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May 19, 2021

BY ELECTRONIC MAIL

Ms. Adrianna Henriquez Olmsted
Zoning Board of Appeals
Newton City Hall
1000 Commonwealth Avenue
Newton, MA 02459-1449

Re: Comprehensive Permit Decision #09-19/Dunstan East, LLC/32-34 Dunstan Street,
12 Kempton Place, 18 and 25 Kempton Place, 24 Kempton Place,
1149 and 1151 Washington Street, 1157 Washington Street, 1169 Washington Street,
1171 Washington Street, 1179 Washington Street, and 1185 Washington Street

Dear Ms. Olmsted,

I am forwarding herewith a revised Stormwater Report relative to the above matter prepared by VHB dated November 26, 2019, most recently revised May 17, 2021.

Please let me know if you have any questions.

Sincerely,

Katherine Braucher Adams

Katherine Braucher Adams

SJB/mer
Attachment

cc: (By Email, w/attachment)
Mr. Neil Cronin
Mr. Michael Gleba
Mr. John Daghlian
(By Email, w/out attachment)
Mr. Robert Korff
Mr. Damien Chaviano
Mr. David Roache
Mr. Scott Lombardi
Ms. Stephanie Moresco

Dunstan East Mixed-Use Redevelopment

Washington Street, Newton, Massachusetts

PREPARED FOR

Mark Development, LLC
275 Grove Street
Suite 2-150
Newton, MA 02466
617.614.9149

PREPARED BY



101 Walnut Street
PO Box 9151
Watertown, MA 02471
617.924.1770

November 26, 2019
Revised February 5, 2020
Revised May 17, 2021



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Project Summary

The Applicant, Mark Development, LLC, is proposing a mixed-use residential and retail development of approximately 302 residential units, 6,247 square feet of retail/restaurant and 322 structured parking spaces, new, relocated and reconstructed roadways in (new) Brook Drive, Dunstan Street and Kempton Place (the Project) on an assemblage of approximately 3.6 acres of developed land located on Washington Street and bounded on the north by Cheese Cake Brook in Newton, Massachusetts (the Project Site). As proposed, the Project consists of three multi-story mixed-use buildings totaling 503,880 gross square feet. The Project will also include ancillary landscape improvements, stormwater management system, and utility connections for the buildings.

The Project includes significant improvements along the Cheese Cake Brook corridor to address floodplain impacts and enhance water quality. Cheese Cake Brook currently follows a man-made channel running west to east along the northern end of the Site. As part of this Project, the southern wall of this channel will be partially removed. The stream will be restored to a naturalized condition. Appropriate plantings and seeding will be placed in this area to promote a more environmentally beneficial setting. With the naturalizing of Cheese Cake Brook as well as some of designed landscape elements of the Project, there will be a considerable increase in flood storage as part of this project. Additionally, naturalizing the stream channel will improve the conveyance in Cheese Cake Brook by providing a wider stream channel and recreating natural topography.

Also, the existing site conditions do not have any treatment for stormwater runoff into the Cheese Cake Brook. The Project proposes an incorporation of a stormwater sand filtration system in order to treat stormwater runoff from the entire site in order to meet State and City regulations and ordinances.

Currently, a large culvert discharges from the Massachusetts Turnpike (I-90) directly into Cheese Cake Brook. The orientation of this outlet will be rotated through the construction of a new headwall to offer some energy dissipation as well as a "plunge pool" for sediment settlement located in reconstructed portion of Cheese Cake Brook.

The existing condition of Washington Street's drainage system flows directly into the MassDOT drainage system on Kempton Place. A stormwater sand filtration system is being proposed to add treatment to these flows before it is discharged into the MassDOT outfall.



Specifically, the Stormwater Report includes evaluation of pre-development and post-development conditions of:

- Surface water quantity and quality;
- Wetlands and water features, including streams and rivers.

In summary, the analyses outlined in this report concludes that Dunstan East Mixed-Use Redevelopment will:

- Increase the amount of pervious land within the Project to improve the watershed and re-establish the stream channel to a naturalized condition. Stream conveyance will also improve as a result of naturalizing the slopes of the stream and reorienting the MassDOT culvert outfall.
- Implement a sustainable stormwater management system to improve the surfacewater and flood storage capacity in order to enhance Cheese Cake Brook during peak storm events.
- Implement traditional stormwater Best Management Practices (BMPs) combined with a concise Operation and Maintenance Plan to provide water quality treatment to an area that originally had no stormwater treatment.
- Extensively restore the Brook to a natural habitat, in order to promote wildlife.
- Protect and minimize disruption to riverfront through the maintenance and/or restoration of protective buffers.



Checklist for Stormwater Report



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 8²
- 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.



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.

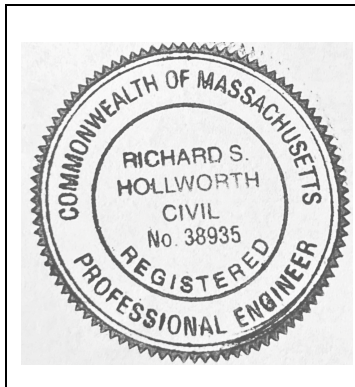
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



May 17, 2021

Signature and Date

Checklist

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

- New development
- Redevelopment **Proposed Project will result in reduction in impervious area**
- 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): Structured Parking Garages

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 Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- 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.



Stormwater Report Narrative

Site Description

The Project Site is located on a 3.6-acre property along the north side of Washington Street between Dunstan Street and Kempton Place in Newton, Massachusetts (see **Figure 1**). The Project Site consists of multiple existing buildings, parking lots and an existing gas station. The Site lies within the Charles River Watershed, and is bounded by the Cheese Cake Brook to the north.

The Project Site is bounded by an existing Wetland Resource Area (Cheese Cake Brook) located to the north, Dunstan Road to the west, Washington Street to the south, and existing office buildings to the east. This Wetland Resource Area accepts stormwater discharge from the Site as well as from Dunstan Street and abutting properties to the west and north. The existing site is not an area of critical environmental concern and is not located near one.

According to the National Resources Conservation Service (NRCS), surface soils on the Site include Urban Land. Geotechnical investigations will be performed at the location of the proposed water quality systems prior to construction. However, based on soil investigations and evaluations performed at various locations around the site, the soils are classified as Hydrologic Soil Group (HSG) B.

Based on the FEMA Flood Insurance Rate Map (FIRM) number 25017C0551E, portions of the Project Site lie inside of the 100-year floodplain (see **Figure 2**).

Existing Drainage Conditions

The Project Site consists of multiple existing buildings, parking lots and an existing gas station. The topography of the existing pavement area varies, sloping from elevation 53 (NAVD88) at Washington Street to elevation 35 along the southern edge of Cheese Cake Brook. The existing grades of Dunstan Street and Kempton Place are steep and are 10.0% and 8.8% respectively. The existing site slopes south to north towards Cheese Cake Brook.

Under existing conditions, stormwater is collected by in-line catch basins and piped via a closed drainage system within Dunstan Street to Cheese Cake Brook along the north portion of the property. The existing site drains to a series of catch basins conveyed through a closed pipe network, and discharges directly and untreated to Cheese Cake Brook, or sheet flows directly to the brook. There is currently no existing



infrastructure on the Site for water quality treatment. **Figure 3** illustrates the existing drainage system and discharge point and **Table 1** provides a summary of the existing conditions hydrologic data.

Table 1 – Existing Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
1E	Cheese Cake Brook	1L	3.59	94	5

The hydrologic analysis is included within Appendix F - *Hydrological Analysis*.

Proposed Drainage Conditions

The Project is designed to comply with the Massachusetts Stormwater Management Regulations and the City of Newton’s Stormwater Ordinance. The Project results in an approximately 10,000-square foot decrease in impervious area therefore is considered a Redevelopment project per the Stormwater Management Regulations. **Table 2** compares the existing and proposed land use for the Project.

Table 2 - Pre/Post Development Areas

Surface Type	Existing Surface Area Conditions (SF)	Proposed Surface Area Conditions (SF)
Pervious	15,666	25,674
Impervious	140,552	130,544
TOTAL	156,218	156,218

Existing drainage and grading patterns were maintained to the maximum extent possible. Stormwater within the limit of work will be collected by new deep sump hooded catch basins and piped to a subsurface sand filter system located in Brook Drive. The sand filter system is designed to collect and treat stormwater runoff from the entire Project Site, including the proposed buildings, Brook Drive, and Kempton Place. It is equipped with a weir that overflows larger storm events into a drainage pipe that discharges to Cheese Cake Brook that abuts the northern portion of the Project Site.

The sand filter system has been sized to treat the 0.63-inch water quality volume to achieve 65% Total Phosphorus (TP) removal and greater than 80% Total Suspended



Solids (TSS) removal for the proposed impervious areas in compliance with the requirements of the Charles River Total Maximum Daily Load (TMDL) for phosphorus removal and the City of Newton’s requirements relative to the Massachusetts MS4 permit.

As part of the proposed improvements to the Site, pavement area will be reduced, and new landscape features will be constructed therefore reducing the overall impervious area on the Site. The Project Site will reduce the total impervious area used by vehicles since most proposed parking spaces will be located in structured parking garages. The Project will also reconstruct the embankment of Cheese Cake Brook which will substantially improve the conveyance of the stream flow through a modified pipe outfall from the highway and a new pipe to direct runoff from the Project Site and roadway.

Figure 4 illustrates the proposed post construction drainage conditions for the Project. Drainage Area F is composed of the roof, roadway, and surface runoff area between Dunstan Street and the building in the center of the site (Building #2). Drainage Area G/H is composed of the roof, roadway, and surface runoff area including to the east of Building #2. Drainage Area FP is a proposed landscaping and flood storage area that will act as a transition into Cheese Cake Brook. **Table 3** provides a summary of the proposed conditions hydrologic data.

Table 3 – Proposed Conditions Hydrologic Data

Drainage Area	Discharge Location	Design Point	Area (acres)	Curve Number	Time of Concentration (min)
F	Cheese Cake Brook	1L	1.33	93	5
G/H	Cheese Cake Brook	1L	1.90	96	5
FP	Cheese Cake Brook	1L	0.36	71	5

The hydrologic analysis is included within Appendix F - *Hydrological Analysis*.

The Project is proposing a second sand filter system located in Kempton Plan that will provide TP removal and TSS removal from stormwater runoff generated from the abutting areas on Washington Street, conveyed through the existing city drain line located in Kempton. Outlet control structures on the existing drain line are proposed to redirect the runoff during smaller storm events to the proposed sand filter system prior to discharging to the Cheese Cake Brook. This will help treat the municipal and state discharges into the Cheese Cake Brook. The Project will also reorient the MassDOT Outlet into Cheese Cake Brook which will help improve the tailwater conditions and conveyance within the Brook.

The site design integrates a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. The Project is not located within a Critical Area and is not considered a LUHPLL, The proposed stormwater management system provides a benefit to the Site by providing



65% phosphorous removal, greater than 80% TSS removal, a reduction in paved parking surfaces, an increase in pervious areas, and improvements to the conveyance outfalls at the Cheese Cake Brook. Refer to Appendix F for water quality calculations.

Environmentally Sensitive and Low Impact Development (LID) Techniques

Low Impact Development (LID) techniques and stormwater Best Management Practices (BMPs) implemented into the site design include reduction of impervious area and providing new landscaped areas that replace and expand the poorly maintained existing vegetation found within the unpaved areas. In general, stormwater from the proposed impervious surfaces is collected in deep sump hooded catch basins and conveyed through a series of closed drainage pipes and treated in a sand filter system prior to discharging to the Cheese Cake Brook in the northwest corner of the Site.

Floodplain Information / Analysis

The compensatory flood storage was analyzed for the project. The intent was to provide compensatory flood storage incrementally equal or greater between each 1-foot contour interval for filled in areas (i.e. Brook Drive and corresponding pedestrian walkway) working up to the 100-year FEMA flood elevation of 38.6 feet (NAVD 88). **Table 4** has broken out the storage volumes while also providing the total site summary for both the existing and proposed flood plains.

The compensatory flood storage area meets the Newton Conservation Commission's Flood Zone Compensatory Storage Policy (approved on January 30, 2020). As shown in **Table 4**, the proposed development has surpassed the additional ten percent compensatory flood storage capacity by providing over fifty five percent additional storage volume.

The existing flood plain limits have been adjusted throughout the Site due to the redevelopment. The Project has consolidated the flood plain area so that it is located within Brook Drive and the Cheese Cake Brook. **Figure 5** shows the existing and proposed floodplain limits along with the grading adjustments across the Site.

The reconstruction and naturalization of the Cheese Cake Brook's flood storage volume with this Project will achieve the City's goals for reducing flooding and restoring natural stream conveyance to a once problematic drainage channel.



Table 4 - Incremental Flood Storage Comparison

Elevation	Existing Incremental Floodplain Storage (CY)¹	Existing Cumulative Floodplain Storage (CY)¹	Proposed Incremental Floodplain Storage (CY)²	Proposed Cumulative Floodplain Storage (CY)²	Net Incremental Storage Increase (CY)
29-30	0.1	0.1	15.7	15.7	(+) 15.6
30-31	18.2	18.3	120.3	136.0	(+) 102.1
31-32	27.0	45.3	175.0	311.0	(+) 148
32-33	29.8	75.1	219.9	530.9	(+) 190.1
33-34	33.4	108.5	257.2	788.1	(+) 223.8
34-35	75.7	184.2	297.7	1085.8	(+) 222
35-36	299.5	483.7	447.6	1533.4	(+) 148.1
36-37	533.6	1017.3	737.9	2271.3	(+) 204.3
37-38	776.6	1793.9	798.3	3069.6	(+) 21.7
38-38.6	571.6	2365.5	616.7	3686.3	(+) 45.1
TOTAL		2365.5		3686.3	(+) 1320.8 (+55.8%)

1. Existing storage calculated from topographic survey by CPA as of May 18, 2019 below floodplain elevation 38.6 ft
2. Proposed storage calculated from proposed grading by VHB as of April 21, 2020 below floodplain elevation 38.6 ft

Note: Very minor updates to the flood plain storage calculations pending further refinement of the architectural and landscape architectural designs.



Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2. VHB has used NOAA's Atlas 14 precipitation frequency data to estimate the rainfall for the 2-year, 10-year, 25-year, and 100-year 24-hour storm events. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 1 and 3, respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. Drainage areas used in the analyses were described in previous sections and shown on Figures 3 and 4. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

Detailed printouts of the HydroCAD analyses are included in Appendix F. **Table 5** presents a summary of existing and proposed conditions peak discharge rates, indicating there is no increase in peak rates between existing and proposed conditions.



Table 5 – Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	25-year	100-year
Design Point L1: Cheese Cake Brook				
Existing	10.5	17.4	21.7	30.7
Proposed	9.8	16.2	20.4	29.2

The proposed redevelopment reduces approximately 10,000-square feet of impervious area which results in a net decrease in peak rates of runoff discharged from the site under post-development conditions compared to pre-development.

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3 to the maximum extent practicable.

Recharge of stormwater in proposed conditions is achieved by an increase in pervious, landscaped, area of approximately 10,000-square feet. This increase in landscaped, pervious area will promote additional surface recharge, as compared to the minimal opportunity for surface recharge under the existing conditions. Due to existing groundwater conditions and soil conditions, proposed infiltration systems are not feasible for the Project.

Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal of stormwater runoff from all proposed impervious surfaces. This will be achieved through the use of deep sump hooded catch basins connected to a sand filtering system with a large storm bypass.

The proposed closed drainage system meets the Charles River Phosphorus TMDL and MS4 requirement by also removing 65% phosphorus by implementing a sand filtration system sized to capture and treat the 0.63-inch of runoff from the Site. The Project has also implemented a second sand filter that intercepts the drainage runoff from Washington street in order to help mitigate the pollutants into the Cheese Cake Brook.

Computations and supporting information for proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix D.



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

The Project site is not considered a LUHPPL.

Standard 6: Critical Areas

The Project does not discharge to or near a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project results in a reduction of impervious area of approximately 10,000 square feet and is therefore considered a redevelopment per the stormwater Management Regulations, however the Site has been designed to meet the ten Stormwater Management Standards.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each. The redevelopment checklist has been included in Appendix E.

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

The Project will disturb approximately 3.6 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix F.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long-Term Pollution Prevention Plan.

Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures which were part of the previous development on this site are to be completely removed during the site redevelopment. The design plans submitted with this report have been designed in full compliance with current standards. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.





Appendix A

Site Information

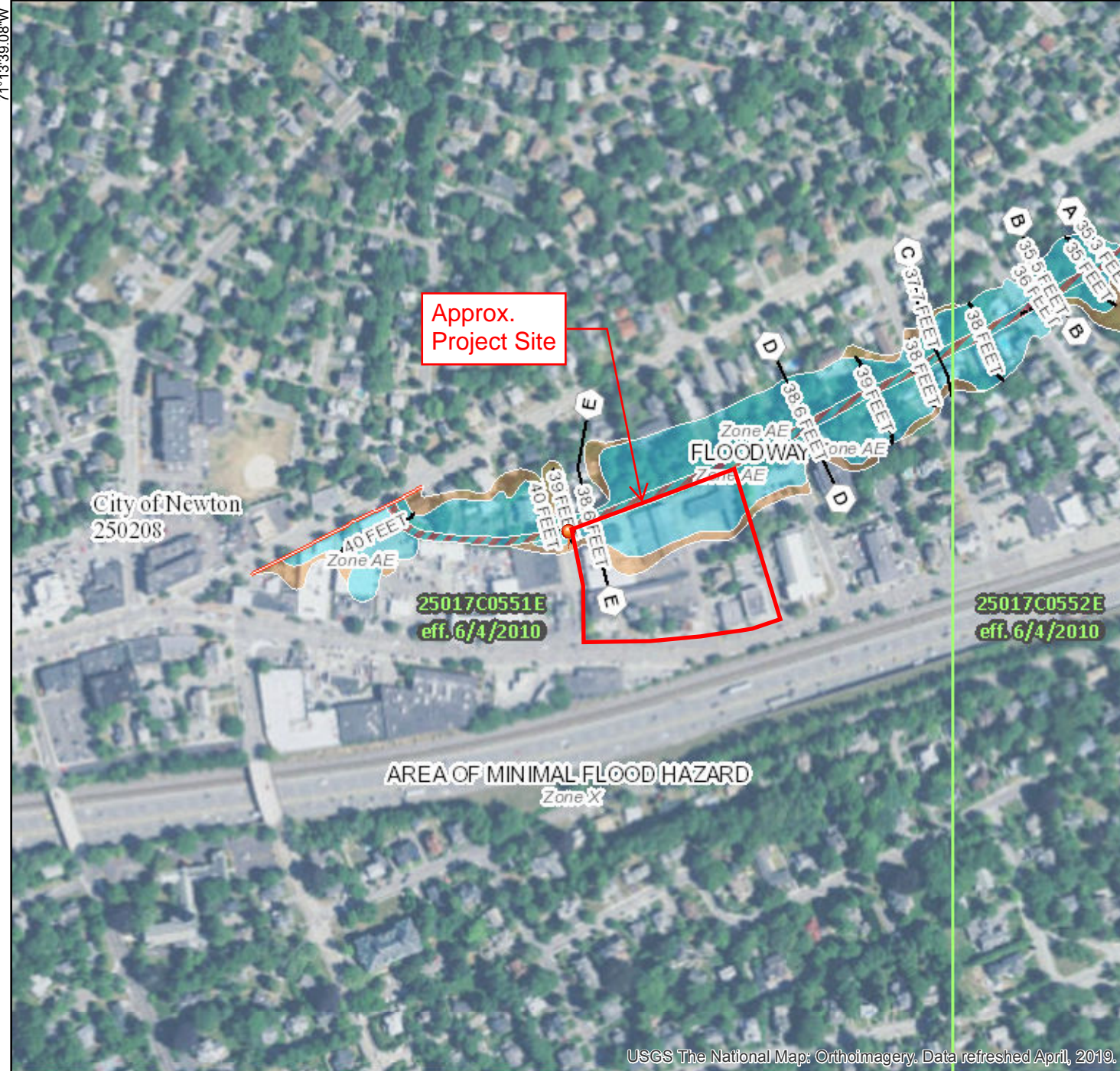
- Site Locus Map
- FEMA Firmette Map
- Existing Drainage Areas
- Proposed Drainage Areas
- Existing/Proposed Floodplain Limit Plan



National Flood Hazard Layer FIRMette



42°21'13.24"N



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
OTHER FEATURES		Levee, Dike, or Floodwall
		Cross Sections with 1% Annual Chance Water Surface Elevation
MAP PANELS		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/14/2019 at 3:01:56 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

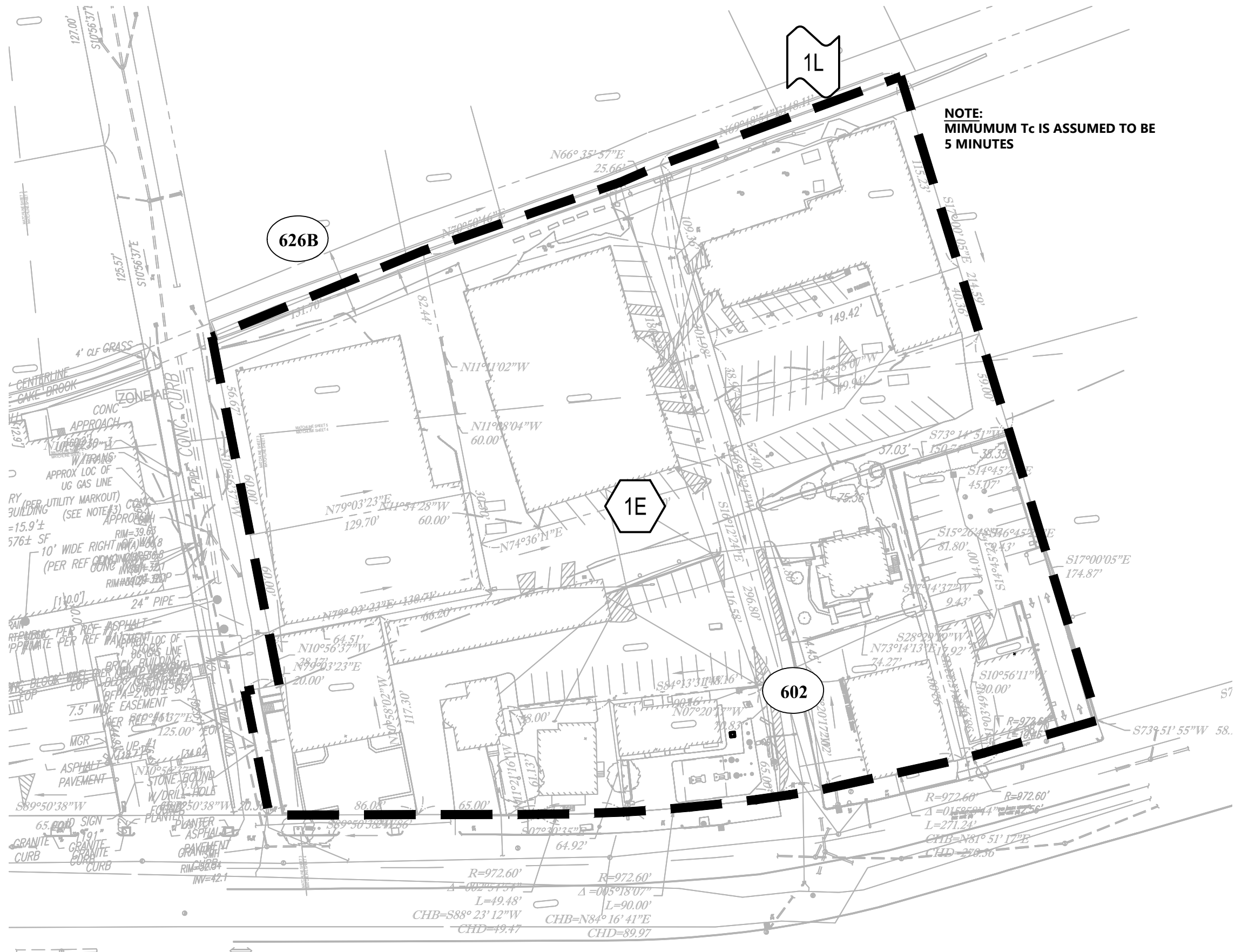
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

USGS The National Map: Orthoimagery. Data refreshed April, 2019.

