Storm Water Management Report

Crescent Avenue
Improvements & Extension
Determination of Adequacy
Plymouth County, Pembroke, Ma

Prepared For:

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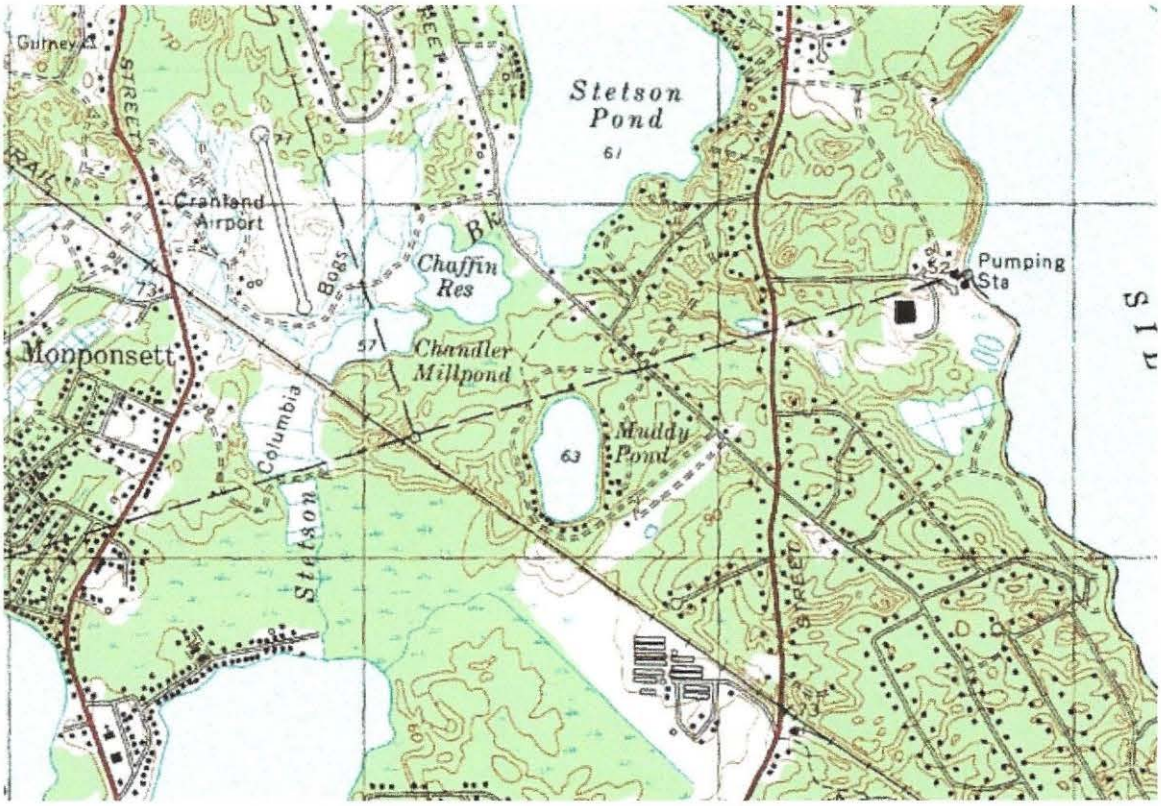
July 10, 2020

Location: **Crescent Avenue**
Pembroke, Ma

Land Use: **New Development / Redevelopment**

Resource: **Crystal Lake, Tributary to a Drinking Water Supply**

Best Management Practices: **Proposed catch basins with sumps & Ultra Urban Inserts w/ Smart Sponge Filter & Cultec 330XLHD Underground Recharge Areas.**



Existing Conditions

Crescent Avenue is located on the South side of Pembroke, off the West side of Plymouth Street, near the Halifax Town line. The entrance to Crescent Ave is approximately fourteen feet wide with degraded pressure treated timber retaining walls on both sides. There are no paved radius areas at the entrance making the street inaccessible to all large town and emergency vehicles.

The existing average pavement width, for Crescent Avenue, is twelve to fourteen feet and serves as access to three houses, house number 9, 10 and the applicant's house along Crystal Lake. The paved portion of Crescent Avenue extends approximately three hundred and twenty five feet from Plymouth Street. The applicant's access, to his house on Crystal Lake, is by way of a private drive off Crescent Avenue constructed for house number 10 that connects to his property.

There are no existing turn-around areas on Crescent Avenue therefore all traffic must use private driveways in order to prevent backing out onto Plymouth Street.

The Lot is not located within Flood Zone, as shown on FIRM Map Number 25023C0203J, Effective Date: July 17, 2012.

Soil Conservation Services (SCS) Soils Survey of Plymouth County, Massachusetts, classifies soils on the property as MfB, Merrimac sandy loam, 0 to 8 percent slopes, hydrologic group A. Permeability is moderately rapid in the solum and rapid to very rapid in the substratum. These soil types are consistent with that found on site in ground water observation holes preformed by: Collins Civil Engineering Group, Inc.

The site does not fall within an "Area of Critical Environmental Concern" (ACEC). No portion of the site is located within a Priority Habitat and Estimated Habitat area as shown on the Massachusetts Natural Heritage Atlas, 13Th Edition.

Proposed Conditions

The applicant owns four plots of land located along the undeveloped portion of Crescent Avenue in the Town of Pembroke, Ma. With proposed improvements, the applicant will be able to access three buildable lots bringing the total number of single-family homes on Crescent Avenue to five.

Proposed improvements to Crescent Avenue are as follows:

1) The intersection at Plymouth Street to be widen with radius areas on both sides to allow larger vehicles such as highway trucks, ambulance and fire trucks to access the street. New retaining walls, on both sides, will be constructed to accommodate the wider access.

2) The existing paved width of Crescent Avenue will be increased from twelve to fourteen feet wide to eighteen feet wide. A monolithically pored cape cod berm, one foot wide, will be constructed on both sides of the street bringing the effective width to twenty feet.

3) The proposed paved access will extend to a length of seven hundred and twenty five feet to allow access for the three buildable lots.

4) Drainage structures and underground recharge areas have been designed to prevent any increase in stormwater run-off, prevent erosion to surrounding areas, remove suspended solids and clean street run-off before discharge into the ground.

5) A turn-around is provided at the intersection of Crescent Avenue and Sherman Street that meets the "Pierce Turning Performance Analysis" standards. This will allow all traffic, including larger vehicles, to exist Crescent Avenue without backing up on to Plymouth Street.

6) The existing structure, located in Halifax along Crystal Lake, shown on assessors map 11 lots 2600 to 2607, to be razed and a new, single family, house is proposed in the Town of Pembroke. The existing house demolition and new house construction are not part of the proposed road improvements, however, it will be a part of the "Notice of Intent" filed with both the Pembroke and Halifax Conservation Commissions and therefor added to this plan.

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

There are no new discharges directly to existing wetlands or waters of the commonwealth. All new discharges, to the proposed underground recharge area, are treated to remove 40% TSS before infiltration. Peak storm water discharges and velocities have been reduced from the existing to the proposed site conditions.

Standard 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.**

The proposed stormwater discharges shall comply with Standard 2. Stormwater management system that are proposed, (i.e. Ultra Urban Filters / Smart Sponge & Cultec recharge units or equivalent), will decrease post development peak discharges from pre development peak discharges. This report summarizes the results of the calculations for the 2, 10, 25 and 100 year 24-hour storms. See the Stormwater Hydraulic Report for full calculations, pre vs. post construction, evaluating the 2, 10, 25 and 100 year 24-storms.

Table 1: Drainage calculations for Crescent Avenue Improvements & Extension

Pre-development conditions: (expressed in cubic feet per second)

Water Shed Sub Area	2 year storm	10 year storm	25 year storm	100 year storm
EWSA-1 into Plymouth Street	0.10	0.21	0.27	0.39
EWSA-2 into Crystal Lake	0.09	0.60	1.06	1.99
Total Existing	0.11	0.68	1.18	2.16

Note: individual sub-areas have different times of concentration and therefore peaks can't be added. Total reflects the addition of sub-area hydrographs.

Table 2: Drainage calculations for Crescent Avenue Improvements & Extension

Post-development conditions: (expressed in cubic feet per second)

Water Shed Sub Area	2 Year Storm	10 Year storm	25 Year Storm	100 Year Storm
PWSA-1A into Plymouth Street	0.08	0.18	0.25	0.36
PWSA-2A to PWSA-2C into Crystal Lake	0.00	0.57	1.06	1.84
Total Proposed	0.08	0.63	1.17	2.01

Note: individual sub-areas have different times of concentration and therefore peaks can't be added. Total reflects the addition of sub-area hydrographs.

Standard 3. **Loss of annual recharge to groundwater should be eliminated or minimized through the use of 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 the 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.**

Loss of annual recharge to groundwater is eliminated through the proposed storm water infiltration systems consisting of Cultec units or equal, for all proposed re-charge areas as noted in this report.

RECHARGE VOLUME

Table 2.3.2: Recharge Target Depth by Hydrologic Soil Group

NRCS HYDROLOGIC SOIL TYPE	APPROX. SOIL TEXTURE	TARGET DEPTH FACTOR (F)
MfB "A"	Sandy Loam	**0.60-inch**

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sandy Loam	MfB "A"	2.41

Existing Impervious Surface = 7,785 Square Feet
Proposed Impervious Surface = 18,250 Square Feet

Recharge Volume Required = 18,250 s.f. – 7,785 s.f. x 0.60" = 523 Cubic Feet

Recharge Area Provided

PRA-1 Volume at inv. Out 58.00 = 521 cubic feet

PRA-2 Volume at inv. Out 55.65 = 640 cubic feet

Total Recharge Volume Provided = 1,161 Cubic Feet

Proposed Re-Charge Area 1 (PRA-1)

DRAWDOWN WITHIN 72 HOURS

To determine whether an infiltration BMP will drain within 72 hours, the following formula must be used.

$$\frac{\text{(flood strage volume provided)}}{\text{(rawls rate silt loam)(1/12)(infiltration surface area)}}$$

$$\textbf{PRA-1 Time}_{\textbf{drawdown}} = \frac{521 \text{ c.f.}}{(2.41 \text{ in/hr})(1/12)(576 \text{ s.f.})} = \textbf{4.5} \text{ hours}$$

Proposed Re-Charge Area 2 (PRA-2)

DRAWDOWN WITHIN 72 HOURS

To determine whether an infiltration BMP will drain within 72 hours, the following formula must be used.

$$\frac{\text{(flood strage volume provided)}}{\text{(rawls rate silt loam)(1/12)(infiltration surface area)}}$$

$$\textbf{PRA-2 Time}_{\textbf{drawdown}} = \frac{640 \text{ c.f.}}{(2.41 \text{ in/hr})(1/12)(702 \text{ s.f.})} = \textbf{4.5} \text{ hours}$$

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

WATER QUALITY TREATMENT VOLUME

V_{WQ} = (D_{WQ}/12 inches/foot) * (A_{IMP} * 43,560 square feet/acre) ***Equation (1)***

V_{WQ} = Required Water Quality Volume (in cubic feet)
D_{WQ} = Water Quality Depth: one half-inch for discharges

Required:

Increased Area of impervious from the existing & proposed development = 10,465 s.f.

RQV inside an ACEC = 10,465 S.F.. x .083 Ft (1") = 872.1 C.F.

Provided:

Total Cultec infiltration volume = 1,161 c.f.

TSS Removal Calculation Sheet

% TSS Removal PCB-1 to Cultec PRA-1

A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (B*C)
PCB-1 W/ Sump & Ultra Urban Filter w/ Smart Sponge	0.80	1.00	0.80
PRA-1	0.80	0.20	0.16

Total % TSS Removal = **0.96**

TSS Removal Calculation Sheet

% TSS Removal PCB-2 to Cultec PRA-1

A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (B*C)	E Remaining Load (C-D)
PCB-2 W/ Sump & Ultra Urban Filter w/ Smart Sponge	0.80	1.00	0.80	0.20
PRA-1	0.80	0.20	0.16	0.04

Total % TSS Removal = **0.96**

TSS Removal Calculation Sheet

% TSS Removal PCB-3 to Cultec PRA-2

A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (B*C)	E Remaining Load (C-D)
PCB-3 W/ Sump & Ultra Urban Filter w/ Smart Sponge	0.80	1.00	0.80	0.20
PRA-2	0.80	0.20	0.16	0.04

Total % TSS Removal = **0.96**

TSS Removal Calculation Sheet

% TSS Removal PCB-4 to Cultec PRA-2

A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (B*C)	E Remaining Load (C-D)
PCB-4 W/ Sump & Ultra Urban Filter w/ Smart Sponge	0.80	1.00	0.80	0.20
PRA-2	0.80	0.20	0.16	0.04

Total % TSS Removal = **0.96**

STANDARD 5: LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS

Source controls and pollution prevention measures to minimize or eliminate the exposure of any LUHPPLs to rain, snow, snow melt, and runoff must be identified in the Long-Term Pollution Prevention Plan. (See Operation and Maintenance Plan)

BMPs determined to be suitable for treating runoff from LUHPPL must be used. (See Standard 4)

One-inch rule applies when calculating *Required Water Quality Volume.* (See Standard 4)

Pretreatment Requirement 44% TSS removal must be achieved before discharge to infiltration structure. (See Standard 4)

STANDARD 6: CRITICAL AREAS

Required Computations or Demonstrations

Standard 6 applies to discharges within Zone II, Interim Wellhead Protection Areas or near or to other Critical Areas: Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters, Special Resource Waters, and Cold-Water Fisheries.

Source control and pollution prevention measures must be identified in a long-term pollution prevention plan.

Use BMPs determined to be suitable for the particular critical area.

STANDARD 7: REDEVELOPMENT

Required Computations or Demonstrations

Submit a Source Control and Pollution Prevention Plan as required by Standard 4. (See Standard 4)

Submit a Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan as required by Standard 8. (See Standard 8)

Submit an Operation and Maintenance Plan as required by Standard 9. (See standard 9)

Submit Illicit Discharge Compliance Statement required by Standard 10. (See standard 10)

Demonstrate that there are no new discharges that cause or contribute to erosion of wetlands or waters of the Commonwealth. (see standard 1)

STANDARD 8: CONSTRUCTION PERIOD CONTROLS

Stormwater Pollution Prevention Plan (SWPPP)

1. Erosion and sediment control measures surrounding the work area will be installed prior to stump removal and construction. Crushed stone tracking pads are to be placed at all construction access points before construction begins. Stabilization of all regarded and soil stockpile areas will be initiated and maintained during all phases of construction.

2. Areas to be left bare before finish grading shall receive a temporary seeding of Perennial Ryegrass applied at a rate of 2 lbs./1,000 sq. ft. at a depth of ½ inch. Limestone shall be applied as a seed bed preparation at a rate of 90 lbs./ sq. ft. Planting seasons shall be from March 1 to June 1 and from August 11 to October 1. Where grass predominates, fertilize according to a soil test at a minimum application rate of 1 lb of nitrogen per 1000 sq. ft. Areas to be left bare before finish grading and seedling outside of planting season shall receive an air-dried woodchip mulch, free of coarse matter, applied at a rate of 185-275 lbs /1,000 s.f.

3. Seedling mixture for finished grassed areas will be as follows:
   Kentucky blue Grass 45%
   Creeping Red Fescue 45%
   Perennial Ryegrass 10%
   Seed to be applied at a rate of 4 lbs./1000sq. ft.
   Fertilizer to be applied at a rate of 2 lbs./sq ft.

4. Planting Seasons shall be April 1 to June 1 and August 15 to Sept 15. After Sept 15th, areas will be stabilized with hay bale check, filter fabric, or woodchip mulch, as required, to control erosion, for areas to have specific landscape coverage other than seedling and sodding, see landscape development plan.

5. Stabilization of slopes in cut areas (using mulch or grass) and the installation of control line at the toe of the slope shall be initiated within 30 days of commencement of the cut.

6. Sediment removed from the control structures will be disposed of in a manner that is consistent with the intent of the plan. All hay bales, silt sock or silt fence retaining sediment over half their height shall have the sediment removed, and any damaged or malfunctioning sections or components replaced.

7. Contractor will be assigned the responsibility for implementing the erosion control and sedimentation control plan. This responsibility includes the installation and monitoring of control measures, informing all parties engaged on the site of the requirements and objectives of the plan, and notifying the proper

town agency if any transfer of this responsibility is to occur. The owner shall be responsible for conveying a copy of the Erosion and Sediment control plan if the title to the land is transferred.

8. The Contractor shall secure the services of a professional engineer, who shall verify in the field that the controls required by this plan are properly installed, and check on the controls not less frequently than weekly and within 48 hours of a significant rainfall event, and shall, by written report, inform the owner or his agent not less frequently than weekly, and the Mansfield Conservation Commission monthly of observations maintenance or corrective activities undertaken.

9. Stockpiles of Soil shall be surrounded by a sediment barrier. Soil stockpiles to be left bare for more than 15 days shall be stabilized with temporary vegetation or mulch. If soil stockpiles are to remain in place for more than 60 days, Filter fabric is to be used in place of hay bales. Side slopes shall not exceed 2:1

10. The contractor shall be responsible for dust control and wind erosion throughout the entirety of his contract. Dust control shall include, but is not limited to the sprinkling of water on all un-vegetated soils and vehicle access points. Contractors shall control dust to prevent any hazards on or near the adjacent roadways.

11. If a final grading is to be delayed more than 30 day after land disturbances, temporary vegetation or mulch shall be used to stabilize soils.

12. Hay bales shall be used only and a temporary measure. Where control measures will be required for more than sixty (60) days, filter fabric shall be used.

13. Where dewatering is necessary, there shall not be a discharge directly into wetlands or watercourses. Proper methods and devices shall be utilized to the extent permitted by law, such as pumping water into a temporary sedimentation bowl, providing surge protection at the inlet and outlet of pumps, or floating the intake of the pump to minimize and retain the suspended solids. If a pumping operation is causing turbidity problems, said operation shall cease until such time as a feasible means of controlling turbidity area determined and implemented.

STANDARD 9: OPERATION AND MAINTENANCE PLAN

A Long -Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that storm water management systems function as designed.

The Long-Term Operation and Maintenance Plan shall at a minimum include:

1. Stormwater management system(s) owners;

Assessors Map B2, Lots 2390 – 2397 & Lots 2418 - 2427
Assessors Map B2, Lot 48
Roger G. Warren
P.O. Box 2447
Basseterre, St. Kitts, West Indies

The owner of the Stormwater management system shall be the applicant(s)/Owner

Note: In case of transfer of property, the new owners will become the responsible party for the Operation & Maintenance post construction.

2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the storm water management system and the requirement for proper operation and maintenance;

The applicants mentioned above, will be assigned the responsibility for implementing the long term Operation and Maintenance Plan (O&M Plan). This responsibility includes the routine and non-routine maintenance task to be undertaken after construction is complete as spelled out below. Part of the responsibility shall be informing all parties engaged on the O&M site of the requirements and objectives of the plan and notifying the proper Town agency of any transfer of this responsibility. The applicant shall be responsible for conveying a copy of the O&M Plan if the title to the land is transferred.

3. The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;

- A comprehensive control program will be implemented at the site which includes catch basin cleaning, replacement of Ultra-Urban filter media, and restrictions on the use of pesticides, fertilizer, salt and other deicing agents. This program will include schedule inspection and maintenance and an estimated operation and maintenance budget.

- Deep sump catch basins with hoods to trap debris, sediments and floating contaminants will be inspected quarterly (4) times a year and cleaned a minimum of once annually or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. Catch basins to be cleaned at the end of foliage season and snow removal season. More frequent cleaning may be necessary and should be determined upon inspection.

- Recharge area to be inspected annually or more frequently as indicated by structure performance. Remove sediment as needed. Rehabilitate recharge area if it fails due to clogging.

- Inspect the Ultra-Urban filter after every major storm for the first year to ensure that the product is functioning properly. Thereafter, check filters and hoods at least twice a year. Maintenance task to include the removal of any debris that might clog the filter. Remove and replace filter media at least once every two years or as needed.

STANDARD 10: All illicit discharges to the storm water management system are prohibited.

Illicit Discharge Compliance Statement

There shall be no illicit discharges to the storm water management system for the proposed project at Crescent Ave, Plymouth County, Massachusetts. All discharges shall be as shown on submitted plans and approved by the local site plan approval authority.

Notwithstanding the foregoing, an illicit discharge does not include discharges from the following activities: firefighting, water line flushing, landscape irrigation, un-contaminated ground water, portable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

_____ Date: _____

Owner of property

_____ Date: _____

Owner of property

Drainage Operation and Maintenance Plan

316 Main Street
North Easton, Ma 02356

This long-term Drainage Operations and Maintenance (O&M) Plan shall be implemented at Crescent Ave, Plymouth County, Pembroke, Ma to ensure that the stormwater management system functions as designed and in accordance with the DEP Stormwater Management Standard No. 9. This Operations and Maintenance Plan is intended to cover all on-site drainage structures. The property owner, Roger G. Warren, possesses the primary responsibility for overseeing and implementing the O&M Plan and designating a person who will be responsible for the proper operation and maintenance of the stormwater structures. In case of transfer of property ownership, future property owners shall be notified of the presence of the stormwater management system and the requirements for proper implementation of the O&M Plan.

O&M Plan Implementation Manager Contact Information:

Assessors Map B2, Lots 2390 – 2397 & Lots 2418 - 2427
Assessors Map B2, Lot 48
Roger G. Warren
P.O. Box 2447
Basseterre, St. Kitts, West Indies

Components of the Operations & Maintenance Plan include:

The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;

- A comprehensive control program will be implemented at the site which includes catch basin cleaning, replacement of Ultra-Urban filter media, and restrictions on the use of pesticides, fertilizer, salt and other deicing agents. This program will include schedule inspection and maintenance and an estimated operation and maintenance budget.

- Deep sump catch basins with hoods to trap debris, sediments and floating contaminants will be inspected quarterly (4) times a year and cleaned a minimum of once annually or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. Catch basins to be cleaned at the end of foliage season and snow removal season. More frequent cleaning may be necessary and should be determined upon inspection.

- Recharge area to be inspected annually or more frequently as indicated by structure performance. Remove sediment as needed. Rehabilitate recharge area if it fails due to clogging.

- Inspect the Ultra-Urban filter after every major storm for the first year to ensure that the product is functioning properly. Thereafter, check filters and hoods at least twice a year. Maintenance task to include the removal of any debris that might clog the filter. Remove and replace filter media at least once every two years or as needed.

Stormwater Runoff Quality:

The stormwater management system protects and enhances the stormwater runoff water quality through removal of sediment and pollutants, and source control significantly reduces the amount of pollutants entering the system. Preventive maintenance of the system will include a comprehensive source reduction program of regular parking lot sweeping and litter removal, prohibitions on the use of pesticides and maintenance of trash areas. These measures are described below.

