# Stormwater Management Plan

**under the**
**Massachusetts Stormwater Management Regulations**

**Beverly Police Station**

**175 Elliott Street**
**Beverly, MA**

August 2019

Applicant:
City of Beverly, MA

Submitted to:
City of Beverly, MA

Prepared by:
Griffin Engineering
Beverly, MA

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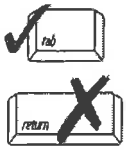
# STORMWATER MANAGEMENT CHECKLIST

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

# Checklist for Stormwater Report

## A. Introduction

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




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

The Stormwater Report must include:

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## B. Stormwater Checklist and Certification

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

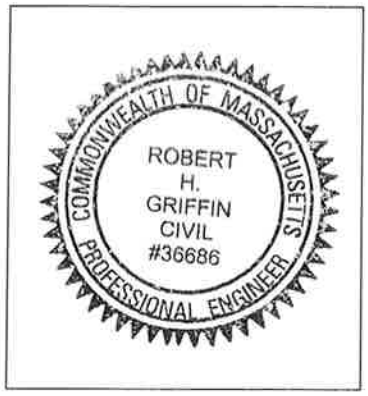
*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that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

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

## Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature




Signature and Date 8/8/19

## Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

# Checklist for Stormwater Report

## Checklist (continued)

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

- ☐ No disturbance to any Wetland Resource Areas
- ☒ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

**Standard 1: No New Untreated Discharges**

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

# Checklist for Stormwater Report

## Checklist (continued)

### Standard 2: Peak Rate Attenuation

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

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

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

### Standard 3: Recharge

☐ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

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

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

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

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

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 3: Recharge** (continued)

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

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

**Standard 4: Water Quality**

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

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

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

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

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

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

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

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 4: Water Quality** (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

**Standard 6: Critical Areas**

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

**Standard 9: Operation and Maintenance Plan**

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

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

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

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

**Standard 10: Prohibition of Illicit Discharges**

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

☐ An Illicit Discharge Compliance Statement is attached;

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

# ATTACHMENT A

# PROJECT DESCRIPTION

## 1.0 INTRODUCTION

This stormwater management report is prepared in support of the proposed site redevelopment and construction of the Beverly Police Station at 175 Elliott Street in Beverly, MA. The drainage system has been designed in accordance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

### 1.1 Existing Conditions

The site is approximately 2.01-acres in size. The western and central portions of the site are paved. Narrow mulched landscape islands bound the parking aisles. The Cummings Center uses the northeast portion of the site for storage, mulch and debris stockpiles, and equipment are present in the storage area. The southeast portion of the site is lawn with a bituminous and gravel walkway providing pedestrian access to the Cummings Center from Elliott Street. The existing gravel areas are dense from years of use. The site is bounded to the north by a commercial parking garage and parking lot, to the west by an ATM building and commercial parking lot, to the east by railroad tracks and to the south by Elliott Street.

The parking lot is relatively flat and drains to three catch basins that discharge to the municipal drainage system in Elliott Street. The three catch basins (CB4, CB5, and CB6) are masonry structures with no sumps or hoods. The drain pipes connecting them are 12-inch vitrified clay pipes with very shallow slopes. The connection from CB4 to the municipal drain manhole DMH3 in Elliott Street has a negative slope, as witnessed on a video inspection of this pipe provided to Griffin Engineering by the Cummings Center. The municipal drainage system in Elliott Street discharges into a large culvert at the McKay Street and Elliott Street intersection. This culvert discharges to the Bass River (tidal). Based on our site inspections and survey data review, the existing drainage system is tidally affected.

The FEMA Firm Flood Map shows that the site is located within a Zone "AE" Flood Hazard area (Elevation 10-ft; NAVD 1988 datum, reference: FEMA FIRM Map No. 25009C0417G dated July 16, 2014). Zone "AE" Flood Hazards are defined as areas subject to inundation by the 100-year flood event, with known base flood elevations.

### 1.2 Proposed Conditions

The project involves redevelopment of the commercial parking lot to the new police station with associated parking lot, walkways, utilities and landscaping. To protect the station from potential sea level rise and since the project site is within a coastal flood zone, site topography will be raised approximately 4 to 6-ft. The first floor of the police station will be 4-ft above the FEMA base flood elevation. Site Plans showing the proposed redevelopment and stormwater management system have been separately provided.

The proposed project is considered a redevelopment and will improve existing conditions by capturing and treating runoff from all of the proposed parking area and walkways prior to discharging to the municipal drainage system and reducing the amount of impervious surfaces on-site. Runoff from the proposed building roof is considered clean and does not require treatment. All of the proposed impervious surfaces on-site will be in full compliance with the 10 Massachusetts DEP Stormwater Management Standards.

## 2.0 STORMWATER MANAGEMENT STANDARDS

### 2.1 Standard 1: No New Untreated Discharges

No new untreated discharges to wetlands or waterways are proposed. The site discharges to the existing municipal drainage system in Elliott Street.

### 2.2 Standard 2: Peak Rate Attenuation

A waiver from Standard 2 applies because the project is located in land subject to coastal storm flowage. According to the FEMA Flood Map, the site will be inundated by flood waters from the Bass River (tidal) during the 100-year flood event. Flood waters will recede as the tide recedes. The proposed stormwater drainage system is hydraulically connected to the Bass River via the municipal drainage system in Elliott Street, which discharges to a large culvert at the McKay Street and Elliott Street intersection.

### 2.3 Standard 3: Recharge

The post-development annual recharge at the site is greater than the pre-development annual recharge because the proposed project increases the amount of landscaping on-site by approximately 1,730 sq. ft. For this reason, this Standard is met with no additional infiltration structures required. Additionally, site constraints such as the lack of space and unsuitable soils make installation of an infiltration structure impracticable.

The United States Department of Agriculture Natural Resources Conservation Service Soil Survey characterizes the soil as Urban Land, which indicates that the soils have been significantly altered or obscured by urban works and structures. A series of test borings, test probes, and test pits were conducted at the site by Haley and Aldrich in August 2001, Sage Environmental, Inc. in November 2018, and Sage Environmental, Inc. in April 2019. According to the Geotechnical Engineering Report by Paul B. Aldinger & Associates (PBA)[1] dated April 2019, underlying soils encountered on-site are mainly comprised of non-engineered fill material, organic silt and peat overlying glaciomarine and glacial till soils. Groundwater levels were

[1] Geotechnical Engineering Report for the Proposed Police Station, Beverly, MA, prepared for Sage Environmental, Inc. of Pawtucket, RI, prepared by Paul B. Aldinger & Associates, Inc. of East Providence, RI. April 2019

observed within the monitoring wells by PBA in April 2019 to be between 1.7 to 2.1 feet below the ground surface. High Groundwater, fill, organic soil, soft clay and hard glacial till are not suitable conditions for an infiltration structure. The Geotechnical Report by PBA was obtained from the City of Beverly.

### 2.4 Standard 4: Water Quality

The minimum required water quality treatment volume for the project site is the first half inch of runoff from impervious surfaces. The proposed stormwater treatment system is designed to provide a weighted average of approximately 93.0% TSS removal. The reader is referred to Water Quality Volume Calculations provided in Attachment B.

The water quality volume is satisfied by a First Defense (FD) proprietary separator pretreatment device and deep-sump, hooded catch basins. The FD pretreatment devices at the site are predicted to achieve an annual 96% TSS removal rate and catch basins were assigned a 25% TSS removal rate. The proprietary separator was sized to adequately treat the required water quality volume (WQV) by converting the WQV to an equivalent peak flow rate (Water Quality Flow (WQF)), in the manner specified by Mass DEP Stormwater Management guidelines.

Approximately 91% of the proposed parking area and walkways will be pretreated by the proprietary separator pretreatment devices and thereby will fully satisfy Standard 4. All of the proposed roof runoff (14,507 sq. ft.) is considered clean by Mass. DEP. Roof runoff will improve runoff water quality by replacing approximately 13,730 sq. ft. of existing untreated pavement. The proposed drainage system provides a level of pretreatment to all of the runoff from the proposed parking area and walkways on-site and approximately 5,345 sq. ft. of pavement and walkways off-site adjacent to the ATM building. Prior to site redevelopment, stormwater runoff from all the impervious surfaces (approximately 61,331 sq. ft.) drained to the Elliott Street municipal drainage system without being treated.

Computations for the proposed proprietary separator are provided in Attachment B. The calculated WQF rate was used with the manufacturer's TSS Removal Efficiency Curve to estimate the annual TSS removal. The efficiency calculations were based on third-party evaluations of the First Defense proprietary separators. The third-party evaluations are provided in Attachment F.

As required by the Stormwater Management Standards, a Long-Term Pollution Prevention Plan has been prepared for the project and is provided in Attachment C. The plan identifies suitable practices for source control and pollution prevention throughout the useful life of the site.

### 2.5 Standard 5: Land Uses with Higher Potential Pollutant Loads

In accordance with the Massachusetts Stormwater Management Standards, the

proposed primary site use is not considered a Land Use with Higher Potential Pollutant Load (LUHPPL). Therefore, this standard does not apply.

### 2.6 Standard 6: Critical Areas

The project site is not tributary to an environmentally-critical area as defined by the Massachusetts Stormwater Management Standards. Therefore, this standard does not apply to this project.

### 2.7 Standard 7: Redevelopment and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The site has been previously developed with a paved parking lot, material stockpiles and equipment storage area. Existing surfaces are primarily gravel, dirt, and pavement. Since the project decreases impervious area by approximately 1,730 sq. ft., the project is considered a redevelopment and is required to meet Standards 2, 3, and the pretreatment and structural BMP requirements of Standard 4, 5, and 6 to the maximum extent practicable and fully comply with all other Standards.

All of the proposed work area on-site meets the 10 DEP Stormwater Management Standards except for approximately 3,491 sq. ft. of proposed pavement and walkways on the subject parcel located adjacent to ATM building (offsite impervious area was omitted from the calculations). Due to the small size of this area and its location downstream of the project, these areas are considered "de minimus" under the criteria listed in the Massachusetts Stormwater Management Handbook and a weighted average method can be used to determine if the 80%TSS removal rate can be achieves on a site-wide basis. The proposed stormwater treatment system is designed to provide a weighted average of approximately 93.0% TSS removal; therefore Standard 4 is met. The reader is referred to Water Quality Volume Calculations provided in Attachment B.

### 2.8 Standard 8: Construction Period Pollution Prevention and Erosion and Sediment Control

Consistent with the NPDES Construction General Permit requirements, a Stormwater Pollution Prevention Plan (SWPPP) is required for any project resulting in over 1-acre of land disturbance. The proposed project anticipates approximately 2.22-acres of land disturbance. Therefore, a SWPPP will be prepared and submitted to the issuing authority prior to land disturbance commencing.

### 2.9 Standard 9: Operation and Maintenance Plan

An Operations & Maintenance Plan has been provided in Attachment D. The owner of the land (City of Beverly) is responsible for system operation and maintenance.

### 2.10 Standard 10: Illicit Discharges

The submitted Long-Term Pollution Prevention Plan (Attachment C) specifies measures to prevent illicit discharges from entering the stormwater management

system. Source control and response plans are also specified to prevent illicit discharges from being conveyed through the stormwater management system.

