246 & 248 WALNUT STREET

A RESIDENTIAL SUBDIVISION
IN READING, MA

STORMWATER MANAGEMENT REPORT

VOLUME 1 OF 2

STORMWATER MANAGEMENT DESIGN

December 20, 2023

PREPARED FOR:

STELLA CONSTRUCTION
25 EVERETT STREET
WOBURN, MA 01810

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MBC JOB NUMBER: 3110

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NO.	**DATE**	**REVISION**	**BY**

THE FOLLOWING REPORT HAS BEEN PREPARED UNDER THE SUPERVISION OF A REGISTERED PROFESSIONAL ENGINEER LICENSED IN THE COMMONWEALTH OF MASSACHUSETTS.

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Volume 1

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STORMWATER MANAGEMENT REPORT – VOLUME 1 OF 2

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SECTION 1.0 INTRODUCTION

The following Stormwater Management Report outlines the proposed drainage design, the analysis of the pre and post development stormwater conditions, the design of the structural and non-structural drainage components, the proposed stormwater mitigation strategies for change in cover and proposed impervious area, compliance with Massachusetts Department of Environmental Protection (MassDEP) Stormwater Handbook, and other related stormwater issues of the development of the project. It also is intended to satisfy the state and local regulations and requirements to protect the surrounding neighborhoods, the natural resources, the existing drainage utilities, and the waters of the Commonwealth from adverse impacts resulting from the stormwater runoff.

This report defines a program for controlling, conveying, treating and discharging the stormwater runoff from the site in accordance with the adopted MassDEP *Stormwater Handbook, the Federal and State Clean Water Acts, the Wetlands Protection Act, the Coastal Zone Act, a portion of the National Pollutant Discharge Elimination System Program and the Town of Reading Subdivision Regulations.*

The report identifies by means of narratives, calculations, plans and specifications that suitable and appropriate quantity and quality control measures have been provided to gather, control, treat, and discharge stormwater runoff. The storm frequencies analyzed are the 2 yr, 10 yr, 25 yr, and 100 yr utilizing NOAA Atlas 14 rainfall data pursuant to MassDEP and local regulations. A summary tabulation of the pre development and post development peak flow rates and volumes is provided for all storm events analyzed.

This stormwater analysis includes a quantity comparison of the pre-developed flows to the post-developed flows to assure that no increase in the rate of runoff at the property boundaries. The design includes the totality of LID practices, BMP's, and Stormwater Management Facilities (SMF's) to control the discharge flow rate from the site at a rate no greater than the existing pre-developed flow rate. This Report also discusses the design for the water quality treatment and groundwater recharge methods, and evaluates the compliance to the various codes, regulations, and policies.

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This report includes:

i) discussion of the project area: existing and proposed,

ii) various record maps and plans

iii) overview discussion of stormwater management design

iv) full analysis of the Pre vs. Post Development conditions,

v) division of the land into SubCatchment Areas,

vi) computation of the weighted average "CN" for each SubCatchment area,

vii) computation of the time of concentrations for each SubCatchment area,

viii) grades of stormwater components from the grading plan of the site,

ix) final HydroCAD report with all subcatchment areas, pipe sizes, types, slopes, and invert elevations, treatment systems, and infiltration areas.

x) summary of pre vs post development flow rates

xi) discussion of BMP

xii) computations of provided vs. required recharge

xiii) computations of provided water quality volume vs. required water quality volume

xiv) operation and maintenance manual

The full plan set entitled Definitive Subdivision Plan Set, "246 & 248 Walnut Street", Reading, MA prepared for Stella Construction, by Meisner Brem Corporation, dated December 5, 2023, revised February 8, consisting of 13 sheets (Plans), is hereby incorporated herein by reference.

SECTION 2.0 GENERAL PROJECT INFORMATION -

SECTION 2.1 GENERAL

The proposed project is two-lot subdivision on a previously developed parcel known as 246 Walnut Street. A new single family home will be constructed on each lot. A new 150 ft long private way will be constructed to service the two lots.

SECTION 2.2 EXISTING CONDITIONS

2.2.1 Site

The site is a single parcel in the Single Family 20 Zone with a total area of about 2 acres. There is currently an existing house, gravel driveway, and small paved driveway. The west side of the site nearest Walnut Street is generally open and grassed. The eastern portion of the site is forested and contains a large wetland area. The site is located just downslope of an interchange associated with Interstate Route 93.

2.2.2 Geology

The property generally slopes to the east, starting from a high point around elevation 124 near #236 Walnut Street and down to the eastern wetland around elevation 98. Slopes are generally between 6% and 30% with the steeper areas near the wetland. NRCS soil mapping indicates soils consisting of Swansea muck and fill associated with Route 93, although on-site soil testing indicates loamy sand with a deep water table.

For more information on soil types, especially NCRS soil mapping see Section 3.3.

2.2.3 Pre Development Drainage Areas and Sub Catchment Areas

The Sub Catchment Areas, or Drainage Areas, all drain to the wetland on the eastern side of the property. This wetland is thus used as the point of analysis.

Subcatchment 100 encompasses all of the upland area on the site as well as offsite flow from 236 Walnut Street. This area consists mostly of woods with some existing pavement and buildings on 236 & 246 Walnut Street. The center area of the site is open and grassed.

2.2.4 Post Development Sub Catchment Areas

There are two Post-Development Drainage Areas. Subcatchment 100 again comprises the portion of the site that will discharge directly to the eastern wetland after development. This is generally the rear of the two new house lots.

Subcatchments 120 and 150 represent the areas that will drain into individual catch basins and infiltration chamber system. This consists of most of the paved access way and most of the offsite flow coming from 236 Walnut Street.

2.2.5 Wetlands

As described above, there is a large wetland area on the eastern portion of the site. several wetlands on the site that are part of a larger interconnected system located offsite. A stream is located just offsite to the east. The 200-foot Riverfront Area associated with the stream projects onto the site.

SECTION 2.3 EXISTING SOILS

2.3.1 NRCS Soil Types

The Soil Conservation Service with the United States Department of Agriculture has mapped the project area for soil types. The SCS soils types are now available online at the USDA Natural Resources Conservation Service (NRCS) website. A print-out of the Off Site Soils and On Site Soils is included herein in Section 3.4.

The USDA classifies soils into four (4) hydrologic soil groups as follows:

TABLE 2.3: NRCS - SCS SOIL GROUPS

SCS Soils Group	General Description
A	Sands & Gravels - highly permeable
B	Glacial Till – more permeable
C	Glacial Till – less permeable
D	Impermeable, silts, clays, muck

Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.[1]

The soils on the site consist of soils within Hydrologic Soil Group D within the wetland, as shown on the NRCS map provided in Section 3.2, and Hydrologic Soil Group A within the upland areas, as shown on the soil testing provided in Volume 2.

SECTION 2.4 PROPOSED DEVELOPMENT

The proposed development is an 2 lot single-family subdivision with an associated 150 ft private way. The private way will be 20 ft wide, paved, and will terminate in a circular turnaround. The lots

[1] Part 630, Hydrology, National Engineering Handbook, Chapter 7, Hydrology by United States Department of Agriculture, Natural Resources Conservation Service, 2007 (210-V1-NEH, May, 2007)

shall be served by municipal sewer and water. Water and sewer service connections to each lot will be constructed along the proposed roadway. The lots shall also be served by underground electric/cable/phone utilities to be constructed along the newly constructed roadway.

The paved areas will drain to catch basins to be constructed along the private way, which then discharges via pipes to an infiltration chamber system known as Stormwater Management Facility 1 (SMF 1). The chamber system will treat, detain, and infiltrate runoff in order to satisfy the State Stormwater Standards.