Drainage System:

Stormwater runoff is collected in deep sump catch basins fitted with Ultra Urban Filters and conveyed via a closed drain pipe network to water quality units (Cultec Re-Charge Areas). This treatment train provides a first flush water quality treatment by removing large sediment particulate and separating floating contaminants from run-off prior to discharge to infiltration systems. Maintenance and cleaning of catch basins, drain manholes, Ultra-Urban Filters, and Underground Rre-charge areas will assure adequate performance.

Maintenance Program:

The Property Manager and maintenance staff will conduct the Operation and maintenance Program set forth in this document. The Manager will ensure that inspections and record keeping are timely and accurate and that cleaning and maintenance are preformed at least on an annual basis. Inspection & Maintenance Log Forms (attached) shall include the date, physical conditions of the structures, depth of sediment in structures, evidence of overtopping or debris blockage and maintenance required of each structure. Records of maintenance will be kept on file at the Property Manager's office and copies of the Inspection & Maintenance Log sheets indicating all work and inspections will be submitted to the Town of Pembroke as required.

Winter Maintenance Program:

Ensure that drainage structures are not blocked by ice, snow, debris or trash during winter months. Sand shall be the primary agent used for driveway and parking lot safety during ice and snow conditions.

Fertilizer Use:

Only slow-release organic low-phosphorous fertilizers will be used in any landscaped areas in order to limit the amount of nutrients that could enter the stormwater system.

Suggested Maintenance Schedule:

The following is a suggested general maintenance schedule that can be used as a reference by the Property Manager. This schedule includes the maintenance action to be taken and when the action is to occur.

Suggested Maintenance Schedule

Site Component	Action to be Taken	Time-line for Completion	Cost Estimate
Catch Basins & Manholes	Quarterly inspections with yearly cleaning, removal of sediments, oils and floatables.	Quarterly Inspections, Yearly Cleaning	$200 per unit per year
Ultra-Urban Filters	Quarterly Inspections Cleaning, removal of sediments, oils and floatables. Replace filter media once every two years.	Monthly Inspections, Cleaning April & October	$350 per unit per 2 years
Subsurface Infiltration Basins	Inspect for standing water for periods in excess of 72 hours and for accumulated sediment	After each significant rainfall for 3 month after construction. Then biannually in April and October	$0.00 per year

Illicit Discharge Compliance Statement:

Per Standard No. 10 of the MassDEP Stormwater Management Standards, there shall be no illicit discharges to the stormwater management system. The Property Manager is responsible for implementing the Operation and Maintenance Plan and overseeing activities at the facility to prevent illicit discharges to the drainage system from occurring.

It is strictly prohibited to discharge any products or substances onto the ground surface or into any drainage structures, such as catch basin inlets, manholes and inspection ports.

Should a spill occur, immediate action steps must be implemented to contain the spill, cordon off the area, clean it up immediately and dispose of it properly to prevent an illicit discharge to the stormwater management system.

Drainage Operation and Maintenance Log

Site Maintenance Supervisor: _____ Date: _____

_____ Routine // _____ Response to Significant Rainfall Event// _____ Other//

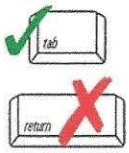
BMP	Frequency	Date Preformed	Comments	Cost
Catch Basins & Drain Manholes	Quarterly Inspections Maintenance Yearly or as necessary			
Ultra-Urban Filters	Quarterly Inspections Replace once every two years or as needed. Immediate Oil/Hazardous Material Removal			
Landscaped & Vegetated Areas	Maintenance as necessary			
Subsurface Infiltration System	Bi-Annual Inspections Significant Rainfall Inspections			

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.

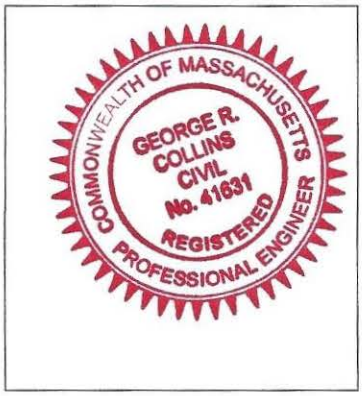
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



10-19-20

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): Standard Roof Infiltration, Ultra-Urban Filters & Cultec Re-Charge Areas

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.

Chapter 4

Proprietary Stormwater BMPs

Proprietary Stormwater best management practices are manufactured systems that use proprietary settling, filtration, absorption/adsorption, vortex principles, vegetation, and other processes to meet the Stormwater Management Standards. There are two general types of Proprietary BMPs: hydrodynamic separators and filtering systems. Both types may be used for retrofits.

Hydrodynamic separators typically use either chambered systems or swirl concentrators to trap and retain sediment from a designed stormwater flow, and use different methods to help prevent the resuspension of sediment during high flow storm events. The retained sediment is removed through periodic maintenance.

Filtering systems typically use a settling chamber and filtering system that removes specific pollutants. The choice of filtering media or cartridges is typically based on the target pollutants.

Subsurface structures, even those that have manufactured storage chambers, are not proprietary BMPs, since the treatment occurs in the soil below the structure not the structure itself.

The effectiveness of Proprietary BMPs varies with the size of the unit, flow requirements, and specific site conditions. The UMass Stormwater Technologies Clearinghouse database evaluates the quality of proprietary BMP effectiveness studies. MassDEP urges Conservation Commissions to use this database when verifying the effectiveness of Proprietary BMPs: www.mastep.net

Advantages/Benefits:

- Useful for pretreatment/removal of TSS
- Can be an excellent choice in ultra-urban or other constrained sites
- Useful for redevelopments and to improve local conditions
- Longevity can be high with proper maintenance

Disadvantages/Limitations:

- Must be sized carefully to achieve design removal efficiencies
- Efficiency may be affected by size of sediment and rate of sediment loading
- Must ensure regular maintenance to achieve design removal efficiencies
- Not appropriate for terminal treatment for runoff from LUHPPLs or discharges near or to critical areas, unless determined suitable for such use by TARP or STEP.

Two Ways to Approve or Deny the Use of Proprietary Stormwater BMPs

1. MassDEP has reviewed the performance of a technology as determined by TARP or STEP and assigned a TSS removal efficiency.
   - If the conditions under which it is proposed to be used are similar to those in the performance testing, presume that the proprietary BMP achieves the assigned TSS removal rate
   - Look at sizing, flow and site conditions.
2. Issuing Authority makes a case-by-case assessment of a specific proposed use of a proprietary technology at a particular site and assigns a TSS removal efficiency.
   - Proponent must submit reports or studies showing effectiveness of BMP.
   - MassDEP strongly recommends using UMass Stormwater Technologies Clearinghouse database to ensure that reports and studies are of high quality (www.mastep.net).
   - Look at sizing, flow and site conditions.
   - For ultra-urban and constrained sites, proprietary BMPs may be the best choice.

Evaluation of Proprietary Stormwater Systems

Local agencies see a range of proposed stormwater management systems ranging from LID systems that mimic natural hydrology to traditional dry detention basins and manufactured systems.

The Stormwater Management Standards require proponents to consider the use of environmentally sensitive site design and LID techniques *before* selecting the appropriate BMPs for their development or redevelopment projects. After that consideration, the proponents may choose among a variety of stormwater BMPs to provide pretreatment, treatment, peak rate attenuation, and infiltration. These include LID BMPS, the traditional BMPs listed in the BMP charts presented in Volume 1, Chapter One, as well as a number of Proprietary BMPs.

MassDEP encourages proponents to consider proprietary BMPs, particularly where site constraints limit the use of LID techniques or traditional BMPs. If sized properly, manufactured (or "proprietary") BMPs can play a pivotal role in meeting the Stormwater Management Standards, particularly on smaller sites where adequate space for other BMPs is not available.

This Chapter provides the following information:

- Process To Approve or Deny the Use of Proprietary Stormwater Technology
- How to Evaluate the Effectiveness of Proprietary BMPs that Do Not Have a MassDEP TSS Removal Efficiency Rating
- Additional Information about Proprietary BMPs, including sources of information and detailed evaluation guidance for each of the 10 Stormwater Standards

If a developer proposes to include a proprietary BMP as a component of the stormwater management system, the local permitting authority must determine

- whether the proprietary BMP can meet the applicable Stormwater Standards;
- if proposed to meet the TSS removal requirements of Standard 4, whether there is sufficient information available to assess the TSS removal efficiency of the proposed proprietary BMP and, if so;
- assign a TSS removal credit.

This task is not easy. Only a few proprietary technologies have had their TSS removal effectiveness evaluated and approved by the Commonwealth. The overwhelming majority of proprietary technologies have not been evaluated by the state. Those technologies may still be used in Massachusetts, if the Conservation Commission or other local permitting authority determines that they can be used to meet the Stormwater Management Standards at a particular site.

Although MassDEP encourages proponents to consider the use of proprietary technologies to manage stormwater, local permitting agencies have the authority and responsibility to decide how these innovative or manufactured systems may be used, whether they are sized correctly for the intended purpose, and, in most cases, assess the proprietary BMP's ability to remove TSS.

Accordingly, **MassDEP encourages Conservation Commissions** and other local agencies to:

- Evaluate proposed proprietary BMPs by consulting the UMASS Stormwater Technologies Clearinghouse (www.mastep.net) and reviewing the information on the proposed technology.

- Ensure that BMPs described as already having been assessed by Massachusetts (through EEA's legacy STEP program) meet the conditions of those approvals, including model numbers, sizing requirements and site conditions. If such a BMP does not meet all applicable conditions, the TSS removal efficiency number established by the State can be questioned by the local permitting authority.
- Use proprietary systems for specialized situations – like heavily constrained redevelopment sites or other locations - where LID techniques or traditional structural BMPs may not provide needed improvements.

MassDEP encourages manufacturers of proprietary technologies to:

- Have their BMP's operating parameters evaluated though the multi-state Technology Acceptance Reciprocity Partnership (TARP) Program. When a technology completes TARP process, MassDEP will assign a specific TSS removal number or range for the tested use of that technology.
- Submit the results of other studies to the UMASS stormwater technology database clearinghouse (www.mastep.net).
- Promote specialized and niche uses of proprietary technologies to provide Conservation Commissions with more tools to improve the environment.

Ideally the developer of a property proposing these kinds of systems and the local agency evaluating the use of a manufactured or innovative stormwater technology will work cooperatively and agree that the proposed technology is appropriate for its intended use and likely to achieve the results intended.

To do that, developers must provide sufficient analytical information to the local agency (preferably third party analysis) so that it can evaluate the proprietary BMP. The local agency may reasonably deny the use of a proposed technology, if it finds that: (a) there is not sufficient information to assess the effectiveness of the technology; or (b) based on the available information, the proposed use of the technology does not meet all the requirements of the Stormwater Management Standards. In order to perform that analysis, local agencies must evaluate the studies provided to them describing the use and effectiveness of these technologies. Local agencies may not unreasonably deny the use of a proposed technology.

Process To Approve or Deny the Use of Proprietary Stormwater Technology

There are only two ways to evaluate a proposed use of a proprietary BMP in Massachusetts:

1. The Commonwealth has evaluated the performance of the technology and assigned a TSS removal efficiency.

In this case, Conservation Commissions and MassDEP shall presume that the proprietary BMP achieves the assigned TSS removal, provided the conditions under which it is proposed to be used are similar to those in the performance testing. MassDEP reserves the right to change the TSS removal number assigned to a proprietary technology based upon its review of subsequent studies.

The performance of a small number of proprietary BMPs was evaluated through EEA's legacy STEP program. In almost all cases, these STEP approvals were for specific sizing and flow

requirements and specific site conditions. Those conditions are listed in the STEP reports. When reviewing this information, Conservation Commissions must analyze the STEP report to verify that the unit being proposed is within the scope of the STEP approval.

Although the STEP program no longer conducts these evaluations, MassDEP will review the performance of and assign a TSS removal efficiency to any proprietary BMPs that successfully complete the multi-state "Technology Acceptance and Reciprocity Partnership" (TARP) assessment process. Currently, MassDEP has not made a similar commitment to assign TSS removal efficiencies based on evaluations conducted under similar programs in other states or third party studies. MassDEP reserves the right to do so in the future.

2. The issuing authority has evaluated the proposed use of a particular proprietary BMP at a specific site and assigned a TSS removal efficiency based upon its own case-by-case review of the effectiveness and intended use of the proprietary BMP.

MassDEP strongly recommends that the issuing authority evaluate proposed BMPs using studies reviewed by the University of Massachusetts and posted on its stormwater database website (www.mastep.net). That database includes information on the relative quality of the studies, and should be used as the basis for a local agency's evaluation of the effectiveness of a proprietary system. Based on this information, the issuing authority may decide to approve or deny the use of any proprietary technology. The issuing authority may not unreasonably deny the use of a proposed technology.

If the operating parameters and performance claims of a proprietary technology have not been fully verified by STEP or TARP and a MassDEP removal efficiency rating has not been assigned, the technology vendor must submit evaluative information to the local agency regarding the technology's effectiveness.

> *Please note that Proprietary BMPs are NOT required to be evaluated by MassDEP to be used in Massachusetts. Only a small number of proprietary BMPs have been evaluated by the Commonwealth, and those evaluations are limited to the specific conditions that were reviewed. In most case in Massachusetts, a proposed use of a particular proprietary BMP at a specific site will be reviewed by the local agency on a case–by-case basis.*

How to Evaluate the Effectiveness of Proprietary BMPs that Do Not Have a MassDEP TSS Removal Efficiency Rating

MassDEP recognizes that the process of reviewing a proposed use of a particular proprietary BMP at a specific site may be daunting. MassDEP has prepared guidance for conducting this review.

Step One: Information that should be submitted as part of the Wetlands NOI.

As more fully set out below, issuing authorities require sufficient information to evaluate proposed uses of proprietary BMPs. If sufficient information is not submitted with the NOI, the Conservation Commission should request additional information as part of the review process.

Specific information that a Conservation Commission may want to request prior to a hearing include:

A A complete description of the proprietary technology or product including a discussion of the advantages of the technology when compared to conventional stormwater treatment systems and LID practices, including:

- Size: What volume is it designed to hold and/or treat? How is the system sized to meet the performance standards in order to handle the required water quality volume, rate of runoff, and types of storms? Standard 4 requires treatment for a required water quality volume, not for a specified design flow rate.
- Technical description, schematic and process flow diagram: How does it work? What are the technical configurations of the unit? Are there any pretreatment requirements? How does it fit in combination with other treatment systems?
- Capital costs and installation process and costs: What does this size system cost? Are there any consumable materials that need to be replaced and if so, how often and how much do they cost? How will the system be installed and who will supervise the installation to ensure that it is done properly? What mistakes can happen during installation? Is any special handling, installation techniques or equipment required?
- Potential disadvantages at this site: Any physical constraints? Weight or buoyancy issues? Durability issues? Energy requirements?
- Operation and maintenance (O&M) requirements and costs: New technologies will not have long-term data on O&M requirements, so it is particularly important that an applicant provide all available information for evaluation.

B. Data on how well the alternative technology works:

- Flow proportional sampling from laboratory testing and full-scale operations that is representative of the potential range of rainfall events (for example, a sufficient number of storms is generally at least 15) and located at sites similar to the conditions of the installation under review.
- Calculation of TSS removal rate should be presented. If there is a removal rating for a similar technology and use posted at http://www.mass.gov/dep/, and the proponent makes a claim for a higher TSS removal rate than for the similar system posted, the applicant must provide sufficient data to support the claim. Removal rates should show removal of various particle sizes across the full range of operating conditions including maximum, minimum and optimal conditions for reliable performance.
- A copy of the site's operation and maintenance plan including operational details on any full-scale installations: e.g., locations, length of time in operation, maintenance logs (logs should record the dates of inspections and cleaning, actions performed, quantities of solids removed, and time required for work).
- Information on any system failures, what those failures were, and how were they corrected.
- Copies of any articles from peer-reviewed, scientific or engineering journals.
- Any approvals or permits from other authorities.
- References along with contact information from other installations.

C. Operation and Maintenance (O&M) Plan:

- To ensure that the system will function as designed, all stormwater management systems must have a written operation and maintenance plan in accordance with Stormwater Management Standard 9. MassDEP stresses the importance of routine maintenance for all stormwater control technologies. A number of alternative technologies perform very well,

but only if they are installed and maintained as specified by the manufacturer. For example, some alternative wet vaults may be able to achieve a high TSS removal rate, but only if they are cleaned often enough to prevent re-entrainment of previously trapped sediment.

- The O & M Plan shall
  - Identify access points to all components of the stormwater system;
  - Specify equipment, personnel, and training needed to inspect and maintain system;
  - Include a list of any safety equipment and safety training required for personnel;
  - Set forth a suggested frequency of inspection and cleaning; and
  - Provide a sample inspection checklist and maintenance log.

Please refer to Standard 9 in the Stormwater Technical Handbook (Volume 1, Chapter 1 and Volume 2, Chapter 1) for further guidance about O&M.

Step Two: Evaluate the submitted information.

An issuing authority (Conservation Commission or MassDEP upon appeal) may want to ask the questions set forth below to determine whether a proposed use of an alternative technology, either as a stand-alone product or in combination with other stormwater control practices and technologies, meets all of the Stormwater Management Standards:

A. **Why is this technology being proposed for this site?** Possible reasons are the alternative technology provides a higher level of environmental protection, uses less land area, and is less expensive on a capital or operation and maintenance cost basis. The performance data and other information provided with the application must support these claims. For example, if the applicant proposes an alternative technology, because it is less expensive to maintain than a conventional stormwater control technology system, the applicant must submit information supporting that claim.

B. **How convincing is the performance data?** Applicants must be able to demonstrate that their calculations show satisfactory performance in a laboratory, and preferably, adequate field-testing results. Were performance data (laboratory or field) collected by the technology developer or by independent organizations? Independent data are preferable, but may not always be available. If applicable, do the data and calculations support the claim of a higher TSS removal rate? Is the site similar to other locations where the alternative technology is already properly operating? The greater the similarity in key factors (e.g., soil conditions, climate, sediment loading rates, surficial geography, slopes), the greater the likelihood that the technology will properly work at the proposed site.

C. **Are the data sets complete?** If there are any gaps, why? Are you satisfied with the reasons given as to why there are gaps? For example, if maintenance data are provided for a two-year period, and there is a six-month gap in the record, a reasonable explanation for the gap should be provided. Is there enough information to persuade the issuing authority that the technology will work as proposed?

D. **Technologies may not work all the time or at all locations, and therefore, failures may be expected.** If there have been failures, either in the laboratory or in real settings, is the applicant able to adequately explain the reasons for the failure? Examples could be poor design, improper sizing, and higher sediment loading than anticipated, extreme hydrologic events, poor installation, or poor maintenance. If it was a design problem, has the design of the technology been modified

to address the problem? For failures that were not design related, what corrections were made to prevent future failure? Were systems rechecked to see if they were functioning properly after corrections were made?

E. **If only limited data is available, is it possible to assess how the technology will work over its expected life?** If seasonality is an issue, the Commission should see data collected over a full change of seasons that reflect a normal weather year, or at least an estimate of normal annual operations based on available data. Can the technology function well for the full range of storm events that must be controlled? If not, is there a way to address this problem?

F. **Is it possible that a technology may effectively meet one Standard, but hamper compliance with other Standards?** For example, a technology might increase the rate of TSS removal, but limit the annual recharge. The applicant should provide documentation to help the Commission make this evaluation. Do the advantages of the technology potentially outweigh its disadvantages?

G. **Check any references provided by the applicant to find out whether previous installations are properly functioning.** If the information indicates that other Conservation Commissions have previously approved this technology for use in their municipalities, check with those Commissions to verify that the system has performed properly. Were there unexpected operation and maintenance costs? If there were problems, did the vendor assist in resolving them?

See the Detailed Proprietary BMP Evaluation Guidance below for more information.

Step Three: Make a decision on the filings.

If there appears to be sufficient information, the Conservation Commission must issue a decision approving (with or without special conditions) or denying the use of the proposed technology to meet the Stormwater Management Standards. There may be instances where the Conservation Commission may want to add conditions to the Order of Conditions to ensure the proper functioning of the alternative stormwater control technology and, if covered in a local wetlands bylaw, require a bond to be posted to pay for any repairs that may be necessary if the alternative system does not perform as designed. Particular attention to inspection and maintenance is advised and should be included in the conditions.

If a Conservation Commission denies the use of a proprietary technology, it must specify the reasons in writing. Because these decisions are subject to appeal, written documentation is critical.

If insufficient information exists, and the Commission cannot adequately evaluate the proposed technology, the Conservation Commission may either deny the project based on the lack of information (and specify what information is lacking in the denial) or ask the applicant to supply additional information The Conservation Commission may also direct the technology vendor to the TARP contacts listed in the References Section of this Chapter.

Other Proprietary BMP Information

Information about the STEP and TARP programs

The two Massachusetts-accepted evaluation programs - the Massachusetts Strategic Envirotechnology Partnership (STEP) and the multi-state "Technology Acceptance and Reciprocity Partnership" (TARP), were established to ensure rigorous testing and independent analysis of the effectiveness of manufactured or innovative (i.e., "proprietary") stormwater systems. Since each of these programs require significant testing, only a small number of systems have completed the programs and have had their effectiveness officially evaluated.

TARP

TARP was formed by the states of California, Illinois, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Virginia to provide reliable performance information about emerging technologies and to reduce the regulatory and permit hurdles that slow down or prevent their use. More information on TARP is available at this web site:
http://www.dep.state.pa.us/dep/deputate/pollprev/techservices/tarp/

STEP

Before ending in 2003, the STEP program evaluated a number of different emerging technologies. STEP produced 2 reports and fact sheets on 3 stormwater technologies. Each was assigned a TSS removal efficiency. The reports are located here
http://www.mass.gov/envir/lean_green/documents/techassessments.htm
and the Facts Sheets are located here:
http://www.mass.gov/envir/lean_green/documents/factsheets.htm

Local agencies must note that the STEP verifications are limited to the specific models being used under specific conditions. If the conditions being proposed are significantly different than the conditions under which the units were tested, or the proposed models are different than the model tested, or the flow rates proposed are different than the flow rates tested, the local permitting authority may question whether the evaluations are applicable and may determine that the proposed proprietary technology is not appropriate for the proposed use or may not be able to remove TSS at the proposed rate.

Since the STEP process was less rigorous than the TARP process, and since the conditions under which STEP evaluations occurred were more limited than the TARP's protocol, developers proposing STEP technologies MUST provide the entire STEP Fact Sheet describing the proposed technology. A Conservation Commission may ask to see the entire report, and, upon request, the developer must provide it.

Conservation Commissions and other local agencies shall NEVER rely solely on information contained in STEP-related letters or excerpts from the STEP Fact Sheets or Reports found in vendor-provided literature or advertising when evaluating these systems.

When developers propose a specific use of a particular proprietary stormwater technology that has not been evaluated by the TARP or STEP program, the local agency is responsible for developing a TSS removal number based upon the site conditions, the proposed use of the technology, and information assessing the effectiveness of the technology.

