TOWN OF PLYMOUTH CAPITAL IMPROVEMENT PLAN REQUEST
FY25 SPRING ANNUAL TOWN MEETING

Department:	**DPW, Engineering Division**	**Priority #:**	**3**
Project Title and Description:	**Townwide Drainage Repairs**	**Total Project Cost:**	**$500,000.00**

Department/Division Head: **James Downey, Acting Town Engineer**

Check if project is: New ☒ Resubmitted ☐ **Cost estimate was developed**: Internally ☒ Externally ☐

For project re-submittals, list prior year(s):

List any funding sources and amounts already granted: _____
_____

Basis of Estimated Costs (attach additional information if available)			**If project has impact on 5 Year Plan and future operating budgets, insert estimated amounts.**		
Capital:	**Cost**	**Comments**	**Fiscal Year:**	**Capital**	**Operations & Maintenance**
Planning and Design			***FY26***		
Labor and Materials	**$500,000.00**		***FY27***	**500,000.00**	
Administration			***FY28***		
Land Acquisition			***FY29***	**500,000.00**	
Equipment			***FY30***		
Other					
Contingency					
Total Capital	**$500,000.00**				

Project Justification and Objective: **The Department of Public Works (DPW) receives calls on drainage issues across town on a regular basis, some of those complaints can be addressed with little capital funding and others require extensive work and larger amounts of money. We currently have a list of future projects that we would like to work towards completing. Out of those that have been identified, we are asking for capital funding in order to move forward with some of those improvements.**

For Capital Project Requests:
Will this project be phased over more than one fiscal year? If yes, enter it on the 5 Year Plan Yes ☒ No ☐
Can this project be phased over more than one fiscal year? Yes ☒ No ☐

For Capital Equipment Requests:
☐ Check if equipment requested is replacement and enter the year, make & model, VIN and present condition of existing equipment

What is the expected lifespan of this new/replacement equipment: _____
Attach backup information, estimates, or justification to support this request.

11/1/2023	PROJECT:	SURVEY:	PLANS:	ROAD STATUS:	PROJECT STATUS:	ESTIMATED COST:
1	PROVINCETOWN VIEW ROAD	COMPLETED	COMPLETED	PRIVATE	NOT STARTED	$95,000
2	WORRALL ROAD #15	COMPLETED	STARTED - 90% DONE	PUBLIC	NOT STARTED	$120,000
3	WORRALL ROAD #35	COMPLETED	STARTED - 60% DONE	PUBLIC	NOT STARTED	$170,000
4	MILFORD STREET	COMPLETED	STARTED - 70% DONE	PUBLIC	NOT STARTED	$195,000
5	CHANDLER STREET	COMPLETED	STARTED - 60% DONE	PUBLIC	NOT STARTED - DUG TEST PITS 8-2023 - NEED TO FINISH PLANS AT LOW POINT	$330,000
6	HALFWAY POND ROAD - FROM BOURNE RD TO LONG POND	COMPLETED	COMPLETED	PUBLIC	NOT STARTED - NEED TO LOCATE A FEW MORE PRIVATE WELLS	$322,000
7	OLD SCHOOL HOUSE ROAD	NOT STARTED	NOT STARTED	PRIVATE - NO EASEMENTS	STARTED - HIGHWAY TRIED TO JET ROD PIPE - SCHEDULEING OUR CAMERA CREW TO COME & INSPECT	$40,000
8	ALDEN STREET @ COLD SPRING SDCHOOL	COMPLETED	STARTED 75% DONE	PUBLIC	EX. INFILTRATION SYSTEM FAILED - REPLACE EX. SYSTEM	$630,000
9	DUCK PLAIN ROAD	COMPLETED	STARTED - 60% DONE	PRIVATE	NOT STARTED	$83,000
10	#502 BOURNE ROAD	COMPLETED	STARTED - 60% DONE	PUBLIC - USED & MAINTAINED	NOT STARTED	$225,000
11	LIBERTY STREET @ PET CEMETARY	NOT STARTED	NOT STARTED	PUBLIC	NOT STARTED	$74,000
12	OAR & LINE ROAD	COMPLETED	STARTED - 50% DONE	PUBLIC	CANNOT INFILTRATE DUE TO PRIVATE WELLS DIVERT WATER TO WATER QUALITY STRUCTURE PRIOR TO	$100,000
13	SAMOSET STREET #45 TO #31	NOT COMPLETED	PRELIMINARY DESIGNS	PUBLIC	PIPE AT STANDISH HAS BE PLUGGED, REDUCING DISCHARGE TO EXISTING BROOK - EVALAUTING SYSTEM,	$1,700,000
14	FEDERAL FURNACE @ DIANE AVE	TBD	TBD	PUBLIC	NOT STARTED - EXISTING LEACHING SYSTEM FAILED? OR NEED TO BE CLEANED?	$70,000
15	SAMOSET AVE	SURVEY STARTED	STARTING DESIGN	PUBLIC	NOT STARTED - NEED TO DIG SOME TEST PITS	$250,000
16	HILL DALE ROAD	COMPLETED	COMPLETED	PUBLIC	NOT STARTED	$20,000
17	PRESIDENTS LANE - DRAINAGE AT BEACON /BIRCHWOOD /FITZGERALD	NOT STARTED	NOT STARTED	PUBLIC	NOT STARTED	$200,000
18	NICKS ROCK ROAD	NOT STARTED	NOT STARTED	PUBLIC	NOT STARTED	$100,000
19	SANDWICH STREET - NO CURBING SIDEWALK ISSUES	NOT STARTED	NOT STARTED	PUBLIC	NOT STARTED	$100,000
20	LITTLE SANDY POND ROAD	NOT STARTED	NOT STARTED	PRIVATE	NOT STARTED	$250,000
21	LINCOLN STREET	TBD	TBD	PUBLIC	NOT STARTED	$20,000
22	JACOBS LADDER	COMPLETED	STARTED	PRIVATE /PUBLIC ?	NOT STARTED - NEED TO DIG TEST PIT FOR SOILS	$100,000
23	EILLISVILLE ROAD @ LOOKOUT POINT ROAD	COMPLETED	STARTED	PUBLIC	NOT STARTED	$21,000
24	HALFWAY POND ROAD - FROM BOURNE RD TO WAREHAM RD	EVALAUTED EX ROADWAY	PREPARED DRAINAGE ISSUE MAPS	PUBLIC /USED & MAINTAINED	CURRENTLY ON SCHEDULE TO BE SHIMMED, THEN EVALAUTE DRAINAGE UPGRADES NEEDED	$200,000
25	MANOMET AVE	NOT STARTED	NOT STARTED	PUBLIC	NOT STARTED	$350,000
26	MONTEGOMERY DRIVE	STAKED EASEMENTS - NO TOPO DONE	PRELIMINARY CALCS TO SEE HOW MANY PITS WILL BE NEEDED - NO PLANS DONE	PUBLIC	NOT STARTED	$250,000
27	EDES STREET	TBD	TBD	PUBLIC?	PUTTING TOGETHER INFORMATION	$60,000
28	HEDGE ROAD - CULVERT UNDER BUILDING	COMPLETED	COMPLETED - ENVIROMENTAL PARTNERS	PUBLIC	NOT STARTED	$1,000,000
29	TAYLOR AVE	OUTFALL SURVEY COMPLETED	STARTED	PUBLIC	NOT STARTED	$921,000

30	#1 CAYUGA CIRCLE	COMPLETED	COMPLETED	PUBLIC	NOT STARTED	$60,000
31	MARKET STREET	COMPLETED	NOT STARTED	PUBLIC	NOT STARTED	$75,000
32	#76 JORDAN ROAD	TBD	TBD	PUBLIC	NOT STARTED	$50,000
33	ROBBINS HILL ROAD	NOT STARTED	NOT STARTED	PUBLIC	REMEDIATE SYSTEM AND CLEAN - POSSBILE REMOVAL OF BUBBLER CATCH BASIN IN YARD	$100,000
34	BLACK CAT ROAD	EVALAUTED EX ROADWAY	PREPARED DRAINAGE ISSUE MAPS	PUBLIC	CURRENTLY ON SCHEDULE TO BE SHIMMED, THEN EVALAUTE DRAINAGE UPGRADES NEEDED	$150,000
35	#2 COD ROAD	NOT STARTED	NOT STARTED	PRIVATE	ADD BERMS & DRIVEWAY APRON	$15,000
					TOTAL	**$8,446,000**