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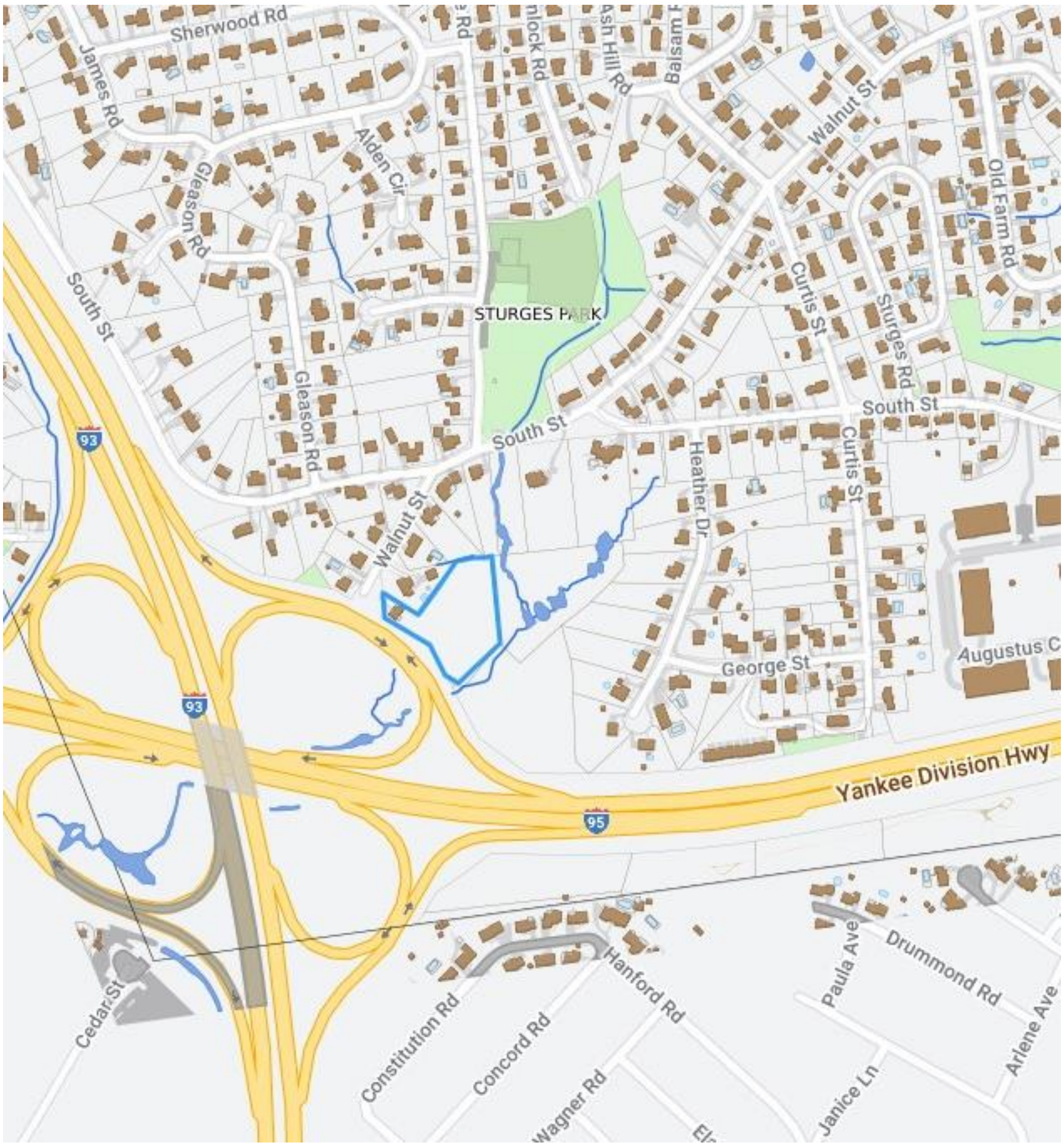
Section 3.0 Maps

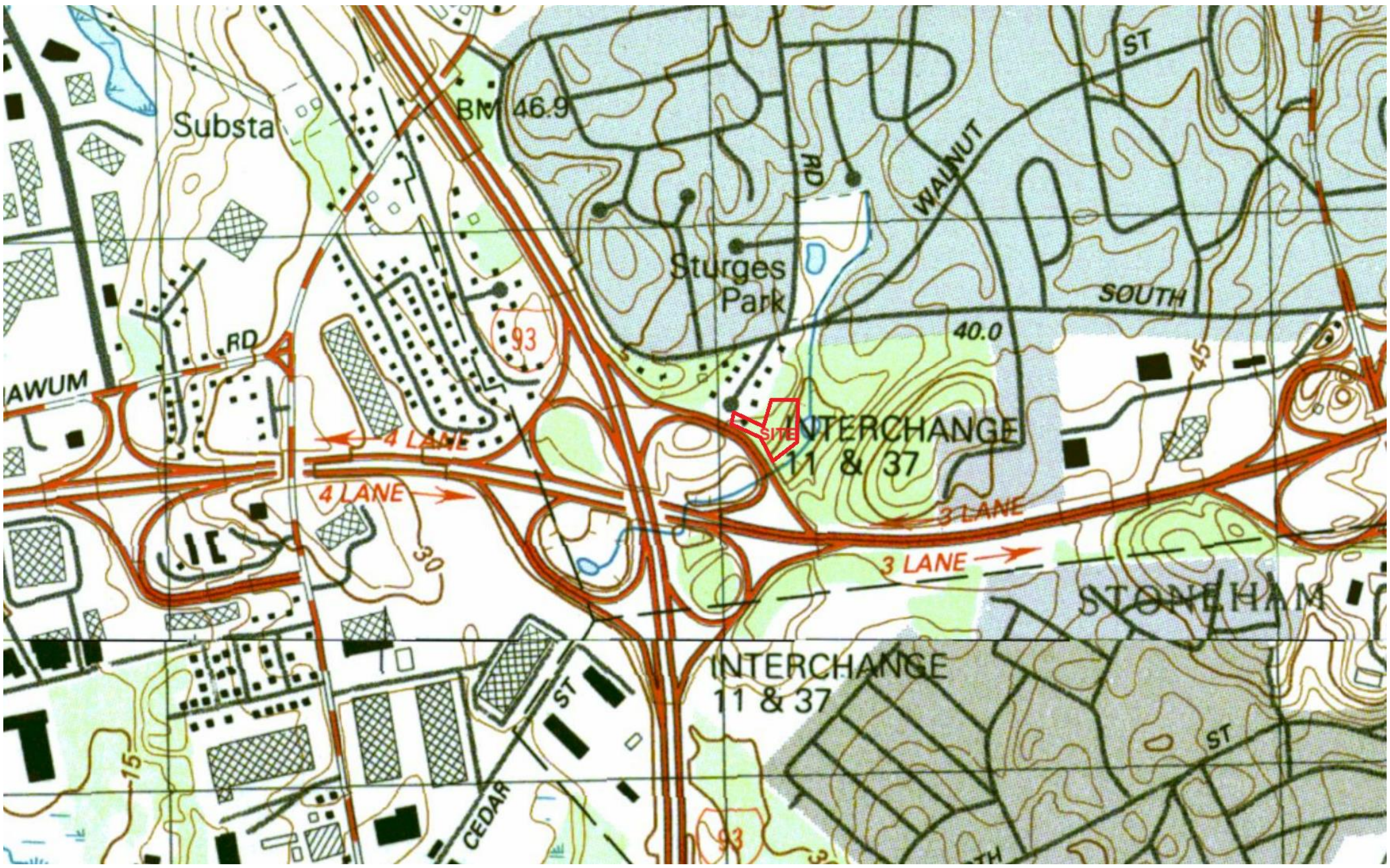
SECTION 3.1 SITE LOCUS MAP

FIGURE 3.1 NOT TO SCALE



SECTION 3.2 USGS MAP

FIGURE 3.2 NOT TO SCALE



SECTION 3.3 SOILS MAP

FIGURE 3.3 ON SITE SOILS: SCALE: AS SHOWN

Note: See Figure 3.4 on the following page for soil legend

FIGURE 3.4: SOIL LEGEND AND SITE COVERAGE (% OF AOI)

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
51A	Swansea muck, 0 to 1 percent slopes	4.6	49.0%
103B	Charlton-Hollis-Rock outcrop complex, 3 to 8 percent slopes	1.4	15.2%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	1.1	11.4%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	1.1	12.1%
656	Udorthents-Urban land complex	1.2	12.3%
Totals for Area of Interest		**9.4**	**100.0%**

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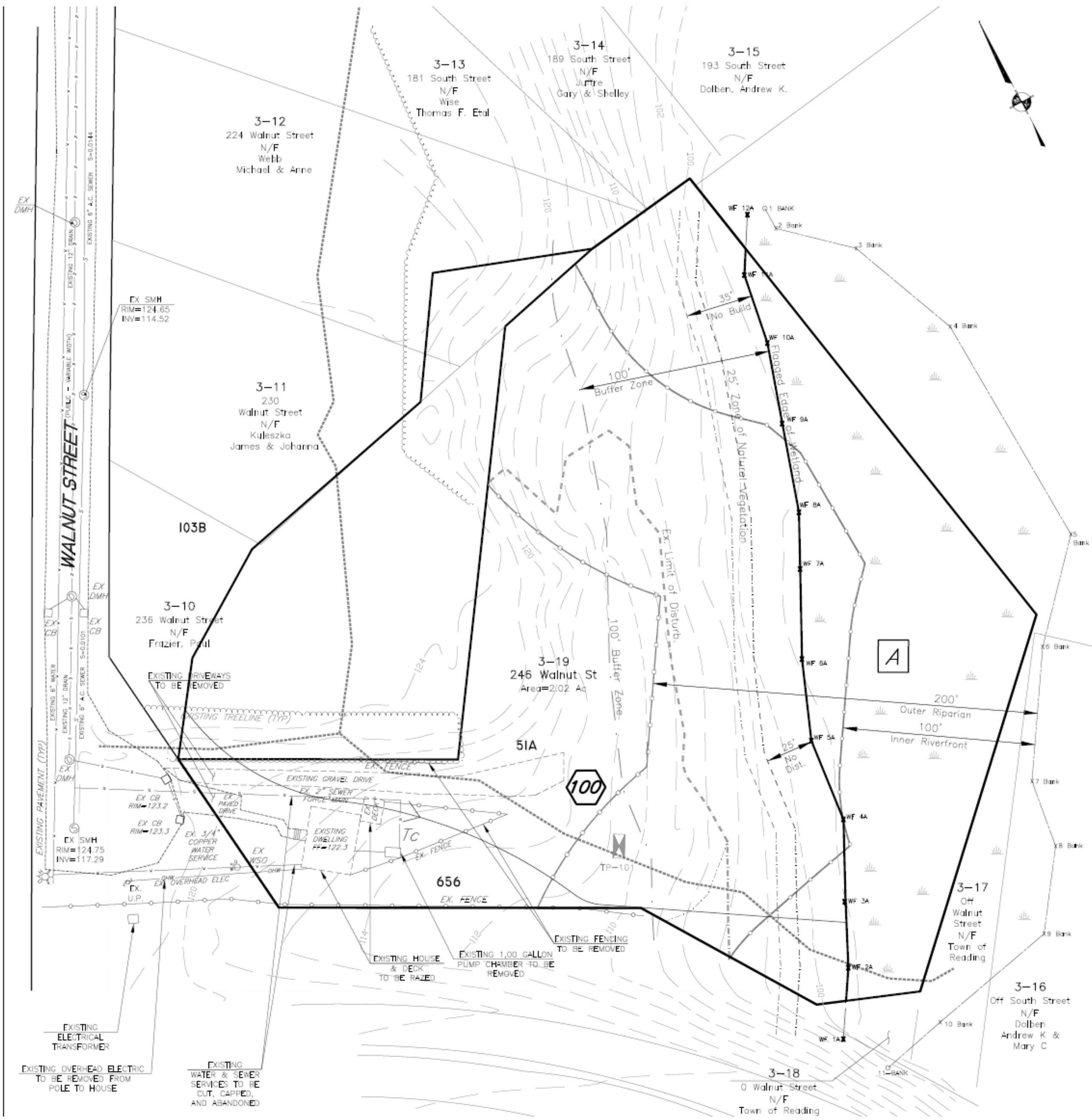
SECTION 3.4 DRAINAGE AREA MAPS – PRE DEVELOPMENT