0 250 500 1,000 1,500 2,000 Feet 1:6,000 42°20'46.65"N

71°13'39.08"W

71°13'1.62"W



Legend

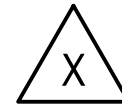
SYMBOLS



DESIGN POINT



DRAINAGE AREA DESIGNATION

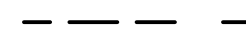


POND

LINETYPES



DRAINAGE AREA BOUNDARY



TIME OF CONCENTRATION FLOW LINE



SOIL TYPE BOUNDARY

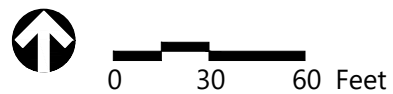


100' BUFFER ZONE

SCS SOIL CLASSIFICATIONS



CANTON-URBAN LAND COMPLEX, 3 TO 15 PERCENT SLOPES, HSG B

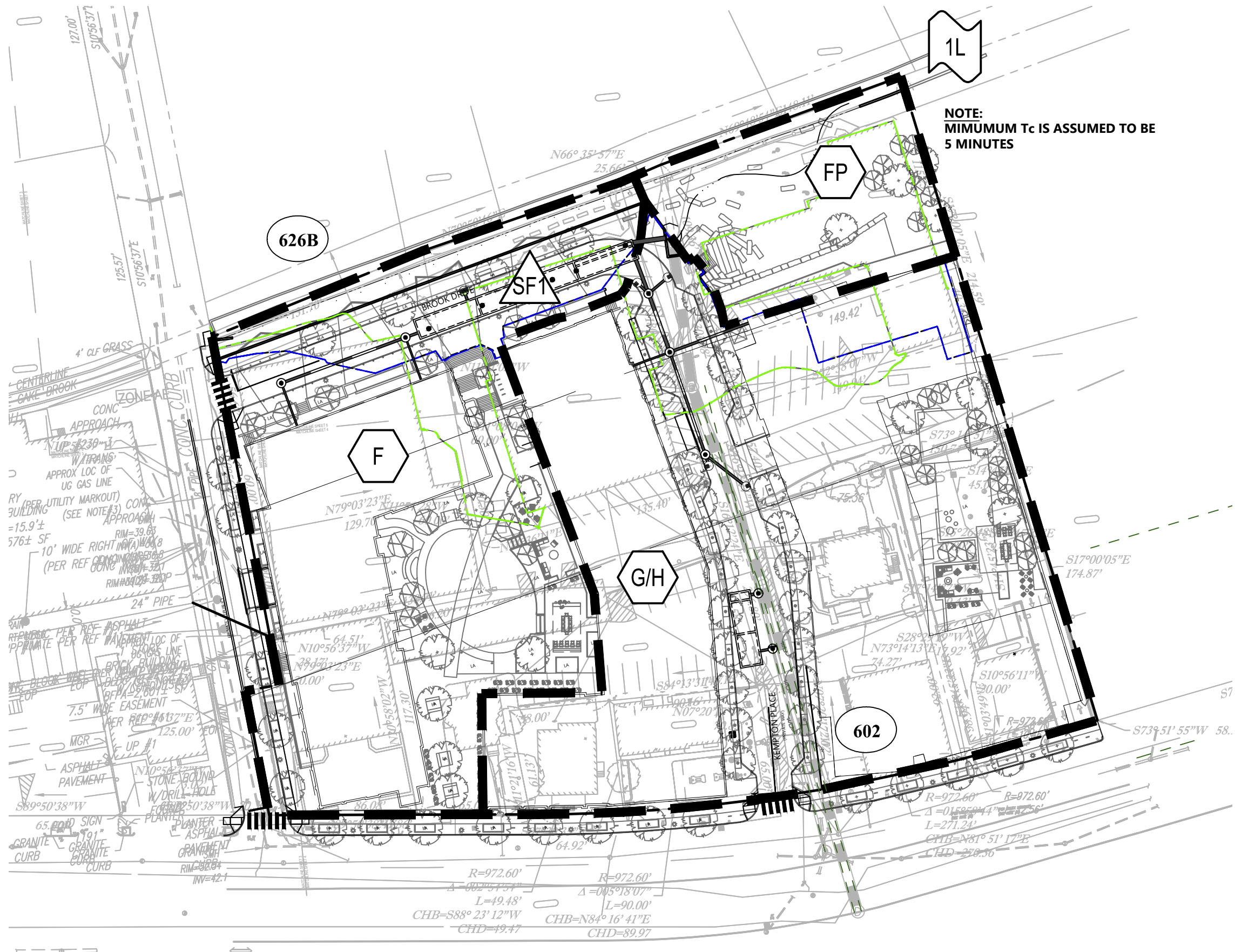


Existing Drainage Conditions

Figure 3

Mark Development
West Newton, MA



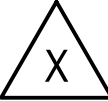
April 2020
Revised May 2021







NOTE:
MIMUMUM Tc IS ASSUMED TO BE
5 MINUTES

Legend

SYMBOLS

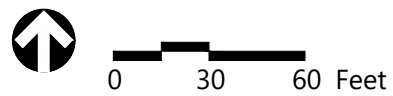
-  DESIGN POINT
-  DRAINAGE AREA DESIGNATION
-  POND

LINETYPES

-  DRAINAGE AREA BOUNDARY
-  TIME OF CONCENTRATION FLOW LINE
-  SOIL TYPE BOUNDARY
-  100' BZ

SCS SOIL CLASSIFICATIONS

-  CANTON-URBAN LAND COMPLEX, 3 TO 15 PERCENT SLOPES, HSG B





Legend

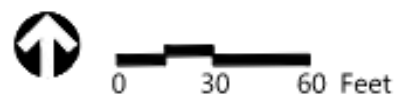
LINETYPES

- - - EXISTING FLOODPLAIN LIMIT
- - - PROPOSED FLOODPLAIN LIMIT

Floodplain Storage Volume Calculations

Elevation	Existing Incremental Floodplain Storage (CY) ¹	Existing Cumulative Floodplain Storage (CY) ¹	Proposed Incremental Floodplain Storage (CY) ²	Proposed Cumulative Floodplain Storage (CY) ²	Net Incremental Storage Increase (CY)
29-30	0.1	0.1	15.7	15.7	(+) 15.6
30-31	18.2	18.3	120.3	136.0	(+) 102.1
31-32	27.0	45.3	175.0	311.0	(+) 148
32-33	29.8	75.1	219.9	530.9	(+) 190.1
33-34	33.4	108.5	257.2	788.1	(+) 223.8
34-35	75.7	184.2	297.7	1085.8	(+) 222
35-36	299.5	483.7	447.6	1533.4	(+) 148.1
36-37	533.6	1017.3	737.9	2271.3	(+) 204.3
37-38	776.6	1793.9	798.3	3069.6	(+) 21.7
38-38.6	571.6	2365.5	616.7	3686.3	(+) 45.1
TOTAL	2365.5		3686.3		(+) 1320.8 (+55.8%)

1. Existing storage calculated from topographic survey by CPA as of May 18, 2019 below floodplain elevation 38.6 ft
 2. Proposed storage calculated from proposed grading by VHB as of April 21, 2020 below floodplain elevation 38.6 ft



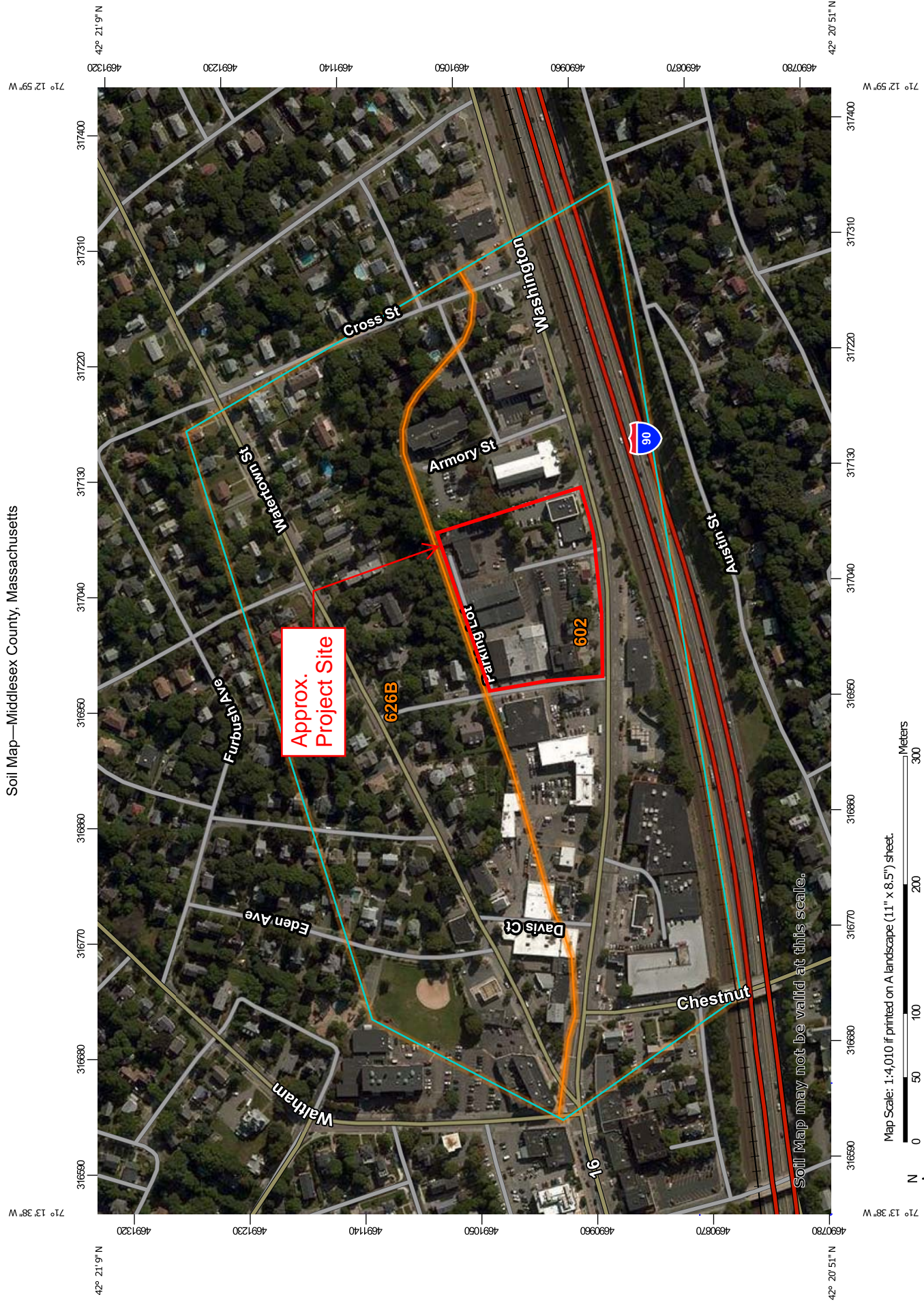


Appendix B

Standard 3 Computations and Supporting Information

- NRCS Web Soil Survey

Soil Map—Middlesex County, Massachusetts



Soil Map may not be valid at this scale.

Map Scale: 1:4,010 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84



MAP LEGEND

- Area of Interest (AOI)
- Area of Interest (AOI)
- Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points
- Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features
- Water Features**
- Streams and Canals
- Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads
- Background**
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
 Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
602	Urban land	24.7	51.3%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	23.4	48.7%
Totals for Area of Interest		48.0	100.0%



Appendix C

Standard 4 & 9 Computations and Supporting Information

- StormCAD Pipe Sizing Report
- Water Quality Volume Calculations
- TSS Removal Worksheets
- Phosphorus Removal Calculations
- Sand Filter System Sizing
- Operation & Maintenance Plan



StormCAD Pipe Sizing Report

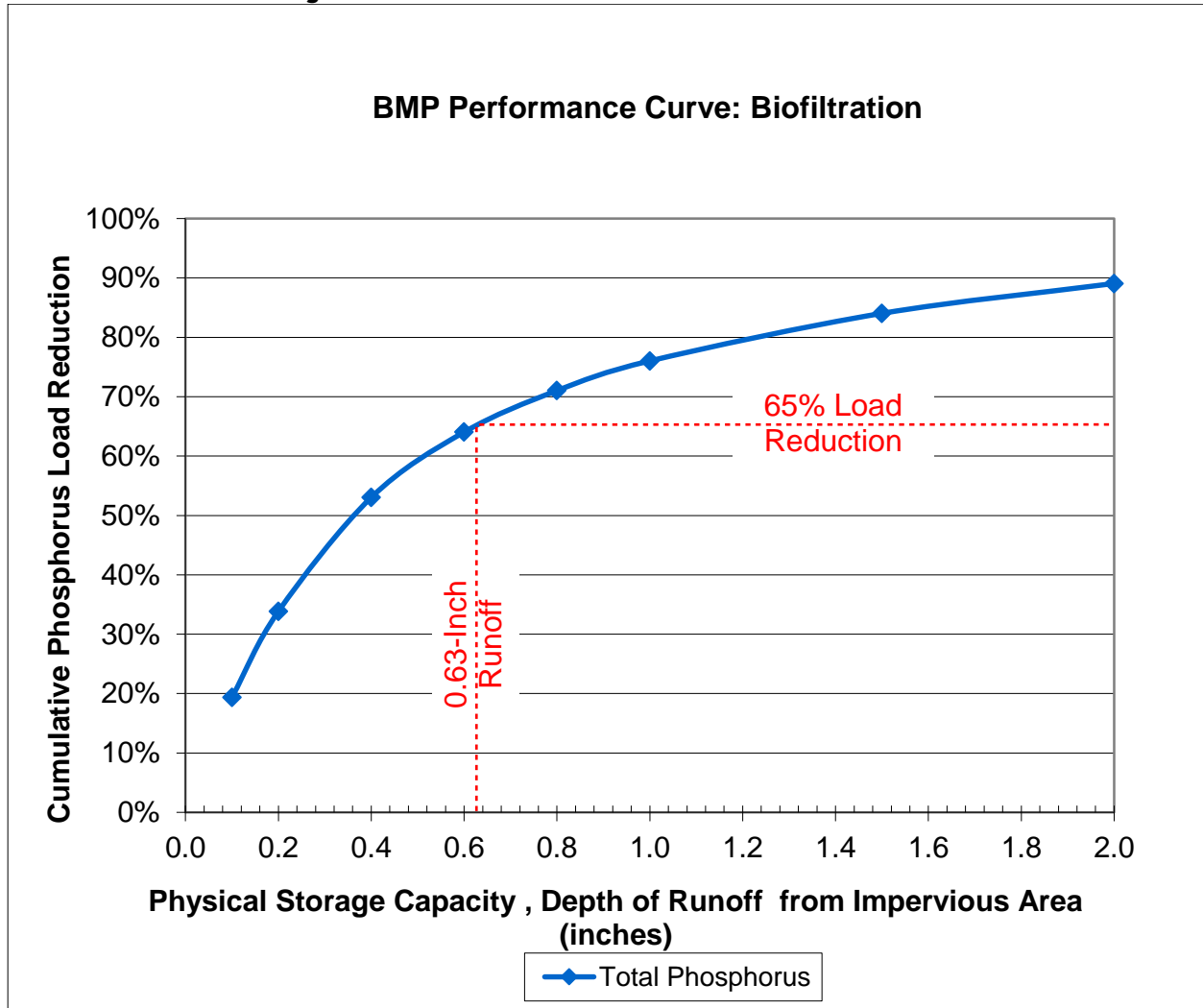


Water Quality Volume Calculations

Table 3- 16: Biofiltration BMP Performance Table

Biofiltration BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	19%	34%	53%	64%	71%	76%	84%	89%

Figure 3- 13: BMP Performance Curve: Biofiltration



Impervious Area	57,502 Building F	WQV	3,019 Building F
	82,956 Building G/H		4,355 Building G/H
	15,665 Washington St		822 Washington St



TSS Removal Worksheets



VHB, Inc.
 101 Walnut Street
 Post Office Box 9151
 Watertown, MA 02471
 P 617.924.1770

TSS Removal Calculation Worksheet

Project Name: **Washington Street Mixed-Us**
 Project Number: **14517.00**
 Location: **Newton, MA**
 Discharge Point: _____
 Drainage Area(s): _____

Sheet: **1 of 1**
 Date: **23-Apr-2020**
 Computed by: **OMW**
 Checked by: **HH**

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
Sand Filter	80%	0.75	0.60	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
 Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).

** Equals remaining load from previous BMP (E)

*** Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 80% removal is used for this calculation (Change name of device and the claimed removal rate shown on the calc. sheet. Remove this sentence if not applicable).

**Treatment Train
 TSS Removal =**

85%



Phosphorus Removal Calculations



Phosphorus Loading - Existing Conditions

Project Name: Dunstan East Mixed-Use Redevelopment

Proj. No.: 14517.00

Project Location: Newton, MA

Date: May 2021

Calculated by: DBL

Checked by:

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area** (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)
Commercial (Development)	Directly Connected	2.32	3.23	7.49	7.54
	Impervious Pervious (HGS B)	0.12	0.36	0.04	
Totals =			3.59	---	7.54

* Per MA MS4 General Permit, Table 3-1, Average Annual Distinct Phosphorus Load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit.

** Site Area includes only the proposed area of redevelopment and excludes the MBTA Rail Yard



Phosphorus Loading to BMPs - Proposed Conditions

Project Name: Dunstan East Mixed-Use Redevelopment
Project Location: Newton, MA

Proj. No.: 14517.00
Date: May 2021
Calculated by: DBL
Checked by:

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)	Phosphorous Removal	Total Phosphorus Removal (lb/yr)
1S	Impervious (High-Density Residential)	2.32	3.00	6.96	7.03	65%	4.57
	Pervious (HGS B)	0.12	0.59	0.07			
Totals =			3.59	---	7.03	---	4.57

Existing Phosphorus Load	7.54
Proposed Phosphorus Load	7.03
<u>Total Phosphorus Removed</u>	<u>4.57</u>
	<u>65%</u>

* Per MA MS4 General Permit, Table 3-1, Average Annual Distinct Phosphorus Load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit.



Weighted Phosphorous Removal Calculation

Project Name: Dunstan East Mixed-Use Redevelopment
Project Location: Newton, MA

Proj. No.: 14517.00
Date: May 2021
Calculated by: DBL
Checked by:

Subcatchment Number	Impervious Area (ac)	Infiltration Rate (in/hr)	Phosphorous Removal	A x PR
1S	3.00	0.00	65%	1.95
Totals =	3.00		---	1.95

Weighted Phosphorous Removal: $S(AxPR) / SA =$ **65.0%**

Note: Phosphorous removal based on EPA "Stormwater Best Management Practices (BMP) Performance Analysis" assuming commercial and high density land uses. Refer to BMP Sizing Calculations for total phosphorous removal percentages by BMP type.