If a proprietary BMP is proposed that has not been evaluated by STEP or TARP, MassDEP strongly encourages local agencies to use third party studies listed on the UMASS Stormwater Technologies Clearinghouse database (www.mastep.net) as the basis for their evaluation of the effectiveness of the proprietary system. While manufactured stormwater technologies are not required to have third party studies to be used in Massachusetts, local agencies in turn are not required to approve the use of these technologies.

The UMASS website (www.mastep.net) grades the quality of the studies evaluating proprietary BMPs. Local agencies must consider this information when deciding whether to approve the use of the proposed technology or what TSS number it will assign to a proposed use of a particular proprietary technology.

If a local agency denies the specific use of a particular alternative technology, the reasons should be specified in writing. This written documentation is important, because denials are subject to appeal and may be overturned, if permission is unreasonably withheld.

Other Sources of Information about Manufactured Stormwater Systems

There are other sources of information about the effectiveness of proprietary BMPs that may be used by local agencies to estimate TSS removal rates.

- ETV: This federal EPA verification program's information can be found at http://www.epa.gov/etv/verifications/vcenter9-9.html. EPA Region I hosts a "virtual trade show" of stormwater technologies with vendor provided information at http://www.epa.gov/ne/assistance/ceitts/stormwater/techs.html.
- New Jersey has a searchable database found at http://www.njcat.org/verification/Verifications.cfm
- Washington Department of Ecology evaluates emerging stormwater treatment technologies, more information and state approvals are found at http://www.ecy.wa.gov/programs/wq/stormwater/newtech
- CSTEV: The University of New Hampshire (UNH) Stormwater Center is evaluating the performance of several stormwater control technology technologies real time and on the ground. Information can be found at http://www.unh.edu/erg/cstev/.
- The American Society of Civil Engineers, EPA and others sponsor an international stormwater best management practices database at http://www.stormwater control technologydatabase.org/.
- MassDEP at http://www.mass.gov/dep/water/wastewater/stormwat.htm has information about stormwater.
- The University of Connecticut: UConn's website at http://nemo.uconn.edu/tools/stormwater/ has information about the interrelationship between increased stormwater runoff and associate pollutants.
- Center for Watershed Protection: This national non-profit at http://www.cwp.org/ provides resource information for local officials.

How To Evaluate the Use of Proprietary BMPs in Critical Areas and for Land Uses with Higher Potential Pollution Load: Standards 5 and 6

The Stormwater Management Standards limits the type of stormwater systems that may be used for treatment in **Critical Areas and Land Uses with Higher Potential Pollutant Loads.**

For new development, proprietary stormwater systems[1] may be used in such areas ONLY as a pretreatment device to one of the devices listed in the Stormwater Management Handbook as suitable for such areas or land uses. See Volume 1, Chapter One. For redevelopment sites, these systems may be used for discharges to Critical Areas or from Land Uses with Higher Potential Pollutant Loads ONLY if site constraints prevent use of the devices determined by MassDEP to be suitable for such areas and land uses.

Since the devices listed by MassDEP for discharges to Critical Areas or from Land Uses with Higher Potential Pollutant Loads were selected based on their ability to capture or treat constituents in addition to TSS (such as toxics, pathogens, nutrients, or temperature), proprietary systems proposed for redevelopment projects in these areas must provide similar capabilities.

How Proprietary Stormwater Systems Can Improve Local Conditions

In some cases local agencies will look further than TSS removal in analyzing the effectiveness of proprietary stormwater systems. Removal efficiencies can vary substantially with the size of particles and there are other valid ways than TSS to measure sediment reductions, so local agencies may need to examine closely the system's effectiveness for the specific site at which it is proposed.

Local agencies may be concerned about other contaminants such as toxics (metals such as lead, copper, zinc, or nickel), nutrients, pathogens or physical changes (such as temperature). If a Conservation Commission or other local agency is concerned about any of these parameters, because the receiving water is impaired or the designated use of the receiving water dictates removal of other pollutants, the local agency may want to request and analyze that kind of data.

Detailed Proprietary BMP Evaluation Guidance for each of the 10 Stormwater Standards

The purpose of this detailed guidance is to provide proponents and local agencies with the kinds of questions used by states when verifying the effectiveness of Proprietary BMPs. These questions should be used to address specific questions local agencies may have about the effectiveness of Proprietary BMPs to meet a specific Stormwater Management Standard. This guidance is not intended as a mandatory checklist that every proponent must submit for every Proprietary BMP.

Both proponents and reviewers of proprietary BMPs can use the following questions to determine if the information submitted about a proprietary BMP is sufficient to allow the proposed use.

[1] Subsurface structures, even if they have manufactured storage chambers, are not proprietary BMPs, since the treatment occurs in the soil below the structure, not in the structure itself.

Using these questions will help proponents and reviewers determine whether a sufficient evaluation of the proprietary BMP has been performed, identify where deficiencies may be present, and reasonably predict the performance of a proprietary BMP at the project site.

General Information

Has the applicant provided a detailed description of the characteristics of the site, described how the proposed proprietary product addresses the unique storm water management requirements of the site, and shown that the proprietary product is in compliance with the Stormwater Management Standards? Has the applicant shown that the BMP is advantageous to the site? Have LID and site design techniques been considered when developing the site design? Items to consider include but are not limited to:

- What is the BMP's proposed use: pretreatment or treatment? Separator, filtration, infiltration or other use?
- Is the project for new development or re-development?
- Are there site constraints that limit what other BMPs can be used?
- Is it in an area of higher potential pollutant loads? (See Standard 5)
- Is there discharge to or near a critical area? (See Standard 6)
- Is there a high flow contribution from off-site?
- Is there a high TSS contribution anticipated from site soils, winter sand application, or other source?
- Are there TMDL requirements or recommendations applicable to the site?
- Are there other reasons that specific pollutants in addition to TSS should be reduced (e.g., Phosphorus, Nitrogen, Bacteria, hydrocarbons)?

Has the applicant provided documentation that the sizing of the device is correct? Is there any reason to allow a smaller size than proposed? Has the applicant demonstrated that the device meets both of the following:

- The Stormwater Management Standards; and
- The sizing procedures and calculations established by the manufacturer and verified through laboratory/field testing.

Has the applicant provided documentation that the product manufacturer's performance claims have been verified through laboratory and/or field-testing? Does the evaluation indicate that the device will work well on this specific site?

- Has the product been approved for use by other agencies in other states; if so, for what pollutants, pollutant levels and/or land use?
- Has the product been listed in the UMASS Stormwater Technologies database, and if so, how have the studies of the product been rated?

Is the product intended for construction period erosion and sedimentation control? If so, has the applicant provided documentation that the product is effective for such use? (See Standard 8 below.)

Did the STEP program evaluate the proposed BMP model and size and assess its TSS removal efficiency? If so, has the applicant:

- provided the complete STEP report (not excerpts or manufacturers' letters)?
- shown that the BMP proposed is one of the models that was evaluated?
- shown that the proposed sizing is the same as the sizing used for the STEP evaluation?

Is the product listed in the UMASS Stormwater Technologies database? If not, has the applicant provided documentation comparable to the studies cited in the database?

If not, are there compelling site-specific reasons why the proprietary BMP should be used (e.g., severe location or space constraints, need to reduce a specific pollutant, flooding, filter devices proposed)?

.

Information Required to Address Specific Stormwater Management Standards

<u>Standard 1: (Untreated discharges)</u>: No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

No new untreated discharges

- Does the use of the product enable the applicant to provide adequate treatment for its new discharges?
- Does the use of the product enable the applicant to retrofit an existing discharge, achieving an improvement over existing conditions (see Standard 7)?
- Is the system designed to prevent erosion and scour?

<u>Standard 2: (Peak rate control and flood prevention)</u>: 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.

Peak rate control

- Does the product have a significant function in managing peak rates of runoff?
- If so, has the applicant documented this function with hydrologic/hydraulic data in lab or field studies?
- How is product performance affected by peak discharges?
- Has the applicant documented its performance with hydrologic/hydraulic in lab or field studies?
- Is the product susceptible to re-suspension and flushing of captured contaminants during a 2 -year or 10-year storm?
- Is the product designed to prevent such re-suspension and flushing? Is this documented in the laboratory/field studies? Was the particle size in those studies comparable to that used to calculate the performance and size of the proprietary BMP?
- If the product is not designed to address re-suspension and flushing, does the project design provide for "off-line" placement of the device?
- Is the product subject to damage or filling by sediment during a flood event or a coastal storm event?

<u>Standard 3: (Recharge)</u>: Loss of annual recharge to ground water 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

- Is the product proposed as part of a recharge system? If so,
- Is it a pre-treatment device intended to remove particulates and/or other pollutants prior to discharge to a recharge BMP?
- Is it a recharge BMP that requires protection by another pre-treatment BMP?
- Does it provide both pre-treatment and recharge?

Standard 4: (80% TSS Removal): 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. Stormwater best management practices are sized to capture the prescribed runoff volume; and

c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

Water Quality Treatment

- Does the product remove TSS?
- Has the applicant provided documentation that the TSS removal capability of the device is based on a particle size distribution meeting accepted evaluation protocols? (See www.mastep.net)
- Does the product provide for control or prevention of re-suspension, scour, and/or flushing of captured solids or other contaminants treated by the product?
- Has the product been sized per manufacturer's standards, as verified by laboratory/filed testing?
- Does the product treat other pollutants, and if so, has applicant provided performance documentation (with verification documented by or consistent with the MassSTEP Database)?
- Is the proposed use of the product in the correct sequence in the "treatment train"?
    - Pretreatment (e.g., coarse particle separation, e.g., sand sized particles such as OK-110 floatables removal)
    - Terminal treatment (e.g. fine particle settling, e.g., silt and fine sand particles such as NJDEP PSD)
    - Polishing treatment (e.g., filtration, bacteria absorption or adsorption)
    - Infiltration
- How will the future use of the site influence the kinds of pollutants to be treated and loading rates of those pollutants (e.g., residential may mean more nutrients, a roadway may mean more coarse TSS)?

Standard 5 (Land Use with Higher Potential Pollutant Loads (LUHPPL)): 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.

Land Uses with Higher Potential Pollutant Loads (LUHPPL)

Does this standard apply to the site? If so,

- Is the product used consistent with the source control requirements of the Stormwater Management Standards?
- Does the technology provide pretreatment prior to discharge to a technology that has been determined to be suitable for runoff LUHPPL? ?
- What pollutants are associated with the LUHPPL? What demonstration can be provided that shows that the proposed BMP is capable of removing and/or treating those pollutants?
- Does the LUHPPL have the potential to generate stormwater runoff that has high concentrations of oil and grease? If so, has the technology been proposed in addition to an oil grit separator or sand filter or as an alternative method of achieving oil and grease removal in place of an oil grit separator or sand filter? If the technology is proposed in place of an oil grit separator or sand filter, what evidence is there that the technology is effective in removing oil and grease?

Standard 6 (Critical Areas): 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.

Critical Areas

Does this standard apply to the site? If so,

- Is the product used for pretreatment prior to discharge to a technology that the Department has determined is suitable for the particular critical area?
- Does the product have any operating characteristics that could adversely affect the critical area, such as
    - Thermal impacts to coldwater fisheries
    - Release of bacteria to shellfish growing areas, bathing beaches
    - Release of previously captured pollutants (scour)

Standard 7 (Redevelopment): 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.

Redevelopment

- Do site constraints make a proprietary BMP a better choice than a traditional BMP?
- Does the product performance documentation enable the Conservation Commission to determine a quantitative rating of the product for achieving one or more of Standards 2-6?
- If the answers to both b and c are "no", does the product documentation enable the Commission to qualitatively determine that the product improves existing conditions relative to one or more of Standards 2-6?

Standard 8: (Erosion, Sediment Control): 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.

Erosion and Sediment Control

- Is the product intended to control erosion and sedimentation during the construction process?
- If so, has the applicant documented this function? How does it fit into the construction period erosion, sedimentation and pollution prevention plan?
- Is the product susceptible to adverse impact by erosion and sedimentation during construction, and if so, has the applicant documented how the product will be protected from such impact?

Standard 9: (Operation and Maintenance): A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

Operation and Maintenance

- Has the applicant completely described the installation, operation, and maintenance of the device? Has the applicant documented how the required maintenance will be done and who will do it?
- Has the applicant included a copy of the manufacturer's installation, inspection, operation, and maintenance procedures in the project O&M plan?
- Is the proposed BMP included in the project's O&M plan?
- Does the product require special materials or equipment for cleaning? If so, what materials or equipment are necessary?
- Has the O&M plan funding accounted for such equipment and materials?
- Does the inspection or maintenance of the device require confined space entry protocols?
- Is the frequency of maintenance and cleaning documented by pollutant loading/removal estimates, experience at other installations, or other information demonstrating that the proposed frequency is adequate?
- How will the future use of site influence O&M needs? More frequent? Less frequent?

Standard 10 (Illicit Discharges): All illicit discharges to the stormwater management system are prohibited.

Have steps been taken to prevent illicit discharges from entering the proprietary BMP?

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Home of UMass Extension & Mass. Ag. Experiment Station

Published on *Center for Agriculture, Food and the Environment* (https://ag.umass.edu)

Massachusetts Stormwater Technology Evaluation Project (MASTEP)

Principal Investigator/Project Leader:
Jerry
Schoen
Water Resources Research Center [1]
Sponsoring Unit(s): Water Resources Research Center [2]
Department of Project: Water Resources Research Center
Project Website: Stormwater Technologies Clearinghouse [3]
Project Description:

MASTEP was a "Stormwater Clearinghouse" web site, with a searchable database of verified technical information on stormwater Best Management Practices (BMPs) to provide information on innovative technologies to BMP users. It was funded by MassDEP until 2014. As it is now out-of-date and no longer funded, we have pulled out the website. We apologize for the inconvenience and suggest looking for similar information in the International Stormwater BMP Database http://www.bmpdatabase.org [4]

Topics: Environmental Conservation [5]
The UMass Center for Agriculture, Food and the Environment is the home of UMass Extension and the Mass. Ag. Experiment Station.

Source URL: https://ag.umass.edu/cafe/nifa-planned-extension-initiatives/massachusetts-stormwater-technology-evaluation-project

Links
[1] http://wrrc.umass.edu/
[2] https://ag.umass.edu/sponsoring-units/water-resources-research-center
[3] http://www.mastep.net
[4] http://www.bmpdatabase.org
[5] https://ag.umass.edu/topic/environmental-conservation

Subject: **FW: AbTech Industries, Inc.**
Date: 10/15/2020 4:38:28 PM Eastern Standard Time
From: blonchar@abtechindustries.com
To: djklenert@aol.com
Cc: bobg@deltamotor.com

David, response from our engineering / regulations department. Let me know if you need further clarification or require more info. I attached our Catch Basin Filtration Solutions Catalog for you. Finally, our local representative is Delta Motor, Mr. Bob Greene. I copied Bob on my email.

From: David Scott <dscott@abtechindustries.com>
Sent: Thursday, October 15, 2020 1:11 PM
To: Benny Lonchar <blonchar@abtechindustries.com>; Shawn Lolling <slolling@abtechindustries.com>
Cc: Bob Backman <bbackman@abtechindustries.com>
Subject: RE: AbTech Industries, Inc.

Benny:

TARP is no longer in existence but it gets confused with NJCAT and/or TAPE these days. TARP used to be a two phase process that included proof of concept in the lab followed up with a two year term used for proving in the field. This was often managed by NJCAT. For a number of reasons, NJDEP took over the TARP process and eliminated the need for field testing.

STEPP lost legs (no funding) several years ago and there are no verified/certified products. The national BMP data base is not a verification/certification program. Its what its name implies – a data base. If you obtain WA DOE certification you can submit your results to the program for inclusion in their report. The latest one being 2016.

Our best chance is to get approval referencing the NJCAT verification for UUF TSS supplemented with other reports as necessary. Local approval in MA usually means getting approval with the various conservation committees. Then the project permit is approved at the municipal level.

Thanks,

David Scott

Cell: (602) 762-6772

AbTech

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NJCAT TECHNOLOGY VERIFICATION

Ultra-Urban® Filter

(DI 304-150M Filter Models)

AbTech Industries

April 2020

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1. Introduction

The AbTech Ultra-Urban® Filter (UUF) is a manufactured treatment device (MTD) designed and produced by AbTech Industries. Its intended use is to capture pollutants like trash, sediments, hydrocarbons and sediment-bound pollutants and prevent them from entering the storm drain infrastructure. To assess Total Suspended Solids (TSS) removal efficiency of the UUF, a full-scale commercially available model (DI 1616N-304-150M) was tested at AbTech's laboratory located in Phoenix, Arizona.

The test procedures used to develop a Quality Assurance Project Plan (QAPP) were based on those approved by the New Jersey Department of Environmental Protection (NJDEP), that established a process for verifying and certifying MTDs. As part of this process, there is currently a laboratory test procedure for assessing Total Suspended Solids (TSS) capture in filtration devices. The NJDEP utilizes the New Jersey Corporation for Advanced Technology (NJCAT) to provide a comprehensive evaluation of the technology specific performance claims relative to the test protocol.

Except for the particle size distribution (PSD) of the test sand, all the requirements of the NJDEP testing protocol: *"New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device,"* dated January 25, 2013 (NJDEP 2013b), were met. The QAPP or test plan was submitted and approved by NJCAT prior to testing. The particle size distribution used for this performance assessment was coarser than what is specified in the NJDEP test protocol, but it is considered suitable depending on the water quality objectives. **For this reason, the performance test results have been verified by NJCAT but do not meet the NJDEP certification requirements.**

This performance assessment and verification includes quantifying the TSS removal efficiency, the total mass of sediment captured and resulting changes in head loss through the MTD, while operating at a constant flow rate. Additionally, higher flow rate tests were conducted to quantify the effluent concentrations that were used as a measure of the filter's ability to retain previously captured sediment, also referred to as scour or washout.

All tests were witnessed by an independent observer, Mike Kimberlain, P.E. of Kimberwerks, Rancho Santa Fe, CA. Mr. Kimberlain submitted his qualifications to NJCAT and was subsequently approved as an independent third-party observer. All analytics were performed by a certified laboratory, IAS Laboratories (IAS), located in Phoenix AZ.

2. Description of Technology

The UUF is an engineered screening and filtration technology designed specifically for stormwater source control. Intended for use at the inlets of drainage networks, components are designed to intercept pollutants from surface runoff flows where they are the most concentrated. There are two inlet types the filters can be fitted into, but the filter components are identical. The UUF Drop-Inlet or DI as shown in **Figure 1** was the tested MTD. The UUF DI does not require modification of existing structures and can be customized for any geometry. Standard models are designed with stainless steel collars or mounting brackets with corrugated recycled plastic or stainless-steel bodies.

Each UUF can be specifically designed to target several pollutants of concern and meet a variety of water quality objectives. To achieve this flexibility, the UUF is supplied with a stainless-steel screen and optional Smart Sponge filtration media. However, this performance evaluation is focused on

screening and removal of settleable sediment; no Smart Sponge or variant of Smart Sponge was added to the tested UUF. Consequently, Smart Sponge was not evaluated as part of this assessment and performance verification. A specialized stainless-steel screen, designed to capture sediment larger than 50 microns, is an integral component of the tested UUF. This 16-inch square Drain-Inlet Ultra Urban Filter Model is identified as "UUF DI 1616N-304-150M", with the 'N" denoting a "Normal" height of 18-inches.

Custom sizes can be fabricated to fit most inlet designs and alternative materials for construction are available to satisfy site-specific requirements.

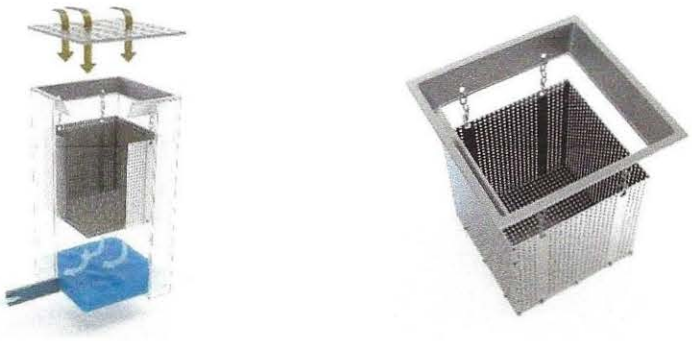

Figure 1 UUF Model DI 1616N-304-150M

3. Laboratory Testing

To test the commercially available UUF DI 1616N-304-150M, the filter was installed into a 24-inch catch basin. The filter system was evaluated using a pumped flow scheme with known test sediment added at a constant rate to minimize inlet concentration variability. Test runs were at a constant flow rate and each was a single batch run. Inlet flows were conveyed directly into the tested UUF from above, simulating the way flow is intended to enter a standard grated inlet catch basin. Treated flows were sampled to measure an effluent average sediment concentration and were not recirculated. Background samples were taken prior to adding test sediment to characterize the source water and account for any influence on efficiency calculations. Water elevations and temperatures were also monitored and recorded throughout the test period. Following performance testing, the flow rate was increased to measure effluent scour concentrations to confirm suitability for on-line installation.

3.1 Test Setup

Testing was conducted in the laboratory test facility at AbTech Industries, located in Phoenix, AZ. The laboratory test setup is depicted in **Figure 2** and consisted of a clean water holding tank, constant head supply tank, pump with VFD, supply pump, flow meter, dry feed auger, streetscape with 24-inch square surface inlet collar, 16-inch square UUF DI filter and discharge pipe.