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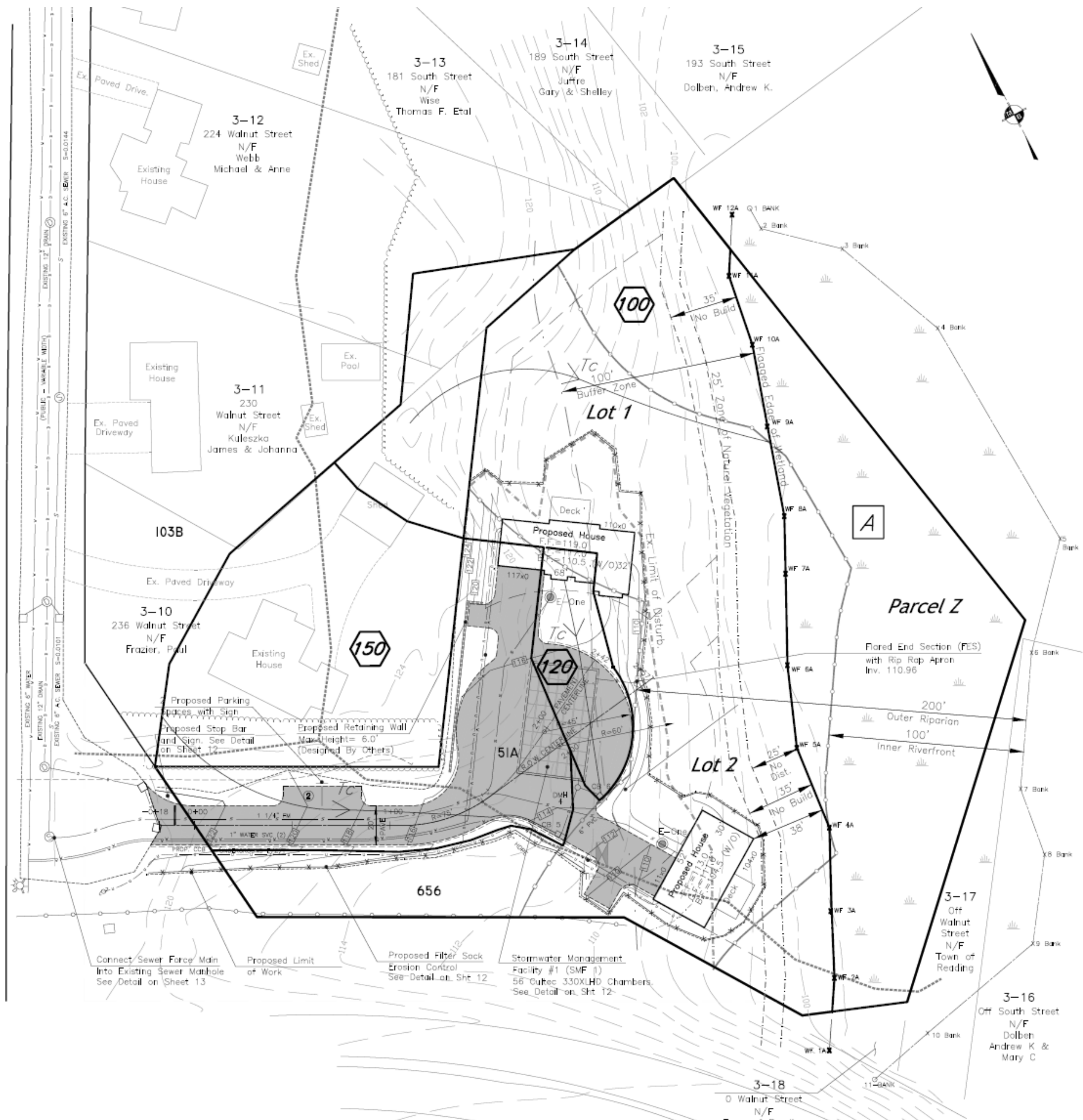
SECTION 3.5 DRAINAGE AREA MAPS – POST DEVELOPMENT



Section 4.0 Stormwater Management Overview

SECTION 4.1 STORMWATER MANAGEMENT PLAN – DEFINITION AND GOALS

4.1.1 Definition

A *Stormwater Management Plan* is a program for controlling, conveying, treating and discharging stormwater runoff. It is a system intended to protect the surrounding neighborhoods, the existing drainage facilities, and the waters of the Commonwealth of Massachusetts from adverse impacts caused by stormwater runoff. The plan consists of engineering designs including drawings, details and specifications of construction, narratives, and supporting calculations to justify the feasibility to construct and comply with the requirements of the adopted MassDEP *Stormwater Handbook, the Federal and State Clean Water Acts, the Wetlands Protection Act, the Coastal Zone Act, a portion of the National Pollutant Discharge Elimination System Program and the Town of Reading Subdivision Regulations.*

4.1.2 Goal

The goal of a *Stormwater Management Plan* is to provide suitable quantity and quality control measures for stormwater runoff from a developed property compliant with the applicable regulatory standards including the adopted MassDEP *Stormwater Handbook*. It should be simplistic in design, cost effective to construct, and reasonable to maintain. The design should blend into the natural features and site resources and take full advantage of existing environmental mechanisms to accomplish any necessary mitigation. The primary intention of the adopted MassDEP *Stormwater Handbook* is to provide the guidance for the selection, implementation and operation and management of such systems.

SECTION 4.2 UNDERSTANDING RUNOFF AND STORMWATER MANAGEMENT

4.2.1 Hydrologic Cycle

The basis of stormwater management begins with the understanding of the natural mechanisms of the earth’s ecosystems. This requires the knowledge of the hydrologic cycle that generates the runoff that in turn creates the rivers, ponds and wetlands we are so familiar with. These surface features are the primary source for the recharge of the subsurface aquifers. Development or the construction of man-made features alters these natural cycles and their performances. The key to good management of the altered circumstances is to know and understand, then imitate the natural mechanisms, controlling the stormwater runoff in much the same way that nature does. This is also a key component of Low Impact Development, mirroring nature by limiting the changed environment, recharging as close as possible to the location of each raindrop, and using natural, sustainable structures where necessary with as little impact as possible.

The hydrologic cycle describes the simplistic logical mechanisms of water within the earth's ecosystems. It is a representation of the equilibrium that is constantly balancing the status of water affected by the variations in the seasons, temperatures, weather and rainfall. It also is affected by both natural and man-made impacts to the ecosystem. The cycle is presented as three basic steps:

PRECIPITATION: consisting of rain, snow, hail, sleet, fog or mist.

COLLECTION and INFILTRATION: representative of the precipitation converting to runoff, concentrating into surface drainage features such as rivers, creeks, lakes, ponds, and wetlands. A portion of this will infiltrate into the soils, percolating downward to recharge the groundwater and contribute to the subsurface aquifers.