Since the project site has been previously developed, a signed Illicit Discharge Compliance Statement cannot be provided at this time. A component of the proposed project includes relocating and abandoning existing utilities from the Cummings Center property. Consistent with the Massachusetts Stormwater Handbook, the property owner will submit a signed Illicit Discharge Compliance Statement prior to discharging any stormwater runoff to the post-construction stormwater BMP's. A draft copy of the Illicit Discharge Statement is provided in Attachment E.

## 3.0 SUMMARY

The proposed drainage system and site redevelopment plans for the police station at 175 Elliott Street conforms to MassDEP Stormwater Management Regulations. The proposed drainage system will treat and remove TSS and other pollutants throughout the project area and minimize erosion. Proper construction and operation and maintenance of the proposed drainage system are critical to its long-term performance. To that end, an Operations and Maintenance Plan and Long-Term Pollution Prevention Plan have been prepared and will be instituted throughout the facility's life.

# ATTACHMENT B

## STORMWATER COMPUTATIONS

B.1 – Recharge Calculations

B.2 – Water Quality Volume Calculations

B.3 – Water Quality Flow Calculations

B.4 – TSS Removal Calculation Worksheets

B.5 – TSS Removal Efficiency Curve
by Hydro International

**Griffin Engineering Group, LLC**
**495 Cabot Street, Suite 2**
**Beverly, MA 01915**

***Phone: 978-927-5111; Fax: 978-927-5103***

# RECHARGE VOLUME & DESIGN CALCULATIONS

| | |
|---|---|
| Job Name: | Beverly Police Station - 175 Elliott St |
| Job No: | 1573 |
| Date: | 8/8/2019 |
| Designer: | MBP |
| Checked By: | RHG |

IMPERVIOUS AREA:

| | Total | |
|---|---|---|
| | (sf) | (acres) |
| Existing* | 61,331 | 1.41 |
| Proposed | 59,601 | 1.37 |
| Net Increase | 0 | 0.00 |
| Net Decrease | 1,730 | 0.04 |

* Existing Impervious Area includes 57,851 sf of impervious area with project limits (pavement, concrete, and roof) & 3,480 of compacted gravel surfaces.

**Required Volume (Rv) to Recharge per MassDEP:**

C Type Soils" 0.25 in

Rv=(0 sf) x (0.25) x (1'/12") = 0 cf

| | |
|---|---|
| Impervious Area Tributary to Infiltration Field: | 0 sf |
| Percentage of Total New Impervious Surfaces: | 0.0% |
| Ratio of Total Impervious Area to Tributary Area: | 0.000 |
| **Adjusted Min. Required Recharge Volume:** | **0 cf** |

**Notes:**

**The project reduces impervious area on-site by approx. 1,730 sq. ft., therefore there is no loss of annual recharge associated with the project. Standard 3 is met with no additional infiltration structures. Additionally, soils on-site are mainly comprised of non-engineered fill material, organic silt and peat overlying glaciomarine and glacial till soils (Classified as "C" & "D" Hydrologic Soil Groups) and groundwater was encountered approx. 1.7 to 2.1 feet below the ground surface in April 2019. These conditions limit the effectiveness of a subsurface infiltration BMP.**

**Griffin Engineering Group, LLC**
**495 Cabot Street, Suite 2**
**Beverly, MA 01915**

***Phone: 978-927-5111; Fax: 978-927-5103***

# WATER QUALITY VOLUME CALCULATION

Job Name: Beverly Police Station - 175 Elliott St
Job No: 1829
Date 8/8/2019
Designer MBP
Checked By: RHG

REQ. WATER QUALITY VOLUME (WQV) DEPTH = 0.5 inch(s) of runoff

WEIGHTED AVERAGE TSS REMOVAL CALCULATION

| Tributary Subcatchments* | Total Area (sf) | Pavement/ Walks (sf) | Roof (sf) | WQV (cf) | % TSS Removal | Imp. Area x TSS + Roof | Treatment Train |
|---|---|---|---|---|---|---|---|
| P3B & P3C | 6,797 | 5,228 | 0 | 218 | 97% | 5,071 | WQS1 - First Defense |
| P4A, P4B, P5A, P5B, & P6 | 39,211 | 24,130 | 1,368 | 1,062 | 97% | 24,774 | WQS2 - First Defense |
| P2A & P3A | 14,623 | 6,900 | 0 | 288 | 96% | 6,624 | WQS3 - First Defense |
| P1A, P1B, P1C, P2B, P7, P8, & P9 | 36,521 | 3,491 | 13,139 | 693 | 25% | 14,012 | De minimus Areas |
| Total: | 97,152 | 39,749 | 14,507 | | **93.0%** | 50,481 | |

* See Subcatchment Plan DR-2 in Attachment D.

Weighted Average

Calculations:
WQV = Imp. Area x 0.5-inch x 1-foot/12-inches
Weighted Average %TSS Removal = Total Imp. Area x TSS / Total Imp. Area

Notes:

1.) Stormwater runoff from the roof (Subcatchments P2B & P5B) is included in the weighted average calculations because MassDEP considers roof runoff to be clean.
2.) Offsite impervious area within Subcatchments P1A, P2A, & P3A (5,345 sf) was omitted from the calculations.

3.) The WQV for the First Defense Proprietary Separator was converted to a WQF per MassDEP requirements. (See Water Quality Flow Calculations).
4.) Refer to Attached TSS Removal Efficiency Curve Prepared by the Manufacturer, Hydro International for the First Defense Proprietary Separator. Removal efficency is calculated based on the WQF.
5.)The proposed pavement and walk areas on-site from Subcatchments P1A, P2A, & P3A is considered "de minimus" under the criteria listed in the Massachusetts Stormwater Management Handbook.

**Griffin Engineering Group, LLC**
**495 Cabot Street, Suite 2**
**Beverly, MA 01915**

***Phone: 978-927-5111; Fax: 978-927-5103***

# WATER QUALITY FLOW CALCULATIONS

Job Name: Beverly Police Station - 175 Elliott St
Job No: 1573
Date: 8/8/2019
Designer: MBP
Checked By: RHG

PROPRIETARY SEPARATORS

REQ. WATER QUALITY VOLUME (WQV) DEPTH = 0.5 inch(s) of runoff

| Structure Name | Imp. Area (sf) | A (miles$^2$) | $t_c$ (min.) | $t_c$ (hrs.) | qu (csm/in) | $Q_{1.0}$ (cfs) | Proposed Device | Proposed Configuration |
|---|---|---|---|---|---|---|---|---|
| WQS1 | 5,228 | 0.00019 | 6.0 | 0.10 | 774 | **0.073** | 4' FD | Online |
| WQS2 | 24,130 | 0.00087 | 6.0 | 0.10 | 774 | **0.335** | 4' FD | Online |
| WQS3 (PCB4) | 10,819 | 0.00039 | 6.0 | 0.10 | 774 | **0.150** | 4' FD | Inlet & Online |

Notes:

$Q_{0.5}$ = (qu)(A)(WQV)

where:

$Q_{0.5}$ = flow rate associated with first 0.5-inch of runoff (WQF)
qu = the unit peak discharge in csm/in
A = impervious surface drainage area in square miles
WQV = water quality volume in watershed inches (0.5)

WQS1 - FIRST DEFENSE PROPRIETARY SEPARATOR
Internal Bypass Configuration
Bypass Flowrate =0.7 cfs (Per Manufacturer)
**WQF = 0.07 cfs -> OK**

WQS2 - FIRST DEFENSE PROPRIETARY SEPARATOR
Internal Bypass Configuration
Bypass Flowrate = 0.7 cfs
**WQF = 0.33 cfs -> OK**

WQS3 - FIRST DEFENSE PROPRIETARY SEPARATOR
Internal Bypass Configuration
Bypass Flowrate = 0.7 cfs
**WQF = 0.15 cfs -> OK**

INSTRUCTIONS:

*Non-automated: Mar. 4, 2008*

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Subcatchments P3B & P3C

## TSS Removal Calculation Worksheet

| A<br>BMP[1] | B<br>TSS Removal Rate[1] | C<br>Starting TSS Load* | D<br>Amount Removed (B*C) | E<br>Remaining Load (C-D) |
|---|---|---|---|---|
| **Deep-Sump and Hooded Catch Basin** | **0.25** | **1.00** | **0.25** | **0.75** |
| **First Defense Proprietary Separator** | **0.96** | **0.75** | **0.72** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |

**Total TSS Removal =** **97%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

Project: Beverly Police Station

Prepared By: MBP

Date: August 2019

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

*Non-automated: Mar. 4, 2008*

Location: Subcatchments P4A, P4B, P5A, & P6

## TSS Removal Calculation Worksheet

| A<br>BMP[1] | B<br>TSS Removal Rate[1] | C<br>Starting TSS Load* | D<br>Amount Removed (B*C) | E<br>Remaining Load (C-D) |
|---|---|---|---|---|
| **Deep-Sump and Hooded Catch Basin** | **0.25** | **1.00** | **0.25** | **0.75** |
| **First Defense Proprietary Separator** | **0.96** | **0.75** | **0.72** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |
| | | **0.03** | **0.00** | **0.03** |

**Total TSS Removal =** **97%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

Project: Beverly Police Station
Prepared By: MBP
Date: August 2019

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

*Non-automated: Mar. 4, 2008*

Location: Subcatchments P2A & P3A

## TSS Removal Calculation Worksheet

| A<br>BMP[1] | B<br>TSS Removal Rate[1] | C<br>Starting TSS Load* | D<br>Amount Removed (B*C) | E<br>Remaining Load (C-D) |
|---|---|---|---|---|
| **First Defense Proprietary Separator** | **0.96** | **1.00** | **0.96** | **0.04** |
| | | **0.04** | **0.00** | **0.04** |
| | | **0.04** | **0.00** | **0.04** |
| | | **0.04** | **0.00** | **0.04** |
| | | **0.04** | **0.00** | **0.04** |

**Total TSS Removal =** **96%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

Project: Beverly Police Station
Prepared By: MBP
Date: August 2019

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

*Version 1, Automated: Mar. 4, 2008*

Location: Subcatchment P1A, P1B, & P1C

## TSS Removal Calculation Worksheet

| B<br>BMP[1] | C<br>TSS Removal Rate[1] | D<br>Starting TSS Load* | E<br>Amount Removed (C*D) | F<br>Remaining Load (D-E) |
|---|---|---|---|---|
| **Deep Sump and Hooded Catch Basin** | **0.25** | **1.00** | **0.25** | **0.75** |
| | **0.00** | **0.75** | **0.00** | **0.75** |
| | **0.00** | **0.75** | **0.00** | **0.75** |
| | **0.00** | **0.75** | **0.00** | **0.75** |
| | **0.00** | **0.75** | **0.00** | **0.75** |