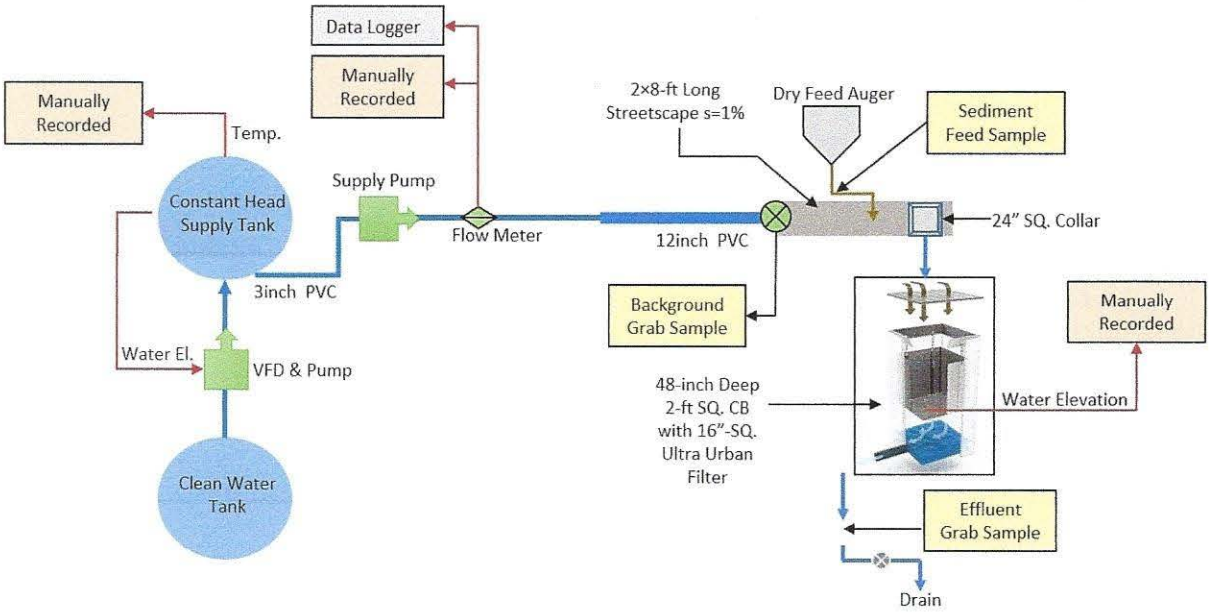

Figure 2 Schematic of Laboratory Test Setup

Testing involved storing water from the City of Phoenix potable water supply in a 2,000 gal. polyethylene tank that was used to maintain a constant water elevation in a 1,000 gal. supply tank. A 3-inch 7.5HP pump with 10HP variable speed drive was used to convey flows from the clean water tank to the constant head supply tank. Water temperatures in the constant head supply tank were measured and recorded manually every minute. A submersible water elevation transmitter was used to control the pump used to fill the constant head supply tank. A second 3-inch pump was used to convey flow from the constant head supply tank through a 3-inch schedule 40 PVC inlet pipe that transitions from pressure flow to gravity flow in a 12-inch PVC pipe. Flow was measured with a Rosemont magnetic flow meter (mag meter) located after the supply pump and before the transition from the 3-inch to 12-inch piping. Flow measurements were recorded both manually and by the data logger.

The 12-inch inlet pipe was connected to an 8-ft long by 2-ft wide "streetscape" with 1% slope draining towards the inlet collar. A Barracuda volumetric auger feeder was used to deposit test sediment onto the streetscape approximately 24-inches upstream of the UUF. Gravity flow through the filter was directly discharged through a solid 8-inch schedule 40 PVC pipe having the invert set at the bottom of the basin floor. Key dimensions of the tested UUF and catch basin are shown in **Figure 3**.

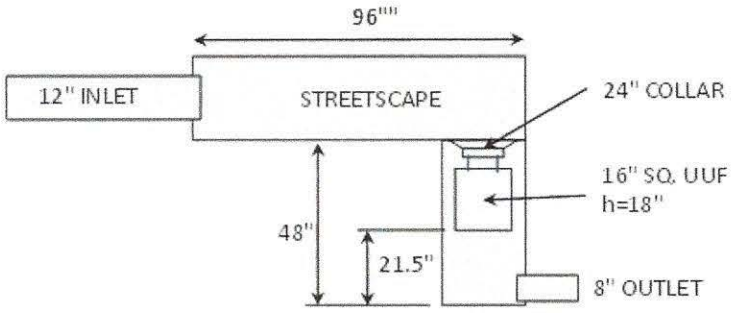

Figure 3 Key Dimensions of Test Apparatus (Elevation View)

3.2 Test Sediment

The test sediment used for this study was #10 silica sand from AGSCO Corporation. Prior to testing, twenty 5-gallon pails were filled with 40 to 50 pounds of test sediment and delivered to IAS Laboratories. A sample was removed from each pail and analyzed for PSD and moisture content by IAS personnel, who then weighed and sealed each pail and returned them to the independent observer. All pails were stored at the testing facility and used as needed for each test run. No seals were opened prior to a test run and without the independent observer present. At the end of each test run, any material remaining in the auger was removed and placed in the same pail and returned to IAS for final weighing. The difference in mass, accounting for moisture content, between each pre and post test run was used to quantify the total dry mass of test sediment used in each test run.

The results of the particle size analysis were averaged and plotted in **Figure 4**. In general, the test sediment was larger than 53 microns and less than 300 microns and the average d_{50} was 117µm. The average moisture content (ASTM Method D4959) of the twenty sediment samples was 0.05%.

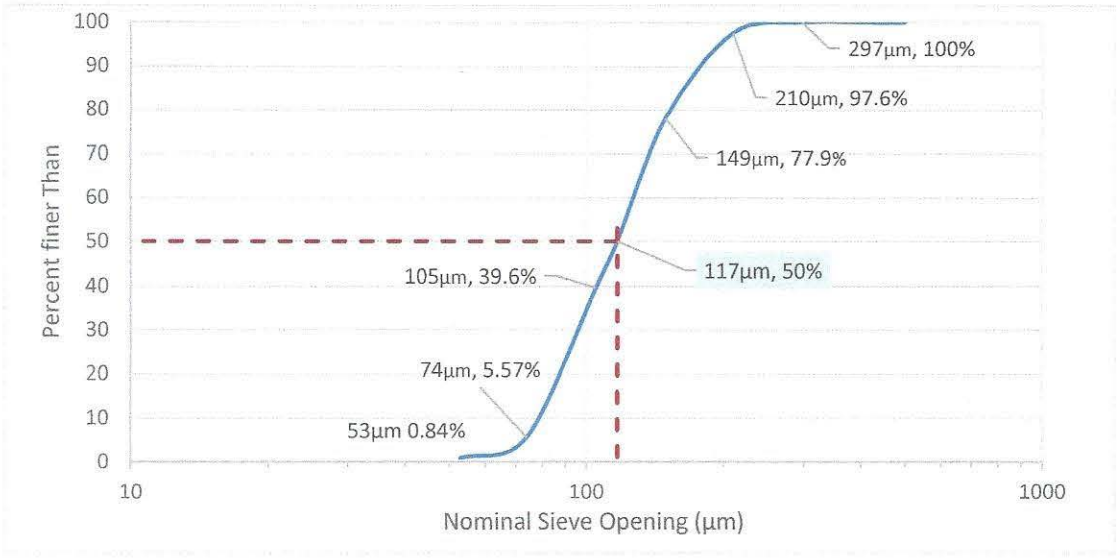

Figure 4 Test Sediment Particle Size Distribution

3.3 Removal Efficiency Testing

Removal Efficiency Testing was conducted based on Section 5 of the NJDEP Laboratory Protocol for Filtration MTDs. Testing was conducted at a flow rate of 0.29 cfs (130 gpm) and with a target influent sediment concentration of 200 mg/L.

Five effluent grab samples, three sediment feed rate samples and three background samples were taken each test run, with each test run lasting 33 minutes in duration, followed by a drain down period. Background samples were taken with every odd-numbered effluent sample (1st, 3rd and 5th). When the test sediment feed was interrupted for measurement, the next effluent sample was collected following a 4-minute delay, which was approximately the same as the longest drain down period. At the tested flow rate and based on the filter's maximum storage volume before bypass, the hydraulic detention time was less than 30 seconds. The sampling schedule followed

during the efficiency testing is summarized in **Table 1**. Effluent and background samples were collected in clean 1L containers supplied by IAS.

Three sediment feed samples were collected during each run to confirm the sediment feed rate, one sample at the start of dosing, one sample in the middle of the test run and one sample just prior to the conclusion of dosing. Each sediment feed rate sample was a minimum of 100 mL and collected in a clean 500 mL sample container, also supplied by IAS. Sediment sampling was timed to the nearest $1/10^{th}$ of a second using a calibrated stopwatch and samples were weighed to the nearest milligram.

Table 1 Removal Efficiency Sampling Frequency

Time	Volume	Auger Feed Mass*	Sed. Feed Rate	Effluent Sample	Background Sample	Drain down (DD) Sample
(minutes)	(gal.)	(lbs)				
0	0	0.00				Not sampled during this part of the test run
1	130	0.22	1			
3	390	0.65				
5	650	1.08		1	1	
7	910	1.52				
9	1,170	1.95				
11	1,430	2.39		2		
13	1,690	2.82				
15	1,950	3.25	2			
17	2,210	3.69				
19	2,470	4.12		3	2	
21	2,730	4.56				
23	2,990	4.99				
25	3,250	5.42		4		
27	3,510	5.86	3			
29	3,770	6.29				
31	4,030	6.73		5	3	
33	4,290	7.16				
End of Test Run. Drain down period begins. Two drain down samples taken at evenly spaced volumes.						

*Excluding mass removed during test sediment sampling

Two drain down samples were collected at the end of each removal efficiency run based on evenly spaced volumes; one at about 15 gallons and one at 30 gallons, to estimate the amount of sediment lost during the drain down period. As the filter had no sump, the drain down period lasted less than 1 minute during the first test runs when there was little sediment in the filter. However, this did increase as sediment accumulated in the UUF over time to about 4 minutes.

3.4 Sediment Mass Loading Testing

The Sediment Mass Loading Capacity testing of the filter is a continuation of the Removal Efficiency testing, after the water elevation exceeded the bypass (height of the filter), which is 18-inches for this UUF model. Except for the flow rate and influent concentrations, all aspects of the test procedures remained unchanged. The influent sediment concentration was increased but was limited due to the maximum discharge rate of the auger. On test run #10, the water elevation recorded was 16-inches, only 2-inches less than bypass. Removal efficiency testing was concluded, and the flow rate reduced to 90% of the treatment flow rate, or 117 gpm, for the remaining sediment mass load test runs. At the lower flow rate, the target maximum influent concentration for the remaining sediment mass load tests was 225 mg/L. An additional four test runs were completed prior to water elevations reaching 18 inches.

3.5 Scour testing

Testing at 200% (260 gpm) of the treatment flow rate was completed as described in the test protocol. On-line stormwater treatment systems, like the UUF, function with an internal bypass to route all conveyed flows without the use of an external bypass or other upstream diversion. The test is designed to demonstrate that the MTD will not resuspend and discharge previously captured sediment above 20 mg/L, which is the effluent concentration discharge limit for on-line applications.

Without removing any captured sediment from the previous performance test runs, three sequential scour tests were conducted. The first scour test was at 130 gpm or 100% of the TTFR (Tested Treatment Flow Rate) and the remaining two at 260 gpm. The second scour test, or first attempt to run a minimum 30-minute test at 260 gpm was unsuccessful. The capacity of the first 3-inch pump with VFD was exceeded and stopped pumping after 5 minutes. Only four effluent samples and three background samples were taken. An additional storage tank and pump was added to the filter's discharge to return flow directly to the Constant Head Supply Tank. The third scour test was successful with both the Clean Water Tank and pump combined with the additional discharge tank and pump.

Both successful scour test runs included a 5-minute ramp-up period to reach the tested scour flow rates. The flow rates remained constant while 15 effluent samples were collected every two minutes. Eight evenly spaced background samples were taken throughout the duration of the first scour test. No background samples were taken during the second 260 gpm scour test since previous testing had demonstrated that background sediment concentration was < 1 mg/L. Accordingly, effluent concentrations were not adjusted, which is considered conservative.

4. Performance Claims

Following the, *"New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device," dated January 25, 2013"*, and using test sediment #10 silica sand from AGSCO Corporation, the following performance claims have been demonstrated:

Verified Total Suspended Solids (TSS) Removal Rate

Based on the laboratory testing conducted, the UUF DI 1616N-304-150M, having dimensions 16

inches square and 18 inches in height, can achieve an overall removal efficiency of 99.5% of TSS with a PSD between 53 microns and 300 microns, with average d_{50}=117μm.

Maximum Treatment Flow Rate (MTFR)

As tested, the UUF DI 1616N-304-150M, with Effective Filtration Treatment Area (EFTA) of 9.78 ft^2, has a MTFR of 130 gpm (loading rate of 13.3 gpm/ft^2).

Maximum Sediment Storage Depth

The UUF DI 1616N-304-150M, has a maximum sediment storage depth of 5-inches based on maintaining the MTFR while accumulating sediment without exceeding a bypass elevation of 18 inches.

Detention Time and Wet Volume

The UUF DI 1616N-304-150M, does not have a sump or wet volume and does not create a tailwater condition that can cause longer hydraulic detention times. The maximum volume of the tested UUF is 20 gallons, but as observed in testing, the drain down volume can be 50-60 gallons depending on the volume of residual water remaining in the system when the pump is turned off. The drain down time increases as sediment accumulates but is expected to be less than 5 minutes with 6 inches of sediment stored in the filter. Neither the drain down time nor volume influenced the test results and as such, does not need to be considered for this type of filter and its intended use.

Sediment Mass Loading Capacity

The sedimentation mass loading capacity is the mass of captured sediment during all removal efficiency and mass load test runs. The sediment mass loading capacity of the UUF DI 1616N-304-150M, was determined to be 90.5 lbs.

On-line/Off-line Applications

The UUF DI 1616N-304-150M will not resuspend and release previously captured sediment that will cause the effluent concentration to exceed 20 mg/L for flow rates less than 200% of the MTFR or 260 gpm.

Maximum Allowable Inflow Drainage Area

The maximum allowable inflow drainage area will vary depending on many factors like: rainfall characteristics (intensity, duration, frequency, inter-event dry period, etc.), the project site, topography, pollutant characteristics and loads, etc. The UUF is intended for source control of surface runoff and is used upstream of retention/detention systems or other practices that limit their discharge flows and can have large drainage catchment areas. Similar to many flow-through treatment practices, the maximum inflow drainage area will be determined by the peak water quality flow rate (Q_{wq}) method (Example: Rational Method), that is directly proportional to the drainage area, and the MTFR; where, the $Q_{wq} \leq$ MTFR. Generally, the hydraulic limitations of standard catch basin design and drainage area will apply and more filters per acre will result in lower annual loading rates and fewer filter service events.

5. Supporting Documentation

The NJDEP Procedure (NJDEP 2013a) for obtaining verification of a stormwater manufactured treatment device (MTD) from the New Jersey Corporation for Advanced Technology (NJCAT) requires that "copies of the laboratory test reports, including all collected and measured data; all data from performance evaluation test runs; spreadsheets containing original data from all performance test runs; all pertinent calculations; etc." be included in this section. This was discussed with NJDEP and it was agreed that as long as such documentation could be made available by NJCAT upon request that it would not be prudent or necessary to include all this information in this verification report.

5.1 Removal Efficiency and Mass Loading Capacity Results

A total of 10 removal efficiency test runs were completed and except for test run #1 (Refer to "Average Influent Concentrations"), all were in accordance with the NJDEP filter protocol. Following the first 10 removal efficiency tests, the MTFR was reduced by 10%, followed by another four test runs to determine the mass load capacity. The target MTFR and influent sediment concentration were 130 gpm and 200 mg/L, respectively. The results from all 10 test runs were used to calculate the overall removal efficiency of the UUF. The removal efficiency was 99.5% for all 14 test runs.

Flow Rate

Flow rates were manually measured and recorded by reading the mag meter for all test runs except test run 1, scour test run 1 and scour test run 3. Manual readings were needed for runs 2-14 because the data logger was being interrupted while attempting to calibrate water elevation sensors and were recorded once every minute to the nearest $1/10^{th}$ of a gpm. For the three test runs successfully recorded by the data logger, flow rates were recorded twice every minute. The flow rate variability for all test runs was less than 1.4% and had a COV (coefficient of variation) of <0.006 (**Table 2a and Table 2b**).

The flow data has been summarized in **Table 2a and 2b**, including compliance to the QA/QC acceptance criteria. The average flow rate for all 10 removal efficiency runs was 130.6 gpm, and 117.5 gpm for the remaining four mass load tests.

Table 2a Removal Efficiency Test Runs – Flow Rates, Temperature, Water Elevation

Test Run	Target Flow Rate (gpm)	Avg. Flow Rate (gpm)	Std. Dev.	% Var.	% Var. ≤ 10% (Y/N)	COV	COV <.03 (Y/N)	Max. Temp (°F)	Max. Temp ≤80°F (Y/N)	Max. Water Elevation (inches)	Less than bypass weir? (Y/N)
1	130	131.8	0.7636	1.38%	Y	0.006	Y	60.0	Y	5.0	Y
2	130	130.4	0.4673	0.31%	Y	0.004	Y	60.5	Y	7.0	Y
3	130	130.2	0.5036	0.15%	Y	0.004	Y	60.1	Y	10.0	Y
4	130	130.5	0.4946	0.38%	Y	0.004	Y	58.5	Y	11.0	Y
5	130	130.3	0.4717	0.23%	Y	0.004	Y	59.3	Y	12.0	Y
6	130	130.8	0.7739	0.62%	Y	0.006	Y	58.6	Y	12.3	Y
7	130	130.4	0.4375	0.31%	Y	0.003	Y	60.3	Y	13.0	Y
8	130	130.4	0.4638	0.31%	Y	0.004	Y	59.2	Y	14.3	Y
9	130	130.6	0.3621	0.46%	Y	0.003	Y	58.5	Y	15.3	Y
10	130	130.4	0.4338	0.31%	Y	0.003	Y	59.2	Y	16.0	Y
Avg. Flow Rate =		**130.6**									

Table 2b Mass Load Test Runs – Flow Rates, Temperature, Water Elevation

Test Run	Target Flow Rate (gpm)	Avg. Flow Rate (gpm)	Std. Dev.	% Var.	% Var. ≤ 10% (Y/N)	COV	COV <.03 (Y/N)	Max. Temp (°F)	Max. Temp ≤80°F (Y/N)	Max. Water Elevation (inches)	Less than bypass weir? (Y/N)
11	117	117.5	0.3812	0.44%	Y	0.003	Y	59.6	Y	15.3	Y
12	117	117.5	0.4138	0.41%	Y	0.004	Y	59.8	Y	16.5	Y
13	117	117.4	0.5599	0.37%	Y	0.005	Y	60.8	Y	17.0	Y
14	117	117.5	0.3889	0.43%	Y	0.003	Y	59.9	Y	17.8	Y
Avg. Flow Rate =		**117.5**									

Sediment Addition

The target sediment concentration was 200 ± 20 mg/L with a COV less than 0.10. Each test run included three 1-minute samples to verify the sediment feed rates complied. All sediment feed sample weights were measured by IAS Laboratories using certified scales to the nearest milligram. **Tables 3a and 3b** summarize feed sample times, weights and rates. All sediment feed rate criteria were met. Visual observations by the third-party independent observer after each run confirmed that none of the sediment remained on the streetscape.

The data obtained from the sediment feed rate sampling is strictly used for quality assurance related to the injection feed rate throughout the test runs. Inlet concentrations for each test run are based on the initial sediment in the auger minus the sediment remaining in the auger, less what is removed for feed rate sampling, or the total feed sample mass.

Table 3a Sediment Feed Data

Run	Feed Sample Duration (seconds)			Total Feed Sample Time	Calibration Feed Sample Mass			Total Feed Sample Mass
Time (min)	1	15	27	(mins)	(grams)	(grams)	(grams)	(grams)
1	60.0	60.0	60.0	3.00	101.011	100.244	102.714	304
2	60.0	60.0	60.0	3.00	98.765	101.777	101.478	302
3	60.0	60.0	60.0	3.00	101.531	102.019	102.984	307
4	60.0	60.0	60.0	3.00	99.347	101.316	102.184	303
5	60.0	60.0	60.0	3.00	99.329	100.001	100.357	300
6	60.0	60.0	60.0	3.00	99.935	104.184	101.469	306
7	60.0	60.0	60.0	3.00	99.644	99.729	100.762	300
8	60.0	60.0	60.0	3.00	98.084	102.590	99.074	300
9	60.0	60.0	60.0	3.00	98.542	100.027	98.837	297
10	60.0	60.0	60.0	3.00	96.963	100.627	100.213	298
11*	60.0	60.0	60.0	3.00	98.337	98.938	101.528	299
12*	60.0	60.0	60.0	3.00	97.502	99.690	100.536	298
13*	60.0	60.0	60.0	3.00	96.556	98.611	100.167	295
14*	60.0	60.0	60.0	3.00	98.212	99.475	100.641	298

Table 3b Sediment Feed Rate Data

Run	Feed Rates (g/min)			Avg.	SD	COV	Compliant (<0.1) (Y/N)
	1	15	27	(g/min)	(g/min)		
1	101	100	103	101	1.26	0.01	Y
2	99	102	101	101	1.66	0.02	Y
3	102	102	103	102	0.74	0.01	Y
4	99	101	102	101	1.45	0.01	Y
5	99	100	100	100	0.52	0.01	Y
6	100	104	101	102	2.15	0.02	Y
7	100	100	101	100	0.62	0.01	Y
8	98	103	99	100	2.37	0.02	Y
9	99	100	99	99	0.79	0.01	Y
10	97	101	100	99	2.01	0.02	Y
11	98	99	102	100	1.70	0.02	Y
12	98	100	101	99	1.57	0.02	Y
13	97	99	100	98	1.81	0.02	Y
14	98	99	101	99	1.21	0.01	Y

Effluent and Background Sampling

To assess the removal efficiency for each test run, five effluent and three background samples were taken. Sampling times and concentrations for both the effluent and background samples are provided in **Table 4**. The discrete effluent and background concentrations are averaged, although all concentrations were less than the reporting limit, or 1 mg/L. For removal efficiency calculations, the background concentrations were assigned 0 mg/L and the effluent concentrations assigned 1 mg/L. The average adjusted effluent concentration accounts for any background concentration.

Table 4 Effluent and Background Concentration Data

Run	Sample	Time (minutes)					Avg. Background TSS	Background ≤ 20 mg/L	Avg. Effluent TSS	Avg. Adjusted Effluent TSS
		5	11	19	25	31	(mg/L)	(Y/N)	(mg/L)	(mg/L)
1	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
2	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
3	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
4	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
5	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
6	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
7	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
8	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
9	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
10	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
11	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
12	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
13	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		
14	Effluent TSS	ND	ND	ND	ND	ND			<1	<1
	Background* TSS	ND		ND		ND	<1	Y		

*Five effluent samples taken at 5, 11, 19, 25 and 31 minutes

*Three background samples taken at 5, 19 and 31 minutes

*Runs 1-10 = Removal Efficiency Test Runs, Runs 11-14 = Mass Load Test Runs

*ND = non-detect. Minimum reporting limit (MRL) = 1 mg/L.

Filter Drain Down

The tested UUF has a post-operation drain down that varies depending on the volume of water and sediment in the filter when the drain down begins. The filter does not create a tailwater or impact storage of water in the upstream piping or streetscape. However, as mentioned earlier, the drain down volume includes any residual water remaining in the system at the time when the pump is turned off.

The drain down volume was measured by diverting flow to a storage barrel when the pump was turned off. Some variability in measuring the volumes was caused by the inaccuracy of diverting the flow to the storage barrel exactly when the pump was stopped and given most of the drain down volume occurred in the first 30 seconds. The drain down time was measured from when the pump was turned off until the volume in the storage barrel "stopped increasing". Often there was still a trickle as the sediment in the filter continued to drain out.