Sand Filter Sizing Calculations



Computations

Project:	<u>Dunstan East</u>	Project #	<u>14517.00</u>
Location:	<u>Newton, MA</u>	Sheet	<u>1 of 2</u>
Calculated by:	<u>DBL</u>	Date:	<u>5-May-21</u>
Checked by:	<u></u>	Date:	<u></u>
Title	<u>Sand Filter Sizing Calculations - Revised</u>		

Sedimentation Chamber Sizing (Sand Filter 1)

$$A_s = -Q/W \ln(1-E)$$

A_s = sedimentation surface area (ft²)

Q = discharge rate from drainage area (ft³/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

(West Side)

WQV = 2,445 ft³
 Q = 0.028 ft³/s
 W = 0.0004 ft/s
 E = 0.9

$A_s = 162.9 \text{ ft}^2$

(East Side)

WQV = 4,287 ft³
 Q = 0.050 ft³/s
 W = 0.0004 ft/s
 E = 0.9

$A_s = 285.6 \text{ ft}^2$

$A_s \text{ Provided} = 390 \text{ ft}^2$ (10' x 39')

$A_s \text{ Provided} = 292.5 \text{ ft}^2$ (7.5' x 39')

Filter Bed Sizing (Sand Filter 1)

(sediment chamber is combined for total flow)

$$A_f = (WQV \times d) / kt(h+d)$$

A_f = filter bed surface area (ft²)

WQV = water quality volume (ft³)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day)

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm

WQV = 6,732 ft³
 d = 1.5 ft
 k = 4 ft/day
 t = 1 day
 h = 2.70 ft

$A_f = 601.1 \text{ ft}^2$

$A_f \text{ Provided} = 610 \text{ ft}^2$

Water Quality Volume Storage Check

(Following Georgia Stormwater Management Manual)

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$\text{WQV} = 6,732 \text{ ft}^3$$

$$\mathbf{75\% \text{ WQV} = 5,049 \text{ ft}^3}$$

V_s = volume within sedimentation chamber below the top of the sand media

V_t = volume within the voids in the filter bed (assume 40% voids)

V_{temp} = temporary volume stored above the filter bed and low flow weir

A_f = provided filter bed surface area (ft^2)

A_s = provided sedimentation surface area (ft^2)

d = filter bed depth (ft)

h_f = average height of water above filter bed during water quality design storm

h_s = height of sedimentation chambers below top of sand media

$$V_s = A_s * h_s$$

$$A_s = 682.5 \text{ ft}^2$$

$$h_s = 2 \text{ ft}$$

$$\mathbf{V_s = 1,365 \text{ ft}^3}$$

$$V_t = A_f * d * 0.4$$

$$A_f = 610 \text{ ft}^2$$

$$d = 1.5 \text{ ft}$$

$$\mathbf{V_t = 366 \text{ ft}^3}$$

$$V_{\text{temp}} = (A_f + A_s) * h_f$$

$$A_f = 610 \text{ ft}^2$$

$$A_s = 682.5 \text{ ft}^2$$

$$h_f = 2.70 \text{ ft}$$

$$\mathbf{V_{\text{temp}} = 3,490 \text{ ft}^3}$$

$$\text{Total Provided WQV} = V_s + V_t + V_{\text{temp}}$$

$$\mathbf{\text{Total WQV} = 5,221 \text{ ft}^3 > 5,049 \text{ ft}^3 \text{ Required}}$$



Computations

Project:	<u>Dunstan East</u>	Project #	<u>14517.00</u>
Location:	<u>Newton, MA</u>	Sheet	<u>3 of 4</u>
Calculated by:	<u>PTM</u>	Date:	<u>10-Jun-20</u>
Checked by:	<u></u>	Date:	<u></u>
Title	<u>Sand Filter Sizing Calculations</u>		

Sedimentation Chamber Sizing (Sand Filter 2)

$$A_s = -Q/W \ln(1-E)$$

A_s = sedimentation surface area (ft²)

Q = discharge rate from drainage area (ft³/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

$$WQV = 1,137 \text{ ft}^3$$

$$Q = 0.013 \text{ ft}^3/\text{s}$$

$$W = 0.0004 \text{ ft/s}$$

$$E = 0.9$$

$$A_s = 75.8 \text{ ft}^2$$

$$A_s \text{ Provided} = 198 \text{ ft}^2$$

Filter Bed Sizing (Sand Filter 2)

$$A_f = (WQV \times d) / kt(h+d)$$

A_f = filter bed surface area (ft²)

WQV = water quality volume (ft³)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day)

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm

$$WQV = 1,137 \text{ ft}^3$$

$$d = 1.5 \text{ ft}$$

$$k = 4 \text{ ft/day}$$

$$t = 1 \text{ day}$$

$$h = 0.90 \text{ ft}$$

$$A_f = 177.7 \text{ ft}^2$$

$$A_f \text{ Provided} = 198 \text{ ft}^2$$

Water Quality Volume Storage Check

(Following Georgia Stormwater Management Manual)

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$\text{WQV} = 1,137 \text{ ft}^3$$

$$\text{75\% WQV} = \mathbf{853 \text{ ft}^3}$$

V_s = volume within sedimentation chamber below the top of the sand media

V_t = volume within the voids in the filter bed (assume 40% voids)

V_{temp} = temporary volume stored above the filter bed and low flow weir

A_f = provided filter bed surface area (ft^2)

A_s = provided sedimentation surface area (ft^2)

d = filter bed depth (ft)

h_f = average height of water above filter bed during water quality design storm

h_s = height of sedimentation chambers below top of sand media

$$V_s = A_s * h_s$$

$$A_s = 198.0 \text{ ft}^2$$

$$h_s = 2 \text{ ft}$$

$$\mathbf{V_s = 396 \text{ ft}^3}$$

$$V_t = A_f * d * 0.4$$

$$A_f = 198 \text{ ft}^2$$

$$d = 1.5 \text{ ft}$$

$$\mathbf{V_t = 118.8 \text{ ft}^3}$$

$$V_{\text{temp}} = (A_f + A_s) * h_f$$

$$A_f = 198 \text{ ft}^2$$

$$A_s = 198.0 \text{ ft}^2$$

$$h_f = 0.90 \text{ ft}$$

$$\mathbf{V_{\text{temp}} = 356 \text{ ft}^3}$$

$$\text{Total Provided WQV} = V_s + V_t + V_{\text{temp}}$$

$$\text{Total WQV} = \mathbf{871 \text{ ft}^3} > \mathbf{853 \text{ ft}^3 \text{ Required}}$$



Operation & Maintenance Plan



Operation & Maintenance Plan

This Operation and Maintenance Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Description of Pollutant Sources

The Project Site consists of three multi-story mixed-use buildings, and subsequent parking along the north side of Washington Street between Dunston Street and Kempton Place in Newton, Massachusetts. The Site lies within the Charles River Watershed, and is bounded by the Cheese Cake Brook to the north.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum asphalt pavement areas semi-annually with a commercial cleaning unit and dispose of removed material.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.



- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- Pet waste provision if applicable.

Management of Snow and Ice

Storage and Disposal

Snow shall be removed from the site shortly after snow events. The standard pavement surfaces will be sanded, and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.
- Do not stockpile snow on permeable pavement surfaces. Sand and grit in snow will clog pavement.
- Plow parking areas paved with permeable asphalt pavement carefully. Plow blades should be set approximately 1" higher than usual to avoid scarring the pavement and loosening material that could potentially clog surface pores.
- Do not apply abrasives such as sand or grit on or adjacent to permeable asphalt pavement.
- Monitor application rates of deicing materials on permeable pavement areas and reduce application rate accordingly. Permeable pavements tend to require less deicer per unit area because the water is not required to remain liquid over the entire parking surface area before discharge.
- Do not apply abrasives such as sand or grit on or adjacent to permeable pavers.
- Avoid plowing of areas with permeable pavers.



Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Specific environmentally sensitive areas, including the 100' buffer zone, should be designated as no and/or reduced salt areas.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials



Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

FACILITY MANAGER

Name: _____ Home Phone: _____
Phone: _____ E-mail: _____

CONSTRUCTION MANAGER

Name: _____ Home Phone: _____
Phone: _____ E-mail: _____

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.



Emergency Notification Phone Numbers

1. FACILITY MANAGER

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

ALTERNATE

Name: _____ Home Phone: _____

Phone: _____ E-mail: _____

2. FIRE DEPARTMENT

Emergency: 911

Business: (617) 796-2210

POLICE DEPARTMENT

Emergency: 911

Business: (617) 796-2107

3. CLEANUP CONTRACTOR:

Address: _____

Phone: _____

4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

Emergency: _____

Northeast Region – Wilmington Office: (978) 694-3200

5. NATIONAL RESPONSE CENTER

Phone: (800) 424-8802

ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY

Emergency: _____

Business: _____

6. CONSERVATION COMMISSION

Contact: Jennifer Steel

Phone: (617) 796-1120

BOARD OF HEALTH

Contact: Deborah Youngblood, PhD

Phone: (617) 796-1420



Hazardous Waste / Oil Spill Report

Date _____ Time _____ AM / PM

Exact location (Transformer #) _____

Type of equipment _____ Make _____ Size _____

S / N _____ Weather Conditions _____

On or near Water Yes If Yes, name of body of Water _____

No

Type of chemical/oil spilled _____

Amount of chemical/oil spilled _____

Cause of Spill _____

Measures taken to contain or clean up spill _____

Amount of chemical/oil recovered _____ Method _____

Material collected as a result of cleanup:

_____ Drums containing _____

_____ Drums containing _____

_____ Drums containing _____

Location and method of debris disposal

Name and address of any person, firm, or corporation suffering damages:

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring:

Spill reported to General Office by _____ Time _____ AM / PM

Spill reported to DEP / National Response Center by _____

DEP Date _____ Time _____ AM / PM Inspector _____

NRC Date _____ Time _____ AM / PM Inspector _____

Additional comments: _____



Assessment - Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department	<u>911</u>
Municipality Health Department	<u>(617) 796-1420</u>
Municipality Conservation Commission:	<u>(617) 796-1120</u>



Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies		Recommended Suppliers
SORBENT PILLOWS/"PIGS"	2	http://www.newpig.com
SORBENT BOOM/SOCK	25 FEET	Item # KIT276 — mobile container with two pigs,
SORBENT PADS	50	26 feet of sock, 50 pads, and five pounds of
LITE-DRI® ABSORBENT	5	absorbent (or equivalent)
POUNDS		http://www.forestry-suppliers.com
SHOVEL	1	Item # 43210 — Manhole cover pick (or
PRY BAR	1	equivalent)
GOGGLES	1 PAIR	Item # 33934 — Shovel (or equivalent)
GLOVES – HEAVY	1 PAIR	Item # 90926 — Gloves (or equivalent)
		Item # 23334 — Goggles (or equivalent)



Stormwater Operation and Maintenance Plan

Project Information

Site

Dunstan East Mixed-Use Redevelopment
Washington Street
Newton, MA

Owner

Mark Development, LLC
275 Grove Street
Suite 2-150
Newton, MA 02466
(617) 614-9149

Site Supervisor

Site Manager Name
Site Manager Address
Site Manager City, State Zip
Site Manager Phone Number

Name: _____

Telephone: _____

Cell phone: _____

Email: _____



Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

Catch Basins

- All catch basins shall be inspected and as necessary at least four times a year and at the end of the foliage and snow removal seasons.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Roof Drain Leaders

- Perform routine roof inspections quarterly.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.
- Clean inlets draining to the subsurface bed twice per year as necessary.

Sand Filter System

- Eroded or barren spots should be reestablished immediately after inspection to prevent additional erosion and accumulation of sediment.
- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Sand Filter Systems should be inspected at least twice a year to ensure proper filtration and function.
- Vacuum trucks shall be used to remove and replace the top few inches of clogged sand as necessary to provide adequate infiltration.



Appendix D

Standard 7 Supporting Information

- Redevelopment Checklist

Chapter 3

Checklist for Redevelopment Projects

Standard 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 stormwater 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 is defined to include

- Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving;
- Development rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area; and
- Remedial projects specifically designed to provide improved stormwater management, such as projects to separate storm drains and sanitary sewers, and stormwater retrofit projects.

Components of redevelopment projects that include development of previously undeveloped sites do not meet this definition. The portion of the project located in a previously developed area must meet Standard 7, but project components within undeveloped areas must meet all the Standards.

MassDEP recognizes that site constraints often make it difficult to comply with all the Standards at a redevelopment site. These constraints are as follows:

Lack of space. Because of the presence of existing structures, on-site subsurface sewage disposal systems, stormwater best management practices, and water bodies and wetlands, and easements, the space available for the installation of additional stormwater BMPs may be quite limited. On many sites it may be difficult or impossible to use space-intensive BMPs such as wet detention basins.

Soils: The presence of bedrock or clay can limit the effectiveness of infiltration or detention BMPs. Often soils at redevelopment sites have been compacted by buildings and heavy traffic, impairing their ability to infiltrate stormwater into the ground.

Underground utilities. The presence of underground utilities including gas and water mains, sewer pipes and electric cable conduits can greatly reduce the amount of land available for BMPs.

This chapter provides specific guidance and checklists to ensure that the applicant has met his/her obligations under Standard 7. Because it may be difficult for a redevelopment project to comply with all the Stormwater Management Standards, Standard 7 provides that a redevelopment project is required to comply with the following Standards only “to the maximum extent practicable”: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing outfalls shall be brought into compliance with Standard 1 only to the maximum extent practicable.

As set forth in Standard 7, the phrase “to the maximum extent practicable” means that:

- (1) Proponents of redevelopment projects have made all reasonable efforts to meet the requirements of Standards 2 and 3 and the pretreatment and structural stormwater best management practices requirements of Standards 4, 5, and 6 and to bring existing outfalls into compliance with Standard 1.
- (2) They have made a complete evaluation of possible stormwater management measures, including environmentally sensitive site design that minimizes land disturbance and impervious surfaces, low impact development techniques and structural stormwater BMPs; and
- (3) If not in full compliance with Standard 1 for existing outfalls, Standards 2 and 3 and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6, they are implementing the highest practicable level of stormwater management.

Generally, an alternative is practicable if it can be implemented within the site being redeveloped, taking into consideration cost, land area requirements, soils and other site constraints. However, offsite alternatives may also be practicable. Proponents must document the evaluation of practicable alternatives with sufficient information to support the conclusions of the analysis.

At the same time, stormwater runoff from redevelopment projects must be properly managed. To this end, Standard 7 provides that redevelopment projects shall comply with all other requirements of the Stormwater Management Standards, including, without limitation, the pollution prevention requirements of Standards 4, 5, and 6, the erosion and sedimentation control requirements of Standard 8, the operation and maintenance requirements of Standard 9, and the prohibition of illicit discharge set forth in Standard 10. Proponents must also improve existing conditions.

Proponents of redevelopment projects shall document their compliance with these requirements. To assist proponents and reviewers in determining whether a redevelopment project complies with Standard 7, MassDEP has prepared the following redevelopment checklist.

[Proponents of MassHighway redevelopment projects and Conservation Commissions reviewing such projects may follow the guidelines for redevelopment provided in the MassHighway Stormwater Handbook for Highways and Bridges (May 2004 or latest version) in lieu of the guidance set forth in this chapter.¹ The MassHighway Stormwater Handbook was developed by the Massachusetts Highway Department and issued by joint correspondence of May 7, 2004 by MassHighway and MassDEP. It provides detailed guidance on the evaluation and implementation of stormwater management practices for MassHighway road and bridge redevelopment projects, including a methodology for screening and selecting Best Management Practices (BMPs). Proponents and reviewers of other public roadway redevelopment projects may find useful information in the MassHighway Stormwater Handbook.]

¹ The MassHighway Handbook published in 2004 must be revised to make it consistent with this Handbook.

Redevelopment Checklist

Existing Conditions

- On-site: For all redevelopment projects, proponents should document existing conditions, including a description of extent of impervious surfaces, soil types, existing land uses with higher potential pollutant loads, and current onsite stormwater management practices.
Existing Conditions are included
- Watershed: Proponents should determine whether the project is located in a watershed or subwatershed, where flooding, low streamflow or poor water quality is an issue.
Existing and proposed floodplains associated with the Cheese Cake Brook are shown on the plans.

The Project

Is the project a redevelopment project?

- Maintenance and improvement of existing roadways - **Yes**
- Development of rehabilitation, expansion or phased project on redeveloped site, or - **Yes**
- Remedial stormwater project – **Yes**

For non-roadway projects, is any portion of the project outside the definition of redevelopment?

- Development of previously undeveloped area - **No**
- Increase in impervious surface - **No**

If a component of the project is not a redevelopment project, the proponent shall use the checklist set forth below to document that at a minimum the proposed stormwater management system fully meets each Standard for that component. The proponent shall also document that the proposed stormwater management system meets the requirements of Standard 7 for the remainder of the project.

The Stormwater Management Standards

The redevelopment checklist reviews compliance with each of the Stormwater Management Standards in order.

Standard 1: (Untreated discharges)

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

Same rule applies for new developments and redevelopments.

Full compliance with Standard 1 is required for new outfalls.

- What BMPs are proposed to ensure that all new discharges associated with the discharge are adequately treated? – **Deep Sump Catch Basins with Hoods and Subsurface Sand Filters**

- What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth? – **Deep Sump Catch Basins with Hoods and Subsurface Sand Filters, with appropriate erosion control measures and stream restoration at proposed headwalls.**
- Will the proposed discharge comply with all applicable requirements of the Massachusetts Clean Waters Act and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00? - **Yes**

Existing outfalls shall be brought into compliance with Standard 1 to the maximum extent practicable.

- Are there any existing discharges associated with the redevelopment project for which new treatment could be provided? – **Yes, and sand filters are proposed**
- If so, the proponent shall specify the stormwater BMP retrofit measures that have been considered to ensure that the discharges are adequately treated and indicate the reasons for adopting or rejecting those measures. (See Section entitled “Retrofit of Existing BMPs”.)
- **Proposing Sand Filters to treat Kempton Place prior to discharging to the Cheese Cake Brook**
- What BMPs have been considered to prevent erosion from existing stormwater discharges?
- **Erosion control, dissipation pads, new low points, and stream restoration at the proposed headwalls, allowing the flow from the headwalls to spread and prevent erosion to prevent flow directly into the Cheese Cake Brook**

Standard 2: (Peak rate control and flood prevention)

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage.

Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 2, comparing post-development to pre-development conditions? - **Yes**
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard. (See Menu of Strategies to Reduce Runoff and Peak Flows and/or Increase Recharge Menu included at the end of this chapter.)

Improvement of existing conditions:

- Does the project reduce the volume and/or rate of runoff to less than current estimated conditions? Has the applicant considered all the alternatives for reducing the volume and/or rate of runoff from the site? (See Menu.) - **Yes**
- Is the project located within a watershed subject to damage by flooding during the 2-year or 10-year 24-hour storm event? If so, does the project design provide for attenuation of the 2-year and 10-year 24-hour storm event to less than current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 2 year or 10 year 24 hour storm event? (See Menu.) - **Yes**
- Is the project located adjacent to a water body or watercourse subject to adverse impacts from flooding during the 100-year 24-hour storm event? If so, are portions of the site available to increase flood storage adjacent to existing Bordering Land Subject to Flooding (BLSF)? - **Yes**
- Have measures been implemented to attenuate peak rates of discharge during the 100-year 24-hour storm event to less than the peak rates under current estimated conditions? Have measures

been implemented to reduce the volume of runoff from the site resulting from the 100-year 24-hour storm event? (See Menu.) - **Yes**

Standard 3: (Recharge to Ground water)

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, 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.

Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 3, comparing post-development to pre-development conditions? - **No**
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard? - **Standard won't be met due to groundwater depth**
- What soil types are present on the site? Is the site is comprised solely of C and D soils and bedrock at the land surface?
- Does the project include sites where recharge is proposed at or adjacent to an area classified as contaminated, sites where contamination has been capped in place, sites that have an Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater, pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.0000; sites that are the location of a solid waste landfill as defined in 310 CMR 19.000; or sites where groundwater from the recharge location flows directly toward a solid waste landfill or 21E site?²
- Is the stormwater runoff from a land use with a higher potential pollutant load? - **No**
- Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply? - **N/A**
- Does the site have an infiltration rate greater than 2.4 inches per hour? - **No**

Improvements to Existing Conditions:

- Does the project increase the required recharge volume over existing (developed) conditions? If so, can the project be redesigned to reduce the required recharge volume by decreasing impervious surfaces (make building higher, put parking under the building, narrower roads, sidewalks on only one side of street, etc.) or using low impact development techniques such as porous pavement? - **Yes: more pervious area is proposed, trees and landscaping improvements, no infiltration proposed under existing conditions, proposing sand filter BMPs.**
- Is the project located within a basin or sub-basin that has been categorized as under high or medium stress by the Massachusetts Water Resources Commission, or where there is other evidence that there are rivers and streams experiencing low flow problems? If so, have measures been considered to replace the natural recharge lost as a result of the prior development? (See Menu.)
- Has the applicant evaluated measures for reducing site runoff? (See Menu.) - **Yes**

Standard 4: (80% TSS Removal)

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

² A mounding analysis is needed if a site falls within this category. See Volume 3.

- 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 BMPs 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.*

Full compliance for any component that is not a redevelopment

Full compliance with the long-term pollution plan requirement for new developments and redevelopments. – **Project Complies**

- Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4? - **Yes**
- Does the pollution prevention plan include the following source control measures? - **Yes**
 - Street sweeping
 - Proper management of snow, salt, sand and other deicing chemicals
 - Proper management of fertilizers, herbicides and pesticides
 - Stabilization of existing eroding surfaces

Compliance to the Maximum Extent Practicable for the other requirements:

- Does the redevelopment design provide for treatment of all runoff from existing (as well as new) impervious areas to achieve 80% TSS removal? If 80% TSS removal is not achieved, has the stormwater management system been designed to remove TSS to the maximum extent practicable? - **Yes**
- Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume? – **N/A**
 - One inch rule applies for discharge
 - within a Zone II or Interim Wellhead Protection Area,
 - near or to another critical area,
 - from a land use with a higher potential pollutant load
 - to the ground where the infiltration rate is greater than 2.4 inches per hour
- Has adequate pretreatment been proposed? - **N/A**
 - 44% TSS Removal Pretreatment Requirement applies if:
 - Stormwater runoff is from a land use with a higher potential pollutant load
 - Stormwater is discharged
 - To the ground within the Zone II or Interim Wellhead Protection Area of a Public Water Supply
 - To the ground with an infiltration rate greater than 2.4 inches per hour
 - Near or to an Outstanding Resource Water, Special Resource Water, Cold-Water Fishery, Shellfish Growing Area, or Bathing Beach.
- If the stormwater BMPs do not meet all the requirements set forth above, the applicant shall document an analysis of alternative approaches for meeting the these requirements. (See Section on Retrofitting Existing BMPs (the “Retrofit Section”). – **N/A**

Improvements to Existing Conditions:

- Have measures been provided to achieve at least partial compliance with the TSS removal standard? - **Fully Complies**
- Have any of the best management practices in the Retrofit Section been considered? – **N/A**
- Have any of the following pollution prevention measures been considered? - **Yes**

- Reduction or elimination of winter sanding, where safe and prudent to do so
- Tighter controls over the application of fertilizers, herbicides, and pesticides
- Landscaping that reduces the need for fertilizer, herbicides and pesticides
- High frequency sweeping of paved surfaces using vacuum sweepers
- Improved catch basin cleaning
- Waterfowl control programs
- Are there any discharges (new or existing) to impaired waters? If so, see TMDL section. – **Site has TMDL phosphorous removal requirements, with which Project complies.**

Standard 5 (Higher Potential Pollutant Loads (HPPL) - N/A

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 stormwater BMPs determined by the Department to be suitable for such use 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.

Full compliance for any component that is not a redevelopment.

Full compliance with pollution prevention requirements for new developments and redevelopments.

Pollution Prevention

- Has the proponent considered any of the following operational source control measures?
 - Formation of a pollution prevention team,
 - Good housekeeping practices,
 - Preventive maintenance procedures,
 - Spill prevention and clean up,
 - Employee training, and
 - Regular inspection of pollutant sources.
- Has the proponent considered implementation of any of the following operational changes to reduce the quantity of pollutants on site?
 - Process changes,
 - Raw material changes,
 - Product changes, or
 - Recycling.
- Has the proponent considered making capital improvements to protect the land uses with higher potential pollutant loads from exposure to rain, snow, snow melt, and stormwater runoff?
 - Enclosing and/or covering pollutant sources (e.g. placing pollutant sources within a building or other enclosure, placing a roof over storage and working areas, placing tarps under pollutant source)
 - Installing a containment system with an emergency shutoff to contain spills?
 - Physically segregating the pollutant source to prevent run-on of uncontaminated stormwater?

