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July 24, 2024 Project #365

Charles Tirone
Conservation Administrator – Reading
16 Lowell Street – Town Hall
Reading, MA 01867

555 West Street, Reading, MA – Stormwater Report

Dear Charles,

Quetti Design LLC (DBA Boston Civil) was tasked to complete a stormwater design and report for the proposed single-family renovation/addition located at 555 West Street in Reading. Refer to the attached site plan for additional information.

The Project site is located within the 100-foot inner riparian buffer zone of the Aberjona River and a portion of the site (outside the limit of work) is within Flood Zone AE, with a base flood elevation of 80.7 per the stamped plot plan prepared by Land Mapping Inc.. The Project will result in an increase of impervious area due to the new construction. The change in land use conditions from existing to proposed are summarized below in **Table 1.**

Table 1: Land Use Summary

Existing (SF)	Roof	Site Impervious	Total Impervious	Permeable Pavers	Deck	Lawn (HSG B)	Total Site
	1,355	1,306	2,661	0	194	12,615	15,470
Proposed (SF)	Roof	Site Impervious	Total Impervious	Permeable Pavers	Deck	Lawn (HSG B)	Total Site
	1,586	916	2,502	311	483	12,174	15,470

There is a proposed decrease of 159 SF of impervious area. Note: decks were not modeled as impervious but were modeled separately from landscaped areas in HydroCAD with a lower CN value (<50% grass, poor condition). Additionally, the 311 SF of proposed pervious paver walkway and patio were conservatively modeled as impervious in HydroCAD.

The property is defined in the NRCS database as having Canton fine sandy loam, with 0 to 8 percent slopes, as well as Freetown muck to the northern side of the lot, with 0 to 1 percent slopes. Canton soils are classified as having a hydrologic soil group (HSG) rating B, and Freetown muck HSG rating B/D. A test pit was performed, which is briefly described on the following page. Refer to the Test Pit Report later in this report under **Attachment D**.

A test pit was performed on June 26, 2024. Refer to the Test Pit Report and attachments for additional information. The site was modeled as HSG rating B, and it was determined that a conservative Rawl's Infiltration Rate of 2.41 inches per hour shall be used for infiltration system design since the bottom of the system falls within the gravelly sand layer.

The post construction rates and volumes and the existing runoff rates for the site are noted in **Table 2** below. Rainfall data was taken from NOAA Atlas 14 (**Attachment C**).

Table 2: Pre vs Post Stormwater Flows

1-Year Storm (2.67″)			
Existing Rate (CFS)	**Post Rate (CFS)**	**Pre Volume (CF)**	**Post Volume (CF)**
0.16	**0.11**	**599**	**481**
5-Year Storm (4.34″)			
Existing Rate (CFS)	**Post Rate (CFS)**	**Pre Volume (CF)**	**Post Volume (CF)**
0.58	**0.49**	**1,838**	**1,573**
10-Year Storm (5.21″)			
Existing Rate (CFS)	**Post Rate (CFS)**	**Pre Volume (CF)**	**Post Volume (CF)**
0.84	**0.73**	**2,618**	**2,275**
25-Year Storm (6.40″)			
Existing Rate (CFS)	**Post Rate (CFS)**	**Pre Volume (CF)**	**Post Volume (CF)**
1.23	**1.08**	**3,779**	**3,343**
100-Year Storm (8.24″)			
Existing Rate (CFS)	**Post Rate (CFS)**	**Pre Volume (CF)**	**Post Volume (CF)**
1.85	**1.68**	**5,721**	**5,179**
Storage Required (HSG B) = 0.35-inch x (1 ft / 12 in) x 2,502 SF = 73 CF **Recharge Storage Provided =160.2 CF (See HydroCAD Report)** **Provided Storage = 160.2 CF > 73 CF = Required Storage**			

One infiltration system is proposed to meet the 0.35-inch storage volume requirement sized over the net increase of impervious area. The system consists of one (1) Cultec R-330XLHD chambers surrounded in crushed stone. The system has been designed to collect and infiltrate the runoff from approximately 889 SF of roof area for the 10-year storm event without overflow. For storm events greater than the 10-year storm, a downspout overflow is modeled. Refer to **Attachments E & F** for the existing and proposed HydroCAD calculations. Additionally, to prevent erosion from the repaved driveway, a gravel strip will collect and infiltrate stormwater runoff from the repaved driveway in the southwest edge of the site.

Non-metal roof areas are considered “clean” by the MA DEP, so the system does not require TSS removal per DEP Guidelines so groundwater pollution should not be a concern if the system is maintained properly. In addition, all attempts to keep excavated land lower than surrounding lands (while maintaining proper erosion controls) should be exercised to help mitigate off-site runoff potential. The contractor shall construct and maintain erosion and sediment control measures in accordance with the latest edition of “Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas” prepared by the DEP and as directed by the local permitting authority.

The system has been designed to infiltrate within the required 72-hour drawdown period that is required by the DEP Stormwater Handbook. The “Static” method formula uses the Rawls Rate, storage volume, and bottom area. Refer to the *Drawdown Calculation* on the following page. Refer to the HydroCAD calculations and site plans for additional information on the proposed stormwater management design.

72 Hour Drawdown Calculation

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

Rv = Storage Volume = 160.2 CF (See HydroCAD calculations)

K = Saturated Hydraulic Conductivity for “Static” and “Simple Dynamic” Methods, Rawls Rate = 2.41 in/hr
Bottom Area = Bottom Area of Recharge Structure = 11.5 ft x 7.5 ft = 86 sf

$\text{Time}_{\text{drawdown}}$ = 160.2 CF / (2.41 in/hr)(1 ft / 12 in) (86 sf) = 9.3 hours

<u>Applicable Massachusetts Stormwater Standards for Redevelopment Project</u>

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

> *The project complies with the Standard, refer to the Site Plan Set and HydroCAD calculations in this report. Additionally, a gravel strip has been provided on the edge of the driveway.*

Standard 2 - Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates.

> *The hydrologic model provided with this report demonstrates that the peak runoff rates and volumes will be reduced in the post development conditions. Refer to the Table 2 of this report demonstrating the rates and volumes from the 1-year, 2-year, 10-year, 25-year, and 100-year storm events.*

Standard 3 - Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance.

> *The project complies with the Standard.*

Standard 4 – Water Quality Control

The proposed subsurface infiltration chambers surrounded in crushed stone do not require pretreatment, because non-metal roof areas are considered "clean" by the MA DEP and the Massachusetts Stormwater Handbook.

Standard 5 – High pollutant potential standards

Not applicable, this site is not classified as a Land Use with Higher Potential Pollutant Loads (LUHPPL) per DEP regulations.

Standard 6 – Wellhead protection area, critical area, cold water fishery or beach area standards.

The project site does not discharge runoff to a critical area as defined by the MA DEP.

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 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." A "redevelopment" project is defined in Massachusetts Stormwater Handbook as "Development, rehabilitation, expansion, and phased projects on previously developed sites, provided the redevelopment results in no increase in impervious area.

The project complies with the Standard.

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

The project is disturbing less than one (1) acres, which does not require a NPDES Construction General Permit or a Stormwater Pollution Prevention Plan (SWPPP). Sheet C-2 shows the location of erosion control measures which consists of perimeter sedimentation controls.

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

Refer to the long-term period pollution prevention plan in Attachment B of this report.

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

An illicit discharge compliance statement will be submitted by the contractor if necessary prior to activation of any stormwater management BMP.

Thank you for reviewing this Stormwater Report. If you have any questions or comments, please give me a call.

Best,

Boston Civil

Kevin Quetti, PE
Principal Engineer

Enclosures:

1) Civil Plan Set dated July 24, 2024
2) Attachment A: MA DEP Checklist
3) Attachment B: Stormwater Operations and Maintenance Plan
4) Attachment C: NOAA Atlas 14 Rainfall Data
5) Attachment D: Test Pit Report dated June 25, 2024
6) Attachment E: Existing HydroCAD Calculations
7) Attachment F: Proposed HydroCAD Calculations

Attachment A:
MA DEP Checklist

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

Checklist for Stormwater Report

A. Introduction

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

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

The Stormwater Report must include:

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

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

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

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

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[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.

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

7/10/2024

Signature and Date

Checklist

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

☐ New development

☑ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (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): Subsurface infilatrion system & permeable pavers

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 (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☑ Soil Analysis provided.

☑ Required Recharge Volume calculation provided.

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

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

☑ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

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 (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 (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.

Attachment B:

Stormwater Operations and Maintenance Plan

711 East Broadway
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T: 413-281-6615
BostonCivil@gmail.com

LONG-TERM POLLUTION PREVENTION PLAN AND STORMWATER OPERATION AND MAINTENANCE PLAN

555 West Street, Reading, MA

TABLE OF CONTENTS

1.0 INTRODUCTION

The Responsible Party shall implement the following good housekeeping procedures at the project site to reduce the possibility of accidental releases and to reduce safety hazards.
The purpose of this document is to specify the pollution prevention measures and stormwater management system operation and maintenance for the 555 West Street site. The Responsible Party indicated below shall implement the management practices outlined in this document and proactively conduct operations at the project site in an environmentally responsible manner. Compliance with this Manual does not in any way dismiss the responsible party, owner, property manager, or occupants from compliance with other applicable federal, state or local laws. All post construction maintenance requirements shall run with the title of the property.

Responsible Party: Property Owner(s)
555 West Street
Reading, MA 01867

This Document has been prepared in compliance with Standards 4 and 9 of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards, which state:

Standard 4:
The Long Term Pollution Prevention Plan shall include the proper procedures for the following:

- Good housekeeping
- Storing materials and waste products inside or under cover
- Vehicle washing
- Routine inspections of stormwater best management practices
- Spill prevention and response
- Maintenance of lawns, gardens, and other landscaped areas
- Pet waste management
- Operation and management of septic systems
- Proper management of deicing chemicals and snow

Standard 9:
The Long-Term Operation and Maintenance Plan shall at a minimum include:

- Stormwater management system(s) owner(s)
- The party or parties responsible for operation and maintenance, including how future property owners shall be notified of the presence of the stormwater management system and the requirement for operation and maintenance
- The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks
- A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point
- A description of public safety features
- An estimated operations and maintenance budget

2.0 LONG-TERM POLLUTION PREVENTION PLAN

The Responsible Party shall implement the following good housekeeping procedures at the project site to reduce the possibility of accidental releases and to reduce safety hazards.

2.1 Storage of Hazardous Materials

To prevent leaks and spills, keep hazardous materials and waste products under cover or inside. Use drip pans or spill containment systems to prevent chemicals from entering the drainage system. Inspect storage areas for materials and waste products at least once per year to determine amount and type of the material on site, and if the material requires disposal.

Securely store liquid petroleum products and other liquid chemicals in federally- and state-approved containers. Restrict access to maintenance personnel and administrators.

2.2 Storage of Waste Products

Collect and store all waste materials in securely lidded dumpster(s) or other secure containers as applicable to the material. Keep dumpster lids closed and the areas around them clean. Do not fill the dumpsters with liquid waste or hose them out. Sweep areas around the dumpster regularly and put the debris in the garbage, instead of sweeping or hosing it into the parking lot. Legally dispose of collected waste on a regular basis.

Segregate liquid wastes, including motor oil, antifreeze, solvents, and lubricants, from solid waste and recycle through hazardous waste disposal companies, whenever possible. Separate oil filters, batteries, tires, and metal filings from grinding and polishing metal parts from common trash items and recycle. These items are not trash and are illegal to dump. Contact a hazardous waste hauler for proper disposal to a hazardous waste collection center.

2.3 Spill Prevention and Response

Implement spill response procedures for releases of significant materials such as fuels, oils, or chemical materials onto the ground or other area that could reasonably be expected to discharge to surface or groundwater.

- For minor spills, keep fifty (50) gallon spill control kits and Speedy Dry at all shop and work areas.
- Immediately contact applicable Federal, State, and local agencies for reportable quantities as required by law.
- Immediately perform applicable containment and cleanup procedures following a spill release.
- Promptly remove and dispose of all material collected during the response in accordance with Federal, State and local requirements. A licensed emergency response contractor may be required to assist in cleanup of releases depending on the amount of the release, and the ability of the Contractor to perform the required response.
- Reportable quantities of chemicals, fuels, or oils are established under the Clean Water Act and enforced through Massachusetts Department of Environmental Protection (DEP).

2.4 Minimize Soil Erosion

Soil erosion facilitates mechanical transport of nutrients, pathogens, and organic matter to surface water bodies. Repair all areas where erosion is occurring throughout the project site. Stabilize bare soil with riprap, seed, mulch, or vegetation.

2.5 Vehicle Washing

No vehicle washing will occur onsite.

2.6 Maintenance of Lawns, Gardens, and other Landscaped Areas

Pesticides and fertilizers shall not be used in the landscaped areas associated with the project site and shall not be stored on-site. Dumping of lawn wastes, brush or leaves or other materials or debris is not permitted in any Resource Area. Grass clippings, pruned branches and any other landscaped waste should be disposed of or composted in an appropriate location.

2.7 Management of Deicing Chemicals and Snow

The qualified contractor selected for snow plowing and deicing shall be made fully aware of the requirements of this section.

No road salt (sodium chloride) shall be stored on-site. The use of magnesium chloride de-icing product with a 0.5 to 1.0 percent sodium chloride mix for snow and ice treatment is permitted. The product shall be stored in a locked room inside the building and shall be used at exterior stairs and walkways. The snow plow contractor shall adhere to these magnesium chloride use and storage requirements.

Use of sand is permitted only for impervious roadways and parking areas.

Before winter begins, the property owner and the contractor shall review snow plowing, deicing, and stockpiling procedures. Street and parking area sweeping should be followed in accordance with the Operation and Maintenance Plan.

2.8 Coordination with other Permits and Requirements

Certain conditions of other approvals affecting the long term management of the property shall be considered part of this Long Term Pollution Prevention Plan. The Owner shall become familiar with those documents and comply with the guidelines set forth in those documents.

3.0 STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

3.1 Introduction

This Operation and Maintenance Plan (O&M Plan) for 555 West Street is required under Standard 9 of the 2008 MassDEP Stormwater Handbook to provide best management practices for implementing maintenance activities for the stormwater management system in a manner that minimizes impacts to wetland resource areas or neighboring parcels.

The Owner shall implement this O&M Plan and proactively conduct operations at the site in an environmentally responsible manner. Compliance with this O&M Plan does not in any way dismiss the Owner from compliance with other applicable Federal, State or local laws.

All stormwater best management practices (BMPs) shall be operated and maintained in accordance with the design plans and the Operation and Maintenance Plan approved by the issuing authority. The Owner shall:

a. Maintain an operation and maintenance log for the last three years, including inspections, repairs, replacement and disposal (for disposal the log shall indicate the type of material and the disposal location). This is a rolling log in which the responsible party records all operation and maintenance activities for the past three years.

b. Make this log available to the Conservation Commission upon request; and

c. Allow members and agents of the Conservation Commission to enter and inspect the premises to evaluate and ensure that the Owner complies with the Operation and Maintenance requirements for each BMP.

3.2 Stormwater Operation and Maintenance Requirements

Inspect and maintain the stormwater management system as directed below. Refer to the Site Plan for the location of each component of the system. Repairs to any component of the system shall be made as soon as possible to prevent any potential pollutants (including silt) from entering the resource areas. The annual cost estimate for this maintenance is $500.00.

<u>Subsurface Infiltration Structures</u>

- Inspect subsurface detention/infiltration structures monthly during the first year of operation. Inspect the inlets and observation ports to determine if there is accumulated sediment within the system. Remove all debris and accumulated sediment that may clog the system.
- If sediment is at or above 3”, the contractor shall vacuum system of debris per the manufacturer’s requirements.
- The system shall be inspected every six months after the first year of operation. Adjust the inspection interval based on previous observations of sediment accumulation and high water elevations.
- Inspect gutter screens and install debris control system on gutters. Inspect and clean every 3 months including the downspout connection screen. Improper maintenance of these items will greatly reduce system life.
- Review the Cultec Operation & Maintenance Guidelines for additional requirements.

<u>Permeable Pavers</u>

- Refer to the Maintenance Guide prepared by the Interlocking Concrete Pavement Institute included with this Operations and Maintenance Plan.

<u>Other Measures</u>

- Pavement and walkways shall be swept in the early spring immediately after snow melt and at least twice other times annually.
- Roof drain inlets, downspouts, and roof drain pipes – All components of the roof drain collection system shall be inspected at least 3 times per year. Sediments and debris shall be removed and disposed of in accordance with all applicable federal, state, and local laws. Any components that

become damaged shall be repaired and replaced immediately upon discovery to assure proper conveyance of stormwater runoff into the subsurface infiltration chambers.

- Vegetation shall be maintained in healthy condition to prevent erosion and sedimentation in the drainage system.

3.3 Repair of the Stormwater Management System

The stormwater management system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants including silt from entering the resource areas or the existing closed drainage system.

3.4 Reporting

The Owner shall maintain a record of drainage system inspections and maintenance (per this Plan) and submit a report to the Conservation Commission or Town as required.

STORMWATER MANAGEMENT SYSTEM INSPECTION FORM

555 West Street **Reading, MA**		**Inspected by:____________** **Date:____________**
Component	**Status/Inspection**	**Action Taken**
Subsurface Infiltration System		
Permeable Pavers		
General site conditions – evidence of erosion, etc.		

SUBMIT COPIES OF STORMWATER MANAGEMENT SYSTEM INSPECTION FORM TO THE READING CONSERVATION DEPARTMENT PER TOWN REQUIREMENTS.

Tech Spec Guide

icpi
Interlocking Concrete Pavement Institute®

Your requested ICPI Tech Spec 23 follows this page.

Design and Installation Professionals frequently turn to interlocking concrete pavements and permeable interlocking concrete pavements because they offer lower initial and life cycle costs and provide environmentally sustainable solutions.

ICPI provides resources for ICP and PICP design, construction, and maintenance. These include: Tech Specs, Guide Specs, Detail Drawings, Construction Tolerance Guides, Fact Sheets, Design Manuals and design software. ICPI also offers several relevant continuing education courses at icpi.org and aecdaily.com

Find the right guide for your location.

Many ICPI members subscribe by state or province to this Tech Spec service to support the development and revision of these technical documents. The ICPI website Technical Center offers the opportunity to select Tech Specs by state or province.

ICPI Tech Spec Library

Tech Spec 23

Interlocking Concrete Pavement Institute®

Maintenance Guide for Permeable Interlocking Concrete Pavements

Introduction

Permeable interlocking concrete pavements (PICP) are a proven method for reducing stormwater runoff and pollutants while supporting pedestrian and vehicular traffic. Many laboratory and in-situ research projects over the past two decades by universities, government stormwater agencies, and industry have demonstrated significant runoff and pollutant reductions with cost-saving benefits. The U.S. Federal Highway Administration **www.fhwa.dot.gov/pavement/concrete/pubs/hif19021.pdf** has published information supporting PICP use in walkways, plazas, driveways, parking lots, alleys and streets.

Like all stormwater control measures, PICP requires maintenance as it traps sediment on its surface not unlike an air conditioning filter. Larger particles are initially trapped while allowing water to pass. Some enter the jointing stone and are trapped there. The jointing stone with larger particles eventually captures smaller particles and this decreases the infiltration rate over time. While still infiltrating water, many smaller particles are trapped within the surface and interior joints. Smaller particles are trapped and eventually decrease infiltration which results in surface ponding.

Every PICP site varies in sediment deposition onto its surface, particle size distribution, and the resulting cleaning frequency. For example, beach sand (a coarse particle size distribution) on the surface will not clog as quickly and require less effort removing than fine clay sediment. Besides the particle size distribution, the rate of surface infiltration decline also depends on the traffic, size, and slope of a contributing impervious area, adjacent vegetation and eroding soil, paver joint widths and jointing stone sizes. ICPI offers a PICP site selection

Figure 1. PICP is seeing increased use in municipal streets to reduce stormwater runoff, local flooding, storm pipe upsizing, and combined sewer overflows. These streets are in Atlanta, GA.

Figure 2. Sand-filled joints and bedding common to interlocking concrete pavement **are not used** *in PICP.*

tool on **www.icpi.org/software** to help identify favorable sites and avoid one that may incur additional maintenance.

While routine maintenance assures long-term infiltration, surface infiltration can be restored from neglected maintenance. A significant advantage of PICP is its ability to remove settled or wheel-packed sediment in the joints. This Tech Spec provides guidance on routine and restorative maintenance practices that support surface infiltration. This bulletin also provides guidance on maintaining the surface as an acceptable pedestrian and vehicular surface.

Practices Supporting Surface Infiltration

PICP design and construction that complies with ICPI guidelines are fundamental to long-term surface infiltration. Guidelines are found in ASCE 68-18 standard on PICP, the ICPI manual, *Permeable Interlocking Concrete Pavements* and in *ICPI Tech Spec 18–Construction of Permeable Interlocking Concrete Pavements* available on **www.icpi.org**. Some essential characteristics described below support continued infiltration.

PICP doesn't use sand. Unlike interlocking concrete pavements, sand jointing or bedding materials to support paving units and dense-graded aggregate bases are not used in PICP. Sand joints and bedding allow very little water to enter and often eventually clog for traffic borne detritus and sediment.

Construction E & S control is essential. Erosion and sediment control during construction is covered in the previously mentioned documents, and is customized to each project via the Stormwater Pollution Prevention Plan or SWPPP. An inspection checklist is provided at the end of this bulletin that includes sediment control. If the PICP is built first and construction traffic must use it, then it will very likely require vacuum cleaning upon construction completion. The ideal situation is PICP constructed late in the project such that it will not receive much construction traffic and sediment. This may require using temporary construction roads.

If PICP receives run-on from upslope pervious or impervious areas, inspect these areas for erosion and sediment, yard waste, materials storage, etc. Sweep or vacuum the contributing drainage area clean and free of any dirt, leaves and mulch as they are a major source of PICP clogging. Lawn and planting beds should be sloped away from PICP areas.

Maintain filled joints with stones. The jointing stones capture sediment at the surface so it can easily be removed. If sediment is allowed to settle and consolidate, then cleaning becomes more difficult since the sediment is inside the joint rather than on the surface. Settlement of jointing stones in the first few months is normal to PICP as open-graded aggregates for jointing and bedding choke into the larger base aggregates beneath and stabilize. This settlement often requires the joints to be refilled with aggregates three to six months after their initial installation. If possible, this should be included in the initial construction contract specifications. Aggregate-filled joints facilitate sediment removal at the surface and provide interlock for pavement structural stability.

Keeping the joints filled during the PICP service life is essential to trapping sediment and facilitating its removal at the surface and ensuring long term performance. Permeable segmental paving systems that do not use jointing aggregates may incur higher maintenance time and costs to extract accumulated sediment from deep within the joints and bedding, or eventually move through the base/subbase aggregates onto the subgrade and reduce its infiltration.

Filled paver joints means filled to the bottom of the paver chamfers with jointing stone. If the pavers have very

Figure 3. Whether eroded onto or dumped on PICP, erosion and sediment control are essential during construction.


Figure 4. Keeping PICP joints filled with permeable aggregate facilitates removal of accumulated sediment.

small or no chamfers, then they should be filled within ¼ in. (6 mm) of the paver surface. Should the top of jointing stone settle below ¼ in. (6 mm), vacuum equipment can be less effective in removing sediment and cleaning becomes potentially more expensive.

Manage mulch, topsoil and winter sand. Finally, stockpiling mulch or topsoil on tarps or on other surfaces during site maintenance activities rather than directly on the PICP surface helps maintain infiltration. Figure 5 illustrates an example of correct management of landscaping material on PICP, as well as the need to exposed soil slopes.

Sand used in the winter for traction is not recommended. Figure 6 illustrates the consequence to PICP joints when subjected to winter sand for traction. If used, sand should be removed with vacuuming in the spring to prevent a substantial decrease in surface infiltration. Using jointing aggregate is recommended as a better alternative to using sand for winter traction. In addition, the aggregate can provide some refilling of the joints.

Surface Infiltration Inspection & Testing

Visual Inspection—Effective ways to assess PICP surface infiltration is by conducting visual inspections or tests on the surface before, during and immediately after rainfall.

Inspect Before a Rainfall—Sediment crusted in the joints when dry is the most opportune time to remove it. During dry periods, the sediment layer in each joint can sometimes dry out and curl upward. This layer can be easily loosened by vacuum equipment.

Additionally, deciduous leaves and pine needles eventually get crushed by traffic, degrade, and work their way into the joints, thereby reducing infiltration. See Figures 7 and 8. The site should be inspected for sediments from adjacent eroding areas and those areas stabilized immediately.

Weeds growing from within joints indicate accumulated sediment in the joints and neglected maintenance. See Figure 9. Weeds will not germinate unless there is accu-

Figure 5. Mulch placed on tarps prevents more expensive cleaning of PICP.

Figure 6. Sand from winter maintenance must be removed the following spring.

Figures 7 and 8. Pine needles and leaves eventually will degrade and get compacted into the joints from traffic. They should be removed by sweeping or vacuuming before that happens.

mulated sediment. Weeds should be removed by hand. Herbicide may kill weeds, but dead vegetation and roots will remain. They typically reduce infiltration and should eventually be removed.

Inspect During and Just After a Rainstorm— The extent of puddles and bird baths observed during and especially after rainstorm indicate a need for surface cleaning.