The two drain down samples were taken approximately when the volume was at one-third and two-thirds of the total volume discharged. Samples were sent to IAS Laboratories to determine the drain down concentrations. Accounting for any background concentrations, the mass of sediment lost during the drain down period was calculated.

All drain down measurements are provided in **Table 5**. As shown, all concentrations were ND and reported as <1 mg/L. As was done for the ND concentrations measured for the effluent samples, the drain down concentrations were also conservatively assumed to be 1 mg/L.

Table 5 Drain Down (DD) Results

Run	Total DD Time	Total DD Volume	DD TSS	Avg. DD TSS	Avg. Background TSS	Avg. Adj. DD TSS	Mass DD
	(minutes)	(gallons)	(mg/L)				(grams)
1	3.07	24	<1 <1	<1	<1	<1	<1
2	3.27	45	<1 <1	<1	<1	<1	<1
3	3.10	45	<1 <1	<1	<1	<1	<1
4	4.12	47	<1 <1	<1	<1	<1	<1
5	3.73	46	<1 <1	<1	<1	<1	<1
6	3.98	47	<1 <1	<1	<1	<1	<1
7	3.92	51	<1 <1	<1	<1	<1	<1
8	4.15	52	<1 <1	<1	<1	<1	<1

9	4.43	53	<1 <1	<1	<1	<1	<1
10	4.53	56	<1 <1	<1	<1	<1	<1
11	4.62	51	<1 <1	<1	<1	<1	<1
12	4.85	51	<1 <1	<1	<1	<1	<1
13	4.92	51	<1 <1	<1	<1	<1	<1
14	5.22	51	<1 <1	<1	<1	<1	<1

Influent and Effluent Flow Volumes

Table 6 includes the influent, drain down and effluent volumes for each test run. These are used for calculating the average influent concentrations as well as influent, drain down and effluent mass of sediment entering and leaving the filter. Because each test run was 33 minutes, including a 3-minute feed rate sampling period, the time when sediment is being injected into the influent flow stream is 30 minutes. The product of average flow rate for each test run and the sediment injection time is used to calculate the influent volume. The effluent volume is calculated from the difference between the influent volume and drain down volume, rounded to the nearest gallon.

Table 6 Drain Down (DD) Results

Run	Test Run Duration (min)	Total Feed Rate Sampling Duration (min)	Sediment Injection Time (min)	Average Flow Rate	Influent Volume	DD Volume	Effluent Volume
	33 mins	≤3 min	≥30 min	(gpm)	(gallons)	(gallons)	(gallons)
1	30.0	3.00	27.0	131.8	3,558	24	3,534
2	33.0	3.00	30.0	130.4	3,912	45	3,867
3	33.0	3.00	30.0	130.2	3,907	45	3,862
4	33.0	3.00	30.0	130.5	3,915	47	3,868
5	33.0	3.00	30.0	130.3	3,908	46	3,862
6	33.0	3.00	30.0	130.8	3,923	47	3,876
7	33.0	3.00	30.0	130.4	3,913	51	3,862
8	33.0	3.00	30.0	130.4	3,911	52	3,859
9	33.0	3.00	30.0	130.6	3,917	53	3,864
10	33.0	3.00	30.0	130.4	3,913	56	3,857
11*	33.0	3.00	30.0	117.5	3,526	51	3,475
12*	33.0	3.00	30.0	117.5	3,524	51	3,473
13*	33.0	3.00	30.0	117.4	3,523	51	3,472
14*	33.0	3.00	30.0	117.5	3,525	51	3,474

Removal Efficiency Calculations

The removal efficiency for each test run is calculated using a mass balance approach that evaluates the mass injected into the UUF less the mass leaving the filter. The total mass of test sediment entering the filter is a weighed measurement that is the difference between the mass of test sediment placed in the auger and what is removed at the end of each test run less the mass removed for the three feed rate samples. **Table 7a and Table 7b** summarize the results of the mass removal rate calculations.

As described in Section 3.2, the initial mass of sediment used for each test run was pre-weighed in 5-gallon pails, to the nearest $1/10^{th}$ of a pound, by IAS using their certified scales. Sediment removed from the auger at the end of each test run was returned to IAS to determine the final mass remaining in the auger, which includes what was removed for sediment feed rate sampling. IAS also determined the PSD and moisture content of the sediment in each pail. The average moisture content from all the test sediment samples was 0.05%, but the moisture content from each pail was used to adjust the total mass injected by the auger. The Influent Mass (adjusted for moisture) is the difference between the total mass injected by the auger and the total feed rate sample mass, as reported in **Table 7a**.

The effluent mass for each test run is calculated from the product of the average (background) adjusted effluent concentration and effluent volume. The mass of sediment leaving the filter during the drain down period is the product of the average (background) adjusted drain down concentration and effluent volume, as reported in **Table 7b**. The total mass captured is determined from the difference between the influent mass (mass entering the filter) and the calculated sum of effluent and drain down mass (mass leaving the filter). For the initial 10 removal efficiency test runs, 64.7 lbs of test sediment was added to the filter and 64.4 lbs of test sediment was captured. Within the accuracy limit of the test, the removal efficiency of each of the test runs #1-14 and the cumulative removal efficiency of all test runs was 99.5%.

Removal efficiency of each test run was calculated as follows:

$$\text{Removal efficiency} = \frac{Mass\ Captured}{Influent\ Mass} \times 100\%$$

Where:

$$\text{Mass Captured} = Influent\ Mass - Effluent\ Mass - Draindown\ Mass$$

Influent mass = $(Inital\ mass\ in\ auger - Final\ mass\ in\ auger) \times (1 - moisture\ percent)$

Effluent mass = $Average\ adjusted\ effluent\ TSS\ concentration \times effluent\ volume$

Average adjusted effluent TSS conc. = $Average\ Effluent\ TSS\ conc. - Average\ Background\ TSS\ conc.$

Effluent volume = $Influent\ volume - Drain\ down\ volume$

Influent volume = Average flow rate × Sediment injection time

Sediment injection time = $Test\ run\ duration - total\ feed\ rate\ sampling\ time$

Drain down mass = $Average\ Adjusted\ drain\ down\ TSS\ concentration \times Drain\ down\ volume$

Average adjusted drain down TSS conc.= $Average\ drain\ down\ TSS\ conc. - Average\ Background\ TSS\ conc.$

Drain down volume = $Measured\ during\ drain\ down$

Table 7a Influent Mass Results

Test Run	Initial Mass in Auger	Final Mass in Auger	Total Mass injected by Auger	Moisture Corrected Influent Mass	Total Feed Sample Mass	Influent Mass
	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)
1	51.5	44.2	7.30	7.30	0.670	6.63
2	51.4	44.2	7.20	7.20	0.666	6.53
3	52.0	44.7	7.30	7.30	0.676	6.62
4	51.3	44.2	7.10	7.10	0.668	6.43
5	50.9	43.8	7.10	7.10	0.661	6.43
6	51.3	44.2	7.10	7.10	0.674	6.42
7	51.2	44.1	7.10	7.10	0.662	6.43
8	51.1	44.1	7.00	7.00	0.661	6.33
9	52.0	44.9	7.10	7.10	0.656	6.44
10	51.7	44.6	7.10	7.10	0.657	6.44
					Total:	**64.7**
11	39.3	32.2	7.10	7.10	0.659	6.44
12	39.4	32.3	7.10	7.10	0.656	6.44
13	39.5	32.4	7.10	7.10	0.651	6.44
14	39.2	32.1	7.10	7.10	0.658	6.44
					Total:	**25.8**

Table 7b Removal Efficiency Results

Test Run	Influent Mass	Effluent Mass	Drain down Mass	Mass Captured	Test Run Removal Efficiency	Cumulative Influent Mass	Cumulative Mass Captured	Cumulative Removal Efficiency
	(lbs)	(lbs)	(lbs)	(lbs)	(%)	(lbs)	(lbs)	(%)
1	6.63	0.03	0.00	6.60	99.6%	6.63	6.60	99.6%
2	6.53	0.03	0.00	6.50	99.5%	13.2	13.1	99.5%
3	6.62	0.03	0.00	6.59	99.5%	19.8	19.7	99.5%
4	6.43	0.03	0.00	6.39	99.5%	26.2	26.1	99.5%
5	6.43	0.03	0.00	6.40	99.5%	32.6	32.5	99.5%
6	6.42	0.03	0.00	6.39	99.5%	39.1	38.9	99.5%
7	6.43	0.03	0.00	6.40	99.5%	45.5	45.3	99.5%
8	6.33	0.03	0.00	6.30	99.5%	51.8	51.6	99.5%
9	6.44	0.03	0.00	6.41	99.5%	58.3	58.0	99.5%
10	6.44	0.03	0.00	6.41	99.5%	64.7	64.4	99.5%
Total:	**64.7**	**0.32**	**0.00**	**64.4**	**99.5%**			
11	6.44	0.03	0.00	6.41	99.5%	71.1	70.8	99.5%
12	6.44	0.03	0.00	6.41	99.5%	77.6	77.2	99.5%
13	6.44	0.03	0.00	6.42	99.6%	84.0	83.6	99.5%
14	6.44	0.03	0.00	6.41	99.5%	90.5	90.0	99.5%
Total:	**25.8**	**0.12**	**0.00**	**25.6**	**99.5%**			

Sediment Mass Load Test Results

The Sediment Mass Loading Capacity of the UUF was determined after the first 10 removal efficiency test runs, when the water elevation in the UUF was 2-inches less than the height of the UUF. The flow rate was reduced to 90% of the treatment flow rate or 117 gpm and an additional four test runs were completed prior to water elevations reaching 18 inches, at which point testing was stopped. The target influent concentration was increased as much as possible, which was 225 mg/L ± 10%, due to the auger feed rate limit. For all fourteen test runs, 90.5 lbs of test sediment was added to the filter and 90.0 lbs of test sediment was captured.

Water elevations in the filter were manually recorded for each test run. A plot of the maximum water elevation recorded for each of the fourteen test runs as the mass of test sediment increases in shown in **Figure 5**. A decrease in elevation was observed on the 11th test run after the flow rate was decreased by 10%. Other than this point, there is a constant increase as sediment accumulates in the filter indicating that the filter has less open area for flow to pass thorough.

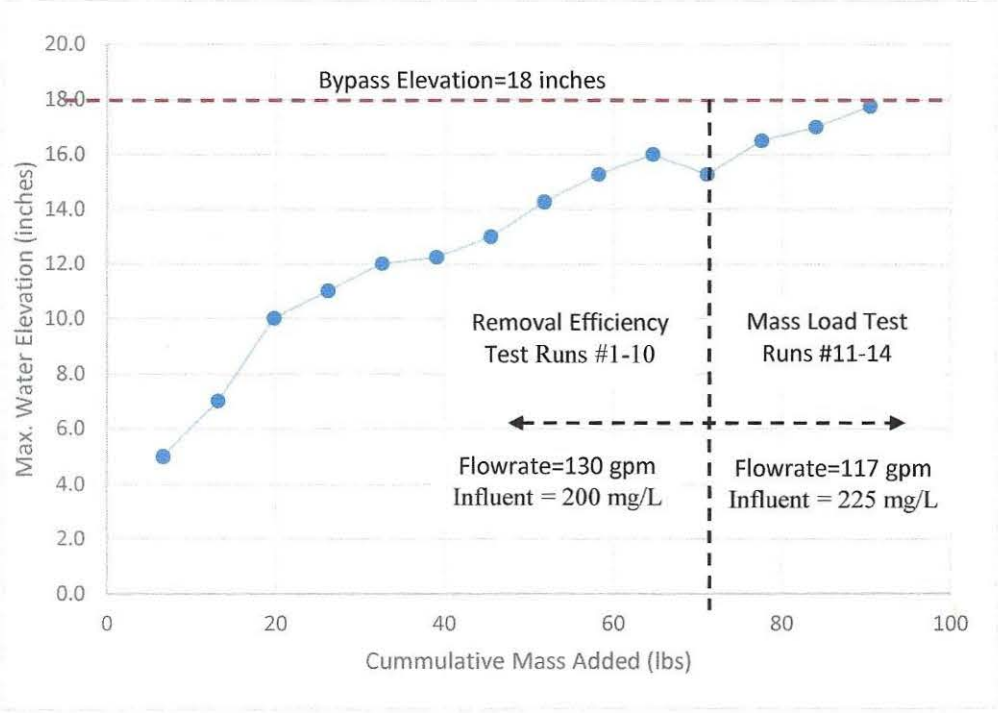

Figure 5 Influence of Mass Load on Water Elevations

Average Influent Concentrations

The average influent concentration for each test run is calculated as the quotient of the influent mass and water volume during dosing. Calculation of these quantities have been previously described and are included in **Table 8**. The influent concentrations for removal efficiency testing can vary between 180 mg/L and 220 mg/L or ±10%. With the auger injecting at its maximum capacity, and the reduced flow rate during mass load test runs #11-14, the target influent concentration during mass load test runs was 225 mg/L ±10%. Excluding the first test run, all influent concentrations are within 3.1% and are in compliance with the test protocol. Test run #1 was shorter than planned

due to available storage volume needed to keep water elevations in the supply tank constant. It was not excluded from the removal efficiency test results given all other test runs achieved greater than 99% capture and its exclusion would not have influenced the results.

Table 8 Influent Concentrations

Test Run	Influent Mass (lbs)	Influent Volume (gallons)	Avg. Influent TSS Conc. (mg/L)	Influent Variability (%)	Influent TSS Compliant (Y/N)
1	6.63	3,558	223	11.5%	N
2	6.53	3,912	200	0.00%	Y
3	6.62	3,907	203	1.50%	Y
4	6.43	3,915	197	1.50%	Y
5	6.43	3,908	197	1.50%	Y
6	6.42	3,923	196	2.00%	Y
7	6.43	3,913	197	1.50%	Y
8	6.33	3,911	194	3.00%	Y
9	6.44	3,917	197	1.50%	Y
10	6.44	3,913	197	1.50%	Y
Total:	**64.7**	**39,172**			
		Average:	**200**	**0.04%**	**Y**
11	6.44	3,526	219	3.00%	Y
12	6.44	3,524	219	3.00%	Y
13	6.44	3,523	219	3.00%	Y
14	6.44	3,525	219	3.00%	Y
Total:	**25.8**	**14,098**			
		Average:	**219**	**3.00%**	**Y**

5.2 Scour Testing Results

As described in Section 3.2, scour testing was completed to determine the maximum on-line flow rate. Results from three sequential test runs are shown in **Tables 9a**, **9b**, and **9c**. Each test run was 33 minutes in duration and included a 5-minute ramp-up period used to reach the target flow rate. The average flow rate and COV does not include the first two flow readings.

Given the maximum water elevation recorded during the last mass load test run #14, which was only slightly below the bypass weir, the flow rate for the first scour test remained the same, at 130 gpm. Very little bypass or sediment was observed in the effluent during the first scour test. Consequently, a second scour test run was attempted at 200% of the MTFR, or 260 gpm, but was terminated due to insufficient flow capacity needed to maintain constant head on the supply pump. Following some changes to the lab set-up, the scour test at 260 gpm was repeated. Given potable water was used for scour tests and previous tests indicated background concentrations < 1 mg/L, no samples were taken during this test run. Results show that the fifteen discrete effluent concentrations for scour test three were all less than 20 mg/L, with an average 7.5 mg/L, demonstrating minimal re-suspension at 200% of the MTFR.

Table 9a Scour Test #1 – 130 gpm

Sample	Time	Flow Rate					Max. Temp	Quality Check ≤80F	Effluent TSS	Back-ground TSS	Adj. Effluent TSS	Quality Check ≤20 mg/L
		Target	Actual	Mean	Std. Dev.	COV						
	(min:sec)	(gpm)					(°F)	(Y/N)	(mg/L)			(Y/N)
	1:00	26	26	Ramp-up Period					No samples taken during ramp up per protocol			
	3:00	78	78.4									
1	5:00	130	130.1	130.3	0.384	0.003	59.5	Y	<1	<1	<1	Y
2	7:00	130	130.4						<1		<1	Y
3	9:00	130	130.3						<1	<1	<1	Y
4	11:00	130	130.1						<1		<1	Y
5	13:00	130	131.3						<1	<1	<1	Y
6	15:00	130	130.3						<1		<1	Y
7	17:00	130	129.8						<1	<1	<1	Y
8	19:00	130	130.5						<1		<1	Y
9	21:00	130	130.4						<1	<1	<1	Y
10	23:00	130	130.5						<1		<1	Y
11	25:00	130	130.1						<1	<1	<1	Y
12	27:00	130	129.7						<1		<1	Y
13	29:00	130	130.3						<1	<1	<1	Y
14	31:00	130	129.9						<1		<1	Y
15	33:02	130	130.6						<1	<1	<1	Y

Table 9b Scour Test #2 – 260 gpm

Sample	Time	Flow Rate					Max. Temp	Quality Check ≤80F	Effluent TSS	Back-ground TSS	Adjusted Effluent TSS	Quality Check ≤20 mg/L
		Target	Actual	Mean	Std. Dev. (SD)	COV (SD/mean)						
	(min:sec)	(gpm)					(°F)	(Y/N)	(mg/L)			(Y/N)
	1:00	52	54.0	Ramp-up Period					No samples taken during ramp up per protocol			
	3:00	156	156.0									
1	5:00	260	260.0						<1	<1	<1	Y
2	7:00	260	Test Terminated due to pump#2 not operating > ~220 gpm Water elevation dropped in supply tank No Flow Data Available after 5 minutes.				59.5	Y	<1		<1	Y
3	9:00	260							<1	<1	<1	Y
4	11:00	260							<1		<1	Y
5	13:00	260							Test Terminated Pump#2 Exceed Capacity No samples taken after 11 minutes.			
6	15:00	260										
7	17:00	260										
8	19:00	260										
9	21:00	260										
10	23:00	260										
11	25:00	260										
12	27:00	260										
13	29:00	260										
14	31:00	260										
15	33:00	260										

Table 9c Scour Test #3 – 260 gpm

Sample	Time	Flow Rate					Max. Temp	Quality Check ≤80F	Effluent TSS	Back-ground TSS*	Adjusted Effluent TSS	Quality Check ≤20 mg/L
		Target	Actual	Mean	Std. Dev.	COV						
	(min:sec)	(gpm)					(°F)	(Y/N)	(mg/L)			(Y/N)
	1:00	52	48.4	Ramp-up Period					No samples taken during ramp up per protocol			
	3:00	156	155.0									
1	5:00	260	257.8						2	0	2	Y
2	7:00	260	262.8						<1		1	Y
3	9:00	260	261.2						5	0	5	Y
4	11:00	260	262.3						1		1	Y
5	13:00	260	261.1						7	0	7	Y
6	15:00	260	260.0	260.6	1.22	0.005	59.5	Y	4		4	Y
7	17:00	260	260.5						6	0	6	Y
8	19:00	260	259.9						17		17	Y
9	21:00	260	260.3						6	0	6	Y
10	23:00	260	259.9						15		15	Y
11	25:00	260	260.7						16	0	16	Y
12	27:00	260	260.0						8		8	Y
13	29:00	260	261.4						14	0	14	Y
14	31:00	260	261.5						3		3	Y
15	33:02	260	259.4						8	0	8	Y

*No background samples taken since all previous BG samples < 1 mg/L.

6. Maintenance

Maintaining the UUF DI 304-150M catch basin filter inserts is required for sustaining hydraulic performance and pollutant removals. It does require planning but is intended to be very simple and inexpensive. All drop-in filter inserts are installed (suspended) in catch basin structures from a collar that is placed under the inlet grate. Once the grate has been removed, there will be full access to trash, sediment or debris that has been captured in the filter insert. Following removal of captured materials, the grate is replaced, and the materials disposed as required by local authorities or regulations. No confined space entry is necessary, and no internal components need to be removed or replaced. Materials captured by the filter that are allowed to dry during long dry periods may harden, which can cause the filter to partially blind if not properly maintained. Should the filter blind and cleaning beyond simple removal of material be required, the UUF filter insert can be removed from the catch basin and cleaned above grade. The frequency of maintenance will vary and if possible, should be determined by inspections that are part of a larger stormwater drainage systems' maintenance program.

Planning Considerations

Safety is the most important consideration before inspecting and removing pollutants from the UUF. Urban stormwater drainage structures are often installed along roadside curbs or in parking lots with limited space. Consider plans for:

- Safety clothing and gear – reflective vests, glasses, steel-toed shoes, gloves
- Allowing personnel space to remove and temporarily store surface grates
- Maneuvering and parking maintenance vehicles
- Equipment for directing traffic and pedestrians - safety cones or barriers and use of appropriate signage
- Equipment for removing the grates (Example: Grate Lifter)
- Tools to loosen consolidated sediment and debris covering the grate
- Storing and disposal of pollutants

Inspection Procedures

1. Locate the catch basins to inspect and refer to the planning considerations listed above.
2. Remove and dispose of any materials blocking the grate openings.
3. Using a light if needed or remove the surface grate to:
    - Take photographs
    - Observe & record the depth of accumulated sediment, trash and debris
4. Complete an inspection form. Record catch basin ID, depth and date.
5. Replace the surface grate if it was removed.
6. Schedule maintenance (clean out) if filter insert is more than half full.

Maintenance Procedures

1. Refer to planning considerations and ideally, only clean out when it is not raining.
2. Contact AbTech Industries for an authorized service provider.
3. Remove surface grate.

4. Use equipment, like a Vactor Truck that can power wash and vacuum.
5. Power wash surface area around the inlet and in the filter to loosen any consolidated sediment and debris.
6. Using the vacuum, suck out trash, foliage and sediment.
7. Pressure wash the sides and bottom of the filter insert to remove captured materials.
8. Repeat steps 6 & 7 until the all the captured materials have been removed.
9. Replace the grate and ensure it is flush with the finished grade.

7. Scaling

Based on the verified test results and loading rate of 13.3 gpm/ft^2, a "Normal" filter height of 18-inches, or "Half" filter height of 10-inches, and total screen filtration treatment area, other model size examples are provided in **Table 10.**

Table 10 UUF DI 304-150M Filter Models

	Model*	Filter Dimensions (inches)			Total Screen Surface Area	Sediment Storage Depth	Treatment Flow Rate	Loading Rate
		L	W	H	ft^2	inches	gpm	gpm/ft^2
Shallow	DI 1212H-304-150M	12	12	10	4.33	3	58	13.3
	DI 1414H-304-150M	14	14	10	5.25	3	70	13.3
	DI 1420H-304-150M	14	20	10	7.50	3	100	13.3
	DI 1616H-304-150M	16	16	10	6.22	3	83	13.3
	DI 2020H-304-150M	20	20	10	8.33	3	111	13.3
	DI 1632H-304-150M	16	32	10	12.4	3	165	13.3
Deep	DI 1212N-304-150M	12	12	18	7.00	5	93	13.3
	DI 1414N-304-150M	14	14	18	8.36	5	111	13.3
	DI 1420N-304-150M	14	20	18	11.9	5	159	13.3
	DI 1616N-304-150M	16	16	18	9.78	5	130	13.3
	DI 2020N-304-150M	20	20	18	12.8	5	170	13.3
	DI 1632N-304-150M	16	32	18	19.6	5	260	13.3

*Not all models are shown. Custom models are available.