EVAPORATION and TRANSPIRATION: the process of vaporizing the water fluid to return it to the atmosphere, by means of thermally evaporating the surface waters, or via the vegetation uptake and natural release through the leaves.[2]

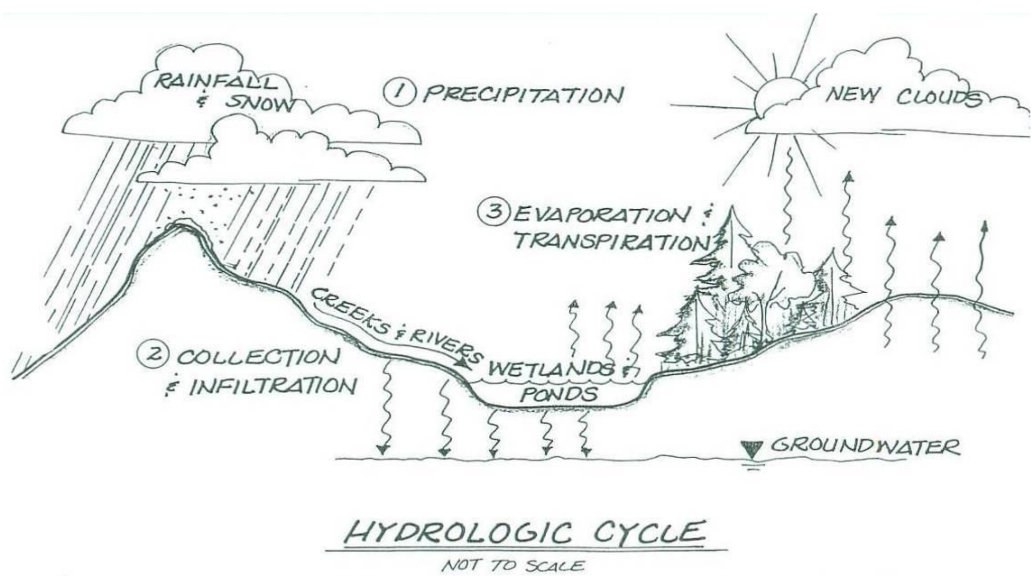


Figure 4.1

[2] Excerpted from: "*Managing Stormwater in Massachusetts*", Volume Two: Best Management Practices (BMP) Manual, dated March 1997

After understanding the role water plays in the earth's ecosystem, the next focus is on the localized features that effect the generation of the runoff. This will aid in predicting the quantities, the quality and the character of the flows.

4.2.2 Stormwater Runoff

Runoff, or surface water movement, is a result of the COLLECTION and INFILTRATION stage of the hydrologic cycle. The volume, speed and character of the runoff flow is dependent on the size of the precipitation event (i.e. the amount of water in a given time period) and the conditions of the land. As the precipitation contacts the surface, the runoff generated is dependent on the contributing area size, shape, topography, soils, antecedent moisture content from previous precipitation including snowmelt, vegetative coverage, and drainage features. These items, in conjunction with man-made features, directly affect the water's movements.

<u>4.2.2.1 Contributing Area</u>

The contributing area establishes the boundary limits for the waters movement. It is the relationship between the topographic features and the physics of gravitational forces. Simply put, as the precipitation falls to the surface, it runs downhill from the highest point. The boundary limits represent the highest established elevations within the "lay of the land", i.e.; the break lines between the basin areas, much like the peak of a roofline, directing the flow in a direction of the lower elevations. The contributing area size is a factor directly correlating the total runoff volume to the available collection surface. The area shape is a function of its consistency or homogeneous nature established by the topography and land features (e.g. a sharp valley with a wide flat floodplain, vs. a long rolling meadows with multiple intermittent drainage channels which will potentially generate two completely different runoff flow regimes).

<u>4.2.2.2 Topography</u>

The topography not only defines the contributing area, but also has a major effect on the rate of runoff, the peak discharge, velocity and the resulting soil erosion potential, and other flow characteristics. The slope differential, or total change in elevation, quantifies the physical vertical drop through the flow travel path length (drop per length, rise/run), used in calculating the runoff velocity (length traveled per time period, feet per second) and thus the travel time (Tc).

The velocity is a result of the concentration of flows that in turn define the creation of the drainage features. The flow velocities are a factor in the energy force behind surface weathering and wear related to erosional factors that develop streambeds and channels. The lack of significant velocity is evident in the ponded areas such as lakes and wetlands. When the velocities increase, the flow regime has the ability to move materials of heavier weight (suspended solids). As it slows the heavier particles separate out and drop to the bottom. The end result is erosion or sedimentation. The velocity changes not only with the slope, but is directly related to the size of the precipitation event, the smoothness of the channel surface (roughness coefficient, n), the cross-sectional geometry, and the depth of flow in the channel bed which is a function of the flow rate (Q).

4.2.2.3 Soils

Soil properties influence the process of the generation of the runoff from rainfall. The major effect of soils to runoff is on the volume of runoff generated as the remnant flow of the soils' ability to percolate, or infiltrate the precipitation contacting it. The type of soil regulates the overall capacity and ability over time to absorb runoff. For example, a clay matrix of soil may percolate a large portion of the beginning precipitation, but as the material quickly reaches a saturation point, it swells, stopping the ability of the runoff to infiltrate into the soil, thus generating a higher level of runoff. On the other hand, a clean sand or gravel matrix could potentially infiltrate all the runoff indefinitely, minimizing surface runoff. The effect of the soils on the runoff estimation calculations is represented as one component of the *"runoff curve number" (CN).* Soils are categorized in one of four generalized groupings, "A","B","C", and "D", ranging from a high infiltration – low runoff "A" type (sand), to a low infiltration – high runoff "D" type (clay or muck).

Infiltration into the different soil horizons (layers) offers water quality treatment by filtration, adsorption, absorption and biochemical breakdown of pollutants. Some soils offer better removal capacities for specific pollutants than others do. The organic topsoil has a tremendous ability to collect and breakdown organic and hydrocarbon compounds. This is due to the composition of the materials similar to compost (breaking down of the foliage, litter and debris), in an environment rich in aerobic (presence of oxygen) bacteria cultures and free-ion receptor points. As the water infiltrates downward into the anaerobic (lack of oxygen) conditions other chemical reactions that can only occur under those environmental conditions will occur along with the physical act of filtering to remove and breakdown additional pollutants. The type of soil including its chemical composition affects the removal rate based on its ionization capacity. Lastly, soil acts as a physical filter trapping particulates, suspended solids, and pathogens.

In summary, infiltration of rain water through the ground helps to cleanse the water by physical (filtration), chemical (ionic exchange), and biological (bacteria) processes.

4.2.2.4 Vegetation

Vegetation affects runoff in several ways. The foliage and its litter maintain the surfaces' ability to infiltrate by protecting it from compacting and sealing under the impacts of precipitation. Some of the rainfall is retained on the surfaces of the leaves and evaporates directly back into the atmosphere. Other trapped water is lagged or stored so long prior to contacting the surface and joining the flow regime, that it is insignificant to affecting the peak runoff. Transpiration from the plants takes a portion of the soil moisture and releases it through the leaves as a natural byproduct of their nutrient uptake. The ground cover vegetation, in combination with the ground litter create numerous micro barriers damming the water flow, slowing and detaining it, resulting in an elongated time of concentration. This flow through the vegetation acts as nature's water quality treatment method, "biofiltering", removing pollutants from the flow regime by plant uptake and biological breakdown. The effects of the vegetation or ground surface characteristics on the runoff estimation is represented as the other component of the *"runoff curve number" (CN)*, incorporated with the soil type.

4.2.2.5 Drainage Features

The drainage features affect the runoff characteristics by collecting, conveying, storing and distributing the flows according to specific site features and their attributes. These include the intermittent rills, creek beds, channels, streams, lakes, ponds, wetlands, swamps, low points, dams, and any other element, structural, man-made or not, that the runoff must pass through to complete the hydrologic cycle. All stormwater modeling assigns a mathematical input to each element in order to represent the resultant water or runoff flows.

Some elements function to reduce, detain, store or slow the runoff flows, such as ponds, wetlands and swamps. The runoff cycle's flow increases and decreases and are often stored and slowed by the ponding of the larger, flatter areas, buffering the downstream features from damaging excessive flow. Part of the micro-ecosystem characteristic of ponding is their ability to survive the water surface fluctuation caused by the periodic flooding and receding. During low flow periods the stored water is a critical source to support the local fauna and flora and contributing to recharging the subsurface aquifers. These areas also act as natural water quality treatment facilities by allowing for sedimentation, biofilter pollutant uptake within the vegetation, and filtering both through the vegetation and the soils.

