inflow Area = 33,751 sf, 94.05% Impervious, Inflow Depth > 7.19" for 100-Year event  
 Inflow = 5.74 cfs @ 12.09 hrs, Volume= 20,224 cf  
 Outflow = 5.74 cfs @ 12.09 hrs, Volume= 20,224 cf, Atten= 0%, Lag= 0.0 min  
 Primary = 5.74 cfs @ 12.09 hrs, Volume= 20,224 cf  
 Routed to Pond D5 : DMH5 CDS to DMH6

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 28.77' @ 12.11 hrs

Flood Elev= 32.81'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 27.28' | <b>18.0" Round Culvert</b> L= 117.0' Ke= 0.500<br>Inlet / Outlet Invert= 27.28' / 26.70' S= 0.0050 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=4.95 cfs @ 12.09 hrs HW=28.72' TW=28.12' (Dynamic Tailwater)↑**1=Culvert** (Outlet Controls 4.95 cfs @ 3.63 fps)

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Type III 24-hr 100-Year Rainfall=7.89"

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## Summary for Pond D5: DMH5 CDS to DMH6

Inflow Area = 45,475 sf, 93.57% Impervious, Inflow Depth > 7.15" for 100-Year event  
Inflow = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf  
Outflow = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf, Atten= 0%, Lag= 0.0 min  
Primary = 7.73 cfs @ 12.09 hrs, Volume= 27,110 cf  
Routed to Pond 1P : DMH6 to Shawsheen

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs  
Peak Elev= 28.16' @ 12.09 hrs  
Flood Elev= 33.76'

| Device | Routing | Invert | Outlet Devices  |
|--------|---------|--------|---|
| #1     | Primary | 26.59' | <b>18.0" Round Culvert</b> L= 100.0' Ke= 0.500<br>Inlet / Outlet Invert= 26.59' / 25.09' S= 0.0150 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf |

**Primary OutFlow** Max=7.51 cfs @ 12.09 hrs HW=28.12' TW=26.37' (Dynamic Tailwater)  
↑1=Culvert (Inlet Controls 7.51 cfs @ 4.25 fps)

## Summary for Link AP1: Offsite Shawsheen River Wetlands

Inflow Area = 66,274 sf, 78.33% Impervious, Inflow Depth > 6.03" for 100-Year event  
Inflow = 9.67 cfs @ 12.09 hrs, Volume= 33,313 cf  
Primary = 9.67 cfs @ 12.09 hrs, Volume= 33,313 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Summary for Link AP2: Offsite Haverhill Street

Inflow Area = 2,649 sf, 34.20% Impervious, Inflow Depth > 3.14" for 100-Year event  
Inflow = 0.22 cfs @ 12.10 hrs, Volume= 693 cf  
Primary = 0.22 cfs @ 12.10 hrs, Volume= 693 cf, Atten= 0%, Lag= 0.0 min

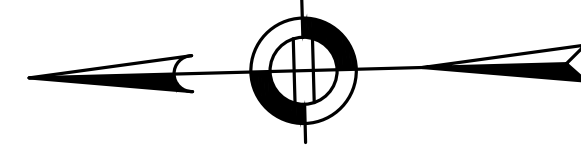
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



# Appendix F: Pre-Development and Post-Development Watershed Maps

---

MAP 35 LOT 8  
20 HAVERHILL STREET  
LISA M. COX  
BOOK 11792 PAGE 190



IP

MAP 35 LOT 7  
16 HAVERHILL STREET  
JPNR, LLC  
BOOK 7154 PAGE 329

EXISTING  
MULTI-TENANT  
OFFICE BUILDING

MAP 36 LOT 91  
16 BALMORAL STREET  
THE BALMORAL  
CONDOMINIUM COMPLEX

MAP 35 LOT 29  
56 YORK STREET  
NEW BRICKSTONE OFFICE, LLC  
BOOK 13994 PAGE 71

100' INNER  
RIPARIAN ZONE

EXISTING  
BUILDING

1S

MAP 35 LOT 5  
12 HAVERHILL STREET  
WINDHAM REALTY LLC  
BOOK 4168 PAGE 210

EXISTING  
BANK BUILDING

2S

RR SPIKE  
HAVERHILL STREET  
(PUBLIC - 60' WIDE)

RIM=33.02'

LIMIT OF FEMA  
FLOWWAY

25' NO DISTURB  
ZONE

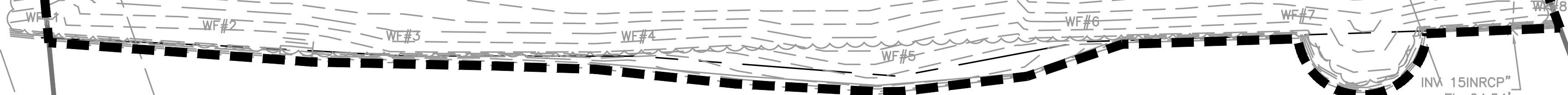
EXISTING  
PAVEMENT

50' NO BUILD  
LINE

TANTALLON ROAD (PRIVATE WAY)