Treatment

- If applicable, compliance with the treatment and pretreatment requirements of Standard 5 only to the Maximum Extent Practicable by directing the stormwater runoff from land uses with higher potential pollutant loads to appropriate stormwater BMPs?
 - Are the BMPs selected capable of removing the pollutants associated with the higher potential pollutant load land (“LUHPPL”) use?
 - Is the land use likely to generate stormwater with high concentrations of oil and grease? If so has an oil grit separator, sand filter, filtering bioretention area or equivalent been proposed for pretreatment?

Improvement of Existing Conditions.

- If the redevelopment converts a site from a non-LUHPPL use to a LUHPPL use, the applicant shall document how the stormwater BMPs shall be modified or replaced to come into compliance with Standard 5.
- What specific measures have been considered to offset the anticipated impacts of land uses with higher potential pollutant loads?
- If the redevelopment proposal is a brownfield project, the applicant shall demonstrate how the stormwater management measures have been designed to prevent mobilization or remobilization of soil and groundwater contamination. (See Brownfield section)

Other Requirements

- Does the discharge comply with all applicable requirements of the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?

Standard 6 (Critical Areas) - N/A

Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, 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 or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A “stormwater 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 the public water supply.

Full compliance for component of project that is not a redevelopment

Full compliance with pollution prevention requirements for new developments and redevelopments.

If applicable, compliance to the Maximum Extent Practicable with the pretreatment and treatment requirements of Standard 6:

- Does the redevelopment project utilize the pretreatment, treatment and infiltration BMPs approved for discharges near or to critical areas?

- If the redevelopment project does not comply with Standard 6, the applicant shall document an analysis of alternative measures for meeting Standard 6. (See Section on Specific Redevelopment Projects.)

Improvements to Existing Conditions:

- Have measures to protect critical areas been considered, including additional pollution prevention measures and structural and non-structural BMPs?

Other Requirements

- Does the discharge comply with the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00, and 314 CMR 5.00?

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), must be developed and implemented.

All redevelopment projects shall fully comply with Standard 8.

- Has the proponent submitted a construction period erosion, sedimentation and pollution prevention plan that meets the requirements of Standard 8?

Yes – the project is covered by a National Pollutant Discharge Elimination System Permit, but a Stormwater Pollution Prevention Plan will be submitted before land disturbance.

Standard 9: (Operation and Maintenance)

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

All redevelopment projects shall fully comply with Standard 9.

- Has the proponent submitted a long-term Operation and Maintenance plan that meets the requirements of Standard 9? – **Yes**

Standard 10 (Illicit Discharges)

All illicit discharges to the stormwater management system are prohibited.

All redevelopment projects shall fully comply with Standard 10.

- Are there any known or suspected illicit discharges to the stormwater management system at the redevelopment project site? – **No**
- Has an illicit connection detection program been implemented using visual screening, dye or smoke testing? - **No**
- Have an Illicit Discharge Compliance Statement and associated site map been submitted verifying that there are no illicit discharges to the stormwater management system at the site? - **No**

Improvements to Existing Conditions:

- Once all illicit discharges are removed, has the proponent implemented any measures to prevent additional illicit discharges? – Yes, LTPPP & SWPPP

Figure 5-1

Menu of Strategies to Reduce Runoff or Peak Flows and/or Increase Recharge

- Rehabilitate the soils
- Plant trees and other vegetation
- Install a green roof
- Maximize naturally vegetated areas
- Reduce impervious surfaces
- Disconnect roof runoff from direct discharge to the drainage system
- Disconnect other existing paved areas from direct discharge to the drainage system, allowing controlled flow over pervious areas or through BMPs providing at least partial recharge
- Install porous pavement and/or other recharge measures (where sustainable and maintainable for promoting infiltration)
- Apply LID techniques for runoff reduction
- Install additional structural BMPs that are appropriate for redevelopment sites including infiltration trenches, subsurface structures, oil-grit separators, proprietary BMPs
- Retrofit existing BMPs

Retrofitting Existing BMPs

Many BMPs can be effectively retrofitted depending on site conditions and the water quantity or quality objectives trying to be achieved.³ The objective of stormwater retrofitting is to remedy problems associated with, and improve water quality mitigation functions of, older, poorly designed, or poorly maintained stormwater management systems. Prior to the development of the stormwater standards, site drainage design did not require stormwater detention for controlling post-development peak flows. As a result, drainage, flooding, and erosion problems can be common in many older developed areas of the state. Furthermore, a majority of the dry detention basins throughout the state have been designed to control peak flows, without regard to water quality mitigation. Therefore, many existing dry detention basins provide only minimal water quality benefit. Incorporating stormwater retrofits into existing developed sites or into redevelopment projects can reduce the adverse impacts of uncontrolled stormwater runoff.

Bioretention Area Retrofits - can be used as a stormwater retrofit, by modifying existing landscaped areas, or if a parking lot is being resurfaced. In highly urban watersheds, they are one of the few practical retrofit options.

Catch Basin Retrofits or Reconstruction - Older catch basins without sumps can be replaced with catch basins having four foot-deep sumps. Sumps provide storage volume for coarse sediments, assuming that accumulated sediment is removed on a regular basis. Hooded outlets, which are covers over the catch basin outlets that extend below the standing water line, can also be used to trap litter and other floatable materials. Leaching catch basins can be installed adjacent to deep sump catch basins to achieve 80% TSS removal. Be aware, however, that many products are being touted as catch basin inserts, but the effectiveness of these devices can vary significantly.

Dry Detention Basin Retrofits - Traditional dry detention basins can be modified to become extended dry detention basins, wet basins, or constructed stormwater wetlands for enhanced pollutant removal. This is one of the most commonly and easily implemented retrofits, since it typically requires little or no additional land area, capitalizes on an existing facility for which there is already some resident acceptance of stormwater management, and involves minimal impacts to environmental resources (Claytor, Center for Watershed Protection, 2000).

There are numerous retrofit options that will enhance the removal of pollutants in detention basins:

- Excavate the basin bottom to create more permanent pool storage.
- Raise the basin embankment to obtain additional storage for extended detention.
- Modify the outfall structure to create a two-stage release to better control small storms while not significantly compromising flood control detention for large storms.
- Increase the flow path from inflow to outflow and eliminate short-circuiting by using baffles, earthen berms or micro-pond topography to increase residence time.
- Incorporate stilling basins at inlets and outlets.
- Regrade the basin bottom to create a wetland area near the basin outlet or revegetate parts of the basin bottom with wetland vegetation to enhance pollutant removal, reduce mowing, and improve aesthetics.
- Create a wetland shelf along the perimeter of a wet basin to improve shoreline stabilization, enhance pollutant filtering, and enhance aesthetic and habitat functions.
- Create a low maintenance “no-mow” wildflower ecosystem in the drier portions of the basin.

³ Additional information on retrofitting stormwater BMPs can be found in the Urban Stormwater Retrofit Practices Manual. See http://www.cwp.org/Downloads/ELC_USRM3app.pdf.

- Provide a high flow bypass to avoid resuspension of captured sediments/pollutants during high flows.
- Eliminate low-flow bypasses.

Drainage Channel Retrofits - Existing channelized streams and drainage conveyances such as drainage channels can be modified to reduce flow velocities and enhance pollutant removal. Weir walls or riprap check dams placed across a channel create opportunities for ponding, infiltration, and establishment of wetland vegetation upstream of the retrofit. In-stream retrofit practices include stream bank stabilization of eroded areas and placement of habitat improvement structures (i.e., flow deflectors, boulders, pools/riffles, and low-flow channels) in natural streams and along stream banks. In-stream retrofits may require an evaluation of potential flooding and floodplain impacts resulting from altered channel conveyance, as well as requirements for local, state, or federal approval for work in wetlands and watercourses.

Parking Lots and Roadways- Parking lots offer ideal opportunities for a wide range of stormwater retrofits:

1. Incorporate bioretention areas into parking lot islands and landscaped areas; tree planter boxes can be converted into functional bioretention areas, rain gardens, or treebox filters to reduce and treat stormwater runoff.
2. Remove curbing and add slotted curb stops. Curbs along the edges of parking lots can sometimes be removed or slotted to re-route runoff to vegetated filter strips, water quality swales, grass channels, or bioretention facilities. The capacity of existing swales may need to be evaluated and expanded as part of this retrofit option.
3. Incorporate new treatment practices such as bioretention areas, sand filters, and constructed stormwater wetlands at the edges of parking lots.
4. In overflow parking or other low-traffic areas, asphalt can be replaced with porous pavement.

Sand Filter Retrofits - are suitable where space is limited, because they consume little surface space and have few site restrictions. Since sand filters cannot treat large drainage areas, retrofitting many small individual sites may be the only option. This option may be expensive.

Storm Drain Outfalls - New stormwater treatment practices can be constructed at the outfalls of existing drainage systems. The new stormwater treatment practices are commonly designed as *off-line devices* to treat the first flush volume and bypass larger storms. Water quality swales, bioretention areas, sand filters, constructed stormwater wetlands, and wet basins are commonly used for this type of retrofit. Other stormwater treatment practices may also be used if there is enough space for construction and maintenance.

Specific Redevelopment Projects

Redevelopment projects present unique challenges for controlling stormwater. It is possible that site constraints may prevent a redevelopment project from complying with one or more of the Stormwater Management Standards. Even if a redevelopment project cannot meet all of the Standards, there may be ample opportunity to improve existing site conditions depending on the other water quality or quantity issues in the watershed. The following special considerations provide unique opportunities for identifying how existing conditions may be improved:

- A. Groundwater Recharge Areas - Redevelopment projects located within these areas (Zone II, Interim Wellhead Protection Areas (IWPA), aquifer protection districts, etc.) should place a high priority on ground water recharge BMPs.
- 1) Disconnecting Rooftop Runoff – In some instances, building roof drains connected to the stormwater drainage system can be disconnected and re-directed to vegetated filter strips, bioretention facilities, or infiltration structures (dry wells or infiltration trenches).
 - 2) Use of Porous Paving Materials - Existing impermeable pavement in overflow parking or other low-traffic areas can sometimes be replaced with alternative permeable materials such as modular concrete paving blocks, modular concrete or plastic lattice, or cast-in-place concrete grids. Site-specific factors including traffic volumes, soil permeability, maintenance, sediment loads, and land use must be carefully considered prior to selection.
- B. Cold-Water Fisheries - Redevelopment projects adjacent to these areas should place a high priority on mitigating potential thermal impacts. Techniques to consider include:
- 1) Maintain Time of Concentration - Time of concentration (T_c) is based on the flow path and length, ground cover, slope and channel shape. When development occurs, T_c is often shortened due to the impervious area, causing greater flows to occur over a shorter period of time. Increasing the T_c will help to reduce the thermal impact of stormwater runoff from warm surface areas. Options to consider include:
 - Increasing the length of the runoff flow path
 - Increasing the surface roughness of the flow path
 - Detaining flows on site
 - Minimizing land disturbance
 - Creating flatter slopes.
 - 2) Disconnecting impervious areas – Breaking up large impervious expanses with vegetated zones will reduce the potential temperature increases of stormwater flowing across hot pavement.
- C. Brownfield Redevelopment – Redeveloping urban and non-urban brownfield sites (which in Massachusetts includes most “disposal sites” under the Massachusetts Contingency Plan [MCP]) are a Commonwealth priority, with ramifications for urban sprawl as well as the remediation of historically contaminated properties. Proponents of brownfield redevelopment projects should evaluate BMPs that will prevent the significant uncontrolled mobilization or remobilization of soil or ground water contamination. BMP considerations at these sites should consider such factors as:
- The location of stormwater infiltration units with respect to contaminated areas
 - Ground water mounding effects on the rate and direction of migration of ground water contaminants
 - The location of outfalls
 - Water quality BMPs.
- D. Runoff to Impaired Water Bodies – If MassDEP has issued a Total Maximum Daily Load (TMDL) that establishes a waste load allocation for stormwater discharge and/or a TMDL Implementation Plan that identifies remedies aimed at reducing the amount of pollutants from stormwater discharges, proponents may be required to install stormwater BMPs that are consistent with the TMDL.

- E. Runoff to Areas of Localized Flooding – Project proponents must also understand the potential impacts of stormwater runoff in areas prone to localized flooding. When completing the checklist, proponents should consider the capacity of the receiving water and/or storm drainage system. When evaluating discharges to areas subject to localized flooding, the proponent should evaluate the ability to maintain and/or improve existing site cover and reduce runoff volume.



Appendix E

Standard 8 Supporting Information

- Erosion & Sedimentation Control Measures
- BMP Maintenance Checklist



Erosion & Sedimentation Control Measures



Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Siltsock Barriers

Siltsock barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Siltsocks will be set with a minimum of five feet storage area at toes of slopes greater than 4:1. Siltsocks shall have a two foot overlap at ends.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, hay bale barriers will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and hay bale barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with Flexstorm® Catch-It Inlet Filters and hay bale barriers (where appropriate) throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.



Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 2:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after identification.
- The underside of hay bales should be kept in close contact with the earth and reset as necessary.



- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

The sedimentation and erosion control plan is included in project plan set; a reduced version and Erosion Control Maintenance checklist is included here for quick reference.



Construction Best Management Practices - Maintenance/Evaluation Checklist

Dunstan East Mixed-Use Redevelopment – Newton, MA
Construction Period Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed <input type="checkbox"/> yes <input type="checkbox"/> no (List Items)	Date of Cleaning/Repair	Performed by:
Silt Sock	Weekly and after storm events			<ul style="list-style-type: none"> • Accumulated sediment • Damaged or broken wattles • Erosion overflowing top of wattle 	<input type="checkbox"/> yes <input type="checkbox"/> no		
Gravel Construction Entrance	Weekly and after storm events			<ul style="list-style-type: none"> • Accumulated sediment • Tracking of sediment outside limit of work 	<input type="checkbox"/> yes <input type="checkbox"/> no		
Catch Basin Protection	Weekly and after storm events			<ul style="list-style-type: none"> • Accumulated sediment within silt sacks • Rips or torn silt sacks 	<input type="checkbox"/> yes <input type="checkbox"/> no		
Vegetated Slope Stabilization	Weekly and after storm events			<ul style="list-style-type: none"> • Ripping of blanket protection • Erosion • Non-growth in vegetation 	<input type="checkbox"/> yes <input type="checkbox"/> no		

Stormwater Control Manager _____

Washington Street Mixed-Use Redevelopment – Newton, MA
Long Term Operation and Maintenance – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed <input type="checkbox"/> yes <input type="checkbox"/> no (List Items)	Date of Cleaning/Repair	Performed by:
Catch Basin	Four times annually			<ul style="list-style-type: none"> • Accumulated sediment within sump • Accumulated debris within catch basins 	<input type="checkbox"/> yes <input type="checkbox"/> no		
Vegetated Slope Stabilization	Weekly and after storm events			<ul style="list-style-type: none"> • Ripping of blanket protection • Erosion • Non-growth in vegetation 	<input type="checkbox"/> yes <input type="checkbox"/> no		
Sand Filter	Monthly and after large storm events			<ul style="list-style-type: none"> • Accumulated sediment within sump • Erosion of sand from overflowing top of weir 	<input type="checkbox"/> yes <input type="checkbox"/> no		

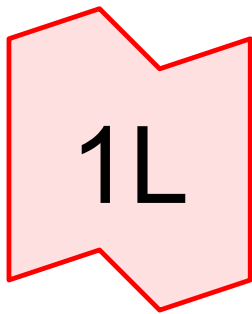
Stormwater Control Manager _____



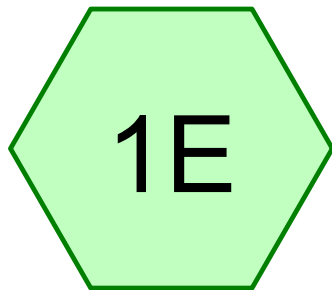
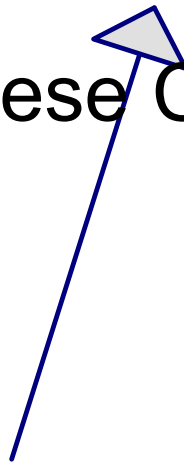
Appendix F

Hydrologic Analysis

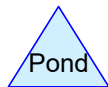
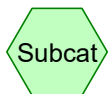
- HydroCAD Analysis: Existing Conditions
- HydroCAD Analysis: Proposed Conditions



Cheese Cake Brook



Existing



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Page 2

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.26	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.13	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.30	2
4	100-Year	Type III 24-hr		Default	24.00	1	8.78	2

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.360	61	>75% Grass cover, Good, HSG B (1E)
3.227	98	Paved parking, HSG B (1E)
3.586	94	TOTAL AREA

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Page 4

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.360	0.000	0.000	0.000	0.360	>75% Grass cover, Good	1E
0.000	3.227	0.000	0.000	0.000	3.227	Paved parking	1E
0.000	3.586	0.000	0.000	0.000	3.586	TOTAL AREA	

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Type III 24-hr 2-Year Rainfall=3.26"

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Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: Existing

Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=2.60"
Flow Length=495' Tc=5.0 min CN=94 Runoff=10.53 cfs 0.778 af

Link 1L: Cheese Cake Brook

Inflow=10.53 cfs 0.778 af
Primary=10.53 cfs 0.778 af

Total Runoff Area = 3.586 ac Runoff Volume = 0.778 af Average Runoff Depth = 2.60"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af, Depth= 2.60"

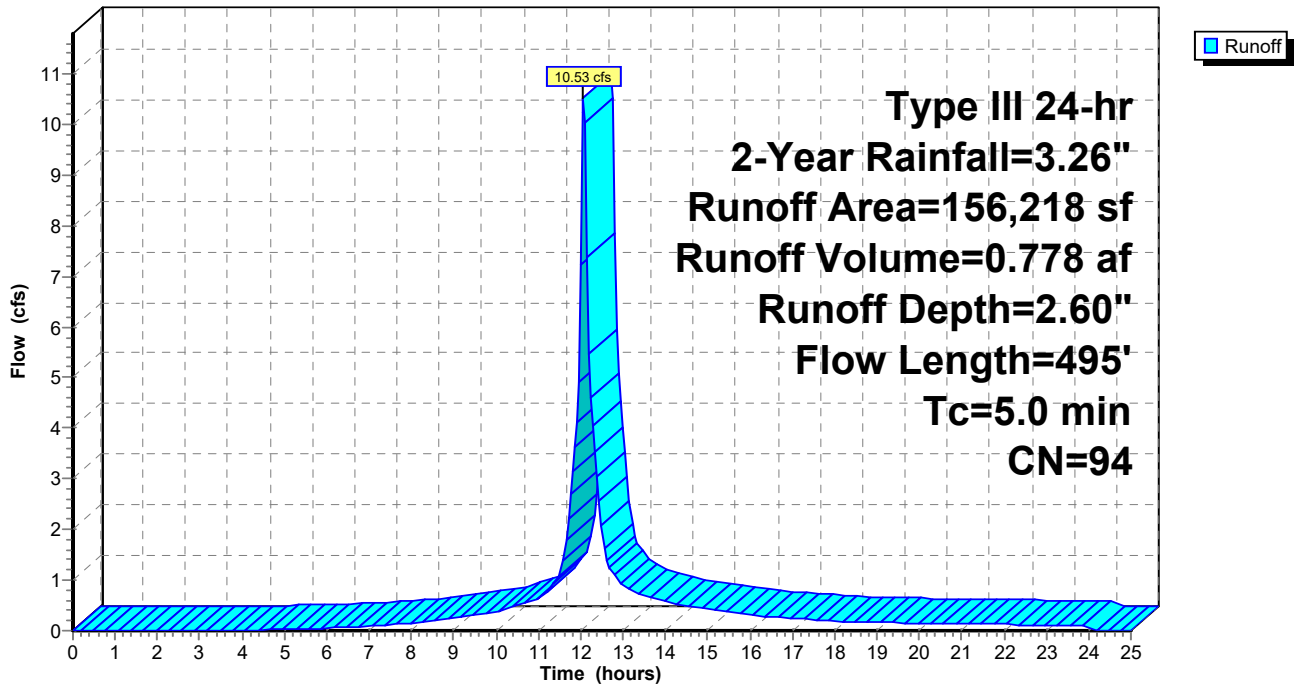
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		Sheet Flow, Pavement Sheet Flow Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		Shallow Concentrated Flow, Pavement Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

Hydrograph



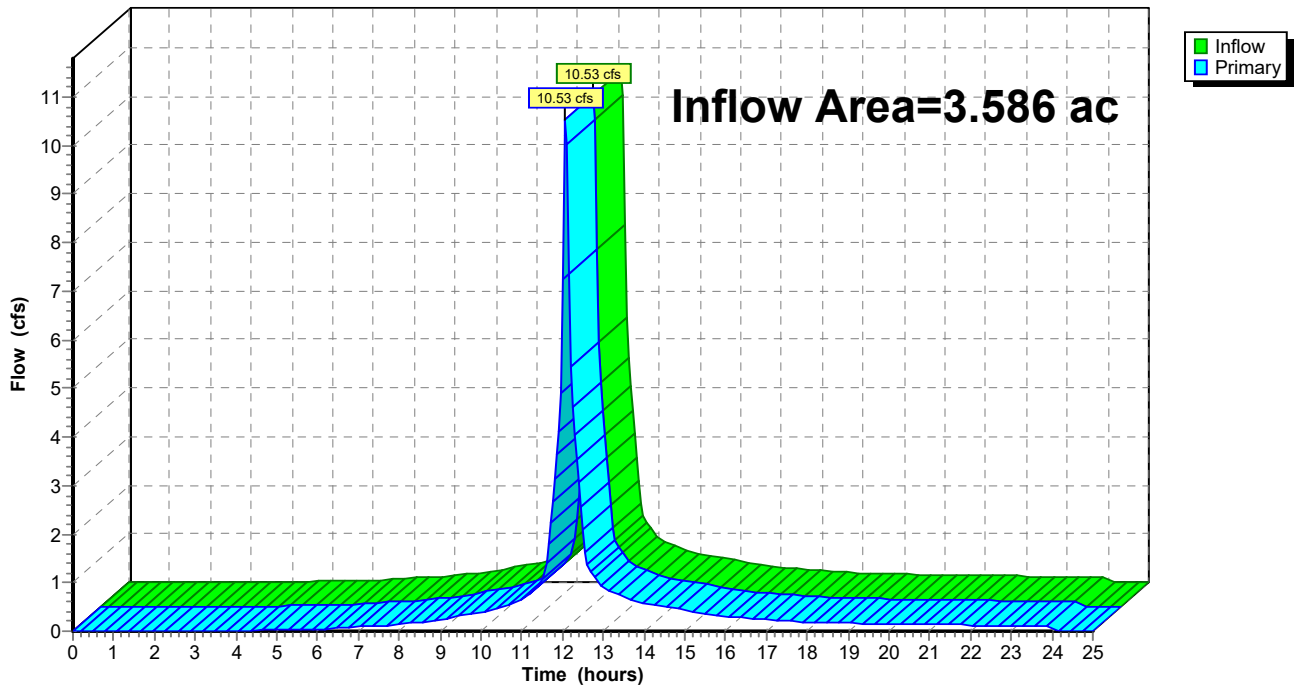
Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 2.60" for 2-Year event
Inflow = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af
Primary = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook

Hydrograph



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Type III 24-hr 10-Year Rainfall=5.13"

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Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: Existing

Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=4.44"
Flow Length=495' Tc=5.0 min CN=94 Runoff=17.42 cfs 1.326 af

Link 1L: Cheese Cake Brook

Inflow=17.42 cfs 1.326 af
Primary=17.42 cfs 1.326 af

Total Runoff Area = 3.586 ac Runoff Volume = 1.326 af Average Runoff Depth = 4.44"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af, Depth= 4.44"

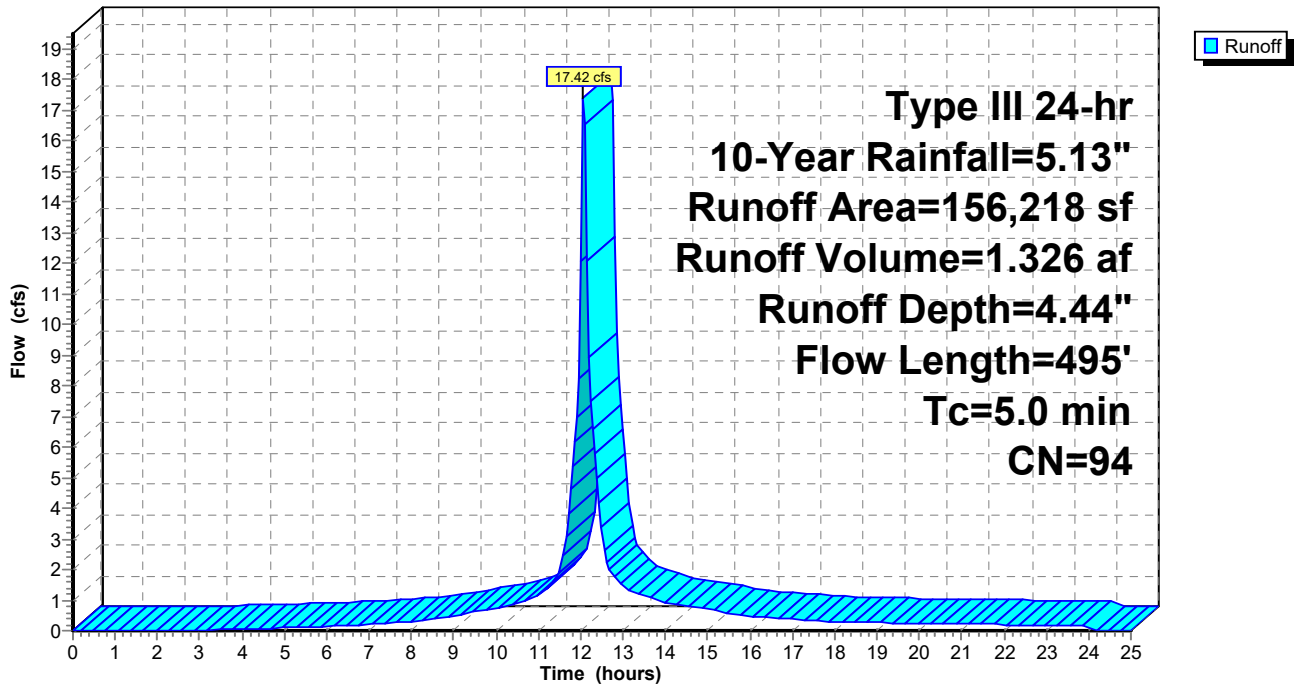
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, $dt= 0.05$ hrs
 Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		Sheet Flow, Pavement Sheet Flow Smooth surfaces $n= 0.011$ $P2= 3.26"$
2.0	445	0.0350	3.80		Shallow Concentrated Flow, Pavement Paved $K_v= 20.3$ fps
2.5	495	Total, Increased to minimum $T_c = 5.0$ min			

Subcatchment 1E: Existing

Hydrograph



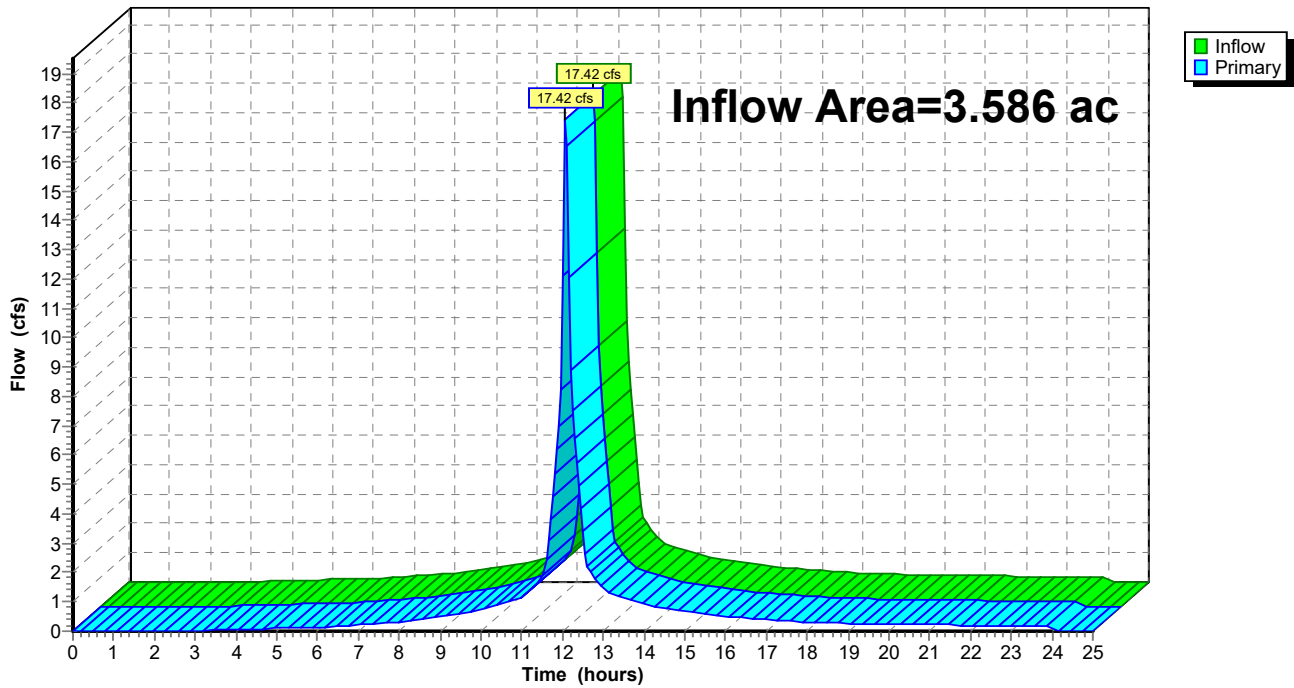
Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 4.44" for 10-Year event
Inflow = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af
Primary = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook

Hydrograph



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Type III 24-hr 25-Year Rainfall=6.30"

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Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: Existing

Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=5.59"
Flow Length=495' Tc=5.0 min CN=94 Runoff=21.68 cfs 1.672 af

Link 1L: Cheese Cake Brook

Inflow=21.68 cfs 1.672 af
Primary=21.68 cfs 1.672 af

Total Runoff Area = 3.586 ac Runoff Volume = 1.672 af Average Runoff Depth = 5.59"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 21.68 cfs @ 12.07 hrs, Volume= 1.672 af, Depth= 5.59"

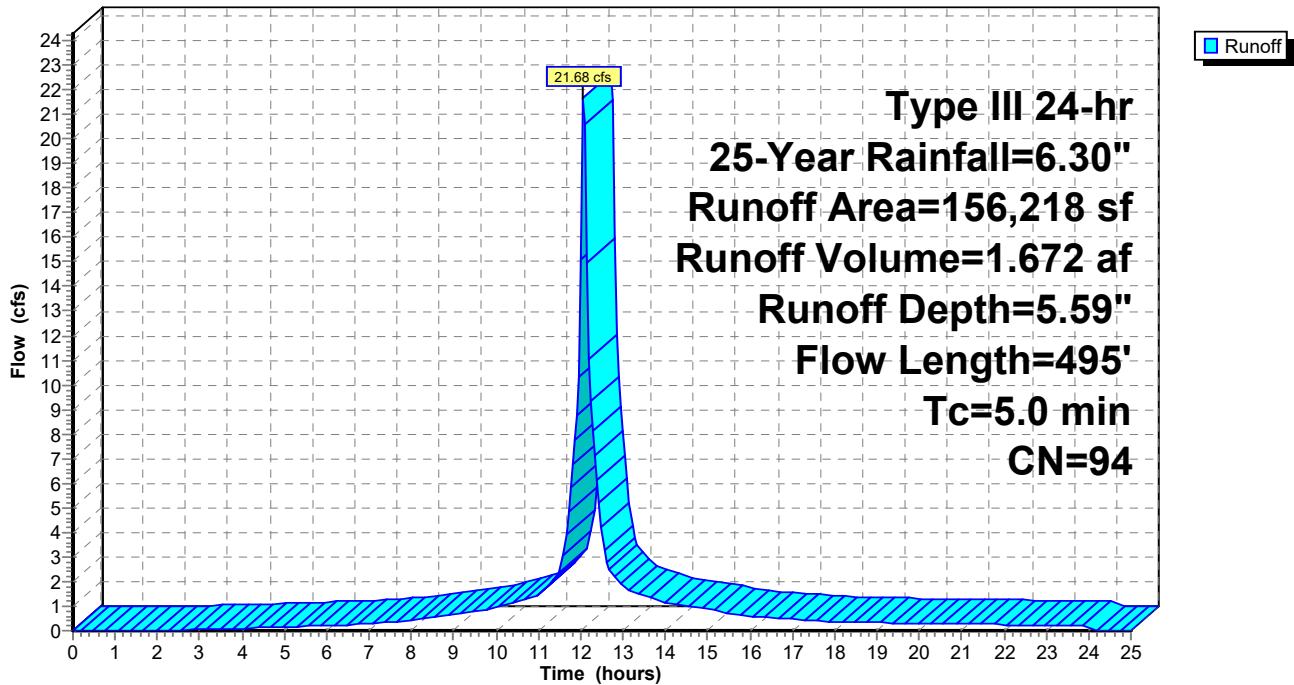
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		Sheet Flow, Pavement Sheet Flow Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		Shallow Concentrated Flow, Pavement Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

Hydrograph



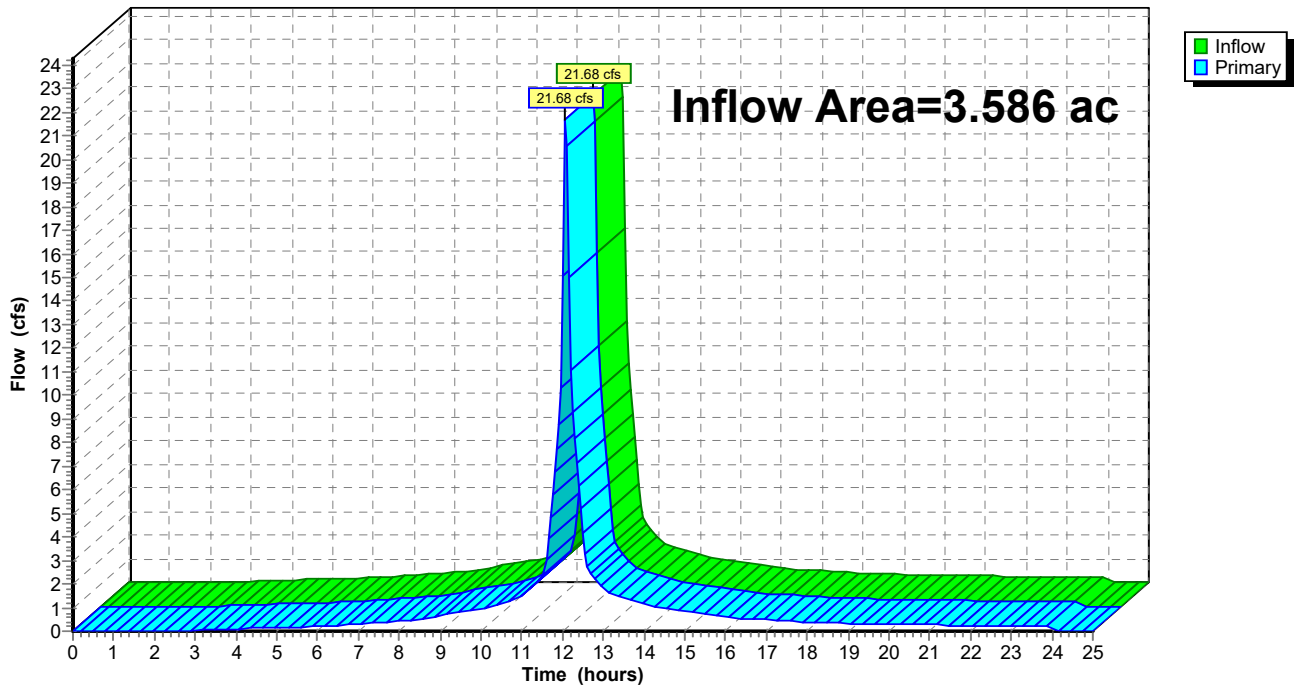
Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 5.59" for 25-Year event
Inflow = 21.68 cfs @ 12.07 hrs, Volume= 1.672 af
Primary = 21.68 cfs @ 12.07 hrs, Volume= 1.672 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook

Hydrograph



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Type III 24-hr 100-Year Rainfall=8.78"

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Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1E: Existing

Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=8.06"
Flow Length=495' Tc=5.0 min CN=94 Runoff=30.65 cfs 2.408 af

Link 1L: Cheese Cake Brook

Inflow=30.65 cfs 2.408 af
Primary=30.65 cfs 2.408 af

Total Runoff Area = 3.586 ac Runoff Volume = 2.408 af Average Runoff Depth = 8.06"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af, Depth= 8.06"

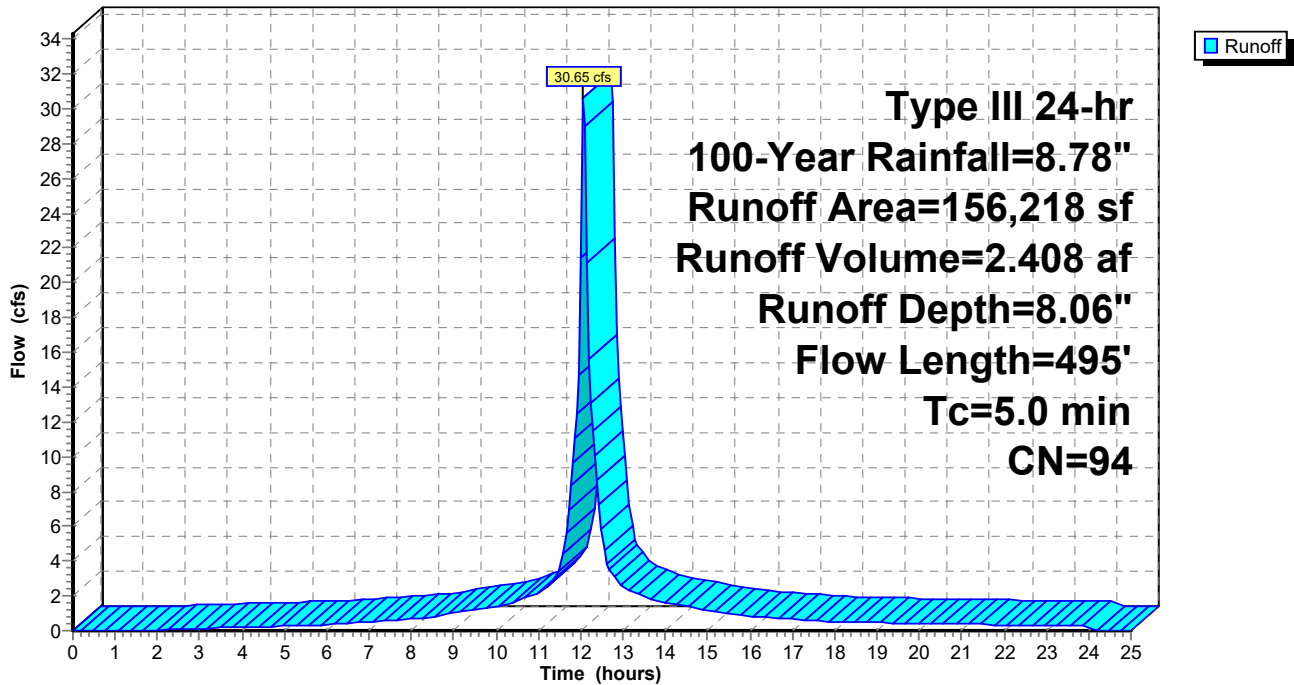
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		Sheet Flow, Pavement Sheet Flow Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		Shallow Concentrated Flow, Pavement Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

Hydrograph



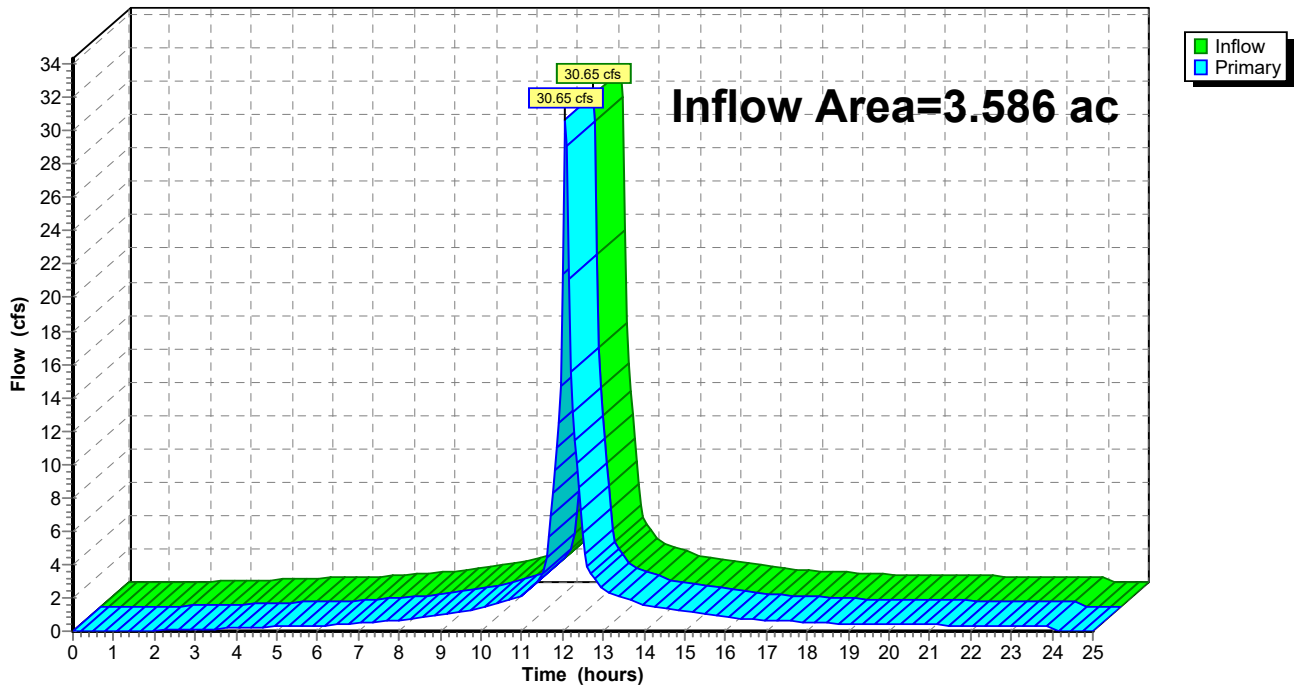
Summary for Link 1L: Cheese Cake Brook

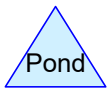
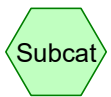
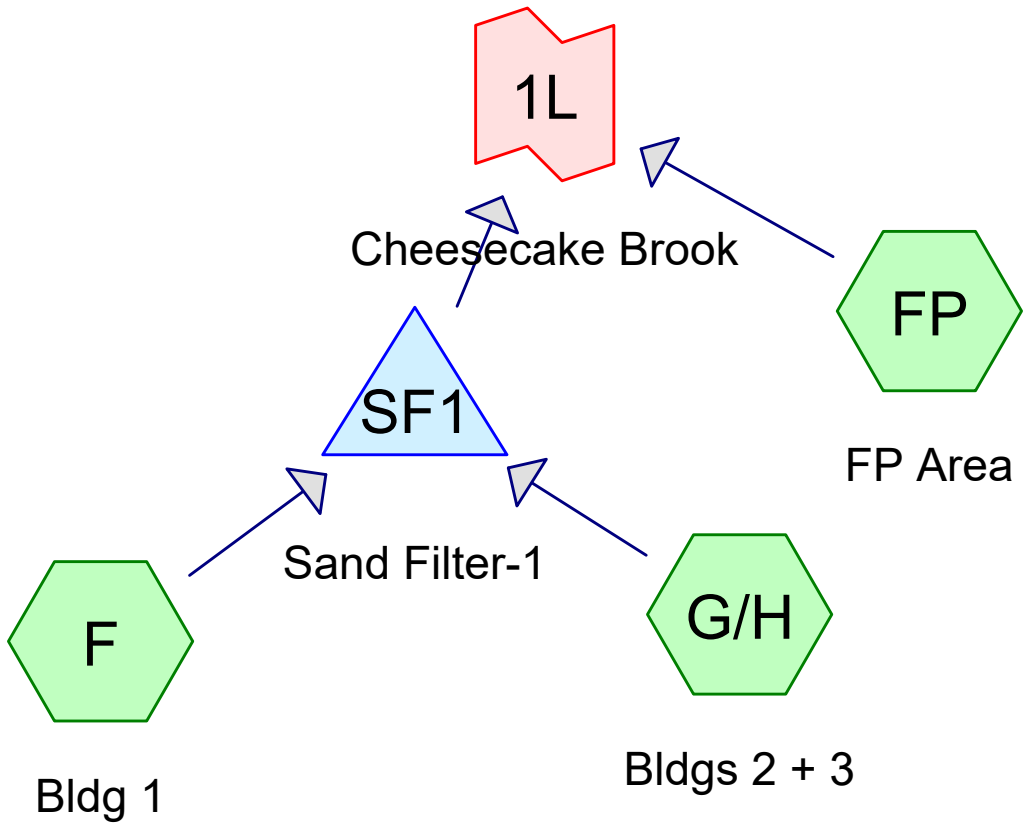
Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 8.06" for 100-Year event
Inflow = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af
Primary = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook

Hydrograph





Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.26	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.13	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.30	2
4	100-Year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.582	61	>75% Grass cover, Good, HSG B (F, FP, G/H)
2.904	98	Paved parking, HSG B (F, G/H)
0.098	98	Unconnected pavement, HSG B (FP)
3.584	92	TOTAL AREA

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Prepared by VHB

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Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.582	0.000	0.000	0.000	0.582	>75% Grass cover, Good	F, FP, G/H
0.000	2.904	0.000	0.000	0.000	2.904	Paved parking	F, G/H
0.000	0.098	0.000	0.000	0.000	0.098	Unconnected pavement	FP
0.000	3.584	0.000	0.000	0.000	3.584	TOTAL AREA	

Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=2.50"
Tc=5.0 min CN=93 Runoff=3.77 cfs 0.275 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=0.67"
Tc=5.0 min UI Adjusted CN=66 Runoff=0.24 cfs 0.020 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=2.81"
Tc=5.0 min CN=96 Runoff=5.87 cfs 0.446 af

Pond SF1: Sand Filter-1 Peak Elev=35.14' Storage=380 cf Inflow=9.63 cfs 0.721 af
Outflow=9.54 cfs 0.716 af

Link 1L: Cheesecake Brook Inflow=9.76 cfs 0.736 af
Primary=9.76 cfs 0.736 af

Total Runoff Area = 3.584 ac Runoff Volume = 0.741 af Average Runoff Depth = 2.48"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 3.77 cfs @ 12.07 hrs, Volume= 0.275 af, Depth= 2.50"

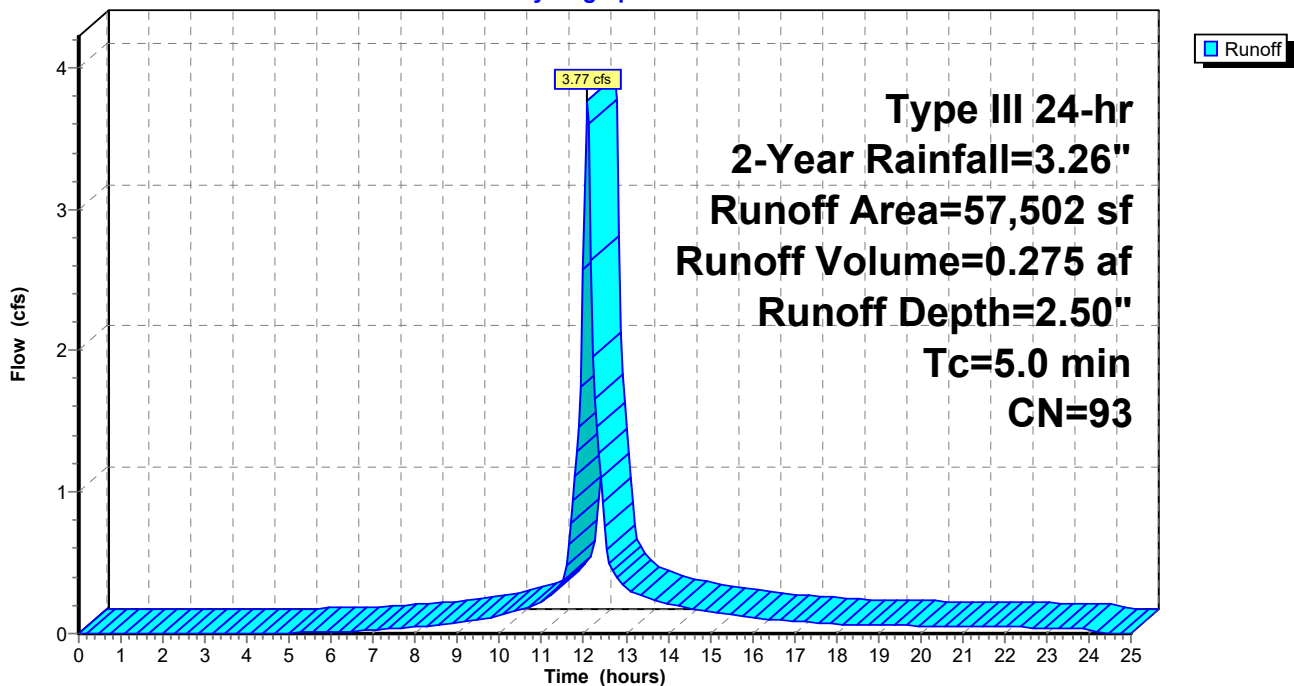
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, $dt= 0.05$ hrs
 Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1

Hydrograph



Summary for Subcatchment FP: FP Area

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.24 cfs @ 12.10 hrs, Volume= 0.020 af, Depth= 0.67"

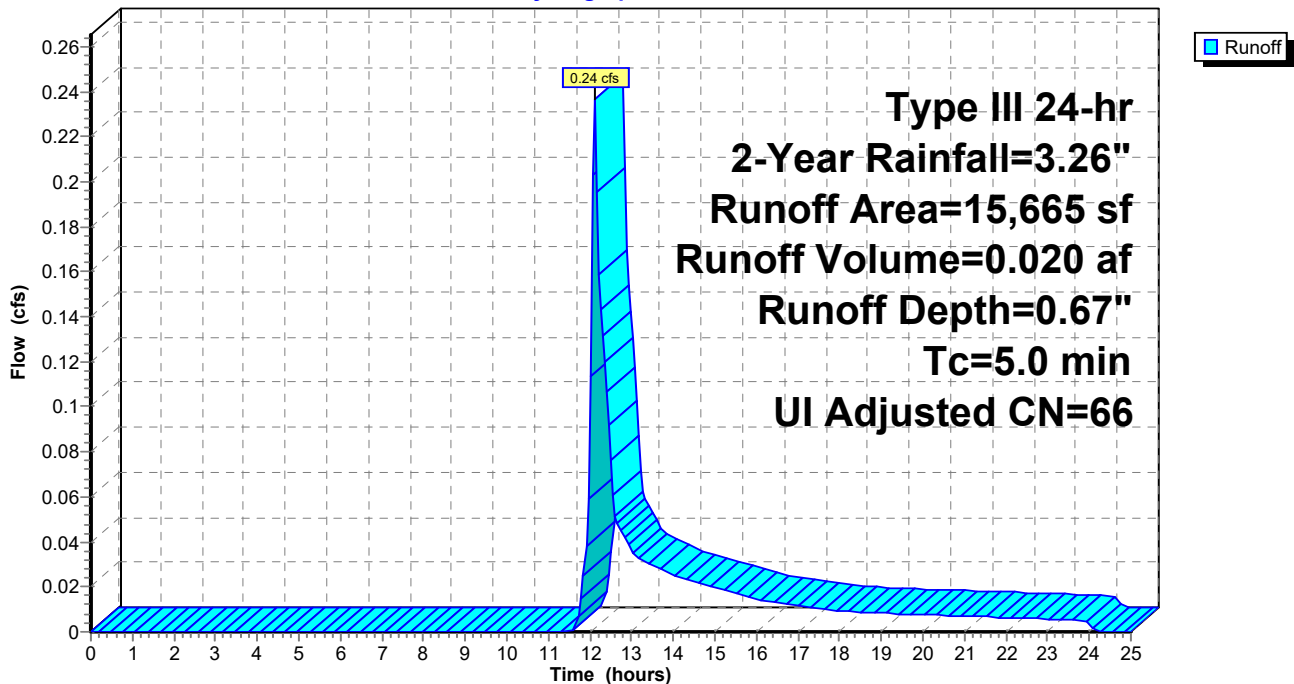
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area

Hydrograph



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 5.87 cfs @ 12.07 hrs, Volume= 0.446 af, Depth= 2.81"

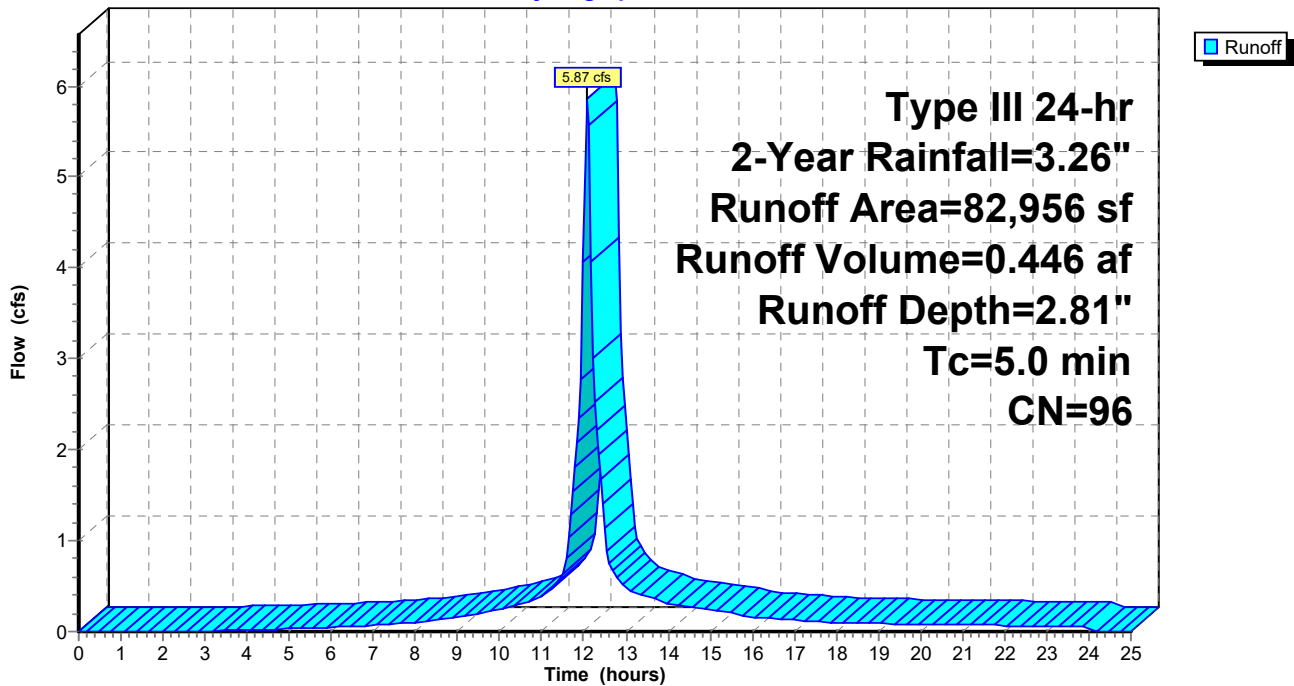
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3

Hydrograph



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 2.68" for 2-Year event
 Inflow = 9.63 cfs @ 12.07 hrs, Volume= 0.721 af
 Outflow = 9.54 cfs @ 12.07 hrs, Volume= 0.716 af, Atten= 1%, Lag= 0.1 min
 Primary = 9.54 cfs @ 12.07 hrs, Volume= 0.716 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 35.14' @ 12.07 hrs Surf.Area= 590 sf Storage= 380 cf
 Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

Plug-Flow detention time= 8.9 min calculated for 0.716 af (99% of inflow)
 Center-of-Mass det. time= 4.3 min (784.0 - 779.7)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	10.00'W x 59.00'L x 2.70'H Prismatic
#2	35.21'	1,053 cf	10.00'W x 39.00'L x 2.70'H Forebay-West Impervious
#3	35.17'	1,170 cf	7.50'W x 39.00'L x 4.00'H Forebay-East
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	24.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	24.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.7' Crest Height

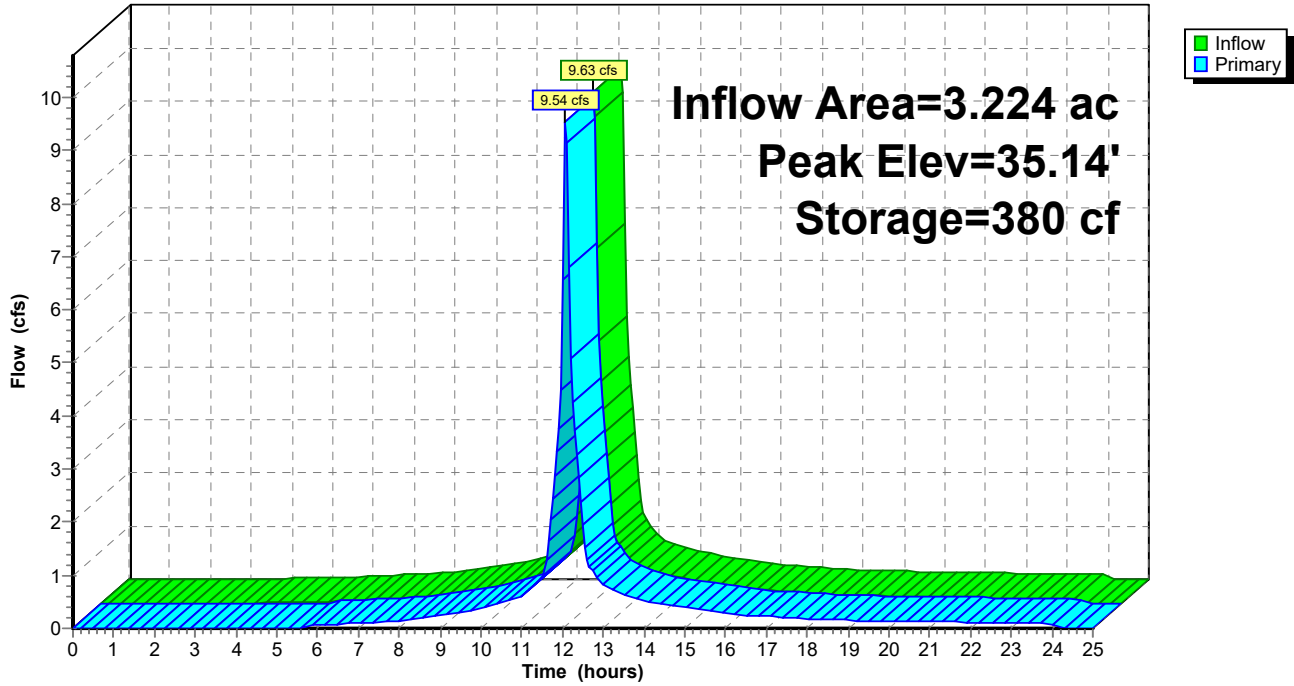
Primary OutFlow Max=9.16 cfs @ 12.07 hrs HW=35.14' (Free Discharge)

↑1=Orifice/Grate (Passes 9.16 cfs of 30.02 cfs potential flow)

↑2=Sharp-Crested Rectangular Weir (Weir Controls 9.16 cfs @ 1.61 fps)

Pond SF1: Sand Filter-1

Hydrograph



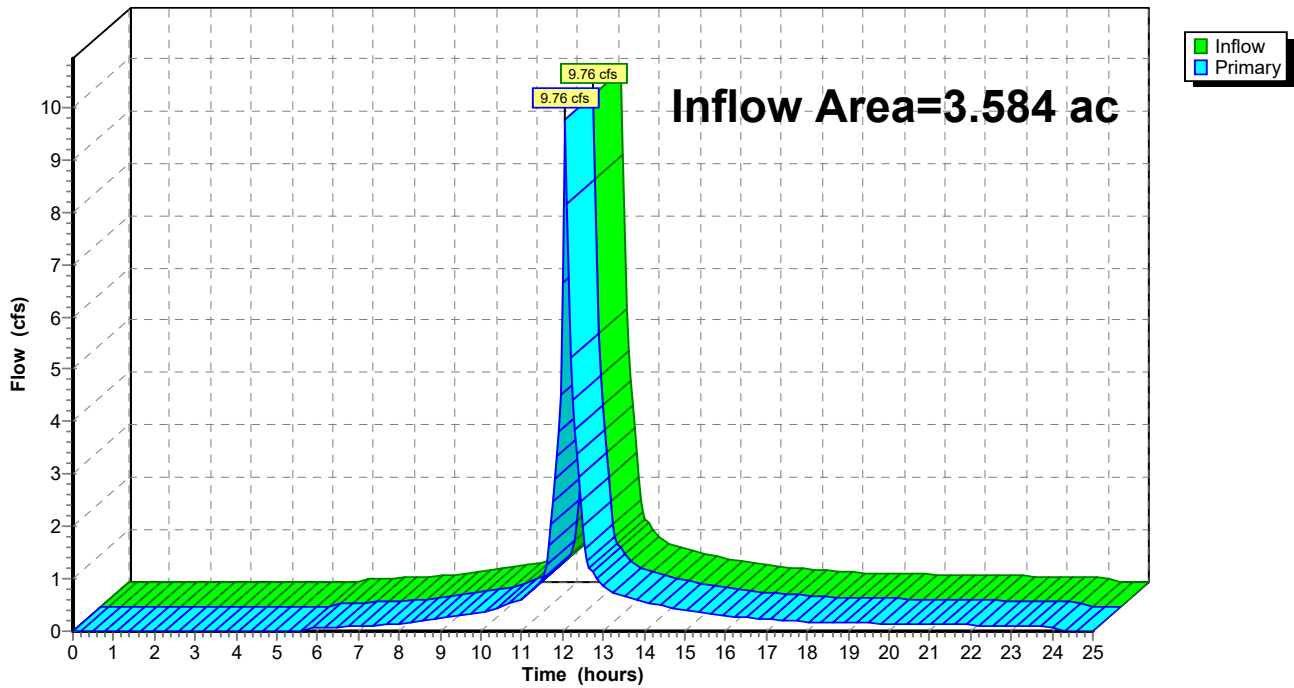
Summary for Link 1L: Cheesecake Brook

Inflow Area = 3.584 ac, 83.75% Impervious, Inflow Depth = 2.46" for 2-Year event
Inflow = 9.76 cfs @ 12.07 hrs, Volume= 0.736 af
Primary = 9.76 cfs @ 12.07 hrs, Volume= 0.736 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook

Hydrograph



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=4.33"
Tc=5.0 min CN=93 Runoff=6.32 cfs 0.476 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=1.82"
Tc=5.0 min UI Adjusted CN=66 Runoff=0.74 cfs 0.054 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=4.66"
Tc=5.0 min CN=96 Runoff=9.47 cfs 0.740 af

Pond SF1: Sand Filter-1 Peak Elev=35.24' Storage=464 cf Inflow=15.79 cfs 1.216 af
Outflow=15.49 cfs 1.210 af

Link 1L: Cheesecake Brook Inflow=16.19 cfs 1.264 af
Primary=16.19 cfs 1.264 af

Total Runoff Area = 3.584 ac Runoff Volume = 1.270 af Average Runoff Depth = 4.25"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 6.32 cfs @ 12.07 hrs, Volume= 0.476 af, Depth= 4.33"

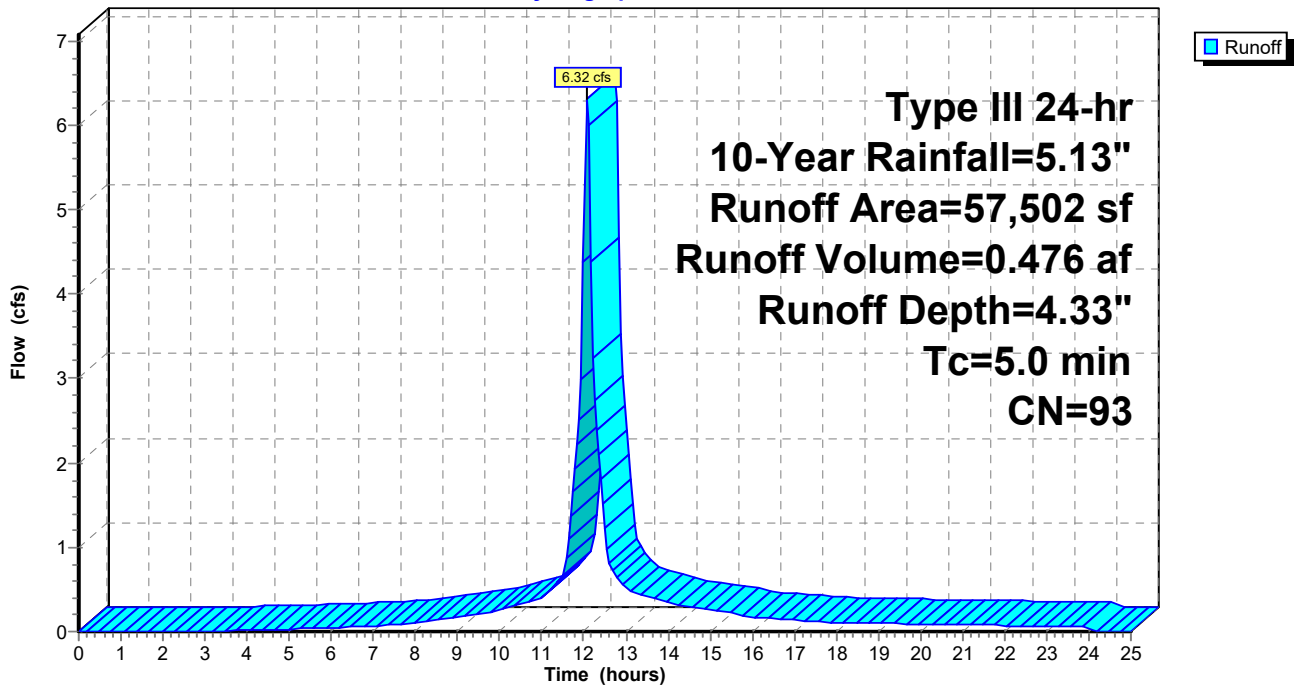
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1