**Total TSS Removal =** **25%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

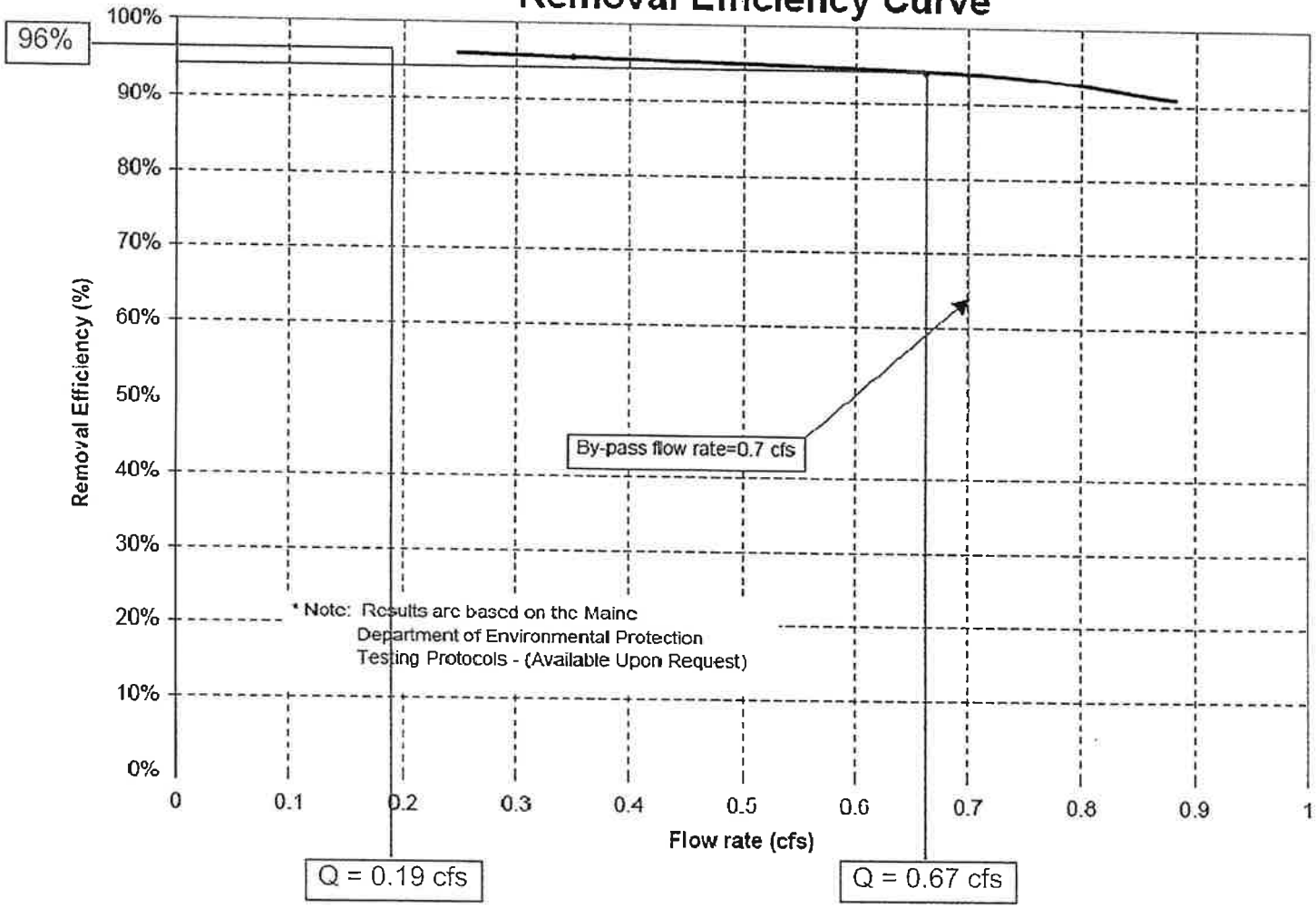
Project: Beverly Police Station
Prepared By: MBP
Date: August 2019

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Hydro International stormwater

# 4-ft Diameter First Defense Removal Efficiency Curve*




Hydro International • 94 Hutchins Drive • Portland, ME 04102 Tel: (207) 756-6200 • Fax: (207) 756-6212
www.Hydro-International.biz

B. 5

# ATTACHMENT C

# LONG TERM POLLUTION PREVENTION PLAN

# BEVERLY POLICE STATION
# 175 ELLIOTT STREET
# LONG TERM POLLUTION PREVENTION PLAN

Long Term Pollution Prevention Plan (LTPPP) has be prepared and incorporated into the long term operation and maintenance plan of the projects stormwater management system. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges and to describe suggested practices to reduce pollutants in stormwater discharges.

*Good housekeeping practices* - The City of Beverly is to keep the site in a neat and orderly condition so that pollutants are not unnecessarily conveyed to the storm drainage system. Materials swept, blown or washed into the storm drains can decrease the system's effectiveness. Some examples of good housekeeping practices are pavement sweeping, litter control, contained outdoor waste and cigarette disposal receptacles, and protected material storage areas. The City should provide proper training and assign responsibilities to personnel to keep the site in a neat and orderly condition.

*Provisions for storing materials and waste products inside or under cover* – Materials such as grease, paint, detergents, metals and raw materials are to be stored in labeled containers within the building in a safe location. Materials stored outdoors should be in containers with secure lids that to prevent contact with stormwater.

A trash and recycling disposal company hired by the owners will pick up waste materials and properly dispose of them at a state approved disposal facility. The proposed dumpsters located on-site will be properly maintained and emptied at least once a week.

*Vehicle washing controls* – Outdoor vehicle washing has the potential of conveying wash water with heavy concentrations of detergents and sediments into the stormwater drainage system. The project site does not include any designated vehicle washing areas, nor is it expected that vehicle washing will take place on-site.

*Requirements for routine inspections and maintenance of stormwater BMP's* - Consistent with Standard 9 of the Massachusetts Stormwater Management Regulations, an Operation and Maintenance Plan has been provided in the Stormwater Management Report. The plan details routine inspection and maintenance of the stormwater BMP's along with associated record keeping forms.

*Spill prevention and response plans* – Sources of potential spill hazards include vehicle fluids and fuels, pesticides, paints, solvents, and liquid cleaning products. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:

1) Spill hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers' recommended spill cleanup protocol.
2) Vehicle fluid and fuel spills shall be remediated according to local and state regulations governing fuel spills.
3) The property owners shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust-pans, mops, rags, gloves, trash bags, trash containers, and absorptive materials such as sand, sawdust, or kitty litter.
4) Spills of toxic or hazardous materials shall be reported to the Massachusetts Department of Environmental Protection at 1-888-304-1133.

*Provisions for maintenance of lawns, garden, and other landscaped areas* - It should be a general goal of the City of Beverly to achieve a high-quality, well-groomed and stable landscape that evolves throughout the seasons and protects the overall condition of the property. All landscaped areas are to be maintained with dense vegetative growth or a layer of mulch so as to minimize sediment transport. Litter and waste is to be removed weekly from the landscaped areas and adjoining parking lots and disposed of properly.

*Requirements for storage and use of fertilizer, herbicides, and pesticides* - Fertilizers, herbicides, and pesticides are not to be stored on site or within the buildings. Should use of some become necessary, application should be performed by a state licensed contractor in accordance with the manufacturer's label instruction and when environmental conditions are conducive to product application

*Pet waste management provisions* - All pet waste is to be scooped up, sealed in a plastic bag, and disposed of properly in the garbage. Pet waste should never be deposited in the stormwater management system for it contains high level of fecal coliform bacteria.

*Provisions for operation and management of septic systems* – There are no septic systems associated with the project site. The sanitary sewer is proposed to be connected to the city sewer main in Elliott Street.

*Snow disposal and deicing chemicals* – Snow will be stockpiled on site until the stockpile areas become a hazard to the daily operation of the site. At that point, snow is to be disposed of at an off-site location. It will be the responsibility of the City of Beverly Department of Public Works or its hired contractors to properly dispose of transported snow according to the Massachusetts DEP, Snow Disposal Guidelines. It is the responsibility of the City and/or its snow removal contractor to follow these guidelines and all applicable laws and regulations.

The City of Beverly will be responsible for the clearing of the sidewalks and building entrances. The owners may need to use a de-icing agent such as salt or potassium

chloride to maintain a safe walking surface. The de-icing agent for the walkways and building entrances may be kept on site in a designated storage room within the building. De-icing agents are not to be stored outside. City of Beverly Department of Public Works will remove snow from parking lot via snow plows and common walkways.

# ATTACHMENT D

## OPERATION & MAINTENANCE PLAN

- Construction Phase Maintenance Inspection Form
- Post-Construction Maintenance Inspection Form
- Inspector Certification Statement
- Operation & Maintenance Schedule
- Hydro International Operation & Maintenance Manual
- Flexstorm Inlet Filter Operation and Maintenance Plan

# OPERATION & MAINTENANCE PLAN

**System Owner:**
City of Beverly

**Party Responsible for O&M:**
The City of Beverly's Contractor shall be responsible for the construction period pollution prevention and erosion and sediment control phase. The City of Beverly will be responsible for the long-term operation and maintenance and repair of all drainage structures located within the Beverly Police Station property. Beverly Commerce Park Inc. (Cummings Center) will be responsible for operation and maintenance of the newly installed drain manholes (PDMH1, PDMH2, PDMH3, PDMH4, and PDMH5) and catch basins (PCB1, PCB3, PCB4, and PCB5) on their property adjacent to the ATM building and garage. A drainage easement will be created allowing the stormwater runoff from the Beverly Police Station to drain towards these structures and to allow the City of Beverly access to these structures. Should ownership of the property change, the succeeding owner shall assume all responsibilities for implementing this Operation and Maintenance Plan.

*Note: The system inspectors should note that drainage pipes, catch basin, manholes, and treatment devices are considered "confined spaces" subject to strict OSHA standards regarding safe entry. Confined spaces present inherent hazards to workers. Only appropriately trained staff with appropriate safety equipment and monitors may enter confined spaces, and then only with a specific entry permit. Also, this work may pose hazards to workers, such as soft ground, flowing or standing water, snakes and rodents. Again, only appropriately trained staff with the necessary safety equipment should undertake such work.*

## Construction Period Pollution Prevention and Erosion and Sediment Control

Installing and maintaining comprehensive erosion controls during construction is critical to the protection of the environment and the proposed drainage system. Following is a list of erosion control measures to be taken to protect the existing and proposed drainage system during construction.

1) Install hay bales, straw wattles, and/or silt fence downhill of all proposed work area as shown on the Sedimentation and Erosion Control Plan (Sheet C3.00).

2) Install the construction entrance(s) at entrance off of Elliott Street and Cummings Center Drive.

3) Install silt sacks (ADS Flexstorm Inlet Filter) in all existing catch basins adjacent to the site on Elliott Street and within the Cummings Center parking area.

4) Temporary soil stockpiles shall be encircled with hay bales or straw wattles and

stabilized with erosion control matting or temporary seeding, depending upon the proposed duration.

5) Stabilize all disturbed areas as soon as practicable. Provide temporary stabilization of soil to be exposed for a long period of time (i.e. one month).

6) Install erosion control matting on all proposed vegetated slopes greater than 3:1 (H:V).