A GUIDE FOR THE DESIGN OF STORM DRAINAGE FACILITIES IN THE TOWN OF PLYMOUTH, MASSACHUSETTS

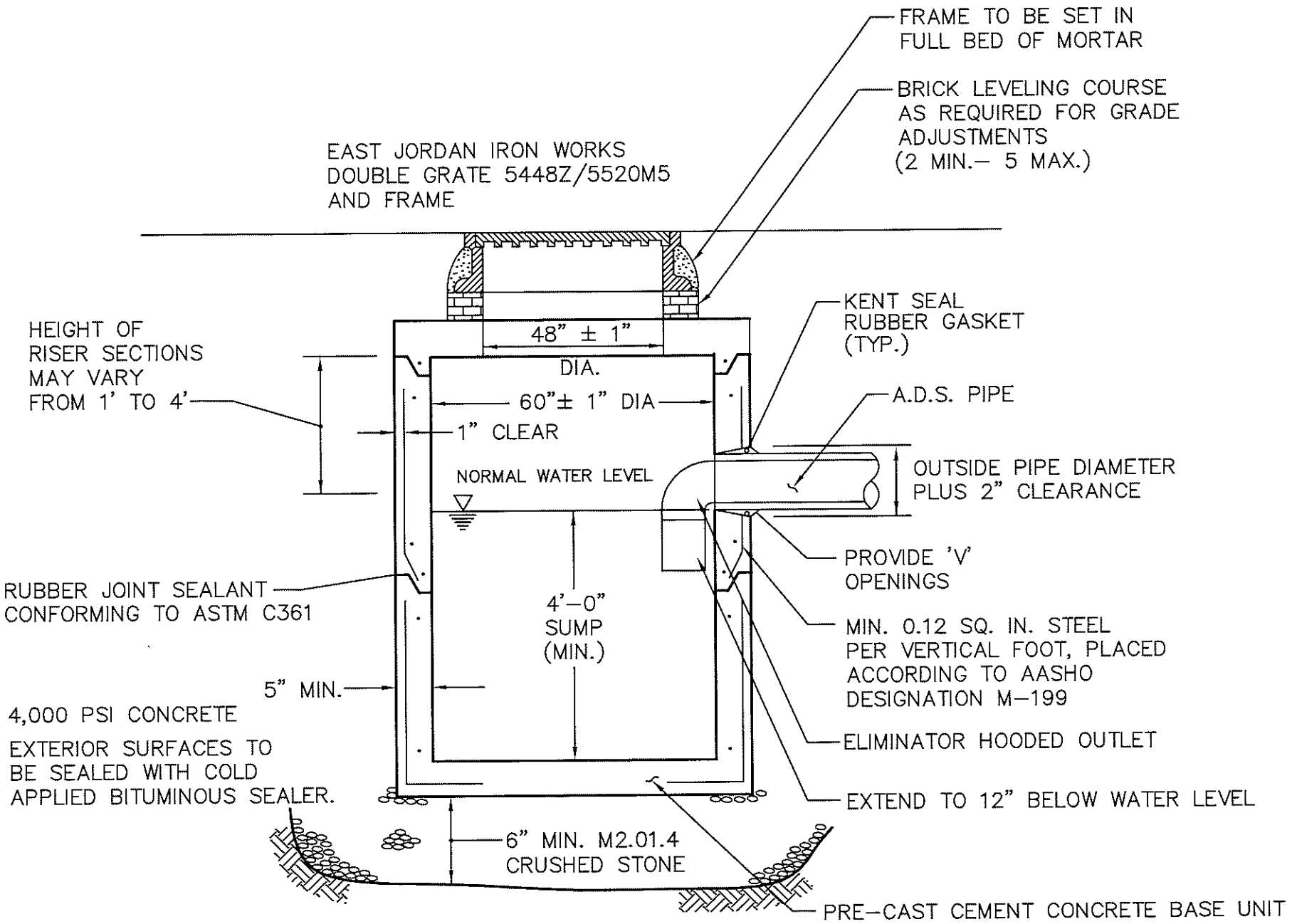
INCLUDING
LOW IMPACT DEVELOPMENT (LID)
STANDARDS

AS AMENDED THROUGH
June 2021

PREPARED WITH SUPPORT FROM THE COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS, SMART GROWTH GRANT FUNDING

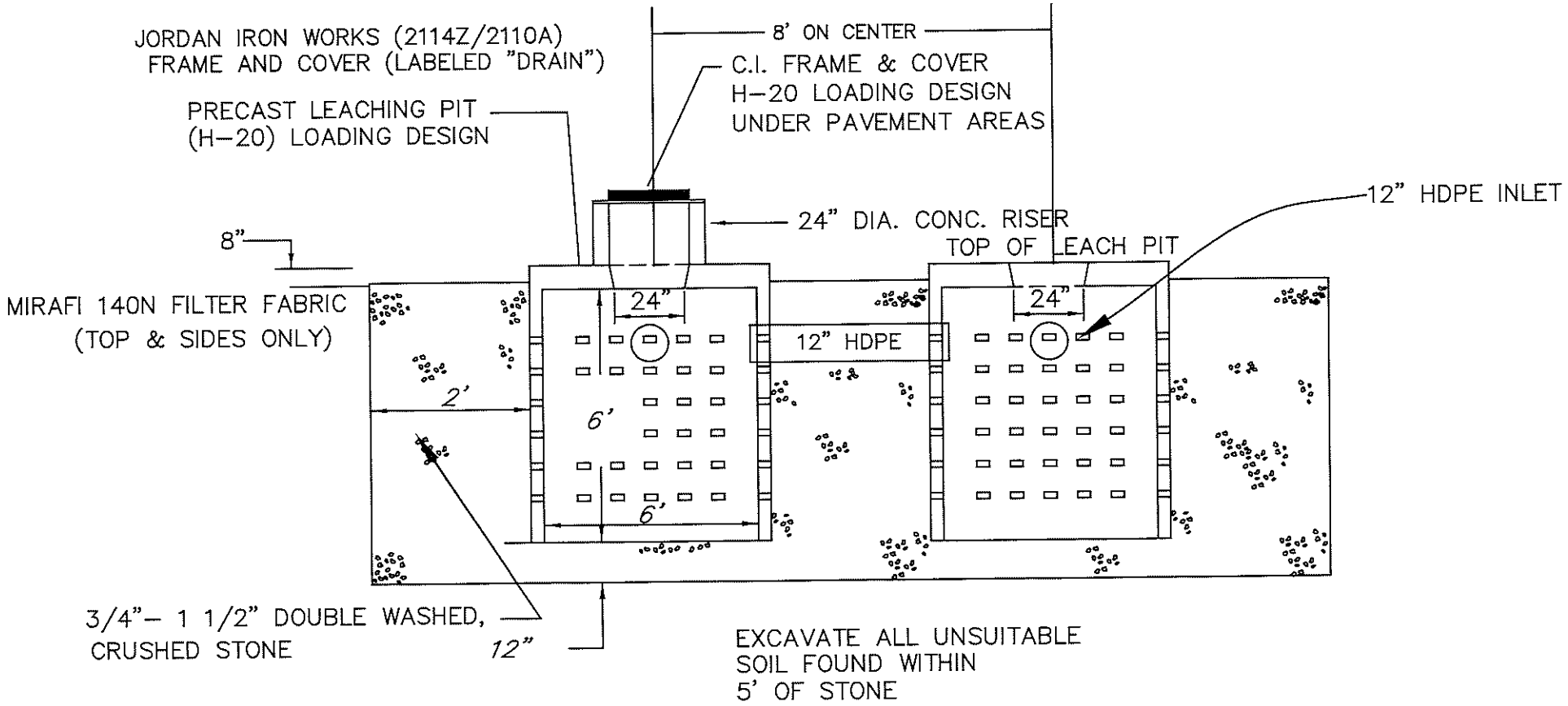
AND

IN COOPERATION WITH COMPREHENSIVE ENVIRONMENTAL INCORPORATED OF MARLBOROUGH, MASSACHUSETTS



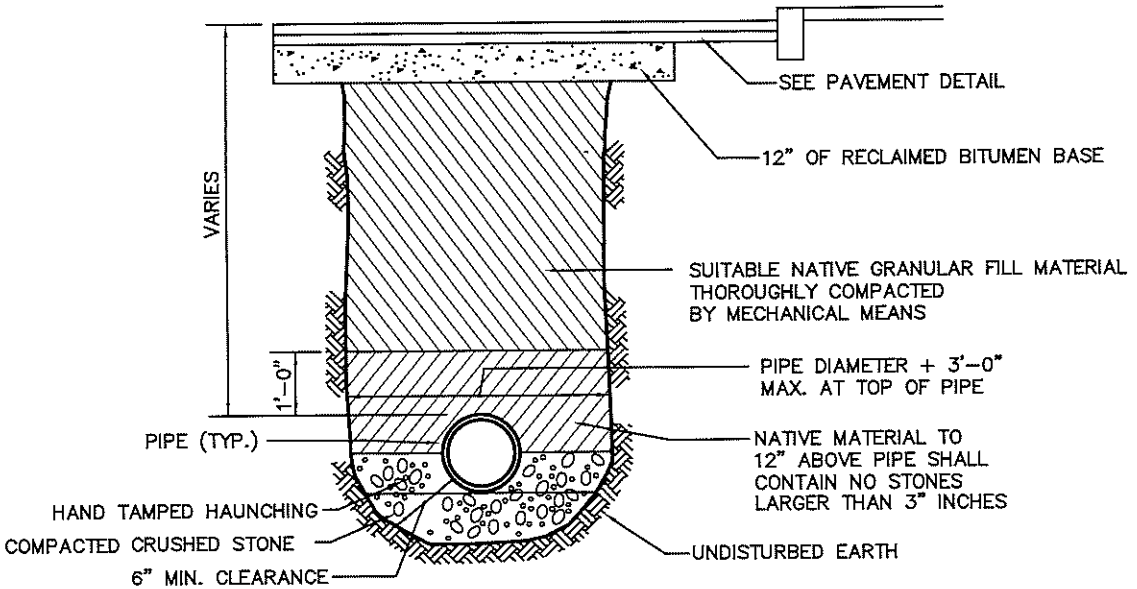
DOUBLE GRATE PRE–CAST CONCRETE CATCH BASIN