Other elements increase the flows and the related velocities, such as creeks, rivers and drainage channels. These features are the conduits for which to transport the runoff and, by virtue of what they are, tend to collect and concentrate the flows, increasing the speed as they go. Since the velocity is a result of the slope, the channel section and roughness coefficient, the natural site characteristics such as the topography, soils, vegetation and ground cover which control those factors. Most drainage channels geometry and capacities are a result of the channel adapting to the natural flow conditions contributing to them. A typical stream cross-section consists of a low flow drainage channel with a capacity to convey the small storm events occurring up to the two year storm frequency (i.e. the typical day to day rainfall). Above the low flow channel is a flatter zone contained

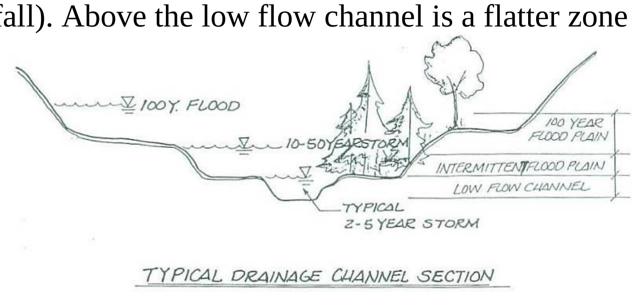


Figure 4.2

between higher banking, referred to as the intermittent flood plain, with a capacity to flow and store the runoff from the five year to up to fifty year storm events, i.e.; the larger, less occurring, but more damaging events. This zone tends to be vegetated, sometimes heavily, due to the infrequency of flooding, and the availability of water from the low flow channel saturation during the drought periods. The vegetation is beneficial in that it slows the flows with root systems that protect the stream channel from erosion. An additional elevated bench to the section is common, and is configured the same, above the intermittent flood plain, and may be commonly referred to as the 100 year floodplain. This is an area that becomes inundated with flooded runoff during extreme rainfalls. It is compounded by the fact that all components of the drainage system are operating beyond capacity, backing the water up into any available storage volume. These events tend to be of uncommon frequency, short lived, but they cause considerable damages.

Finally, total watershed areas and time of concentration are significant factors in the impacts of various storm frequencies. Typically, rivers and large streams will engage in maximum flow many days after the initial or the most intense part of the rainfall event. This is because it takes many hours for the runoff from large watersheds to join with other flows from hundreds of rills and channels, dozens of creeks, tributaries, and streams prior to joining sections of the upstream river, then time for the river to flow downstream for many miles. Therefore, on shorter, intense storms the small drainage area sites near rivers may have little impact on the river's flooding impacts that will be occurring many hours in the future and well after the peak discharges from a specific small site, downstream and near the river. Detaining these small site flows could actually be detrimental by delaying the peak discharge rate to join with the larger watershed peak flows. The topic point being discussed is simply that an individual site's drainage system should be analyzed as part of a whole and not myopically, by each small developed site.

SECTION 4.3 STORMWATER MANAGEMENT DESIGN

Stormwater Management Facilities need to be developed with consideration of a wide range of variables within the clearly defined objective to provide runoff control. Selection of the proper treatment mechanisms for the specific site use and characteristics are the key to successful management.

Generally, stormwater management systems are considered an element of the framework of an overall water resource system for a particular watershed. The designer first evaluates the impacts from a regional perspective, and then narrows the focus to the specific site. As the designer determines the components of the specific site drainage system, various related factors, both regionally and locally are considered, evaluated, incorporated, and detailed into the engineering design.

Stormwater management combines a distinct range of interrelated variables to compose a unified program of action. These are divided into five categories:

1) Design Issues: storm frequencies and intensities, soils, vegetation, groundwater, peak flows, quality treatment, life/safety

2) Regional Issues: climate, watershed/ sub-basin relationship, environmental sensitivity to receiving waters
3) Local Issues: adjacent land use, material specifications and availability, access and construction feasibility
4) Costs: project costs, stormwater management costs, cost/benefit analysis, land availability and value
5) Maintenance: owner/manager of system, responsible entity, expertise, equipment handler, inspection, protection, monitoring

Using these parameters as a guide, the designer evaluates the site conditions, develops a drainage concept, and performs hydrologic and stormwater design and hydraulic calculations to prepare the basis for the plan. The design concept is supported by the hydrologic, hydraulic and modeling / routing calculations, the plan design and details and the material specifications of the drainage system components. After a submittal and approval process with the appropriate authority, the design engineer or municipal engineer should monitor the construction for compliance with the intended design concept of the plans. Site inspections are performed to verify the assumed site conditions and allow for modifications if the conditions vary. Upon completing the construction, the system implementation, performance monitoring, and maintenance phase begins. At this point the day to day operation would be the responsibility of the operating entity. The design engineer should be available to the owner to monitor the system for operational troubleshooting and in-situ modifications as required.

Selection of suitable stormwater management systems is site-specific. All sites are different, this is inherent in stormwater management design. There is no single process or detail that can be used in every instance. All of the previously mentioned design parameters should be reviewed to help in developing the "best design" for a particular site, but note that ultimately each design is customized to the specifics of the runoff and site characteristics. As mentioned previously, the final design is often based on Low Impact Development (LID) techniques or the selection of Best Management Practices (BMP) that have been developed considering all site parameters. All BMP's must have detailed specifications designed for each site and for each usage within a project.

Above all, throughout the system design and BMP selection process, the final choices should adhere to the following primary goals:

1) Imitate Natural Control Mechanisms
2) Preserve and Utilize the Existing Natural Resources
3) Quantity and Quality control
4) Simple, Long Lasting Design
5) Cost Effective Construction
6) Easy Maintenance

With these concepts in mind, the design engineer determines the best choice for a quality design.

SECTION 4.4 BEST MANAGEMENT PRACTICES (BMP)

Best Management Practices (BMP), for the purposes of stormwater management, are structural, non-structural and managerial techniques that are recognized to be the most effective and practical means to prevent, control and reduce non-point source pollutants from entering receiving waters. They consist of proven engineering designs, source controls, managed facility operations and maintenance, and public education and awareness programs.

Best Management Practices are utilized to prevent and reduce the adverse impacts due to runoff by:

1) Preserving the hydrologic conditions to resemble the pre-developed conditions,
2) Reducing and preventing flooding by managing the peak runoff rates,
3) Treating the discharges prior to entering the receiving water bodies; removing sediments, oils, and other pollutants; "polishing" the runoff,
4) Minimizing erosion and sedimentation,
5) Reducing the total suspended solids and other pollutants; improving the water quality,
6) Protecting the sensitive environments related to the natural resources.

BMP's vary in their intended usage and ability to be adapted to the site conditions. They also offer differing types and degrees of mitigation, sometimes requiring combinations of systems in order to comply with performance standards. It is imperative that the BMP selection process includes the review of the benefits and drawbacks to identify the limitations of the choice.

The most cost efficient, productive and yet simple BMP's are those that are constructed and operate similar to natural systems. The mechanisms of the earth's ecosystems offer examples of the best practices. Surface vegetation acts to control erosion, slow runoff, filter out and biologically uptake pollutants. Creeks and rivers convey flows through channels with a natural capacity to handle runoff. Ponds, lakes and wetland swamps store excessive flows, slowing the runoff allowing for sedimentation and biological pollutant breakdown. All these items contribute to the recharge of the subsurface aquifers. Because of their natural origins, they continually adapt to changes modifying their configurations, balancing the system as a whole.

The best manmade systems are those similar to the existing natural site features, incorporated into the terrain and operated under the same mechanisms. The end product is an aesthetic blend of synthetic facilities melded into the natural landscape, requiring less maintenance, and resulting in better performance.

SECTION 4.5 STORMWATER MANAGEMENT OVERVIEW - SUMMARY AND CONCLUSION

Precipitation, whether it occurs as rain or snow, is the primary contributing source of water that **runs off** the surface of a watershed. The kind of soil and type of vegetation have a major controlling effect on the portion of the precipitation that "runs off" or generally known as runoff. The combined effect of the soil and the vegetative cover on the amount of runoff is represented by the runoff Curve Numbers (CN).

The hydrologic cycle is an explanation of how rainfall either infiltrates, transpires, evaporates, or runs off. The runoff component is the primary feature of stormwater management. The concepts of LID and BMP are to mirror nature as much as possible and to design mitigation strategies to have the least impact as possible. Properly designed stormwater management systems serve to minimize the impact of development through designed processes and controls.

Development and drainage improvements, along with the site's topography and shape characteristics are a factor in the rate of runoff. Drainage systems are modeled, both hydrologic and hydraulic, to determine the peak runoff flow rates which are used to predict the impacts due to development and to design a stormwater management system for mitigation.

The stormwater management plan identifies the site parameters and conditions for a designer to take advantage of the mechanisms of the naturally occurring features. With careful planning, many of the natural resources can be left undisturbed benefiting and enhancing the project and yet providing mitigation for the impacts of the development. A quality plan will not only control the flow and provide treatment, but it will also protect the sensitive natural resources.

Lastly, any specific BMP's utilized should be constructed and maintained properly to be fully effective. Often, the maintenance falls onto municipal public works staff, a homeowner's association, or a single homeowner. Also too often, simple maintenance is neglected and eventually affects the systems capacity to properly treat the runoff as designed.

Yet, in the last 30 years, stormwater management has made a huge and positive impact on our environment in developed areas, which should continue with the advent of newer technologies and increased use.

