ENGINEERING, INC.
ENGINEERS
SURVEYORS

STORMWATER REPORT

For

Maritime Haven

36, 42, 48 Robinwood Road
Wareham, MA 02532

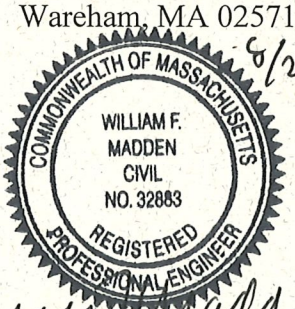
Prepared for

RESI, LLC

2 Charles Street
Providence, RI 02904

Prepared by

G.A.F. Engineering, Inc.
266 Main Street
Wareham, MA 02571



8/25/21

August 25, 2021
G.A.F. Job No.: 20-9600

266 MAIN ST.
WAREHAM, MA 02571

TEL 508.295.6600
FAX 508.295.6634

Table of Contents

DRAINAGE NARRATIVE

General Description

The project site is comprised of three parcels of land currently shown as lots A, B, and C on Wareham Assessors Map 4. The total area of the lots is 8.03 acres. Each of the lots has frontage on Robinwood Road and waterfront access to Buzzards Bay.

Lot A contains the remains of an old foundation and garage slab. Lot B is the site of the former friary, a seven-bedroom mansion style building. There is a garage with a small apartment unit on Lot C.

The property is proposed to be re-developed as a seven-lot residential subdivision with each lot containing a minimum of 43,000 square feet of land and 180 feet of frontage. The additional frontage and access required to create the lots will be provided by the construction of a twenty-foot wide paved road within a forty-foot layout. The road will intersect Robinwood Road near the center of the property and extend for a distance of approximately 650 feet to a cul-de-sac. The existing structures will be demolished and removed from the site.

This project is required to comply with the Massachusetts Stormwater Management Standards as well as the applicable drainage requirements of the Town of Wareham. A detailed description of the system design and performance is provided as follows.

Existing Conditions

This property, being adjacent to Buzzards Bay, is located within coastal flood zones as determined by FEMA ranging from velocity zones VE-18 and VE-19 to AE-16 and AE-14 which extends across Robinwood Road.

Approximately two thirds of the property is open lawn area that is relatively flat with several low areas that contain stormwater such that there is no existing discharge onto abutting properties or into Buzzards Bay. The northwest third of the property is wooded. The topography rises toward Robinwood Road to elevation fifteen at the very northwest corner. At this location there is a small deep isolated vegetated wetland which will not be disturbed by the project.

There are two soils classifications on the property as mapped by the USDA Natural Resources Conservation Service. The central and northern portions of the property are mapped as unit 259B, Carver loamy coarse sand, 3 to 8 percent slopes, with a Hydrologic Soil Group rating A. The areas adjacent to Robinwood Road and extending southward to the existing access driveway and the lawn area between the large house and beach are mapped as unit 256B, Deerfield loamy fine sand, 3 to 8 percent slopes, also having a Hydrologic Soil Group rating A. The presence of these pervious soils combined with the existing topography contains stormwater on the property.

Proposed Conditions

The stormwater management system design for this project utilizes a low impact development approach by minimizing changes is topography necessary for the road construction and by specifying a water quality swale and raingarden to provide the necessary water quality treatment and infiltration requirements as dictated by the pervious soils.

The road grades will be established at one percent longitudinally with a cross pitch of two percent to the north side. No curbing is proposed along this side of the road so that stormwater can flow onto the grassed shoulder freely and enter the water quality swale along its entire length.

The swale terminates at the low point in the road at the entrance to a five foot wide by one hundred thirty foot long raingarden which provides the final treatment and infiltration of the required water quality volume.

Each of the homes will be constructed with flood zone compliant foundations which have fill restrictions such that the majority of the lawn areas of the lots will remain at there present elevations. This will ensure that there will be no new discharge of stormwater onto adjacent properties or to Buzzards Bay.