NOT TO SCALE



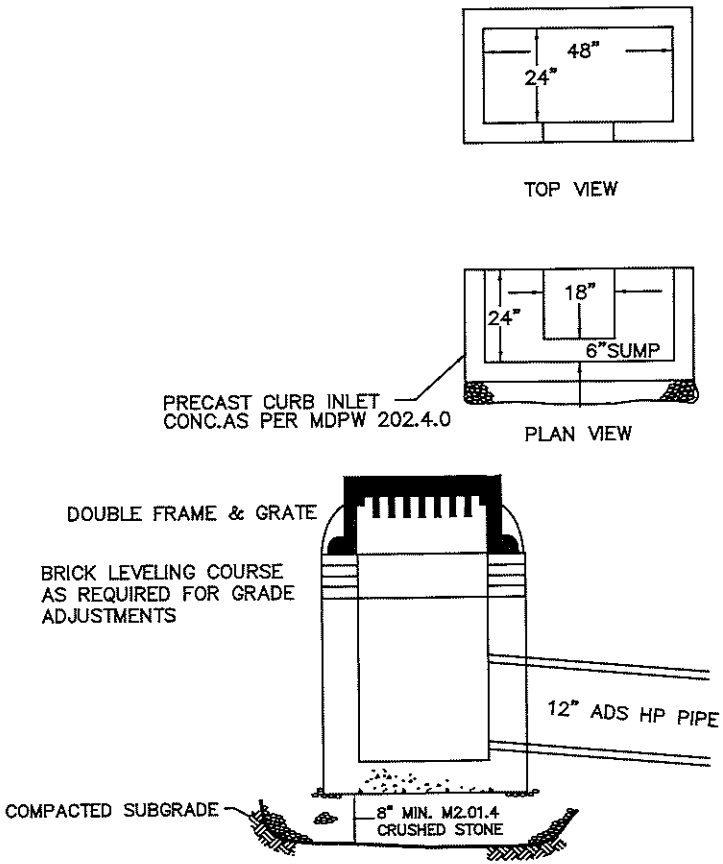
DRAINAGE LEACHING SYSTEM DETAIL

NOT TO SCALE

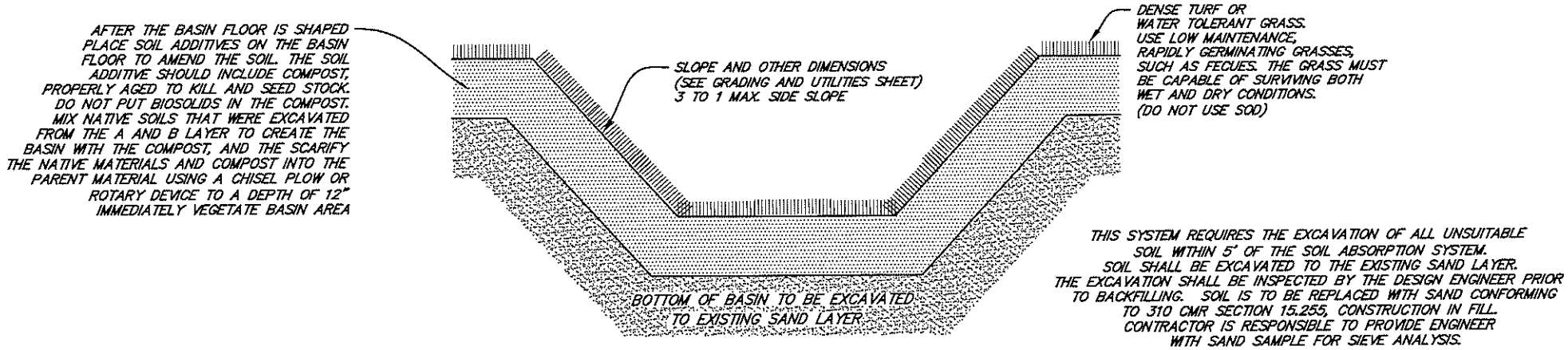


TYPICAL DRAIN PIPE DETAIL

NOT TO SCALE

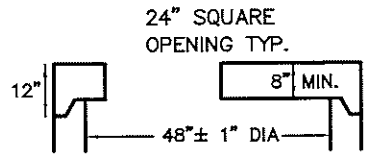


TYPICAL DOUBLE GRATE DROP BOX

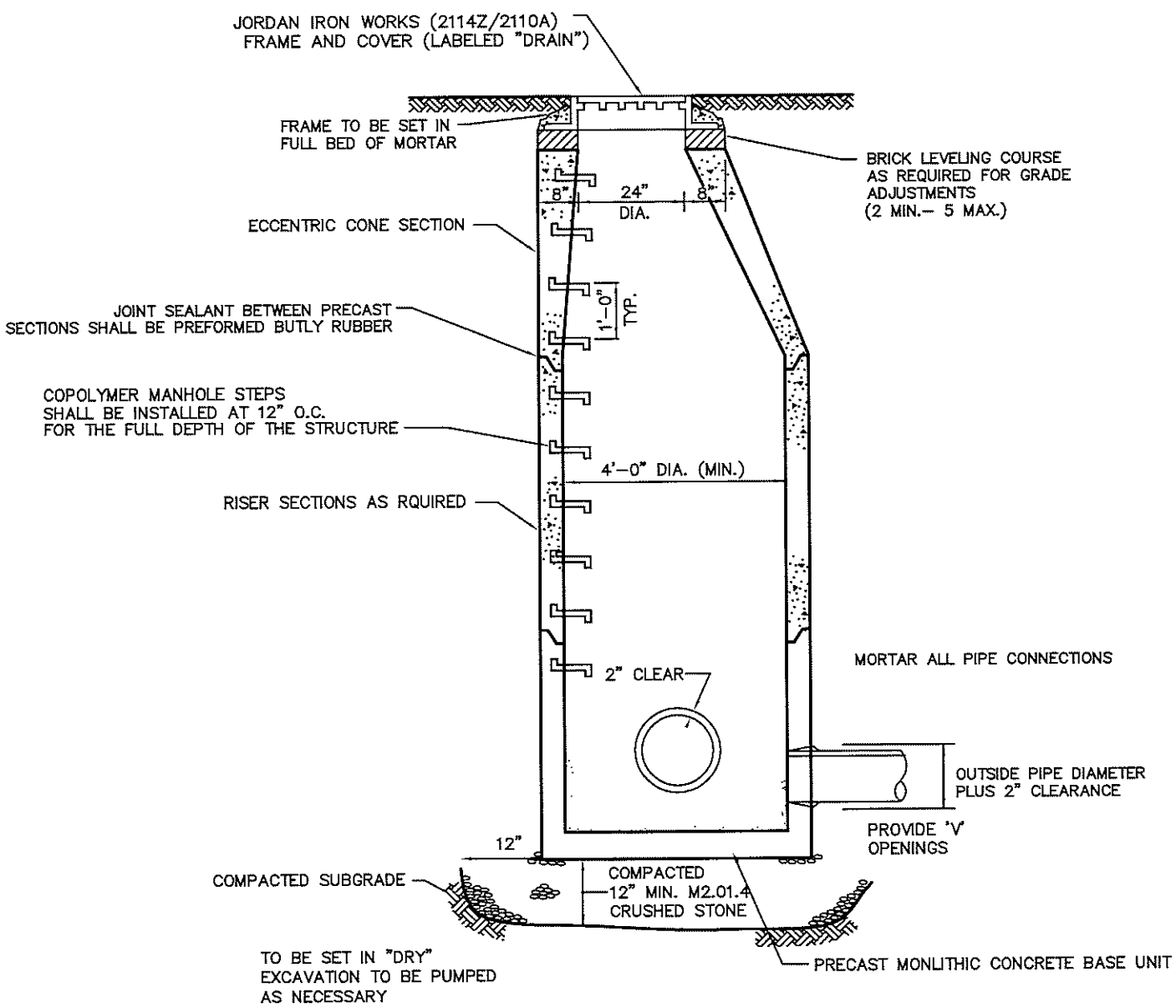


INFILTRATION BASIN CROSS-SECTION

NOT TO SCALE



ALTERNATE TOP SLAB



PRECAST CONCRETE DRAIN MANHOLE

NOT TO SCALE

A Guide for the Design of Storm Drainage Facilities in the Town of Plymouth, Massachusetts

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Appendices

1.0 Introduction

Plymouth has developed this update to *A Guide for the Design of Storm Drainage Facilities in the Town of Plymouth, Massachusetts* (the "Stormwater Management Manual") to provide design guidelines and criteria that will help implement better drainage design and Low Impact Development in Plymouth. The original document was created in 1983, and many new stormwater management techniques have been developed since that time which can enhance water quality both in the ground and at the surface. These updates have been coordinated through the Department of Public Works Engineering and Environmental Management Divisions, Health Department, Conservation Commission and Planning Departments to facilitate a coordinated and comprehensive approach to stormwater design.

This manual is not intended to provide detailed design guidelines for every BMP imaginable, as this information can be found within numerous other sources. Instead, this manual lays out design criteria that establish a foundation for good design, promotes consistent submittals, and provides references to other sources for more detailed information. Nothing in this document relieves the designer of the responsibility to exercise professional judgment, prudent stormwater design principles, and accurate assessments of the existing condition. Included within this manual are:

Section 2. Submittal Requirements – This section outlines submittal requirements for a pre-application and application submittal, including a Stormwater Management Plan and an Operation and Maintenance Strategy. The pre-application submittal was created to encourage discussions with the Town throughout the design process to better direct the use of LID on developments.

Section 3. Design Performance Criteria – This section outlines the stormwater design criteria that must be met for regulated development and redevelopment projects.

Section 4. Closed System Design Criteria – This section outlines design criteria that must be met for closed drainage systems.

Section 5. Stormwater Best Management Practices – This section includes a BMP selection matrix that identifies the applicability of specific BMPs to various site conditions, such as soils and high groundwater, as well as their applicable uses (e.g., peak control, recharge, water quality control, etc.). The matrix also includes as available typical pollutant removal rates for total suspended solids (TSS), total nitrogen, total phosphorus and bacteria, to aid in the selection of BMPs for discharges to waters with listed impairments for these pollutants. Setbacks are also provided for certain BMPs. References for further design information are provided for each of the BMPs listed.

In addition to the BMP selection matrix, Section 5 includes a table of specific design considerations for certain BMPs. These design considerations highlight key design components, where they may differ from the listed references. Also included is a table outlining Plymouth's preferences for BMP design and selection.

Massachusetts has recently promulgated regulations that include Stormwater Management Standards (formerly the Massachusetts Stormwater Policy), through amendments to 310 CMR 10.00: Wetlands Protection Regulations and 314 CMR 9.00: 401 Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Material Disposal in Waters Within the Commonwealth. Recognizing that the Massachusetts Stormwater Management Standards shall be met for all projects within the jurisdiction of these regulations, and that the Massachusetts Stormwater Handbook, which includes additional guidance to these regulations, may change over time, all stormwater management designs must meet the design criteria or standards in the Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations or within this manual, whichever is more stringent in the protection of the town's environmental and infrastructure resources and as authorized through any permitting agencies under whose purview the project falls.

The Town of Plymouth will not implement the proposed requirement for Aggregation 314 CMR 21, at the local level should they be adopted at the state level.

2.0 Submittal Requirements

Projects involving development of new land uses and alteration or redevelopment of existing land uses must meet storm water management requirements and are subject to review under various bylaws, rules, and regulations in the Town of Plymouth.

The Town in each case may request such additional information as is necessary to enable determination of whether the proposed land disturbance activity will protect water resources and meet the objectives of the applicable regulations.

Any uses not involving land disturbance and individual Single-Family, Two-Family and 3-Family projects shall be exempt from Submittal Requirements (Section 2.0).

2.1 Pre-Application Submittal Requirements

Plymouth requires the use of Low Impact Development (LID) techniques in site design. This requires a multi-step process that begins with site planning and layout. To standardize the information provided for review, the Town has developed the following submittal policy for applicants who will be requesting a Zoning Permit. The Town's review of this pre-submittal application in no way changes the applicant's sole responsibility for the successful design of stormwater management components as well as any other aspect for the site.

The Pre-Application review is a key factor in the process of LID design, and is intended to create a working dialogue and understanding with the Town and the applicant regarding the goals of the stormwater design. Unlike conventional development and stormwater controls, an LID approach to design begins with an assessment of environmental and hydrologic conditions on the site and how to best work around these. The upfront planning for the site is as critical as the ultimate stormwater controls chosen for the site. As such, Plymouth requires a pre-application submittal for all projects incorporating LID. Any uses not involving land disturbance and individual Single-Family, Two-Family and 3-Family projects shall be exempt from Submittal Requirements (Section 2.0).

Throughout the pre-submittal process, the comments and information provided by the Town with respect to the site and the stormwater design are advisory in nature. The applicant is solely responsible for the successful design of the stormwater management systems for the site.

The objective is to:

- Develop a site plan that reflects natural hydrology.
- Minimize impervious surfaces.
- Treat stormwater in numerous small, decentralized structures.
- Use natural topography for drainageways and storage areas.

- Preserve portions of the site in undisturbed, natural conditions.
- Lengthen travel paths to increase time of concentration and attenuate peak rates.
- Advise the designer and applicant of the Town's goals with respect to stormwater management at the site, and, to the extent practical, of any known concerns or issues regarding stormwater management at the subject property.
- Advise the designer and applicant of anticipated constraints affecting the Application Submittal Requirements (Section 2.2) or of additional information needed in the Application Submittal Requirements at the time of filing.