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SECTION 5.0 STORMWATER MANAGEMENT SYSTEM

SECTION 5.1 MASSDEP STORMWATER MANAGEMENT STANDARDS

The proposed Storm Water Management Plan addresses the Storm Water Management Standards that have been developed by MassDEP to protect the waters of the Commonwealth from adverse impacts resulting from storm water runoff. The design is based on concepts and recommendations obtained from various sources and criteria primarily the Massachusetts Stormwater Handbook, http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html

The following is a re-printing of the Massachusetts Stormwater Standards

THE STORMWATER MANAGEMENT STANDARDS

1. No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
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.
3. Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.
4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

   a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;

   b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and

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

5. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.
6. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A “storm water discharge” as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.
7. A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.
8. A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.
9. A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.
10. All illicit discharges to the stormwater management system are prohibited.[3]

[3] Massachusetts Stormwater Handbook, Volume 1:
http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html

SECTION 5.2 HYDROLOGIC MODEL

5.2.1 Flow Rate Models

5.2.2 Standard 2: No Increase in Post Development Peak Discharge Rates

The purpose of a majority of the Stormwater Management Calculations is an attempt to model the Pre Development vs. Post Development flow rates. This is a critical component of stormwater management outline as Standard 2 and is encapsulated best by again quoting from the MassDEP Stormwater Handbook:

> **Standard 2:** Stormwater management systems shall be designed so that the 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.
>
> To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate be equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms. BMPs that slow runoff rates through storage and gradual release, such as LID techniques, extended dry detention basins, and wet basins, must be provided to meet Standard 2. Where an area is within the 100-year coastal flood plain or land subject to coastal storm flowage, the control of peak discharge rates is usually unnecessary and may be waived.
>
> For projects subject to jurisdiction under the Wetlands Protection Act, the issuing authority relies on TR 20 and 55[4], which are guides for estimating the effects of land use changes on runoff volume and peak rates of discharge published by Natural Resource Conservation Service (NRCS*)*. Applicants must calculate runoff rates from pre-existing and post-development conditions. **Measurement of peak discharge rates is calculated at a design point, typically the lowest point of discharge at the downgradient property boundary.** (emphasis added) The topography of the site may require evaluation at more than one design point, if flow leaves the property in more than one direction. An applicant may demonstrate that a feature beyond the property boundary (e.g. culvert) is more appropriate as a design point.[5]
>
> Proponents must also evaluate the impact of peak discharges from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding will result from peak discharges from the 100-year 24-hour storms, BMPs must also be provided to attenuate these discharges. [6]

[4] NRCS TR 20&55 - http://www.wsi.nrcs.usda.gov/products/W2Q/H&H/Tools_Models/tool_mod.html. See the Hydrology Handbook for Conservation Commissioners, http://www.mass.gov/dep/water/laws/hydrol.pdf.
[5] The evaluation may show that retaining the 100-year 24-hour storm event is not needed. In some cases, retaining stormwater from the 100-year 24-hour storm event onsite may aggravate downstream impacts, because of the project's location within the watershed and the timing of the release of stormwater.
[6]Massachusetts Stormwater Handbook, Volume 1:
http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html

Flow rate estimates were predicted utilizing *Guidelines for Soil and Water Conservation in Urbanized Areas of Massachusetts*, dated October 1997, prepared by U.S. National Resources Conservation Service (NRCS) and "Urban Hydrology for Small Watersheds, Technical Release Number 55", dated 1986, prepared by NRCS. The chosen storm type for this area is the TR 55, Type III storm.

Flow estimate calculations were performed using the "HydroCAD v 10.05" (HydroCAD) stormwater computer modeling software. In addition, the facilities are designed in accordance with generally accepted engineering principles and practices, in conformance with all jurisdictional requirements.

5.2.3 Point of Analysis

<u>5.2.3.1 Description of Subject Site – Point of Analysis Determination</u>

It is important to note the underlined portion above (emphasis added) to highlight a critical component in Stormwater Management and Hydrologic Analysis: the Point of Analysis at the downgradient property boundary.

In order to meet Standard 2 to determine the impact from runoff quantity as a result of development it is necessary to hydrologically model the runoff in an undeveloped site condition, pre-development, and then again in a proposed developed condition, post-development. The representative models are run under the critical design storm frequency events to determine the estimated flow rates for the given scenarios. In all instances, the models are run at a determined Point of Analysis, or possibly at multiple Points of Analysis dependent on property lines, grades, and if the site is within more than one primary watershed. This is a critical concept in stormwater management.

The Points of Analysis for this subject property are as follows:

A Eastern Wetland

Sucbatchment Series 100

5.2.4 Strategies for Mitigation of Stormwater Runoff

The undeveloped rates (Pre) are compared to the developed rates (Post), resulting in a differential volume representative of the "*increase in peak runoff due to the development*". At such time a set of Best Management Practice (BMP) designs are incorporated to mitigate the increase. In this case the primary BMP structural components for the majority of the changed runoff are the infiltration chambers.

The proposed stormwater management design is incorporated into the proposed post-development HydroCAD model and run under the critical design storm scenarios to determine the operational performance of the system. Discharge volumes, velocities, depth of flows and dissipation spreads are then calculated to verify the impacts to the receiving areas.

The proposed storm water management plan for this project has been developed using Structural and Non-Structural Best Management Practices (BMP's).

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Section 6.0 Design Summary and Conclusions: **PRE VS. POST ANALYSIS**

6.1 SUMMARY - DISCUSSION

The following informational charts are a synopsis of the comparative scenario models to determine the stormwater runoff conditions. The data is a result of mathematical models representing the pre and post developed conditions. The pre-developed results were compared to the post-developed results to determine the approximate sizing requirements of the BMP's to be used to mitigate the impacts due to development.

The following tables represent the site condition data and the results of the HydroCAD® Stormwater Modeling System by HydroCAD Software Solution, LLC to verify that the proposed stormwater management system will comply with the guidelines for *Soil and Water Conservation in Urbanized Areas of Massachusetts,* and the Commonwealth of Massachusetts adopted and referenced *Stormwater Management Handbook*.

The following summary tabulations are developed separately for each design storm event for the Point of Analysis described in Section 5.2.3. The design storm events include the 2-year, 10-year, 25-year, and 100-year design storm frequencies. The rainfall depths for these storm events are given by NOAA Atlas 14. The tabulations show the results of the entire stormwater management system to the points of analysis.

The complete stormwater models for the 2-year, 10-year, 25-year, and 100-year design storm frequencies are presented in Volume 2 of this report.

The Point of Analysis outlined in Section 5.2.3 above is reprinted here for reference:

A Eastern Wetland

Sucbatchment Series 100

6.2 SUMMARY TABLES: PRE-DEVEOPMENT VS POST-DEVELOPMENT

Table 6.1 Point of Analysis A – Eastern Wetland – Peak Flow Rates

Storm Frequency	Rainfall (in)	Pre-Development (cfs)	Post-Development (cfs)	Difference (cfs)
2 Year Storm	3.30	**0.00**	**0.00**	**-0.00**
10 Year Storm	5.21	**0.13**	**0.05**	**-0.08**
25 Year Storm	6.39	**0.54**	**0.28**	**-0.26**
100 Year Storm	8.22	**2.01**	**1.82**	**-0.19**

Table 6.2 Point of Analysis A – Eastern Wetland – Volumes

Storm Frequency	Rainfall (in)	Pre-Development (cf)	Post-Development (cf)	Difference (cf)
2 Year Storm	3.30	**15**	**0**	**-15**
10 Year Storm	5.21	**1,919**	**1,019**	**-900**
25 Year Storm	6.39	**4,416**	**2,900**	**-1,516**
100 Year Storm	8.22	**9,811**	**9,437**	**-374**

6.3 CONCLUSION

On the issue of ensuring no increase in the post development peak flow rate of runoff, Standards 1 and 2 of the MassDEP Stormwater Handbook and associated regulations states:

> **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**.**
>
> **Standard 2:** Stormwater management systems shall be designed so that the 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.
>
> To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate is equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms. [7]

Then also,

> Proponents must also evaluate the impact of peak discharges from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding will result from peak discharges from the 100-year 24-hour storms, BMPs must also be provided to attenuate these discharges.

The location of the design point is a critical criteria, also defined in the Stormwater Handbook as:

> Measurement of peak discharge rates is calculated at a design point, typically the lowest point of discharge <u>at the downgradient property boundary</u>. The topography of the site may require evaluation at more than one design point, if flow leaves the property in more than one direction. (emphasis added).

Standard 1 and Standard 2 are met. The project design has no untreated direct discharge to any wetland resource area. The Stormwater Management Facility detains the storm event up to and including the 100-year storm and provides treatment for almost all of the paved area.

The quantitative analysis of the peak flow rates tabulated above show no increase in the rate of runoff and volume of runoff at the Point of Analysis for the 2 year, 10 year, 25 year, and 100 year storm events. The increase in post development runoff is properly attenuated by the proposed on–site stormwater controls and designs.

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[7] Massachusetts Stormwater Handbook, Volume 1: Standard 2, http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html

SECTION 7.0 DOCUMENTING COMPLIANCE WITH STANDARD 3: RECHARGE

7.1 Recharge – Provide Required Annual Recharge (Rv)

7.1.1 Determine Required Recharge (Rv)

Mass DEP outlines Standard 3 to address Groundwater Recharge as follows:

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

Reference is made to the regulations and Volume 3 of the Stormwater Handbook as to the basis of the required calculations.

The stormwater runoff volume to be recharged to groundwater is determined using the existing site (predevelopment) soil conditions. The total impervious area introduced through site development is multiplied by one of the following recharge factors.

TABLE 8.1 RECHARGE RATES

Hydrologic Group	Volume to Recharge (x Total Impervious Area)
A	0.60 inches of runoff
B	0.35 inches of runoff
C	0.25 inches of runoff
D	0.10 inches of runoff

The Required Recharge is based on the following formula:

$$Rv = F \times A_{IMP}$$

Where:

Rv	= *Required Recharge Volume*, expressed in Ft^3, cubic yards, or acre-feet
F	= Target Depth Factor associated with each Hydrologic Soil Group
A_{IMP}	= Impervious Area pavement and rooftop area on site

For the subject property, using the *Static Method* with the target factor of 0.60 inches based on Soil Group A, the computation follows:

Given:	HSG A =	0.60 in.	
	A_{IMP} =	22,527 ft^2	(includes off-site impervious areas)

$Rv = ((22{,}527\ ft^2) \times 0.60\ in) \div (12\ in/ft) =$ 1,127 ft^3

Required Recharge (Rv) = 1,127 ft^3

7.1.2 Determine Recharge Provided:

Recharge Volume at: <u>SMF 1 – Cultec Infiltration Chambers</u>

Given:	Volume of Chambers below outlet =	3,825 CF	(From HydroCAD)
	Total Bottom Area =	2,102 SF	(From HydroCAD)

Calculations:

$Rv_{(Provided)}$ = Volume below outlet = <u>3,825 CF</u> Provided

$Rv_{(Provided)}$ = 3,825 CF > *Rv* = 1,127 CF

The provided storage (without accounting for any infiltration) of the infiltration systems is 3,825 cubic feet. In reality the recharge provided is greater than this number due to infiltration. It is also worth noting that the required recharge volume includes offsite impervious areas, which do not need to be recharged.

Standard 3, Required Recharge is provided: 3,825 CF > 1,127 CF

7.1.3 Verify Basin Drains

CHECK THAT INFILTRATION BASINS DRAIN WITHIN 72 HOURS:

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:

Rv = Storage Volume
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 8). For "Dynamic Field" Method, use 50% of the in-situ saturated hydraulic conductivity.
Bottom Area = Bottom Area of Recharge Structure

TABLE 7.2: 1982 RAWLS RATES[8]

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

Soil Test 101 in the vicinity of the proposed infiltration system (SMF 1) indicates loamy sand. The Rawls Rate for Loamy Sand is these calculations and the Hydrologic Model.

Check Time to Drain (T_D) less than 72 hours with infiltration rate 2.41 inches per hour

[8] Rawls, Brakensiek and Saxton, 1982, Estimation of Soil Water Properties, Transactions American Society of Agricultural Engineers 25(5): 1316 - 1320, 1328

Infiltration at SMF 1:

T_D = 1,127 ft³ / (2.41 in/hr) x (1 ft/12 in) x (2,102 SF)

T_D = 1,127 ft³ / 422 ft³/hour

TD = 2.7 hours < 72 hours	Full Recharge Volume will Drain in less than 72 hours	**OK**

Therefore the infiltration systems will drain within 72 hours as required.

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Section 8.0 Documenting Compliance with Standard 4: Water Quality Volume

8.1 Water Quality Volume – V_{WQ}

8.1.1 Water Quality Volume V_{WQ} – Brief Description of Requirement

Mass DEP outlines Standard 4 to address Total Suspended Solids as follows:

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

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

The formula for determining the Water Quality Volume is:

$$V_{WQ} = (DWQ/12 \text{ inches/foot}) * (A_{IMP})$$

Where:

V_{WQ} = *Required Water Quality Volume (in cubic feet)*

D_{WQ} = *Water Quality Depth:* one-inch *for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour; ½-inch for discharges near or to other areas.*

A_{IMP} = *Impervious Area (in square feet)*

For the subject project, since there will be exfiltration to soils with an infiltration rate greater than 2.4 inches per hour, a Water Quality Depth of 1 inch is used:

Use: D_{WQ} = 1 inch

8.1.2 SMF 1 Water Quality Volume VWQ:

Given:

A_{IMP} = 22,527 ft^2 (includes off-site impervious areas)

$V_{WQ} = (D_{WQ} / 12$ inches/foot) * (A_{IMP} square feet)

$V_{WQ} = $ (*1 inch*/12 inches/foot) * (22,527 ft^2)

$\mathbf{V_{WQ} = 1{,}878\ ft^3}$

VWQ Provided in Cultec Chambers (SMF 1) below lowest outlet = 3,825 CF (From HydroCAD))

Check Water Quality Volume

$V_{WQ}^{Provided}$ = 3,825 ft^3 > $V_{WQ}^{Required}$ = 1,878 ft^3 ------	**OK**

8.1.3 SMF 1 Separator Row Sizing Calculations

There is no stated methodology in the Massachusetts Stormwater Handbook to size a chamber system separator row. The methodology for sizing a sediment forebay will be used in this calculation: *"At minimum, size the volume of the sediment forebay to hold 0.1-inch/impervious acre to pretreat water quality volume"*

V_{Req} = (0.1 inch) x A_{IMP}

V_{Req} = (0.1 inch) x (22,527 ft^2) x (1ft/12in) = 188 ft^3

$V_{(Provided)}$ = 52.2 ft^3 per chamber x 8 chambers in Seperator Row = 417 ft^3

$V_{(Provided)}$ = 417 ft^3 > V_{Req} = 188 ft^3 ------	**OK**

8.2 Total Suspended Solids (TSS)

General Description of TSS Removal provided via SMF 1:

Paved runoff will enter standard catch basins designed with deep sumps ($\geq$ 4 feet) to settle large suspended and non suspended solids.

The piped conveyance system discharges the runoff into a Cultec Separator Row, which is wrapped in geotextile fabric to trap the suspended and non suspended solids. The runoff then continues into the Cultec Infiltration System. This system detains runoff and infiltrates it into the ground.

In summary, several LID and BMP techniques are being used to achieve the 80% TSS removal as outlined on the MassDEP stormwater worksheets shown on the following pages.

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TABLE 8.1: TOTAL SUSPENDED SOLIDS: SMF 1

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

Version 1, Automated: Mar. 4, 2008

Location: SMF 1: Cultec Infiltration System

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Subsurface Infiltration Structure	0.80	0.75	0.60	0.15
	0.00	0.15	0.00	0.15
	0.00	0.15	0.00	0.15
	0.00	0.15	0.00	0.15

Total TSS Removal = 85%

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

Project: 246 & 248 Walnut St, Reading
Prepared By: IJA
Date: 11/29/2023

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

TSS = 85% which is greater than 80% required ------------ OK

Standard 4 is met with the use of various BMP techniques as described above and as outlined in MassDEP TSS Table 8.1

SECTION 9.0 REMAINING STATE STANDARDS

The following is a brief discussion of State Standards 5, 6, 7, 8, 9 and 10.

Standards 5, 6 and 7 are not applicable to this project. There is no higher pollutant load expected, there is no discharge to a critical area, and the project is not filed as re-development.

Standards 8 is met via construction phase erosion and sediment control procedures that are depicted on the project plans.

Standards 9 and 10 are met with the Operation and Maintenance Plan and Illicit Discharge Statement. See Section 10

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SECTION 10.0 OPERATION AND MAINTENANCE

10.1 INTRODUCTION

This section addresses the issue of operation and maintenance for the proposed Stormwater Management System after construction (Standard 9), and an illicit discharge statement (Standard 10). If this section is separated from the remainder of this Stormwater Management Report (SMR), the SMR is hereby incorporated by reference, a copy of which will be in the records of the Reading Planning Board as well as other locations. The title of the final SMR is:

"246 & 248 WALNUT STREET"
A RESIDENTIAL SUBDIVISION
IN READING, MA
STORMWATER MANAGEMENT REPORT
December 20, 2023
Prepared For:
Stella Construction
25 Everett St, Woburn, MA 01810
Prepared By:
Meisner Brem Corporation
142 Littleton Road, Ste. 16
Westford, MA 01886
MBC Job Number: 3110

The maintenance standards presented herein are based on Mass DEP "The Stormwater Handbook", as previously referenced, *the Federal and State Clean Water Acts, the Wetlands Protection Act, the Coastal Zone Act, a portion of the National Pollutant Discharge Elimination System Program and the Town of Reading Subdivision Regulations* with various reports and guidance associated therewith.

These maintenance and operations procedures are intended as general guidelines, however additional procedures shall be developed if necessary, as the systems are completed and operated over a period of time. As with all stormwater facilities, the conditions change or the management of them can be simplified as the operation personnel become more familiar with them. The most effective maintenance and operations can be customized to the specific facility as the system develops and situations merit.

10.2 DESIGN PARAMETERS OF EROSION CONTROL AND MANAGEMENT

Generally, storm water management systems are considered an element of the framework of an overall water resource system for a particular watershed. The designer first evaluates the impacts from a regional perspective, then narrows the focus to the specific site. As the designer determines the components of the specific site drainage system, various related factors, both regionally and locally are considered, evaluated, incorporated, and detailed into the engineering design.