In order to minimize surface runoff on the lots and provide additional infiltration each home will collect the roof runoff and convey it to subsurface chambers. A minimum of two chambers for each home have been specified to provide storage in excess of the minimum infiltration requirements.

Due to the above proposed design elements, existing site topography and soils, and location within a coastal flood zone, a waiver is being requested from the requirement to analyze pre-development and post-development runoff rates and volumes. As previously noted any potential increases are retained on the project site.

In our opinion the successful development of this project in compliance with the design will not result in any adverse impacts to the environment or adjacent properties with respect to stormwater runoff. Compliance with each of the standards listed within the Massachusetts Stormwater Management Handbook are included within this report.

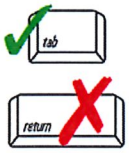
.

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

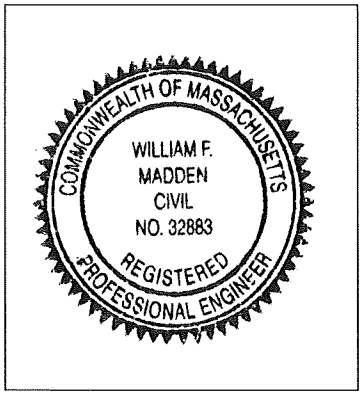
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

COMPLIANCE WITH THE STORMWATER MANAGEMENT STANDARDS

The Stormwater Management Standards

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

    - *This project does not include any conveyances that discharge off the site.*

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

    - *This project is located within land subject to coastal storm flowage. A waiver is requested from the requirement to analyze peak discharge rates.*

3. Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

    - *Recharge for each home is provided with the collection of roof runoff which is directed to subsurface chambers. A raingarden has been specified for the treatment and infiltration of the road runoff.*

4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

    a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
    b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
    c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

- *This project includes a water quality swale and raingarden to achieve the required TSS removal rate.*

5. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

    - *This project is not considered a land use with higher potential pollutant loads.*

6. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

    - *This project is not located within a Zone II of a public water supply. There are no existing or proposed stormwater discharges.*

7. A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

- *This project is considered new development. Full compliance with the standards is the goal of this project.*

8. A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

    - *Construction period erosion and sedimentation control measures are included on the design plans and in this report.*

9. A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

    - *A long-term operation and maintenance plan has been listed on the design plans and is included in this report.*

10. All illicit discharges to the stormwater management system are prohibited.

    - *An illicit discharge compliance statement is included in the drainage report.*

Date: 8/25/2021

To whom it may concern:

I hereby certify that no illicit discharge connections to the drainage system presently exist for the Maritime Haven subdivision nor will any be permitted in the future.

RESI , LLC

Long Term Operation and Maintenance Plan

Responsible Party: Maritime Haven Homeowners Association
Maritime Row
Wareham, MA 02532

The property owners are responsible for the inspection, operation and maintenance of the Stormwater Management System. The Homeowners Association will be provided with copies of the approved site design and as-built plans to make them aware of the locations of system components. A copy of this Operation and Maintenance (O & M) Plan should also be provided.

System Description: The drainage system consists of a water quality swale which runs parallel to the road along the north side. Runoff is conveyed in the swale to a low point where it enters a raingarden for final storage, treatment, and infiltration.

Water Quality Swale: Drainage swales shall be inspected semi-annually. Maintenance and repairs must be made as necessary. Additional inspections should be made during the first few months to make sure the vegetation becomes adequately established. Repair and re-seed as required. Check swales for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, erosion, ponding and sedimentation. Regular maintenance includes mowing, fertilizing, liming, watering, pruning, and weed and pest control. Mow drainage swales at least once per year. Grass clippings shall be removed. Do not cut the grass shorter than 3-4 inches, otherwise the effectiveness of the vegetation in reducing flow velocities and pollutant removal may be diminished. Do not let the grass height exceed six inches. Manually remove sediment and debris at least twice a year and re-seed if necessary to maintain a dense growth of vegetation. Sediment shall be disposed of in accordance with all local, state, and federal regulations.