7) All erosion control measures are to be inspected weekly and after each rainfall event. Additional erosion control materials (i.e. hay bales, straw wattles, silt fence, filter fabric) are to be kept on site and readily accessible as required.

8) Sediment accumulation up-gradient of the erosion controls (haybales, straw wattles or silt fence) greater than 6" in depth shall be removed and disposed of in accordance with all applicable regulations.

9) The stabilized construction entrance(s) shall be inspected weekly. The entrance(s) shall be maintained by adding additional clean, angular stone to remove the soil from the construction vehicle tires. If soil is still observed leaving the site from construction vehicle tires, adjacent roadways shall be kept clean by street sweeping.

10) Dust shall be controlled using on-site water trucks as required.

11) All erosion control measures shall be maintained, repaired or replaced as required or directed by the owner's engineer, the City Engineer, or the City Conservation Agent.

12) The contractor shall comply will the Erosion Control Notes listed on the project drawings (Sheet C1.00).

**TABLE 1: Construction Phase Inspection and Maintenance Procedures**

| Control | Inspection Frequency (1) | Maintenance Procedure |
|---|---|---|
| Construction Entrance | Weekly | a |
| Silt Fence | Weekly | a |
| Rip-Rap | Weekly | a |
| Stormwater Control Berm | Weekly | a |
| Dust Control | Daily | b |
| Permanent Stabilization | Weekly | c |

1. Inspection frequencies are a minimum. Site conditions may warrant more frequent review. All control shall be inspected after each storm event which exceeds 0.5 inches in 24-hours.

2. Maintenance Procedures shall be reviewed and revised as necessary to protect the environment.

    a. Remove accumulated debris and replace as necessary.
    b. Water or calcium chloride shall be utilized to prevent the generation of dust.
    c. Disturbed areas shall either be paved or stabilized by permanent seeding.

The attached Construction Phase Maintenance Inspection Form shall be completed weekly and retained with project files.

**Post-Development Operation and Maintenance**

The stormwater management system is a series of catch basins located at low points within the paved parking lot. Stormwater collected by the catch basins is conveyed through a series of drain manholes and proprietary stormwater devices (First Defense Stormwater Treatment Device) prior to discharging to the existing municipal drainage system in Elliott Street. Stormwater runoff from the building rooftop is collected by roof drains and conveyed by to the sites drainage system.

1) Inspections. Inspection of the drainage system components are to be performed by a trained service provider licensed by City Engineering Department. During the first year of operation the drainage system shall be inspected on a quarterly basis. The inspection frequency can be reduced after the first year to annual inspections provided that the quarterly inspections do not indicate the need for more frequent inspections. If more frequent inspections become appropriate at any time, they should be implemented. Inspections should be documented by taking necessary notes, completing the required forms, measurements, photographs, and retaining service receipts. An annual report shall be provided to the Engineering Department by December 31st of each year. Any major deficiencies requiring repair shall be reported to the Engineering Department within 48-hours of discovery. The following inspections are required of the system owner.

    *Paved Parking Surfaces* – As part of normal site clean-up and as discussed in the Long Term Pollution Prevention Plan, debris is to be removed from the parking lots as it accumulates. Weekly patrolling for litter is recommended. Sand from winter ice and traction control should be removed semi-annually (ie. during early spring and late fall). Significant oil leaks should be swept up and disposed of using oil-absorbent materials as they are discovered. Any oil spills or leaks that reach the catch basins must be reported to the Massachusetts DEP oil spill hotline.

*Catch Basins* - Remove the grate and visually inspect for corrosion and structural damage. Inspect pipe inlets and bottoms for signs of infiltration or inflow. The grate and hoods on the catch basins should be inspected on a quarterly basis during the first year and semi-annual thereafter. Cleaning of the catch basins should be done on a yearly basis and by a vacuum truck or clamshell. The contractor is to take care to avoid damaging the catch basin hood. While cleaning, if a layer of oil is observed floating on the water surface, place an oil-absorbent pillow on the surface, allow to soak and remove. Repeat this process until the oil layer is removed. Alternatively, have the oil layer pumped out by a licensed disposal contractor and appropriately disposed of. The oil absorbent pillows must be drummed for disposal by a licensed disposal contractor.

*Area Drains* - Remove the cover from the area drain and empty debris/sediment from geotextile filter bag. Replace filter bag as needed. Visually inspect for structural damage. Using a wooden pole, probe the sump to determine the depth of sediment. Accumulation greater than 6" indicates clean-out. Take care as to not damage the structure. The grate and filter bag should be inspected on a quarterly basis and cleaning of the area drain sump should be done on a yearly basis.

*Drain Manholes* - Remove the cover and visually inspect for corrosion and structural damage. Inspect pipe inlets and bottoms for signs of infiltration or inflow. The drain manhole should be inspected on a quarterly basis during the first year and semi-annual thereafter.

*First Defense Stormwater Treatment Device* – A copy of the manufacturer's Operation & Maintenance Manual is provided at the end of this section which contains the required operation and maintenance procedures for the treatment devices. The devices should be inspected for corrosion and structural damage on a quarterly basis during the first year and semi-annually thereafter. The device also should be cleaned on a yearly basis and in accordance with the manufacturer's procedural recommendations.

2) Snow Storage Area – The City of Beverly is responsible for snow removal within the police department parking lot including parking spaces adjacent to ATM building. Snow storage areas are located on the northeast and southeast sides of the property within the lawn areas. Snow shall not be cast into Elliott Street or within the Cummings Center parking lot. Debris from melted snow shall be cleared from the site and properly disposed of at the end of the snow season or no later than May 15th.

3) Fertilizer, Herbicide, & Pesticide – The following City of Beverly restrictions shall apply if these chemicals are to be used:

- Fertilizers utilized for landscaping and lawn care shall be slow released, low-nitrogen type (<5%) and phosphorous free, and shall not be sued within 25-ft of a wetland resource area.
- Pesticides, fungicides, and herbicides shall not be sued within 100-ft of wetland resource area.

## BEVERLY POLICE STATION – 175 ELLIOTT STREET, BEVERLY, MA

## CONSTRUCTION PHASE MAINTENANCE INSPECTION FORM

Inspections/reports must be completed at least once every 7 calendar days AND within 24 hours following a rainfall event of 0.50 inches or greater.

**Inspection Type:** ☐ **Routine (every 7 calendar days)**
☐ **Routine (within 24 hours of 0.50 inches or greater of rainfall)**

**Date of Inspection:** _____

**Weather/Storm Event Information:**

Storm Start Time: _____

Storm Duration: _____

Time Elapsed Since Last Storm: _____

Approximate Amount of Rainfall (inches): _____

Weather Conditions during site inspection: _____

**Site Notes:**

_____

_____

_____

_____

_____

_____

_____

_____

_____

## CONSTRUCTION PHASE INSPECTION FORM

| BMP Inspection Areas | Satisfactory | Unsatisfactory | Comments/Corrective Action Required |
|---|---|---|---|
| Construction Entrance/Exit | | | |
| Street Entrance Condition | | | |
| Silt Fence, Haybales, and/or Straw Wattles Condition | | | |
| Construction laydown area | | | |
| Catch basin inlet protection (ADS Flexstorm Inlet Filter) | | | |
| Material Storage Areas | | | |
| Waste Storage Areas | | | |
| Concrete Washout | | | |
| Temporary Sedimentation Trap (if Applicable) | | | |
| Drainage Swale with Checkdams (if Applicable) | | | |
| Dust | | | |
| Housekeeping / Trash | | | |
| Other Necessary Controls: | | | |
| | | | |
| | | | |

Description of any discharges occurring at the time of inspection

## BEVERLY POLICE STATION – 175 ELLIOTT STREET, BEVERLY, MA

## POST-CONSTRUCTION MAINTENANCE INSPECTION FORM

Inspections/reports must be completed quarterly for the first year of operation. Inspection frequency can be reduced after the first year to annual inspections provided that the quarterly inspections do not indicate the need for more frequent inspections.

**Inspection Type:** ☐ **Quarterly Inspection**
☐ **Annually Inspection**
☐ **Emergency Inspection (i.e. Ponding, Flooding, and/or Severe Erosion)**

**Date of Inspection:** _____

**Weather Conditions during site inspection:** _____

**Site Notes:**

_____

_____

_____

_____

_____

_____

_____

_____

_____

## POST-CONSTRUCTION INSPECTION FORM

| BMP Inspection Areas | Satisfactory | Unsatisfactory | Comments/Corrective Action Required |
|---|---|---|---|
| Catch Basins (PCB2, PCB7A, PCB7B, & PCB8) | | | |
| Drain Manholes (PDMH7, PDMH8, & PDMH9) | | | |
| Area Drains (AD1, AD2, & AD3) | | | |
| Water Quality Structure (WQS1 & WQS2) – First Defense Stormwater Treatment Device | | | |
| Trench Drain | | | |
| Housekeeping / Trash | | | |
| | | | |
| Other Necessary Controls | | | |
| | | | |
| | | | |
| | | | |

Description of any discharges occurring at the time of inspection

Certification Statement must be signed for each inspection report:

**Certification Statement:**

I certify that I personally conducted this inspection and that I personally prepared this inspection report noting the deficiencies, if any, in BMP's and the corrective actions taken. I certify that the information in this report is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including fines and imprisonment for knowing violations.

Name of Inspector: _____
Title of Inspector: _____
Qualifications of Inspector: _____

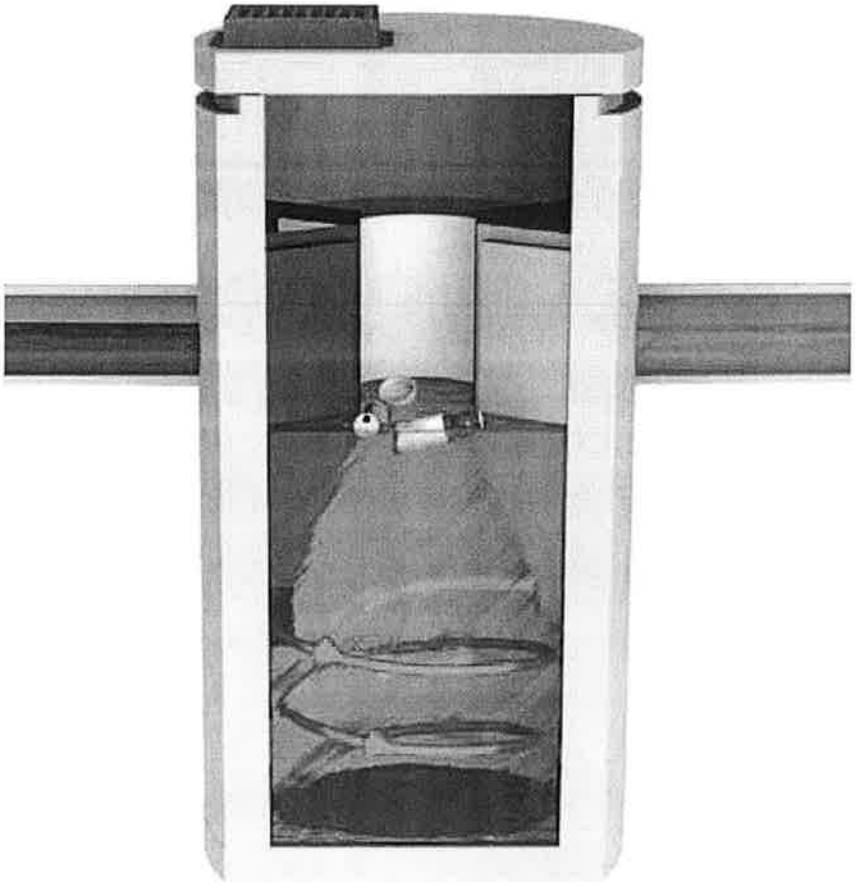
_____
Signature of Inspector

# OPERATION & MAINTENANCE PLAN SCHEDULE

Project: Beverly Police Station - 175 Elliott St
Project Address: 175 Elliott Street, Beverly, MA
Date: 8/7/2019
Party Responsible: City of Beverly
Annual Maint. Budget: $4,350

| Task | Description/Schedule | Maintenance Activity | Est. Annual Maint. Cost | Inspection | |
|---|---|---|---|---|---|
| | | | | Date: | Inspector: |
| Street Sweeping | Perform sweeping of paved parking areas and walkways after spring thaw to remove any traction sand applied during the winter months. Also, perform sweeping during late fall to remove any leaf litter and debris. | Sweep, power broom, or vacuum paved parking lots and walkways | $1,000 | | |
| | | | | | |
| Catchbasins & Drain Manholes | Inspect grates, covers, and hoods quarterly for the first year and semi-annual thereafter. Also, inspect pipe inlets and precast structures for infiltration and inflow. | Vacuum Deep Sump Annually | $1,750 | | |
| | | | | | |
| First Defense Water Quality Treatment Devices | Inspect covers, inlets, and plastic insert quarterly for the first year and semi-annual thereafter. Clean yearly per Manufacturers' recommendations | Vacuum Deep Sump Annually | $700 | | |
| | | | | | |
| Area Drains & Trench Drain | Inspect grates and replaceable filter bags are to be inspected monthly during the first year and quarterly thereafter. Also, inspect pipe inlets and structures for infiltration and inflow. | None unless Insp. Warrants Otherwise | $400 | | |
| | | | | | |
| Snow Storage Area(s) | Debris from melted snow shall be cleaned form the site and properly disposed of at the end of the snow season (by May 15th). | Clean Annually | $500 | | |

Hydro International



# Operation and Maintenance Manual

## First® Defense

Vortex Separator for Stormwater Treatment

Stormwater Solutions

Turning Water Around ...®

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**DISCLAIMER:** Information and data contained in this manual is exclusively for the purpose of assisting in the operation and maintenance of Hydro International plc's First Defense®. No warranty is given nor can liability be accepted for use of this information for any other purpose. Hydro International plc has a policy of continuous product development and reserves the right to amend specifications without notice.

**Hydro International** (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

# First Defense® by Hydro International

Capturing more than 25 years of separation design experience, the First Defense® is Hydro International's latest addition to its family of hydrodynamic vortex separators intended for stormwater applications. It has been developed with ease of installation and maintenance at the forefront without sacrificing performance or design flexibility.

All internal components are housed in either a 4-ft or 6-ft diameter precast manhole that is designed to withstand traffic loads. Each model can be used as a catch basin inlet or standard manhole with solid cover so that runoff can enter from an overhead grate, inlet pipe or both without diminishing performance.

The First Defense® has internal components that are designed to generate rotational flow within the device without requiring a tangential inlet. Flow within the precast chamber is controlled to prevent turbulence and its unique reverse-flow outlet intake ensures a longer retention time by preventing short-circuiting. An internal bypass prevents high flow re-suspension and washout and eliminates the need for additional bypass structures. The internals can easily be adjusted to change the angle between the inlet and outlet for storm drain directional changes and dual inlets can be accomodated in most cases. This simplifies grading and site design so that flow can be conveyed from isolated locations within the same site without increasing the number of structures.

For removal of fine sediment and associated pollutants, oil spills, trash and debris, the first choice in stormwater treatment systems is the First Defense®.

## First Defense® Components

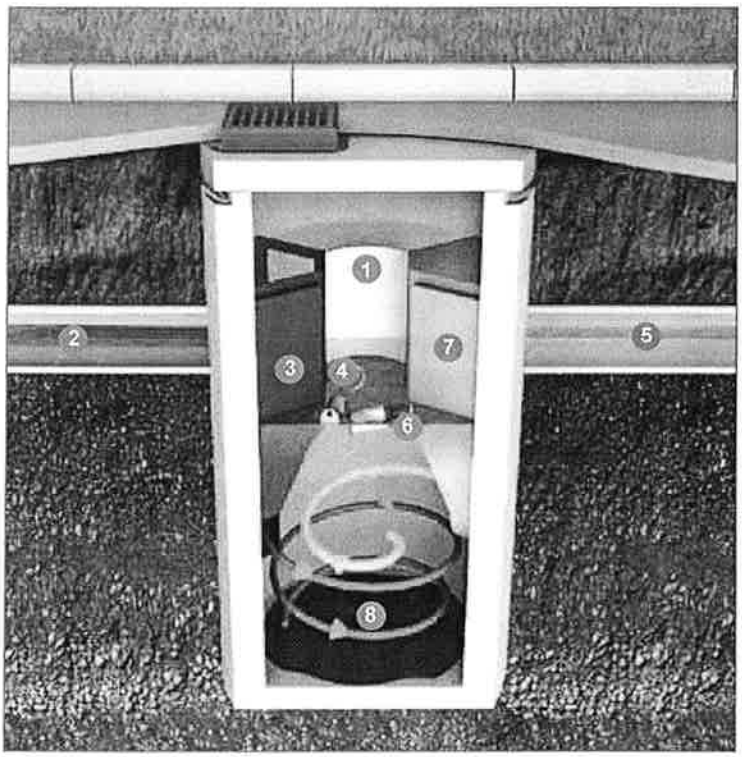
1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port (not pictured)**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Outlet Chute**
8. **Sediment Storage**

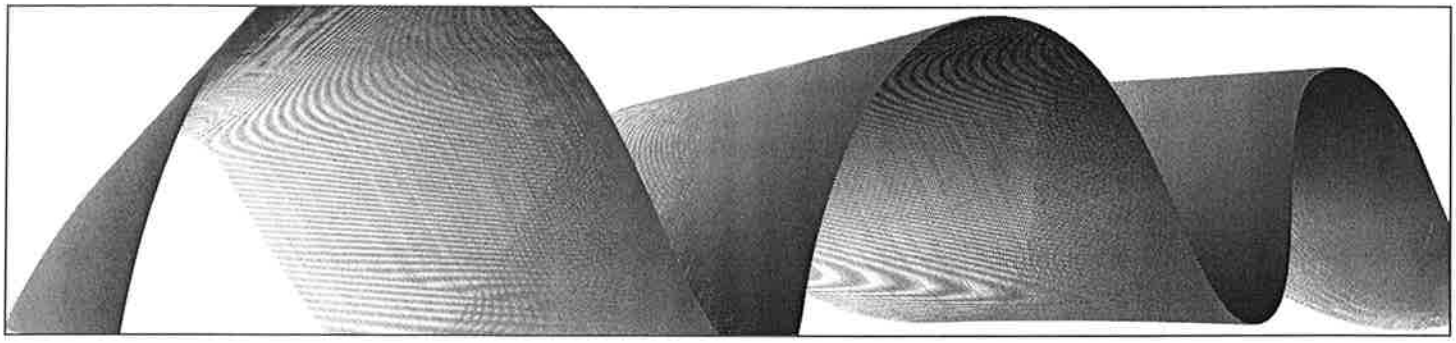
## Benefits of the First Defense®

- Compact and flexible design
  - Can be used as a catch basin inlet and directional change manhole
  - Optional one or two inlets
  - Does not require a bypass structure
- Hydrodynamic Vortex Separation
  - Extended and structured flow path
  - Minimal headloss
  - Reduces turbulence and re-suspension
  - Reverse-flow outlet intake prevents short-circuiting
  - Improved efficiency for all flows
- Delivered Pre-assembled for easy and fast installation
- Simple to inspect and maintain
- Independently verified

## Applications

- New developments and retrofits
- Utility yards
- Streets and roadways
- Parking lots
- Pre-treatment for filters, infiltration and storage
- Industrial and commercial facilities
- Wetlands protection





# Operation

## Introduction

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

## Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume. The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow internally-bypassed storm events. Accessories such as oil absorbant pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

## Wet Sump

The sump of the First Defense® retains a standing water level between storm events. The water in the sump prevents stored sediment from solidifying in the base of the unit. The clean-out procedure becomes more difficult and labor intensive if the system allows fine sediment to dry-out and consolidate. Dried sediment must be manually removed by maintenance crews. This is a labor intensive operation in a hazardous environment.

# Maintenance

## Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

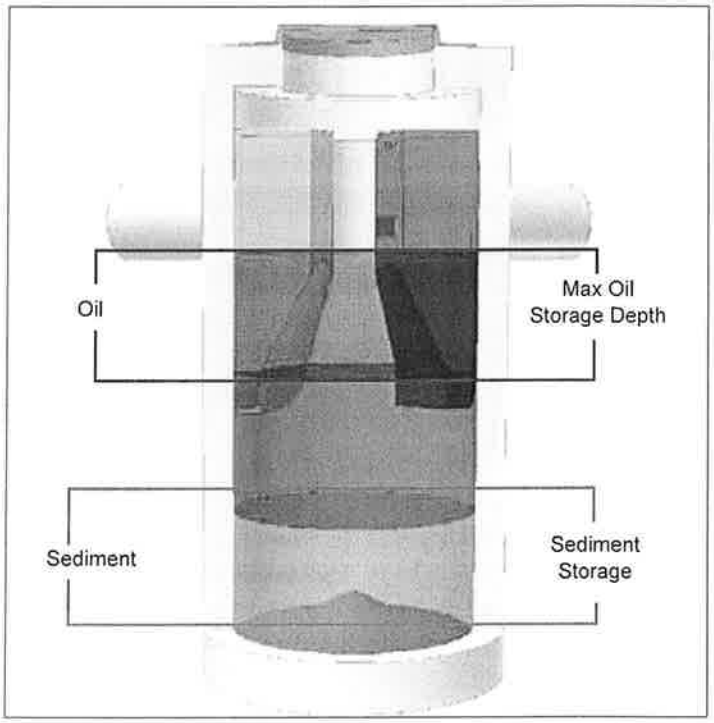



*Fig.1 Pollutant storage volumes in the First Defense®.*

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

## Determining Your Maintenance Schedule

The frequency of cleanout is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil/flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 800 gallons.

## Inspection

Inspection is a simple process that does not involve entry into the First Defense®. Maintenance crews should be familiar with the First Defense® and its components prior to inspection.

### *Scheduling*

- It is important to inspect your First Defense® every six months during the first year of operation to determine your site-specific rate of pollutant accumulation.
- Typically, inspection may be conducted during any season of the year.

### *Recommended Equipment*

- Safety Equipment and Personal Protective Equipment (traffic cones, work gloves, etc.)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net
- Sediment probe (such as a Sludge Judge®)
- Trash bag for removed floatables
- First Defense® Maintenance Log

Table 1. First Defense® Pollutant Storage Capacities and Maximum Cleanout Depths

| Unit Diameter | Total Oil Storage | Oil Clean-out Depth | Total Sediment Storage | Sediment Clean-out Depth | Max. Liquid Volume Removed |
|---|---|---|---|---|---|
| (ft) | (gal) | (in) | (gal) | (in) | (gal) |
| 4 | 180 | <23.5 | 202 | 26 | 202-342 |
| 6 | 420 | <23.5 | 626 | 36 | 626-1,046 |

**NOTE**

The total volume removed will depend on the oil accumulation level. Oil accumulation is typically much less than sediment, however removal of oil and sediment during the same service is recommended.

*Inspection Procedures*

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.2 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the outer annulus of the chamber.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

## Floatables and Sediment Cleanout

Floatables cleanout is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.2).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

*Scheduling*

- Floatables and sump cleanout are typically conducted once a year during any season.

- Floatables and sump cleanout should occur as soon as possible following a spill in the contributing drainage area.

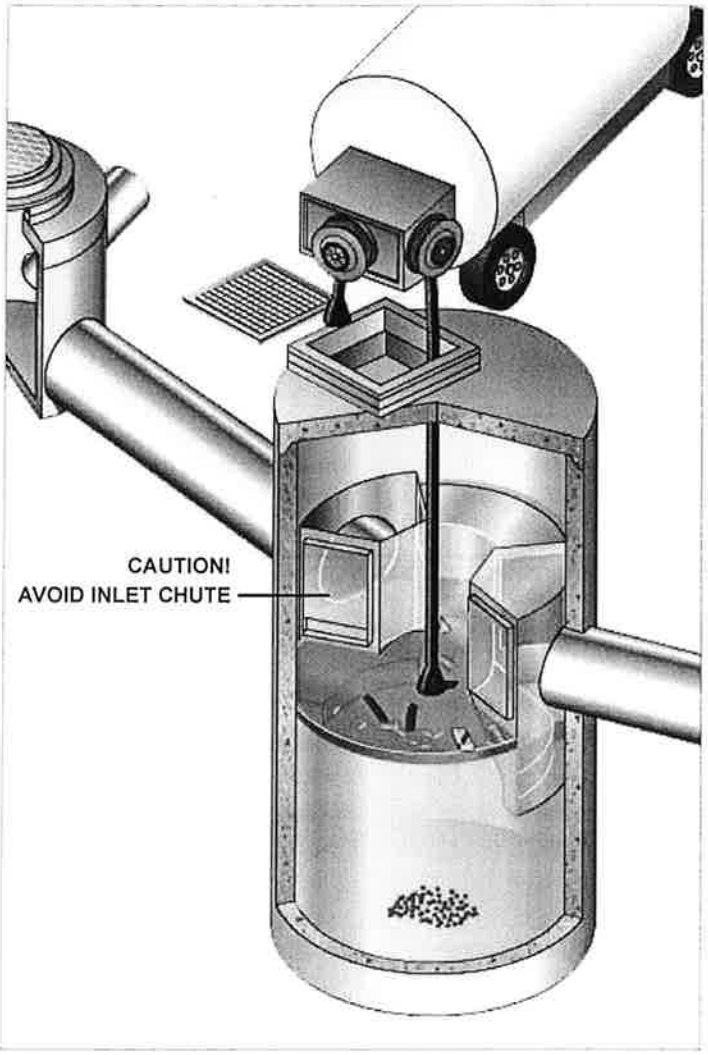



*Fig.2 Floatables are removed with a vactor hose.*

*Recommended Equipment*

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

*Floatables and sediment Clean Out Procedures*

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.2) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.3).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

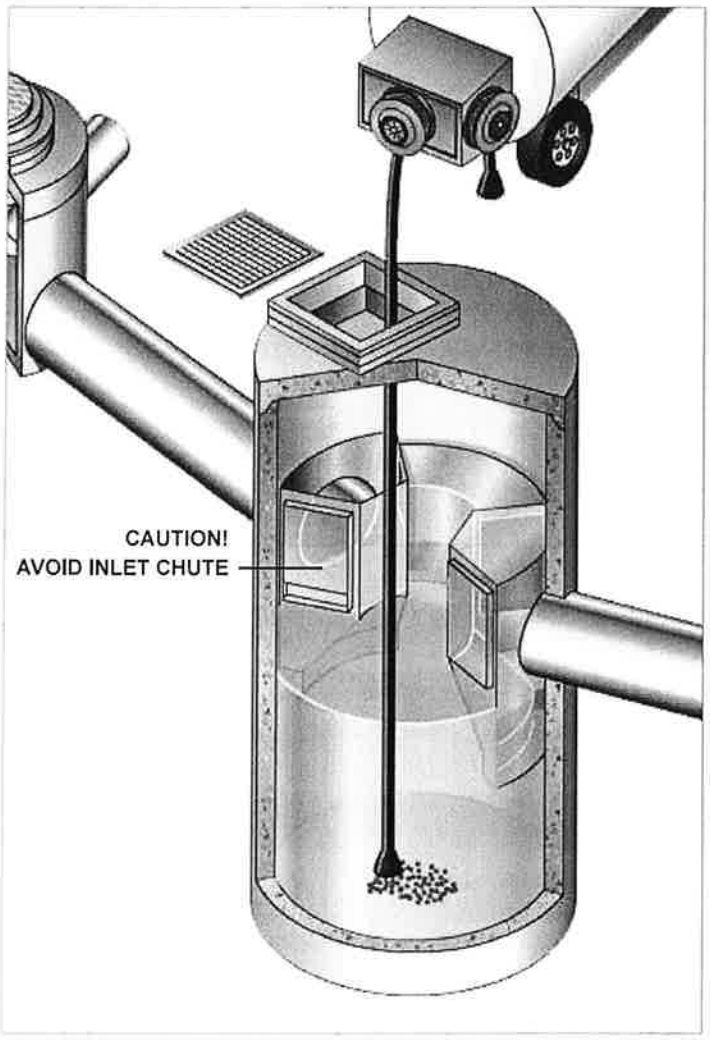



*Fig.3 Sediment is removed with a vactor hose*

# Maintenance at a Glance

| Activity | Frequency |
|---|---|
| Inspection | - Regularly during first year of installation<br>- Every 6 months after the first year of installation |
| Oil and Floatables Removal | - Once per year, with sediment removal<br>- Following a spill in the drainage area |
| Sediment Removal | - Once per year or as needed<br>- Following a spill in the drainage area |
| NOTE: For most cleanouts it is not necessary to remove the entire volume of liquid in the vessel. Only removing the first few inches of oils/floatables and the sediment storage volume is required. | |

# First Defense® Installation Log

| | |
|---|---|
| HYDRO INTERNATIONAL REFERENCE NUMBER: | |
| SITE NAME: | |
| SITE LOCATION: | |
| OWNER: | CONTRACTOR: |
| CONTACT NAME: | CONTACT NAME: |
| COMPANY NAME: | COMPANY NAME: |
| ADDRESS: | ADDRESS: |
| TELEPHONE: | TELEPHONE: |
| FAX: | FAX: |

**INSTALLATION DATE:** / /

**MODEL SIZE (CIRCLE ONE):** **4-FT** **6-FT**

**INLET (CIRCLE ALL THAT APPLY):** **GRATE INLET (CATCH BASIN)** **INLET PIPE (FLOW THROUGH)**

**Hydro International** (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Hydro International®

# First Defense® Inspection and Maintenance Log

| Date | Initials | Depth of Floatables and Oils | Sediment Depth Measured | Volume of Sediment Removed | Site Activity and Comments |
|---|---|---|---|---|---|
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**Hydro International** (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

# FLEXSTORM OPERATION AND MAINTENANCE PLAN

FLEXSTORM INLET FILTERS™

## OPERATION & MAINTENANCE PLAN

Installation Instructions:

1. Remove grate from the drainage structure
2. Clean stone and dirt from ledge (lip) of drainage structure
3. Drop the FLEXSTORM inlet filter through the clear opening such that the hangers rest firmly on the lip of the structure.
4. Replace the grate and confirm it is not elevated more than 1/8", the thickness of the steel hangers.

**Frequency of Inspections:**

1. Inspection should occur following any rain event >½".
2. Post construction inspections should occur 4 times per year. In snowfall affected regions additional inspections should take place before and after snowfall season.
3. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than 3 times/year.

**Maintenance Guidelines:**

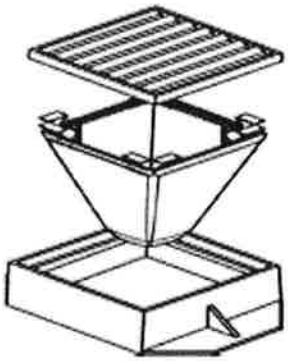
1. Empty the sediment bag if more than half filled with sediment and debris, or as directed.
2. Remove the grate, engage the lifting bars with the FLEXSTORM Removal Tool, and lift from drainage structure.
3. Dispose of sediment or debris as directed by the Engineer or Maintenance contract.
4. An industrial vacuum can be used to collect sediment.
5. Remove caked on silt from sediment bag and flush with Medium spray with optimal filtration.
6. Replace bag if torn or punctured to >½" diameter on lower half of bag.

**Post Construction PC Bag Maintenance:**

1. At 50% saturation the average 2'x2' Adsorb-it lined PC filter will retain approximately 75 oz (4.2 lbs) of oil and should be serviced. To recover the oils the filter can be centrifuged or passed through a wringer.
2. Oil skimmer pouches start to turn black when saturated, indicating time for replacement. Each ClearTec Rubberizer pouch will absorb ~62oz (4 lbs) of oil before needing replacement.
3. Dispose of all oil contaminated products in accordance with EPA guidelines. ClearTec Rubberizer, since a solidifier, will not leach under pressure and can be disposed of in most landfills, recycled for industrial applications, or burned as fuel.

**Sediment Bag Replacement:**

1. Remove the bag by loosening or cutting off clamping bag.
2. Take new sediment bag and secure worm drive clamping band to the frame channel.
3. Ensure Bag is secure and there is no slack around perimeter.



**STRUCTURE ID#/LOCATION:**

| DATE | TASK PERFORMED | INSPECTOR |
|---|---|---|
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# ATTACHMENT E

# ILLICIT DISCHARGE STATEMENT

# ILLICIT DISCHARGE COMPLIANCE STATEMENT

I verify that no illicit discharges exist on the site and through the implementation of a pollution prevention plan measures are set forth to prevent illicit discharges from entering the stormwater management system.

| Signature | Print Name | Date |
|---|---|---|
| Title | Company | |
| Signature | Print Name | Date |
| Title | Company | |
| Signature | Print Name | Date |
| Title | Company | |

# ATTACHMENT F

# PROPRIETARY SEPARATOR THIRD-PARTY EVALUATIONS

Hydro International stormwater

stormwater

www.hydro-international.biz

# First Defense® Performance Evaluation

For submission to the Massachusetts Stormwater Technology Evaluation Project (MASTEP)
Stormwater Technology Clearinghouse

February, 2011

# First Defense® Performance Evaluation

## Summary

Hydro International successfully completed First Defense® laboratory testing to assess washout retention and SSC/TSS removal efficiency. Test procedures were based on NJDEP and WI DNR protocols. Performance evaluation included varying flow rates up to 200% of the Maximum Treatment Flow Rate (MTFR) and varying influent concentrations using OK-110 silica sand, with 50% pre-loaded sediment sump.