8. Statements

The following signed statements from the manufacturer (AbTech), third-party observer (Kimberwerks) and NJCAT are required to complete the NJCAT verification process.

AbTech
Leader of Stormwater Purification

March 18, 2020

Dr. Richard Magee, Sc.D., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology (NJCAT)
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Pint on Hudson
Hoboken, NJ 07030

RE: Manufacturers Statement of Compliance

Dear Dr. Magee,

AbTech Industries (the manufacturer) has completed verification testing for the Ultra Urban® Filter (UUF) model DI1616-304-150M at AbTech's testing facility. The performance assessment and verification included quantifying the sediment removal efficiency, the total mass of sediment captured and resulting changes in headlosses, while operating at a constant flow rate. Additionally, high flow rate tests were conducted to quantifying the effluent concentrations that are used as a measure of the filter's ability to retain previously captured sediment, also referred to as scour or washout.

Except for the specified particle size distribution, test protocols were in accordance with the, "New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device" (January 25, 2013). To ensure compliance with these protocols, a test plan was completed and submitted to NJCAT for review and approval, all testing and sampling collection and handling was witnessed by an approved independent observer, Mike Kimberlain, P.E. of Kimberwerks, and all analytics were performed by a certified laboratory, IAS Laboratories (IAS), located in Phoenix Arizona.

Please accept this letter as the manufacturers statement of compliance. Specifically, AbTech has followed all procedures to ensure that the results and performance claims presented in this verification report are in compliance with the standards set forth in the test protocol.

Sincerely,

David A. Scott, CPSWQ
Program Development Manager
AbTech Industries

4110 N. Scottsdale Rd., Suite 235 Scottsdale, AZ 85251 USA
P: 480.874.4000 E: info@abtechindustries.com W: abtechindustries.com

KimberWerks, Inc.
P.O. Box 7198
Rancho Santa Fe, California 92067
(858) 381-6209

March 19, 2020

Richard S. Magee Sc.D., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology
Center for Environmental Systems
Stevens Institute of Technology
Castle Point on Hudson
Hoboken, NJ 07030
973-879-3056 (M)
rsmagee@rcn.com

Re: **Statement of Third-Party Observer**
Performance Verification of the AbTech Industries, Inc. Ultra Urban Filter
Model UUF DI1616N-304-150M

Dr. Magee,

KimberWerks, Inc. has been engaged by AbTech Industries, Inc. (AbTech) to act as the third-party observer for the Performance Verification Testing of their Ultra Urban Filter Model UUF DI1616N-304-150M Filtration Manufactured Treatment Device. Performance Verification testing was performed by AbTech personnel under the direction of Mr. David Scott, Program Development Manager, and began on February 17th and ended on February 21st. The Performance Verification was performed at AbTech's facility located at 3610 East Southern Avenue, Suite 2, Phoenix, Arizona 85040.

I was personally on site to observe the testing and I remained on site to observe the testing for its full duration. It is my professional opinion that the Performance Verification Testing conducted by AbTech meets or exceeds the requirements of the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device (January 25, 2013)* with the noted exception in the report regarding the intentional deviation from the Protocol Section 5.B. (Test Sediment) Particle Size Distribution. In addition, I have personally reviewed the data sets, calculations, and conclusions associated with the Removal Efficiency and Scour Testing in the *NJCAT TECHNOLOGY VERIFICATION: Ultra-Urban® Filter Model UUF DI1616N-304-150M* report by AbTech Industries dated March 2020 and hereby state they conform to my observations while acting as third-party observer.

Please let me know should you have any questions or need any clarification to these statements.

Sincerely,

Michael Kimberlain, P.E., CPSWQ
mkimberlain@kimberwerks.com
(858) 381-6209

KimberWerks, Inc.
P.O. Box 7198
Rancho Santa Fe, California 92067
(858) 381-6209

March 19, 2020

Richard S. Magee Sc.D., P.E., BCEE
Executive Director
New Jersey Corporation for Advanced Technology
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Re: **Third-Party Observer Statement of Disclosure / Disclosure Record**

Dr. Magee,

In accordance with the *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology (January 25, 2013), Section 4. B Conflict of Interest* KimberWerks, Inc. would like to inform NJCAT that we have no disclosures that would represent a conflict of interest. KimberWerks, Inc. has no personal, professional, or financial interest in the outcome of the Performance Verification Testing performed by AbTech Industries, Inc. and has no personal, professional, or financial interest in AbTech Industries, Inc.

KimberWerks, Inc. is a privately owned Engineering Consulting company that regularly performs work in the areas of Civil Engineering, Storm Water, Waste Water, and Potable Water and as such has in the past engaged with various Storm Water MTD Manufactures including but not limited to: AbTech, Industries, Inc., Prinsco, Hydro International, Advanced Drainage Systems, Forterra Building Products, OldCastle Stormwater Solutions, Lane Enterprises, AquaShield, and Jensen Stormwater Systems. None of these engagements present a personal, professional, or financial conflict of interest as the engagements did not include (and are not limited to):

- having an ownership stake in any of the companies;
- receiving commission for selling a MTD for a manufacturer;
- having a licensing agreement with the manufacturer; or
- receiving funding or grants not associated with a testing program from the manufacturer.

Please let me know should you have any questions or need any clarification to these statements.

Sincerely,

Michael Kimberlain, P.E., CPSWQ
mkimberlain@kimberwerks.com
(858) 381-6209

Center for Environmental Systems
Stevens Institute of Technology
One Castle Point
Hoboken, NJ 07030-0000

March 25, 2020

Mr. David Scott
Program Development Manager
AbTech Industries
4110 N. Scottsdale Rd., Suite 235
Scottsdale, AZ 85251

Dear Mr. Scott,

Based on my review, evaluation and assessment of the testing conducted on AbTech's Ultra Urban® Filter (UUF) model DI 1616N-304-150M at the company's testing facility in Phoenix, Arizona, under the third party oversight of Kimberwerks, the test protocol requirements contained in the *"New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device"* (NJDEP Filter Protocol) were met with one exception: the sediment test particle size distribution (PSD) was coarser than specified in the NJDEP protocol. Consequently, the verification report does not qualify for NJDEP certification.

Test Sediment Feed – The particle size distribution used for this performance assessment was coarser than what is specified in the NJDEP test protocol but may be considered suitable for the intended application depending on the water quality objectives. In general, the test sediment was larger than 53 microns and less than 300 microns and the average d_{50} was 117µm. In comparison, the d_{50} for the test sediment specified in the protocol is 75 microns and 45% is between 2µm and 50µm and about 10% between 300µm and 1,000µm

Removal Efficiency Testing – The tested UUF DI 1616N-304-150M achieved an overall removal efficiency of 99.5% TSS with a PSD between 53 microns and 300 microns, with average d_{50}=117µm for all test runs.

Tested Treatment Flow Rate - The UUF Model UUF DI1616N-304-150M, with Effective Filtration Treatment Area (EFTA) area of 9.78 ft^2, has a MTFR 130 gpm (loading rate 13.3 gpm/ft^2).

Sediment Mass Loading Capacity - The sedimentation mass loading capacity of the UUF DI 1616N-304-150M, was determined to be 90.5 lbs.

On-line/Off-line Applications - Scour testing results showed the average effluent concentration (7.5 mg/L) not to exceed 20 mg/L for flow rates up to 200% of the treatment flow rate, or 260 gpm.

All other criteria and requirements of the NJDEP Filter Protocol were met. These include: flow rate measurements COV <0.03; test sediment influent concentration COV <0.10; test sediment influent concentration within 10% of the targeted value of 200 mg/L (or 400 mg/L); influent background concentrations <20 mg/L; and water temperature <80 °F.

Sincerely,

Richard S. Magee, Sc.D., P.E., BCEE
Executive Director

9. References

1. NJDEP 2013a. New Jersey Department of Environmental Protection Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology. January 25, 2013.

2. NJDEP 2013b. New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device. January 25, 2013.

3. ASTM D422-63(2007). Standard Test Method for Particle-Size Analysis of Soils.

4. ASTM D3977-97(2019). Standard Test Methods for Determining Concentrations in Water Samples.

5. ASTM D4959-16. Standard Test Method for Determination of Water Content of Soil by Direct Heating.

AbTech INDUSTRIES

Ultra-Urban® Filter / Smart Sponge® Technology:

OPERATION, MAINTENANCE & CHANGE–OUT

Ultra Urban Filter Inspection

Deployment methods of the *Ultra Urban Filter*, in either the Drain Inlet (DI) or the Curb Opening (CO) configuration, allow for similar inspection protocols. The frequency of inspection and established guidelines for inspection are discussed.

1. Frequency

Inspection scheduling is site specific as it needs to take into account local weather pattern, site/watershed profile and contaminants loading. In general, inspections should be conducted at least as often as:

- Twice per year – within 60 days of the rainy start date and within 60 days after the rainy season ends.
- Quarterly – once each calendar year quarter.
- After major storms.

1.1 Items for inspection

The goal of the inspection is to assess the accumulation of any trash, debris, or particulate matter in the inlet basket and assess the viability of the filtration media to conduct water.

Always employ proper traffic management and handling procedures for all inspections where vehicles and pedestrians have access.

If contained in a Catch Basin, remove manhole/ lid(s)/ grate(s) and observe from above:

1. The inlet basket for settled trash and debris inside.
2. The inlet basket for standing water.
3. The inlet basket for the high water line.
4. The *Ultra Urban Filter* structure for any abnormalities, damage, or deterioration
5. Replace manhole/ lid(s) / grate(s) as appropriate.

Do not adjust or inspect unit during periods of rain or when the system is actively working (releasing of stormwater through the unit). Always employ OSHA regulated rules for confined space when working inside below ground structures.

Inspect:

1. Anything not observable from above (see previous list).
2. The inlet grid and inlet face of the media for "fouled" media due to the clogging of pores from trash or other particulate matter (the outside surface of the media may be a brown color or otherwise obviously clogged with particulate matter).
3. The inlet face of the media for "fouled" media due to the absorption of hydrocarbons (the outside surface of the media will be a black color).
4. For DI deployments make sure the collar straps are attached properly to the *Ultra Urban Filter*. On CO deployments the *Ultra Urban Filter* needs to be secured to the mounting bracket and that all flow diverters, if any, remain intact.
5. Replace manhole/ lid(s)/ grate(s) as appropriate.

1.2 Inspection Documentation

Complete the *Ultra Urban Filter* Inspection and Maintenance Report. This report will assist in the decision process to initiate appropriate maintenance activities.

Ultra Urban Filter Maintenance

Proper maintenance of an *Ultra Urban Filter* is essential to retain the overall pollutant removal capabilities of the individual devices. The guidelines for the creation of a routine maintenance cycle for a specific site are outlined below.

2. Guidelines

The primary purpose of the *Ultra Urban Filter*, like any effective filtration system, is to filter out and prevent pollutants from entering our waterways. Accordingly, the pollutants being captured by the *Ultra Urban Filter* must be periodically removed. The goal of the maintenance activities is not only to repair or extend the functionality of the filtration media, but also to prevent malfunctions of the media before they occur. As previously noted, trash, debris, and other particulate matter are detrimental to the proper function of the media; therefore, maintenance activities focus primarily on these types of contaminants.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site.

Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is also good practice to inspect the system after severe storm events.

2.1 Types of Maintenance

Currently, two types of maintenance have been defined:

- Ordinary/minor maintenance
- Major maintenance

Ordinary maintenance activities are often combined with inspection and will require the use of a vac-truck.

Ordinary/minor maintenance typically involves:

- Inspection of the installation itself
- Removal of vegetation, trash and debris and sediment by vac-truck

Major maintenance typically includes:

- Sediment removal
- *Ultra Urban Filter* cleaning/hydraulic testing (once a year)
- Unit replacement

Important: Applicable safety (OSHA) and disposable regulations should be followed during all maintenance activities.

Two to four scheduled inspections/maintenance activities should take place during the year.

First, an inspection/minor maintenance activity should be done. During the minor maintenance activity (routine inspection, debris removal), the need for major maintenance should be determined and, if disposal during major maintenance will be required, samples of the sediment and media should be obtained.

Second, if required, a major maintenance activity (replacement of the *Ultra Urban Filter(s)* and/or associated sediment removal) should be performed. Major maintenance may also be required if, from visual inspection, the integrity of the *Ultra Urban Filter* unit is damaged.

In addition to these two scheduled activities, it is important to check the condition of the *Ultra Urban Filter(s)* after major storms for damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary

to adjust the maintenance activity schedule depending on the actual operating conditions encountered by the system.

In general, minor maintenance activities will occur late in the rainy season, and major maintenance will occur in late summer to early fall when flows into the system are not likely to be present.

2.2 Hydraulic Testing

As identified earlier, the objectives of the *Ultra Urban Filter* are to filter out contaminants from high speed stormwater runoff. The primary effect, as well as, ongoing effect of the *Smart Sponge* filtration media will be the accumulation of sediment at the inlet basket and on the *Smart Sponge's* polymer components, therefore causing a sizable reduction of the hydraulic conductivity of the *Ultra Urban Filter*. It is therefore suggested that, at least once a year and preferably during a major maintenance event, a hydraulic conductivity test of the *Ultra Urban Filter* is carried out. Due to flow patterns, it is expected that the *Ultra Urban Filter* inlet basket will be more heavily impacted by sediment accumulation and hydrocarbon coating.

Following the above mentioned guidelines, upon inspection of the *Ultra Urban Filter*, the operator should have these materials on hand and follow the testing procedure below:

List of Materials:

1. *Ultra Urban Filter(s)* in question
2. Two buckets marked at 5 gallons
3. Chronometer or watch with second's hand
4. Disposal container in compliance with local regulations for the expected contaminants
5. Rubber gloves
6. Hand towel

Testing procedure:

1. Remove sediment, trash and debris from the inlet basket and verify the overall integrity of the *Ultra Urban Filter*.
2. Remove *Ultra Urban Filter* from catch basin or curb opening.
3. Position the plastic container (with 5 gallons mark) underneath the *Ultra Urban Filter* for collecting the test water.
4. Fill a 5-gallon container with tap water; pour it over through *Ultra Urban Filter* and measure the time elapsed from the start of the pour-through until the 5 gallons have been collected in the plastic container below the filtration bed.
5. Repeat steps 4 and 5 at least 3 times and calculate the average.
6. If collecting time is:
    (a) below 20 seconds, the *Ultra Urban Filter* at that point on is still operating within its design parameters.
    (b) above 20 seconds, the *Ultra Urban Filter(s)* tested need to be replaced.

2.3 Frequency of Replacement

The primary factors for controlling timing of maintenance for the *Ultra Urban Filter* are sediment accumulation and media fouling/saturation.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media. The flow through the system will naturally decrease as more and more solids are trapped. Eventually the flow through the system will be low enough to require replacement of the *Ultra Urban Filter*. It may be possible to extend the usable span of the *Ultra Urban Filter* by proper street cleaning and land management techniques upstream from the stormwater management system.

Site conditions greatly influence maintenance requirements. *Ultra Urban Filters* located in areas with erosion or active construction should be inspected and maintained more often than those in fully stabilized areas.

The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after large storms.

Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual sub-catchment. It is recommended that the maintenance entity develop a database to properly manage *Ultra Urban Filter* maintenance for each installed unit.

Prior to the development of the maintenance database, the following maintenance frequencies should be followed:

- Inspection/minor maintenance
  - One time per year
  - After major storms
- Major maintenance
  - One time per year
  - In the event of a chemical spill

Frequencies should be updated as required. Sediment removal and unit replacement are recommended on an annual basis until sufficient information has been obtained about a particular system to justify a different replacement schedule.

Once an understanding of site characteristics has been established, maintenance may not be needed for one to two years, but regular inspection should continue.

3. *Inspection and Maintenance Documentation*

Complete the *Ultra Urban Filter* Inspection and Maintenance Report. This report will assist in the decision process to initiate appropriate maintenance activities.

As it is well known in the regulatory environment, properly inspecting and maintaining treatment devices may not always be enough. The facility owners are often required to document that the ease of review and demonstration, one should develop an Inspection and Maintenance Process to retain inspection and maintenance records for any treatment device employed for the facility.

An important part of the record keeping will be the development of an inspection and maintenance database. For the ease of review and demonstration, a *Maintenance Report* and *Inspection and Data Sheet* (like the ones in Appendix A and B) that summarize all inspection and maintenance activities should be developed.

Appendix A

Ultra Urban Filter
Inspection Data Sheet

Date:_____ Personnel: _____

Location:_____ System Size:_____

System Type:

No.	Inspection Item	
1	Is settled trash, debris, and/or sediment in the inlet basket area?	YES ? NO ?
2	Is water trapped in the inlet basket or is there evidence of the high water mark above the water level difference (WLD) barrier?	YES ? NO ?
3	Is the inlet basket structure clean and free of abnormalities?	YES ? NO ?
4	Is the Ultra Urban Filter structure damaged or deteriorated, or is there evidence of leaky joints?	YES ? NO ?
5	Is the inlet basket above the media clogged with trash or other particulate matter?	YES ? NO ?
6	Is the media just below the inlet basket a black color due to hydrocarbon absorption?	YES ? NO ?
7	Are there any obvious, above ground sources of contamination entering the system?	YES ? NO ?

Appendix B

Ultra Urban Filter
Maintenance Report

No.	Maintenance Activity	Date Done
1	Collect and remove trash, debris, etc.	
2	Remove water as required.	
3	Clean up inlet basket, and inspect for sources of abnormalities.	
4	Repair or replace damaged or deteriorated structural components.	
5	Remove obstructions from the inlet basket.	
6	Conduct O&M procedures as needed for the other devices. Repair or replace as needed.	
7	Notify Agency or owner representative.	

GROUND WATER RESCUE, INC.

*24 Ryden Street, Quincy, MA 02169 * Tel: 617-773-1128 * Fax: 617-773-0510*

www.kleanstream.com

June 9, 2015

David J Klenert
Collins Civil Engineering Group, Inc.
225 South Main Street
West Bridgewater, MA 02379

Re: *THE ELIMINATOR*™ Oil & Floating Debris Trap with Elimo Filter

Dear Mr. Klenert,

Thank you for your recent inquiry regarding *THE ELIMINATOR*™ Oil and Floating Debris Trap with Elimo Filter. I understand you wish to use our trap and filter on a project in Easton, MA. The Elimo Filter is currently undergoing pilot testing at two sites in Massachusetts and two sites in NY.

Our laboratory testing indicates that the 8" trap & filter will exceed 80% TSS removal.

Our pilot study is scheduled to be complete in September of this year with all data published by December 2015.

We trust the foregoing meets your requirements.

Sincerely,

Micheal J. Glynne
President.

The Eliminator™ The Only Way To Flow

11-11-83

COMMONWEALTH OF MASSACHUSETTS

LAND COURT

DEPARTMENT OF THE TRIAL COURT

In the Matter of the petition of Fred W. Swanson et ux

numbered 39542 after consideration, the Court doth adjudge and decree that ~~said~~

Roger G. Warren, of Guelph, Ontario, Canada,
substituted petitioner on motion,

~~of~~ ~~Massachusetts~~ ~~in the County~~ ~~and Commonwealth of~~

is the owner in fee simple

of ~~that~~ certain parcels of land situate ~~in~~ partly in Pembroke and partly in Halifax in the County of Plymouth and Commonwealth of Massachusetts, bounded and described as follows:

FIRST PARCEL:

Northeasterly	by Sherman Street, four hundred thirty-three and 59/100 (433.59) feet;
Southerly	by Crescent Avenue, two hundred twenty-nine and 12/100 (229.12) feet;
Southwesterly	by Crane Street, two hundred ninety-seven and 81/100 (297.81) feet; and
Northwesterly	by Thompson Street, two hundred twenty-nine and 68/100 (229.68) feet.

Said land is shown as Lot 1 on the plan hereinafter mentioned.

SECOND PARCEL:

Northwesterly and Northerly	by Crescent Avenue, three hundred seventy-six and 82/100 (376.82) feet;
Easterly	by Sherman Street, about ninety-two (92) feet;
Southerly	by Crystal Lake;
Westerly	by land now or formerly of the Town of Halifax, about sixty-five (65) feet; and

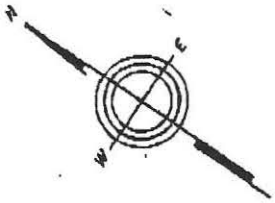
39542 A

PLAN OF LAND IN PEMBROKE AND HALIFAX

Robert C. Batley, Surveyor

November 16, 1976

For Roger Warren



L.C. No. 28574 A | L.C. No. 22275 A

PLYMOUTH ST.

ST. | AVE.

RAMSDELL ST.

(Private - 30.00 Wide) | (Private - 40.00 Wide)

MORSE ST.

THOMPSON

L.C. No. 41649 Confirmation (Pending)

L.C. No. 41649 Confirmation (Pending)

SHERMAN (Private - 30.00 Wide) ST.

CRESCENT

C.B. top broken

30.00

S 32° 31' 50" E

C.B.

433.59 "By"

WAY

S 0°08'00" W 92.7± "By"

C.B.

L.C. No. 41652 Confirmation (Pending)

N 57°08'00" E 151.66

229.68 "By"

78.02

N 49°36'05" E

"By" 229.12 N 88° 52' 00" W

S 88° 32' 00" E 273.38

376.82± "By"

65.1±

N0°08'00" E

WAY

"By" 297.81

N 40° 23' 55" W

C.B.

C.B.

C.B.

30.00

CRANE ST. (Private - 30.00 Wide)

1

2

CRYSTAL LAKE (A Great Pond)

88.23

172.93

S 27° 35' 36" W

Town of Halifax

35.21

N 36° 08' 00" E

Esther S. Cook

L.C. No. 41649 Confirmation (Pending)

Abutters are not adjudicated.

Locus Comprises Lots 1 and 2

Copy of part of plan filed in LAND REGISTRATION OFFICE

APRIL 6, 1977

Scale of this plan 100 feet to an inch.