Hydrograph



Summary for Subcatchment FP: FP Area

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 0.74 cfs @ 12.09 hrs, Volume= 0.054 af, Depth= 1.82"

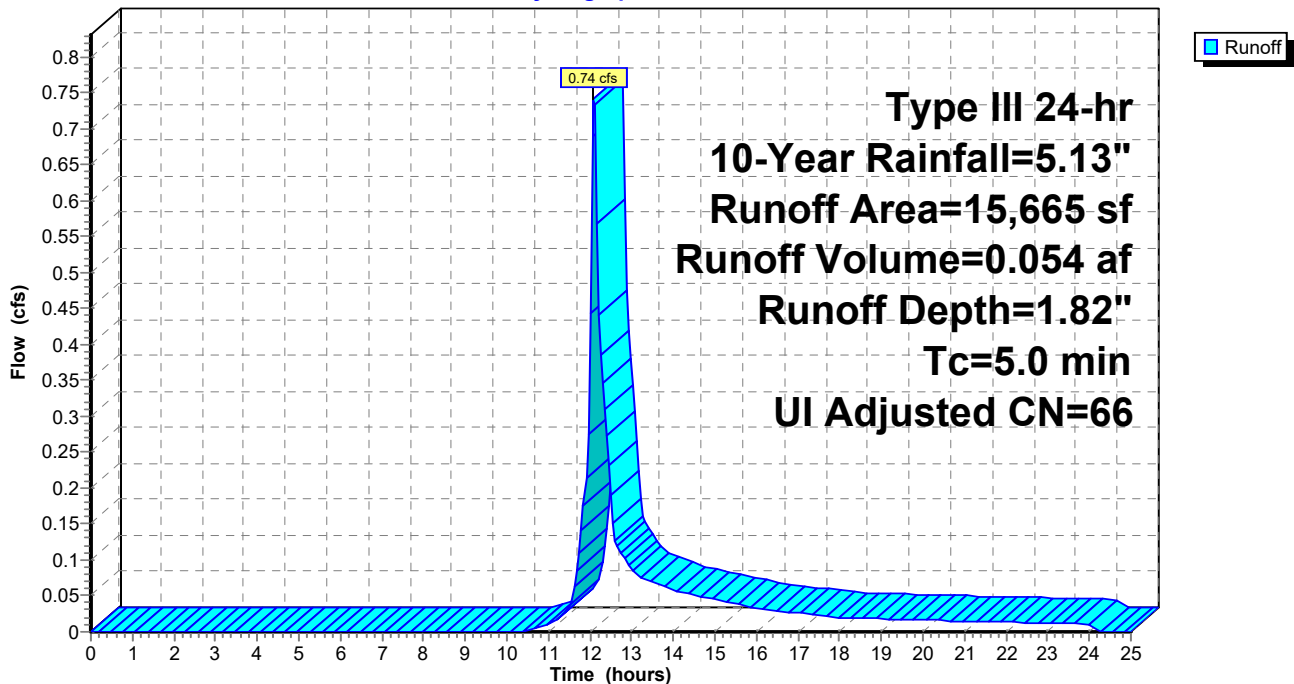
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, $dt= 0.05$ hrs
 Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area

Hydrograph



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.47 cfs @ 12.07 hrs, Volume= 0.740 af, Depth= 4.66"

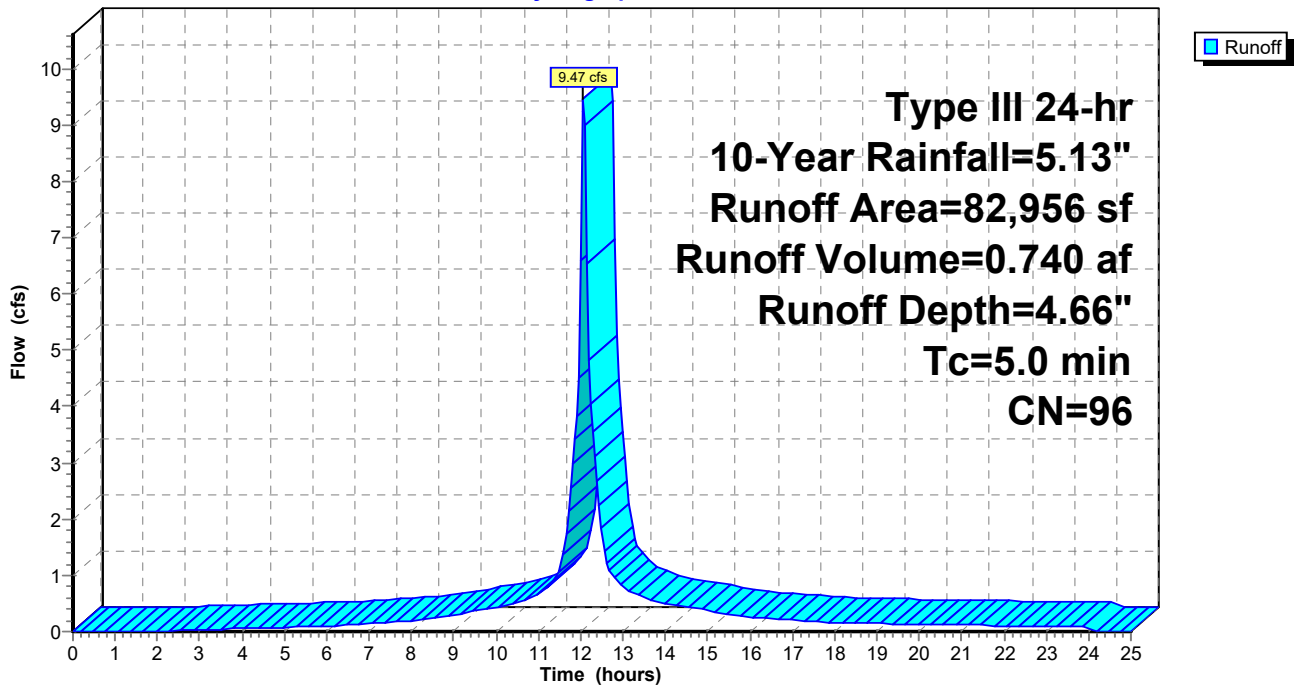
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3

Hydrograph



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 4.52" for 10-Year event
 Inflow = 15.79 cfs @ 12.07 hrs, Volume= 1.216 af
 Outflow = 15.49 cfs @ 12.07 hrs, Volume= 1.210 af, Atten= 2%, Lag= 0.2 min
 Primary = 15.49 cfs @ 12.07 hrs, Volume= 1.210 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 35.24' @ 12.07 hrs Surf.Area= 883 sf Storage= 464 cf
 Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

Plug-Flow detention time= 6.0 min calculated for 1.208 af (99% of inflow)
 Center-of-Mass det. time= 3.0 min (770.1 - 767.0)

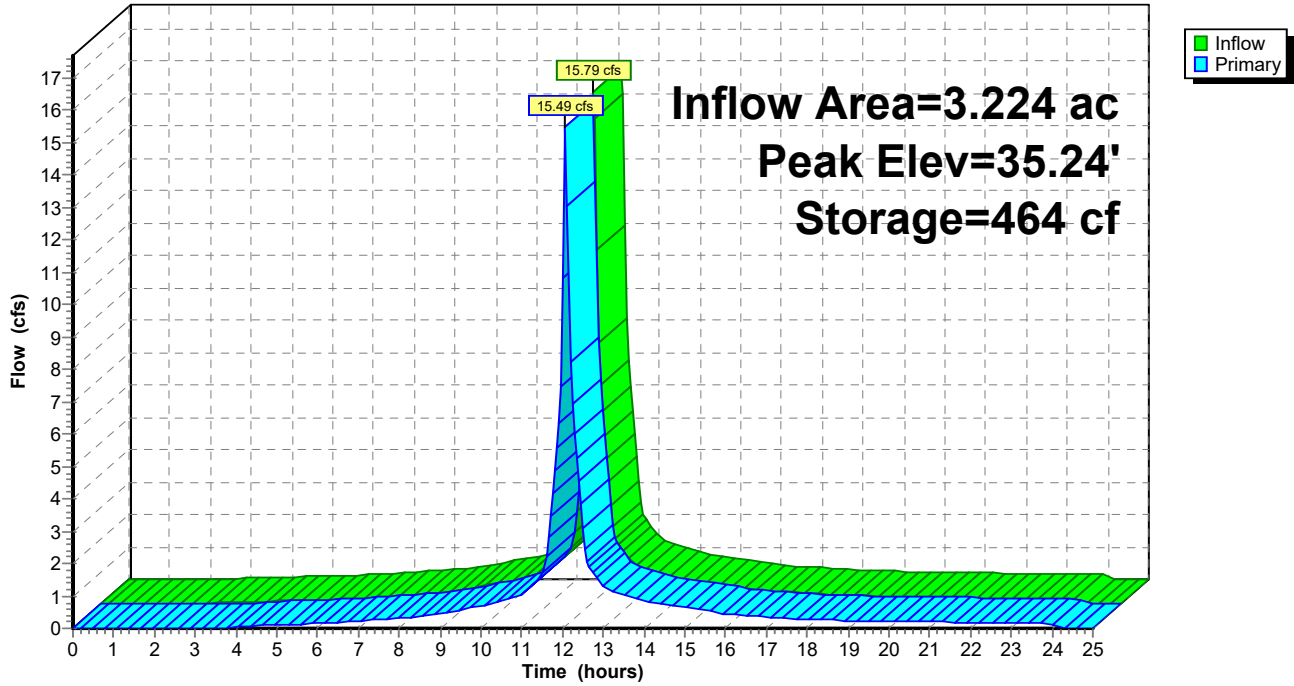
Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	10.00'W x 59.00'L x 2.70'H Prismatic
#2	35.21'	1,053 cf	10.00'W x 39.00'L x 2.70'H Forebay-West Impervious
#3	35.17'	1,170 cf	7.50'W x 39.00'L x 4.00'H Forebay-East
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	24.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	24.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.7' Crest Height

Primary OutFlow Max=14.95 cfs @ 12.07 hrs HW=35.23' (Free Discharge)
 ↑ **1=Orifice/Grate** (Passes 14.95 cfs of 30.36 cfs potential flow)
 ↑ **2=Sharp-Crested Rectangular Weir**(Weir Controls 14.95 cfs @ 1.90 fps)

Pond SF1: Sand Filter-1

Hydrograph



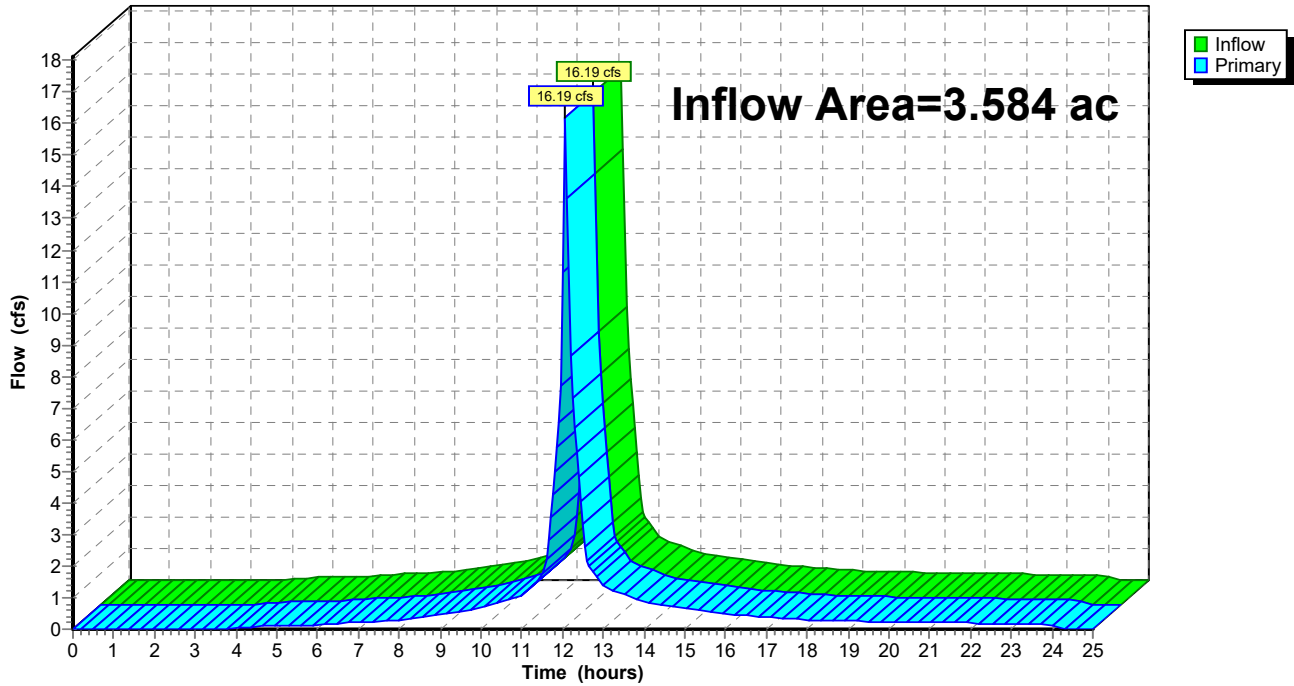
Summary for Link 1L: Cheesecake Brook

Inflow Area = 3.584 ac, 83.75% Impervious, Inflow Depth = 4.23" for 10-Year event
Inflow = 16.19 cfs @ 12.08 hrs, Volume= 1.264 af
Primary = 16.19 cfs @ 12.08 hrs, Volume= 1.264 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook

Hydrograph



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=5.48"
Tc=5.0 min CN=93 Runoff=7.90 cfs 0.603 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=2.66"
Tc=5.0 min UI Adjusted CN=66 Runoff=1.11 cfs 0.080 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=5.83"
Tc=5.0 min CN=96 Runoff=11.71 cfs 0.925 af

Pond SF1: Sand Filter-1 Peak Elev=35.29' Storage=530 cf Inflow=19.61 cfs 1.527 af
Outflow=19.24 cfs 1.522 af

Link 1L: Cheesecake Brook Inflow=20.35 cfs 1.602 af
Primary=20.35 cfs 1.602 af

Total Runoff Area = 3.584 ac Runoff Volume = 1.607 af Average Runoff Depth = 5.38"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 7.90 cfs @ 12.07 hrs, Volume= 0.603 af, Depth= 5.48"

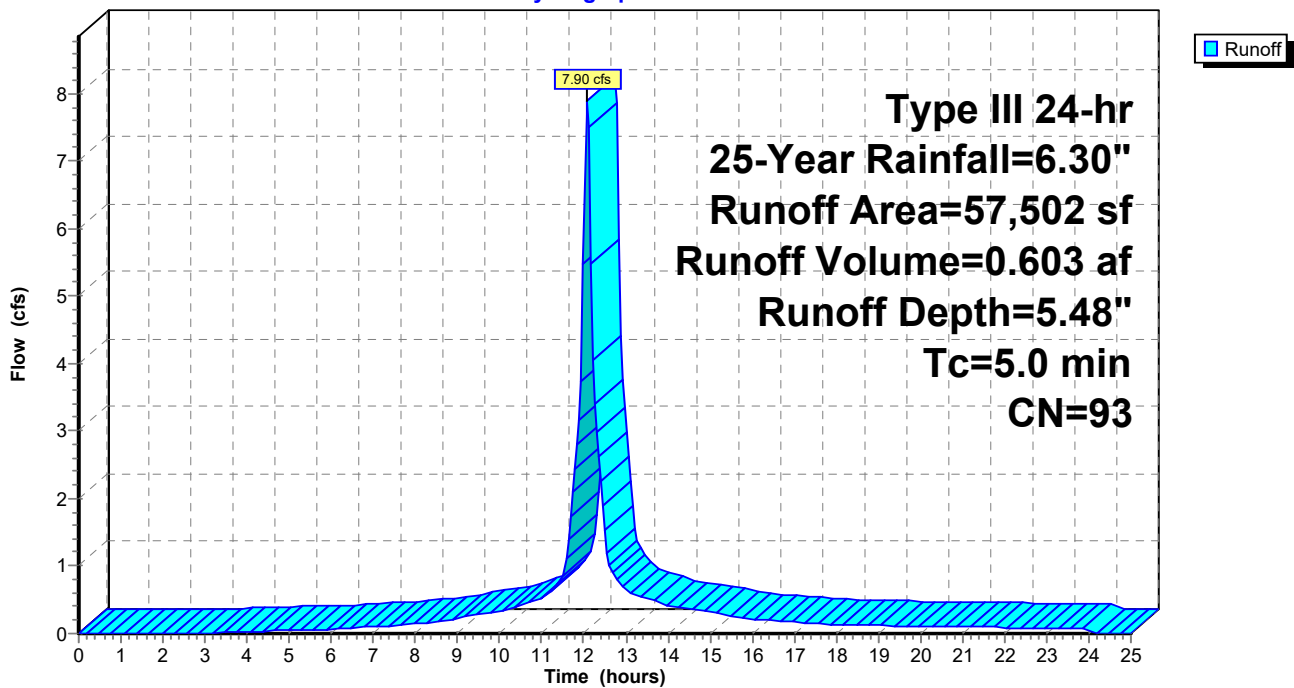
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, $dt= 0.05$ hrs
 Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1

Hydrograph



Summary for Subcatchment FP: FP Area

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 1.11 cfs @ 12.08 hrs, Volume= 0.080 af, Depth= 2.66"

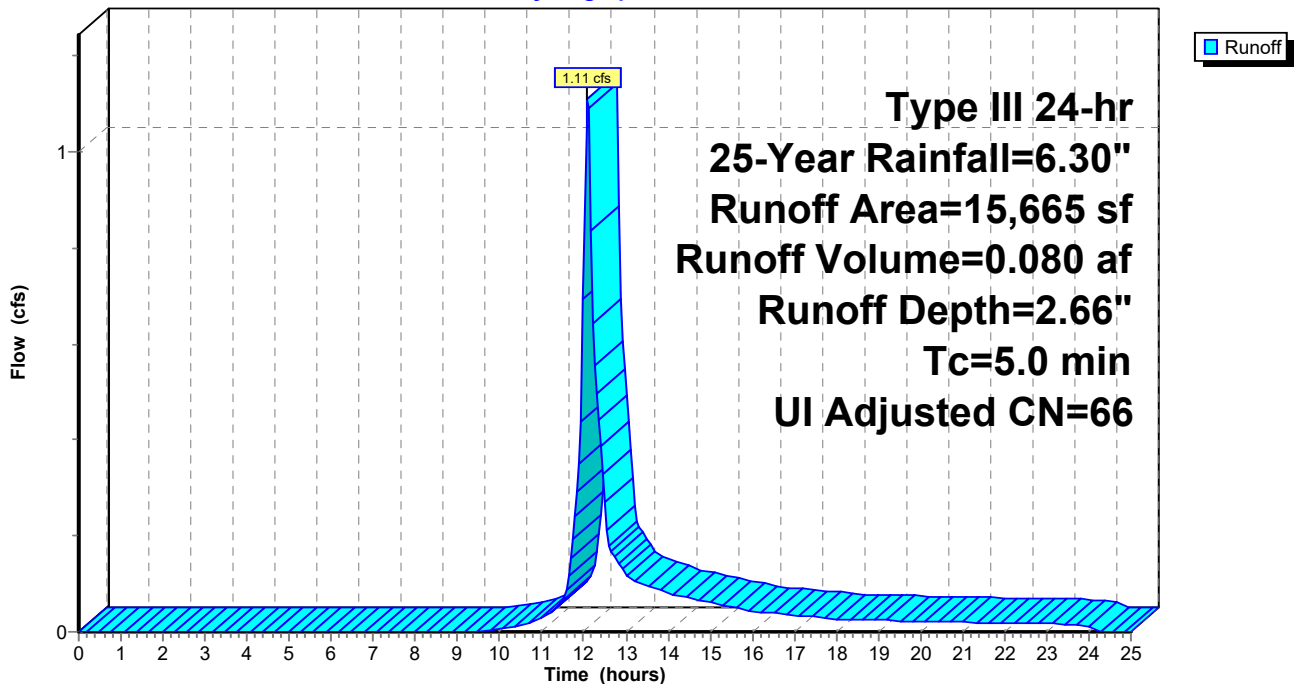
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area

Hydrograph



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 11.71 cfs @ 12.07 hrs, Volume= 0.925 af, Depth= 5.83"

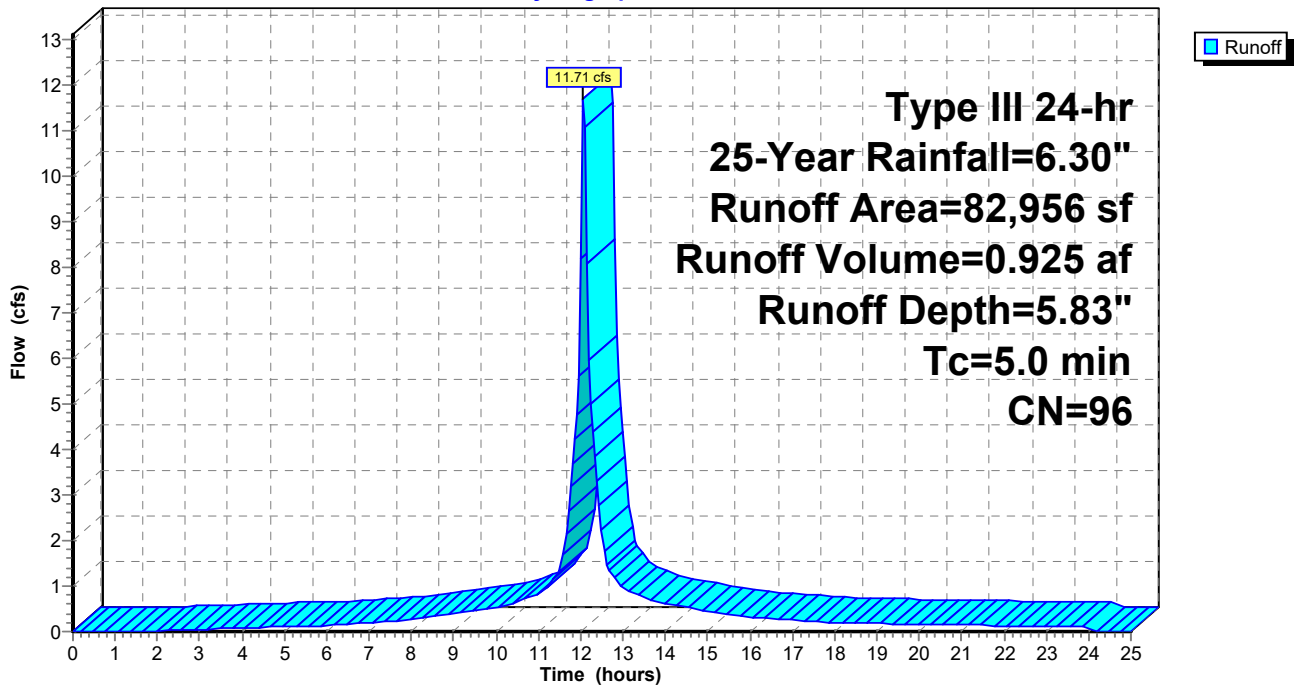
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3