Table 1. ASTM C1781 test results: relationship between time required to infiltrate and calculated surface infiltration rate

Time to infiltrate water		Approximate surface infiltration rate inches/hr (mm/hr)	
Minutes	Seconds	8 lbs. (3.6 kg) water	40 lbs. (18 kg) water
0.5	30	235 (5,913)	1,175 (29,564)
1	60	117 (2,956)	587 (14,782)
2	120	59 (1,478)	294 (7,391)
4	240	29 (739)	147 (3,696)
6	360	20 (493)	98 (2,464)
8	480	15 (370)	73 (1,848)
15	900	8 (197)	39 (985)
30	1800	4 (99)	20 (493)
60	3600	2 (49)	10 (246)

Note: I = (K • M)/(D^2 • t), where
I = Surface infiltration rate, in./hr (mm/hr)
K = 126,870 for US customary units (4,583,666,000 for metric)
M = water mass, lbs (kg)
D = ring diameter (12 in. or 305 mm)
t = time for water to infiltrate in seconds

- Acceptable performance > 100 in./hr (2,500 mm/h)
- Plan to clean soon
- Clean immediately < 20 in./hr (500 mm/hr)

A minor amount of ponding is likely to occur particularly at transitions from impervious pavement surfaces to PICP. This often occurs first as sediment is transported by runoff and vehicles. See Figures 10 and 11. Should ponding areas occupy more than 20% of the entire PICP surface, then surface cleaning should be conducted. While a rainstorm's exact conclusion is difficult to predict, standing water on PICP for more than 15 minutes during or after a rainstorm likely indicates a location approaching clogging.

Test Surface Infiltration—A quick and subjective test for the amount of surface infiltration is pouring water on PICP. If the water spreads rather than infiltrates, the extent of spreading suggests an area that may be clogging. Should more than approximately 20% of the surface area see ponding during or immediately after a rainstorm, a more objective measure of surface infiltration of these areas can be accomplished using ASTM C1781 *Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems.* Figure 12 illustrates the test set up using a 12 in. (300 mm) diameter ring set on plumber's putty. (The ring can be metal or plastic.) Figure 13 illustrates the test apparatus in

Figure 9. Weeds indicate sediment accumulation and lack of surface cleaning to remove it.

Figure 10. Erosion of adjacent asphalt and sediment deposition on PICP.

Figure 11. Ponding on PICP typically first occurs at the junction with impermeable pavement.

Figure 12. Steps in setting up test equipment for measuring surface infiltration using ASTM C1781.

place with water poured into it.

ASTM C1781 test method begins with "pre-wetting" an area inside the ring to ensure the surface and materials beneath are wet. This is done by slowing pouring 8 lbs (3.6 kg) of water while not allowing the head of water on the paver surface to exceed $^{3}/_{8}$ in. (10 mm) depth. If the time to infiltrate 8 lbs of water is less than 30 seconds (using a stopwatch typically on a cell phone), the subsequent test is done using 40 lbs (18 kg) of water. If more than 30 seconds, then 8 lbs of water is used in the subsequent tests. Again, a $^{3}/_{8}$ in. (10 mm) head is maintained during the pour while being timed with a stopwatch. The surface infiltration rate is calculated using formulas in the test method.

If infiltration measurements on ponded areas consistently result in rates below 20 in./hour (508 mm/hr), they require immediate surface cleaning. PICP surfaces sloped over 2% with less than 40 in./hr infiltrate rate require immediate surface cleaning. An infiltration rate of 20 in./hr equates to 30 minutes' infiltration time and 40 in./hr results in 15 minutes. Table 1 further illustrates the relationship between time

Figure 13. ASTM C1781: pouring the wanter into a 12 in. (300 mm) inside diameter ring set on plumber's putty.

for 40 lbs (18 kg) of water to infiltrate and the calculated infiltration rate. ICPI offers a downloadable calculator for converting time of infiltration to infiltration rates when using C1781. See **www.icpi.org/software.**

Surface Infiltration Maintenance Types

Routine and Restorative Maintenance—There are two approaches or service types for maintaining PICP surface infiltration: routine and restorative. Routine maintenance is done regularly to maintain infiltration. It removes most loose sediment and debris from the surface before being trapped and stuck in the jointing aggregates thereby causing clogging. Routine maintenance may require reinstatement of a small amount of jointing stones or none at all.

Routine Maintenance Equipment Options for Maintaining Various Sized PICP Applications

Cleaning Small Pedestrian Areas and Driveways

Theas are typically under 2,000 sf or 200 m^2 and include patios, plazas, sidewalks, and driveways. Equipment options follow:

Hand-held Bristle Broom— Sweep as needed to clear the surface clear of loose debris. See Figure 14.

Leaf Blower (electric or gas powered)—A minimum air speed of 120 mph (190 kph) is recommended. Jointing aggregates remain in place while removing loose debris such as leaves from the surface. See Figure 15.

Rotary Brush with Plastic Bristles—These are often used to spread jointing stone during construction. Same equipment can be used to clean surface to top of joints. Bristles can flip debris out of joints (depends on bristle reach into the joints). A small amount of aggregate may need to be replaced in the joints after using. See Figure 16.

Wet/Dry Shop Vacuum or Walk-behind Vacuum—Use equipment with a minimum 4 (peak) HP motor with minimum 130 cubic feet (3.7 m^3) per minute suction. These machines can remove some jointing aggregates so they may require replenishment. See Figures 17 and 18.

Power Washer—This equipment should be capable of 1,400 to 1,800 psi (9.6 to 12.4 MPa) pressure. Apply the spray at a 30° angle approximately 18 to 24 in. (45 to 60 cm) from the surface and adjust as needed. This equipment will evacuate jointing aggregate and replenishment will be required. Power washing alone generally is not an optimal cleaning approach because there is almost no opportunity on most sites to remove the water-suspended sediment before the water is absorbed back into the pavement. See Figure 19.

Cleaning Large PICP Areas

These are typically over 2,000 sf or 200 m^2 such as large plazas, long sidewalks and driveways, parking lots, alleys and streets. Equipment options follow:

Street Sweepers—These typically have rotating plastic bristle brushes positioned near the curb side and center pickup into a hopper at the rear. Do not use water as it slows removal of loose dirt into the machine. This machine does provide a small vacuum force to manage dust, but the cleaning action is provided by the mechanical sweeping, so it is moderately effective among large machines for removing sediment in the joints. Bristles from the the main broom can reach into joints parallel to the direction of the broom rotation, but have little effect on the joints not aligned with the broom rotation. See Figure 20.

Regenerative Air Sweepers—Includes a box positioned under the truck and on the pavement through which air is blown and recirculated (hence the term regenerative air). The pavement must have no convex (or reverse) crown in order to create an adequate seal for suction in the box. Air pressure flowing through it picks up loose debris and sediment. Rotating brushes can be used to direct dirt and debris toward the box. See Figure 21.

Figure 14. Bristle broom for removing loose debris

Figure 15. Blowing debris to curbs or gutters for removal and disposal.

Figure 16. Rotary brushes increase cleaning efficiencies.

Restorative Infiltration Maintenance for Large Clogged Surfaces

Restorative maintenance is conducted when sediment has lodged in the jointing stones from traffic and weather. The condition indicates that the PICP surfaces have not been regularly cleaned. Restorative maintenance requires some or complete removal of the jointing aggregates to increase infiltration. The depth of jointing stone removed depends on the penetration depth of the sediment into the joints. This can be determined on a sample of a few clogged joints (typically where ponding occurred) by prying out stones and sediment with a flat head screwdriver until little or no accumulated sediment appears.

True Vacuum Sweepers—These can withdraw jointing material and even the concrete pavers. Therefore, the vacuum engine revolutions must be adjusted by the machine operator during a few test runs to find the setting that withdraws the needed depth of sediment and jointing aggregate. After withdrawal, jointing aggregates will require replenishment. The suction orifice is typically about a yard (meter) wide and positioned on the curb side of the truck. Extremely clogged surfaces will require two or more passes. Figure 22 shows this machine. It is often used by municipalities to clean out storm drain catch basins and may require a separate vacuum attachment to clean pavements.

High-power Washing and Vacuum Equipment—Figure 23 shows the equipment for restorative cleaning where water is applied to help loosen sediment and stones in the joints. Figure 23 shows a vacuum that withdraws sediment and stones immediately after applying water. The water and debris are drawn into a vac truck.

Figure 17. Wet/dry shop vacuum cleans loose sediment from a PICP residential driveway

Figure 18. Walk-behind vacuum cleans a small parking area.

Figure 19. Power washing requires a little practice to minimize jointing stone removal.

High Pressure Air/Vacuum—High pressure air is blasted into the joints and has been shown to be very effective at dislodging sediment and debris. A second step is then required to vacuum up the debris that is dislodged. In Figure 24, the machine in the foreground blows debris completely out of the joints and the second machine takes up the debris into a vac truck similar to that used to clean catch basins. See Figure 24. As with all restorative cleaning methods, clean jointing stone is spread and the empty joints are filled. After removing excess stones from the surface, the pavers with filled joints are compacted with a minimum 5,000 lbf (22 kN) vibratory plate compactor operating at 75-90 Hz. See Figure 25. This helps settle the stones into the joints. Any joints were stones have settled should be filled with more stones within a 1/4 inch (5 mm) of the paver surfaces.

Maintenance Equipment Performance

In 2020, the University of Toronto completed a two year research project, Maintenance Equipment Testing on Accelerated Clogged Permeable Interlocking Concrete Pavements. This study evaluated maintenance equipment for restoration of infiltration rates of PICP systems when joints become severely clogged. The research was conducted at the Toronto & Region Conservation Authority's Kortright Centre in Vaughn, Ontario. The research scope of work included the construction of seven 10 ft. by 10 ft. PICP partial infiltration test pads. The cells were carefully clogged to a surface infiltration rate of ≤ 10 in/hr. The sediment infill used to clog the system was regional street cleaning sediments with a known particle size distribution. Five different technologies were investigated: full vacuum sweeper, regenerative air sweeper, dry mechanical sweeper, water pressure washing, and a hybrid high pressure air/vac system specifically designed for permeable pavement. The objective of the study was to evaluate the effectiveness of each method at restoring surface infiltration rates. The impact of cohesive soil sediment was also evaluated as part of the study. All cleaning technologies significantly improve surface infiltration rates. However, the high pressure air-vac hybrid had the best and least variable results, and was the only technique able to fully restore surface infiltration rates. Joint penetration depth was generally a good indicator of restoration effectiveness, except if sediment gradation varies. A complete copy of the report can be found at **https://tinyurl.com/y67zhydz**.

Figure 20. This type of mechanical sweeper removes sediment from joints parallel to the direction of the broom rotation.

Also in 2020 the United States Geological Survey Madison, WI office published results of a four year investigation on cleaning PICP, Assessment of Restorative Maintenance Practices on the Infiltration Capacity of Permeable Pavement Assessment of Restorative Maintenance Practices on the Infiltration Capacity of Permeable Pavement. Since 2014, this research site has collected water quality, temperature, infiltration rates, and surface flow data with three types of permeable pavement sections (pervious asphalt, porous

Figure 21. A regenerative air machine does routine cleaning in a PICP parking lot.

Figure 22. A true vacuum machine cleaning neglected PICP.

concrete, and permeable interlocking concrete pavement). Contributory drainage from an adjacent parking lot provided an opportunity for accelerate clogging and collect data for 9:1 and 5:1 drainage ratios. The following six pavement cleaning methods were evaluated over a 4-year period: manual cleaning with a masonry trowel; Leaf blower and broom; true vacuum; water-enhanced vacuum; high pressure air system; and pressure washer with soil vacuum. An evaluation of the efficiency of each method was based on comparing surface infiltration rates, pre and post cleaning. Surface variability was high due to surface flow patterns across the permeable surfaces. All cleaning methods improved surface infiltration rates. PICP showed the greatest recovery compared to pervious concrete or pervious asphalt. These systems were more difficult to maintain due to sedimentation penetrating into the solid matrix related to the twisting of interconnected pores created during placement. Different cleaning methods produce different results however, in all instances, when the same method was applied, PICP showed the greatest recovery in infiltration capacity. At this particular site the majority of clogging occurred within the top 1 inch. A complete copy of the report can be found at **https://tinyurl.com/yy9nhou8**.

Inspection Intervals and Procedures for Maintaining Surface Infiltration

Routine maintenance provides the best infiltration performance by implementing the following procedures:

1. **Weekly—**Prevent contamination from routine landscape maintenance such as grass clippings from mowing, hedge trimming, mulching plant beds, etc. by:
   - Broom sweep debris from the paver surface, or
   - Blow debris from the paver surface with a powered leaf blower onto other surfaces that will not retransmit it to the PICP surface.
   - Mechanically sweep paver surface.
   - Remove loose debris, leaves, needles, sediment, topsoil, mulch, etc. after severe rain storms using the above procedures.
   - Collect and dispose of debris.
2. **Semi-annually—**Remove loose surface debris from the pavers and jointing stones (1) when trees have defoliated in the fall and (2) at the end of winter snowfall.
   - Use a wet/dry vacuum for small areas and a regenerative air machine for larger areas.

Figure 23. This equipment provides combined washing and vacuum of unmaintained PICP.

Figure 24. This equipment blows sediment and soiled aggregate from the joints and uses vacuum equipment to remove them.

Figure 25. No matter the equipment used, after removing sediment soiled aggregate, clean aggregate is placed in the joints, the surfaced cleaned and compacted.

- Replenish jointing stone as needed to the bottom of the paver chamfers.
- Check any observation wells and outlet pipes from underdrains to confirm drain down and water outflows.

3. **As needed—**Based on observation and during rainstorms and subsequent surface infiltration tests, remove and replenish the jointing stones and sediment using restorative cleaning equipment and procedures.

Note: *Various factors will affect each project's routine maintenance schedule and each must be reviewed individually.*

Winter Maintenance

Snow Removal—Unlike other permeable pavement surfaces, PICP demonstrates durability in the winter. PICP can be plowed with steel or hard rubber blades. Steel blades typically scratch all pavement surfaces. When using commercial snow removal companies, confirm in writing they provide protective edges on the snowplow equipment to avoid scratching the surface. Most pavers have chamfers on their surface edges which can help protect the edges from chipping by snow plows. For smaller areas, use a plastic snow shovel and fit snow blowers with plastic on the scoops and on the gliders. When possible deposit plowed snow onto grassy areas and not on the PICP when the plowed snow is dirty. Such dirt will remain and likely help clog the PICP surface after the snow melts.

Deicers—When used sparingly, deicers should not damage PICP surfaces as the brine typically forms on the surface to lower the freezing temperature of water and eventually moves into the joints with melting ice or snow. Some deicers will accelerate surface wear on some styles of pavers with blasted or hammered surfaces.

A 2020 University of Toronto study on pavement deicing operations quantified some significant winter safety benefits when using PICP. Besides confirming that the use of permeable pavers can eliminate the occurrence of snow melt refreezing and forming black ice, snow and ice can also melt and dry quicker when deicers are used on PICP. More importantly, the research confirmed that a much lower deicing salt application rate is required on PICP compared to impervious asphalt, while still maintaining a high level

Figure 26. This is an example of snow that should have been deposited on a grassy area. If such areas are not available, then vacuum clean the PICP in the early spring.

Table 2. Maintenance guidelines for all PICP distresses

Distress	Activity	Frequency
Clogging	Schedule appropriate routine cleaning method based on site conditions. Utilize restoration cleaning methods as needed when surface infiltration rates decrease below project threshold. Hot spot cleaning may be appropriate.	1 to 2 times annually; adjust frequency based on sediment loading
Clogged/Damaged Secondary Features	Clean out or repair secondary drainage features.	Annually, after major rain event
Depressions	Repair all paver surface depressions, exceeding 0.5 in. (13 mm)	Annually, repair as needed
Rutting	Repair all paver surface rutting, exceeding 0.6 in. (15 mm)	Annually, repair as needed
Faulting	Repair all paver surface faulting, exceeding 0.25 in. (6 mm)	Annually, repair as needed
Damage Paver Units	Replace medium to high severity cracked, spalled or chipped paver units.	Annually, repair as needed
Edge Restraint Damage	Repair pavers offset by more than 0.25 in. (6 mm) from adjacent units or curbs, inlets, etc.	Annually, repair as needed
Excessive Joint Width	Repair pavers exhibiting joint widths exceeding 0.5 in. (13 mm)	Annually, repair as needed
Joint Filler Loss	Replenish aggregate in joints.	As needed
Horizontal Creep	Repair areas exhibiting horizontal creep exceeding 0.4 in. (10 mm)	Annually, repair as needed
Excessive Settlement	For settlements greater than 1 in. consult a pavement engineer versed in OGA design and construction to determine cause and correction.	As needed.
Additional Distresses	Missing pavers shall be replaced. A geotechnical investigation is recommended for pavement heaves.	Annually, repair as needed

of slip and skid resistance. The study also demonstrated that PICP systems can attenuate and buffer the release of salt back into the environment, an important finding since there is concern about snowmelt and stormwater runoff environmentally damaging lakes and rivers.

Deicer types acceptable for use in on PICP surfaces include sodium chloride, calcium chloride and potassium chloride. Do not use magnesium chloride as it will eventually destroy all concrete materials. Anti-icing agents that contain ammonium nitrate and ammonium sulfate should not be used since they can also erode concrete. Always read and follow the manufacturer's recommendations for use and heed all warnings and cautions.

Maintenance for Other Distresses

Over time and traffic, PICP can exhibit other distresses besides surface ponding from clogged joints. These are outlined in Table 2 and remedies are provided.

Utility Restoration Guidelines

1. Remove and store pavers for reuse. Secure undisturbed pavers in opening with wood or metal frame.
2. Remove and dispose of all jointing and bedding aggregate as they typically cannot be re-used.
3. Remove the aggregate base and subbase material. Incidental mixing of base and subbase aggregates is acceptable, but make every effort to separate them. Store in on impermeable pavement or a geotextile to prevent contamination. Do not reuse contaminated aggregate.
4. Re-compact subgrade material as required for stability during utility repairs.
5. Repair or install utility as required.
6. If below the bottom of the subbase, place and compact dense-graded road base in lifts not exceeding 6 in. (150 mm) and compact to 100 percent of standard Proctor maximum dry density. The top of the dense-graded aggregate should be at the same elevation as the bottom of the open-graded subbase aggregate. Alternately flowable fill could be used to reestablish the subgrade surface.
7. Reinstate and compact the subbase aggregate in minimum 6 in. (150 mm) lifts. Use a minimum 13,500 (65 kN) plate compactor with a compaction indicator. Add new subbase aggregate if needed.
8. Reinstate and compact the base aggregate as one 4 in. (100 mm) lift. Use a minimum 13,500 lbf (65 kN) plate compactor with a compaction indicator. A lightweight deflectomer (LWD) can be used to ensure that deflections of the compacted base aggregate are below an average of 0.5 mm (assuming a minimum 12 in. (300 mm)) compacted aggregate subbase. An LWD should be used according to ASTM E2835.
9. Place and screed new bedding aggregate in a consistent thickness layer between 1.5 and 2 in. (38 and 50 mm).
10. Reinstate pavers with at surface at least 1 in. (25 mm) higher than the final elevation. Compact the pavers in two perpendicular directions with a minimum 5,000 lbf (22 kN) plate compactor. Fill joints with aggregate, sweep away excess, and compact the pavers in two perpendicular directions again. Compact pavers so they are level with surrounding pavers.
11. Sweep surface clean and remove any excess aggregate and debris.

Other recommendations include keeping all removed materials clean and free of sediment and debris. Minimize excess debris from construction activities and equipment entering the permeable surface. Store all materials away from the permeable surface, otherwise separate materials from the permeable surface with geotextile. Pavement cuts located parallel and close to the wheel path should be extended to include the wheel path. Cuts located within 3 ft (1 m) of a curb or construction joint should include the removal of the adjacent base and subbase to the edge of the curb or construction joint.

References

Drake, et al. (2020), "De-icing Operations for Permeable Interlocking Concrete Pavements", University of Toronto, Dept. of Civil and Mineral Engineering

Danz, et al. (2020), "Assessment of Restorative Maintenance Practices on the Infiltration Capacity of Permeable Pavement", U.S. Geological Survey, Middleton, WI

icpi

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BOD Approved: August 2020

Attachment C:
NOAA Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 10, Version 3
Location name: Reading, Massachusetts, USA*
Latitude: 42.5308°, Longitude: -71.1314°
Elevation: 89 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.311** (0.240-0.390)	**0.375** (0.289-0.471)	**0.479** (0.369-0.604)	**0.566** (0.433-0.718)	**0.685** (0.509-0.911)	**0.775** (0.565-1.05)	**0.870** (0.618-1.23)	**0.980** (0.658-1.41)	**1.14** (0.739-1.71)	**1.28** (0.808-1.95)
10-min	**0.440** (0.340-0.553)	**0.531** (0.410-0.667)	**0.679** (0.523-0.856)	**0.802** (0.614-1.02)	**0.971** (0.722-1.29)	**1.10** (0.800-1.49)	**1.23** (0.876-1.74)	**1.39** (0.932-2.00)	**1.62** (1.05-2.42)	**1.81** (1.14-2.76)
15-min	**0.518** (0.400-0.650)	**0.625** (0.482-0.785)	**0.799** (0.615-1.01)	**0.943** (0.722-1.20)	**1.14** (0.849-1.52)	**1.29** (0.941-1.76)	**1.45** (1.03-2.05)	**1.63** (1.10-2.36)	**1.90** (1.23-2.84)	**2.13** (1.35-3.24)
30-min	**0.711** (0.550-0.893)	**0.858** (0.663-1.08)	**1.10** (0.846-1.38)	**1.30** (0.994-1.65)	**1.57** (1.17-2.09)	**1.78** (1.30-2.42)	**2.00** (1.42-2.83)	**2.25** (1.51-3.24)	**2.62** (1.70-3.92)	**2.94** (1.86-4.48)
60-min	**0.905** (0.699-1.14)	**1.09** (0.843-1.37)	**1.40** (1.08-1.76)	**1.65** (1.26-2.10)	**2.00** (1.49-2.66)	**2.26** (1.65-3.08)	**2.54** (1.81-3.60)	**2.87** (1.92-4.14)	**3.34** (2.16-5.00)	**3.74** (2.37-5.71)
2-hr	**1.17** (0.914-1.46)	**1.42** (1.11-1.78)	**1.84** (1.42-2.30)	**2.17** (1.68-2.74)	**2.64** (1.98-3.50)	**2.99** (2.20-4.06)	**3.36** (2.42-4.77)	**3.82** (2.58-5.48)	**4.53** (2.94-6.73)	**5.14** (3.26-7.79)
3-hr	**1.36** (1.07-1.70)	**1.66** (1.30-2.06)	**2.14** (1.67-2.67)	**2.54** (1.97-3.19)	**3.09** (2.33-4.09)	**3.50** (2.59-4.74)	**3.94** (2.85-5.59)	**4.50** (3.04-6.42)	**5.36** (3.48-7.92)	**6.11** (3.89-9.21)
6-hr	**1.76** (1.38-2.17)	**2.14** (1.68-2.65)	**2.77** (2.17-3.44)	**3.29** (2.56-4.11)	**4.01** (3.04-5.27)	**4.54** (3.38-6.11)	**5.12** (3.73-7.21)	**5.85** (3.96-8.29)	**6.98** (4.56-10.2)	**7.97** (5.08-11.9)
12-hr	**2.23** (1.77-2.73)	**2.72** (2.16-3.34)	**3.53** (2.79-4.35)	**4.20** (3.30-5.20)	**5.13** (3.90-6.68)	**5.81** (4.34-7.76)	**6.55** (4.78-9.14)	**7.47** (5.09-10.5)	**8.90** (5.83-13.0)	**10.1** (6.48-15.0)
24-hr	**2.67** (2.13-3.24)	**3.30** (2.63-4.02)	**4.34** (3.45-5.31)	**5.21** (4.11-6.41)	**6.40** (4.91-8.30)	**7.28** (5.48-9.67)	**8.24** (6.06-11.4)	**9.44** (6.45-13.2)	**11.3** (7.45-16.4)	**13.0** (8.34-19.1)
2-day	**3.02** (2.43-3.66)	**3.82** (3.07-4.63)	**5.13** (4.10-6.23)	**6.22** (4.94-7.59)	**7.71** (5.96-9.96)	**8.80** (6.69-11.7)	**10.0** (7.45-13.9)	**11.6** (7.95-16.1)	**14.2** (9.32-20.3)	**16.4** (10.6-24.0)
3-day	**3.31** (2.67-3.98)	**4.17** (3.36-5.03)	**5.58** (4.48-6.75)	**6.75** (5.39-8.21)	**8.36** (6.49-10.8)	**9.53** (7.27-12.6)	**10.8** (8.10-15.0)	**12.6** (8.63-17.4)	**15.4** (10.1-22.0)	**17.9** (11.5-26.0)
4-day	**3.59** (2.90-4.30)	**4.48** (3.62-5.38)	**5.93** (4.78-7.15)	**7.13** (5.71-8.65)	**8.79** (6.85-11.3)	**10.0** (7.65-13.2)	**11.4** (8.50-15.7)	**13.1** (9.04-18.1)	**16.0** (10.6-22.8)	**18.6** (12.0-27.0)
7-day	**4.36** (3.55-5.20)	**5.28** (4.29-6.31)	**6.78** (5.50-8.14)	**8.03** (6.47-9.69)	**9.75** (7.63-12.4)	**11.0** (8.45-14.4)	**12.4** (9.30-17.0)	**14.2** (9.84-19.5)	**17.2** (11.4-24.4)	**19.8** (12.8-28.6)
10-day	**5.06** (4.13-6.02)	**6.00** (4.90-7.15)	**7.55** (6.14-9.02)	**8.83** (7.14-10.6)	**10.6** (8.31-13.4)	**11.9** (9.14-15.4)	**13.3** (9.98-18.1)	**15.2** (10.5-20.6)	**18.1** (12.0-25.5)	**20.7** (13.4-29.7)
20-day	**7.04** (5.79-8.31)	**8.08** (6.64-9.55)	**9.78** (8.01-11.6)	**11.2** (9.11-13.4)	**13.1** (10.3-16.4)	**14.6** (11.2-18.6)	**16.1** (12.0-21.3)	**17.9** (12.5-24.2)	**20.6** (13.7-28.7)	**22.8** (14.8-32.4)
30-day	**8.69** (7.18-10.2)	**9.80** (8.09-11.5)	**11.6** (9.56-13.7)	**13.1** (10.7-15.6)	**15.2** (12.0-18.8)	**16.8** (12.9-21.2)	**18.4** (13.6-24.0)	**20.2** (14.1-27.1)	**22.6** (15.1-31.4)	**24.5** (16.0-34.7)
45-day	**10.8** (8.96-12.6)	**12.0** (9.94-14.0)	**13.9** (11.5-16.4)	**15.6** (12.8-18.4)	**17.8** (14.0-21.8)	**19.5** (15.0-24.4)	**21.2** (15.6-27.3)	**22.9** (16.1-30.6)	**25.1** (16.9-34.7)	**26.7** (17.4-37.7)
60-day	**12.6** (10.5-14.7)	**13.8** (11.5-16.2)	**15.9** (13.2-18.6)	**17.6** (14.5-20.7)	**19.9** (15.7-24.3)	**21.7** (16.7-27.0)	**23.5** (17.3-30.0)	**25.2** (17.8-33.4)	**27.2** (18.4-37.5)	**28.7** (18.7-40.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