AP2

30'  
APPROXIMATE  
LOCATION  
EXISTING SEWER  
EASEMENT



SHAWSHEEN RIVER

AP1

**HOWARD STEIN HUDSON**  
114 Turnpike Road, Suite 2C  
Chelmsford, MA 01824  
www.hshassoc.com

PREPARED FOR:  
Neil Rosenberg  
7 Tantallon Road  
Andover, MA 01810

**PROPOSED MULTIFAMILY  
REDEVELOPMENT PROJECT  
7 TANTALLON ROAD  
ANDOVER, MA, 01810**

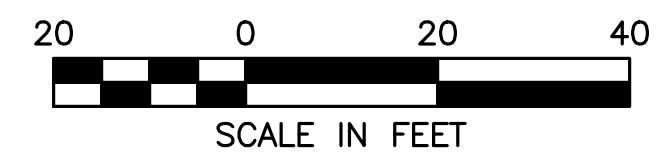
REVISIONS:

| NO | BY | DATE     | DESCRIPTION             |
|----|----|----------|-------------------------|
| 1  | TM | 12/21/17 | RESPONSE TO COMMENTS    |
| 2  | TM | 1/26/18  | RESUBMIT TO TOWN        |
| 3  | TM | 2/5/18   | RESPOND TO COMMENTS     |
| 4  | SM | 03/28/19 | ADJ. DATUM & ELEVATIONS |
| 5  | SM | 02/17/20 | LAYOUT/DRAINAGE REVS.   |
| 6  | PB | 07/08/21 | DRAINAGE REVS.          |
| 7  | MB | 10/26/22 | DRAINAGE REVS.          |

SITE  
PLAN

**PRE-DEVELOPMENT  
DRAINAGE MAP**

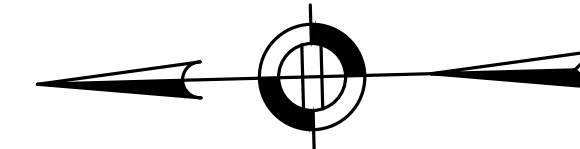
DATE: 10-24-2017  
PROJECT NUMBER: 17024  
DESIGNED BY: TM  
DRAWN BY: TM  
CHECKED BY: KE



1

SHEET 1 OF 2

MAP 35 LOT 8  
20 HAVERHILL STREET  
LISA M. COX  
BOOK 11792 PAGE 190



IP

MAP 35 LOT 7  
16 HAVERHILL STREET  
JPNR, LLC  
BOOK 7154 PAGE 329

EXISTING  
MULTI-TENANT  
OFFICE BUILDING

MAP 36 LOT 91  
16 BALMORAL STREET  
THE BALMORAL  
CONDOMINIUM COMPLEX

MAP 35 LOT 29  
56 YORK STREET  
NEW BRICKSTONE OFFICE, LLC  
BOOK 13994 PAGE 71

LIMIT OF FEMA  
FLOODWAY

APPROXIMATE  
LOCATION  
EXISTING SEWER  
EASEMENT

10S

200' INNER  
RIPARIAN ZONE

DMH  
RIM=33.71'

DMH  
RIM=34.14'

15S

100' INNER  
RIPARIAN ZONE

14S

13S

MAP 35 LOT 5  
12 HAVERHILL STREET  
WINDHAM REALTY LLC  
BOOK 418 PAGE 210

EXISTING  
BANK BUILDING

12S

RR SPIKE  
HAVERHILL STREET  
(PUBLIC - 60' WIDE)

RIM=33.02'

11S

AP2

TANTALON ROAD (PRIVATE WAY)

50' NO BUILD  
LINE

25' NO DISTURB  
ZONE

25' NO  
DISTURB

INV. 15INRCP"  
EL=24.54'

10S

SHAWSHEEN RIVER

AP1

**HOWARD STEIN HUDSON**  
114 Turnpike Road, Suite 2C  
Chelmsford, MA 01824  
www.hshassoc.com

PREPARED FOR:  
Neil Rosenberg  
7 Tantalon Road  
Andover, MA 01810

**PROPOSED MULTIFAMILY  
REDEVELOPMENT PROJECT**  
7 TANTALON ROAD  
ANDOVER, MA, 01810

REVISIONS:

| NO | BY | DATE     | DESCRIPTION             |
|----|----|----------|-------------------------|
| 1  | TM | 12/21/17 | RESPONSE TO COMMENTS    |
| 2  | TM | 1/26/18  | RESUBMIT TO TOWN        |
| 3  | TM | 2/5/18   | RESPOND TO COMMENTS     |
| 4  | SM | 03/28/19 | ADJ. DATUM & ELEVATIONS |
| 5  | SM | 02/17/20 | LAYOUT/DRAINAGE REVS.   |
| 6  | PB | 07/08/21 | DRAINAGE REVS.          |
| 7  | MB | 10/26/22 | DRAINAGE REVS.          |

SITE  
PLAN

**POST-DEVELOPMENT  
DRAINAGE MAP**

|                 |            |
|-----------------|------------|
| DATE:           | 10-24-2017 |
| PROJECT NUMBER: | 17024      |
| DESIGNED BY:    | TM         |
| DRAWN BY:       | TM         |
| CHECKED BY:     | KE         |

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SHEET 2 OF 2