Hydrograph



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 5.68" for 25-Year event
 Inflow = 19.61 cfs @ 12.07 hrs, Volume= 1.527 af
 Outflow = 19.24 cfs @ 12.07 hrs, Volume= 1.522 af, Atten= 2%, Lag= 0.2 min
 Primary = 19.24 cfs @ 12.07 hrs, Volume= 1.522 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 35.29' @ 12.07 hrs Surf.Area= 883 sf Storage= 530 cf
 Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

Plug-Flow detention time= 4.8 min calculated for 1.519 af (99% of inflow)
 Center-of-Mass det. time= 2.6 min (764.5 - 762.0)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	10.00'W x 59.00'L x 2.70'H Prismatic
#2	35.21'	1,053 cf	10.00'W x 39.00'L x 2.70'H Forebay-West Impervious
#3	35.17'	1,170 cf	7.50'W x 39.00'L x 4.00'H Forebay-East
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	24.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	24.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.7' Crest Height

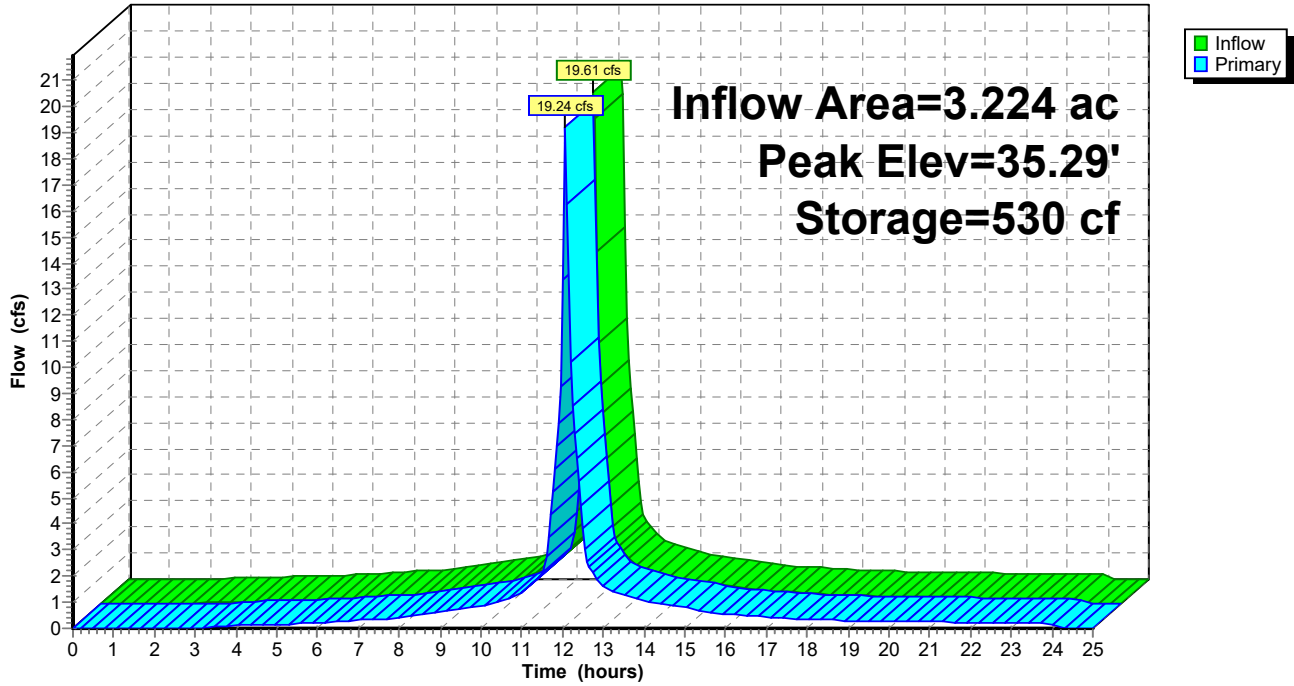
Primary OutFlow Max=18.55 cfs @ 12.07 hrs HW=35.28' (Free Discharge)

↑ **1=Orifice/Grate** (Passes 18.55 cfs of 30.55 cfs potential flow)

↑ **2=Sharp-Crested Rectangular Weir** (Weir Controls 18.55 cfs @ 2.05 fps)

Pond SF1: Sand Filter-1

Hydrograph



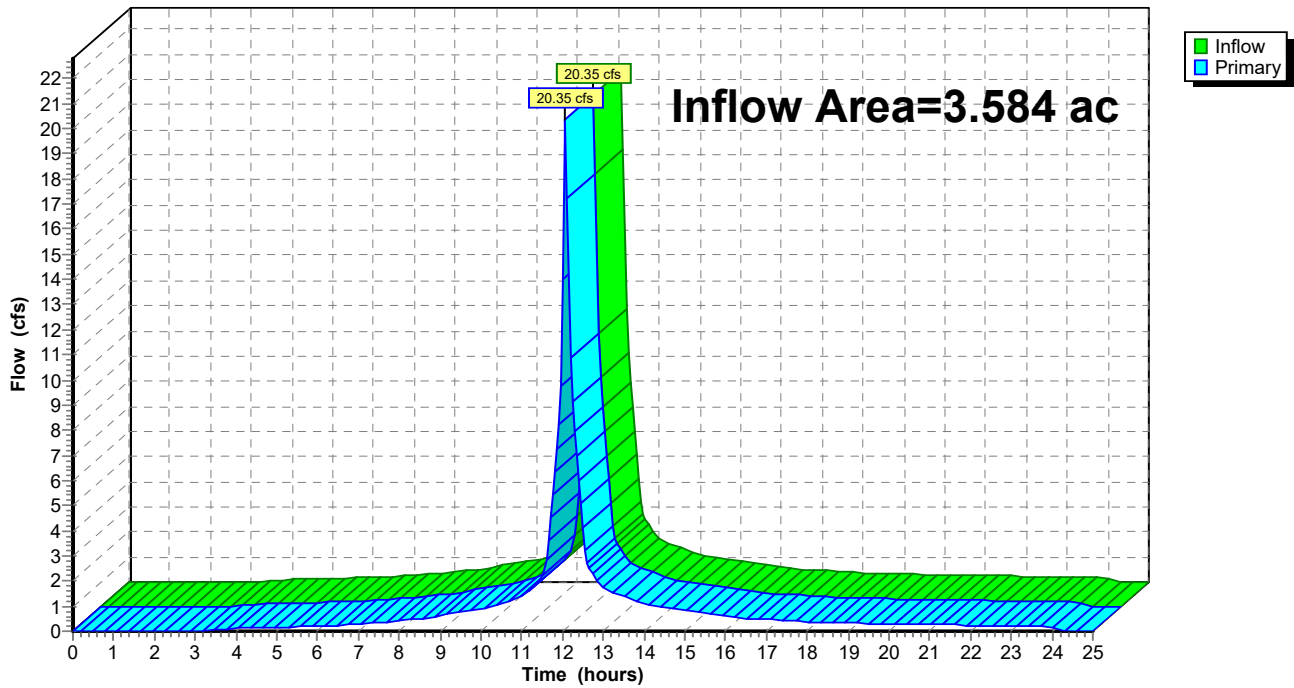
Summary for Link 1L: Cheesecake Brook

Inflow Area = 3.584 ac, 83.75% Impervious, Inflow Depth = 5.36" for 25-Year event
Inflow = 20.35 cfs @ 12.07 hrs, Volume= 1.602 af
Primary = 20.35 cfs @ 12.07 hrs, Volume= 1.602 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook

Hydrograph



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=7.94"
Tc=5.0 min CN=93 Runoff=11.21 cfs 0.873 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=4.66"
Tc=5.0 min UI Adjusted CN=66 Runoff=1.96 cfs 0.140 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=8.30"
Tc=5.0 min CN=96 Runoff=16.43 cfs 1.317 af

Pond SF1: Sand Filter-1 Peak Elev=35.39' Storage=657 cf Inflow=27.64 cfs 2.190 af
Outflow=27.19 cfs 2.185 af

Link 1L: Cheesecake Brook Inflow=29.16 cfs 2.325 af
Primary=29.16 cfs 2.325 af

Total Runoff Area = 3.584 ac Runoff Volume = 2.330 af Average Runoff Depth = 7.80"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: Tc<2dt may require smaller dt

Runoff = 11.21 cfs @ 12.07 hrs, Volume= 0.873 af, Depth= 7.94"

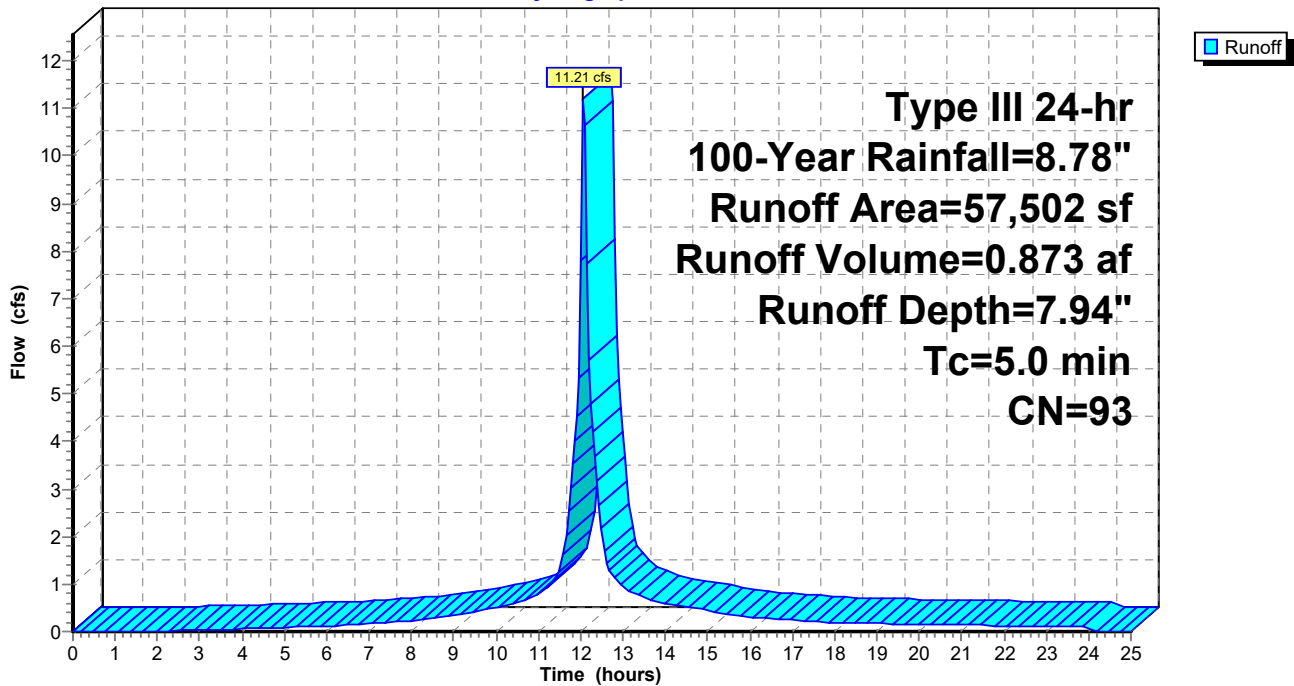
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1

Hydrograph



Summary for Subcatchment FP: FP Area

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 1.96 cfs @ 12.08 hrs, Volume= 0.140 af, Depth= 4.66"

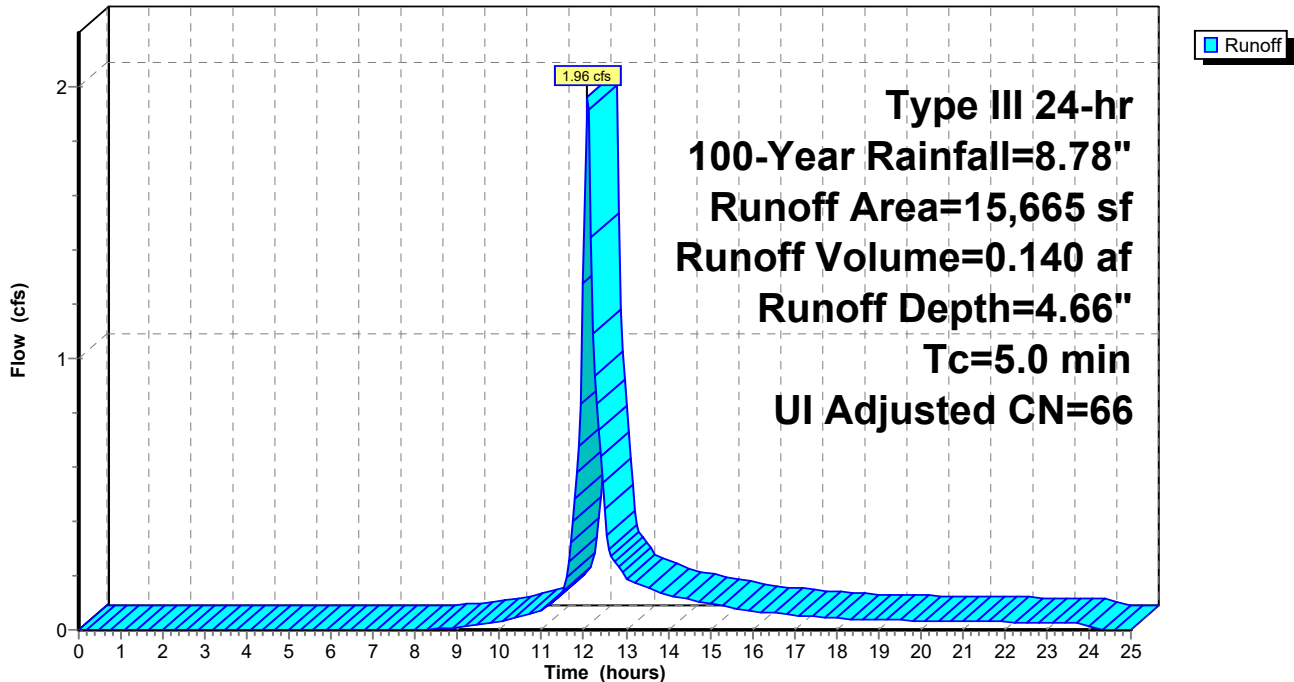
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area

Hydrograph



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: $T_c < 2dt$ may require smaller dt

Runoff = 16.43 cfs @ 12.07 hrs, Volume= 1.317 af, Depth= 8.30"

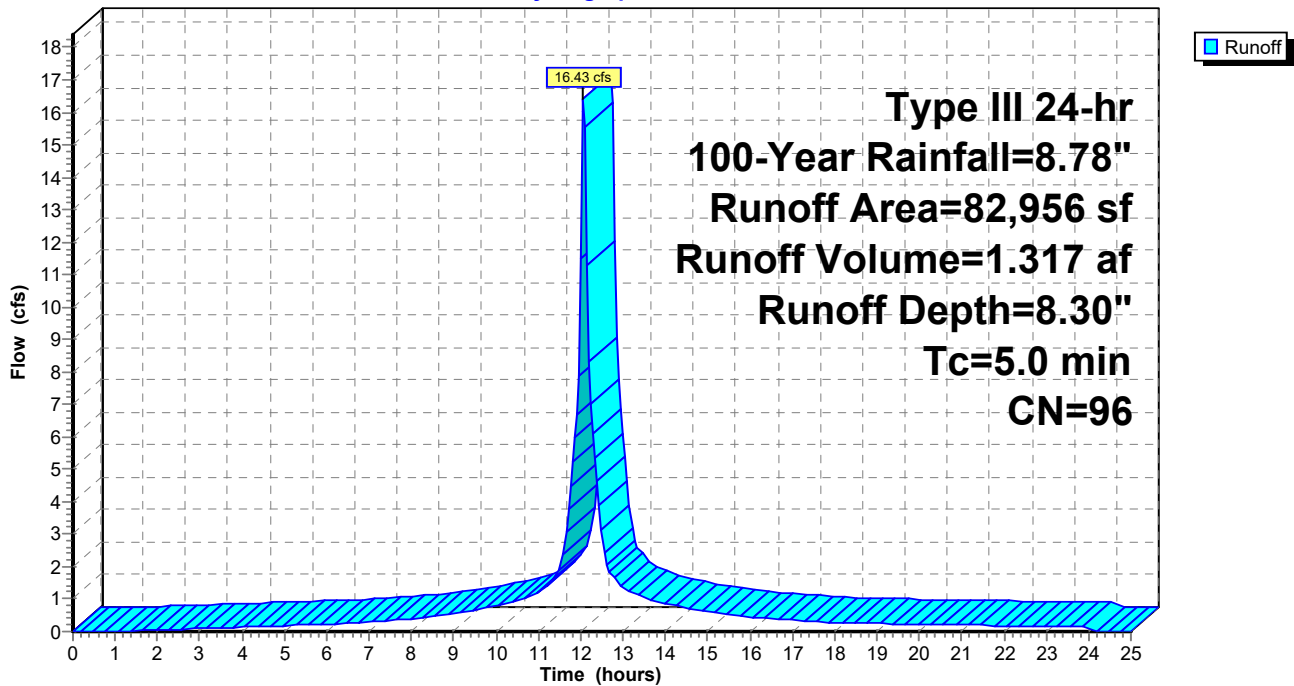
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, $dt= 0.05$ hrs
 Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3

Hydrograph



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 8.15" for 100-Year event
 Inflow = 27.64 cfs @ 12.07 hrs, Volume= 2.190 af
 Outflow = 27.19 cfs @ 12.07 hrs, Volume= 2.185 af, Atten= 2%, Lag= 0.2 min
 Primary = 27.19 cfs @ 12.07 hrs, Volume= 2.185 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
 Peak Elev= 35.39' @ 12.07 hrs Surf.Area= 883 sf Storage= 657 cf
 Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

Plug-Flow detention time= 3.5 min calculated for 2.181 af (100% of inflow)
 Center-of-Mass det. time= 2.0 min (756.7 - 754.7)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	10.00'W x 59.00'L x 2.70'H Prismatic
#2	35.21'	1,053 cf	10.00'W x 39.00'L x 2.70'H Forebay-West Impervious
#3	35.17'	1,170 cf	7.50'W x 39.00'L x 4.00'H Forebay-East
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	24.0" Vert. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	24.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s) 2.7' Crest Height

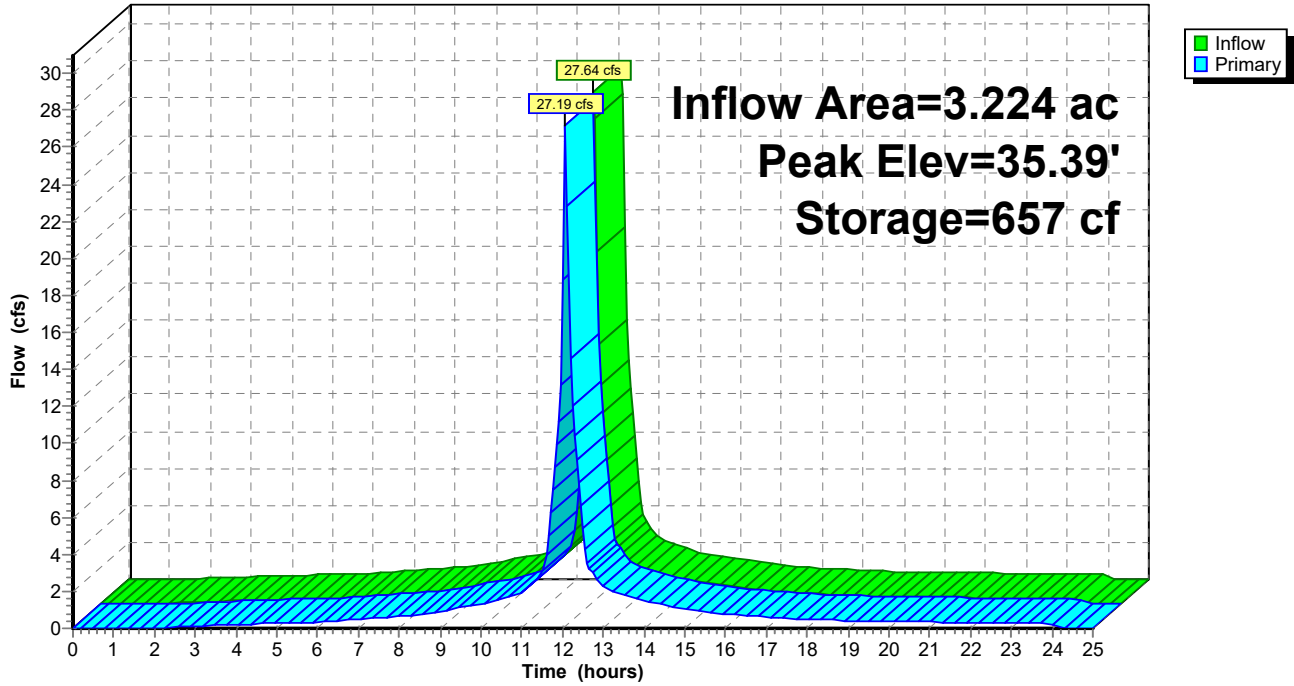
Primary OutFlow Max=26.20 cfs @ 12.07 hrs HW=35.38' (Free Discharge)

↑ **1=Orifice/Grate** (Passes 26.20 cfs of 30.91 cfs potential flow)

↑ **2=Sharp-Crested Rectangular Weir**(Weir Controls 26.20 cfs @ 2.30 fps)

Pond SF1: Sand Filter-1

Hydrograph



Summary for Link 1L: Cheesecake Brook

Inflow Area = 3.584 ac, 83.75% Impervious, Inflow Depth = 7.78" for 100-Year event
Inflow = 29.16 cfs @ 12.07 hrs, Volume= 2.325 af
Primary = 29.16 cfs @ 12.07 hrs, Volume= 2.325 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook

Hydrograph