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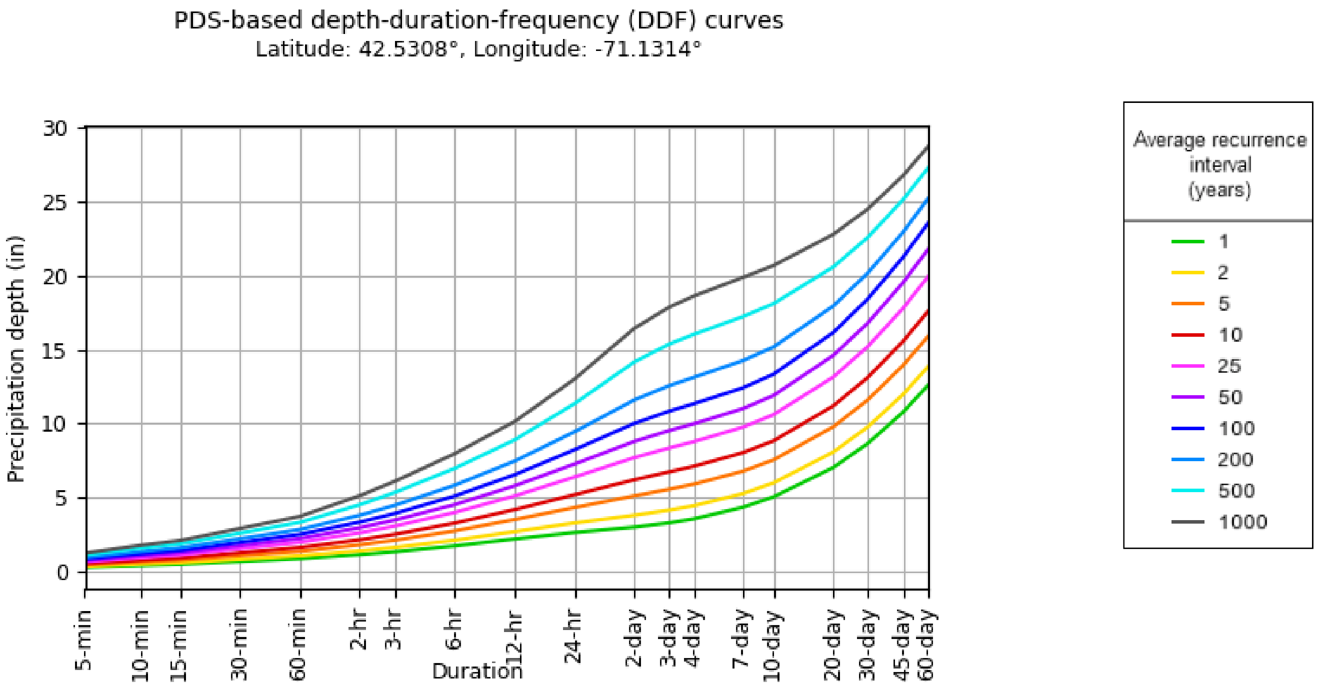
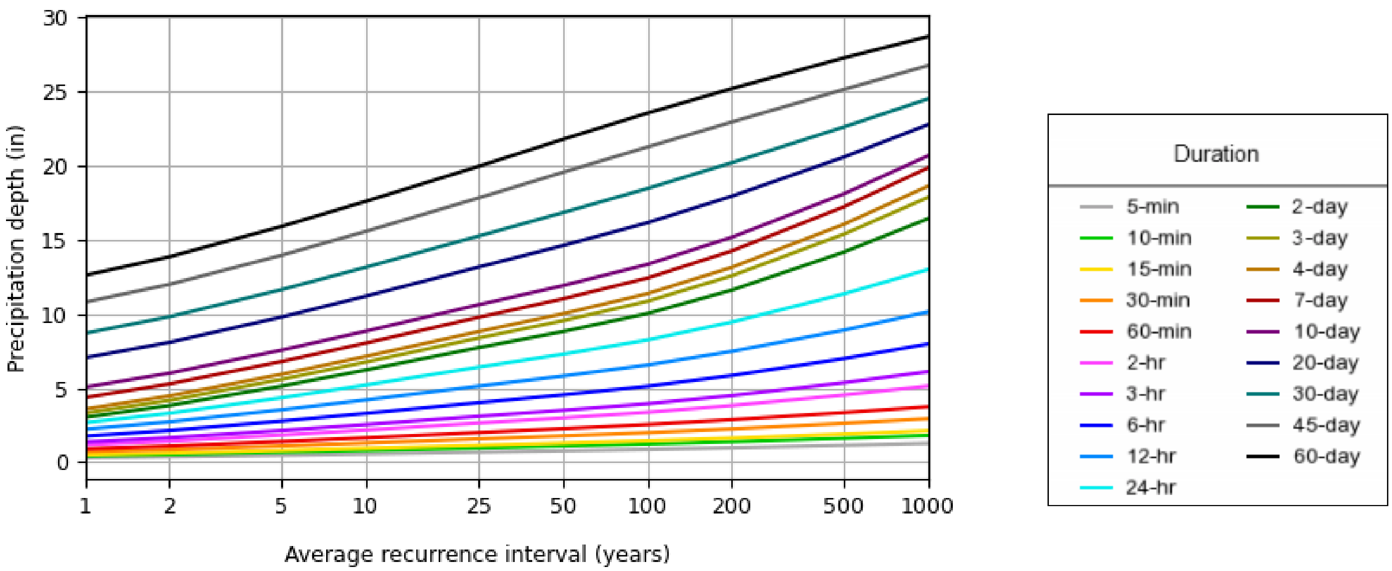
PF graphical





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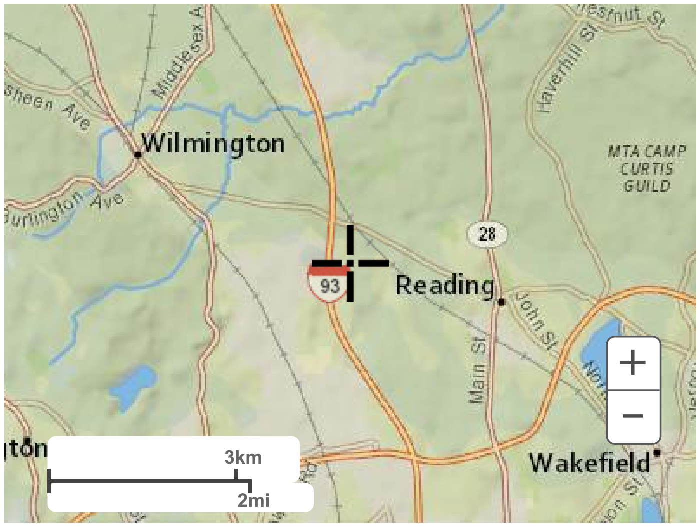
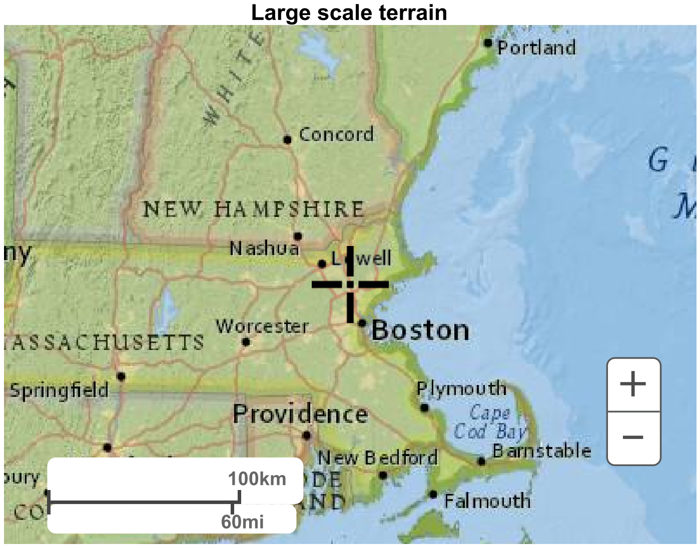
Maps & aerials

Small scale terrain



Large scale terrain



Large scale map

Large scale aerial

Attachment D:
Test Pit Report

BOSTON CIVIL
ENGINEERING & LAND PLANNING

711 East Broadway
Boston, MA 02127
T: 413-281-6615
BostonCivil@gmail.com

June 25, 2024 Project #365

Charles Tirone
Conservation Administrator - Reading
16 Lowell Street – Town Hall
Reading, MA 01867

555 West Street, Reading, MA – Test Pit Report

Dear Charles,

Two test pits were conducted at the single-family residence at the location noted above. Quetti Design LLC (DBA Boston Civil) was tasked to determine the consistency or deviation of the soils in relation to the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) database. Refer to the site plan set and the attached exhibits which show the approximate location of the test pit and soil profile. The test pit was performed at 10:00 AM on Monday, June 24, 2024. The observations are described below.

The property is defined in the NRCS database as having Canton fine sandy loam, with 0 to 8 percent slopes, as well as Freetown muck to the northern side of the lot, with 0 to 1 percent slopes. Canton soils are classified as having a hydrologic soil group (HSG) rating B, and Freetown muck HSG rating B/D.

Soil Observations:

Test Pit #1

This test pit was divided into three layers for the purposes of analysis and report. Layer 1, the shallowest, was observed at 6 inches thick and consisted of fill. Layer 2 was observed at 21 inches thick and consisted of gravelly fine sandy loam. Layer 3 was observed at 53 inches thick to the bottom of excavation and consisted of very gravelly sand. No groundwater, redox features, and weeping were observed, and the excavation was stopped due to large stones. Based on these observations, the system shall be designed with a conservative Rawl's Rate of 2.41 inches per hour.

Test Pit #2

This test pit was divided into three layers for the purposes of analysis and report. Layer 1, the shallowest, was observed at 6 inches thick and consisted of fill. Layer 2 was observed at 20 inches thick and consisted of dense fine sand. Layer 3 was observed at 7 inches thick to the bottom of excavation and consisted of peat. Due to the presence of peat, it is not recommended that a stormwater system be placed in this area.

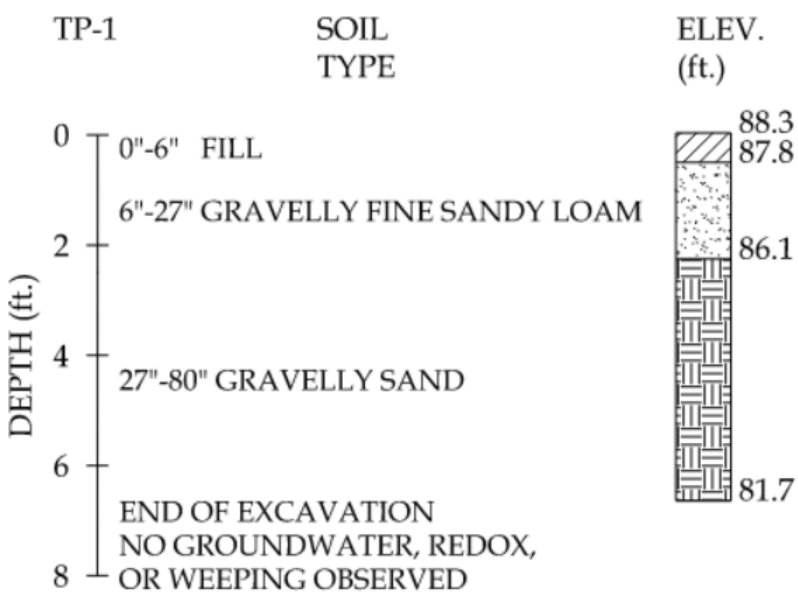
Canton soil is known for being well drained and Freetown muck is known for being very poorly drained, but the site has been previously developed and the NRCS maps do not provide an accurate reflection of the current conditions. The system shall be designed to drawdown within the required 72-hour period as required by the Massachusetts Stormwater Handbook. In addition, all attempts to keep excavated land lower than surrounding lands (while maintaining proper erosion controls) should be exercised to help mitigate off-site runoff potential. The contractor shall construct and maintain erosion and sediment control measures in accordance with the latest edition of "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas" prepared by the DEP and as directed by the local permitting authority. The contractor shall notify the engineer if any discrepancies from the data in this report are observed in the field prior to construction.

This analysis shall only be used for stormwater infiltration use to help determine the rate at which the system may drain and to estimate the seasonal high groundwater elevation. No other use is expressed or implied.

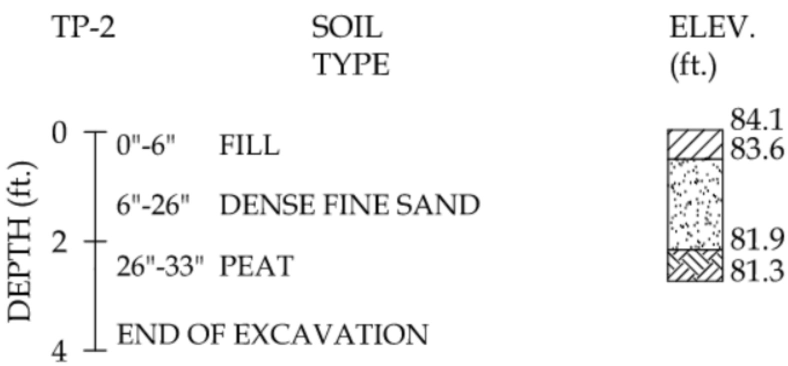
Respectfully submitted,

Kevin Quetti, PE
Principal Engineer
Boston Civil

Test Pit #1 Photo and Profile Sketch (Not to Scale)



Test Pit #2 Photo and Profile Sketch (Not to Scale)



Soil Map (555 West Street, Reading, MA)

Map Scale: 1:2,600 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 35, 70, 140, 210

Feet: 0, 100, 200, 400, 600

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

Middlesex County, Massachusetts

6A—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svky
Elevation: 0 to 1,320 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Scarboro and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro

Setting

Landform: Drainageways, outwash deltas, outwash terraces, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from schist and/or sandy glaciofluvial deposits derived from gneiss and/or sandy glaciofluvial deposits derived from granite

Typical profile

Oe - 0 to 3 inches: mucky peat
A - 3 to 11 inches: mucky fine sandy loam
Cg1 - 11 to 21 inches: sand
Cg2 - 21 to 65 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Ecological site: F144AY031MA - Very Wet Outwash
Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Wareham

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Walpole

Percent of map unit: 5 percent
Landform: Deltas, depressions, outwash terraces, depressions, outwash plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Freetown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Depressions, depressions, swamps, kettles, marshes, bogs
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Surface area covered with cobbles, stones or boulders: 0.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: F144AY043MA - Acidic Organic Wetlands
Hydric soil rating: Yes

Minor Components

Whitman

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 5 percent
Landform: Bogs, swamps, marshes, depressions, depressions, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

104C—Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w69p
Elevation: 0 to 1,270 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis, extremely stony, and similar soils: 35 percent
Charlton, extremely stony, and similar soils: 25 percent
Rock outcrop: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis, Extremely Stony

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 7 inches: gravelly fine sandy loam
Bw - 7 to 16 inches: gravelly fine sandy loam
2R - 16 to 26 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 8 to 23 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton, Extremely Stony

Setting

Landform: Hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Ridges, hills
Parent material: Igneous and metamorphic rock

Typical profile

R - 0 to 79 inches: bedrock

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)

Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Canton, extremely stony

Percent of map unit: 7 percent
Landform: Moraines, hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, extremely stony

Percent of map unit: 6 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Montauk, extremely stony

Percent of map unit: 1 percent
Landform: Hills, recessionial moraines, ground moraines, drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Scituate, extremely stony

Percent of map unit: 1 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

255A—Windsor loamy sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkg
Elevation: 0 to 990 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Windsor, loamy sand, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Windsor, Loamy Sand

Setting

Landform: Outwash plains, outwash terraces, deltas, dunes
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Loose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss

Typical profile

O - 0 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: loamy sand
Bw - 3 to 25 inches: loamy sand
C - 25 to 65 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Deerfield, loamy sand
Percent of map unit: 10 percent
Landform: Deltas, terraces, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Hinckley, loamy sand
Percent of map unit: 5 percent
Landform: Deltas, kames, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, side slope, crest, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

256A—Deerfield loamy fine sand, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2xfg8
Elevation: 0 to 1,100 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Deerfield and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Deerfield

Setting
Landform: Outwash terraces, outwash deltas, outwash plains, kame terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand
Bw - 9 to 25 inches: loamy fine sand
BC - 25 to 33 inches: fine sand
Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: About 15 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Sodium adsorption ratio, maximum: 11.0
Available water supply, 0 to 60 inches: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A
Ecological site: F144AY027MA - Moist Sandy Outwash
Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 7 percent
Landform: Outwash terraces, kame terraces, outwash deltas, outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Wareham

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Sudbury

Percent of map unit: 2 percent
Landform: Outwash plains, kame terraces, outwash deltas, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex, linear
Across-slope shape: Convex, linear, concave
Hydric soil rating: No

Ninigret

Percent of map unit: 1 percent
Landform: Kame terraces, outwash plains, outwash terraces
Landform position (three-dimensional): Tread
Down-slope shape: Convex, linear

Across-slope shape: Convex, concave
Hydric soil rating: No

302B—Montauk fine sandy loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w80t
Elevation: 30 to 1,120 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Montauk, extremely stony, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Montauk, Extremely Stony

Setting

Landform: Ground moraines, drumlins, recessionial moraines, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 6 inches: fine sandy loam
Bw1 - 6 to 28 inches: fine sandy loam
Bw2 - 28 to 36 inches: sandy loam
2Cd - 36 to 74 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 1.42 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Minor Components

Scituate, extremely stony

Percent of map unit: 8 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Canton, extremely stony

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Ridgebury, extremely stony

Percent of map unit: 2 percent
Landform: Depressions, ground moraines, hills, drainageways
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

422B—Canton fine sandy loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w818
Elevation: 0 to 1,180 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Canton, extremely stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canton, Extremely Stony

Setting

Landform: Moraines, hills, ridges
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 5 inches: fine sandy loam
Bw1 - 5 to 16 inches: fine sandy loam
Bw2 - 16 to 22 inches: gravelly fine sandy loam
2C - 22 to 67 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Scituate, extremely stony

Percent of map unit: 6 percent
Landform: Hills, ground moraines, drumlins
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Charlton, extremely stony

Percent of map unit: 6 percent
Landform: Ridges, ground moraines, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest

Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

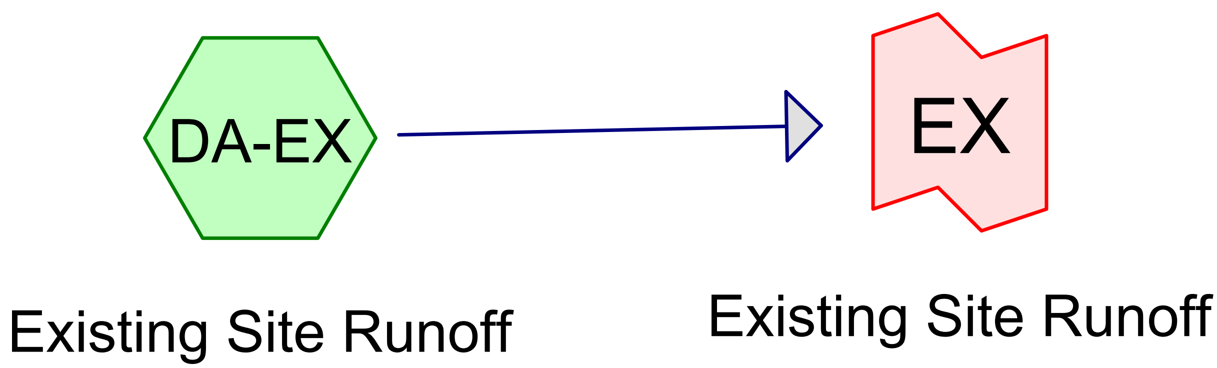
Montauk, extremely stony

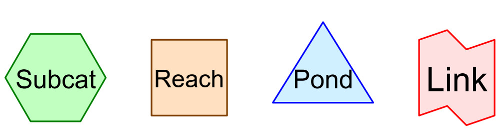
Percent of map unit: 4 percent
Landform: Recessionial moraines, ground moraines, hills, drumlins
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Hydric soil rating: No

Swansea

Percent of map unit: 4 percent
Landform: Marshes, depressions, bogs, swamps, kettles
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Attachment E:
Existing HydroCAD Calculations





Routing Diagram for 555 West Street-Reading
Prepared by Boston Civil, Printed 7/3/2024
HydroCAD® 10.10-6a s/n 12058 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	NOAA 24-hr	D	Default	24.00	1	2.67	2
2	5 Year	NOAA 24-hr	D	Default	24.00	1	4.34	2
3	10 Year	NOAA 24-hr	D	Default	24.00	1	5.21	2
4	25 Year	NOAA 24-hr	D	Default	24.00	1	6.40	2
5	100 Year	NOAA 24-hr	D	Default	24.00	1	8.24	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
194	79	<50% Grass cover, Poor, HSG B (DA-EX)
12,615	61	>75% Grass cover, Good, HSG B (DA-EX)
1,306	98	Paved parking, HSG B (DA-EX)
1,355	98	Roofs, HSG B (DA-EX)
15,470	**68**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
15,470	HSG B	DA-EX
0	HSG C	
0	HSG D	
0	Other	
15,470		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
0	194	0	0	0	194	<50% Grass cover, Poor	
0	12,615	0	0	0	12,615	>75% Grass cover, Good	
0	1,306	0	0	0	1,306	Paved parking	
0	1,355	0	0	0	1,355	Roofs	
0	**15,470**	**0**	**0**	**0**	**15,470**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-EX: Existing Site Runoff Runoff Area=15,470 sf 17.20% Impervious Runoff Depth=0.46"
Tc=6.0 min CN=68 Runoff=0.16 cfs 599 cf

Link EX: Existing Site Runoff Inflow=0.16 cfs 599 cf
Primary=0.16 cfs 599 cf

Total Runoff Area = 15,470 sf Runoff Volume = 599 cf Average Runoff Depth = 0.46"
82.80% Pervious = 12,809 sf 17.20% Impervious = 2,661 sf