Louis A. Moore, Engineer for Court

PEMBROKE

HALIFAX

THIS PLAN FILED WITH CERTIFICATE NO. 71230

RCS

Fax 508-580-8336

Attn. George Collins

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID	B2-47	Account Number	0
Prior Parcel ID	--		
Property Owner	WARREN ROGER G.	Property Location	0 THOMPSON STREET
		Property Use	LAND
Mailing Address	P.O. BOX 2447	Most Recent Sale Date	11/7/1979
	BASSETERRE, ST. KITTS	Legal Reference	4750-386
City	WEST INDIES	Grantor	
Mailing State	Zip 00001	Sale Price	0
ParcelZoning		Land Area	1.744 acres

Current Property Assessment

Card 1 Value	Building Value 0	Xtra Features Value 0	Land Value 193,500	Total Value 193,500

Building Description

Building Style N/A	Foundation Type N/A	Flooring Type N/A
# of Living Units N/A	Frame Type N/A	Basement Floor N/A
Year Built N/A	Roof Structure N/A	Heating Type N/A
Building Grade N/A	Roof Cover N/A	Heating Fuel N/A
Building Condition N/A	Siding N/A	Air Conditioning 0%
Finished Area (SF) N/A	Interior Walls N/A	# of Bsmt Garages 0
Number Rooms 0	# of Bedrooms 0	# of Full Baths 0
# of 3/4 Baths 0	# of 1/2 Baths 0	# of Other Fixtures 0

Legal Description

Narrative Description of Property

This property contains 1.744 acres of land mainly classified as LAND with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images

Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID	B2-47	**Account Number**	0
Prior Parcel ID	--		
Property Owner	WARREN ROGER G. C/O MARY DELPRETE	**Property Location**	THOMPSON STREET
		Property Use	LAND
Mailing Address	282 ELM STREET	**Most Recent Sale Date**	11/7/1979
		Legal Reference	4750-386
City	DUXBURY	**Grantor**	
Mailing State	MA **Zip** 02332	**Sale Price**	0
ParcelZoning		**Land Area**	1.744 acres

Current Property Assessment

Card 1 Value	Building Value	Xtra Features Value	Land Value	Total Value
	0	0	179,900	179,900

Building Description

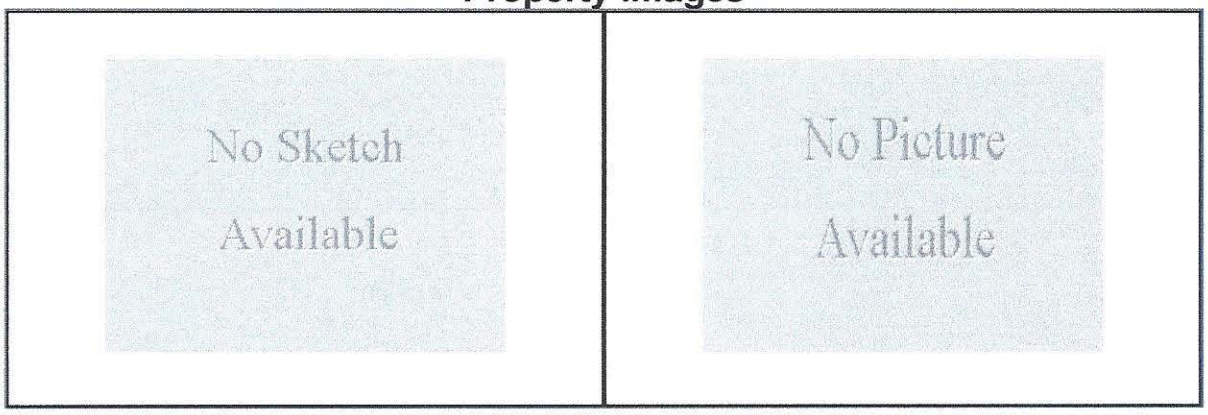
Building Style N/A	**Foundation Type** N/A	**Flooring Type** N/A
# of Living Units N/A	**Frame Type** N/A	**Basement Floor** N/A
Year Built N/A	**Roof Structure** N/A	**Heating Type** N/A
Building Grade N/A	**Roof Cover** N/A	**Heating Fuel** N/A
Building Condition N/A	**Siding** N/A	**Air Conditioning** 0%
Finished Area (SF) N/A	**Interior Walls** N/A	**# of Bsmt Garages** 0
Number Rooms 0	**# of Bedrooms** 0	**# of Full Baths** 0
# of 3/4 Baths 0	**# of 1/2 Baths** 0	**# of Other Fixtures** 0

Legal Description

Narrative Description of Property

This property contains 1.744 acres of land mainly classified as LAND with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID	B2-48	Account Number	0
Prior Parcel ID	--		
Property Owner	WARREN ROGER G.	Property Location	0 CRESCENT AVENUE/HALIFAX
		Property Use	UNDEV
Mailing Address	P.O. BOX 2447	Most Recent Sale Date	11/7/1979
	BASSETERRE, ST. KITTS	Legal Reference	4750-386
City	WEST INDIES	Grantor	
Mailing State	Zip 00001	Sale Price	0
ParcelZoning		Land Area	0.354 acres

Current Property Assessment

Card 1 Value	Building Value 0	Xtra Features Value 0	Land Value 3,500	Total Value 3,500

Building Description

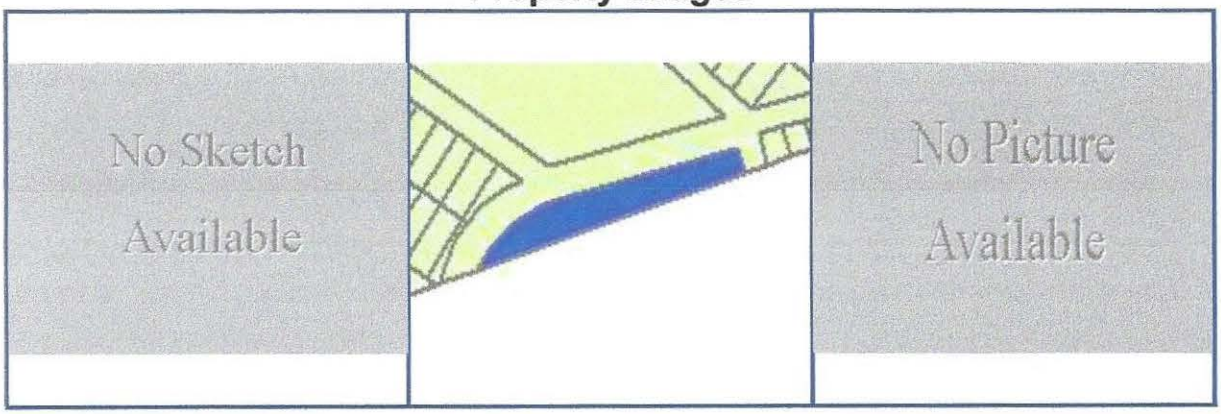
Building Style N/A	Foundation Type N/A	Flooring Type N/A
# of Living Units N/A	Frame Type N/A	Basement Floor N/A
Year Built N/A	Roof Structure N/A	Heating Type N/A
Building Grade N/A	Roof Cover N/A	Heating Fuel N/A
Building Condition N/A	Siding N/A	Air Conditioning 0%
Finished Area (SF) N/A	Interior Walls N/A	# of Bsmt Garages 0
Number Rooms 0	# of Bedrooms 0	# of Full Baths 0
# of 3/4 Baths 0	# of 1/2 Baths 0	# of Other Fixtures 0

Legal Description

Narrative Description of Property

This property contains 0.354 acres of land mainly classified as UNDEV with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID B2-48	Account Number 0
Prior Parcel ID --	
Property Owner WARREN ROGER G. C/O MARY DELPRETE	Property Location CRESCENT AVENUE/HALIFAX
	Property Use UNDEV
Mailing Address 282 ELM STREET	Most Recent Sale Date 11/7/1979
	Legal Reference 4750-386
City DUXBURY	Grantor
Mailing State MA Zip 02332	Sale Price 0
ParcelZoning	Land Area 0.354 acres

Current Property Assessment

Card 1 Value	Building Value 0	Xtra Features Value 0	Land Value 3,500	Total Value 3,500

Building Description

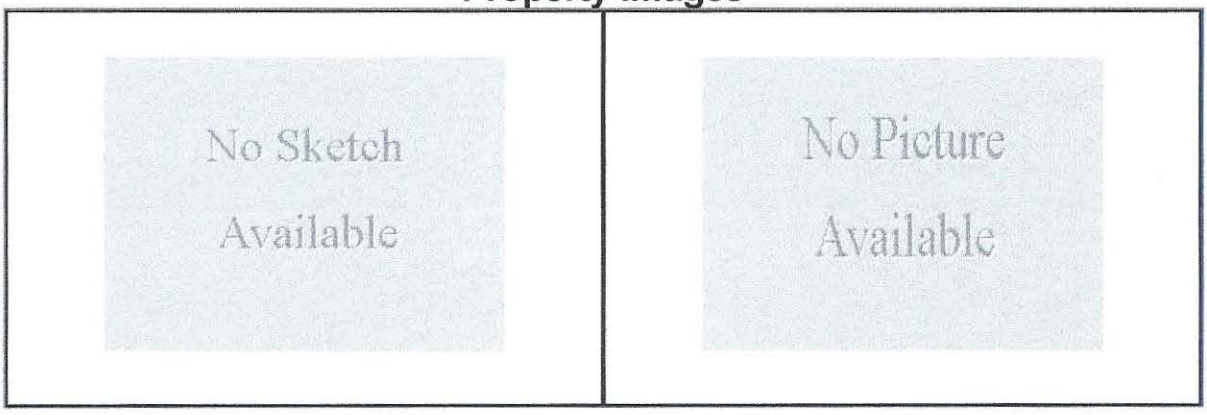
Building Style N/A	Foundation Type N/A	Flooring Type N/A
# of Living Units N/A	Frame Type N/A	Basement Floor N/A
Year Built N/A	Roof Structure N/A	Heating Type N/A
Building Grade N/A	Roof Cover N/A	Heating Fuel N/A
Building Condition N/A	Siding N/A	Air Conditioning 0%
Finished Area (SF) N/A	Interior Walls N/A	# of Bsmt Garages 0
Number Rooms 0	# of Bedrooms 0	# of Full Baths 0
# of 3/4 Baths 0	# of 1/2 Baths 0	# of Other Fixtures 0

Legal Description

Narrative Description of Property

This property contains 0.354 acres of land mainly classified as UNDEV with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



MORTGAGE

I, ROGER G. WARREN of 147 Sheridan Street, Easton, Massachusetts, to secure the payment of six thousand, ninety-three and 45/100 ($6093.45) dollars as per our note of even date, grant to FRED W. SWANSON, sometimes known as FREDERICK W. SWANSON, and BRIDIE T. SWANSON, husband and wife, both of Brockton, Plymouth County, Massachusetts, with MORTGAGE COVENANTS,

the land in Pembroke and Halifax, Plymouth County, Massachusetts, with the buildings thereon, situated on both sides of a private way known as Crescent Avenue, being shown as Lots 1 and 2 on a certain "Plan of Land in Pembroke & Halifax December 3, 1975, Scale 1" = 100 Robert C. Bailey, Reg. Land Surveyor Pembroke, Mass.", to be recorded with the Land Court, and being more particularly bounded and described according to said plan as follows:

LOT 1: A certain parcel of vacant land in said Pembroke, lying between four private ways known as Crescent Avenue, Sherman Street, Thompson Street and Crane Street, and bounded as follows:

Beginning in the Northerly corner of the premises conveyed, at a concrete bound marking the intersection of Sherman and Thompson Streets, said bound being situated 567.26 feet South 57° 08' 00" WEST from the Southerly corner of the intersection of Thompson Street (a private way) and Plymouth Street (a public way) in said Pembroke; thence running

SOUTH 32° 51' 50" EAST,	by Sherman Street, 240 feet, to land of Theodore and Ruth Kaiser; thence,
SOUTH 57° 08' 00" WEST,	by said Kaiser land, 99.78 feet, to a corner; thence,
SOUTH 36° 53' 05" EAST,	still by said Kaiser land, 60.15 feet, to a corner; thence,
NORTH 57° 08' 00" EAST,	still by said Kaiser land, 95.56 feet, to the Southwesterly line of Sherman Street; thence,
SOUTH 32° 51' 50" EAST,	by Sherman Street, 133.59 feet, to a concrete bound at the intersection of Sherman Street and Crescent Avenue; thence,
NORTH 88° 52' 00" WEST,	by Crescent Avenue, 229.12 feet, to a concrete bound at the intersection of Crescent Avenue and Crane Street; thence,
NORTH 40° 23' 55" WEST,	by Crane Street 297.81 feet, to a concrete bound at the intersection of Crane Street and Thompson Street; thence
NORTH 49° 36' 05" EAST,	by Thompson Street, 78.02 feet, to an angle; and thence,
NORTH 57° 08' 00" EAST,	still by Thompson Street, 151.64 feet, to the concrete bound at the point of beginning.

Containing 70,099 square feet of land, according to said plan.

This conveyance is made subject to and with the benefit of the restrictions set forth in a deed from the Town of Pembroke, dated September 24, 1963, recorded with said Deeds, Book 3063, Page 132, in so far as the same may be now in force and applicable.

Executed as a sealed instrument, this 5th day of November, 1979.

ROGER G. WARREN

COMMONWEALTH OF MASSACHUSETTS

PLYMOUTH, SS November 5th, 1979

Then personally appeared the above-named Roger G. Warren, and acknowledged the foregoing instrument to be his free act and deed, before me,

Notary Public

My commission expires:

March 22, 1985

REC'D NOV 7 1979 AT 12-13 PM AND RECORDED

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID	B2-2390	Account Number	0
Prior Parcel ID	B2-2391- -2397,2418--2427		
Property Owner	WARREN ROGER G.	Property Location	0 CRESCENT AVENUE
		Property Use	LAND
Mailing Address	P.O. BOX 2447	Most Recent Sale Date	7/1/1983
	BASSETERRE, ST. KITTS	Legal Reference	5390-184
City	WEST INDIES	Grantor	
Mailing State	Zip 00001	Sale Price	14,000
ParcelZoning		Land Area	0.992 acres

Current Property Assessment

Card 1 Value	Building Value 0	Xtra Features Value 0	Land Value 185,900	Total Value 185,900

Building Description

Building Style N/A	Foundation Type N/A	Flooring Type N/A
# of Living Units N/A	Frame Type N/A	Basement Floor N/A
Year Built N/A	Roof Structure N/A	Heating Type N/A
Building Grade N/A	Roof Cover N/A	Heating Fuel N/A
Building Condition N/A	Siding N/A	Air Conditioning 0%
Finished Area (SF) N/A	Interior Walls N/A	# of Bsmt Garages 0
Number Rooms 0	# of Bedrooms 0	# of Full Baths 0
# of 3/4 Baths 0	# of 1/2 Baths 0	# of Other Fixtures 0

Legal Description

Narrative Description of Property

This property contains 0.992 acres of land mainly classified as LAND with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images

Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID B2-2390

Prior Parcel ID B2-2391- -2397,2418--2427

Property Owner WARREN ROGER G.
C/O MARY DELPRETE

Mailing Address 282 ELM STREET

City DUXBURY

Mailing State MA Zip 02332

ParcelZoning

Account Number 0

Property Location CHANDLER STREET

Property Use LAND

Most Recent Sale Date 7/1/1983

Legal Reference 5390-184

Grantor

Sale Price 14,000

Land Area 0.992 acres

Current Property Assessment

Card 1 Value	Building Value	Xtra Features Value	Land Value	Total Value
	0	0	146,700	146,700

Building Description

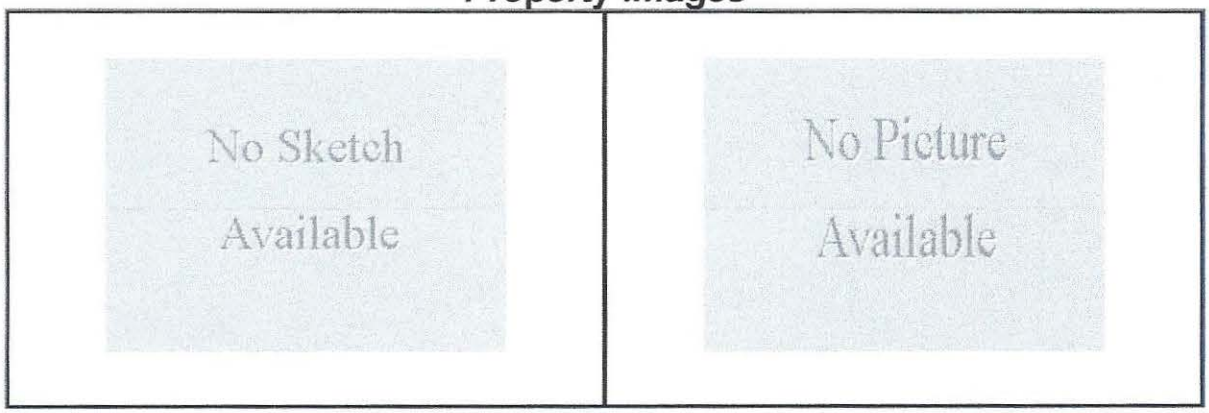
Building Style N/A	Foundation Type N/A	Flooring Type N/A
# of Living Units N/A	Frame Type N/A	Basement Floor N/A
Year Built N/A	Roof Structure N/A	Heating Type N/A
Building Grade N/A	Roof Cover N/A	Heating Fuel N/A
Building Condition N/A	Siding N/A	Air Conditioning 0%
Finished Area (SF) N/A	Interior Walls N/A	# of Bsmt Garages 0
Number Rooms 0	# of Bedrooms 0	# of Full Baths 0
# of 3/4 Baths 0	# of 1/2 Baths 0	# of Other Fixtures 0

Legal Description

Narrative Description of Property

This property contains 0.992 acres of land mainly classified as LAND with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

AUG 184 BOOK 5390

ROLAND P. LEARY CO., INC.,

a corporation duly established under the laws of Massachusetts
and having its usual place of business at 1 Bonnie Brier Drive, Pembroke, of $14,000.00
Plymouth County, Massachusetts, for consideration paid,

grants to ROGER G. WARREN
#3415 SW 24th Street #5

of Gainesville Florida with quitclaim covenants

The following parcels of land situated Southerly of Plymouth St., Pembroke, Mass., as shown on Plan G and H of Monponsett Lake and Land Co. Said plan being recorded in Plymouth County Registry of Deeds Plan Book 1, Page 44 and 45 and also being shown on Pembroke Assessors' Plan A2 and Plan B2 as follows:

SOLD
5390/185

Lots: 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427.

Also that portion of land in the following lots which are situated within the boundary lines of the Town of Pembroke:

Lots: 2594, 2595, 2596, 2597, 2598 and 2599.

For our title see deed of Halifax Country Club, Inc. to Roland P. Leary Co., Inc., Plymouth County Registry of Deeds Book 4548, Page 108.

See Certif of Vote Plymouth Reg of Deeds Book 4548 Page 253

CANCELLED

COMMONWEALTH OF MASSACHUSETTS
DEEDS EXCISE
JUL-1'83
31.92

In witness whereof, the said Roland P. Leary Co., Inc.
has caused its corporate seal to be hereto affixed and these presents to be signed, acknowledged and delivered in its name and behalf by Roland P. Leary
its President hereto duly authorized, this first
day of July, in the year one thousand nine hundred and eighty-three.

Signed and sealed in presence of

Roland P. Leary Co. Inc.
by Roland P. Leary
PRESIDENT

The Commonwealth of Massachusetts

Plymouth, ss. July 1, 1983

Then personally appeared the above named Roland P. Leary, President,
and acknowledged the foregoing instrument to be the free act and deed of the Roland P. Leary
Co., Inc. before me,

Abraham Spigel
ABRAHAM SPIGEL Notary Public
My commission expires Oct. 14 1988

REC'D JUL 1 1983 AT 9-40 AM AND RECORDED

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID	B2-2594	**Account Number**	0
Prior Parcel ID	B2-2595-99--		
Property Owner	WARREN ROGER G.	**Property Location**	0 CRESCENT AVENUE
		Property Use	UNDEV
Mailing Address	P.O. BOX 2447	**Most Recent Sale Date**	7/1/1983
	BASSETERRE, ST. KITTS	**Legal Reference**	4548-108 ? wrong
City	WEST INDIES	**Grantor**	
Mailing State	**Zip** 00001	**Sale Price**	0
ParcelZoning		**Land Area**	0.124 acres

Current Property Assessment

Card 1 Value	Building Value	Xtra Features Value	Land Value	Total Value
	0	0	1,200	1,200

Building Description

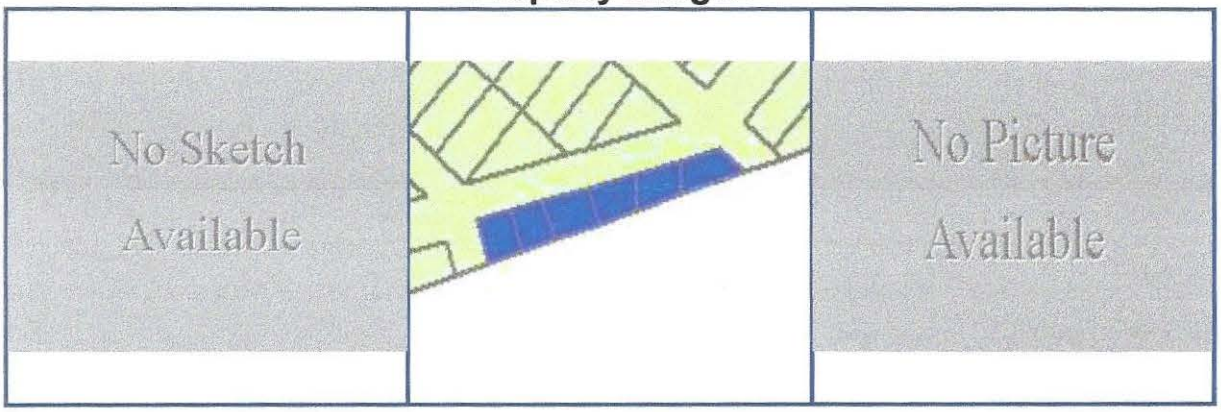
Building Style N/A	**Foundation Type** N/A	**Flooring Type** N/A
# of Living Units N/A	**Frame Type** N/A	**Basement Floor** N/A
Year Built N/A	**Roof Structure** N/A	**Heating Type** N/A
Building Grade N/A	**Roof Cover** N/A	**Heating Fuel** N/A
Building Condition N/A	**Siding** N/A	**Air Conditioning** 0%
Finished Area (SF) N/A	**Interior Walls** N/A	**# of Bsmt Garages** 0
Number Rooms 0	**# of Bedrooms** 0	**# of Full Baths** 0
# of 3/4 Baths 0	**# of 1/2 Baths** 0	**# of Other Fixtures** 0

Legal Description

Narrative Description of Property

This property contains 0.124 acres of land mainly classified as UNDEV with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

Unofficial Property Record Card - Pembroke, MA

General Property Data

Parcel ID B2-2594	**Account Number** 0
Prior Parcel ID B2-2595-99--	
Property Owner WARREN ROGER G. C/O MARY DELPRETE	**Property Location** CRESCENT AVENUE
	Property Use UNDEV
Mailing Address 282 ELM STREET	**Most Recent Sale Date** 7/1/1983
	Legal Reference 4548-108
City DUXBURY	**Grantor**
Mailing State MA **Zip** 02332	**Sale Price** 0
ParcelZoning	**Land Area** 0.124 acres

Current Property Assessment

Card 1 Value	Building Value	Xtra Features Value	Land Value	Total Value
	0	0	1,200	1,200

Building Description

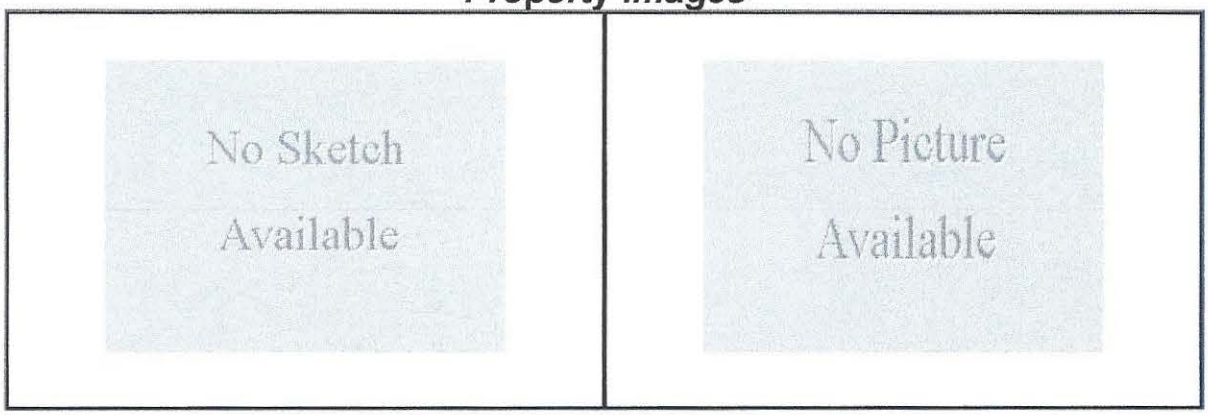
Building Style N/A	**Foundation Type** N/A	**Flooring Type** N/A
# of Living Units N/A	**Frame Type** N/A	**Basement Floor** N/A
Year Built N/A	**Roof Structure** N/A	**Heating Type** N/A
Building Grade N/A	**Roof Cover** N/A	**Heating Fuel** N/A
Building Condition N/A	**Siding** N/A	**Air Conditioning** 0%
Finished Area (SF) N/A	**Interior Walls** N/A	**# of Bsmt Garages** 0
Number Rooms 0	**# of Bedrooms** 0	**# of Full Baths** 0
# of 3/4 Baths 0	**# of 1/2 Baths** 0	**# of Other Fixtures** 0

Legal Description

Narrative Description of Property

This property contains 0.124 acres of land mainly classified as UNDEV with a(n) N/A style building, built about N/A , having N/A exterior and N/A roof cover, with N/A unit(s), 0 room(s), 0 bedroom(s), 0 bath(s), 0 half bath(s).