The Pre-Application Submittal shall contain sufficient information to describe the nature and purpose of the proposed development, pertinent conditions of the site and the adjacent areas, and proposed development options considered. The applicant shall submit such material as is necessary to show that the proposed development will comply with the Stormwater Design Guidelines.

The Pre-Application Cover Sheet (Appendix A), shall be submitted by the Applicant prior to filing the application (see Section 2.2) to the Town Engineering Department, with copies to the Environmental Management Division of DPW, Planning Department, Conservation Commission and Health Department. A response from the Town will be transmitted to the Applicant within 30 days. The response may provide comments; request additional information; request a coordination meeting with the applicant; or may note that the Town has no comments based on the Pre-Application Cover Sheet.

a. **Contents**. The Pre-Application Submittal shall contain the following information:

1. Pre-Application Cover Sheet (Appendix A), completed, including names, addresses, and telephone numbers of the owner, applicant, and person(s) or firm(s) preparing the submittal.
2. A concise, well-thought-out narrative describing the conceptual stormwater design, the proposed or anticipated impacts and constraints, and the proposed measures to minimize or mitigate those impacts based on the design chosen. A group meeting with representatives of DPW, Planning and Conservation staff as may be appropriate, scheduled with the applicant's engineer who is prepared to discuss same is strongly encouraged. The narrative should include:
    a. Be as concise and project-specific as possible. The narrative does not need to include extensive discussion of standard hydrologic concepts and LID principles. Instead, it should focus on how the project proposes to address environmental conditions, integrate development with natural drainage features, and minimize or mitigate for impacts. Please refer to Table 3 BMP Selection Table in these Guidelines.
    b. Clearly identify if the project is a redevelopment of a property, describing the changes in stormwater flows and describing the constraints of the site with respect to stormwater design system choices.
    c. Outline the proposed LID Concepts, including the LID techniques that will be used on the site which affect hydrologic calculations.

d. Hydrologic calculations shall be performed and included. The level of detail shall be appropriate to support the conceptual project strategy for integration of Low Impact Development elements into the project.
e. Identify the Town of Plymouth permits or review procedures understood to be applicable to the project, along with other state and federal permits that may affect the site design or drainage design for the project.
f. Identify the worst-case future condition that can reasonably be anticipated should a particular BMP/stormwater design component fail. The goal is to identify what potential impacts to Public Safety (such as flooding of a public roadway) could occur in the event of a failure in order to assess when a LID design component may need additional safety features, such as provisions for additional overflow capacity.
g. Identify any known conditions or features, either on or off-site (e.g., existing stormwater discharges, infiltration systems, flood control structures, or other feature), that could affect the performance of the proposed stormwater system or that could result in cumulative impacts to listed resources of concern (please refer to section 3.0 #7) when considered in conjunction with the new stormwater system.

3. A conceptual plan, and the following, if available, although not required, clearly showing:
    a. Scale of conceptual plan at 1"=20' or 1"=40' is preferable.
    b. General location and description of significant natural features as obtained from Massachusetts Geographic Information System (MA GIS), soil surveys, aerial photographs, flood maps, quadrangle maps or other available sources[1] including:
        i. Watercourses and water bodies (such as streams, ponds, vernal pools), wetland resource areas and lands within 100 feet of these resources, riparian (river) zones, recharge groundwater protection areas, high-permeability soils, and erosion-prone soils, woodland conservation areas, farmland, meadows and floodplain information, including the 100-year flood elevation and/or boundaries of coastal flooding. Many of these maps may be viewed in the Conservation/Planning Office.
        ii. Topographical features including contours.
        iii. Approximate tree and shrub lines.
        iv. Approximate direction of groundwater flow from groundwater flow map (Conservation/Planning office).
        v. Critical areas as defined under Section 3.0, number 7 and Certified Vernal Pools and Potential Vernal Pools, These maps are available on line and in the Conservation/Planning office.
        vi. Existing abutting streets.

[1] If guidance is needed on locating this information, please see the Planning or Town Engineer's office for assistance. Internet resources are listed on the Pre-Application Cover Sheet in Appendix A for many of these maps.

c. Preferred site development layout that minimizes total impervious area; reflects the existing topography; and maximizes the continued use of existing drainageways, swales, depressions, and storage areas in their natural state, consistent with applicable wetland resource regulations. The layout plan shall include the estimated total proposed area of disturbance and total proposed impervious area.
d. Conceptual locations and types of stormwater management controls.

2.2 Application Submittal Requirements

A. Stormwater Management Plan

The Stormwater Management Plan shall be submitted with either a Building Permit, Site Plan Approval request, Subdivision, Conservation Permit, Health Department Permit or Special Permit Application, whichever is applicable,[2] and shall contain sufficient information to describe the nature and purpose of the proposed development, pertinent conditions of the site and the adjacent areas, and proposed best management practices for the permanent management and treatment of stormwater. The Stormwater Management Plan shall contain sufficient information for the Town to evaluate the environmental impact, effectiveness, and acceptability of the measures proposed by the applicant for reducing adverse impacts from stormwater. The Stormwater Management Plan shall fully describe the project in drawings, and narrative. The applicant shall submit the following information, unless otherwise authorized in writing by the reviewing authority:

1. A narrative providing responses to Town comments resulting from review of the Pre-Application Submittal.
2. A plan showing title, date, north arrow, names of abutters, scale (1"=20' or 1"=40'), legend, and locus map (1"=800'). Other standard scales are acceptable if approved by the reviewing authority.
3. The existing zoning and land use at the site.
4. The location(s) of existing and proposed easements that would affect the proposed use/stormwater management plan and that would be necessary to provide access for maintenance of any stormwater management facilities.
5. The location of existing and proposed utilities.
6. The site's existing & proposed topography with contours at 2 foot intervals.
7. The existing site hydrology.
8. A description & delineation of existing stormwater conveyances, impoundments, wetlands, and critical areas of interest (please refer to Section 3.0 #7) on or adjacent to the site or which receives stormwater flows from the site.

[2] If a project is subject to Special Permit, Conservation, Subdivision or other regulatory permitting, this Stormwater Management Plan Application will be submitted with the application for these permits which will be in advance of the building permit application.

9. A delineation of any flood hazard areas (including but not limited to 100-year flood boundaries, floodway boundaries, velocity zones, and other areas subject to flooding or coastal storm flowage) as shown on the FEMA maps or as surveyed at the site. Where detailed Flood Insurance Studies (FIS) have been prepared by FEMA, flood elevation and/or coastal storm flowage data must be obtained from these studies.
10. Soils data pertaining to the design of each area to be used for stormwater retention, detention, or infiltration, including:
    a. An estimate made by a qualified individual, such as a Licensed Soil Evaluator, certified Soil Scientist, hydrogeologist, or geotechnical engineer, of seasonal high groundwater elevation at each such facility;
    b. A classification of the Hydrologic Soil Groups (HSG) soils on site using classification methodologies developed by U.S. Natural Resources Conservation Service (NRCS), based on observations by a qualified individual, such as a Licensed Soil Evaluator, certified Soil Scientist, hydrogeologist, or geotechnical engineer in accordance with the Massachusetts Stormwater Handbook;
    c. Identification of depth to restrictive layer and/or bedrock observed within 4 feet of the bottom of any such proposed facility, and deeper if required to evaluate potential impacts of the proposed design;
    d. Corroborating soil textural analysis or field tested saturated hydraulic conductivity rates at each facility in accordance with procedures identified in the Massachusetts Stormwater Handbook.
11. The existing and proposed vegetation or other cover types, with area and runoff coefficient for each.
12. A drainage area map clearly showing pre and post construction watershed boundaries, drainage areas and stormwater flow paths. Proposed analysis points and corresponding sub-catchment boundaries shall be identified. Off-site areas contributing to the proposed drainage system shall be identified. Analysis points shall be the same for both pre-development and post-development analyses.
13. A description, drawings, and detailed calculations of all components of the proposed drainage system including:
    a. A narrative describing what elements of design are considered by the applicant to be subject to revision (e.g., houses in a subdivision, driveways, landscape areas, locations of rain gardens). The hydrologic calculations must conservatively account for any design components that might be altered by subsequent lot development, unless the applicant documents that legal restrictions on such design modifications have been provided (e.g., gravel driveways that can be paved by the

ultimate owner must be considered paved in the hydrologic calculations).

b. The narrative should clearly identify if the project is a redevelopment of a property, describing the changes in stormwater flows and describing the constraints of the site with respect to stormwater design system choices.
c. Identify the worst-case future condition should a particular BMP/stormwater design component fail. The goal is to identify what potential impacts to Public Safety (such as flooding of a public roadway) could occur in the event of a failure in order to assess when a LID design component may need a safety feature, such as an overflow outlet.
d. Identify any known conditions or features, either on or off-site (e.g., existing stormwater discharges, infiltration systems, flood control structures, or other feature), that could affect the performance of the proposed stormwater system or that could result in cumulative impacts to listed resources of concern (please refer to section 3.0 #7) when considered in conjunction with the new stormwater system.
e. If requested, locations, typical sections and profiles of specific brooks or streams,
f. Locations, typical sections and profiles of drainage swales and their method of stabilization. All designed drainage channels should be supported by calculations demonstrating **capacity** and **stability** under design flow conditions.
g. Locations of all conveyance, storage, and treatment systems.
h. Profile at true vertical scale showing the water surface elevation throughout the proposed closed drainage system for the 2 and 10-year storm, including the estimated tailwater at the system outlet. Basis for tailwater estimate shall be documented.
i. All measures for the detention, retention or infiltration of water,
j. All measures for the treatment and protection of water quality,
k. The details for all components of the proposed drainage systems and stormwater management facilities,
l. Notes on drawings specifying materials to be used and construction specifications,
m. Expected hydrology with detailed supporting calculations. If appropriate computer output should include graphic hydrographs to facilitate review.

14. The proposed improvements including location of buildings or other structures, impervious surfaces, and drainage facilities, if applicable.
15. General notes concerning timing, schedules, and sequence of development including clearing, stripping, rough grading, construction, final grading, and

vegetative stabilization. If the proponent is required to have a NPDES permit,[3] a copy of the SWPPP must be filed prior to the start of construction.

16. A maintenance schedule for the period of construction, if known.
17. Any other information requested by the Town.

B. Erosion and Sediment Control

Please refer to the Town of Plymouth Zoning Bylaw, Section 205-18 Natural Features Conservation Requirements with respect to erosion and sediment controls. Please submit a narrative addressing these requirements (a copy of the SWPPP, if available, may be attached as an alternative.)

Section 2.3.5 Construction Site Stormwater Runoff Control of the Massachusetts MS4 General Permit requires that the operator of a construction site elimante erosion and maintain sediment on site so it is not transported in stormwater and allowed to discharge to a water of the US through the Town's MS4. The construction site stormwater runoff control program required by the MS4 General Permit is separate and distinct program from EPA's stormwater construction permit. Not only does this requirement pertain to stormwater, but includes, and is not limited to discarded building materials, concrete truck wash out, litter and sanitary wastes.