Summary for Subcatchment DA-EX: Existing Site Runoff

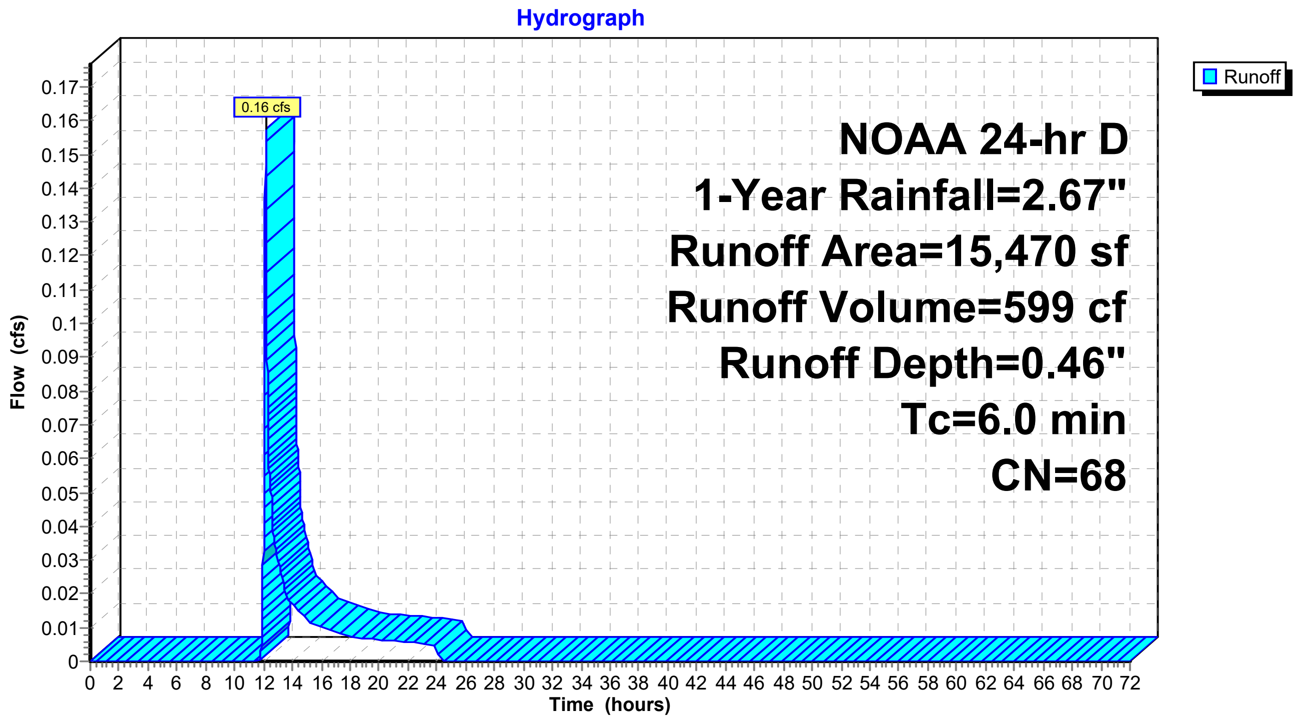
Runoff = 0.16 cfs @ 12.14 hrs, Volume= 599 cf, Depth= 0.46"
Routed to Link EX : Existing Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 1-Year Rainfall=2.67"

Area (sf)	CN	Description
1,355	98	Roofs, HSG B
1,306	98	Paved parking, HSG B
12,615	61	>75% Grass cover, Good, HSG B
194	79	<50% Grass cover, Poor, HSG B
15,470	68	Weighted Average
12,809		82.80% Pervious Area
2,661		17.20% Impervious Area

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

Subcatchment DA-EX: Existing Site Runoff

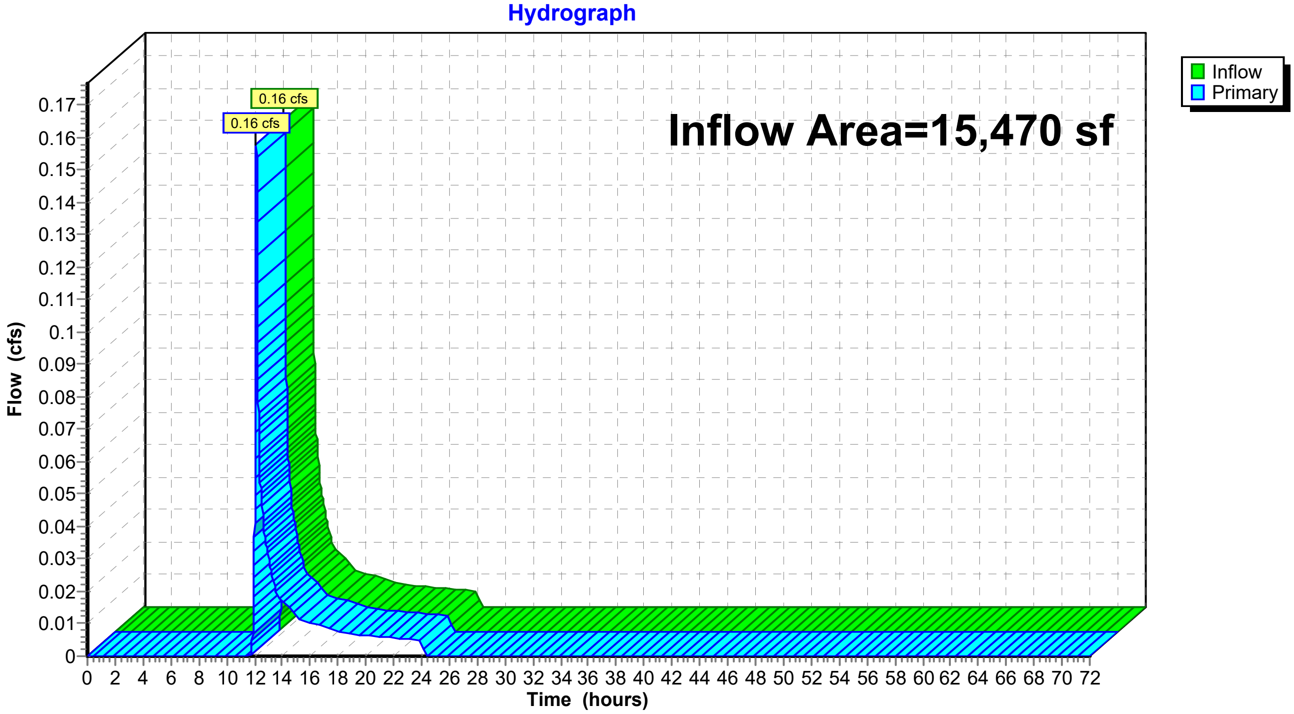


Summary for Link EX: Existing Site Runoff

Inflow Area = 15,470 sf, 17.20% Impervious, Inflow Depth = 0.46" for 1-Year event
Inflow = 0.16 cfs @ 12.14 hrs, Volume= 599 cf
Primary = 0.16 cfs @ 12.14 hrs, Volume= 599 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link EX: Existing Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-EX: Existing Site Runoff Runoff Area=15,470 sf 17.20% Impervious Runoff Depth=1.43"
Tc=6.0 min CN=68 Runoff=0.58 cfs 1,838 cf

Link EX: Existing Site Runoff Inflow=0.58 cfs 1,838 cf
Primary=0.58 cfs 1,838 cf

Total Runoff Area = 15,470 sf Runoff Volume = 1,838 cf Average Runoff Depth = 1.43"
82.80% Pervious = 12,809 sf 17.20% Impervious = 2,661 sf

Summary for Subcatchment DA-EX: Existing Site Runoff

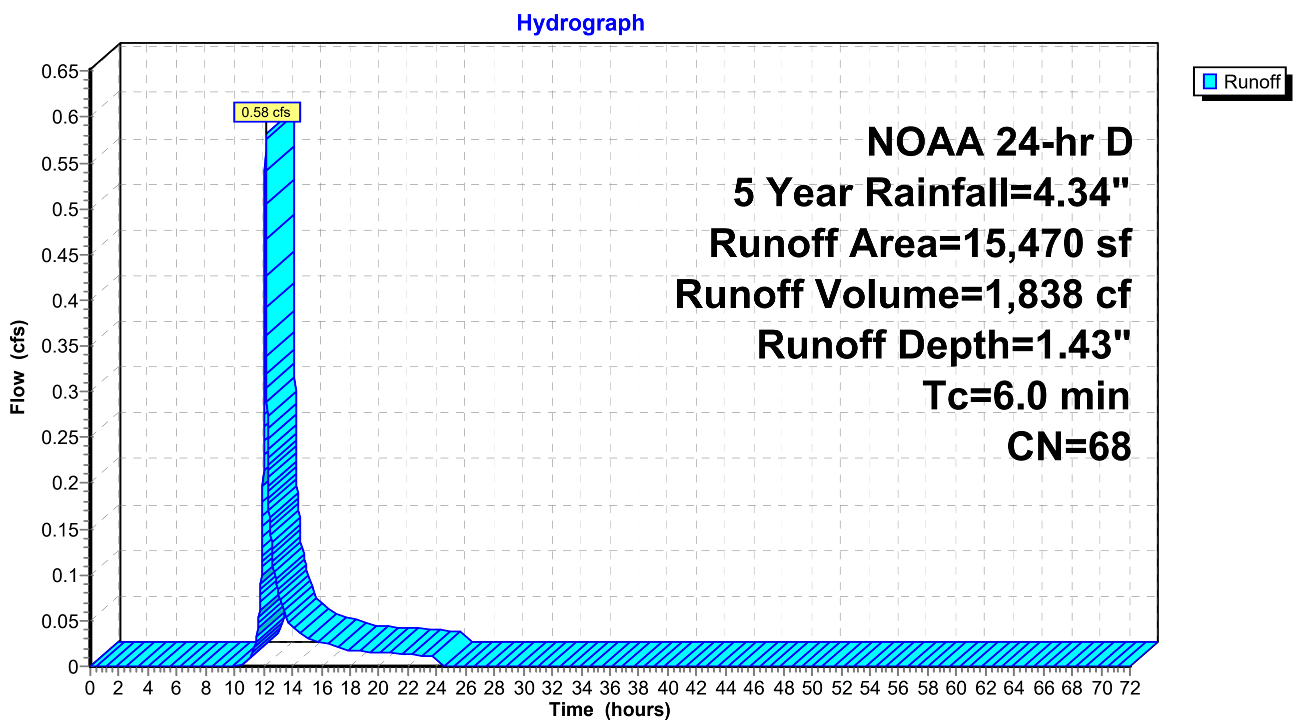
Runoff = 0.58 cfs @ 12.14 hrs, Volume= 1,838 cf, Depth= 1.43"
Routed to Link EX : Existing Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 5 Year Rainfall=4.34"

Area (sf)	CN	Description
1,355	98	Roofs, HSG B
1,306	98	Paved parking, HSG B
12,615	61	>75% Grass cover, Good, HSG B
194	79	<50% Grass cover, Poor, HSG B
15,470	68	Weighted Average
12,809		82.80% Pervious Area
2,661		17.20% Impervious Area

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

Subcatchment DA-EX: Existing Site Runoff

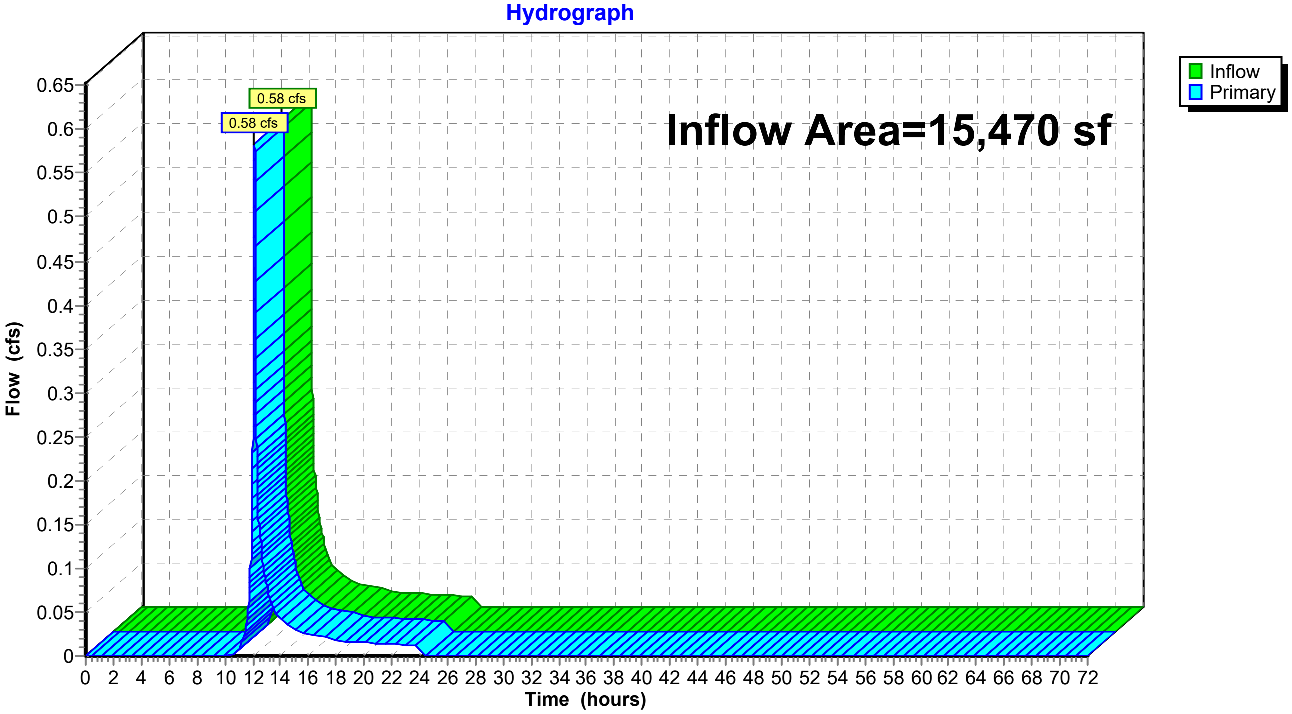


Summary for Link EX: Existing Site Runoff

Inflow Area = 15,470 sf, 17.20% Impervious, Inflow Depth = 1.43" for 5 Year event
Inflow = 0.58 cfs @ 12.14 hrs, Volume= 1,838 cf
Primary = 0.58 cfs @ 12.14 hrs, Volume= 1,838 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link EX: Existing Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-EX: Existing Site Runoff Runoff Area=15,470 sf 17.20% Impervious Runoff Depth=2.03"
Tc=6.0 min CN=68 Runoff=0.84 cfs 2,618 cf

Link EX: Existing Site Runoff Inflow=0.84 cfs 2,618 cf
Primary=0.84 cfs 2,618 cf

Total Runoff Area = 15,470 sf Runoff Volume = 2,618 cf Average Runoff Depth = 2.03"
82.80% Pervious = 12,809 sf 17.20% Impervious = 2,661 sf

Summary for Subcatchment DA-EX: Existing Site Runoff

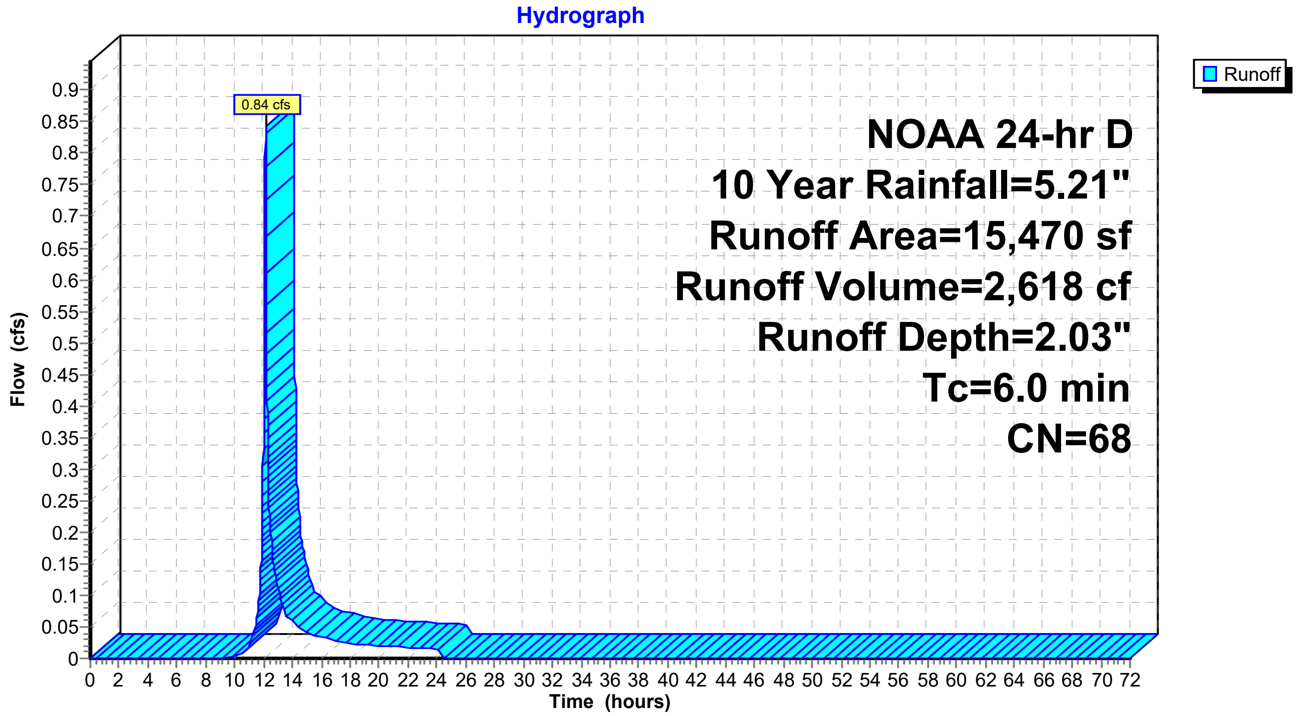
Runoff = 0.84 cfs @ 12.13 hrs, Volume= 2,618 cf, Depth= 2.03"
Routed to Link EX : Existing Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10 Year Rainfall=5.21"

Area (sf)	CN	Description
1,355	98	Roofs, HSG B
1,306	98	Paved parking, HSG B
12,615	61	>75% Grass cover, Good, HSG B
194	79	<50% Grass cover, Poor, HSG B
15,470	68	Weighted Average
12,809		82.80% Pervious Area
2,661		17.20% Impervious Area

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

Subcatchment DA-EX: Existing Site Runoff

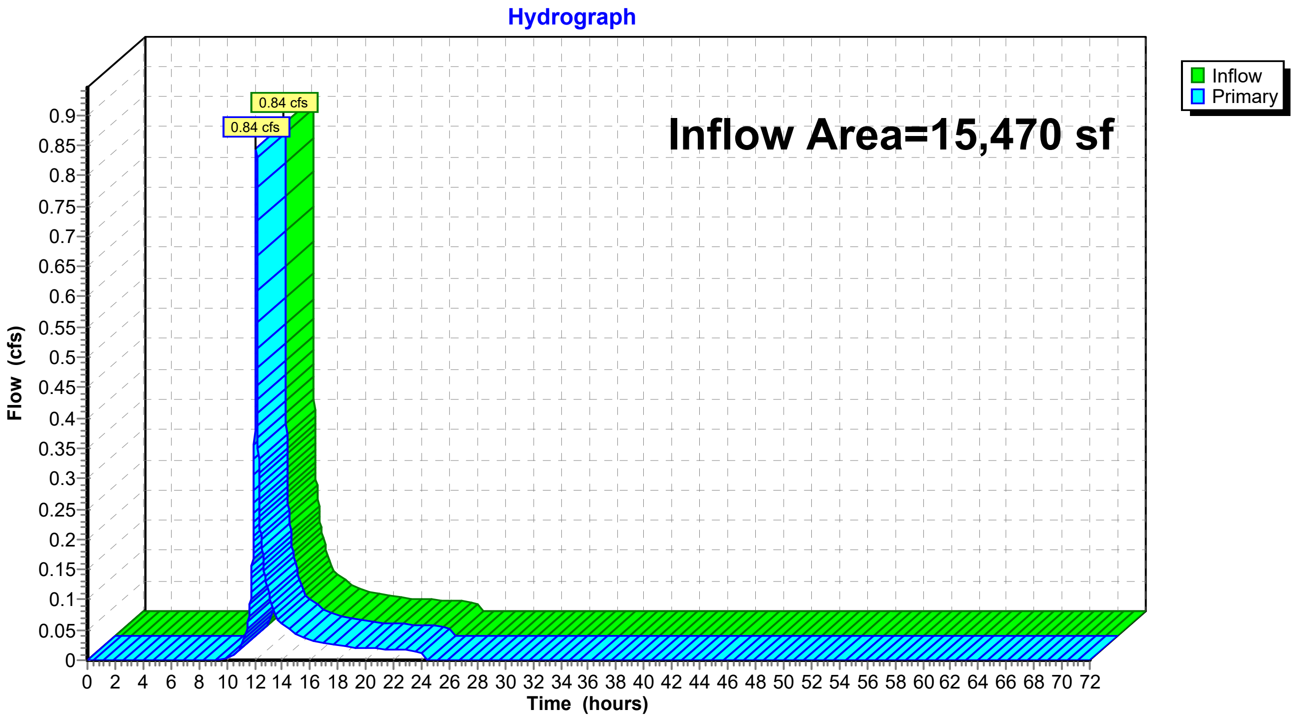


Summary for Link EX: Existing Site Runoff

Inflow Area = 15,470 sf, 17.20% Impervious, Inflow Depth = 2.03" for 10 Year event
Inflow = 0.84 cfs @ 12.13 hrs, Volume= 2,618 cf
Primary = 0.84 cfs @ 12.13 hrs, Volume= 2,618 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link EX: Existing Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-EX: Existing Site Runoff Runoff Area=15,470 sf 17.20% Impervious Runoff Depth=2.93"
Tc=6.0 min CN=68 Runoff=1.23 cfs 3,779 cf

Link EX: Existing Site Runoff Inflow=1.23 cfs 3,779 cf
Primary=1.23 cfs 3,779 cf

Total Runoff Area = 15,470 sf Runoff Volume = 3,779 cf Average Runoff Depth = 2.93"
82.80% Pervious = 12,809 sf 17.20% Impervious = 2,661 sf

Summary for Subcatchment DA-EX: Existing Site Runoff

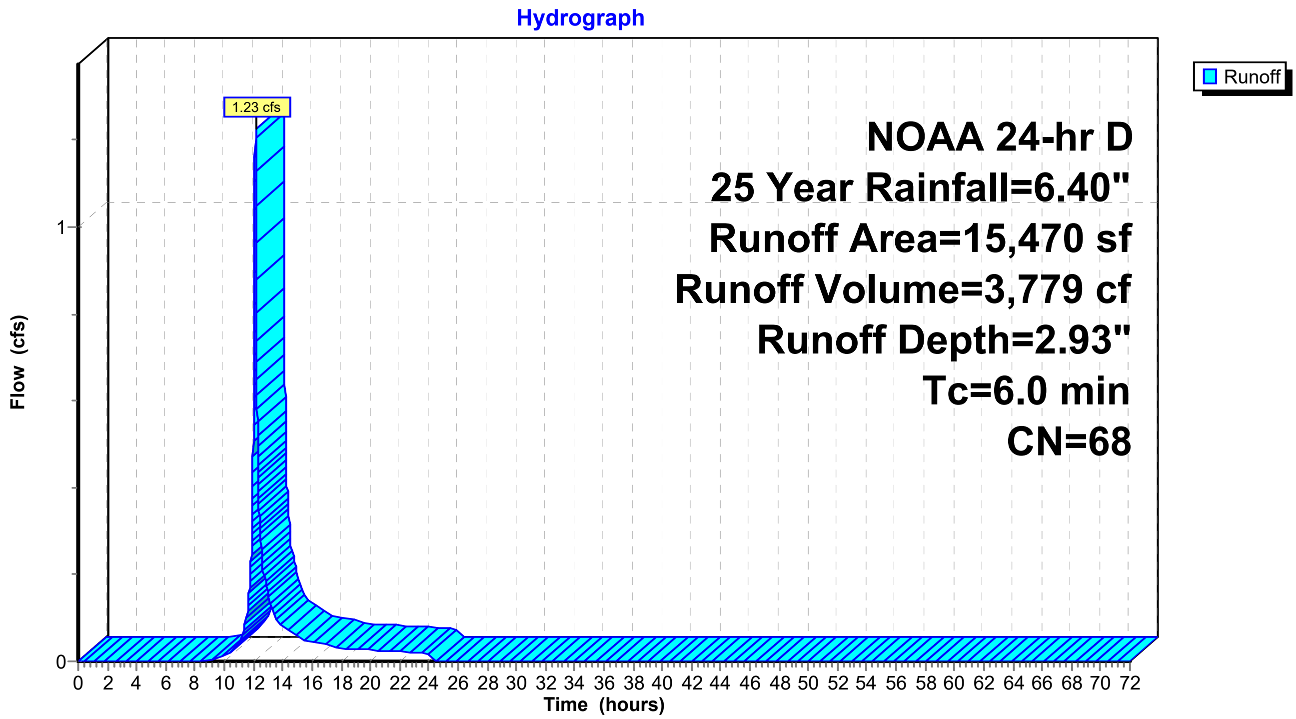
Runoff = 1.23 cfs @ 12.13 hrs, Volume= 3,779 cf, Depth= 2.93"
Routed to Link EX : Existing Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 25 Year Rainfall=6.40"

Area (sf)	CN	Description
1,355	98	Roofs, HSG B
1,306	98	Paved parking, HSG B
12,615	61	>75% Grass cover, Good, HSG B
194	79	<50% Grass cover, Poor, HSG B
15,470	68	Weighted Average
12,809		82.80% Pervious Area
2,661		17.20% Impervious Area