Stormwater management combines a distinct range of interrelated variables to compose a unified program of action. These are divided into five categories:

- Design Issues: storm frequencies and intensities, soils, vegetation, groundwater, peak flows, quality treatment, life/safety
- Regional Issues: climate, watershed/ sub-basin relationship, environmental sensitivity to receiving waters
- Local Issues: adjacent land use, material specifications and availability, access and construction feasibility
- Costs: project costs, storm water management costs, cost/benefit analysis, land availability and value
- Maintenance: owner/manager of system, responsible entity, expertise, equipment handler, inspection, protection, monitoring

Using these parameters as a guide, the designer evaluates the site conditions, developing a drainage concept and performs hydrologic and design calculations to prepare the basis for the plan. The design concept is supported by the engineering hydraulic and routing calculations, the plan details and the material specifications of the drainage system components. A key component of a good design is an understanding of the requirements of maintenance, especially since many of these systems will be maintained by a Homeowner’s Association.

10.3 OPERATION AND MAINTENANCE OF STORMWATER MANAGEMENT FACILITIES

Proper maintenance is essential to ensure that the performance of the system meets the design expectation. A system that is not maintained may fail and could lead to financial loss, damage to surrounding infrastructure or environmentally sensitive areas and increasing the liability of the property owners.

10.3.1 Personnel and Education

Personnel make the difference between a Stormwater Management System that performs as designed throughout its lifetime or one that fails due to lack of attention. *Education* provides the personnel with the skills needed to effectively maintain a Stormwater Management System. *Record Keeping* allows the personnel to track the maintenance and the System's performance so as to determine when major maintenance tasks are required.

Maintenance of the structural components of the stormwater management facilities will be the responsibility of the homeowners association. Maintenance should be performed as outlined below in items 1-10. In addition to the town, each of the homeowners – through their association - should have a copy of this report with a copy of the grading design plan. Full comprehension of these documents will educate the homeowners and allow them to properly maintain the stormwater management system.

The homeowners association should be aware of the Stormwater Management Facilities' intended purpose of removing contaminants from the stormwater runoff flow from the site. The result is the collection, removal and storage of the contaminants within the facility components. These potentially consist of trash/debris, oils, sediment and soluble/insoluble materials. In most situations, these can be handled, stored and disposed of with minimal safety requirements, in that the health hazards are non-existent or minimal with the concentrations involved. However, the owner shall be aware of the risk and/or the possibility of potential dangers. An example would be in the system was inundated with an excessive concentration due to an accidental spill.

10.3.2 Record Keeping

Record Keeping – It is recommended that a record log be kept of measured sediment levels at regular (annual) maintenance and after each major storm event. Sediment accumulation should be measured at the retention basin and logged in the record. Sediment should be removed annually, or when the sediment buildup has met the threshold outlined below. These activities should be logged as well.

Forms for recording the inspections and maintenance are included at the end of this section.

10.3.3 Post-Development Operation and Maintenance schedule

Upon completion of construction, this Operation and Maintenance schedule shall be adhered to by the Owners and their agents, advisors, consultants, and contractors, or any future agent with associated responsibility**.** The outline below shall be adhered to as closely as possible to ensure the proper function of the drainage system.

1. The paved areas shall be swept annually, at a minimum. Sweeping shall be done after the final snow melt when sand or de-icer can be easily swept. Any collected debris shall be removed in accordance with all local, state, and federal regulations.

2. Any culverts shall be inspected at least twice per year, including one time after the final snowmelt of the season, and any obstructions shall be removed and disposed of in accordance with all local, state, and federal regulations.

3. No erosion control measures shall be removed until all contributing upslope areas are stabilized.

4. Snow plowing of the roadway shall be performed regularly and after all storms which result in an accumulation of snow 1 inch or greater.

5. The use of road salt and similar de-icers should be minimized and restricted to paved areas only. Road salt and de-icers shall not be stored on-site.

6. See section 10.3.4 for individual BMP procedures.

10.3.4 Permanent Best Management Practices

Operation and maintenance of the catch basins, inlets, infiltration systems, and associated drainage structures should occur as follows. A map of these systems is provided in Section 10.3.7 of this report:

1. Catch Basins – Deep Sump– Inspect catch basins at least four times per year and at the end of the foliage and snow- removal seasons. Sediments must also be removed once per year, preferably in early May, 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. If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary.
2. Inlets – Pipe inlets and spillway structures should be inspected annually and after every major storm. Accumulated debris and sediment should be removed. If pipes are coated, the coating should be checked and repaired as necessary.
3. Outlets – Pipe outlets should be inspected annually and after every major storm. The condition of the pipes should then be noted and repairs made as necessary. If erosion is taking place, then measures should be taken to stabilize and protect the affected area of the outlet.

4. Cultec Infiltration Systems- Systems should be inspected at least twice annually, and following any rainfall event exceeding 2.5 inches in a 24 hour period, with maintenance or rehabilitation conducted as warranted by such inspection. Pretreatment measures such as the separator row should be inspected at least twice annually, and cleaned of accumulated sediment as warranted by inspection, but no less than once annually. The separator row can be cleaned via a high pressure water nozzle inserted through the inlet catch basins. The water nozzle should be used to flush sediment into the inlet catch basin for vacuuming.

   If an infiltration system does not drain within 72-hours following a rainfall event, then a qualified professional should assess the condition of the facility to determine measures required to restore infiltration function, including but not limited to removal of accumulated sediments or reconstruction of the infiltration system.

5. Outlet Protection (riprap apron) – The outlet protection should be inspected at least annually and after every major storm. If the riprap has been displaced, undermined or damaged, it should be repaired immediately. The channel immediately below the outlet should be checked to see that erosion is not occurring. The downstream channel should be kept clear of obstructions such as fallen trees, debris, and sediment that could change flow patterns and/or tailwater depths on the pipes. Repairs must be carried out immediately to avoid additional damage to the outlet protection apron.

6. Loam and Seed: Loam and seed establishes grasses on highly erodible soils or critically eroding areas. Loam and seed stabilizes the underlying soil, reduces damages from sediment, maintains or improves water quality and reduces stormwater runoff. On steeper slopes, jute matting, organic mesh, or other devices are used to retain the soil until a full lawn or slope is fully stabilized with mature grow in. Fertilizer and seed type and application rates are on the final drawings.

10.3.5 Other Site Controls

1. Good house keeping - The contractor is necessary for maintaining accurate and complete records of the construction activities on site. The contractor must also ensure that chemicals, pesticides, and fertilizers are properly stored. Regular disposal of garbage, rubbish or sanitary waste disposal, and prompt cleanup of spills is necessary to minimize the potential for pollution.

2. Waste disposal, sanitary septic disposal, and materials management - The proper management should include storage of hazardous materials such as paints, oils, etc. These materials should be stored in the contractor's vehicle or placed on an impervious floor or surface, i.e. (Basement floor or concrete slab.)

3. Spills - All personnel involved with the construction activities have knowledge of whom to contact in the event of a spill that is a source of storm water contamination. The contractor shall ensure that appropriate measures are taken to prevent spills and respond in the event of a spill. In the event of a spill the contractor should take measures to reduce storm water contact stopping the source of the spill, contain the spill, and absorb the material as quickly as possible.
4. Sanitary portable toilets shall be utilized to avoid direct discharge.
5. Vehicle wash down – in appropriate locations over 100 feet from wetlands draining to a sediment basin

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10.3.6 Illicit Discharge Statement

The undersigned certifies that no illicit discharges will be permitted on the property, at all times, in perpetuity. The undersigned further certifies that no illicit discharges presently exist at the site.

____
Signature

If any illicit discharge is accidentally released, the following protocol is to be utilized:

If the construction site has a release of a hazardous substance or of oil in an amount which exceeds a reportable quantity as defined at 40 CFR Part 11, 40 CFR Part 117, or 40 CFR Part 302 then the permittee shall:

a) Call the National Response Center,

b) Modify the Pollution Prevention Plan as to the nature of the release and,

c) Submit a written description of the spill.

10.3.7 Operation and Maintenance Generic Forms

See the following pages for the following forms:

- Best Management Practices – Summary of Inspections
- Grading and Stabilization Activities Log

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Project Site: ______________________

Location: ______________________

Phase or Limits: ______________________

Best Management Practices

Summary of Inspections

Inspection Number	Date	Inspector	Item Inspected (see list @ right)	Condition/Remarks	Action to be Taken	Follow up Comments

List of Inspections

A. Hay Bale/Silt Fence
B. Sediment Ponds
C. Site Clearing, Grub
D. Storm Drain Pipe & Conveyance
E. BMP - Indicate type (mandatory)
F. Stone Condition
G. Velocity Dissipaters
H. Structural Components
I. Permanent Stabilization

Submittal Log

Date	Agency

Stormwater Pollution Prevention Plan (SWPPP)

Grading and Stabilization Activities Log

Date Grading Activity Initiated	**Description of Grading Activity**	**Description of Stabilization Measure and Location**	**Date Grading Activity Ceased** (Indicate Temporary or Permanent)	**Date When Stabilization Measures Initiated**

Use Additional Sheets if Necessary

EPA SWPPP Template, Version 1.0