The MS4 Permit requires site inspections and enforcement of sedimentation control measures by the Town. As such the Town has developed the following site inspection requirements to meet the goals of MS4 General Permit.

- The Owner of the Site shall submit to the Town's Engineering Department the resume of the individual (ESC Inspector) that will perform the required inspections.
- The ESC Inspector shall be a Massachusetts Registered Civil Professional Engineer, a Certified Professional in Erosion and Sedimentation Control (CPESC), Certified Erosion, Sediment & StormWater Inspectors (CESSWI), or Certified Inspector of Sediment and Erosion Control (CISEC).
- This ESC Inspector is separate from personal conducting inspections under the Construction General Permit's inspection requirements.
- The ESC Inspector shall be retained by the Site Owner.
- The ESC Inspector shall inspect the Site on a monthly basis for evidence of sedimentation or other pollutant discharge to the MS4.
- The ESC Inspector shall issue a report that identifies erosion on site, the condition of ESC Best Management Practices, and sedimentation or other pollutant discharge to the MS4.
- The report shall include a Drawing, at appropriate scale, that identifies erosion on site, the condition of ESC Best Management Practices, and sedimentation or other pollutant discharge to the MS4.
- In the event there is a discharge to or a threat of a discharge to the MS4, all ESC Inspector shall be empowered to shut the project down until appropriate corrective action is taken. If a discharge has occurred, at a minimum, the

C. Operation and Maintenance Strategy

An Operation and Maintenance Strategy (O&M Strategy) for the permanent storm water management system is required at the time of application for all projects. The maintenance strategy should be designed to ensure that the Massachusetts Surface Water Quality Standards contained in 314 CMR 4.00 are met in all seasons and throughout the life of the system, and should identify the responsible party and contact information for the maintenance of the stormwater system.

Where a failure of the stormwater design could lead to a flooding hazard, the Responsible Parties must submit annual reports regarding the inspection and maintenance of the BMPs for which they are responsible. The annual reports must include: (1) descriptions of the condition of the BMPs, (2) descriptions of maintenance performed and (3) receipts for maintenance performed. Any changes to the owner/Responsible Party identified in this section should be provided in writing to the Town Engineer within 15 working days of the effective date of the change, including an outline of any changes to the maintenance schedule or O&M Strategy.

[3] See Pre-Application Cover Sheet (Appendix A).

3.0 Design Performance Criteria

The design criteria summarized in Table 1 and presented below shall be used to design stormwater management controls:

1. **No Untreated Discharges**
   All new stormwater discharges to wetlands, local water bodies, municipal drainage systems, or abutting property, must be treated in compliance with these criteria.

2. **Site Planning**
   Low impact development (LID) techniques must be incorporated into redevelopment projects in the Town.[4] Applicants must use decentralized systems that involve the placement of a number of small treatment and infiltration devices located close to the various impervious surfaces that generate stormwater runoff in place of a centralized system comprised of closed pipes that direct all drainage from the entire site into one large detention basin. Exceptions may be made for incidences where a demonstrated public purpose (such as preserving a historic resource or a significant natural feature) is found to be served by the permitting board or agency which would necessitate the use of underground recharge systems.

   The site planning process shall be documented and include the following steps:

   (a) Perform Site Analysis – Identify and map important natural features such as streams and drainageways, floodplains, wetlands, recharge groundwater protection areas, high-permeability soils, steep slopes and erosion-prone soils, woodland conservation areas, farmland, and meadows.

   (b) Layout Preferred Development Scenario – Prepare preferred site development layout that minimizes total impervious area, reflects the existing topography, and uses existing hydrologic features. Potential layout may consider cluster development, parking garages, taller buildings, reduced road widths, smaller parking areas, permeable paving, and green roofs. Roadway layouts shall minimize disturbance of natural drainage patterns by following existing grades.

   (c) Create a Decentralized Stormwater System – Manage runoff at the source to the extent practical through the use of small decentralized structures, such as swales, bioretention areas, infiltration structures, filter strips, rain barrels, cisterns, dry wells, and vegetated areas. Increase the time of concentration (average time for rainfall to reach a point) by using open, vegetated drainage systems and maximizing overland or sheet flow.

[4] Unless the criteria within these Guidelines which allows for alternative design as described herein is shown to be met.

Where unpaved roads are proposed, the designer must consider the implications of the unpaved surface with respect to the sustainability of LID Best Management Practices (BMPs). The basis for the engineering design of BMPs for projects with unpaved roadways shall include proven techniques for addressing erosion and sedimentation concerns. The Massachusetts Unpaved Roads BMP Manual by Berkshire Regional Planning Commission, 2001[5] is cited as a source of relevant information.

Table 1. Summary of Design Criteria

Issue Being Addressed	Design Criteria	Important Considerations
Discharges	All new discharges to wetlands, local water bodies, municipal drainage systems, or abutting property must be treated.	
Site Planning	Low impact development (LID) site design techniques must be incorporated into all projects in the Town (the use of LID structural BMPs is encouraged, but such use does not by itself constitute a "site design technique").	Site planning and layout must undergo pre-application review before final design. Pre-filing submittals shall contain DEP attributes, town critical areas of interest on and near the site, goals of the stormwater design, proposed changes to the site, proposed impacts or minimization of impacts based on the design, and list of any waivers.
Peak Control	Post-development peak discharge rates can not exceed pre-development peak discharge rates for the 2-, 10- & 25-yr, 24-hr storm events. Evaluate the 100-yr storm event for offsite flooding impacts.	Control of peak discharge rates may be waived for areas within the 100-year coastal flood zone or subject to coastal tidal flow, if no detrimental impacts to downgradient infrastructure or neighboring properties can be demonstrated. Emergency spill ways shall be designed to safely pass the 100-year storm assuming the primary outlet structure is not functioning.

[5] Berkshire Regional Planning Commission. (Winter 2001). *The Massachusetts Unpaved Roads BMP Manual: A Guidebook on How to Improve Water Quality While Addressing Common Problems.* (Project 98-06/319). Pittsfield, MA: Berkshire Regional Planning Commission.

Table 1. Summary of Design Criteria		
Stormwater Recharge	$Re_v = [(S)(IA)]/12$ where Re_v = recharge volume IA = total impervious area S = Soil Specific Recharge Factor (inch)* A soils = 0.60 B soils = 0.35 C soils = 0.25 D soils = 0.10 In C and D soils and where bedrock is at the land surface, proponents are required to infiltrate the required volume only to the maximum extent practicable. *Note: The Soil Specific Recharge Factors were obtained from the Stormwater Management Standards contained within the Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations for recharge. Refer to these regulations for the most up to date recharge factors.	The recharge volume represents the volume per storm event. Annual recharge requirements must also be calculated using these criteria. Infiltration rates of soils for sizing recharge structures shall be calculated in accordance with the methods outlined in the Massachusetts Stormwater Handbook. Static infiltration sizing is required for any infiltration BMP used for treatment. Dynamic infiltration sizing may be used for recharge of clean roof runoff and for recharge following a treatment BMP. Consistent with the intent of the Stormwater Management Manual to implement LID Stormwater Management design, underground stormwater recharge systems may be allowed as follows: a. Underground recharge systems may be allowed for rooftop runoff. b. Underground recharge systems may be allowed for redevelopment projects and retrofits, where it is demonstrated that surface recharge systems or bioretention systems are not feasible. c. Exceptions may be made for incidences where a demonstrated public purpose (such as preserving a historic resource or a significant natural feature is found to be served by the permitting board or agency which would necessitate the use of underground recharge systems. d. Underground detention units may be used to accommodate peak storage control.

Table 1. Summary of Design Criteria		
Water Quality Volume (WQV)	WQV = [(1")(IA)]	For any BMP that discharges to a cold water fishery, treatment must consist of infiltration, use of a gravel underdrain outlet, or other approved method for mitigation of temperature increases associated with surface water ponding.
Pollutant Removal	TSS – 90% T. Phos. – 60% T. Nitrogen – 30%	
Critical Areas	Only approved BMPs are allowed for discharges to critical areas. Shut down & containment required near critical resources.	Approved Treatment BMPs: • Filtering bioretention areas • Constructed stormwater wetlands • Gravel wetlands • Proprietary media filter • Sand/organic filters • Wet basins (lined & sealed if 44% pretreatment not attained) • Exfiltrating bioretention areas • Dry wells • Infiltration basins • Infiltration trenches • Subsurface structures
Redevelopment	Must meet the same standards as new development, unless it is proven to be infeasible and is otherwise consistent with the Guidelines herein. At a minimum, Water Quality Volume WQV=[(0.8")(IA) or Pollutant Removal TSS-80%; T.Phos.-50%	Pre-development refers to the site as it was before it was developed. It does not refer to existing conditions. Infeasible means not technologically possible, or not economically practicable and achievable in light of best industry practices.
Erosion and Sedimentation Controls	Develop and implement an erosion and sedimentation control plan.	Plan should satisfy SWPPP requirements if required and Zoning Bylaw.
Illicit Discharges	Submit an Illicit Discharge Compliance Statement verifying no illicit discharges exist on the site.	Applies to both new and redevelopment. For redevelopment, provide summary of steps taken to verify no illicit discharges.

Table 1. Summary of Design Criteria		
Pretreatment	Provide pretreatment for all treatment and recharge BMPs. Pre-treatment shall be designed for hydraulic capacity, and in addition to hold 1-year worth of sediment. To obtain an annual sediment volume, perform the following calculation. For impervious areas: Area to be sanded (acres x 500 pounds/acre-storm ÷ 90 lbs/ft^3 x 10 storms/yr = ft^3 of sediments/yr For pervious areas: Use the Revised Universal Soil Loss Equation (RUSLE)	
O&M	All applicants must develop an O&M strategy.	Must cover responsible party, funding, routing O&M practices, major repair/replacement items, and records retention and reporting.

3. Peak Control

The following criteria shall be followed to control peak discharge rates and improve the overall effectiveness of the stormwater treatment systems. These are minimum design criteria.

(a) The post-development peak discharge rate shall be equal to or less than the pre-development peak discharge rate (based on a 2-year, 10-year, and 25-year, 24-hour storm); ***and***

(b) The 100-year, 24-hour storm event must be evaluated to demonstrate that there will not be increased flooding impacts off-site.

(c) The site shall be designed to ensure that all runoff from the site up to the maximum design storm for the particular structure will actually enter the control structure. For example, the control structure may be designed for the 25-year storm, while the drainage system may only be sized to handle a ten-year storm, with larger storms flooding the distribution system and traveling overland. This overland flow, or overflow, must be directed into the peak control structure; ***and***

(d) For each design storm, the applicant shall account for all run-on and run-off (including off-site impacts) in both pre- and post-development conditions; ***and***

(e) Emergency spill ways shall be designed to safely pass the 100-year storm assuming the primary outlet structure is not functioning; ***and***

(f) Use SCS methods (TR-20 or TR-55) to develop hydrographs and peak flow rates for the proposed development site. The hydrograph time interval (dT) in TR-20 shall be no greater than 0.1 hours. All areas shall be accounted for in the pre/post runoff calculations. The total tributary area that contributes flow from the proposed site, including runoff entering the site through piped drainage or surface runoff from off-site sources, shall be included even if a portion does not contribute flow to the BMP. The objective is for the development's storm drain design to account for total runoff leaving the site; ***and***

(g) Use Curve Numbers (CN) values as provided in Table 2 to calculate stormwater runoff rates for pre/post construction ground surface conditions; ***and***

(h) Any site that was wooded within the last five years shall be considered undisturbed woods for all pre-construction runoff

(i) Off-site areas should be modeled as "present land use condition" in good hydrologic condition for the 2 and 10-year storm events for both pre and post development calculations; ***and***

(j) The length of overland sheet flow used in time of concentration (t_c) calculations shall be limited to no more than 50 feet for pre- and post-development conditions.

Table 2. Approved CN Values for the SCS Methods (TR-20, TR-55)

	Hydrologic Soil Group			
Pre-Construction Runoff Curve Number (CN Values)	**A**	**B**	**C**	**D**
Open space such as lawns, parks, and cemeteries[2]	68	79	86	89
Woods and forest[3]	30	55	70	77
Impervious areas such as paved parking lots, driveways and roofs	98	98	98	98
Gravel roads (processed, dense graded)	76	85	89	91
Dirt roads	72	82	87	89
Newly graded pervious areas (no vegetation)	77	86	91	94
Post-Construction Runoff-Curve Number (CN Value)	**A**	**B**	**C**	**D**
Open space such as lawns, parks, and cemeteries[2]	68	79	86	89
Woods and forest that is selectively cleared[3]	43	65	76	82
Impervious areas such as paved parking lots, driveways and roofs	98	98	98	98
Gravel roads (processed, dense graded)	76	85	89	91
Dirt roads	72	82	87	89
Newly graded pervious areas (no vegetation)	77	86	91	94

Source: TR-55, 1986

Notes:

1. *The runoff curve numbers are for use in calculating runoff with SCS methods or other approved models.*
2. *The open space CN values for lawns, parks, and cemeteries assumes a "poor" condition for grass cover since the post-construction amount of grass cover cannot be predicted or guaranteed.*
3. *The pre-construction CN value for woods and forest is based on a "good" condition where the woods are undisturbed and brush adequately covers the soil. The post-construction CN value for woods and forest is based on a "fair" condition if any selective cutting is conducted since the soils typically become compacted due to the equipment used to remove the large white pines and there may be post-cutting wind damage to the remaining unsupported canopy. If the applicant can demonstrate that no disturbance will occur during construction, then the pre-construction CN value for woods may be used for the post-construction runoff calculations. A note should be placed on the plan indicating where selective cutting will occur.*

4. Stormwater Recharge

The volume of water to be recharged shall be based on the site soils. The volume of water to be retained from the developed site shall be calculated using the following equation:

$Re_v = [(S)(IA)]/12$, where

Re_v = recharge volume

IA = total impervious area

S = Soil Specific Recharge Factor (inch)

Hydrologic Group	Soil Specific Recharge Factor*
A	0.60
B	0.35
C	0.25
D	0.10

*Note: The Soil Specific Recharge Factors were obtained from the Stormwater Management Standards contained within the Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations for recharge. Refer to these regulations for the most up to date recharge factors.

The following criteria shall also apply:

(a) In C and D soils and where bedrock is at the land surface, proponents are required to infiltrate the required volume only to the maximum extent practicable.

(b) All recharge systems must receive pre-treatment prior to recharge. All pretreatment devices must meet the criteria outlined under Design Criteria 4.

(c) Compaction of soils in designated recharge areas must be minimized during or after construction.

(d) If more than one soil type is present at the site, a composite soil specific recharge factor shall be computed based on the proportion of total site area within each soil type. To the extent practical, the recharge volume provided at the site shall be directed to the most permeable soils available.

(e) The Town may alter or eliminate the recharge volume requirement if the site is situated on unsuitable soils (i.e., marine clays), karst or in an urban redevelopment area. In this situation, non-structural practices (filter strips that treat rooftop or parking lot runoff, sheet flow discharge to stream buffers, and grass channels that treat roadway runoff) shall be implemented to the maximum extent

practicable and the remaining or untreated volume included in the water quality volume.

(f) The system shall be designed based on calculated infiltration rates using the methods outlined in the Massachusetts Stormwater Handbook.

(g) All units/devices shall be designed to drain within 72 hours from the end of the storm.

(h) Consistent with the intent of the Stormwater Management Manual to implement Low Impact Development (LID) Stormwater Management design, underground stormwater recharge systems may be allowed as follows:

i. Underground recharge systems may be allowed for rooftop runoff.

ii. Underground recharge systems may be allowed for re-development projects and retro-fits, where it is demonstrated that surface recharge systems or bioretention systems are not feasible.

iii. Exceptions may be made for incidences where a demonstrated public purpose (such as preserving a historic resource or a significant natural feature) is found to be served by the permitting board or agency which would necessitate the use of underground recharge systems.

iv. Underground detention units may be used to accommodate peak storage control

5. Water Quality Volume

The water quality volume required to be treated shall be calculated as:

WQV = [(1 inch)(IA)]/12, where
WQV = water quality volume
IA = total impervious area
12 = conversion factor (inches per foot)

If infeasible for redevelopment, Town may decrease WQV= [(0.8")(IA)]/12. For any BMP that discharges to a cold water fishery, treatment must consist of infiltration, use of a gravel underdrain outlet, or other approved method for mitigation of temperature increases associated with surface water ponding.

6. Pollutant Removal

All treatment devices should remove the following percentages:

Total Suspended Solids – 90%

If requested by the Town:
Total Phosphorus – 60%
Total Nitrogen – 30%
If infeasible for redevelopment, treatment devices should remove following percentages: TSS-80%; Total Phosphorus-50%

7. Critical Areas

Critical areas include all waters listed on the most recent version of the *Massachusetts Integrated List of Water, Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 303(d) and 305(b) of the Clean Water Act.* In Plymouth, Critical Areas of Interest also include, if not contained within the listings noted in the preceding sentence: Zone II of public water supplies,[5] coastal waters, eelgrass beds, shellfish beds, anadromous fish runs, cold water fisheries, aquatic rare and endangered species habitat[6] including coastal plain ponds, and headwaters and tributaries to streams and surface waters.

(a) Only approved BMPs are allowed for discharges to critical areas. Approved treatment BMPs are listed in Table 1.

(b) Provisions for shut down and containment are required near critical resources.

8. Redevelopment

Redevelopment projects must meet the same criteria as new development to the maximum extent practicable, unless infeasible to attain pollutant removal or water quality volume. Redevelopment provisions allow Town to decrease WQV and pollutant removal standards per s.5 and s.6 above.

For the purposes of the redevelopment projects, pre-development refers to the site as it was before it was developed. It does not refer to existing conditions.

9. Erosion and Sedimentation Controls

Please refer to the Town of Plymouth Zoning Bylaw, Section 205-18 Natural Features Conservation Requirements with respect to erosion and sediment controls.

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[5] In a Zone II of a public water supply, with respect to the Town of Plymouth Zoning Bylaw Section 205-57, the more restrictive of the water quality requirements shall govern where there is a discrepancy with these Guidelines.

[6] AND where said rare or endangered species is dependent on a resource which may be impacted by the proposed design (such as an 'upland' salamander depending on a vernal pool for reproduction).

10. Illicit Discharges

The applicant shall submit an Illicit Discharge Compliance Statement verifying no illicit discharges exist on the site. For redevelopment projects, the applicant must provide a summary of the steps taken to verify no illicit discharges.

11. Pretreatment

Pretreatment devices must be designed as follows:

(a) Pre-treatment devices shall be provided for each Stormwater Treatment System (STS); ***and***

(b) Pre-treatment devices shall be designed to capture anticipated pollutants, such as oil and grease; ***and***

(c) The Revised Universal Soil Loss Equation (RUSLE)8 shall be used to calculate sediment deposits that occur from pervious areas adjacent to the BMP; ***and***

(d) Pretreatment structures shall be sized to hold an annual sediment loading. An annual sediment load shall be calculated by adding the sediment loading from pervious areas to the sediment loading from impervious areas. The sediment loading from impervious areas should be calculated using a sand application rate of 500 lbs/acre for sanding of roadways, parking areas and access drives within the subcatchment area, a sand density of 90 lbs per cubic foot and assuming a minimum frequency of ten sandings per year. To obtain an annual sediment volume, perform the following calculation:

Sanding Load from Impervious Areas:

$$\text{Impervious area (acres) to be sanded} \times 500 \frac{\text{pounds}}{\text{Acre-storm}} \div 90 \frac{\text{pounds}}{\text{ft}^3} \times 10 \frac{\text{storms}}{\text{year}} = \text{cubic feet of sediment/yr}$$

$$\text{Annual sediment volume} = \underset{\text{From Impervious Areas}}{\text{Sediment Load}} + \underset{\text{from Pervious Areas}}{\text{Sediment Load}}$$

(e) The developer shall maintain any STSs used to trap sediment during construction to prevent sediment from leaving the site, and shall remove all sediment from all STSs when construction is finished and the site is stabilized.

12. O&M

All applicants must develop an O&M Strategy containing the information outlined in Section 2.0.

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8 Developed by the Natural Resources Conservation Service, USDA to predict soil erosion due to water.

4.0 Closed Drainage Systems

The following criteria shall be used to design closed drainage systems that collect and convey runoff from roadways. The requirements in this section shall not be interpreted to in any way reduce the requirement that stormwater systems must be decentralized to the extent practical. Except as amended herein, all other relevant provisions within this document apply to closed drainage systems.

1. Basis of Design

Closed systems shall be designed in accordance with the relevant provisions of the latest edition of the Massachusetts Highway Department Project Development and Design Guide, as amended herein.

(a) Rational Method – The Rational Method shall be used to size closed drainage system components and the following runoff coefficient values shall be applied:

- Heavily wooded: 0.20
- Grassed: 0.30
- Bare Ground and Gravel: 0.50
- Roads (paved and unpaved): 0.90
- All other pavement: 0.90
- Roofs: 0.90

2. Drainage Structures

(a) Catchbasin frames and grates shall be LeBaron LF 248-2, three flange or acceptable equivalent.

(b) Manhole frames and covers shall be LeBaron LF 110A or acceptable equivalent.

(c) A single grate catchbasin shall be considered to have a maximum inlet capacity of 2.5 CFS. Inlets of greater capacity shall be subject to individual analysis and approval.

(d) Systems with more than four catch basins shall have a gas/oil separator provided in the last structure prior to outlet.

3. Pipe

(a) Drain pipes shall be a minimum of 12 inches in diameter.

(b) Minimum cover for concrete pipe shall be 2.5 feet.

(c) Corrugated metal pipe shall not be used.

(d) High density polyethylene pipe (HDPE) may be used. Minimum cover shall comply with manufacturer requirements. In no case shall cover be less than 18 inches for HDPE pipe.

(e) In cases where 18 inches cover can not be provided, ductile iron pipe may be considered. Use of ductile iron pipe must be in accordance with manufacturer's requirements.

4. Leaching Drainage Structures

The following requirements apply specifically to roadway leaching drainage structures within roadways.

(a) Roadway leaching drainage structures are manholes or other subsurface structures that collect roadway drainage and provide infiltration capacity in lieu of an outlet to a swale or surface basin.

(b) Use of leaching drainage structures for peak control as described herein shall only be considered if it can be demonstrated that there is no practical means to outlet the stormwater to other Best Management Practices as described in Section 3.0 Design Performance Criteria.

(c) Leaching catch basins or drop inlets will not be allowed. All catch basins, including catch basins upstream of roadway leaching drainage structures, shall be provided with deep sumps.

(d) Roadway leaching drainage structures shall be sized using the Static Method specified in the Massachusetts Stormwater Handbook and the criteria contained herein. A percolation test shall be performed at the location of each roadway leaching drainage structure. An actual percolation rate of greater than ten minutes per inch will not be considered adequate for this type of design.

(e) Roadway leaching drainage structures shall be sized to provide a minimum of three feet of freeboard to the roadway surface above the maximum water elevation for the design storm event.

(f) A minimum design rate of four times the actual rate (measured by percolation test) will be used to size roadway leaching drainage structures.

5. Closed System Outlets

In order to verify that sufficient capacity will be provided in detention facilities downstream of closed system outlets collecting and conveying stormwater runoff from roadways, the Closed System Detention Worksheet in Appendix B shall be completed and submitted.

The worksheet is not intended in any way to replace or supercede other sizing criteria contained in these guidelines. The intention of this worksheet is to provide supplemental verification that adequate capacity exists to avoid roadway flooding during the design storm event.

Where it can be demonstrated that there is no risk of roadway flooding, the worksheet will not be required.

5.0 Stormwater Best Management Practices

5.1 BMP Selection

Not all BMPs are created equal. Some are suitable for controlling peak flows, but provide little to no water quality treatment. Some are suitable for permeable soils, but don't work well with tighter, clay soils. Some BMPs will remove a significant amount of sediment, but do little to treat phosphorus or nitrogen. In order to provide comprehensive stormwater management, BMPs must be selected to fit the site and ultimate treatment goals.

Plymouth has prepared a BMP selection matrix (Table 3) to aid in the selection and siting of BMPs based on specific site conditions. The applicability of various BMPs based on site specific information is summarized in the table through the use of a shaded circle and an outline of a circle. A shaded circle indicates that the BMP is applicable under that site criteria, while an outline of a circle indicates that it may be applied with careful site design. The absence of a circle indicates that the BMP is not appropriate for the particular site criteria. The site criteria evaluated for suitability includes:

- Drainage Area – The size of the drainage area going to the BMP will have some influence on the selection of BMPs, as some BMPs are well suited to large drainage areas, while others work best collecting stormwater from smaller areas. Plymouth encourages breaking the site up into smaller drainage areas for treatment.

- Soil Hydrologic Group – The soil hydrologic group influences the type of BMP that can be used on the site, particularly, infiltration type BMPs. Applicability is defined based on the four soil classifications A, B, C and D.

- Land Area – The amount of land required for each BMP was defined simply as 'Requires Large Land Area' and 'Requires Small Land Area'.

- Applicability – Defines the applicable uses of each BMP including peak control, recharge, water quality control, oil/grease and floatable removal, pretreatment, conveyance and distribution.

- Pollutant Removal – General pollutant removal efficiencies for each BMP were listed as available for total suspended solids, bacteria, total nitrogen and total phosphorus. These removal efficiencies are provided to aid in the selection of BMPs to address stormwater discharges to impaired waters. For example, if a water body is listed as impaired due to excess bacteria levels, a BMP targeted for bacteria removal should be selected.

  New development and redevelopment BMPs located in the Plymouth Harbor drainage area shall be optimized for nitrogen removal (see Table 3 for nitrogen removal ratings).

- Setbacks – Setbacks to several features are listed for certain BMPs. These setbacks are based on septic system setbacks outlined in 310 CMR 15.000.

- References – References are provided for further information on BMP design.

Table 3. Best Management

	Drainage Area (acres)					Soil Hydrologic Group				Depth to High Water Table / Depth to		Land Area		Applicability							Pollutant Removal				
	0-5	5-10	10-25	25-50	50+	A	B	C	D	0-3 ft	3+ ft	Requires Large Land Area	Requires Small Land Area	Peak Control	Recharge	WQ Control	Oil/Grease & Floatables Removal	Pretreatment	Conveyance	Distributes	TSS	Bacteria	Total Nitrogen	Total Phosphorus	Reference
Low Impact Development (LID)																									
Site Management Practices																									
Comprehensive LID Site Design	●	●	●	●	●	●	●	●	●	●	●		●	○											
Disconnect Impervious Area	●	●	●	●	●	●	●	●	●	●	●		●	○											
Minimize Disturbance Area	●	●	●	●	●	●	●	●	●	●	●		●	○											
Minimize Site Imperviousness	●	●	●	●	●	●	●	●	●	●	●		●	○											
Flow Path Practices	●	●	●	●	●	●	●	●	●	●	●		●	○					●	●					
Preserve Infiltratable Soils	●	●	●	●	●	●	●	●	●	●	●		●	○											
Preserve Natural Depression Areas	●	●	●	●	●	●	●	●	●	●	●		●	○											
Other: Natural Vegetation Preservation, Soil Amendment	●	●	●	●	●	●	●	●	●	●	●		●	○											
Interception or Recharge Practices (constructed BMPs)																									
Green Roof						●	●	●	●	●	●			○							No Credit				1
Rain Barrel/Cisterns (with on-site re-use)						●	●	●	●	●	●		●								No Credit				1
Rain Garden/Bioretention[1]	●					●	●	○	○	○	●		●	○	●	●					90%, 90%		30-50%, 65%	30-90%, 65%	1, 2
Pervious Pavers/Pervious Pavement	●	●	●	●	●	●	●			○	●			●	●	●					80%				1
Runoff Management BMPs																									
Basins																									
Detention	○	○	●	●	●	●	●	●	●	○	●	●		●							No Credit	<10%	5-50%	10-30%	1
Dry Extended Detention	○	○	●	●	●	●	●	●	●	○	●	●		●		○					50%, 58%	<10%	15-50%, 30%	10-30%, 26%	1, 2
Wet Extended Detention ("Enhanced Wet Pond")	○	○	●	●	●	●	●	●	●	●	●			●		●					80%		55%	68%	2
Wet Pond	○	○	●	●	●	○	●	●	●	●	●	●		●		●					80%, 70%	40-90%	10-50%, 35%	30-70%, 45%	1, 2
Created Wetland	○	○	●	●	●	○	○	●	●	●	○	●		●		●					80%, 80%	75%	20-55%, 55%	40-60%, 42%	1, 2
Buffers																									
Vegetated Filter Strip	●					●	●	●	●	●	●			○		●					10 (25°) - 45% (50°), 73%		No data, 46%	No data, 45%	1, 2
Infiltration Systems																									
Infiltration Basin (Recharge Basin)	●	●	●	●		●	●				●	●		●	●	●					80%, 90%	90%	50-60%, 60%	60-70%, 65%	1, 2
Infiltration (Recharge) Trenches and Beds	●	●				●	●				●	●		●	●	●					80%, 75%	90%	40-70%, 55%	40-70%, 60%	1, 2
Dry Wells and Galleys	●	○				●	●				●		●	○	●	●					80%				1
Leaching Catch Basins/Leaching Basins	●					●	●				●		●	○	●	●					90%				1
Filter Systems																									
Organic/Sand Filter	●					●	●	●	●	○	●		●			●					80%, 85%		20-40%, 10%	10-50%, 45%	1, 2
Rain Garden/Bioretention[1]	●					●	●	○	○	○	●		●		○	●					80%, 90%		30-50%, 65%	30-90%, 65%	1, 2
Water Quality Swales																									
Dry Swale	●					●	○				●		●		○	●			●						
Wet Swale	●					○	○	●	●	●	○		●			●		○	●		70%	65%	10-90%	20-90%	1, 2
Bioretention swale	●					●	●	○	○	○	●		●		○	●			●		70%		10-90%	20-95%	1
Vault Structures																									
Deep Sump Catch Basins	●					●	●	●	●	●			●					●			25%				1
Water Quality Inlet/Oil/Water Separator	●					●	●	●	●				●			○	●	●	○		25%				1
Hydrodynamic Separators	●					●	●	●	●	○	●		●			○	○	●	○		Varies, 35%		No data, 10%	No data, 5%	1, 2
Proprietary Systems (some proprietary systems may be covered in the above categories)																									
Other "Vault" Structures	●	●	○			●	●	●	●	○	●					○	○	●	○						
Catch Basin Inserts	●					●	●	●	●							○	●	●							
Outlet Adaptations	●					●	●	●	●							○	●	○		○					
Conveyance Practices																									
Vegetated Channel						●	●	●	●	●	●		●			○		●	●		50%				1
Level Spreader	●					●	●	●	●				●												
Flow Splitter	●	●	●	●	●	●	●	●	●				●							●					

● Applicable
○ May be applicable w/ careful design

References:
1 Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations, Massachusetts Stormwater Handbook

3 NH DES Memorandum, Subject: BMP Removal Efficiencies for TSS, TN and TP, Date Last Revised: 5/24/07

Notes:
[1]Bioretention in C and D soils requires an underdrain to discharge.

[2]Setbacks from Massachusetts Title 5 Regulations, 310 CMR 15.00, obtained from MA DEP's website on October 5, 2007. Setbacks for the Detention Basin and all setbacks under 'Septic System Leachfield and Septic System Tank' are from the Stormwater Management Standards in association with the Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations.

Table 3. Best Management

	Setbacks (feet)[2]																					Design References for Further Information
	Private Wells	Public Wells	Irrigation Well	Public Reservoir	Tributaries to Surface Water Supplies	Upslope Surface Waters	Downslope Surface Waters	Open, Surface or Subsurface Drains which discharge to Surface Water Supplies or Tributaries thereto	Other Open, Surface or Subsurface Drains (excluding foundation drains) which intercept seasonal high groundwater table	Other Open, Surface or Subsurface Drains (excluding foundation drains)	Cellar Foundations	Slab Foundations	Property Lines	Bordering Vegetated Wetland, Salt Marshes, Inland and Coastal Bank	Certified Vernal Pools	Wetlands bordering Surface Water Supply or Tributary thereto	Slope	Septic System Leach Fields	Septic System Tank	
Low Impact Development (LID)																						
Site Management Practices																						Prince George's County Maryland DER
Comprehensive LID Site Design																						Prince George's County Maryland DER
Disconnect Impervious Area																						Prince George's County Maryland DER
Minimize Disturbance Area																						Prince George's County Maryland DER
Minimize Site Imperviousness																						Prince George's County Maryland DER
Flow Path Practices																						
Preserve Infiltratible Soils																						
Preserve Natural Depression Areas																						
Other: Natural Vegetation Preservation, Soil Amendment																						
Interception or Recharge Practices (constructed BMPs)																						MA LID Toolkit
Green Roof																						MA LID Toolkit
Rain Barrel/Cisterns (with on-site re-use)																						MA LID Toolkit
Rain Garden/Bioretention[1]	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50				MA LID Toolkit
Pervious Pavers/Pervious Pavement	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50				MA LID Toolkit
Runoff Management BMPs																						
Basins																						
Detention	50												10					50	25			MassHighway 2004
Dry Extended Detention																						MassHighway 2004
Wet Extended Detention ("Enhanced Wet Pond")																						MassHighway 2004
Wet Pond																						MassHighway 2004
Created Wetland																						MassHighway 2004
Buffers																						
Vegetated Filter Strip																						MassHighway 2004
Infiltration Systems																						
Infiltration Basin (Recharge Basin)	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50	100			MassHighway 2004
Infiltration (Recharge)Trenches and Beds	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50	100			MassHighway 2004
Dry Wells and Galleys	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50	100			MassHighway 2004
Leaching Catch Basins/Leaching Basins	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15					MassHighway 2004
Filter Systems	100	400	25	400	200	50	50	100														
Organic/Sand Filter																						
Rain Garden/Bioretention[1]	100	400	25	400	200	50	50	100	50	10	20	10	10	50	100	100	15	50	100			MassHighway 2004
Water Quality Swales																						
Dry Swale																						MassHighway 2004
Wet Swale																						MassHighway 2004
Bioretention Swale																						MassHighway 2004
Vault Structures																						
Deep Sump Catch Basins																						MassHighway 2004
Water Quality Inlet/Oil/Water Separator																						MASTEP
Hydrodynamic Separator																						
Proprietary Systems (some proprietary systems may be covered in the above categories)																						MASTEP
Other Vault Structures																						MASTEP
Catch Basin Inserts																						MASTEP
Outlet Adaptations																						
Conveyance Practices																						MassHighway 2004
Vegetated Channel																						
Level Spreader																						MassHighway 2004
Flow Splitter																						

● Applicable

○ May be applicable w/ careful design

References:

1 Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations, Massachusetts Stormwater Handbook

2 NH DES Memorandum, Subject: BMP Removal Efficiencies for TSS, TN and TP, Date Last Revised: 5/24/07

Notes:

[1]Bioretention in C and D soils requires an underdrain to discharge.

[2]Setbacks from Massachusetts Title 5 Regulations, 310 CMR 15.00, obtained from MA DEP's website on October 5, 2007. Setbacks for the Detention Basin and all setbacks under 'Septic System Leachfield and Septic System Tank' are from the Stormwater Management Standards in association with the Massachusetts Wetland Protection Regulations and 401 Water Quality Certification Regulations.

In addition to the references provided in the BMP Matrix table, Plymouth has outlined important design considerations for some BMPs. These are included in Table 4. In some cases, these design considerations include refinement taking into account local conditions and preferences and should take precedence.

Plymouth has also outlined its preferences for the types of BMPs used to achieve Low Impact Development Goals. These preferences are included in Table 5.

5.2 Other Design Considerations

Landscape features also play an important role to the hydrologic cycle. Soil preparation and plant selection can impact the amount of runoff leaving a site and influence watering requirements. Plymouth recommends that an experienced landscape designer be involved in the selection of plants for the landscape and for stormwater treatment BMPs such as bioretention devices to promote an appropriate selection that is attractive and functional for the available site conditions.

5.3 As-built Drawings Requirement

The permittee shall submit as-built drawings prior to Town's issuance of certificate of occupancy. The as-built drawings must depict all on-site controls, both structural and non-structural, designed to manage the stormwater associated with the completed site.

Table 4. Important Design Considerations	
BMP Type	**Important Design Considerations**
Low Impact Development (LID)	
Site Management Practices	Projects must undergo pre-file for review before final design. Pre-filing submittal requirements are outlined in Section 2.0.
Interception or Recharge Practices (constructed BMPs)	
Green Roof	
Rain Barrel/Cisterns (with on-site re-use)	
Rain Garden/Bioretention	1. Soil mix must contain <5% silt/clay passing the #200 sieve; 2. Filter fabric shall not be placed beneath the soil mix; 3. Underdrain required in C, D soils and where groundwater levels exceed allowable clearance for infiltration.
Pervious Pavers/Pervious Pavement	1. If unit pavers are used, joints must be at least 3/8" wide or consist of units with a pattern of open areas that allow for infiltration of runoff. 2. Pavers must be placed over an open-graded aggregate base that filters, stores, and infiltrates runoff.
Runoff Management BMPs	1. Emergency spill ways shall be designed to safely pass the 100-year storm assuming the primary outlet structure is not functioning.
Basins	
Detention	
Dry Extended Detention	
Wet Extended Detention	
Wet Pond	1. An underdrain gravel outlet must be used to cool discharges to cold water fisheries. 2. The permanent pool must be sized with a minimum pool to runoff ratio of 4:1.
Created Wetland	
Buffers	
Vegetated Filter Strip	
Infiltration Systems	1. Pretreatment to remove sediments is required for all infiltration systems and must be sized to hold one year worth of sediment; 2. When used as treatment, infiltration rate may not exceed 2.4 inches/hour; 3. Soil infiltration rates shall be calculated in accordance with the Massachusetts Stormwater Handbook; 4. Minimum 3 foot separation between bottom of BMP and seasonal high groundwater; 5. Infiltration systems must drain completely within 72 hours; 6. Avoid compaction of soils in infiltration area. 7. Closed roadway infiltration systems shall provide three feet of freeboard.
Infiltration Basin (Recharge Basin)	
Infiltration (Recharge) Trenches and Beds	
Dry Wells and Galleys	

Table 4. Important Design Considerations	
Leaching Catch Basins/Leaching Basins	
Filter Systems	
Organic/Sand Filter	
Bioretention (includes rain gardens)	1. Soil mix must contain <5% silt/clay passing the #200 sieve; 2. No filter fabric is allowed beneath the soil mix; 3. Underdrain required in C, D soils and where groundwater levels exceed allowable clearance for infiltration.
Water Quality Swales	
Dry Swale	Conform to design criteria in MassHighway (2004), except delete the "Hydraulic Residence Time" criterion and instead size the swale to retain and infiltrate the Water Quality Volume
Wet Swale	Size for WQV (MassHighway, 2004)
Bioretention Swale	Size for WQV (MassHighway, 2004)
Vault Structures	
Deep Sump Catch Basins	
Water Quality Inlet/Oil/Water Separator	
Hydrodynamic Separators	Performance criteria must be documented, based on credible study (as categorized by MASTEP) - see Note 1
Proprietary Systems (some proprietary systems may be covered in the above categories)	
Other "Vault" Structures	Performance criteria must be documented, based on credible study (as categorized by MASTEP) - see Note 1
Catch Basin Inserts	Performance criteria must be documented, based on credible study (as categorized by MASTEP) - see Note 1
Outlet Adaptations	Performance criteria must be documented, based on credible study (as categorized by MASTEP) - see Note 1
Conveyance Practices	
Vegetated Channel	Vegetated channels shall be designed for both capacity (ability to carry design flows without overtopping) and stability (resistance to erosion under the full range of design flows)
Level Spreader	Level spreaders must be sited and constructed, so as not to result in the re-establishment of concentrated flow down-slope of the device.
Flow Splitter	

Notes:

1. The Massachusetts Stormwater Technology Evaluation Project (MASTEP) provides a web site at http://www.mastep.net/ to provide verified technical information on innovative technologies for stormwater Best Management Practices (BMPs). The program does not rate the technologies, but provides information on whether the technologies have been evaluated according to accepted protocols and/or credible scientific evaluation procedures. Vendors' claims regarding removal efficiencies for particular products should be evaluated only after consulting the MASTEP database, to determine whether appropriate studies have been conducted to verify the claims.

Table 5. Preferred BMPs for LID

	Preferred BMPs Based on Soil Types and Groundwater		
	A or B Soils	**C or D Soils**	**High Groundwater**
1. Always begin with Site Management Practices to minimize runoff a. Minimize disturbance area b. Preserve natural depression areas c. Preserved infiltratable soils d. Minimize site imperviousness e. Disconnect impervious area	1. Dry wells/ leaching catch basins 2. Pervious pavement 3. Greenroof 4. Filter strips 5. Rain barrel/ cistern	1. Filter strips 2. Rain barrel/ cistern	1. Filter strips 2. Greenroof 3. Rain barrel/ cistern
2. Implement water quality BMPs for remaining runoff. Control the stormwater runoff where it is generated rather than an "end of pipe" solution. Consider the pollutant of concern based on the type of development and known impairments to receiving waters. All BMPs require pretreatment.	1. Raingardens/ bioretention that infiltrates 2. Surface infiltration system 3. Organic/ sand filter 4. Dry treatment swale 5. Vegetated filter strip 6. Extended detention	1. Raingardens/ bioretention to underdrain discharge 2. Organic/ sand filter to underdrain discharge 3. Wetlands 4. Wet pond 5. Wet or dry treatment swale 6. Vegetated filter strip 7. Extended detention	1. Raingardens/ bioretention to underdrain discharge 2. Organic/ sand filter to underdrain discharge 3. Wetlands 4. Wet pond 5. Wet or dry treatment swale 6. Vegetated filter strip 7. Extended detention
3. Provide peak flow control for remaining runoff.	1. Extended detention 2. Detention basin 3. Underground peak control	1. Extended detention 2. Detention basin 3. Wet pond 4. Underground peak control	1. Extended detention 2. Detention basin 3. Wet pond 4. Underground peak control
4. The following may not be used as a stand alone treatment device, rather can be used as pretreatment in combination with other treatment devices. a. Water quality inlet/oil/water separator b. Hydrodynamic separators c. Other "vault" structures d. Catch basin inserts			