Raingardens: Bio-retention areas (raingardens) shall be inspected at least once per year to ensure the basin is operating as intended. Inspect the basin during and after major storm events for evidence of clogging or erosion. Potential problems which should be checked include subsidence, erosion, cracking or tree growth on the side slopes. Make any necessary repairs immediately. Mow the side slopes at least twice per year. Remove sediment as necessary and dispose of in accordance with local, state, and federal guidelines and regulations.

Inline Drains: Inline drains shall be cleaned four times per year and inspected monthly. Any removed sediment shall be disposed of in accordance with local, state, and federal guidelines and regulations.

Check Dams: A check dam is a small dam constructed across a drainage swale. The check dam serves to lower the velocity of flow. Reduced runoff velocity reduces erosion and gullying in the channel and allows sediment to settle out. Inspect check dams after significant rainfall events and

when maintaining the swale. Repair any damage and remove sediment as needed. Sediment shall be disposed of in accordance with all local, state, and federal regulations.

Public Safety Features: The raingarden and swale are constructed with 3:1 side slopes. They will drain dry shortly after the end of the storm events.

Operation and Maintenance Budget: The estimated annual cost for inspection, mowing, and sediment removal associated with the maintenance of the Stormwater Management System is $1,500.

Reference: For full details on drainage system Construction, Operation and Maintenance refer to the current edition of the Massachusetts Stormwater Handbook.

Construction Period Pollution Prevention and

Erosion & Sedimentation Control Plan

Narrative: This project consists of construction of a private residential subdivision road with associated grading, drainage, and utilities.

Responsible Parties: The site contractor and the owner.

Construction Period Operation / Maintenance Plan:

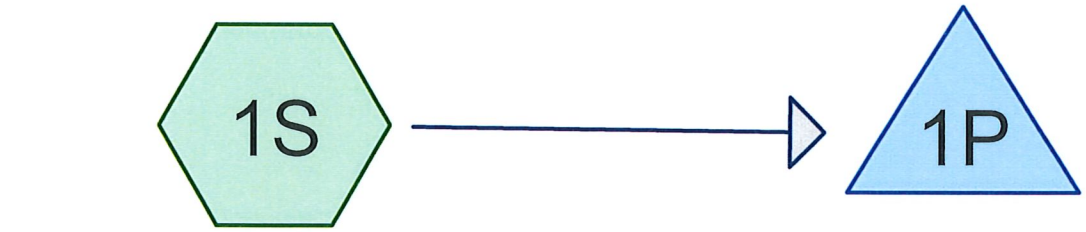
- Provide sufficient refuse containers and empty as needed.
- Inspect erosion controls daily. Repair or replace as needed.
- Police the area for safety hazards and trash on a daily basis.
- Store materials away from drainage and resource areas.
- Provide or receive only the materials which can be installed promptly.
- Inspect vehicles for leaks and repair or replace when necessary.
- Provide dust control with watering.
- Maintain truck runoff pads.
- Provide a contact person for complaints and to receive notification of problems.
- Direct dewatering to adequately sized containment areas.

Construction Sequence:

- Install erosion controls per the plans.
- Install silt sacks in existing catch basins.
- Clear the land, remove stumps, and rough grade.
- Demolish and remove existing buildings and foundations.
- Install drainage structures and utilities.
- Install base course of pavement.
- Install top course pavement.
- Install landscaping. Loam & seed disturbed areas.
- Install permanent pavement markings.
- Remove erosion controls.