Property Images



Disclaimer: This information is believed to be correct but is subject to change and is not warranteed.

QUITCLAIM DEED PAGE 383 BOOK 4750

We, FRED W. SWANSON, sometimes known as FREDERICK W. SWANSON, and BRIDIE T. SWANSON, husband and wife, both of Brockton, Plymouth County, Massachusetts, for consideration paid in the sum of TEN THOUSAND FOUR HUNDRED AND 00/100 ($10,400.00) DOLLARS, grant to ROGER G. WARREN of 147 Sheridan Street, Easton, Bristol County, Massachusetts, with QUITCLAIM COVENANTS,

the land in Pembroke and Halifax, Plymouth County, Massachusetts, with the buildings theron, situated on both sides of a private way known as Crescent Avenue, being shown as Lots 1 and 2 on a certain "Plan of Land in Pembroke & Halifax December 3, 1975, Scale 1" = 100' Robert C. Bailey, Reg. Land Surveyor Pembroke, Mass.", to be recorded with the Land Court, and being more particularly bounded and described according to said plan as follows:

LOT 1: A certain parcel of vacant land in said Pembroke, lying between four private ways known as Crescent Avenue, Sherman Street, Thompson Street and Crane Street, and bounded as follows:

Beginning in the Northerly corner of the premises conveyed, at a concrete bound marking the intersection of Sherman and Thompson Streets, said bound being situated 567.26 feet South 57° 08' 00" WEST from the Southerly corner of the intersection of Thompson Street (a private way) and Plymouth Street (a public way) in said Pembroke; thence running

SOUTH 32° 51' 50" EAST, by Sherman Street, 240 feet, to land of Theodore and Ruth Kaiser; thence,

SOUTH 57° 08' 00" WEST, by said Kaiser land, 99.78 feet, to a corner; thence,

SOUTH 36° 53' 05" EAST, still by said Kaiser land 60.15 feet, to a corner; thence,

NORTH 57° 08' 00" EAST, still by said Kaiser land, 95.56 feet, to the Southwesterly line of Sherman Street; thence,

SOUTH 32° 51' 50" EAST, by Sherman Street, 133.59 feet, to a concrete bound at the intersection of Sherman Street and Crescent Avenue, thence,

NORTH 88° 52' 00" WEST, by Crescent Avenue, 229.12 feet, to a concrete bound at the intersection of Crescent Avenue and Crane Street; thence,

NORTH 40° 23' 55" WEST, by Crane Street, 297.81 feet, to a concrete bound at the intersection of Crane Street and Thompson Street; thence,

NORTH 49° 36' 05" EAST, by Thompson Street, 78.02 feet, to an angle; and thence,

NORTH 57° 08' 00" EAST, still by Thompson Street, 151.64 feet, to the concrete bound at the point of beginning.

Containing 70,099 square feet of land, according to said plan.

CANCELLED 1163

COMMONWEALTH OF MASSACHUSETTS
DEEDS EXCISE
NOV-7'79
$23.94
P.B. 11005

LOT 2: A certain parcel of land, with the buildings thereon, situated partly in Pembroke and partly in Halifax, lying between two private ways known as Crescent Avenue and Sherman Street, and a body of water variously known as Spring Lake, Crystal Lake and Muddy Pond, bounded as follows:

Beginning at a point in the town line between the Towns of Pembroke and Halifax, said point lying in the Southeasterly line of Crescent Avenue, distant 1,116.89 feet NORTH 87° 55' 36" EAST from a bound marking an angle in said town line and 1058.16 feet SOUTH 87° 55' 36" WEST from a county bound in said town line on the Southwesterly side of Plymouth Street, a public way; thence, running

NORTH 36° 08' 00" EAST, by Crescent Avenue, 33.21 feet, to a point of curvature; thence,

EASTERLY, still by Crescent Avenue, by a curve having a radius of 71.08 feet, an arc distance of 68.23 feet, to a concrete bound at a point of tangency; thence,

SOUTH 88° 52' 00" EAST, still by Crescent Avenue, 275.38 feet, to a concrete bound at the intersection of Crescent Avenue and Sherman Street; thence,

SOUTH 01° 08' 00" WEST, by Sherman Street, 92 feet, more or less, to Crystal Lake, so-called; thence

WESTERLY, by the shore of Crystal Lake, as it curves, 183 feet, more or less, to the Southeasterly corner of Lot 2606, as shown on plan hereinafter mentioned; thence,

NORTH 01° 08' 00" EAST, by land of owners unknown, being a portion of said Lot 2606, 65 feet, more or less, to said town line; and thence,

SOUTH 87° 55' 36" WEST, by said town line, 172.93 feet, to the point of beginning.

Containing 24,700 square feet of land more or less, according to said plan.

Also, the land in Pembroke, Plymouth County, Massachusetts, situated on the Southwesterly side of a private way known as Sherman Street, and being shown as Lots numbered 2362 and 2363 on "Plan H Monponsett Lake and Land Company", dated July 1888, drawn by A. H. French, Civil Engineer, recorded with Plymouth County Registry of Deeds, Plan Book 1, Page 45, to which plan reference may be had for a more particular description of said premises.

Meaning and intending to convey and hereby conveying Lots numbered 2332 through 2343, 2354 through 2361, 2362 and 2363, 2364 through 2367, and 2600 through 2605 as shown on a certain plan entitled "Plan H Monponsett Lake and Land Company Pembroke and Halifax, Plymouth Co. Mass." dated July 1888, drawn by A. B. French, Civil Engineer, recorded with Plymouth County Registry of Deeds, Plan Book 1, Page 45, together with those portions of Lots numbered 2606 through 2610 on said plan as lie in the Town of Pembroke.

For record of title see two deeds- Fred W. Swanson to us dated May 24, 1973 and recorded with Plymouth Deeds, Book 3929, Pages 622 and 625, respectively; two deeds from Halifax Country Club, Inc., dated November 12, 1974 and May 27, 1975, to us, recorded with said Plymouth Deeds as documents numbered and of 1975, respectively. See deed from Roger G. Warren to us dated November 8, 1976, recorded with Plymouth Deeds, Book 4251, Page 341.

This conveyance is made subject to and with the benefit of the restrictions set forth in a deed from the Town of Pembroke, dated September 24, 1963, recorded with said Deeds, Book 3063, Page 132, in so far as the same may be now in force and applicable.

Executed as a sealed instrument, this 5th day ov November, 1979.

Fred W. Swanson
FRED W. SWANSON

Bridie T. Swanson
BRIDIE T. SWANSON

COMMONWEALTH OF MASSACHUSETTS

PLYMOUTH, SS. November 5, 1979

Then personally appeared the above-named FRED W. SWANSON, also known as FREDERICK W. SWANSON, and BRIDIE T. SWANSON and acknowledged the foregoing instrument to be their free act and deed, before me,

Notary Public

My commission expires:
April 22, 1985

REC'D NOV 7 1979 AT 12-13 PM AND RECORDED

Discharge
Bk. 6056
Pg. 303

MORTGAGE

I, ROGER G. WARREN of 147 Sheridan Street, Easton, Massachusetts, to secure the payment of six thousand, ninety-three and 45/100 ($6093.45) dollars as per our note of even date, grant to FRED W. SWANSON, sometimes known as FREDERICK W. SWANSON, and BRIDIE T. SWANSON, husband and wife, both of Brockton, Plymouth County, Massachusetts, with MORTGAGE COVENANTS,

the land in Pembroke and Halifax, Plymouth County, Massachusetts, with the buildings thereon, situated on both sides of a private way known as Crescent Avenue, being shown as Lots 1 and 2 on a certain "Plan of Land in Pembroke & Halifax December 3, 1975, Scale 1" = 100' Robert C. Bailey, Reg. Land Surveyor Pembroke, Mass.", to be recorded with the Land Court, and being more particularly bounded and described according to said plan as follows:

LOT 1: A certain parcel of vacant land in said Pembroke, lying between four private ways known as Crescent Avenue, Sherman Street, Thompson Street and Crane Street, and bounded as follows:

Beginning in the Northerly corner of the premises conveyed, at a concrete bound marking the intersection of Sherman and Thompson Streets, said bound being situated 567.26 feet South 57° 08' 00" WEST from the Southerly corner of the intersection of Thompson Street (a private way) and Plymouth Street (a public way) in said Pembroke; thence running

SOUTH 32° 51' 50" EAST, by Sherman Street, 240 feet, to land of Theodore and Ruth Kaiser; thence,

SOUTH 57° 08' 00" WEST, by said Kaiser land, 99.78 feet, to a corner; thence,

SOUTH 36° 53' 05" EAST, still by said Kaiser land, 60.15 feet, to a corner; thence,

NORTH 57° 08' 00" EAST, still by said Kaiser land, 95.56 feet, to the Southwesterly line of Sherman Street; thence,

SOUTH 32° 51' 50" EAST, by Sherman Street, 133.59 feet, to a concrete bound at the intersection of Sherman Street and Crescent Avenue; thence,

NORTH 88° 52' 00" WEST, by Crescent Avenue, 229.12 feet, to a concrete bound at the intersection of Crescent Avenue and Crane Street; thence,

NORTH 40° 23' 55" WEST, by Crane Street 297.81 feet, to a concrete bound at the intersection of Crane Street and Thompson Street; thence

NORTH 49° 36' 05" EAST, by Thompson Street, 78.02 feet, to an angle; and thence,

NORTH 57° 08' 00" EAST, still by Thompson Street, 151.64 feet, to the concrete bound at the point of beginning.

Containing 70,099 square feet of land, according to said plan.

LOT 2: A certain parcel of land, with the buildings thereon, situated partly in Pembroke and partly in Halifax, lying between two private ways known as Crescent Avenue and Sherman Street, and a body of water variously known as Spring Lake, Crystal Lake and Muddy Pond, bounded as follows:

Beginning at a point in the town line between the Towns of Pembroke and Halifax, said point lying in the Southeasterly line of Crescent Avenue, distant 1,116.89 feet NORTH 87° 55' 36" EAST from a bound marking an angle in said town line and 1058.16 feet SOUTH 87° 55' 36" WEST from a county bound in said town line on the Southwesterly side of Plymouth Street, a public way; thence, running

NORTH 36° 08' 00" EAST,	by Crescent Avenue, 33.21 feet, to a point of curvature; thence,
EASTERLY,	still by Crescent Avenue, by a curve having a radius of 71.08 feet, an arc distance of 68.23 feet, to a concrete bound at a point of tangency; thence,
SOUTH 88° 52' 00" EAST,	still by Crescent Avenue, 275.38 feet, to a concrete bound at the intersection of Crescent Avenue and Sherman Street; thence,
SOUTH 01° 08' 00" WEST,	by Sherman Street, 92 feet, more or less, to Crystal Lake, so-called; thence,
WESTERLY,	by the shore of Crystal Lake, as it curves, 183 feet, more or less, to the Southeasterly corner of Lot 2606, as shown on plan hereinafter mentioned; thence,
NORTH 01° 08' 00" EAST,	by land of owners unknown, being a portion of said Lot 2606, 65 feet, more or less, to said town line; and thence,
SOUTH 87° 55' 36" WEST,	by said town line 172.93 feet, to the point of beginning.

Containing 24,700 square feet of land, more or less, according to said plan.

Also, the land in Pembroke, Plymouth County, Massachusetts, situated on the Southwesterly side of a private way known as Sherman Street, and being shown as Lots numbered 2362 and 2363 on "Plan H Monponsett Lake and Land Company", dated July 1888, drawn by A. H. French, Civil Engineer, recorded with Plymouth County Registry of Deeds, Plan Book 1, Page 45, to which plan reference may be had for a more particular description of said premises.

Meaning and intending to convey and hereby conveying Lots numbered 2332 through 2343, 2354 through 2361, 2362 and 2363, 2364 through 2367, and 2600 through 2605 as shown on a certain plan entitled "Plan H Monponsett Lake and Land Company Pembroke and Halifax, Plymouth Co. Mass." dated July 1888, drawn by A. B. French, Civil Engineer, recorded with Plymouth County Registry of Deeds, Plan Book 1, Page 45, together with those portions of Lots numbered 2606 through 2610 on said plan as lie in the Town of Pembroke.

Being the same premises conveyed to me from Fred. W. Swanson, sometimes known as Frederick W. Swanson and Bridie T. Swanson, husband and wife, by deed of even date to be recorded herewith.

This conveyance is made subject to and with the benefit of the restrictions set forth in a deed from the Town of Pembroke, dated September 24, 1963, recorded with said Deeds, Book 3063, Page 132, in so far as the same may be now in force and applicable.

Executed as a sealed instrument, this 5th day of November, 1979.

ROGER G. WARREN

COMMONWEALTH OF MASSACHUSETTS

PLYMOUTH, SS November 5th, 1979

Then personally appeared the above-named Roger G. Warren, and acknowledged the foregoing instrument to be his free act and deed, before me,

Notary Public

My commission expires:

March 22, 1985

REC'D NOV 7 1979 AT 12-13 PM AND RECORDED

1 45


Stetson Lake
Plymouth
Road
Ramsdell
Street
Morse
Sherman
Chandler
Link
Crane
Bishop
Walnut
Thompson
Crescent
Spring Lake
Avenue
Plan-B.
Monponsett
Lake and Land Company
Pembroke and Halifax, Plymouth Co. Mass.
Scale = 1 in. = 60 feet
July 1888
A. S. French Civil Engineer
Brookline Mass.
5390/194
11121/9
9999/080
5390/184
SOLD (5390/105)

BK 1112 PG 009

74863

MASSACHUSETTS QUITCLAIM DEED SHORT FORM (INDIVIDUAL) 881

We, Candace T. Kniffen, John N. Mulready, Sr., and Troy E. Garron, as we are and constitute the Board of Selectmen for the Town of Halifax

of Halifax, Plymouth County, Massachusetts,

~~being unmarried~~, for consideration paid, and in full consideration of SIX HUNDRED FIFTY ($650.00) DOLLARS,

grant to Roger G. Warren *

of 89 Crescent Avenue, Halifax, Plymouth County, MA with quitclaim covenants

the land in Halifax, Plymouth County, Massachusetts, located on Crescent Avenue.

[Description and encumbrances, if any]

A certain parcel of land situated in Halifax, Plymouth County, Massachusetts and being shown as Lot 2606 on Plan 5 entitled "Monponsett Lake and Land Company" dated July 1888 by A. H. French, Civil Engineer, Brookline, MA and recorded with the Plymouth Registry of Deeds in Plan Book 1, page 45.

Said Lot 2606 is bounded and described as follows: beginning at the southwest corner of Lot 2606, thence

Northerly	by Lot 2607 forty (40) feet;
Easterly	by the Town Line thirty (30) feet;
Southerly	by Lot 2605 forty (40) feet;
Westerly	by Crystal Lake (shown as Spring Lake on said plan) thirty (30) feet,

Received & Recorded
PLYMOUTH COUNTY
REGISTRY OF DEEDS
16 JUL 1992 09:00AM
JOHN D. RIORDAN
REGISTER

said Lot containing 1,200 square feet, more or less.

For title reference, see Instrument of Taking, Book 4002, Page 338 (1974).

This conveyance is in accordance with, and in compliance with, the terms of Massachusetts General Laws, Chapter 44, Section 63A.

For Grantors' authority for this conveyance, see vote of Halifax Town Meeting of March 5, 1945, and recorded with the Plymouth County Registry of Deeds on July 3, 1985, Book 6184, Page 159.

CANCELLED

Witness our hand s and seals this 7th day of July, 19 92.

Candace T. Kniffen

Candace T. Kniffen

John N. Mulready, Sr.

Troy E. Garron

The Commonwealth of Massachusetts

Plymouth, ss. July 7 1992

Then personally appeared the above named Candace T. Kniffen, John N. Mulready, Sr. and Troy E. Garron and acknowledged the foregoing instrument to be their free act and deed before me.

Beverly A. Smith
Notary Public — Justice of the Peace

My commission expires Sept 25 1998

Mail 4*
Halifax Board of Selectman
499 Plymouth St
Halifax, MA 02338

(*Individual — Joint Tenants — Tenants in Common.)

CHAPTER 183 SEC. 6 AS AMENDED BY CHAPTER 497 OF 1969

Every deed presented for record shall contain or have endorsed upon it the full name, residence and post office address of the grantee and a recital of the amount of the full consideration thereof in dollars or the nature of the other consideration therefor, if not delivered for a specific monetary sum. The full consideration shall mean the total price for the conveyance without deduction for any liens or encumbrances assumed by the grantee or remaining thereon. All such endorsements and recitals shall be recorded as part of the deed. Failure to comply with this section shall not affect the validity of any deed. No register of deeds shall accept a deed for recording unless it is in compliance with the requirements of this section.

BK 9998 PG080

MASSACHUSETTS QUITCLAIM DEED SHORT FORM (INDIVIDUAL) 861

We, John N. Mulready, Sr., Candace T. Kniffen, and Troy Garron, as we are and constitute the Board of Selectmen for the Town of Halifax
of Halifax, Plymouth County, Massachusetts,

~~being unmarried~~, for consideration paid, and in full consideration of Five Hundred Six and 06/100 ($506.06) Dollars,
grant to Roger G. Warren *

of 89 Crescent Avenue, Halifax, Plymouth County, MA, with quitclaim covenants

the land in Halifax, Plymouth County, Massachusetts located on the easterly side of Crescent Avenue and being shown as Lot 2607 on a Plan of Land known as Plan G of
[Description and/or recommendation, if any]

of Monponsett Lake and Land Company. Said Plan being recorded in the Plymouth County Registry of Deeds in Book 1, Page 44. Said Lot 2607 being more particularly bounded and described as follows:

By Lot 2606 of said Plan for a distance of 40 feet more or less:

By the Town Line of Pembroke, MA. 30 feet more or less:

By Lot 2608 of said Plan for a distance of 40 feet more or less;

By the Shoreline of Spring Lake (now known as Crystal Lake) 20 feet more or less.

Said Lot 2607 containing 1,000 square feet more or less.

For Title reference, see deed recorded in Plymouth County Registry of Deeds in Book 4839, Page 307.

This conveyance is made in accordance with the terms of Massachusetts General Laws Chapter 44, Section 63A.

For Grantors' authority for this conveyance, see vote of Halifax Town Meeting of March 5, 1945, and recorded with the Plymouth County Registry of Deeds on July 3, 1985, Book 6184, Page 159.

EXCISE TAX 158A008 08:42 XMPT CASH 0.00 0.00 10/22/90 DEEDS REG 18 PLYMOUTH CANCELLED

Witness our hand s and seals this eighteenth day of September 19 90

John N. Mulready, Sr.

Candace T. Kniffen

Troy E. Garron

The Commonwealth of Massachusetts

Plymouth, ss. September 18 1990

Then personally appeared the above named, John N. Mulready, Sr., Candace T. Kniffen, and Troy Garron,
and acknowledged the foregoing instrument to be their free act and deed before me

Ruth V. Pelletier

Notary Public — Justice of the Peace

My commission expires April 9 1994

(*Individual — Joint Tenants — Tenants in Common.)

CHAPTER 183 SEC. 6 AS AMENDED BY CHAPTER 497 OF 1969

Every deed presented for record shall contain or have endorsed upon it the full name, residence and post office address of the grantee and a recital of the amount of the full consideration thereof in dollars or the nature of the other consideration therefor, if not delivered for a specific monetary sum. The full consideration shall mean the total price for the conveyance without deduction for any liens or encumbrances assumed by the grantee or remaining thereon. All such endorsements and recitals shall be recorded as part of the deed. Failure to comply with this section shall not affect the validity of any deed. No register of deeds shall accept a deed for recording unless it is in compliance with the requirements of this section.

REC'D OCT 22 1990 AT 10 34 AM AND RECORDED

Storm Water Management Report

Crescent Avenue
Improvements & Extension
Determination of Adequacy
Plymouth County, Pembroke, Ma

Prepared For:

Roger Warren
P.O. Box 2447
Basseterre, St. Kitts, West Indies

Prepared By:

Collins Civil Engineering Group, Inc.
225 South Main Street
West Bridgewater, Massachusetts 02379

Tel. (508) 580 - 2332

October 19, 2020