

Storm Water Management Analysis & Design

I. Project Description

The proposed project is to construct a single family house including driveway and utilities on lot with total area of 4957 sq. ft or 0.114 Ac.

On site soil test, performed by Bibba Brothers, indicates the soil is sandy-gravel with percolation rate better than 2.0 min/in. The depth of test pit reaches 144 inches (12 ft) with no ground water. Bottom of test pit elevation is about 93.0



II. Drainage Analysis

A. Method Used For Storm Runoff Analysis

Rational Formula: $Q = CiA$, shall be used for the storm runoff analysis. Where

Q = Runoff Peak Rate, cfs; C = Runoff Coefficient,

i = Rainfall Intensity, in/hr. A : Area, Acre

For Runoff Total Volume, $V_R = CiAt$; t is time of storm duration, Hr.

D. Required Runoff Control

Based on Belmont Requirement, all runoff from proposed impervious area shall be controlled on site for 24-hr 100-year storm, if the site is capable

$$\text{Total Runoff Volume Need to Be Control} = 0.9 \times 1852 \times 8.57 \times \frac{1}{12} = 1190.4 \text{ ft}^3$$

E. Control Facility Selection

1. 3' x 3' and 3' deep small leaching pit with 2' thickness crushed stone around and under it provides



$$\text{Pit Storage Volume} = 3 \times 3 \times 3 \times \frac{\pi}{4} = 21.2 \text{ ft}^3/\text{Ea}$$

$$\text{Stone Void Storage Volume} = 2 \times 7.5 \times 7.5 \times \frac{\pi}{4} \times 0.35 \text{ (bottom)}$$

$$+ (7.5 \times 7.5 - 3.5 \times 3.5) \frac{\pi}{4} \times 3 \times 0.35 \text{ (side)}$$

$$= 30.9 + 36.3 = 67.2 \text{ ft}^3/\text{Ea}$$

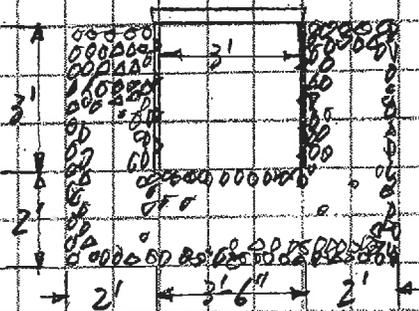
$$\text{Total storage volume} = 67.2 + 21.2 = 88.4 \text{ ft}^3/\text{Ea}$$

Volume of water exfiltration into ground at 24-hr

$$\text{duration} = \frac{24}{12} \times \frac{60}{2} \times \frac{1}{2} \text{ (Safety Factor of 2)} \times 44.2 \text{ (bottom area only)}$$

$$= 1326 \text{ ft}^3/\text{Ea}$$

In general, the exfiltration volume per day should be no more than 5 times of storage volume = $5 \times 88.4 = 442 \text{ ft}^3/\text{Ea}$.



Therefore, the total capacity of a 3' ϕ leaching pit with 2 ft thickness crushed stone around and under it should be no more than $6 \times 88.4 = 530.4 \text{ ft}^3/\text{ea}$, not the storage capacity plus exfiltration volume of $88.4 + 1326 = 1414.4 \text{ ft}^3/\text{ea}$.

F. Control Area Analysis

1. Driveway/walkway/wall 510 ft^2

$$\text{Runoff Volume} = 0.9 \times 510 \times \frac{8.57}{12} = 327.8 \text{ ft}^3$$

@ 24 Hr, 100-y storm

2. $\frac{1}{4}$ of the roof 294 ft^2

$$\text{Runoff Volume} = 0.9 \times 294 \times \frac{8.57}{12} = 189.0 \text{ ft}^3$$

@ 24 Hr, 100-y storm

$$\text{Total Runoff Volume} = 327.8 + 189 = 516.8 \text{ ft}^3 < 530.4 \text{ ft}^3$$

Use one 3' ϕ leaching pit to control this total 804 ft^2 impervious area.

3. Rest Roof and patio: Area = 1050 ft^2

$$\text{Runoff Volume} = 0.9 \times 1050 \times \frac{8.57}{12} = 674.9 \text{ ft}^3$$

@ 24 Hr, 100-year storm

It need two pits, therefore, the front only for control the runoff from driveway/walk/wall and may be some grass area.



5. Arrangement

- Use one 3' ϕ leaching pit with 2" thickness crushed stone around and under it to control all runoff from driveway/wall and $\frac{1}{4}$ building roof area.
- Use a trench grate in front of garage to collect runoff from driveway/wall area then discharge to a small pit with sump for solid to settle before discharge to leaching pit.
- Use two 3' ϕ leaching pits to control the $\frac{3}{4}$ roof/patio runoff. A mini-grate shall be used to collect runoff from the 12'x14' patio and some grass area.
- All roof downspouts shall be connected by using 4" ϕ PVC pipe to the two leaching pits.
- The pipe connect driveway trench grate to sump and 3' ϕ leaching pit shall be 6" ϕ HD PVC pipe.

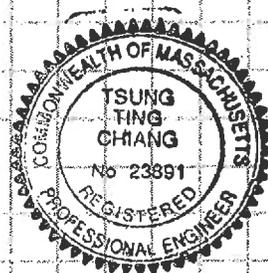
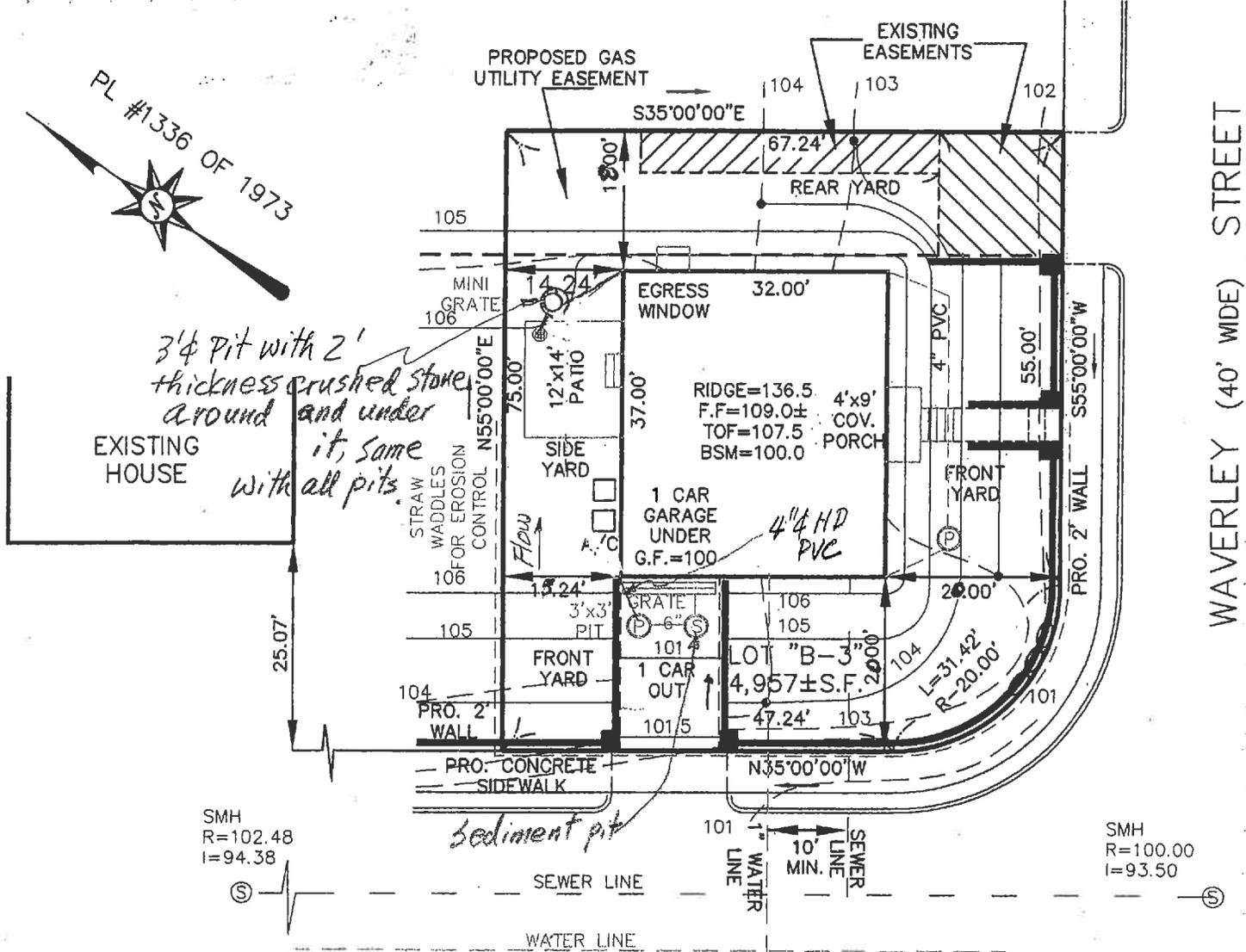
6. Total Impervious Area Controlled at 100-y, 24 hr storm

Area = 1652 ft² and pervious area of 252 ft²

89% total impervious area plus 8% pervious area.



G. Control Facility Arrangement



H. Runoff Peak Rate And Total Runoff Volume Analysis -
With Storm Water Control Facilities

the capacity of control facilities are more than the total runoff from all new impervious area at 24-Hr duration, 100-year storm. Therefore, it is equivalent that the impervious areas are been seperated out of the project site. Thus, the runoff

coefficient at post-development condition with control facilities

$$= \frac{0.3 \times 2853 + 0.9 \times 200}{4957} = 0.209 \quad \text{Project Site} = 4957 \text{ ft}^2 = 0.114 \text{ Ac}$$



Storm Frequen Year	Rainfall Intensity in/Hr	Peak Runoff Rate CFS			Total Runoff Volume ft ³		
		Pre-Develop Condition C=0.30	Post Develop With Control C=0.209	Change increase (decrease)	Pre-Develop Condition C=0.30	Post-Develop With Control C=0.209	Change increase (decrease)
2-year	3.15	0.108	0.075	(0.033)	390.4	263.3	(127.1)
10-year	4.75	0.162	0.113	(0.049)	588.6	397.1	(191.5)
25-year	6.0	0.205	0.143	(0.062)	743.6	501.6	(242.0)
100-year	8.57	0.293	0.204	(0.089)	1062.0	716.4	(345.6)

Runoff from the project site is much less at post-development condition with control facilities than at pre-development condition.



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Checklist for Stormwater Management and Erosion Control Report

B. Report 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 Report. The checklist is also intended to provide the reviewing authority with a summary of the components necessary for a comprehensive Report that addresses the ten Stormwater Standards.

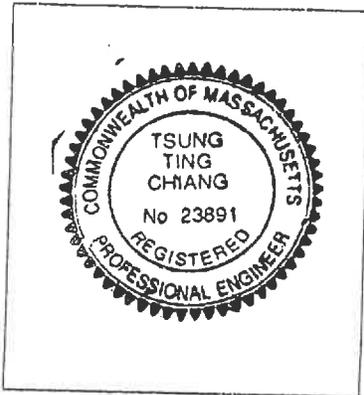
Note: Because stormwater requirements vary from project to project, it is possible that a complete Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not 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 Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Management and Erosion Control Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan, 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



T. T. Chiang 7/29/2015
Signature and Date



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Checklist for Stormwater Management and Erosion Control Report

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

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
- 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): Leaching Facilities

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



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Checklist for Stormwater Management and Erosion Control Report

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

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.
- Any potential change to the existing conditions of abutting properties from any increase in volume of stormwater runoff have been identified in the Report
- The Report provides calculations demonstrating that the post-development discharge volume is equal to or less than the pre-development discharge volume from the 2-year and the 10-year 24-hour storms.
- The Report provides a quantitative impact of discharge volumes from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding result from the discharge volumes from the 100-year 24-hour storms, BMPs also are described in the Report that the applicant will implement and maintained to attenuate these discharges.
- Any potential change to the existing conditions of abutting properties from erosion, silting, flooding, or sedimentation have been identified in the Report.
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent adverse impacts from erosion, silting, flooding, or sedimentation.
- Any potential impacts to wetlands have been identified in the Report.
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent adverse impacts to wetlands.

Additional Requirements for Projects other than One and Two Family Developments:

- Any potential impacts to ground water levels or wells have been identified in the Report, including quantitative projections of changes in the seasonal high water table and quantitative projections of storm-related short-term mounding calculations associated with Infiltration BMPs for a 24-hour 10 year design storm.
- The Report describes the practices and controls that the Applicant will implement and maintain (if required) to prevent adverse impacts to ground water levels or wells for a 24-hour 10 year design storm.

Requirements Specific to Section 34.6.4.1(d)

- Is stormwater from the pre-development site discharged directly to (check all that apply):



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Checklist for Stormwater Management and Erosion Control Report

- A surface water body (specify the water body)
- The Belmont MS4 (storm sewers)
- Another MS4 (specify the MS4)
- Other (specify)
- Will stormwater from the post-development site be discharges directly to (check all that apply):
 - A surface water body (specify the water body)
 - The Belmont MS4 (storm sewers) *only the grass/wooded area runoff*
 - Another MS4 (specify the MS4)
 - Other (specify)
- Any potential impacts upon streams, wetlands and/or storm sewers have been identified in the Report. (Explain in Report narrative)
 - These will be prevented with mitigating measures that the Applicant will implement and maintain (explain in Report narrative)
 - These will be prevented without mitigating measures (explain in Report narrative)
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent any adverse impacts to streams, wetlands and/or storm sewers.

Additional Requirements for Projects other than One and Two Family Developments:

- If the discharge is to an MS4, a certification that the discharge meets Massachusetts Surface Water Quality Standards and any applicable approved Total Maximum Daily Load (TMDL) waste load allocation is included in the Report.

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 Field¹
- 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.



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Checklist for Stormwater Management and Erosion Control Report

- 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.
- 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

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)



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Checklist for Stormwater Management and Erosion Control Report

- 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.
- 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 proprietary 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)

N/A

- 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

N/A

- 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.

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



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Checklist for Stormwater Management and Erosion Control Report

- 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.
- Adverse impacts due to erosion, sedimentation, or both during disturbance and construction activities are prevented:
- With erosion and sediment controls that the Applicant will implement and maintain (explain in Report narrative)
 - Without erosion and sediment controls (explain in Report narrative)



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Checklist for Stormwater Management and Erosion Control Report

- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.
- 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; *owner of the property*
 - 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.

OPERATION AND MAINTENANCE PLAN

The purpose of this operation and maintenance plan is to prevent erosion, sedimentation, pollution or other deterioration of the area adjacent to Lot B-3, Waverley Terrace, Belmont, MA. To that end, the project proponent will perform the following activities and inspection on a continuing annual basis.

INITIAL INSPECTIONS AND MONITORING

ITEM	FREQUENCY
Monitor sediment pit, leaching pits and any other drainage structure for proper functioning and record observations.	Beginning when each structure is opened for stormwater receipt and at least once a year.

INITIAL INSPECTIONS AND MONITORING

- | | |
|--|--|
| A. Sweeping of paved areas. | Just after the snow melts in early spring, before the sand enters the sediment pit and when necessary. |
| A. Monitor leaching pits for effectiveness and clean up if necessary. | Once per year. |
| B. Inspect and clean sediment pit. Dispose of sediments, oil and grease in accordance with applicable law. | Once per year. |
| C. Inspect and repair landscape areas to provide stabilized soils. | Spring and Fall. |
| D. Maintenance of sediment pit shall conform to the guidelines of the Stormwater Management Volume II of the State Department of Environmental Protection. | |
| E. Observe the following practices: | |

During construction, straw wattles shall be used to prevent soil from being washed to the street and neighboring land.