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

Subcatchment DA-EX: Existing Site Runoff

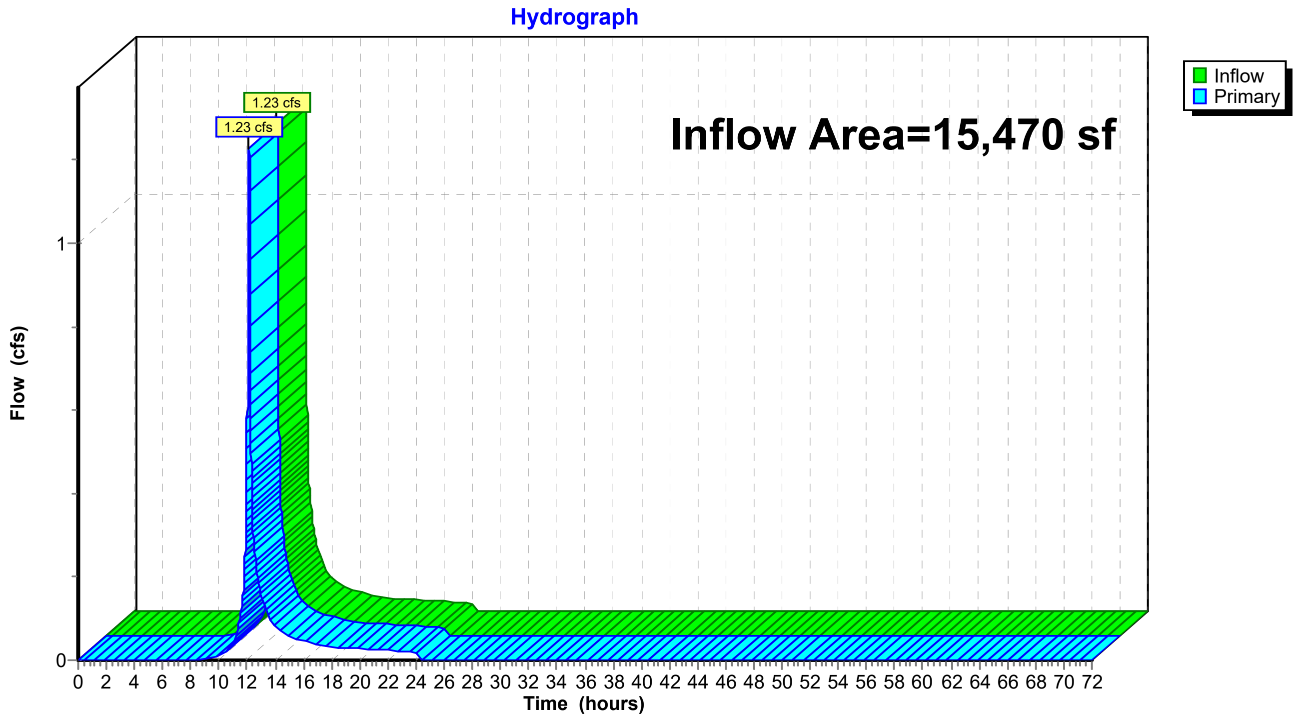


Summary for Link EX: Existing Site Runoff

Inflow Area = 15,470 sf, 17.20% Impervious, Inflow Depth = 2.93" for 25 Year event
Inflow = 1.23 cfs @ 12.13 hrs, Volume= 3,779 cf
Primary = 1.23 cfs @ 12.13 hrs, Volume= 3,779 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link EX: Existing Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-EX: Existing Site Runoff Runoff Area=15,470 sf 17.20% Impervious Runoff Depth=4.44"
Tc=6.0 min CN=68 Runoff=1.85 cfs 5,721 cf

Link EX: Existing Site Runoff Inflow=1.85 cfs 5,721 cf
Primary=1.85 cfs 5,721 cf

Total Runoff Area = 15,470 sf Runoff Volume = 5,721 cf Average Runoff Depth = 4.44"
82.80% Pervious = 12,809 sf 17.20% Impervious = 2,661 sf

Summary for Subcatchment DA-EX: Existing Site Runoff

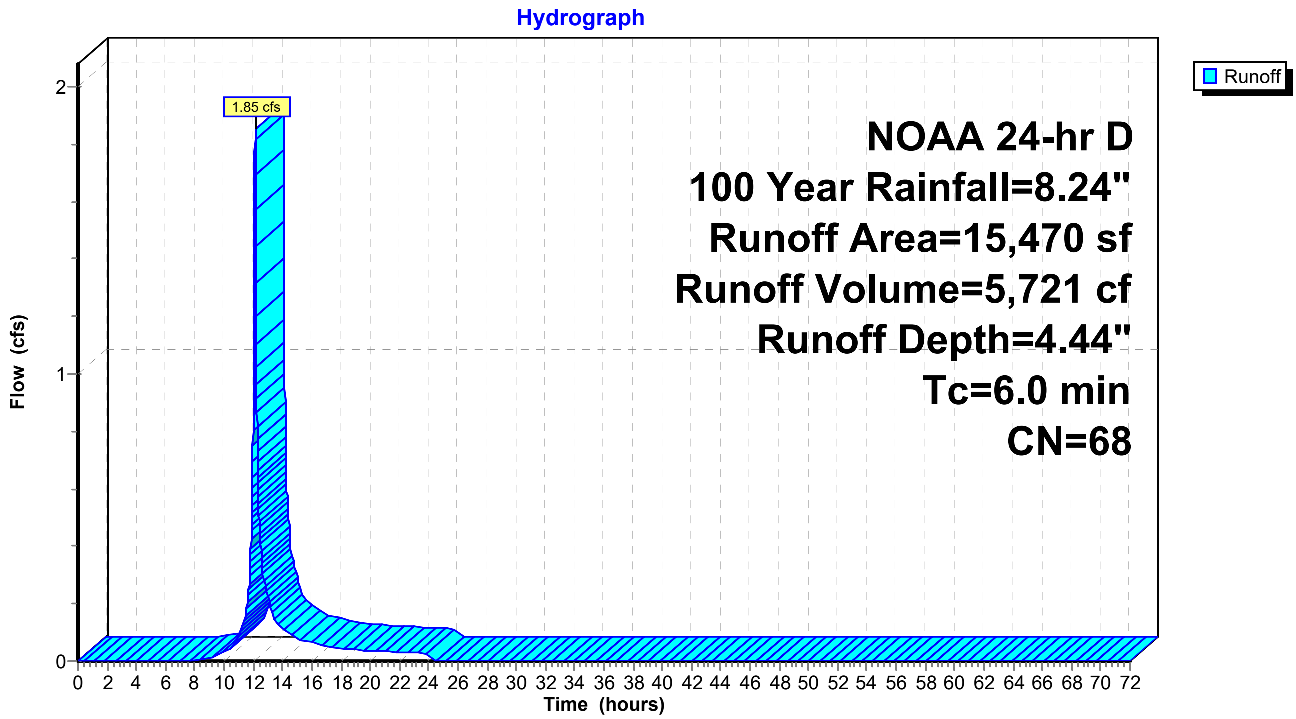
Runoff = 1.85 cfs @ 12.13 hrs, Volume= 5,721 cf, Depth= 4.44"
Routed to Link EX : Existing Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100 Year Rainfall=8.24"

Area (sf)	CN	Description
1,355	98	Roofs, HSG B
1,306	98	Paved parking, HSG B
12,615	61	>75% Grass cover, Good, HSG B
194	79	<50% Grass cover, Poor, HSG B
15,470	68	Weighted Average
12,809		82.80% Pervious Area
2,661		17.20% Impervious Area

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

Subcatchment DA-EX: Existing Site Runoff

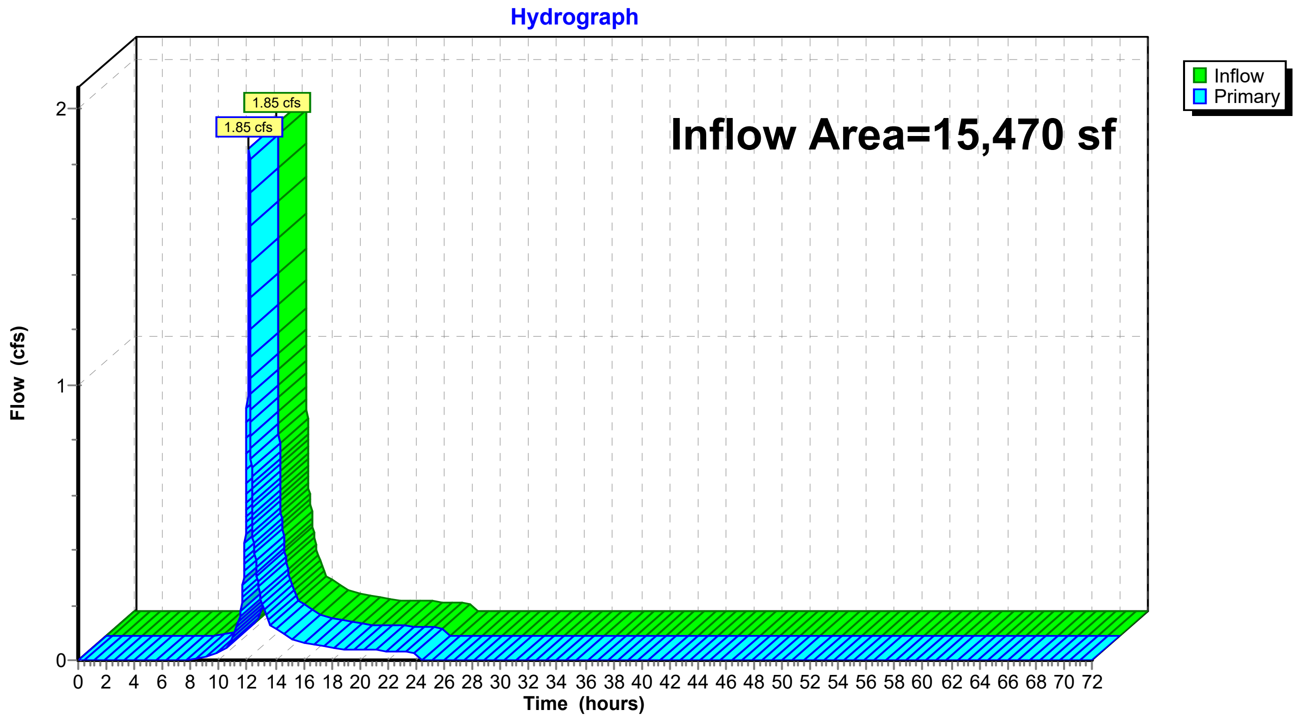


Summary for Link EX: Existing Site Runoff

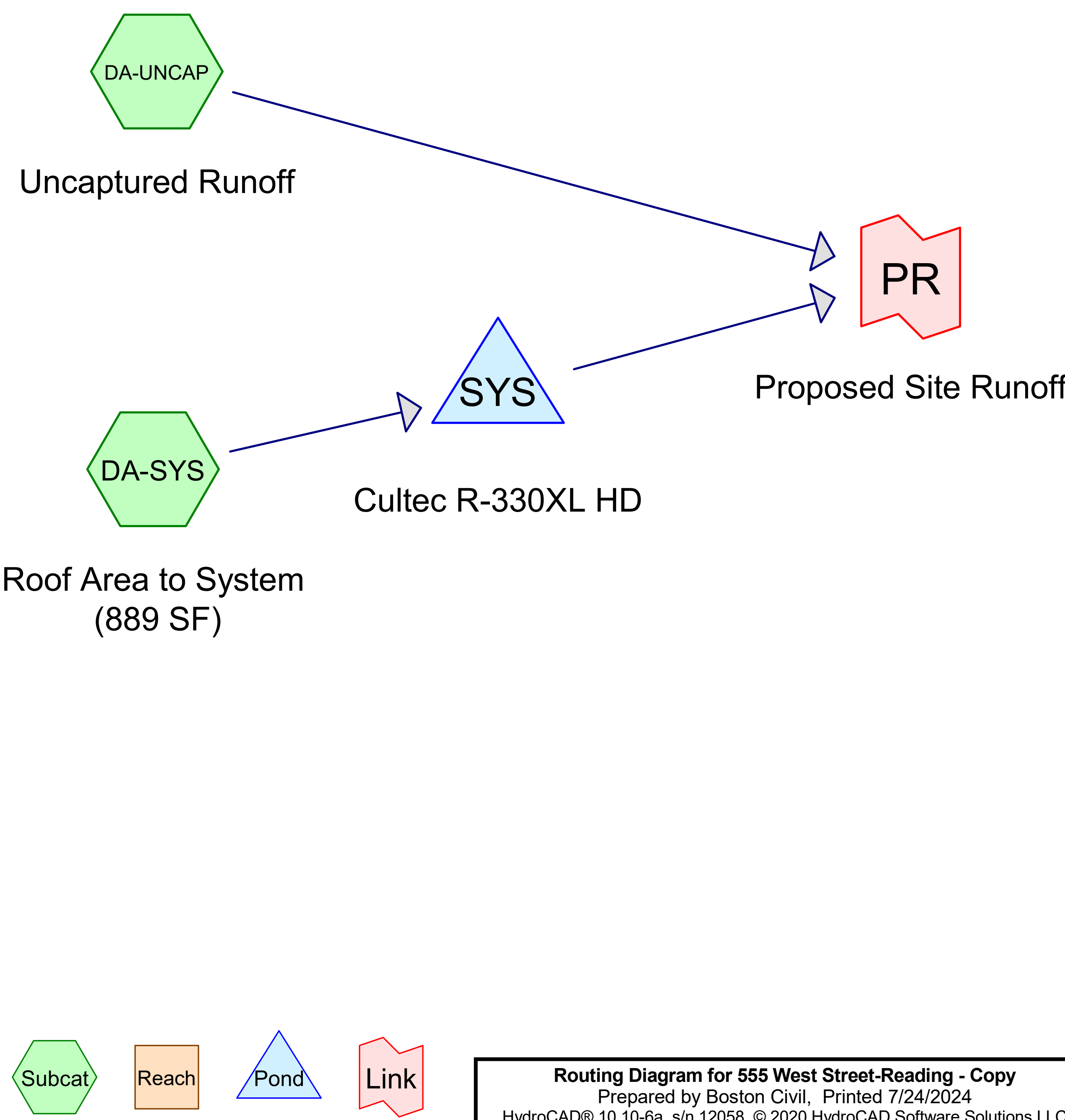
Inflow Area = 15,470 sf, 17.20% Impervious, Inflow Depth = 4.44" for 100 Year event
Inflow = 1.85 cfs @ 12.13 hrs, Volume= 5,721 cf
Primary = 1.85 cfs @ 12.13 hrs, Volume= 5,721 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link EX: Existing Site Runoff



Attachment F:
Proposed HydroCAD Calculations



Routing Diagram for 555 West Street-Reading - Copy
Prepared by Boston Civil, Printed 7/24/2024
HydroCAD® 10.10-6a s/n 12058 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-Year	NOAA 24-hr	D	Default	24.00	1	2.67	2
2	5 Year	NOAA 24-hr	D	Default	24.00	1	4.34	2
3	10 Year	NOAA 24-hr	D	Default	24.00	1	5.21	2
4	25 Year	NOAA 24-hr	D	Default	24.00	1	6.40	2
5	100 Year	NOAA 24-hr	D	Default	24.00	1	8.24	2

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
483	79	<50% Grass cover, Poor, HSG B (DA-UNCAP)
12,174	61	>75% Grass cover, Good, HSG B (DA-UNCAP)
916	98	Paved parking, HSG B (DA-UNCAP)
311	98	Permeable Pavers, HSG B (DA-UNCAP)
1,586	98	Roofs, HSG B (DA-SYS, DA-UNCAP)
15,470	**68**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
15,470	HSG B	DA-SYS, DA-UNCAP
0	HSG C	
0	HSG D	
0	Other	
15,470		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcatchment Numbers
0	483	0	0	0	483	<50% Grass cover, Poor	DA-UNCAP
0	12,174	0	0	0	12,174	>75% Grass cover, Good	DA-UNCAP
0	916	0	0	0	916	Paved parking	DA-UNCAP
0	311	0	0	0	311	Permeable Pavers	DA-UNCAP
0	1,586	0	0	0	1,586	Roofs	DA-SYS, DA-UNCAP
0	**15,470**	**0**	**0**	**0**	**15,470**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-SYS: Roof Area to System (889 SF) Runoff Area=889 sf 100.00% Impervious Runoff Depth=2.44"
Tc=6.0 min CN=98 Runoff=0.05 cfs 181 cf

Subcatchment DA-UNCAP: Uncaptured Runoff Runoff Area=14,581 sf 13.20% Impervious Runoff Depth=0.40"
Tc=6.0 min CN=66 Runoff=0.11 cfs 481 cf

Pond SYS: Cultec R-330XL HD Peak Elev=84.65' Storage=53 cf Inflow=0.05 cfs 181 cf
Discarded=0.01 cfs 181 cf Primary=0.00 cfs 0 cf Outflow=0.01 cfs 181 cf

Link PR: Proposed Site Runoff Inflow=0.11 cfs 481 cf
Primary=0.11 cfs 481 cf

Total Runoff Area = 15,470 sf Runoff Volume = 662 cf Average Runoff Depth = 0.51"
81.82% Pervious = 12,657 sf 18.18% Impervious = 2,813 sf

Summary for Subcatchment DA-SYS: Roof Area to System (889 SF)

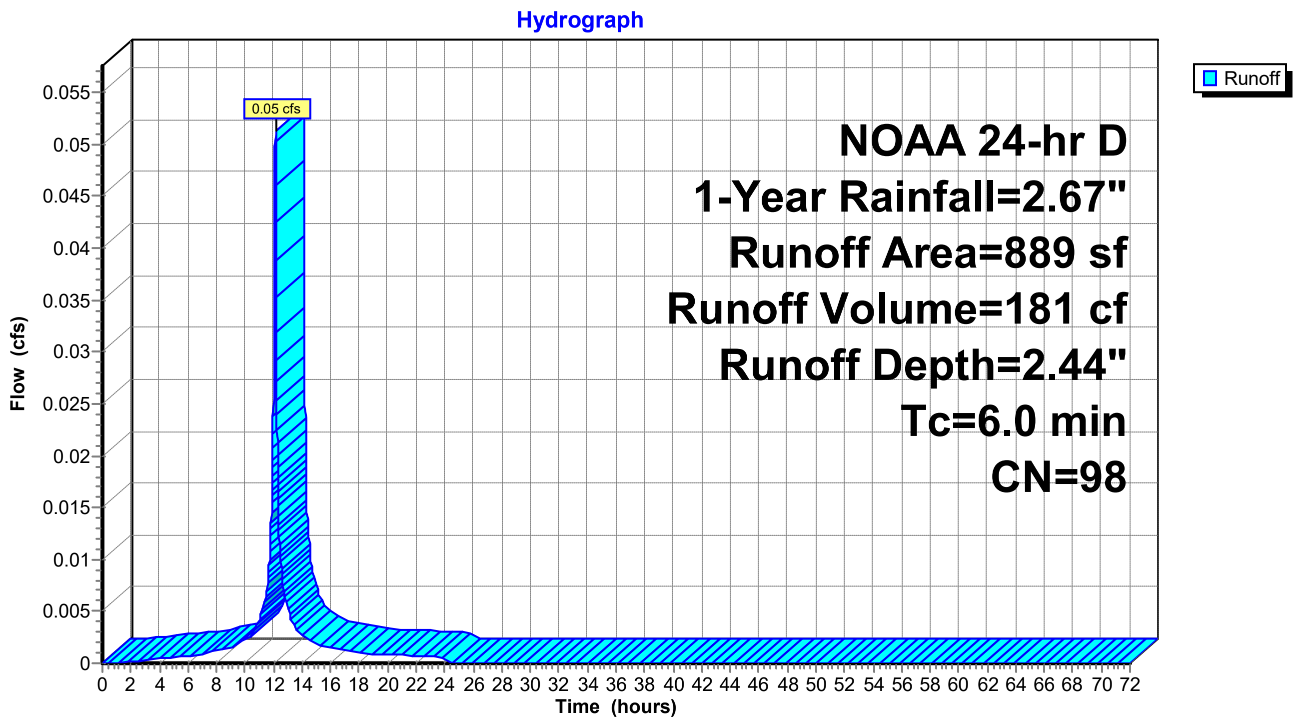
Runoff = 0.05 cfs @ 12.13 hrs, Volume= 181 cf, Depth= 2.44"
Routed to Pond SYS : Cultec R-330XL HD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 1-Year Rainfall=2.67"

Area (sf)	CN	Description
889	98	Roofs, HSG B
889		100.00% Impervious Area

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

Subcatchment DA-SYS: Roof Area to System (889 SF)



Summary for Subcatchment DA-UNCAP: Uncaptured Runoff

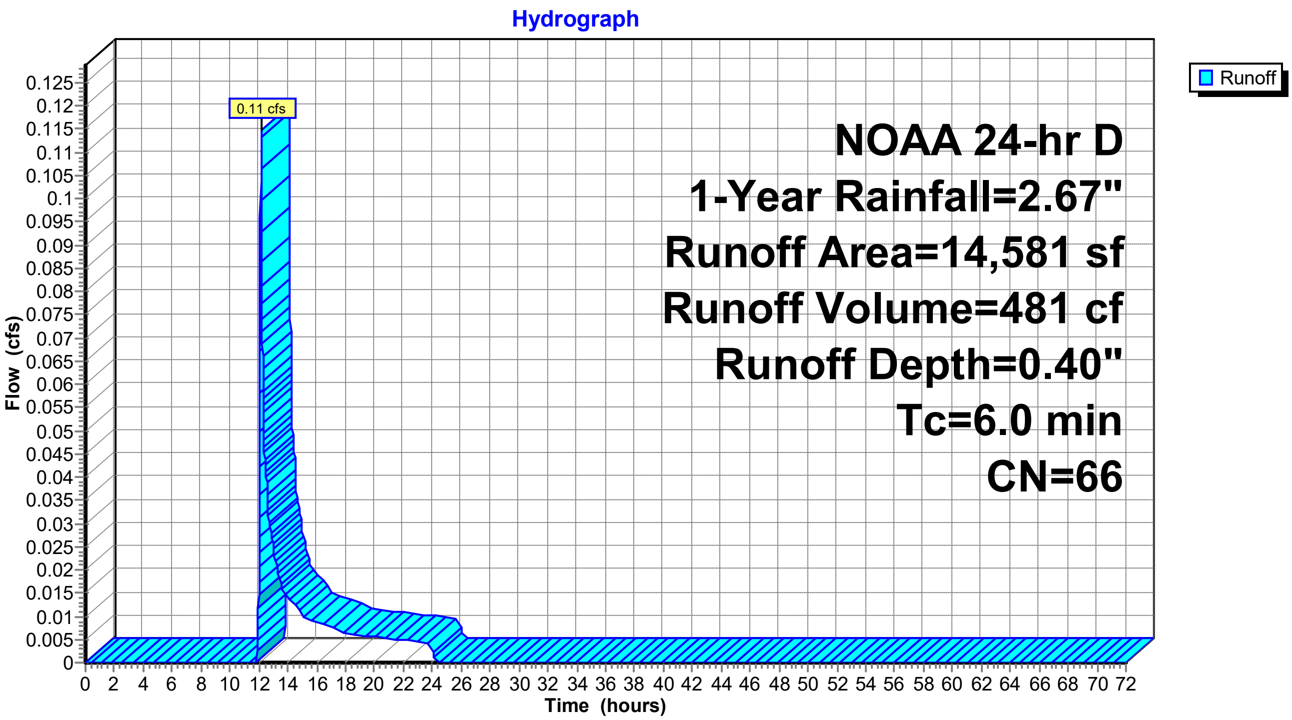
Runoff = 0.11 cfs @ 12.15 hrs, Volume= 481 cf, Depth= 0.40"
Routed to Link PR : Proposed Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 1-Year Rainfall=2.67"

	Area (sf)	CN	Description
	697	98	Roofs, HSG B
	916	98	Paved parking, HSG B
	12,174	61	>75% Grass cover, Good, HSG B
	483	79	<50% Grass cover, Poor, HSG B
*	311	98	Permeable Pavers, HSG B
	14,581	66	Weighted Average
	12,657		86.80% Pervious Area
	1,924		13.20% Impervious Area

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

Subcatchment DA-UNCAP: Uncaptured Runoff



Summary for Pond SYS: Cultec R-330XL HD

Inflow Area = 889 sf,100.00% Impervious, Inflow Depth = 2.44" for 1-Year event
Inflow = 0.05 cfs @ 12.13 hrs, Volume= 181 cf
Outflow = 0.01 cfs @ 12.67 hrs, Volume= 181 cf, Atten= 86%, Lag= 32.7 min
Discarded = 0.01 cfs @ 12.67 hrs, Volume= 181 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link PR : Proposed Site Runoff

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 4
Peak Elev= 84.65' @ 12.67 hrs Surf.Area= 86 sf Storage= 53 cf

Plug-Flow detention time= 52.3 min calculated for 181 cf (100% of inflow)
Center-of-Mass det. time= 52.3 min (815.0 - 762.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.50'	97 cf	**7.50'W x 11.50'L x 3.54'H Field A** 305 cf Overall - 63 cf Embedded = 242 cf x 40.0% Voids
#2A	84.00'	63 cf	**Cultec R-330XLHD** Inside #1 Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	85.20'	1 cf	**0.33'D x 6.00'H Downspout for Overflow Model** -Impervious
		161 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.50'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	87.10'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.67 hrs HW=84.65' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=83.50' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond SYS: Cultec R-330XL HD - Chamber Wizard Field A

Chamber Model = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

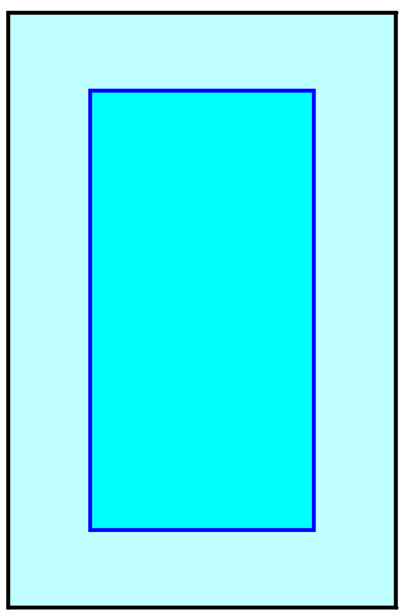
1 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 8.50' Row Length +18.0" End Stone x 2 = 11.50' Base Length
1 Rows x 52.0" Wide + 19.0" Side Stone x 2 = 7.50' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

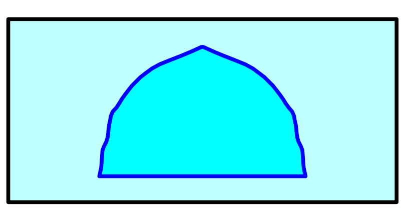
1 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 63.3 cf Chamber Storage

305.5 cf Field - 63.3 cf Chambers = 242.1 cf Stone x 40.0% Voids = 96.9 cf Stone Storage

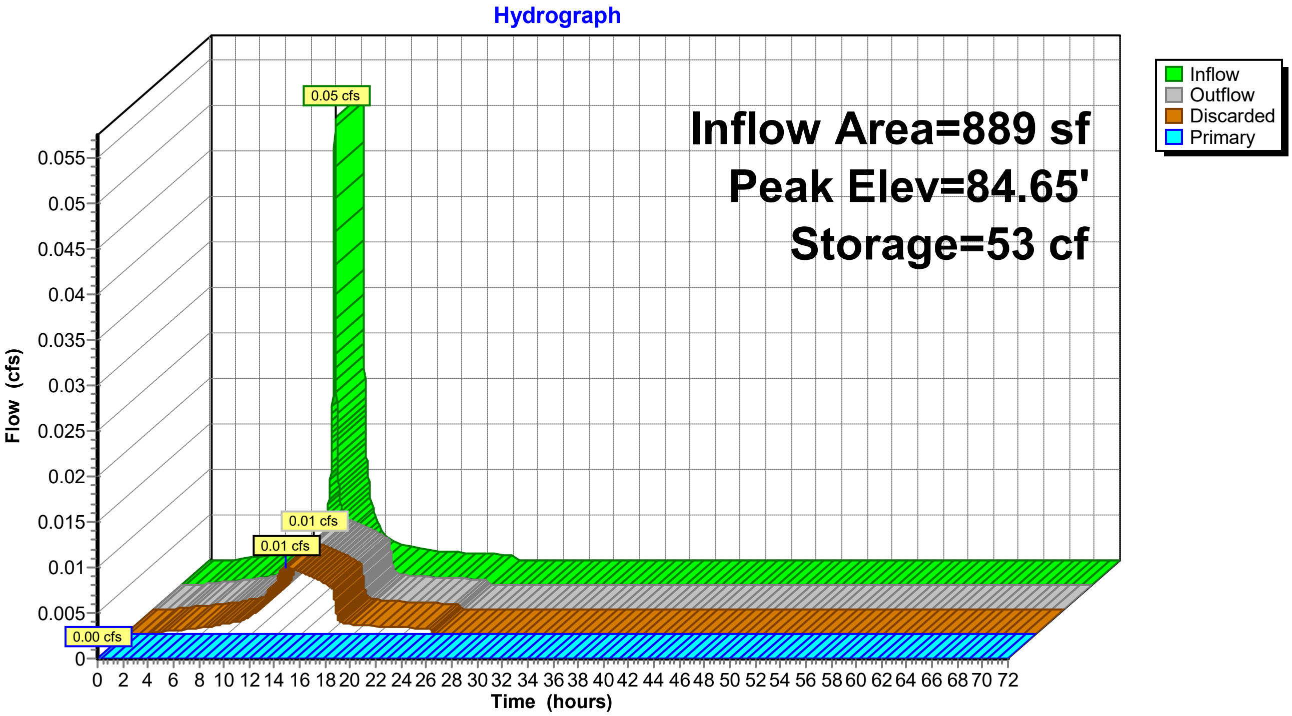
Chamber Storage + Stone Storage = 160.2 cf = 0.004 af
Overall Storage Efficiency = 52.4%
Overall System Size = 11.50' x 7.50' x 3.54'

1 Chambers
11.3 cy Field
9.0 cy Stone





Pond SYS: Cultec R-330XL HD

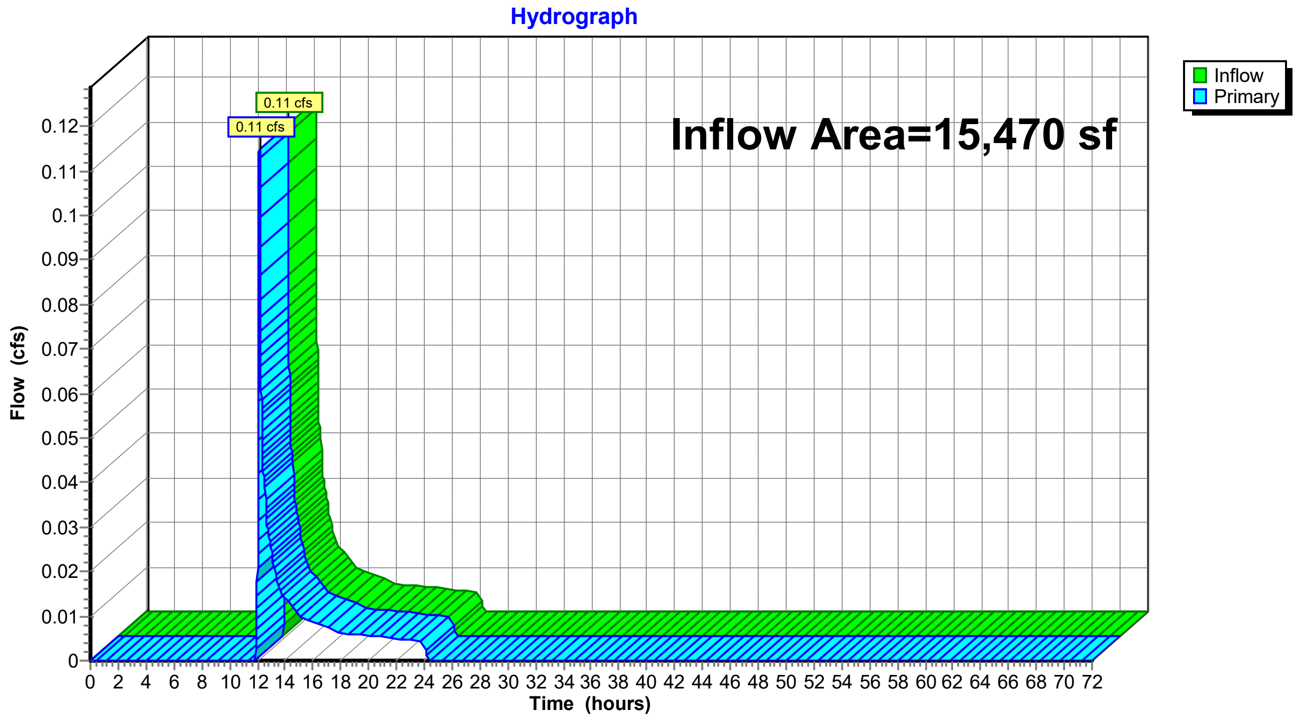


Summary for Link PR: Proposed Site Runoff

Inflow Area = 15,470 sf, 18.18% Impervious, Inflow Depth = 0.37" for 1-Year event
Inflow = 0.11 cfs @ 12.15 hrs, Volume= 481 cf
Primary = 0.11 cfs @ 12.15 hrs, Volume= 481 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link PR: Proposed Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-SYS: Roof Area to System (889 SF) Runoff Area=889 sf 100.00% Impervious Runoff Depth=4.10"
Tc=6.0 min CN=98 Runoff=0.08 cfs 304 cf

Subcatchment DA-UNCAP: Uncaptured Runoff Runoff Area=14,581 sf 13.20% Impervious Runoff Depth=1.29"
Tc=6.0 min CN=66 Runoff=0.49 cfs 1,573 cf

Pond SYS: Cultec R-330XL HD Peak Elev=85.65' Storage=105 cf Inflow=0.08 cfs 304 cf
Discarded=0.01 cfs 304 cf Primary=0.00 cfs 0 cf Outflow=0.01 cfs 304 cf

Link PR: Proposed Site Runoff Inflow=0.49 cfs 1,573 cf
Primary=0.49 cfs 1,573 cf

Total Runoff Area = 15,470 sf Runoff Volume = 1,877 cf Average Runoff Depth = 1.46"
81.82% Pervious = 12,657 sf 18.18% Impervious = 2,813 sf

Summary for Subcatchment DA-SYS: Roof Area to System (889 SF)

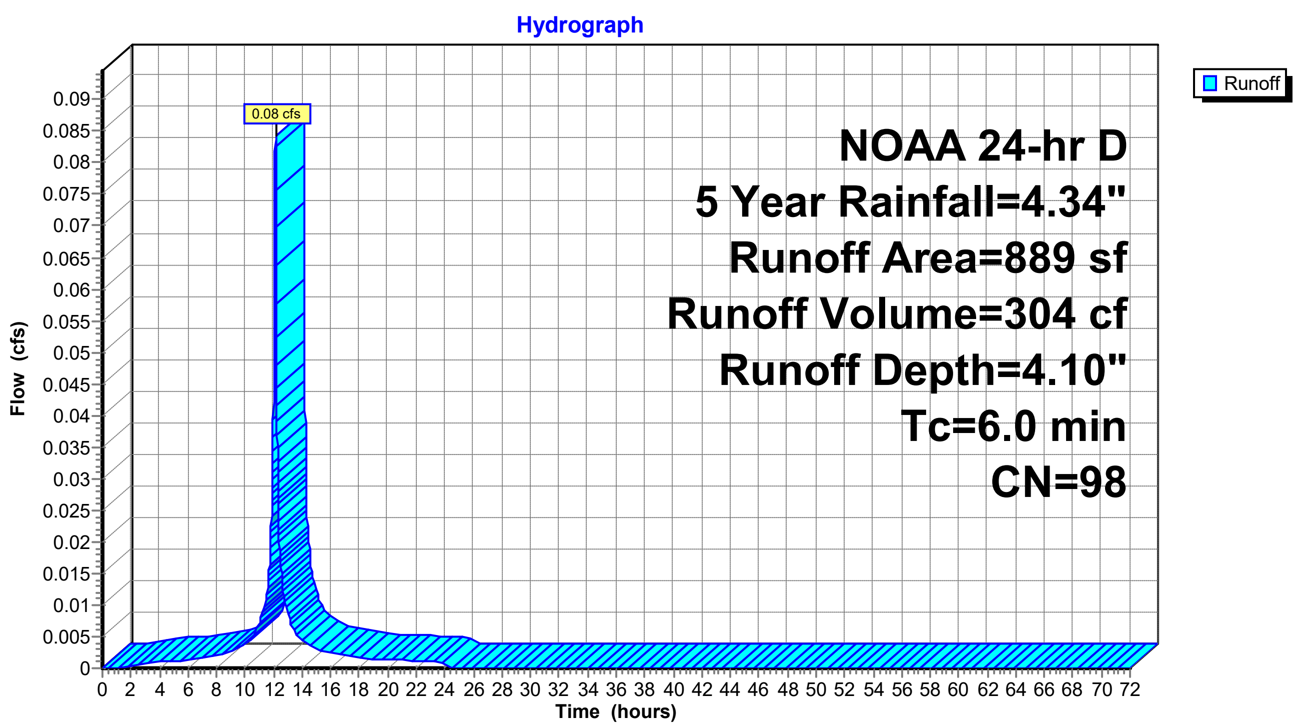
Runoff = 0.08 cfs @ 12.13 hrs, Volume= 304 cf, Depth= 4.10"
Routed to Pond SYS : Cultec R-330XL HD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 5 Year Rainfall=4.34"

Area (sf)	CN	Description
889	98	Roofs, HSG B
889		100.00% Impervious Area

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

Subcatchment DA-SYS: Roof Area to System (889 SF)



Summary for Subcatchment DA-UNCAP: Uncaptured Runoff

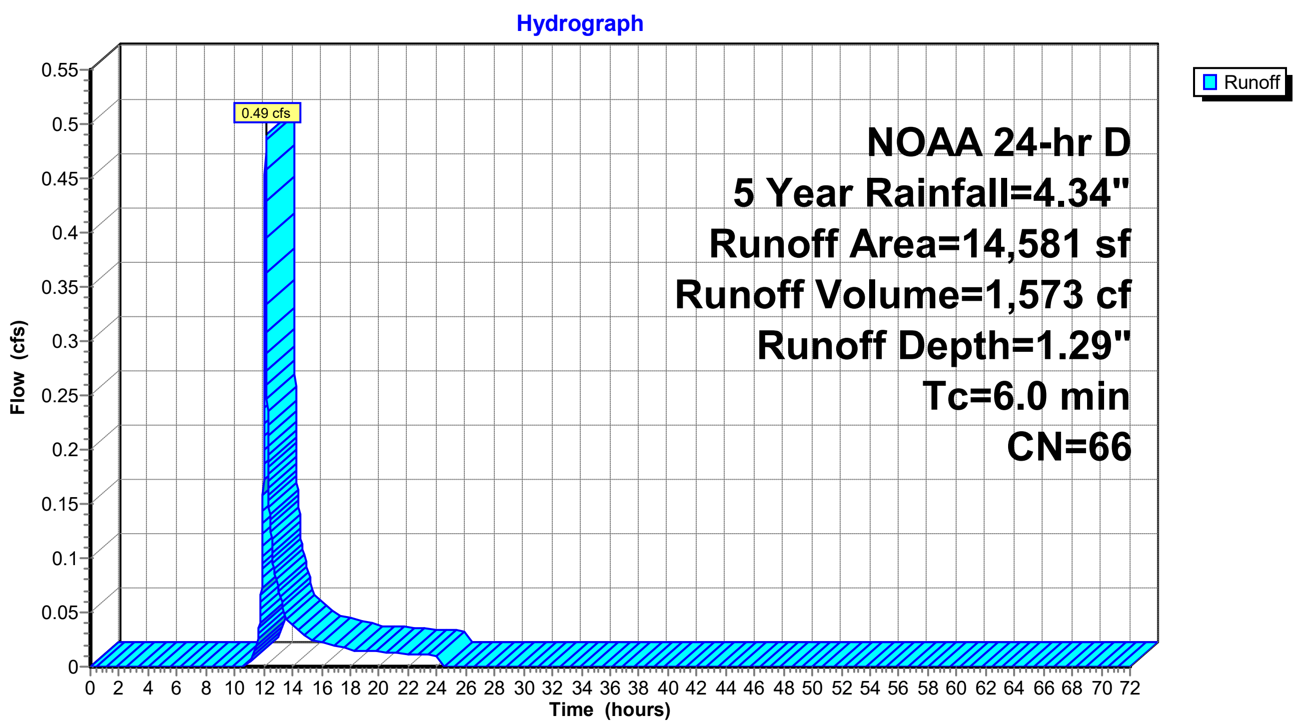
Runoff = 0.49 cfs @ 12.14 hrs, Volume= 1,573 cf, Depth= 1.29"
Routed to Link PR : Proposed Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 5 Year Rainfall=4.34"

	Area (sf)	CN	Description
	697	98	Roofs, HSG B
	916	98	Paved parking, HSG B
	12,174	61	>75% Grass cover, Good, HSG B
	483	79	<50% Grass cover, Poor, HSG B
*	311	98	Permeable Pavers, HSG B
	14,581	66	Weighted Average
	12,657		86.80% Pervious Area
	1,924		13.20% Impervious Area

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

Subcatchment DA-UNCAP: Uncaptured Runoff



Summary for Pond SYS: Cultec R-330XL HD

Inflow Area = 889 sf,100.00% Impervious, Inflow Depth = 4.10" for 5 Year event
Inflow = 0.08 cfs @ 12.13 hrs, Volume= 304 cf
Outflow = 0.01 cfs @ 12.93 hrs, Volume= 304 cf, Atten= 89%, Lag= 48.2 min
Discarded = 0.01 cfs @ 12.93 hrs, Volume= 304 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link PR : Proposed Site Runoff

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 4
Peak Elev= 85.65' @ 12.93 hrs Surf.Area= 86 sf Storage= 105 cf

Plug-Flow detention time= 91.4 min calculated for 304 cf (100% of inflow)
Center-of-Mass det. time= 91.4 min (843.3 - 751.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.50'	97 cf	**7.50'W x 11.50'L x 3.54'H Field A**
			305 cf Overall - 63 cf Embedded = 242 cf x 40.0% Voids
#2A	84.00'	63 cf	**Cultec R-330XLHD** Inside #1
			Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
			Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
			Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	85.20'	1 cf	**0.33'D x 6.00'H Downspout for Overflow Model** -Impervious
		161 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.50'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	87.10'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.93 hrs HW=85.65' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=83.50' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond SYS: Cultec R-330XL HD - Chamber Wizard Field A

Chamber Model = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

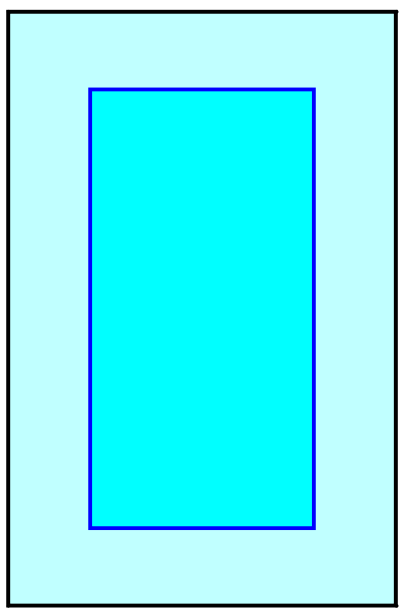
1 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 8.50' Row Length +18.0" End Stone x 2 = 11.50' Base Length
1 Rows x 52.0" Wide + 19.0" Side Stone x 2 = 7.50' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

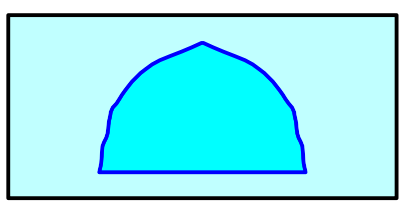
1 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 63.3 cf Chamber Storage

305.5 cf Field - 63.3 cf Chambers = 242.1 cf Stone x 40.0% Voids = 96.9 cf Stone Storage

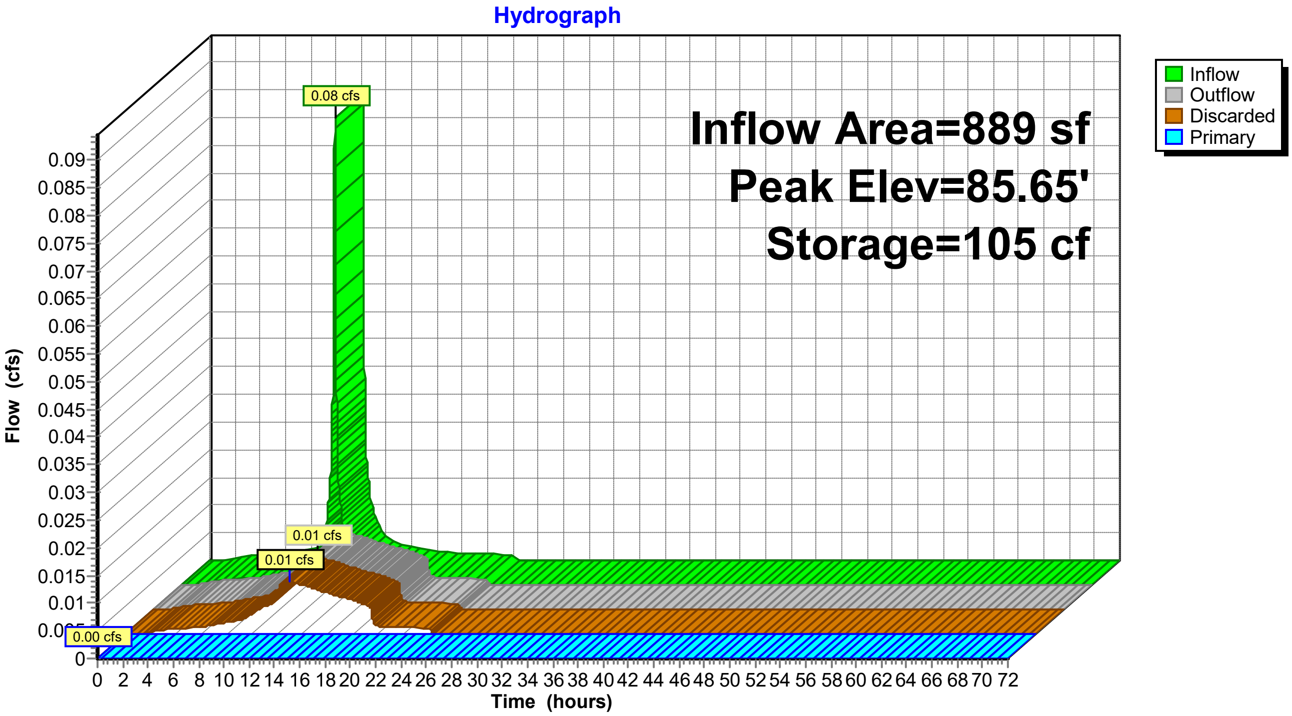
Chamber Storage + Stone Storage = 160.2 cf = 0.004 af
Overall Storage Efficiency = 52.4%
Overall System Size = 11.50' x 7.50' x 3.54'

1 Chambers
11.3 cy Field
9.0 cy Stone





Pond SYS: Cultec R-330XL HD

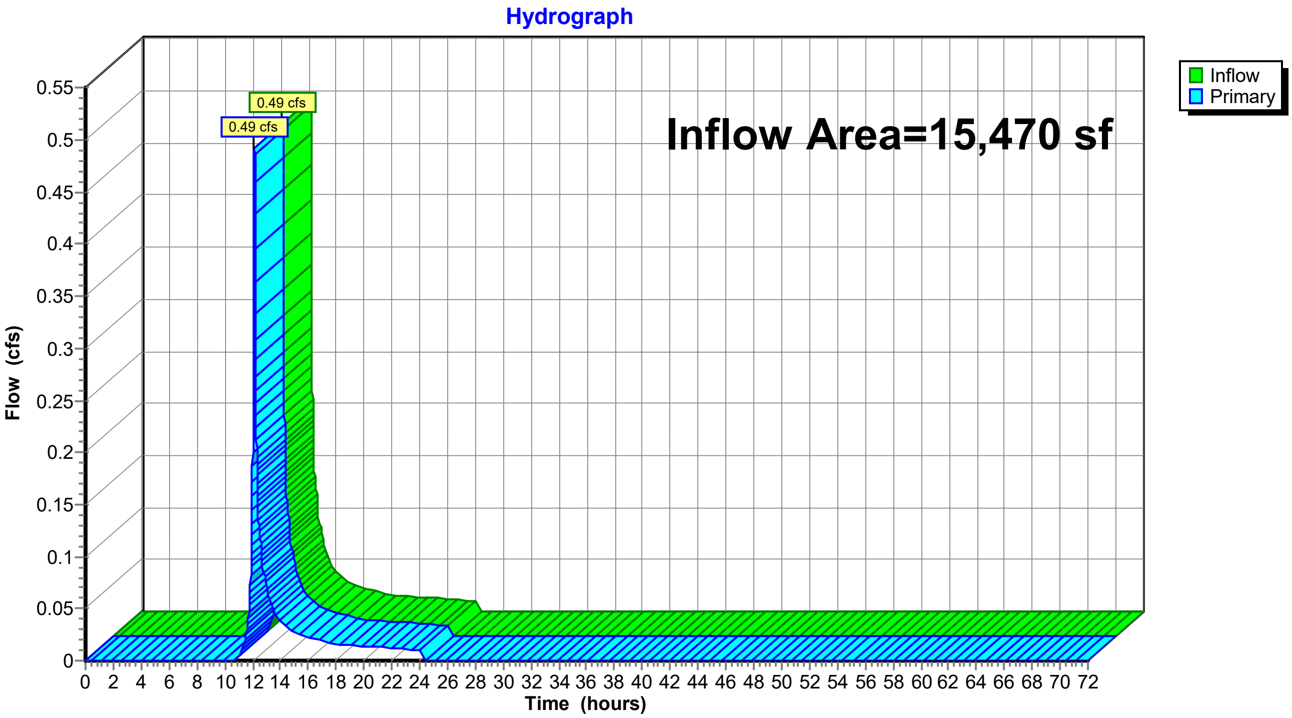


Summary for Link PR: Proposed Site Runoff

Inflow Area = 15,470 sf, 18.18% Impervious, Inflow Depth = 1.22" for 5 Year event
Inflow = 0.49 cfs @ 12.14 hrs, Volume= 1,573 cf
Primary = 0.49 cfs @ 12.14 hrs, Volume= 1,573 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link PR: Proposed Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-SYS: Roof Area to System (889 SF) Runoff Area=889 sf 100.00% Impervious Runoff Depth=4.97"
Tc=6.0 min CN=98 Runoff=0.10 cfs 368 cf

Subcatchment DA-UNCAP: Uncaptured Runoff Runoff Area=14,581 sf 13.20% Impervious Runoff Depth=1.87"
Tc=6.0 min CN=66 Runoff=0.73 cfs 2,275 cf

Pond SYS: Cultec R-330XL HD Peak Elev=86.27' Storage=133 cf Inflow=0.10 cfs 368 cf
Discarded=0.01 cfs 368 cf Primary=0.00 cfs 0 cf Outflow=0.01 cfs 368 cf

Link PR: Proposed Site Runoff Inflow=0.73 cfs 2,275 cf
Primary=0.73 cfs 2,275 cf

Total Runoff Area = 15,470 sf Runoff Volume = 2,643 cf Average Runoff Depth = 2.05"
81.82% Pervious = 12,657 sf 18.18% Impervious = 2,813 sf

Summary for Subcatchment DA-SYS: Roof Area to System (889 SF)

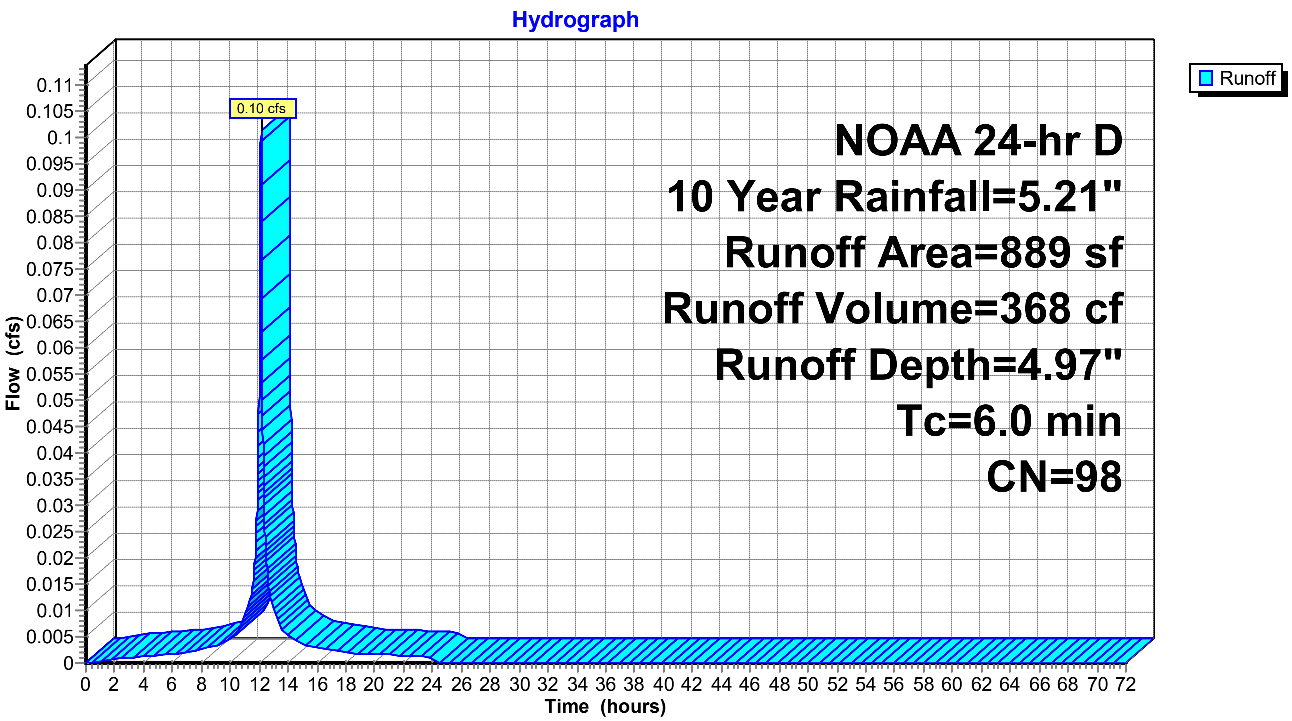
Runoff = 0.10 cfs @ 12.13 hrs, Volume= 368 cf, Depth= 4.97"
Routed to Pond SYS : Cultec R-330XL HD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10 Year Rainfall=5.21"

Area (sf)	CN	Description
889	98	Roofs, HSG B
889		100.00% Impervious Area

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

Subcatchment DA-SYS: Roof Area to System (889 SF)



Summary for Subcatchment DA-UNCAP: Uncaptured Runoff

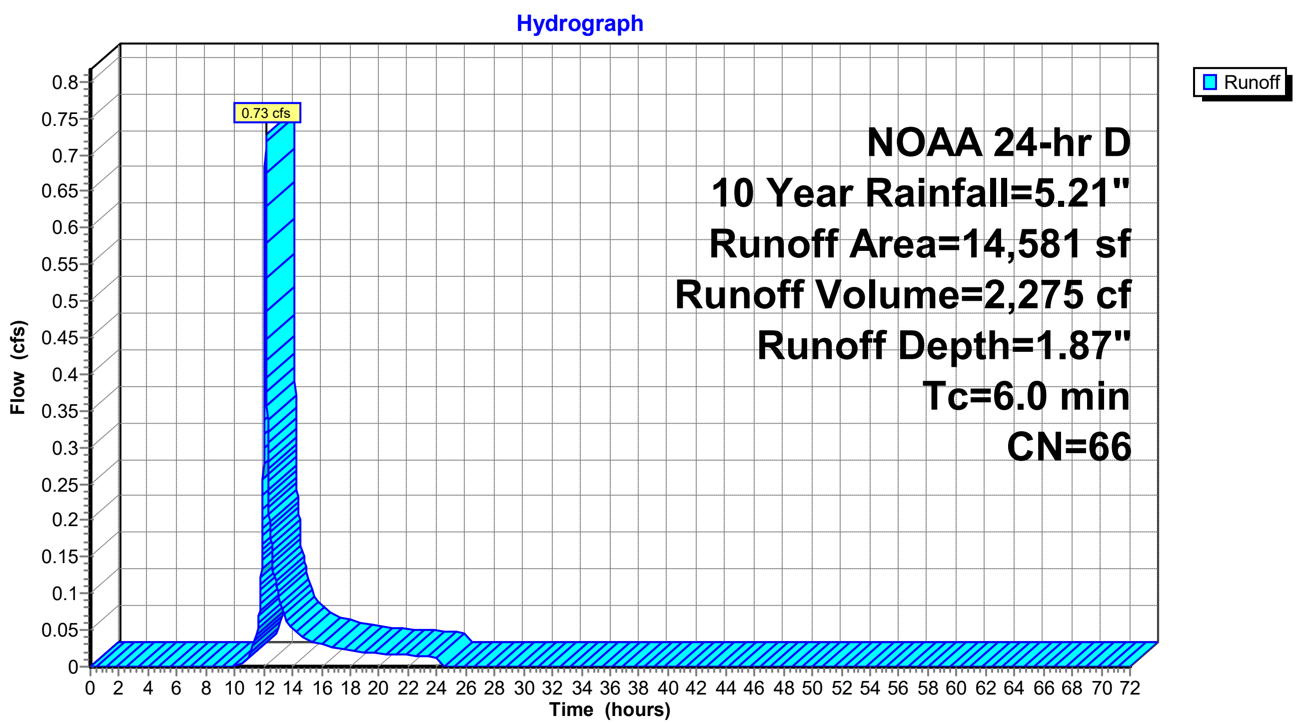
Runoff = 0.73 cfs @ 12.14 hrs, Volume= 2,275 cf, Depth= 1.87"
Routed to Link PR : Proposed Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10 Year Rainfall=5.21"

	Area (sf)	CN	Description
	697	98	Roofs, HSG B
	916	98	Paved parking, HSG B
	12,174	61	>75% Grass cover, Good, HSG B
	483	79	<50% Grass cover, Poor, HSG B
*	311	98	Permeable Pavers, HSG B
	14,581	66	Weighted Average
	12,657		86.80% Pervious Area
	1,924		13.20% Impervious Area

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

Subcatchment DA-UNCAP: Uncaptured Runoff



Summary for Pond SYS: Cultec R-330XL HD

Inflow Area = 889 sf,100.00% Impervious, Inflow Depth = 4.97" for 10 Year event
Inflow = 0.10 cfs @ 12.13 hrs, Volume= 368 cf
Outflow = 0.01 cfs @ 12.98 hrs, Volume= 368 cf, Atten= 89%, Lag= 51.1 min
Discarded = 0.01 cfs @ 12.98 hrs, Volume= 368 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Link PR : Proposed Site Runoff

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 4
Peak Elev= 86.27' @ 12.98 hrs Surf.Area= 86 sf Storage= 133 cf

Plug-Flow detention time= 108.5 min calculated for 368 cf (100% of inflow)
Center-of-Mass det. time= 108.5 min (857.1 - 748.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.50'	97 cf	**7.50'W x 11.50'L x 3.54'H Field A**
			305 cf Overall - 63 cf Embedded = 242 cf x 40.0% Voids
#2A	84.00'	63 cf	**Cultec R-330XLHD** Inside #1
			Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
			Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
			Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	85.20'	1 cf	**0.33'D x 6.00'H Downspout for Overflow Model** -Impervious
		161 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.50'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	87.10'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.98 hrs HW=86.27' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=83.50' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Pond SYS: Cultec R-330XL HD - Chamber Wizard Field A

Chamber Model = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

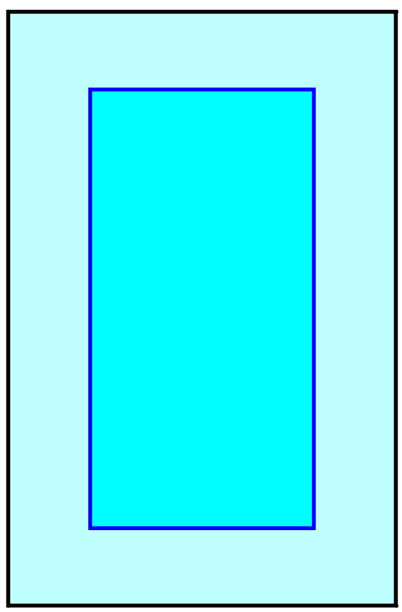
1 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 8.50' Row Length +18.0" End Stone x 2 = 11.50' Base Length
1 Rows x 52.0" Wide + 19.0" Side Stone x 2 = 7.50' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

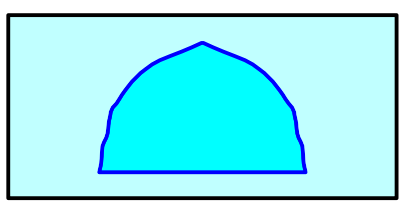
1 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 63.3 cf Chamber Storage

305.5 cf Field - 63.3 cf Chambers = 242.1 cf Stone x 40.0% Voids = 96.9 cf Stone Storage

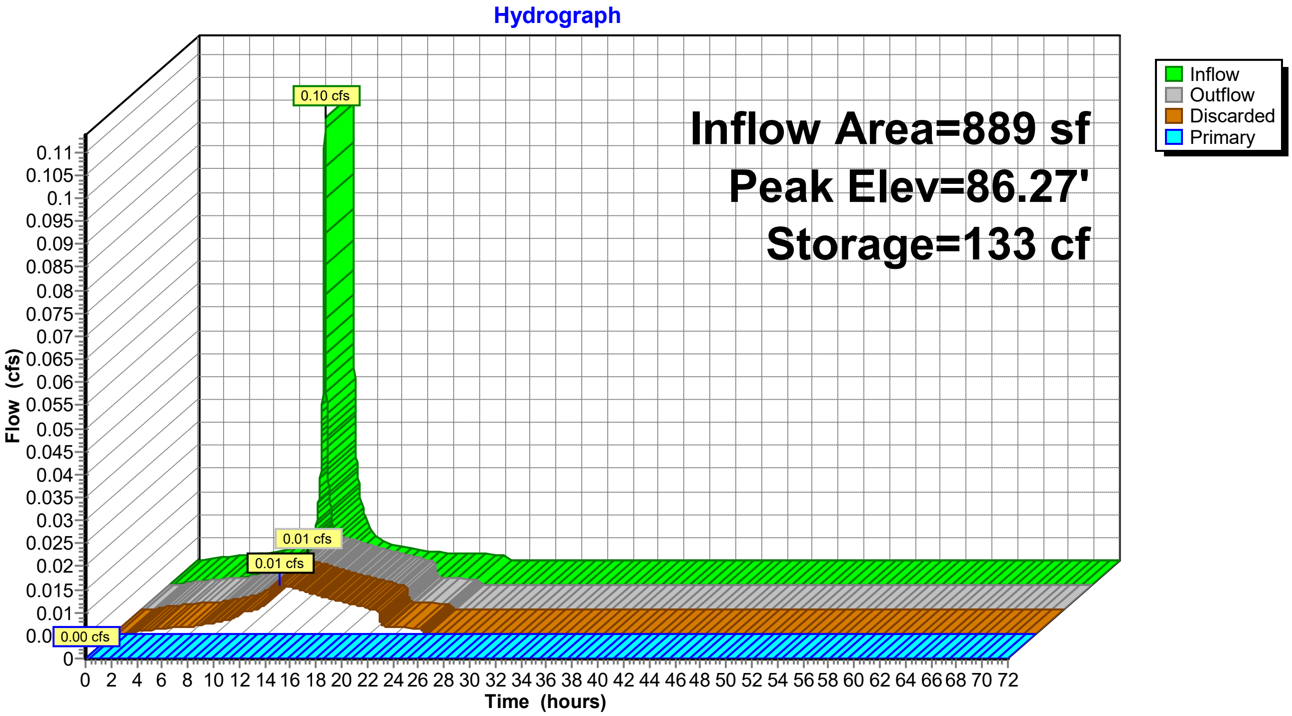
Chamber Storage + Stone Storage = 160.2 cf = 0.004 af
Overall Storage Efficiency = 52.4%
Overall System Size = 11.50' x 7.50' x 3.54'

1 Chambers
11.3 cy Field
9.0 cy Stone





Pond SYS: Cultec R-330XL HD

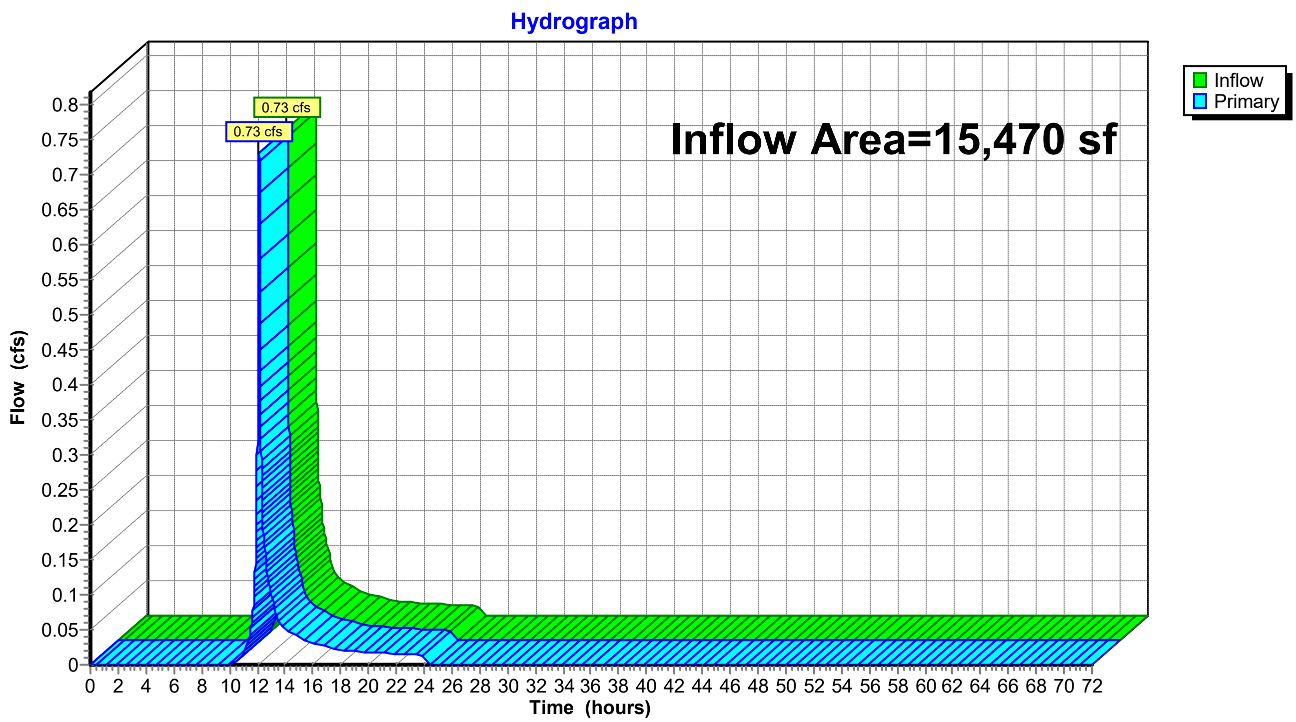


Summary for Link PR: Proposed Site Runoff

Inflow Area = 15,470 sf, 18.18% Impervious, Inflow Depth = 1.76" for 10 Year event
Inflow = 0.73 cfs @ 12.14 hrs, Volume= 2,275 cf
Primary = 0.73 cfs @ 12.14 hrs, Volume= 2,275 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link PR: Proposed Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-SYS: Roof Area to System (889 SF) Runoff Area=889 sf 100.00% Impervious Runoff Depth=6.16"
Tc=6.0 min CN=98 Runoff=0.12 cfs 456 cf

Subcatchment DA-UNCAP: Uncaptured Runoff Runoff Area=14,581 sf 13.20% Impervious Runoff Depth=2.74"
Tc=6.0 min CN=66 Runoff=1.08 cfs 3,330 cf

Pond SYS: Cultec R-330XL HD Peak Elev=87.20' Storage=160 cf Inflow=0.12 cfs 456 cf
Discarded=0.01 cfs 444 cf Primary=0.02 cfs 13 cf Outflow=0.03 cfs 457 cf

Link PR: Proposed Site Runoff Inflow=1.08 cfs 3,343 cf
Primary=1.08 cfs 3,343 cf

Total Runoff Area = 15,470 sf Runoff Volume = 3,786 cf Average Runoff Depth = 2.94"
81.82% Pervious = 12,657 sf 18.18% Impervious = 2,813 sf

Summary for Subcatchment DA-SYS: Roof Area to System (889 SF)

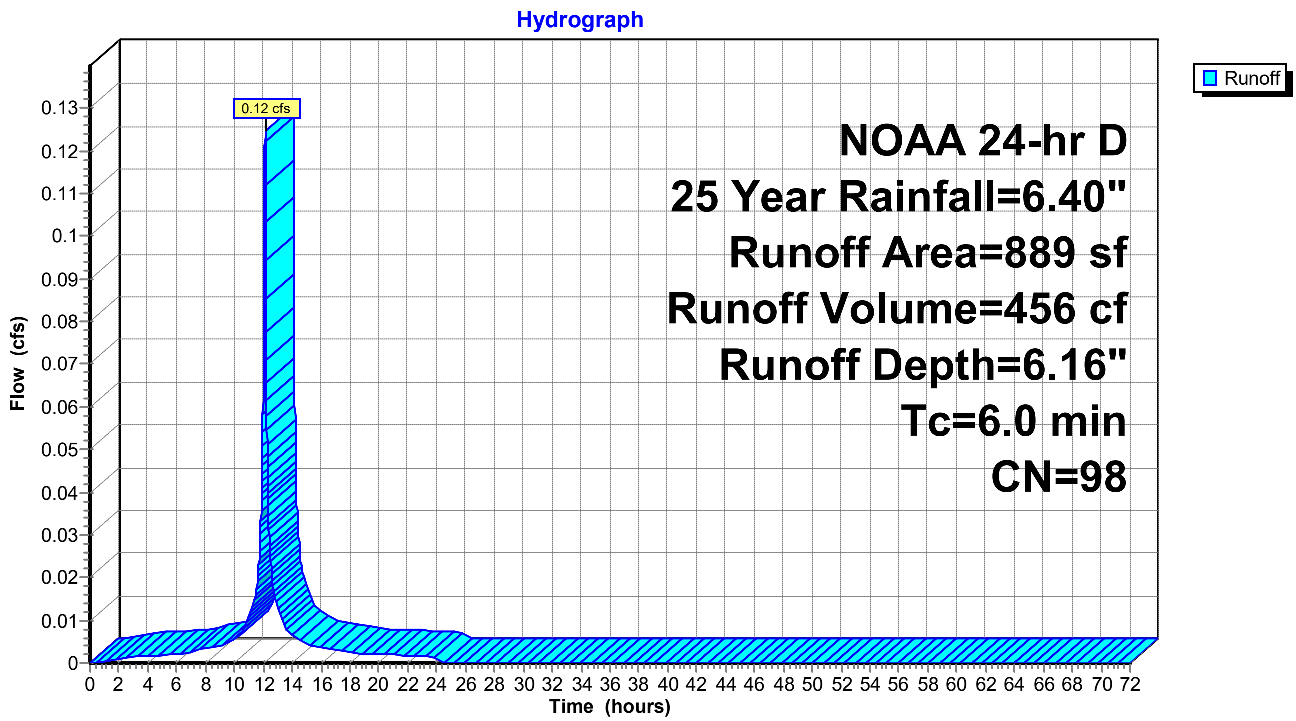
Runoff = 0.12 cfs @ 12.13 hrs, Volume= 456 cf, Depth= 6.16"
Routed to Pond SYS : Cultec R-330XL HD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 25 Year Rainfall=6.40"

Area (sf)	CN	Description
889	98	Roofs, HSG B
889		100.00% Impervious Area

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

Subcatchment DA-SYS: Roof Area to System (889 SF)



Summary for Subcatchment DA-UNCAP: Uncaptured Runoff

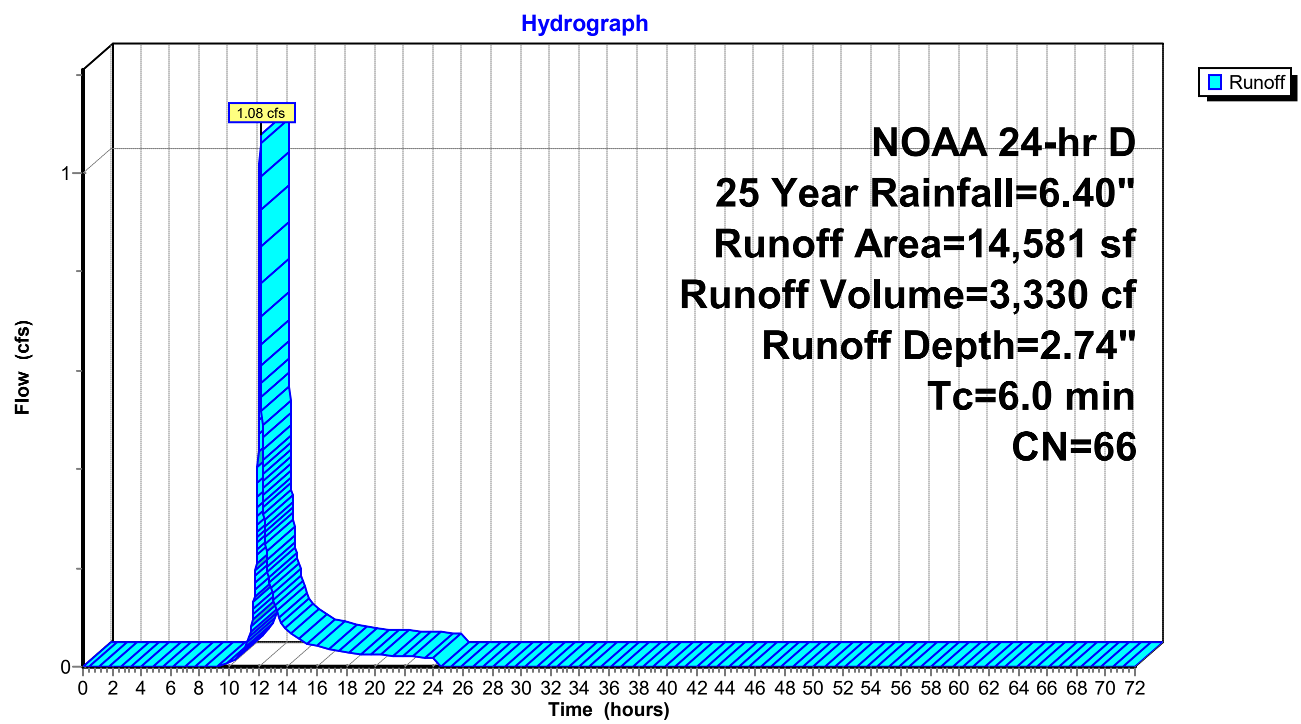
Runoff = 1.08 cfs @ 12.13 hrs, Volume= 3,330 cf, Depth= 2.74"
Routed to Link PR : Proposed Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 25 Year Rainfall=6.40"

	Area (sf)	CN	Description
	697	98	Roofs, HSG B
	916	98	Paved parking, HSG B
	12,174	61	>75% Grass cover, Good, HSG B
	483	79	<50% Grass cover, Poor, HSG B
*	311	98	Permeable Pavers, HSG B
	14,581	66	Weighted Average
	12,657		86.80% Pervious Area
	1,924		13.20% Impervious Area

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

Subcatchment DA-UNCAP: Uncaptured Runoff



Summary for Pond SYS: Cultec R-330XL HD

Inflow Area = 889 sf,100.00% Impervious, Inflow Depth = 6.16" for 25 Year event
Inflow = 0.12 cfs @ 12.13 hrs, Volume= 456 cf
Outflow = 0.03 cfs @ 12.42 hrs, Volume= 457 cf, Atten= 74%, Lag= 17.7 min
Discarded = 0.01 cfs @ 12.42 hrs, Volume= 444 cf
Primary = 0.02 cfs @ 12.42 hrs, Volume= 13 cf
Routed to Link PR : Proposed Site Runoff

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 4
Peak Elev= 87.20' @ 12.42 hrs Surf.Area= 86 sf Storage= 160 cf

Plug-Flow detention time= 118.9 min calculated for 456 cf (100% of inflow)
Center-of-Mass det. time= 119.1 min (864.3 - 745.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.50'	97 cf	**7.50'W x 11.50'L x 3.54'H Field A**
			305 cf Overall - 63 cf Embedded = 242 cf x 40.0% Voids
#2A	84.00'	63 cf	**Cultec R-330XLHD** Inside #1
			Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
			Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
			Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	85.20'	1 cf	**0.33'D x 6.00'H Downspout for Overflow Model** -Impervious
		161 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.50'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	87.10'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.42 hrs HW=87.18' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.02 cfs @ 12.42 hrs HW=87.18' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 0.96 fps)

Pond SYS: Cultec R-330XL HD - Chamber Wizard Field A

Chamber Model = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

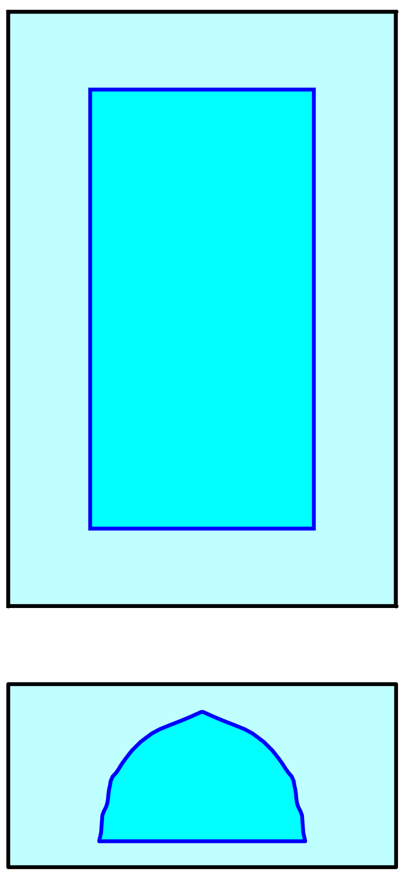
1 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 8.50' Row Length +18.0" End Stone x 2 = 11.50' Base Length
1 Rows x 52.0" Wide + 19.0" Side Stone x 2 = 7.50' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

1 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 63.3 cf Chamber Storage

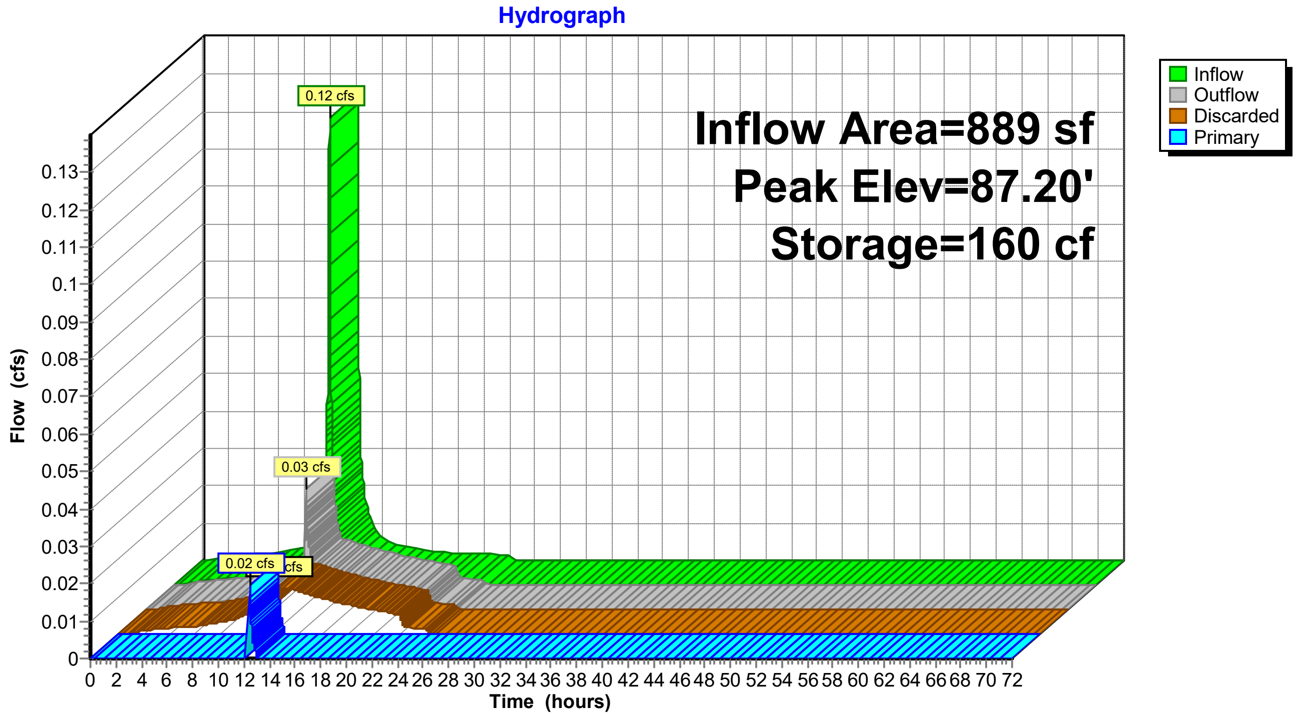
305.5 cf Field - 63.3 cf Chambers = 242.1 cf Stone x 40.0% Voids = 96.9 cf Stone Storage

Chamber Storage + Stone Storage = 160.2 cf = 0.004 af
Overall Storage Efficiency = 52.4%
Overall System Size = 11.50' x 7.50' x 3.54'

1 Chambers
11.3 cy Field
9.0 cy Stone



Pond SYS: Cultec R-330XL HD

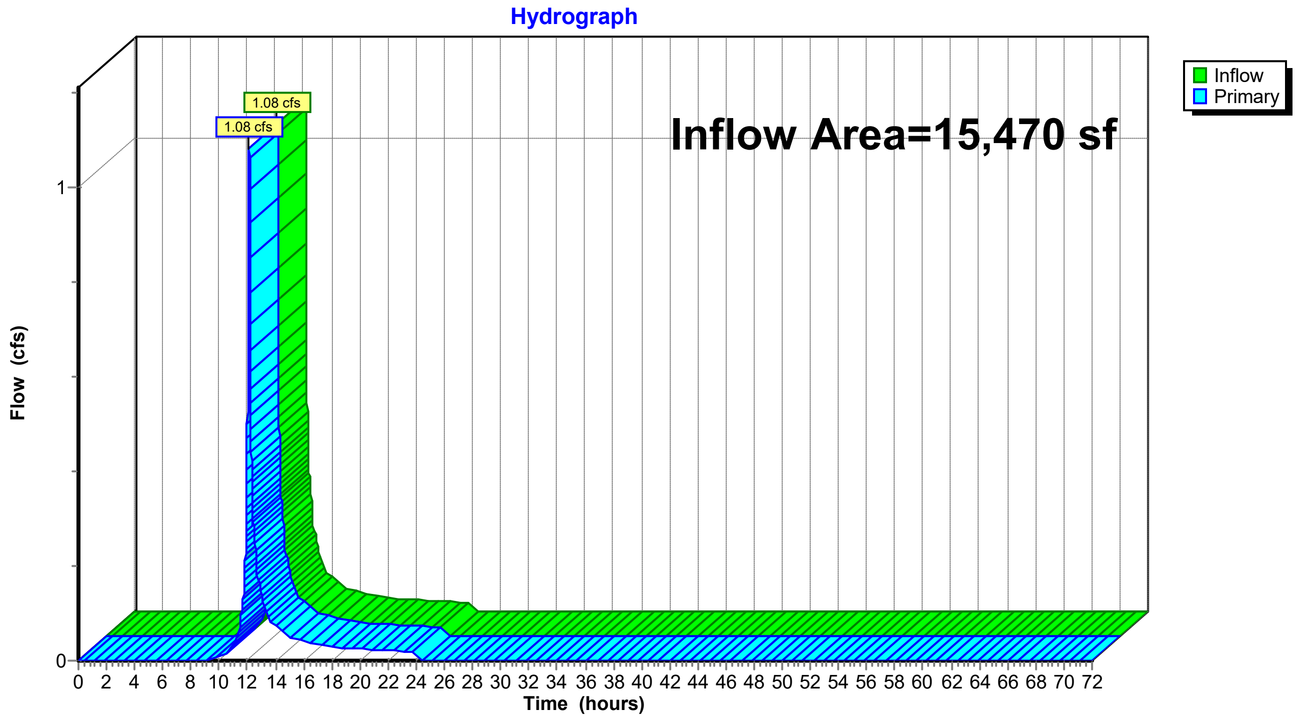


Summary for Link PR: Proposed Site Runoff

Inflow Area = 15,470 sf, 18.18% Impervious, Inflow Depth = 2.59" for 25 Year event
Inflow = 1.08 cfs @ 12.13 hrs, Volume= 3,343 cf
Primary = 1.08 cfs @ 12.13 hrs, Volume= 3,343 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link PR: Proposed Site Runoff



Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 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 DA-SYS: Roof Area to System (889 SF) Runoff Area=889 sf 100.00% Impervious Runoff Depth=8.00"
Tc=6.0 min CN=98 Runoff=0.16 cfs 593 cf

Subcatchment DA-UNCAP: Uncaptured Runoff Runoff Area=14,581 sf 13.20% Impervious Runoff Depth=4.21"
Tc=6.0 min CN=66 Runoff=1.66 cfs 5,110 cf

Pond SYS: Cultec R-330XL HD Peak Elev=87.28' Storage=160 cf Inflow=0.16 cfs 593 cf
Discarded=0.01 cfs 506 cf Primary=0.07 cfs 70 cf Outflow=0.08 cfs 576 cf

Link PR: Proposed Site Runoff Inflow=1.68 cfs 5,179 cf
Primary=1.68 cfs 5,179 cf

Total Runoff Area = 15,470 sf Runoff Volume = 5,702 cf Average Runoff Depth = 4.42"
81.82% Pervious = 12,657 sf 18.18% Impervious = 2,813 sf

Summary for Subcatchment DA-SYS: Roof Area to System (889 SF)

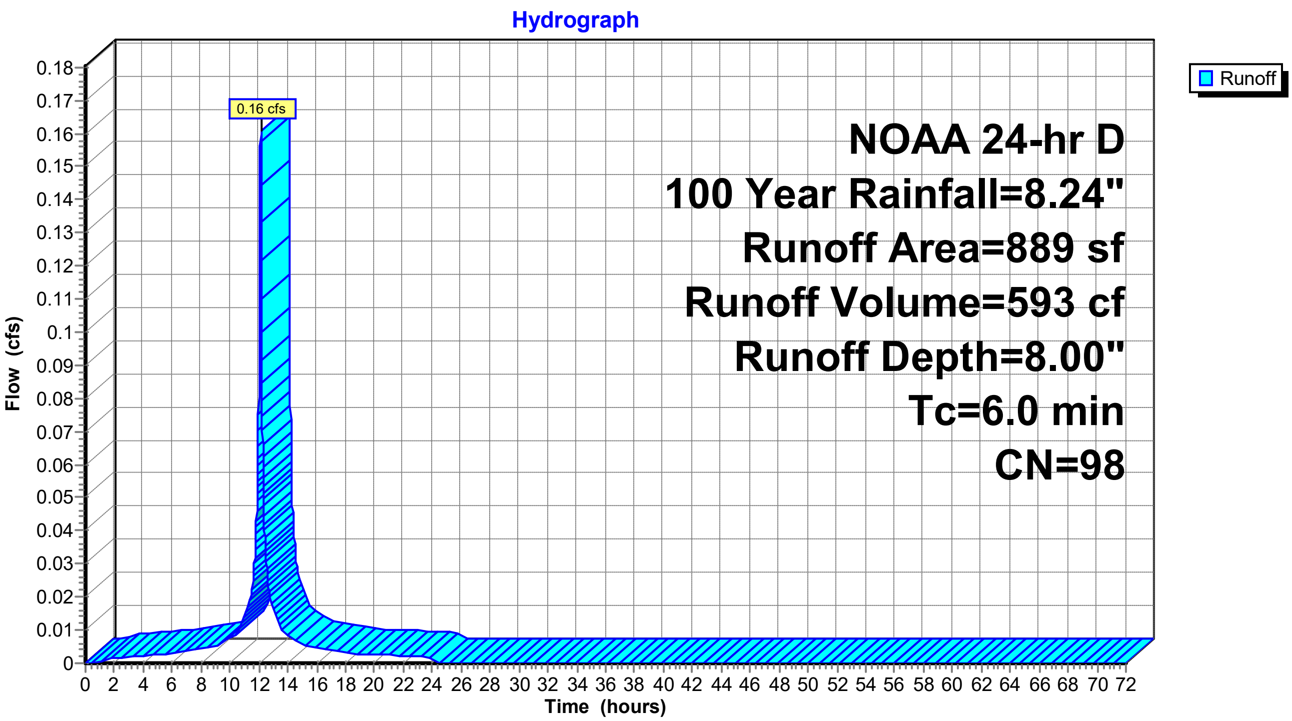
Runoff = 0.16 cfs @ 12.13 hrs, Volume= 593 cf, Depth= 8.00"
Routed to Pond SYS : Cultec R-330XL HD

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100 Year Rainfall=8.24"

Area (sf)	CN	Description
889	98	Roofs, HSG B
889		100.00% Impervious Area

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

Subcatchment DA-SYS: Roof Area to System (889 SF)



Summary for Subcatchment DA-UNCAP: Uncaptured Runoff

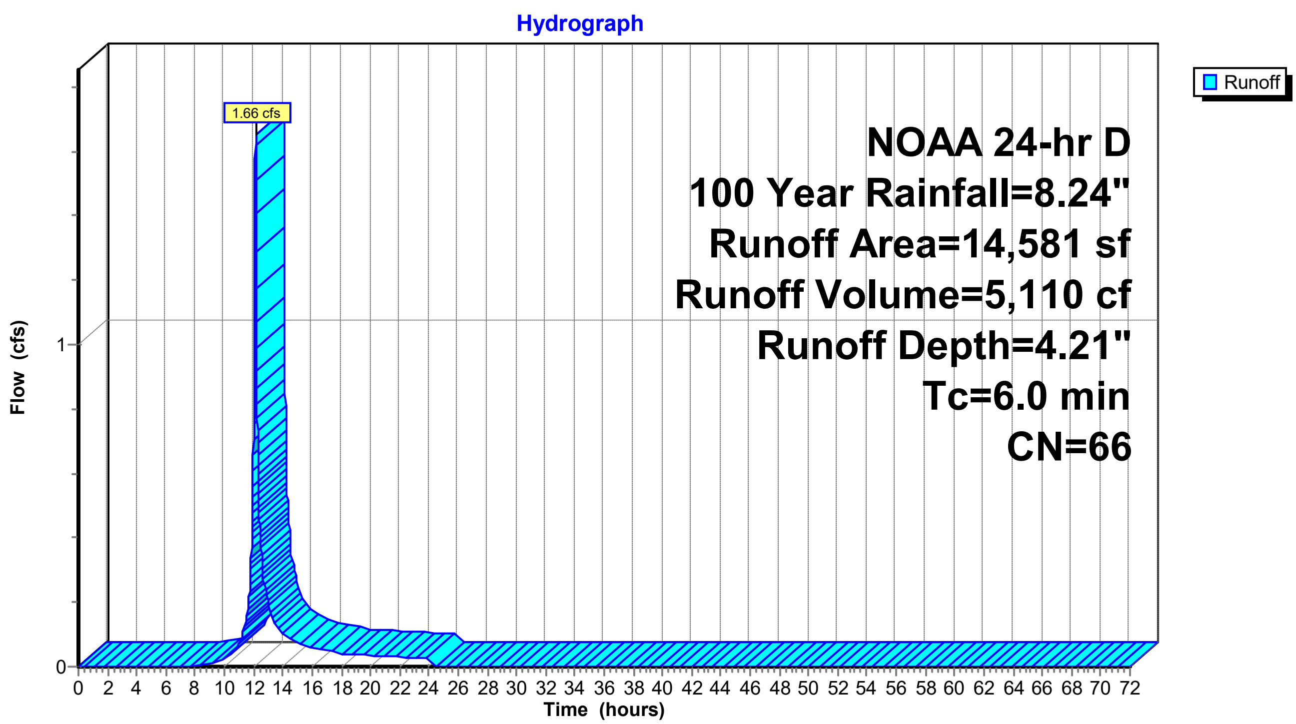
Runoff = 1.66 cfs @ 12.13 hrs, Volume= 5,110 cf, Depth= 4.21"
Routed to Link PR : Proposed Site Runoff

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100 Year Rainfall=8.24"

	Area (sf)	CN	Description
	697	98	Roofs, HSG B
	916	98	Paved parking, HSG B
	12,174	61	>75% Grass cover, Good, HSG B
	483	79	<50% Grass cover, Poor, HSG B
*	311	98	Permeable Pavers, HSG B
	14,581	66	Weighted Average
	12,657		86.80% Pervious Area
	1,924		13.20% Impervious Area

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

Subcatchment DA-UNCAP: Uncaptured Runoff



Summary for Pond SYS: Cultec R-330XL HD

Inflow Area = 889 sf,100.00% Impervious, Inflow Depth = 8.00" for 100 Year event
Inflow = 0.16 cfs @ 12.13 hrs, Volume= 593 cf
Outflow = 0.08 cfs @ 12.17 hrs, Volume= 576 cf, Atten= 51%, Lag= 2.7 min
Discarded = 0.01 cfs @ 12.14 hrs, Volume= 506 cf
Primary = 0.07 cfs @ 12.17 hrs, Volume= 70 cf
Routed to Link PR : Proposed Site Runoff

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 4
Peak Elev= 87.28' @ 12.17 hrs Surf.Area= 86 sf Storage= 160 cf

Plug-Flow detention time= 129.7 min calculated for 576 cf (97% of inflow)
Center-of-Mass det. time= 111.1 min (852.7 - 741.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	83.50'	97 cf	**7.50'W x 11.50'L x 3.54'H Field A**
			305 cf Overall - 63 cf Embedded = 242 cf x 40.0% Voids
#2A	84.00'	63 cf	**Cultec R-330XLHD** Inside #1
			Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
			Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
			Row Length Adjustment= +1.50' x 7.45 sf x 1 rows
#3	85.20'	1 cf	**0.33'D x 6.00'H Downspout for Overflow Model** -Impervious
		161 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	83.50'	**2.410 in/hr Exfiltration over Wetted area**
#2	Primary	87.10'	**4.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.14 hrs HW=87.21' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.07 cfs @ 12.17 hrs HW=87.28' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.07 cfs @ 1.43 fps)

Pond SYS: Cultec R-330XL HD - Chamber Wizard Field A

Chamber Model = Cultec R-330XLHD (Cultec Recharger® 330XLHD)
Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf
Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap
Row Length Adjustment= +1.50' x 7.45 sf x 1 rows

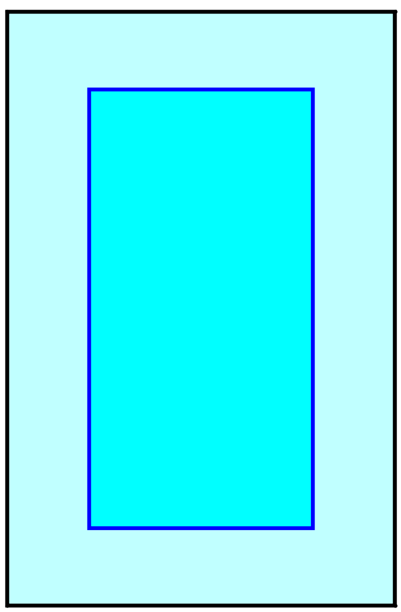
1 Chambers/Row x 7.00' Long +1.50' Row Adjustment = 8.50' Row Length +18.0" End Stone x 2 = 11.50' Base Length
1 Rows x 52.0" Wide + 19.0" Side Stone x 2 = 7.50' Base Width
6.0" Stone Base + 30.5" Chamber Height + 6.0" Stone Cover = 3.54' Field Height

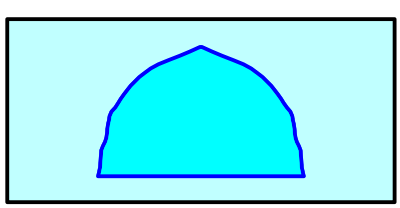
1 Chambers x 52.2 cf +1.50' Row Adjustment x 7.45 sf x 1 Rows = 63.3 cf Chamber Storage

305.5 cf Field - 63.3 cf Chambers = 242.1 cf Stone x 40.0% Voids = 96.9 cf Stone Storage

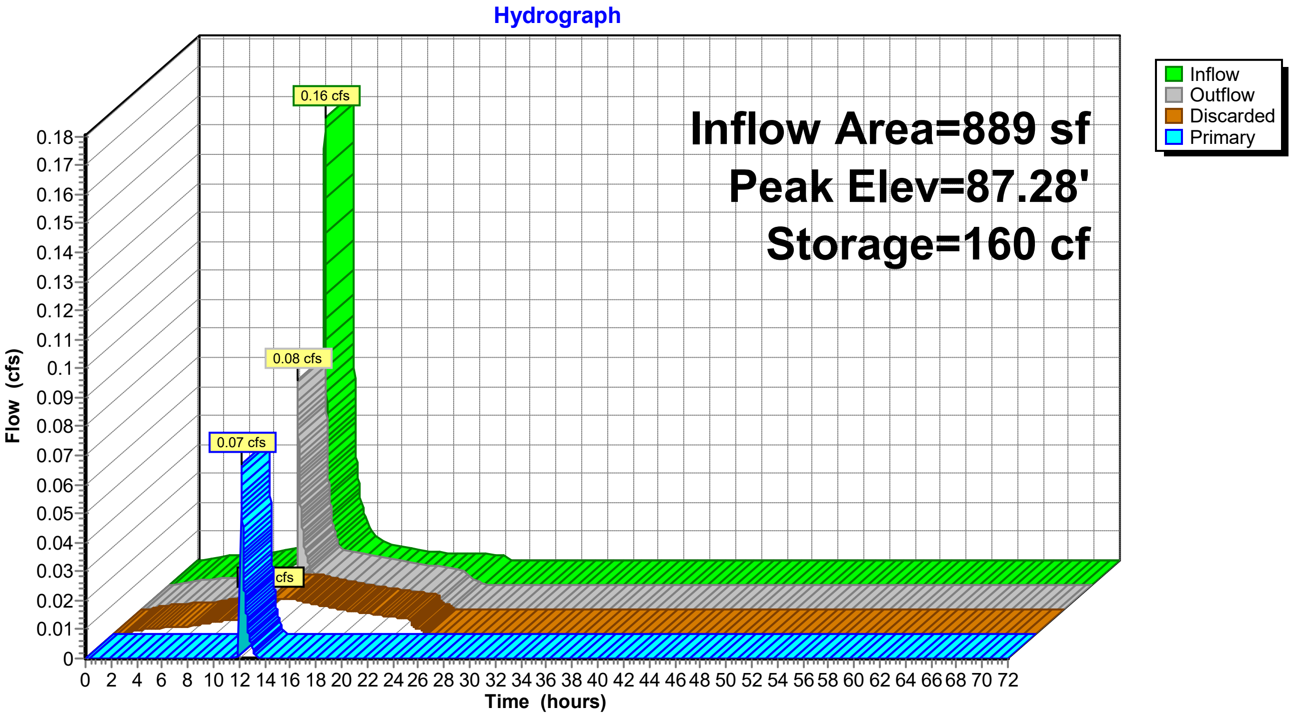
Chamber Storage + Stone Storage = 160.2 cf = 0.004 af
Overall Storage Efficiency = 52.4%
Overall System Size = 11.50' x 7.50' x 3.54'

1 Chambers
11.3 cy Field
9.0 cy Stone





Pond SYS: Cultec R-330XL HD



Summary for Link PR: Proposed Site Runoff

Inflow Area = 15,470 sf, 18.18% Impervious, Inflow Depth = 4.02" for 100 Year event
Inflow = 1.68 cfs @ 12.14 hrs, Volume= 5,179 cf
Primary = 1.68 cfs @ 12.14 hrs, Volume= 5,179 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link PR: Proposed Site Runoff