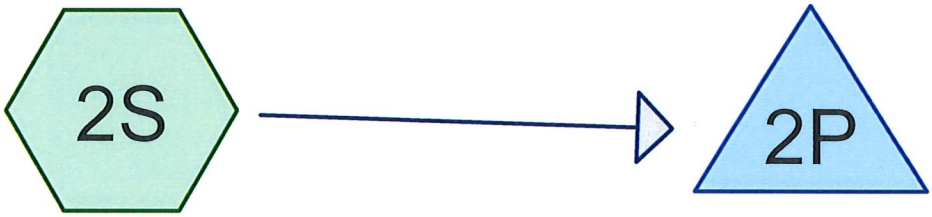
Maintenance Schedule:

- Erosion controls are to be inspected daily and repaired or replaced as needed.
- Trash is to be picked up daily.
- Water shall be used for dust control as needed.
- Silt sacks shall be emptied or replaced when full.
- Vehicles shall be inspected daily for any leaks and repaired or replaced as needed.



Road and Driveways

Raingarden & WQS



2000 SF Roof

Cultec Chambers

Subcat Reach Pond Link

Routing Diagram for 9600 WQV

Prepared by G.A.F. Engineering, Inc., Printed 8/24/2021

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.046	98	Portion of House Roof (2S)
0.367	98	Road and Lots 50 and 51 drives (1S)
0.413	**98**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.413	Other	1S, 2S
0.413		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchme Numbers
0.000	0.000	0.000	0.000	0.046	0.046	Portion of House Roof	2S
0.000	0.000	0.000	0.000	0.367	0.367	Road and Lots 50 and 51 drives	1S
0.000	**0.000**	**0.000**	**0.000**	**0.413**	**0.413**	**TOTAL AREA**	

Time span=1.00-36.00 hrs, dt=0.05 hrs, 701 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Road and Driveways Runoff Area=16,000 sf 100.00% Impervious Runoff Depth=0.79"
Tc=6.0 min CN=98 Runoff=0.32 cfs 0.024 af

Subcatchment 2S: 2000 SF Roof Runoff Area=2,000 sf 100.00% Impervious Runoff Depth=0.79"
Tc=6.0 min CN=98 Runoff=0.04 cfs 0.003 af

Pond 1P: Raingarden & WQS Peak Elev=2.17' Storage=319 cf Inflow=0.32 cfs 0.024 af
Outflow=0.07 cfs 0.024 af

Pond 2P: Cultec Chambers Peak Elev=4.31' Storage=25 cf Inflow=0.04 cfs 0.003 af
Outflow=0.01 cfs 0.003 af

Total Runoff Area = 0.413 ac Runoff Volume = 0.027 af Average Runoff Depth = 0.79"
0.00% Pervious = 0.000 ac 100.00% Impervious = 0.413 ac

Summary for Subcatchment 1S: Road and Driveways

Runoff = 0.32 cfs @ 12.09 hrs, Volume= 0.024 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1 Inch First Flush Rainfall=1.00"

	Area (sf)	CN	Description
*	16,000	98	Road and Lots 50 and 51 drives
	16,000		100.00% Impervious Area

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

Summary for Subcatchment 2S: 2000 SF Roof

Runoff = 0.04 cfs @ 12.09 hrs, Volume= 0.003 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1 Inch First Flush Rainfall=1.00"

	Area (sf)	CN	Description
*	2,000	98	Portion of House Roof
	2,000		100.00% Impervious Area

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

Summary for Pond 1P: Raingarden & WQS

Inflow Area = 0.367 ac,100.00% Impervious, Inflow Depth = 0.79" for 1 Inch First Flush event
Inflow = 0.32 cfs @ 12.09 hrs, Volume= 0.024 af
Outflow = 0.07 cfs @ 12.25 hrs, Volume= 0.024 af, Atten= 77%, Lag= 9.7 min
Discarded = 0.07 cfs @ 12.25 hrs, Volume= 0.024 af

Routing by Stor-Ind method, Time Span= 1.00-36.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 2.17' @ 12.49 hrs Surf.Area= 1,300 sf Storage= 319 cf