Positive removals were achieved for all flows and concentrations, with greater than 70% SSC/TSS efficiency based on the NJDEP weighted removal efficiency calculation method. Non-detectable (<4 mg/L) SSC and TSS effluent concentrations and over 90% sediment retention indicated that no detectable washout had occurred.

These findings indicate that washout would be minimal even with a larger MTFR or a shallower sump design. Alternatively, it is reasonable to expect that finer particle sizes with lower settling velocities would be retained and not washed out at the tested flow rates.

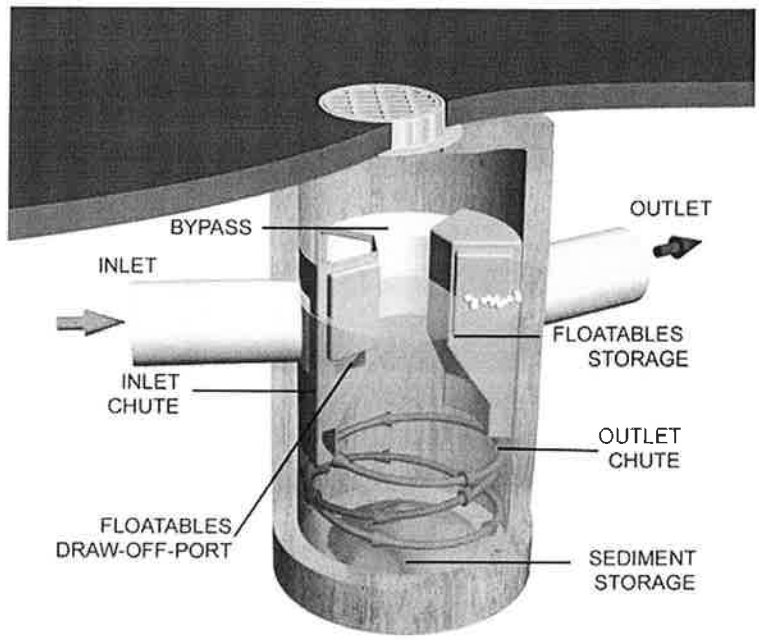


**Figure 1: First Defense® - Internal components and flow path**

© 2011 Hydro International Performance Evaluation – First Defense®

## Introduction

The First Defense® is an enhanced vortex separator designed to remove floating and settleable pollutants commonly found in stormwater runoff. A key feature of the First Defense is an internal Bypass Chute (Figure 1) that allows treatment without requiring additional flow-diversion structures and prevents scour velocities from re-suspending captured pollutants. The MTFRs are 0.7 cfs and 2.2 cfs for the 4-ft and 6-ft diameter models, respectively. Internal weirs are set to ensure all flows up to the MTFRs can be treated without bypass. This laboratory-based test program was conducted to evaluate the overall system performance while accounting for variable inlet concentrations and sediment retention over a wide range of loading rates.

## Test Objectives

The First Defense was tested utilizing protocols that met or exceeded the most recent recommendations by testing authorities, including NJDEP and WIDNR. Objectives included:

- Determine the MTFR using washout as the limiting factor.
- Quantify washout at 125% and 200% of the MTFR by measuring the maximum effluent concentration and maximum allowable reduction in sump load.
- Determine the Suspended Sediment Concentration (SSC) and Total Suspended Solids (TSS) removal efficiency for inlet concentrations of 50 mg/L, 100 mg/L, and 200 mg/L at 25%, 50%, 75%, 100%, and 125% of the MTFR, with the sump filled to 50% of the maximum storage volume.
- Determine the weighted removal efficiency based on the calculation method described in the NJDEP protocol for laboratory testing of hydrodynamic sedimentation devices.
- Provide independent witnessing during testing to validate and confirm procedures described and followed in this report.
- Validate TSS and SSC analytics by outsourcing samples to an independent, state-certified laboratory.

In an effort to satisfy regulations that require results reported according to TSS procedures, results of this study included both TSS and SSC analysis. Recent settleable solids performance evaluations are reporting percent removal of SSC with a general consensus that SSC methods can improve the accuracy and repeatability of measurements for samples that have relatively high sediment settling velocities.

## Test System Description

The distribution of the test material, US Silica OK-110, is shown in Figure 2. Approximately 20% of the particles are less than 75 µm with the remaining 80% are between 75 and 150 µm.

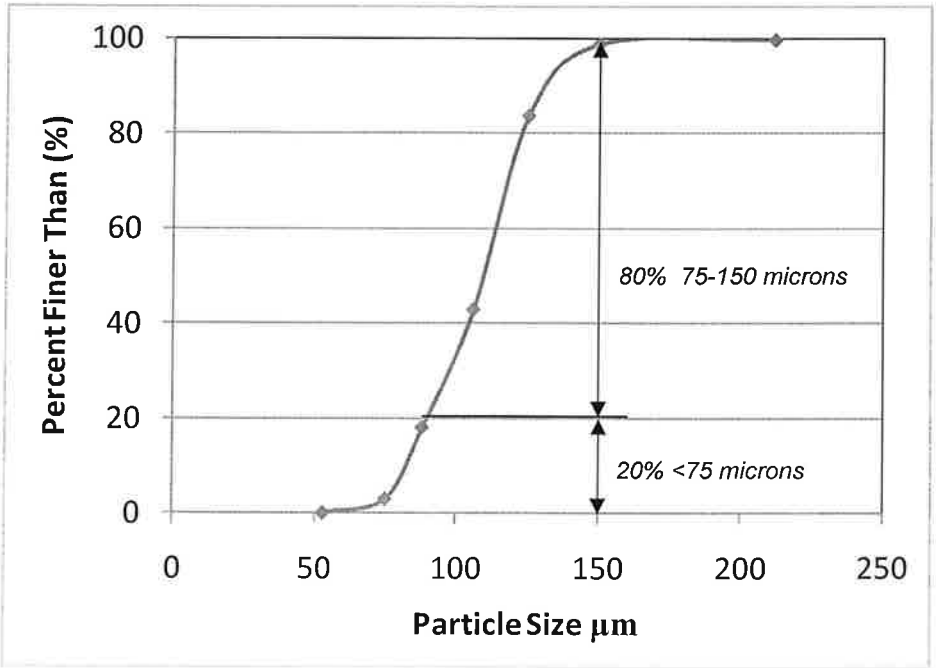


**Figure 2: Test sand particle size gradation (OK-110)**

A full-scale First Defense with 4-ft diameter vortex chamber was tested at Hydro International's state-of-the-art hydraulics laboratory in Portland, ME. Clean water from a 23,000-gallon reservoir was pumped using an 8-inch variable Flygt pump at targeted flow rates through a pipe network to the First Defense (see Figure 3). Dosing equipment delivered a slurry of the OK-110 test material to the First Defense. Grab samples were collected at the inlet sampling point and effluent pipe. Effluent was discharged back into the reservoir.

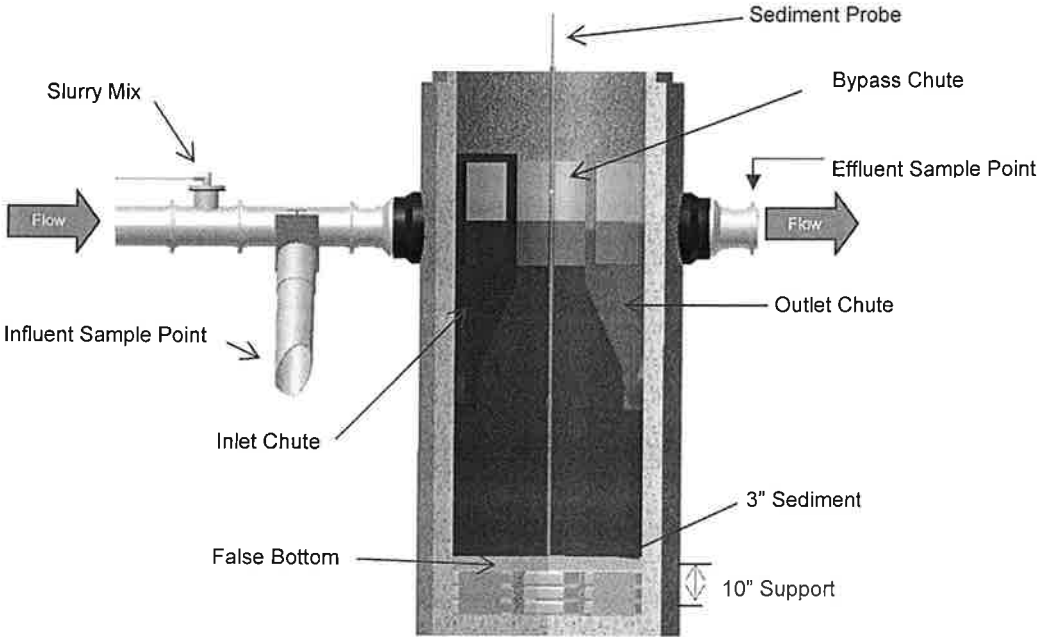


**Figure 3: Cutaway diagram of test setup with false bottom, sediment probe and internal components**

## Washout Test Procedure

The sediment storage sump was pre-loaded to 50% maximum storage volume by depositing greater than three inches of OK-110 on a false floor 10 inches from the sump bottom (Figure 3). The sediment depth was measured with a sediment probe at thirteen locations, evenly spaced over the sump bottom, and averaged to determine initial sediment depth.

Clean water from the reservoir was pumped to the First Defense vortex chamber at the target flow rate of 0.88 cfs for 125% of the MTFR. After the flow had stabilized, water was pumped to the test unit for a period of 15-minutes. At the conclusion of the test period, the sediment depth was re-measured and compared to the initial depth.

After determining that greater than 90% of the pre-loaded volume remained in the sump, washout testing using effluent sampling was initiated. The pump was restarted at the target flow rate of 0.88 cfs, and influent and effluent samples were collected after the flow rate had stabilized. For a test period of 25 minutes, influent and effluent samples were collected at five-minute intervals, resulting in six paired samples, which were analyzed for SSC by ASTM D3977 Method B and TSS by APHA SM2540D. The test was repeated for the flow rate of 1.4 cfs or 200% of the MTFR.

A representative from the University of New Hampshire Stormwater Center observed all of the tests as an independent witness and reviewed data analysis and quality control procedures of the external laboratory used for sample analysis.

## Removal Efficiency Test Procedure

The sediment storage sump was pre-loaded to 50% maximum storage volume by depositing greater than three inches of the test sand on a false floor 10 inches from the sump bottom. Clean water from the reservoir was pumped to the First Defense vortex chamber. The five target flow rates were 25%, 50%, 75%, 100%, and 125% of the MTFR. Background influent and effluent samples were collected to ensure clean water supplied from the reservoir did not exceed non-detect concentrations of 4 mg/L for SSC/TSS.

A slurry mixture dosing system (see Figure 4) was used to obtain the variable influent concentrations of 50 mg/L, 100 mg/L and 200 mg/L for the target flow rates. The required mass of test sand was mixed with clean water in a 60-gallon barrel to form the slurry, which was continually stirred to keep the mixture in suspension. The slurry was pumped at a constant rate from the mixing barrel to a dosing port located upstream of the First Defense using a peristaltic pump. The first influent sample was collected after displacing three test volumes, or three residence times within the vessel. Four additional influent samples were collected at one-minute intervals.

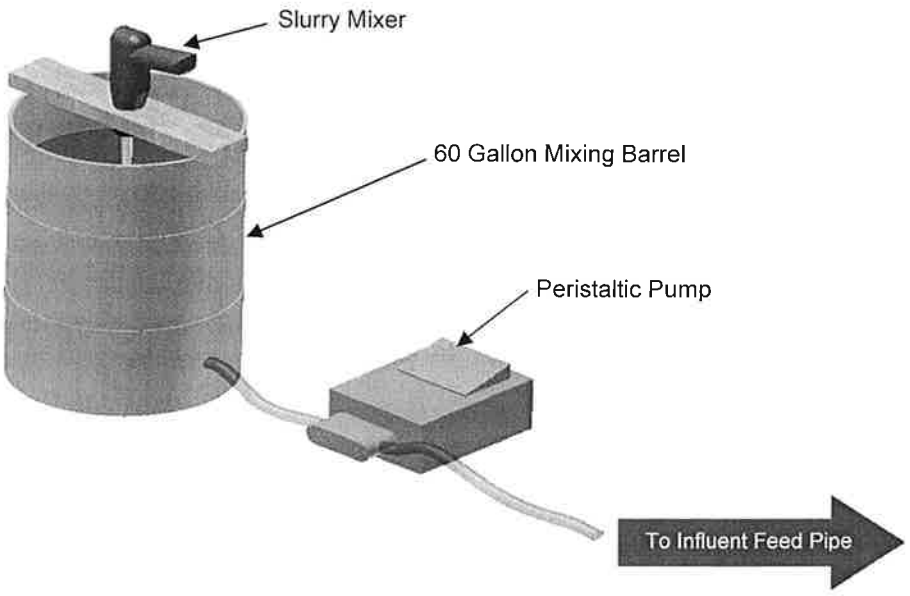


**Figure 4: Slurry Mixture Dosing System**

The first effluent sample was collected one residence time after collection of the first influent sample. Four additional effluent samples were collected at the same time interval, for a total of five repeats. The test was repeated for three influent concentrations at five flow rates, for a total of 150 influent and effluent samples collected for 15 test runs.

Dosing was ceased after collection of the last effluent sample. Another set of influent and effluent background samples was collected one residence time after the peristaltic pump had stopped and sediment was no longer entering the system. The influent and effluent samples were analyzed for SSC by ASTM D3977 Method B and TSS by APHA SM2540D.

A representative from the University of New Hampshire Stormwater Center observed 20% of the tests as an independent witness and reviewed data analysis and quality control procedures of the external laboratory used for sample analysis. Twenty percent of the SSC samples for the removal efficiency testing were analyzed by an external laboratory and all TSS samples were analyzed by an external laboratory.

## Washout Test Results and Discussion

The ability of the First Defense to retain sediment solids was evaluated in two ways:

1. Measure the reduction in the sediment sump level prior to and following testing at operating rates of 125% and 200% of the MTFR with the sump 50% pre-loaded, and

2. Measure the effluent concentrations with the sump 50% pre-loaded with sediment at operating rates 125% and 200% of the MTFR.

The goal of the first part of the washout testing was to demonstrate that less than 10% of the sediment was reduced (i.e. show greater than 90% of the sediment was retained). Sediment depths were determined by averaging the depth measurements taken from 13 sampling locations within the sump. Sampling locations were replicated for each flow rate with the intent of monitoring changes in depths throughout the sump. Although the initial sediment depth was approximately three inches as measured from the false floor, additional sediment was deposited throughout the test program resulting in sediment depths greater than three inches. However, for both flow rate tests, the difference in average sediment depth prior to and following testing remained the same and all measurements were greater than three inches.

The goal of the second part of the test was to demonstrate that effluent concentrations did not exceed 10 mg/L at operating rates of 125% and 200% of the MTFR. As seen in Table 1, at 50% of the sediment capacity, the effluent concentrations were below the analytical detention limit of 4 mg/L for both TSS and SSC for flow rates of 125% and 200% of the MTFR.

**Table 1: Washout test results for First Defense® at 125% and 200% MTFR**

| Percent of MTFR | Influent Flow (cfs) | Effluent EMC (mg/L) | |
|---|---|---|---|
| | | SSC | TSS |
| 125 | 0.88 | Non detect | Non detect |
| 200 | 1.4 | Non detect | Non detect |

Overall, the First Defense met or exceeded the test requirements to show no measurable effluent TSS or SSC concentrations, as well as retaining greater than 90% of the pre-loaded sediment, at both 125% and 200% of the MTFR.

## Removal Efficiency Test Results and Discussion

Removal efficiency data was based on a total of 150 influent and effluent samples collected from 15 test runs at five target flow rates and three target inlet concentrations. Each test run included five influent and effluent samples that were averaged to determine the test run "event mean concentrations" (EMC) and resulting removal efficiencies for SSC and TSS. All tests were run with sediment pre-loaded to 50% of the sump volume.

**Table 2: First Defense Performance Test Results - Test Sand OK-110**

| Test Run | Percent of MTFR | Target Flow (cfs) | Target EMC (mg/L) | EMC (mg/L) | | | | % Removal Efficiency | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Influent | | Effluent | | | |
| | | | | SSC | TSS | SSC | TSS | (SSC) | (TSS) |
| 1 | 25 | 0.18 | 50 | 43 | 20 | 2.7 | 0 | 94 | 100 |
| 2 | 25 | 0.18 | 100 | 103 | 49 | 6.2 | 0 | 94 | 100 |
| 3 | 25 | 0.18 | 200 | 216 | 114 | 7.8 | 10 | 96 | 91 |
| 4 | 50 | 0.35 | 50 | 55 | 33 | 11 | 6 | 80 | 82 |
| 5 | 50 | 0.35 | 100 | 107 | 52 | 28 | 14 | 74 | 73 |
| 6 | 50 | 0.35 | 200 | 232 | 98 | 50 | 29 | 78 | 70 |
| 7 | 75 | 0.53 | 50 | 47 | 25 | 23 | 11 | 52 | 56 |
| 8 | 75 | 0.53 | 100 | 105 | 57 | 37 | 26 | 65 | 54 |
| 9 | 75 | 0.53 | 200 | 192 | 126 | 81 | 41 | 58 | 67 |
| 10 | 100 | 0.71 | 50 | 62 | 37 | 28 | 15 | 55 | 59 |
| 11 | 100 | 0.71 | 100 | 123 | 67 | 58 | 33 | 53 | 51 |
| 12 | 100 | 0.71 | 200 | 196 | 111 | 107 | 54 | 45 | 51 |
| 13 | 125 | 0.88 | 50 | 39 | 16 | 21 | 13 | 44 | 19 |
| 14 | 125 | 0.88 | 100 | 112 | 50 | 66 | 36 | 41 | 28 |
| 15 | 125 | 0.88 | 200 | 190 | 104 | 99 | 58 | 48 | 44 |

***Note: All TSS samples analyzed by external state-certified laboratory.***

The results from all SSC and TSS test runs with the sump volume greater than 50% full are shown in Table 2. Target flow rates ranged from 25% of the MTFR (0.18 cfs) to 125% of the MTFR (0.88 cfs) and target influent EMC concentrations ranged from 50 mg/L to 200 mg/L. Consistent with flow-based separation systems, the results indicate that system performance was dependent on flow rate, with higher removal efficiencies achieved at lower flow rates. In general, the discrete removal efficiencies for the 15 test runs remained positive for flow rates up to 125% of the MTFR, at which point bypass would be occurring. This demonstrates better control over the tested loading rates than conventional gravity-based separators with internal bypass.

All samples were included in calculating the removal rates, as there were no observed outliers. Minimal variation was measured between the SSC target influent concentration and the measured SSC concentrations. Measured influent TSS concentrations were approximately 50% lower than the target EMC. However, lower TSS measurements are expected for particles having high settling velocities due to the TSS analytical method, and both the TSS influent and effluent measurements were consistent with this trend. As a result, the variation of TSS influent concentration relative to the target EMC did not have a significant effect on removal efficiencies.

The annual system performance was calculated using the NJDEP method for weighting removal efficiency data. The results in Table 3 show that the First Defense will achieve approximately 70% removal of SSC/TSS based on the NJDEP weighted removal efficiency calculation.

**Table 3: First Defense NJ DEP Weighted Removal Efficiency**

| % MTFR | Target Flow (cfs) | NJDEP Weight Factor | Average Removal Efficiency | | Weighted Removal Efficiency | |
|---|---|---|---|---|---|---|
| | | | SSC | TSS | SSC | TSS |
| 25 | 0.18 | 0.25 | 95% | 94% | 24% | 23% |
| 50 | 0.35 | 0.30 | 77% | 79% | 23% | 24% |
| 75 | 0.53 | 0.20 | 58% | 63% | 12% | 13% |
| 100 | 0.71 | 0.15 | 51% | 47% | 8% | 7% |
| 125 | 0.88 | 0.10 | 44% | 32% | 4% | 3% |
| | | | | **Treatment Efficiency =** | **71%** | **70%** |

## Washout Testing Conclusions

The washout test results showed no measurable washout from the First Defense when 50% of the sump was pre-loaded with OK-110 at flow rates of 125% and 200% of the MTFR. Additionally, washout test results showed sediment retention greater than 90% of the pre-loaded sediment for both 125% and 200% of the MTFR.

Washout testing results also met the NJDEP protocol requirement of less than 10 mg/L effluent concentration for both 125% and 200% of the MTFR. In conclusion, the First Defense met or exceeded the test requirements to show no measurable effluent TSS or SSC levels. This implies that a larger MTFR or a shallower sump is possible. Alternatively, it is reasonable to expect that finer particle sizes with lower settling velocities are likely to be retained and not washed out at the tested flow rates.

## Removal Efficiency Testing Conclusions

Removal efficiency results from 15 test runs, operating within a flow range of 0.18 – 0.88 cfs showed good correlation between flow rate and removal efficiency for both SSC and TSS. In general, removal efficiencies were independent of the inlet concentrations, which ranged from 50 to 200 mg/L. The NJDEP weighted TSS/SSC removal efficiency calculation showed that overall performance was 70% for the First Defense with sediment pre-loaded in the sump to reduce the sump volume by 50%.