Plug-Flow detention time= 50.8 min calculated for 0.024 af (100% of inflow)
Center-of-Mass det. time= 50.5 min (838.3 - 787.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1.00'	250 cf	**5.00'W x 130.00'L x 1.00'H Crushed Stone** 650 cf Overall - 26 cf Embedded = 624 cf x 40.0% Voids
#2	1.25'	26 cf	**6.0" Round Pipe Storage** Inside #1 L= 130.0'
#3	2.00'	520 cf	**5.00'W x 130.00'L x 2.00'H Engineered Soil** 1,300 cf Overall x 40.0% Voids
#4	4.00'	3,016 cf	**5.00'W x 130.00'L x 2.00'H Raingarden Z=3.0**
#5	5.00'	1,710 cf	**3.00'W x 380.00'L x 1.50'H Prismatoid**
		5,521 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	1.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 12.25 hrs HW=2.04' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

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

Version 1, Automated: Mar. 4, 2008

Location: 36, 42, 48 Robinwood Road Wareham

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Water Quality Swale - Dry	0.70	1.00	0.70	0.30
Rain Garden	0.90	0.30	0.27	0.03
	0.00	0.03	0.00	0.03
	0.00	0.03	0.00	0.03
	0.00	0.03	0.00	0.03

Total TSS Removal = 97%

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

Project: Maritime Haven
Prepared By: GAF Engineering, Inc.
Date: 25-Aug-21

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

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

Recharge Volume Calculation

Required Recharge Depth = 0.60 inch volume from impervious surfaces (HSG A Soil)

The roof area for each home is approximately 1,575 square feet. Design for 2,000 square feet.

Required Recharge Volume = 2,000 sf x 0.60/12 = 100 cubic feet

Total volume in underground chambers = 230 cubic feet

230 cf > 100 cf OK

Recharge System Drawdown time (72 hrs. max.)

$$\text{Time} = \frac{\text{Storage Volume}}{(\text{Rawls Rate})\,(\text{Bottom Area})}$$

Chambers:

$$\text{Time} = \frac{230 \text{ cf}}{(2.41 \text{ inches/hour})(1 \text{ ft}/12 \text{ inches})(196 \text{ sf})}$$

5.84 hours < 72 hours OK

The Raingarden provides a volume in excess of the 1.0 inch water quality volume therefore it also exceeds the required infiltration volume. The drawdown time is confirmed below.

$$\text{Time} = \frac{5{,}521 \text{ cf}}{(2.41 \text{ inches/hour})(1 \text{ ft}/12 \text{ inches})(650 \text{ sf})}$$

42 hours < 72 hours OK

Water Quality Volume Calculation

Area to Raingarden

Design Water Quality Depth = 1.00 inch volume from pavement

Total Pavement Area = 16,000 sf

Water Quality Volume = 16,000 sf x 1.00"/12 = 1,333 cf

Total Storage in Raingarden = 5,521 cf (HydroCAD)

5,521 cf > 1,333 cf - OK

G.A.F. Engineering, Inc.
August 25, 2021
G.A.F. Job No.: 20-9600

Hydrologic Soil Group—Plymouth County, Massachusetts
(Maritime Haven)

MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 13, Jun 9, 2020

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

Date(s) aerial images were photographed: Jul 10, 2018—Nov 17, 2018

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	D	1.5	1.0%
53A	Freetown muck, ponded, 0 to 1 percent slopes	B/D	1.8	1.2%
66A	Ipswich - Pawcatuck - Matunuck complex, 0 to 2 percent slopes, very frequently flooded	A/D	6.2	4.0%
252A	Carver coarse sand, 0 to 3 percent slopes	A	0.1	0.0%
256B	Deerfield loamy fine sand, 3 to 8 percent slopes	A	10.9	7.0%
259B	Carver loamy coarse sand, 3 to 8 percent slopes	A	42.3	27.4%
259C	Carver loamy coarse sand, 8 to 15 percent slopes	A	22.2	14.4%
608	Water, ocean		66.8	43.3%
610	Beaches, sand		2.4	1.6%
Totals for Area of Interest			**154.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher