Stormwater Management Report
Municipal Parking Lot & Green Infrastructure Project

Mechanic Street
Spencer, MA

PREPARED FOR:

Town of Spencer

January 6, 2020

Revised
February 21, 2020

PREPARED BY

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Springfield, MA 01103

Project No. 20170390.D51

FUSS & O'NEILL

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Municipal Parking Lot & Green Infrastructure Project

1 Executive Summary

The Town of Spencer proposes to construct a new municipal parking lot located at Mechanic Street in Spencer, Massachusetts. A portion of the property is currently a parking lot while the remaining portion is a poor stand of grass, the location of two recently demolished structures. The site is bounded by the United State Postal Service to the north, Wall Street, LLC to the west, a residential property to the south, and Mechanic Street to the east. The project location is depicted on the Site Location Map attached as *Figure 1* in this report.

The project includes the construction of a parking lot with associated stormwater management systems and landscaping (i.e., green infrastructure). The overall drainage pattern of the site will be similar to existing conditions.

The proposed stormwater management system design is consistent with the guidelines of the Massachusetts Stormwater Handbook and the Spencer Stormwater Bylaw and Regulations. Green infrastructure Stormwater best management practices (BMPs) have been implemented to reduce runoff volumes and Stormwater pollutant loads, mitigate increases in peak runoff rates and to promote groundwater recharge. The existing and proposed site conditions and proposed stormwater management system are described in detail in *Section 2* of this report.

The design drawings include controls to protect receiving stormwater systems and properties adjacent to the development from erosion and sedimentation impacts caused by construction site runoff. The plan incorporates both non-structural and structural controls, such as inspections, waste management, good housekeeping and maintenance, perimeter sediment barriers, dust suppression, and a construction entrance. The proposed drainage systems will be protected with catch basin inlet protection devices, erosion control blankets, and compost filter socks. Additional information related to erosion and sediment controls is included in *Section* 4. In order to ensure the long-term success of the stormwater management system, post-construction operation and maintenance practices will be required in accordance with the Long-Term Operation and Maintenance Plan that has been developed for the site.

In addition to flood resilience and water quality benefits, the project will create a highly-visible public green space in the downtown area, providing aesthetic improvements and reducing heat island impacts. The project will showcase green stormwater techniques and offer opportunities for public education and outreach through signage and general use by the public. The project will demonstrate the application of green infrastructure practices in the downtown area and serve as an example for other potential retrofit sites in the community. The proposed project will also advance the Town's broader downtown revitalization and overall economic development initiatives as an Environmental Justice community.

2 Project Description

2.1 Existing Conditions

The project is located west of Mechanic Street on three parcels identified by the Spencer Tax Assessor as Map ID U07-35, U07-36, and U07-37, which total approximately 0.53 acres. The site consists of two former residential lots and an adjacent municipal parking lot located at 14, 18, and 20 Mechanic Street. The site contains an existing parking lot and poor stand of grass, where two deteriorated buildings were demolished in 2019. There is no stormwater drainage infrastructure located on the property.

There are no wetlands on the site. The site is not within a NHESP Priority Habitat of Rare Species, Estimated Habitat of Rare Wildlife, or Area of Critical Environmental Concern (ACEC).

Federal Emergency Management Agency (FEMA) mapping shows that the site lies in Zone X, in an area outside the 500-year floodplain. FEMA Flood Insurance Rate Map (FIRM) (Panel Number 25027C0780E, Effective Date: July 4, 2011) is included as *Figure 2*.

The site is characterized by Natural Resources Conservation Service (NRCS) as Paxton-Urban Land complex, 8 to 15 percent slopes (622C), defined by a hydrologic soil group rating "C". The NRCS soils report is included in *Figure 3*.

Fuss & O'Neill observed five test pits and performed infiltration testing at the site in areas of the proposed bioretention cells and infiltration systems. Test pits were excavated to depths between four and eight feet below ground surface. Soil conditions, including soil texture, color, horizon depths, and evidence of saturation were logged in the field in addition the results of the infiltration testing. No evidence of seasonal high groundwater was observed. Soils were found to be a mix of sand, gravel, and fill material. Infiltration rates (i.e., in-situ saturated hydraulic conductivity) were observed to be between 5 and 10 inches per hour, which is considered a "rapid infiltration rate" requiring at least 44% total suspended solids (TSS) pretreatment according to the MA Stormwater Standards. For design purposes, the infiltration rate was assumed to be 50% of the in-situ saturated hydraulic conductivity. The results of the test pits and infiltration testing can be found in *Appendix A*.

2.2 Proposed Conditions

The project includes the construction of a municipal parking lot with associated stormwater management systems and landscaping (i.e., green infrastructure). The stormwater management system is comprised of bioretention areas and a subsurface infiltration system. Runoff from the parking lot and a portion of Mechanic Street sheet flows into one of the three bioretention areas before being conveyed into the subsurface infiltration system.

The proposed BMPs have been sized to accommodate the 100-year design storm without overflow (i.e., no surface discharge from the site) and have been modeled using the infiltration rates observed during field testing. Through the use of these green infrastructure stormwater BMPs, reduction in runoff volume and pollutant loads, stormwater peak discharge, groundwater recharge and stormwater treatment are achieved.

3 Hydrologic Analysis

The hydrologic analyses for existing and proposed conditions were completed using a computer software package, HydroCAD version 10.00-20, to determine peak runoff flow rates and total runoff volumes for the watershed models. The model is based on the NRCS Technical Release 20 and Technical Release 55 (TR-55), and is subject to cumulative rainfall/volume dependent routing calculations. Hydrographs are prepared for each element of the watershed and routed through the dynamic-storage-indication method to produce various time-based results.

Two design points were developed for the project. Design Point 10 (denoted as Link 10L in the hydrologic analyses) is Mechanic Street to the east of the site. Design Point 20 (denoted as Link 20L) is the abutting property to the west of the site.

The pre-development hydrologic analysis is included as *Appendix B*, and the post-development hydrologic analysis is in *Appendix C*.

3.1 Existing Watershed Summary

Stormwater runoff from the site is conveyed via sheet flow to the two design points. Mechanic Street and the abutting property to the west have been used as the limits of analysis. Two subcatchments have been established for the project's pre-development conditions, as described below.

- **Subcatchment 10S** consists of a portion of Mechanic Street, parking lot, and grass in poor condition. Runoff from this area sheet flows towards the gutter line in Mechanic Street (Design Point 10L).

- **Subcatchment 20S** consists of a portion of the parking lot and grass in poor condition. Runoff from this area sheet flows towards the abutting property to the west (Design Point 20L).

The Pre-Development Watershed Map is included as *Figure 4*.

3.2 Proposed Watershed Summary

The boundary of the post-development analysis is the same as the pre-development conditions. However, the subcatchments have been further delineated based on the drainage area to each individual BMPs drainage area. The post-development subcatchments are described below.

- **Subcatchment 10S** consists of the northeastern portion of the parking lot. Runoff sheet flows into the bioretention area, denoted as 10P, before being conveyed into the subsurface infiltration system, denoted as 30P. Runoff is ultimately infiltrated into the ground.

- **Subcatchment 20S** consists of the norther portion of Mechanic Street. Runoff from Mechanic Street sheet flows into a roadside raingarden through an opening in the existing curb. Overflow from the roadside raingarden is conveyed under the sidewalk into the bioretention area, denoted

as 10P, before being conveyed into the subsurface infiltration system, denoted as 30P. Runoff is ultimately infiltrated into the ground.

- **Subcatchment 30S** consists of the western portion of the parking lot and adjacent grassed area. Runoff sheet flows into the proposed catch basin, before being conveyed into the subsurface infiltration system, denoted as 30P. Runoff is ultimately infiltrated into the ground.

- **Subcatchment 40S** consists of a grassed area to the west of the parking lot. Runoff sheet flows towards the abutting property to the west (Design Point 20L).

- **Subcatchment 50S** consists of the southeastern portion of the parking lot. Runoff sheet flows into the bioretention area, denoted as 50P, before being conveyed into the subsurface infiltration system, denoted as 30P. Runoff is ultimately infiltrated into the ground.

- **Subcatchment 60S** consists of a small portion of the parking lot and southern portion of Mechanic Street. Runoff sheet flows towards the gutter line in Mechanic Street (Design Point 10L).

The Post-Development Watershed Map is included as *Figure 5*.

3.3 Hydrologic Analysis Results

The proposed BMPs attenuate peak flows from the site, effectively reducing the site's runoff rates compared to existing condition. The pre- and post-development peak flow rates for the two design points are included in the below tables.

2 Year Design Storm				
Design Point	Existing Flow (CFS)	Proposed Flow (CFS)	Net Change (CFS)	Net Change (%)
10L - Mechanic Street	1.13	0.21	-0.92	-81%
20L - Abutting Property West	0.87	0.08	-0.79	-91%
Total	2.00	0.29	-1.71	-86%

10 Year Design Storm				
Design Point	Existing Flow (CFS)	Proposed Flow (CFS)	Net Change (CFS)	Net Change (%)
10L - Mechanic Street	1.80	0.32	-1.48	-82%
20L - Abutting Property West	1.41	0.17	-1.24	-88%
Total	3.21	0.49	-2.72	-85%

25 Year Design Storm				
Design Point	Existing Flow (CFS)	Proposed Flow (CFS)	Net Change (CFS)	Net Change (%)
10L - Mechanic Street	2.31	0.40	-1.91	-83%
20L - Abutting Property West	1.82	0.25	-1.57	-86%
Total	4.13	0.65	-3.48	-84%

100 Year Design Storm				
Design Point	Existing Flow (CFS)	Proposed Flow (CFS)	Net Change (CFS)	Net Change (%)
10L - Mechanic Street	3.35	0.58	-2.77	-83%
20L - Abutting Property West	2.65	0.41	-2.24	-85%
Total	6.00	0.99	-5.01	-84%

The results indicates that the proposed improvements will reduce peak runoff rates from the site for the 2-, 10-, 25-, and 100-year, Type III, 24-hour storm events as compared to the pre-development peak runoff rates. The proposed bioretention and infiltration systems will infiltrate the entire runoff volume up to the 100-year design storm, effectively eliminating surface stormwater discharge from the site for most storm events.

3.4 Storm Sewer Design

The drainage analysis for the proposed stormwater management system was completed using Bentley System's StormCAD computer program. Input information for the model was derived using the Rational Formula. Times of concentrations were assumed to be the minimal allowable time of 5 minutes. The StormCAD output indicates that the proposed pipe and catch basins will have adequate capacity to convey and drain the 25-year design storm. Calculations for the proposed storm sewer network are included in Appendix D.

3.5 Climate Resilience

The climate projections for Massachusetts suggest that high-intensity rainfall events will continue to become more frequent with a changing climate, which has implications for the design of drainage infrastructure and stormwater BMPs. The proposed conditions hydrologic analysis and the drainage analysis for the proposed stormwater system were evaluated for a future climate change scenario to account for projected increases in design storm precipitation amounts. MassDOT has developed projected percent change in 24-hour 100-year return interval precipitation (in comparison to the baseline period of 1986-2005) based on downscaled climate projections for Massachusetts. Projections are provided for a range of future time periods, global warming scenarios, and climate model outputs. Our future climate change scenario assumed a 50-year design life (2070 timeframe), a worst-case emissions scenario (RCP 8.5) which is consistent with agency guidance, and median model output, resulting in a

predicted 20% increase in the 24-hour 100-year return interval precipitation. The hydrologic model for the project was therefore run with design storm amounts that are 20% larger than the corresponding NOAA Atlas 14 values.

The results show that even under this future climate scenario, the proposed project still reduces peak rates of runoff for the 2, 10, 25, and 100-year storm when compared with existing conditions. For the future 100-year storm, peak water elevations in Bioretention Basins 10P and 50P are predicted to be below the top of the basins. The peak capacity of the Subsurface Infiltration System 30P will be exceeded by approximately 0.18 feet for the future 100-year storm while still infiltrating the entire future 25-year storm.

The StormCAD output indicates that the proposed pipe and catch basins will have adequate capacity to convey and drain the future 25-year design storm, even with the 20% increase in intensity.

4 Soil Erosion and Sedimentation Control

Soil erosion and sedimentation control details and narratives for construction periods are provided on the site plans. Soil erosion and sedimentation control details and procedures are consistent with the "Massachusetts Erosion and Sediment Control Guideline for Urban and Suburban Areas."

Construction period erosion and sedimentation controls will include a construction entrance, compost filter socks, erosion control blankets, catch basin inlet protection, and water for dust control. Additional erosion and sediment controls will be utilized as required. Perimeter sediment controls will be placed down-gradient of disturbed areas. Water will be applied to exposed soils to provide dust control as needed.

Waste materials generated from construction activities will include excavated soil and pavement. All excavation debris and other waste will be transported to an approved disposal facility.

5 Construction Sequence

Construction is a dynamic operation that is affected by weather and other unanticipated conditions. Therefore, the layout of erosion and sediment controls shown on the plans will likely be modified to best manage changing field conditions. The Massachusetts Erosion and Sediment Controls Guidelines for Urban and Suburban Areas recognize this. Work with Engineer, owner and regulatory agencies so that the intent of the guidelines are met until all disturbed areas are permanently stabilized. The following is a general sequence of major construction operations.

Construction is anticipated to start in the spring of 2020.

1. Install erosion and sediment controls.
2. Begin general construction.
   2.1. Strip and stockpile existing topsoil. Temporary seed stockpiles as required.
   2.2. Rough grade and temporary stabilized disturbed areas.
   2.3. Construct site utilities and stormwater features.

2.4. Adjust erosion and sediment controls as required during construction.
2.5. Once areas have reached subgrade, re-spread stockpiled topsoil and stabilized areas that have reached finished grade.

3. Maintain all erosion and sediment controls measures until all disturbed areas are stabilized. Sweep Roads and employ dust control measures as needed throughout construction.
4. Remove any temporary control measures and accumulated sediment from permanent structures.

6 Massachusetts Stormwater Handbook Standards

The following is a description of how the proposed project conforms with the stormwater management standards (Standards) outlined in the Massachusetts Stormwater Handbook. The Stormwater Management Checklist is included in *Appendix E*.

Standard 1: No Untreated Discharge or Erosion to Wetlands
There are no wetlands on the site. An unnamed stream that originates at Muzzy Meadow Pond, and flows underground for several hundred feet, remerges near the northwest corner of the site and flows away from the site. Perimeter erosion controls will protect undisturbed wetland buffers and wetland resource areas from sedimentation until the site is stabilized. No concentrated flows are proposed into wetlands and/or waterways of the Commonwealth.

Standard 2: Peak Rate Attenuation
Post-development discharge rates from the 2-, 10-, 25-, and 100-year storm events will decrease as a result of the development compared to the pre-development condition. This will be achieved by the storage provide by the subsurface infiltration system. Peak flow results are included above.

Standard 3: Stormwater Recharge
The subsurface infiltration system will allow infiltration and groundwater recharge. The subsurface infiltration system has been designed to provide storage in excess of the recharge volume required by this standard. All the stormwater entering the subsurface infiltration system will be infiltrated into the ground. BMP sizing calculation are included in *Appendix F*.

Standard 4: Water Quality
The subsurface infiltration system will provide water quality treatment through infiltration. The full Water Quality Volume will be treated through the infiltration system. All runoff entering the infiltration system will infiltrate into the ground. The bioretention cells and the deep sump catch basin will provide 25% TSS pretreatment of runoff prior to discharge into the subsurface infiltration system. Total Suspended Solid (TSS) removal calculations are included in *Appendix G*.

Standard 5: Land Uses with Higher Potential Pollutant Loads
The project does not contain any area of higher pollutant loads as defined by the Massachusetts Stormwater Handbook. The proposed parking lot is not considered a parking lot with high-intensity use (1,000 vehicle trips per day or more), as defined in the Massachusetts Stormwater Handbook.

Standard 6: Critical Areas

The site is not located within Zone II or Interim Wellhead Protection Areas, or other Critical Areas, which include Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters, Special Resource Waters, and Cold-Water Fisheries.

Standard 7: Redevelopment
The proposed project is considered a redevelopment project per the Massachusetts Stormwater Handbook.

Standard 8: Construction Pollution Prevention and Erosion and Sediment Controls
General erosion and sedimentation controls will be implemented and maintained in accordance with local, state, and federal requirements until construction is complete and disturbed areas have been stabilized.

Standard 9: Long-Term Operation and Maintenance Plan
A Long Term Operation and Maintenance Plan has been prepared and is included in *Appendix H*.

Standard 10: Illicit Discharges to Drainage System
There are no known illicit discharges at the project site. This project will not result in illicit discharges to Stormwater Management Systems as defined in the Massachusetts Stormwater Handbook.

7 Summary

This Stormwater Management Report describes proposed work and stormwater management associated with the parking lot and green infrastructure project on Mechanic Street in Spencer, Massachusetts. The stormwater management system, which includes an infiltration system, bioretention areas, proprietary water quality system, and a storm sewer system, will provide water quality treatment, runoff reduction, groundwater recharge, and peak flow attenuation. Peak runoff rates from the site will decrease when compared to pre-development conditions during the 2-, 10-, 25-, and 100-year storm events. The proposed bioretention and infiltration systems will infiltrate the entire runoff volume associated with the 100-year design storm, effectively eliminating surface stormwater discharge from the site for all analyzed storms

The proposed design addresses the applicable standards set forth in the MassDEP Stormwater Management Guidelines as described in *Section 6* of this report as well as the standards contained in the Spencer Stormwater Bylaw and Regulations. Erosion control measures have been incorporated into the design. Based on the conditions summarized above, the proposed site improvements will have no adverse effect on abutters or the receiving drainage systems.

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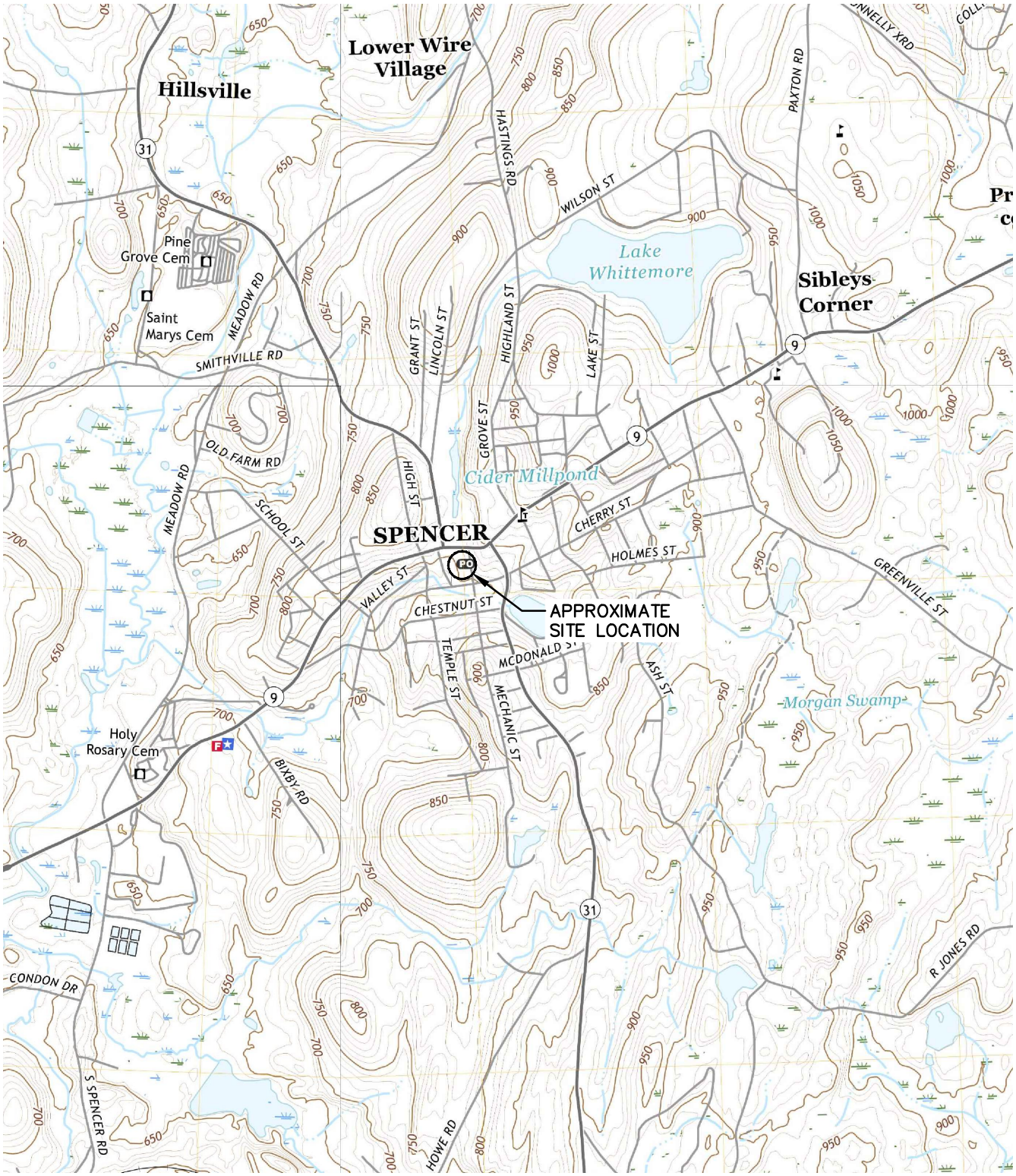
Figure 1

Site Location Map



MAP REFERENCE:
THIS MAP WAS PREPARED FROM THE FOLLOWING USGS 7.5 MINUTE SERIES TOPOGRAPHICAL MAPS:
PAXTON, PAXTON QUADRANGLE, 2018
LEICESTER, LEICESTER QUADRANGLE, 2018
EAST BROOKFIELD, EAST BROOKFIELD QUADRANGLE, 2018
NORTH BROOKFIELD, NORTH BROOKFIELD QUADRANGLE, 2018

SCALE:
HORZ.: 1" = 2000'
VERT.:
DATUM:
HORZ.:
VERT.:
0 1000 2000
GRAPHIC SCALE

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TOWN OF SPENCER

SITE LOCATION MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

SPENCER MASSACHUSETTS

PROJ. No.: 20170390.D51
DATE: DECEMBER 2019

FIGURE 1

FUSS & O'NEILL

Figure 2

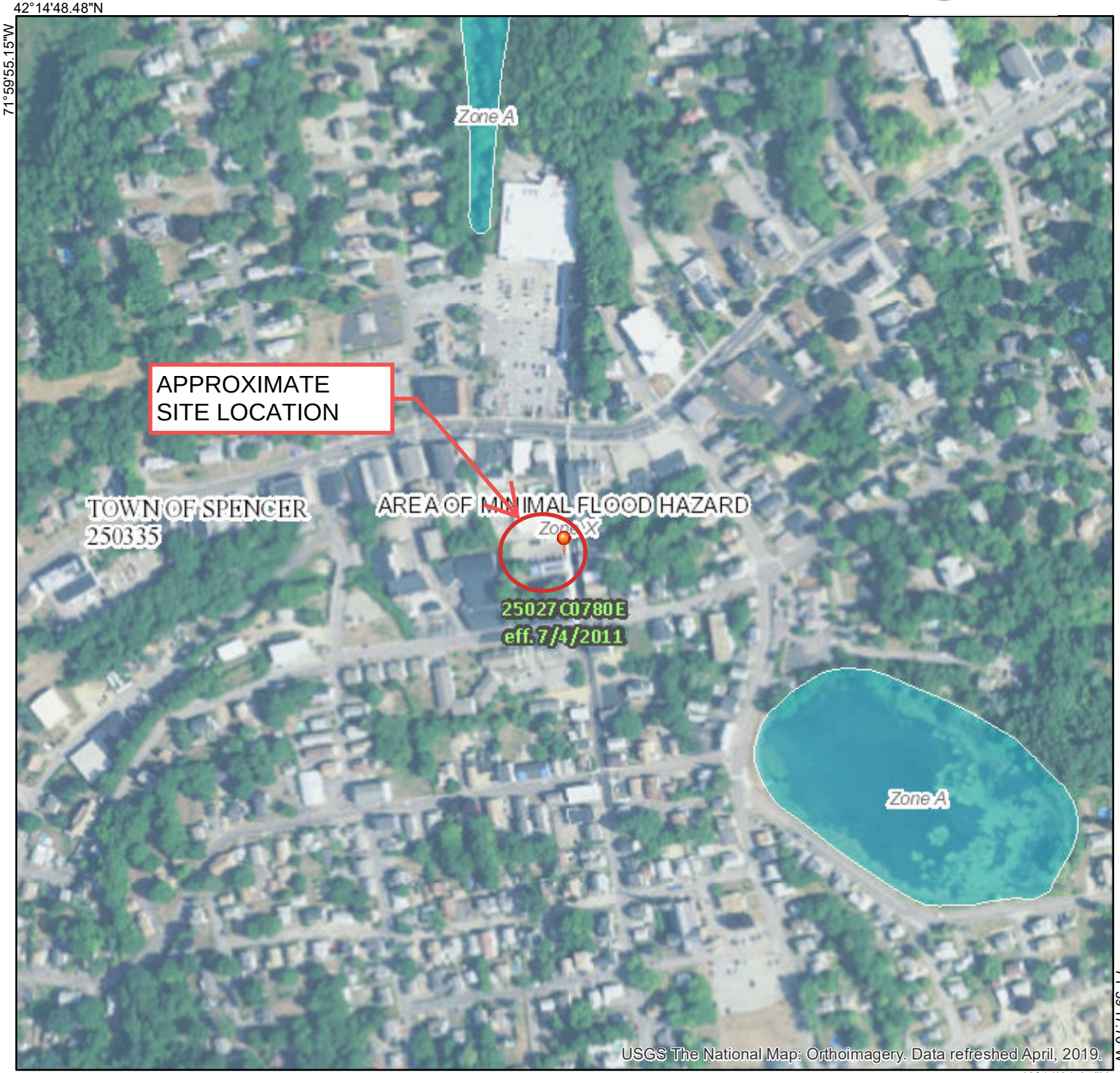
Flood Insurance Rate Map

National Flood Hazard Layer FIRMette

FEMA

42°14'48.48"N

71°59'55.15"W



71°59'17.70"W

42°14'21.85"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 11/27/2019 at 8:16:05 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

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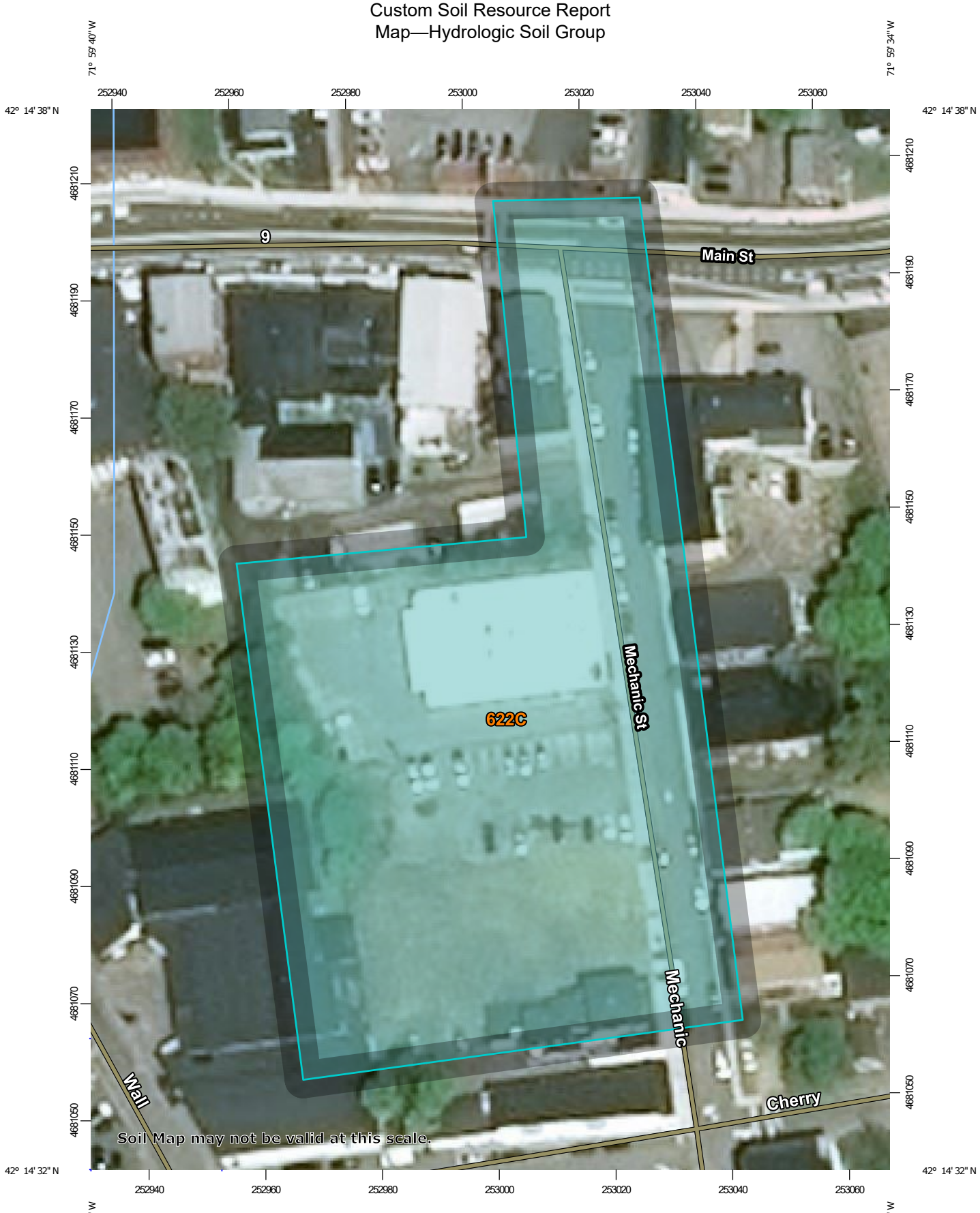
Figure 3

NRCS Web Soil Survey Map

Custom Soil Resource Report
Map—Hydrologic Soil Group



Map Scale: 1:882 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 10 20 40 60

Feet: 0 40 80 160 240

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

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DATE: DECEMBER 2019

Figure 3

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: May 18, 2019—Jul 9, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

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Figure 3

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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Figure 3

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
622C	Paxton-Urban land complex, 8 to 15 percent slopes	C	2.0	100.0%
Totals for Area of Interest			**2.0**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

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Figure 3

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

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Figure 3

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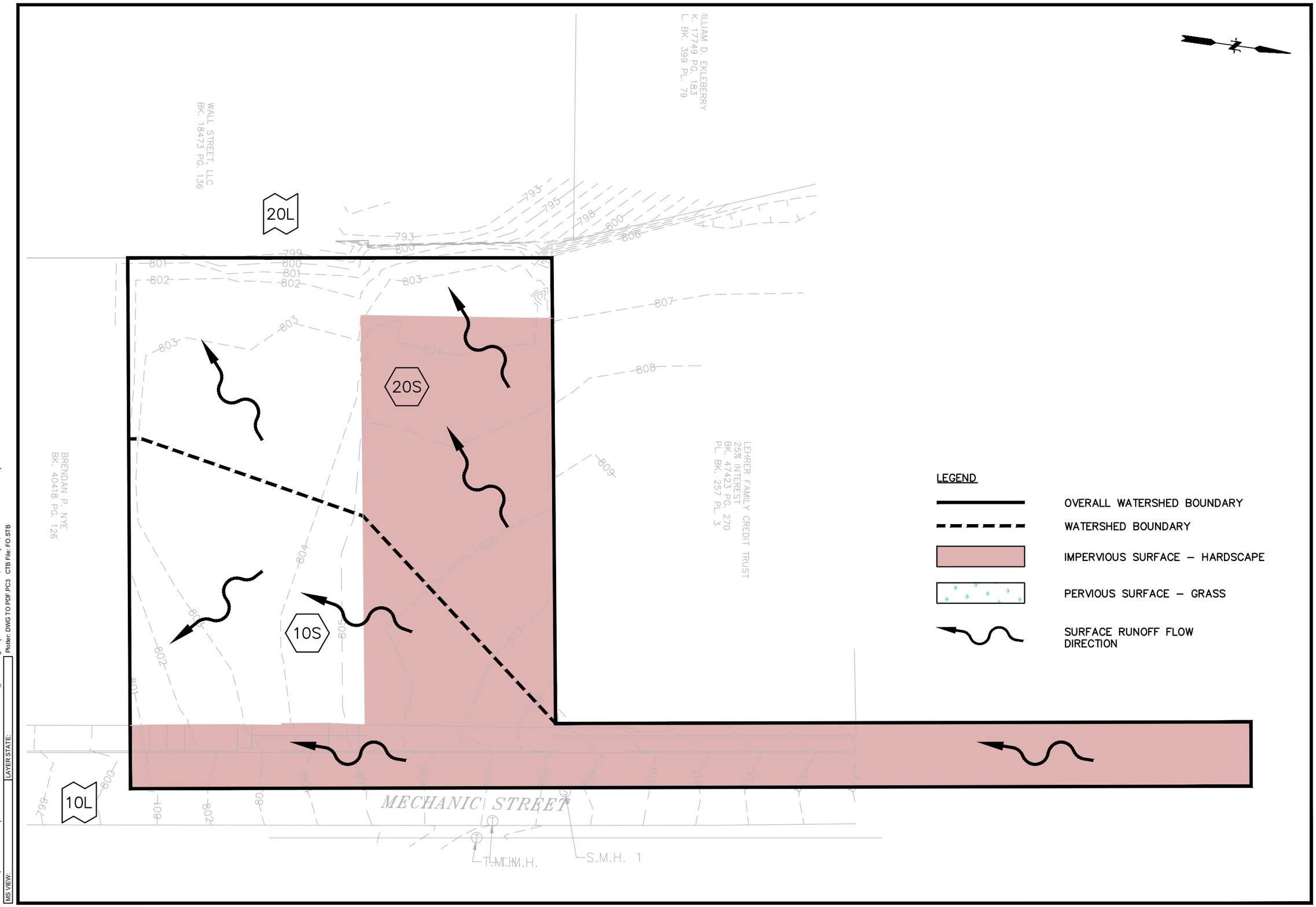
Figure 4

Pre-Development Watershed Map



File Path: \\private\dfs\CadPro\JDWG\P20170390\D51\Civil\Plan\20170390.D51_DRA01.dwg Layout: FIG 4 Plotted: Mon, January 06, 2020 - 10:32 AM User: jvaldez
MS VIEW: LAYER STATE: Plotter: DWG TO PDF.PC3 CTB File: FO.STB

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.:
VERT.:
0 15 30
GRAPHIC SCALE

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TOWN OF SPENCER
PRE-DEVELOPMENT WATERSHED MAP
MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT
SPENCER MASSACHUSETTS

PROJ. No.: 20170390.D51
DATE: JANUARY 2020

FIGURE 4

FUSS & O'NEILL

Figure 5

Post-Development Watershed Map

WILLIAM D. EKLEBERRY
K. 17749 PG. 183
L. BK. 399 PL. 79

WALL STREET, LLC
BK. 18473 PG. 136

BRENDAN P. NYE
BK. 40418 PG. 126

LEHRER FAMILY CREDIT TRUST
25% INTEREST
BK. 47423 PG. 270
PL. BK. 257 PL. 3

20L

40S

30S

30P

10P

10S

50S

50P

60S

20S

10L

MECHANIC STREET

T.M.H.

S.M.H. 1

LEGEND

- OVERALL WATERSHED BOUNDARY
- WATERSHED BOUNDARY
- IMPERVIOUS SURFACE – HARDSCAPE
- PERVIOUS SURFACE – GRASS
- FLOW DIRECTION

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.:
VERT.:
0 15 30
GRAPHIC SCALE

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TOWN OF SPENCER

PRE-DEVELOPMENT WATERSHED MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

MASSACHUSETTS

SPENCER

PROJ. No.: 20170390.D51
DATE: FEBRUARY 2020

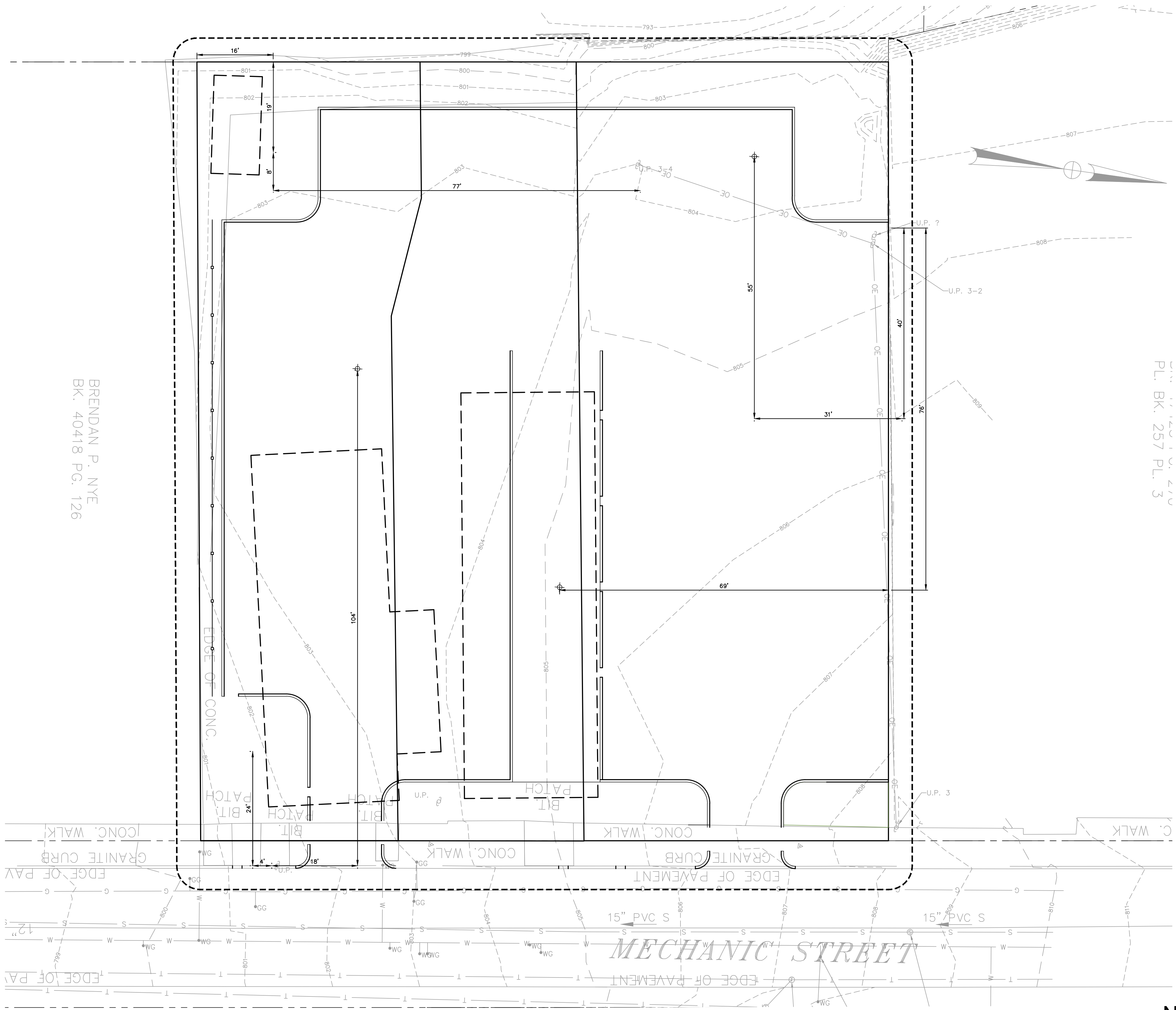
FIGURE 5

File Path: J:\DWG\P20170390\D51\Civil\Plan\20170390.D51_DRA01.dwg Layout: FIG 5 Plotted: Thu, February 20, 2020 - 9:14 AM User: jvaldez
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
MS VIEW: LAYER STATE:

FUSS & O'NEILL

Appendix A

Soil Investigations



PERMITTING PLANS
NOT FOR CONSTRUCTION

File Path: J:\DWG\P2017\0390\D51\Civil\Plan\20170390.D51_STP01.dwg Layout: TEST PIT MAP Plotted: Mon, January 06, 2020 - 11:37 AM User: kthimotee
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
MS VIEW:
LAYER STATE:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 10'
VERT.:
DATUM:
HORZ.:
VERT.:
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

TOWN OF SPENCER

TEST PIT MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

SPENCER MASSACHUSETTS

PROJ. No.: 20170390.D51
DATE: 01/07/2020

APP.A

Test Pit # TP-1

Location: Spencer, MA

Project Name:	Mechanic Street Parking Lot
Project Number	20170390.D51
Date:	11/20/2019
Time:	9:00
Sample Prefix:	
Logged By:	Matthew Kissane

Contractor:	Spencer Highway Dept.
Operator:	
Backfill:	original material

FUSS & O'NEILL

LOGGING DEPTH from -- to	SOIL DESCRIPTION	USCS CODE	FIELD TESTING	SAMPLE NUMBER	SAMPLE DEPTH from -- to	TIME
0' - 5'	Fn-Md SAND, some 1/4 - 1/2" Gravel, some 3 - 4' Cobbles and Construction Debris (FILL), light brown, moist.	SP	-	TP-1(4-5')	4' - 5'	
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General Test pit Description

	Native Soil	Clean Fill (i.e. brick concrete, asphalt)	Dimension lumber	Metals	Tires	Other
Description						
Percentage						

APPROX. SURFACE ELE. (FT-MSL)	
DIMENSIONS OF PIT:	~ 3' x 10'
TOTAL DEPTH	5'
DEPTH TO BEDROCK	n/a
DEPTH TO MOTTLING	n/a
DEPTH TO ROOTS	n/a
DEPTH TO WATER	n/a
WERE PHOTOS TAKEN?	yes
SAMPLING METHOD	bucket of excavator
FIELD INSTRUMENT	n/a

Photo #s

TEST PIT SKETCH:

COMMENTS:

Infiltrometer Test #1 - 1.5"/15 mins

Infiltrometer Test #1 - 1.7"/15 mins

Infiltrometer Test #1 - 0.8"/15 mins

Average = 1.33"/15 mins = 5.33"/hour

Test Pit # TP-2

Location: Spencer, MA

Project Name:	Mechanic Street Parking Lot
Project Number:	20170390.D51
Date:	11/20/2019
Time:	10:15
Sample Prefix:	
Logged By:	Matthew Kissane

Contractor:	Spencer Highway Dept.
Operator:	
Backfill:	original material

FUSS & O'NEILL

LOGGING DEPTH from -- to	SOIL DESCRIPTION	USCS CODE	FIELD TESTING	SAMPLE NUMBER	SAMPLE DEPTH from -- to	TIME
0' - 5'	Fn-Md SAND, some 1/2 - 1" Gravel, some 1 - 1.5' Cobbles and Construction Debris (FILL), dark brown, moist.	SP	-	TP-1(4-5')	4' - 5'	
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--					--	
--					--	

General Test pit Description

	Native Soil	Clean Fill (i.e. brick concrete, asphalt)	Dimension lumber	Metals	Tires	Other
Description						
Percentage						

APPROX. SURFACE ELE. (FT-MSL)	
DIMENSIONS OF PIT:	~ 3' x 10'
TOTAL DEPTH	5'
DEPTH TO BEDROCK	n/a
DEPTH TO MOTTLING	n/a
DEPTH TO ROOTS	n/a
DEPTH TO WATER	n/a
WERE PHOTOS TAKEN?	yes
SAMPLING METHOD	bucket of excavator
FIELD INSTRUMENT	n/a

Photo #s

TEST PIT SKETCH:

COMMENTS:

Infiltrometer Test #1 - 1.8"/15 mins

Infiltrometer Test #1 - 1.6"/15 mins

Infiltrometer Test #1 - 1.6"/15 mins

Average = 1.66"/15 mins = 6.66"/hour

Test Pit # TP-3

Location: Spencer, MA

Project Name:	Mechanic Street Parking Lot
Project Number:	20170390.D51
Date:	11/20/2019
Time:	11:20
Sample Prefix:	
Logged By:	Matthew Kissane

Contractor:	Spencer Highway Dept.
Operator:	
Backfill:	original material

FUSS & O'NEILL

LOGGING DEPTH from -- to	SOIL DESCRIPTION	USCS CODE	FIELD TESTING	SAMPLE NUMBER	SAMPLE DEPTH from -- to	TIME
0' - 7'	Fn-Md SAND, some 1/4 - 3/4" Gravel, some 1 - 3' Cobbles and Construction Debris (FILL), light-to-dark brown, moist.	SP	-	TP-1(6-7')	6' - 7'	
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General Test pit Description

	Native Soil	Clean Fill (i.e. brick concrete, asphalt)	Dimension lumber	Metals	Tires	Other
Description						
Percentage						

APPROX. SURFACE ELE. (FT-MSL)	
DIMENSIONS OF PIT:	~ 3' x 10'
TOTAL DEPTH	7'
DEPTH TO BEDROCK	n/a
DEPTH TO MOTTLING	n/a
DEPTH TO ROOTS	n/a
DEPTH TO WATER	n/a
WERE PHOTOS TAKEN?	yes
SAMPLING METHOD	bucket of excavator
FIELD INSTRUMENT	n/a

Photo #s

TEST PIT SKETCH:

COMMENTS:

Infiltrometer Test #1 - 1.5"/15 mins

Infiltrometer Test #1 - 1.6"/15 mins

Infiltrometer Test #1 - 1.7"/15 mins

Average = 1.60"/15 mins = 6.40"/hour

Test Pit # TP-4

Location: Spencer, MA

Project Name:	Mechanic Street Parking Lot
Project Number:	20170390.D51
Date:	11/20/2019
Time:	12:30
Sample Prefix:	
Logged By:	Matthew Kissane

Contractor:	Spencer Highway Dept.
Operator:	
Backfill:	original material

FUSS & O'NEILL

LOGGING DEPTH from -- to	SOIL DESCRIPTION	USCS CODE	FIELD TESTING	SAMPLE NUMBER	SAMPLE DEPTH from -- to	TIME
0' - 5'	Fn-Md SAND, some 1/4 - 3/4" Gravel, some 1 - 3' Cobbles and Construction Debris (FILL), dark brown, moist.	SP	-	TP-1(4-5')	4' - 5'	
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--					--	
--					--	
--					--	
--					--	
--					--	
--					--	

General Test pit Description

	Native Soil	Clean Fill (i.e. brick concrete, asphalt)	Dimension lumber	Metals	Tires	Other
Description						
Percentage						

APPROX. SURFACE ELE. (FT-MSL)	
DIMENSIONS OF PIT:	~ 3' x 10'
TOTAL DEPTH	5'
DEPTH TO BEDROCK	n/a
DEPTH TO MOTTLING	n/a
DEPTH TO ROOTS	n/a
DEPTH TO WATER	n/a
WERE PHOTOS TAKEN?	yes
SAMPLING METHOD	bucket of excavator
FIELD INSTRUMENT	n/a

Photo #s

TEST PIT SKETCH:

COMMENTS:

Infiltrometer Test #1 - 2.6"/15 mins

Infiltrometer Test #1 - 1.8"/15 mins

Infiltrometer Test #1 - 2.2"/15 mins

Average = 2.20"/15 mins = 8.80"/hour

Test Pit # TP-5

Location: Spencer, MA

Project Name:	Mechanic Street Parking Lot
Project Number:	20170390.D51
Date:	11/20/2019
Time:	13:20
Sample Prefix:	
Logged By:	Matthew Kissane

Contractor:	Spencer Highway Dept.
Operator:	
Backfill:	original material

FUSS & O'NEILL

LOGGING DEPTH from -- to	SOIL DESCRIPTION	USCS CODE	FIELD TESTING	SAMPLE NUMBER	SAMPLE DEPTH from -- to	TIME
0' - 6'	Fn-Md SAND, some 1/4 - 3/4" Gravel, some 1 - 2' Cobbles and Construction Debris (FILL), light-to-dark brown, moist.	SP	-	TP-1(5-6')	5' - 6'	
--					--	
--					--	
--					--	
--					--	
--					--	
--					--	
--					--	

General Test pit Description

	Native Soil	Clean Fill (i.e. brick concrete, asphalt)	Dimension lumber	Metals	Tires	Other
Description						
Percentage						

APPROX. SURFACE ELE. (FT-MSL)	
DIMENSIONS OF PIT:	~ 3' x 10'
TOTAL DEPTH	6'
DEPTH TO BEDROCK	n/a
DEPTH TO MOTTLING	n/a
DEPTH TO ROOTS	n/a
DEPTH TO WATER	n/a
WERE PHOTOS TAKEN?	yes
SAMPLING METHOD	bucket of excavator
FIELD INSTRUMENT	n/a

Photo #s

TEST PIT SKETCH:

COMMENTS:

Infiltrometer Test #1 - 2.8"/15 mins

Infiltrometer Test #1 - 2.4"/15 mins

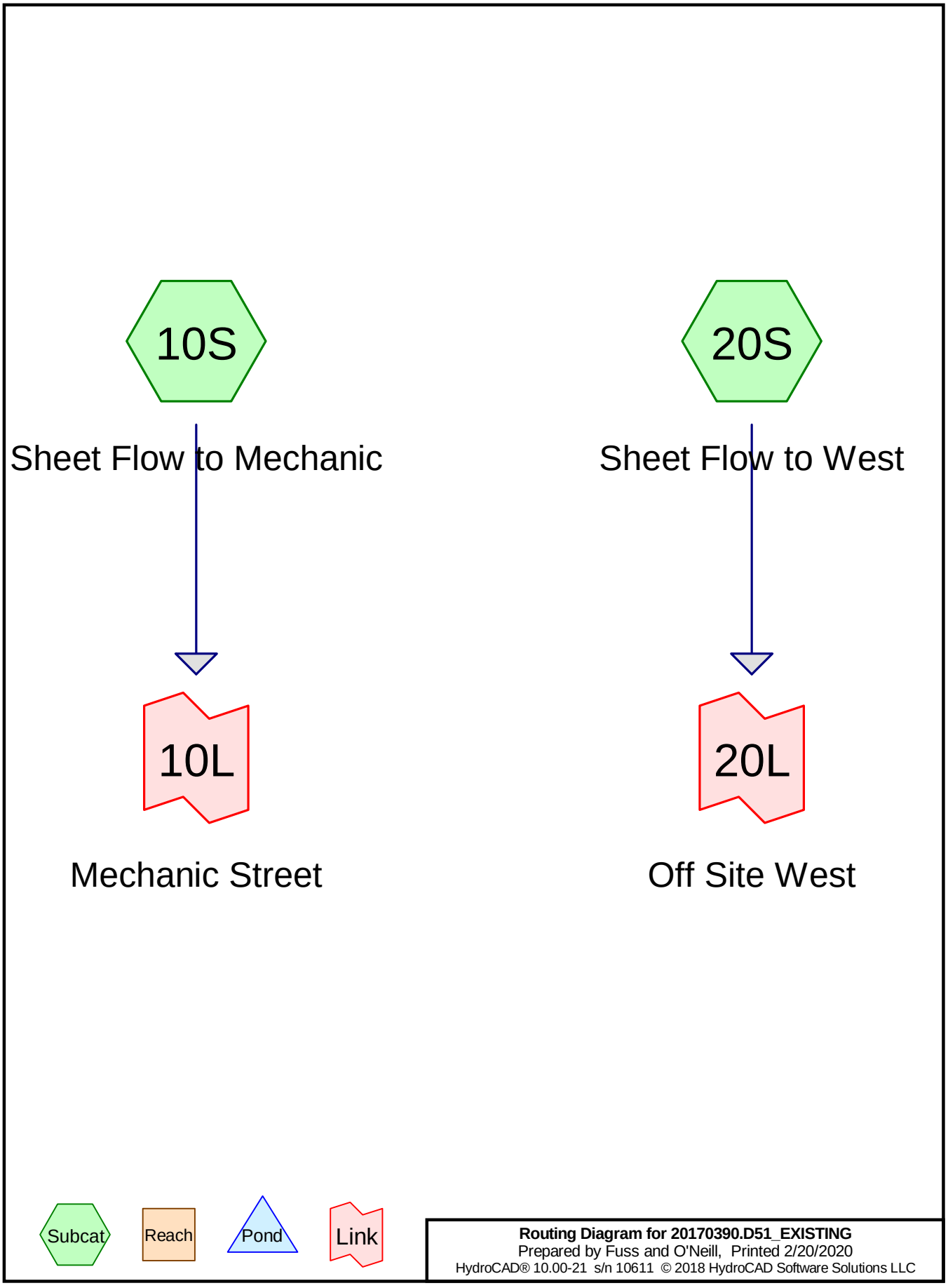
Infiltrometer Test #1 - 2.5"/15 mins

Average = 2.57"/15 mins = 10.27"/hour

FUSS & O'NEILL

Appendix B

Pre-Development Watershed Analysis



Routing Diagram for 20170390.D51_EXISTING
Prepared by Fuss and O'Neill, Printed 2/20/2020

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.324	86	<50% Grass cover, Poor, HSG C (10S, 20S)
0.402	98	Paved parking, HSG C (10S, 20S)
0.726	**93**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.726	HSG C	10S, 20S
0.000	HSG D	
0.000	Other	
0.726		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.324	0.000	0.000	0.324	<50% Grass cover, Poor	10S, 20S
0.000	0.000	0.402	0.000	0.000	0.402	Paved parking	10S, 20S
0.000	**0.000**	**0.726**	**0.000**	**0.000**	**0.726**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Mechanic Runoff Area=17,581 sf 61.10% Impervious Runoff Depth=2.46"
Tc=6.0 min CN=93 Runoff=1.13 cfs 0.083 af

Subcatchment 20S: Sheet Flow to West Runoff Area=14,028 sf 48.27% Impervious Runoff Depth=2.37"
Tc=6.0 min CN=92 Runoff=0.87 cfs 0.064 af

Link 10L: Mechanic Street Inflow=1.13 cfs 0.083 af
Primary=1.13 cfs 0.083 af

Link 20L: Off Site West Inflow=0.87 cfs 0.064 af
Primary=0.87 cfs 0.064 af

Total Runoff Area = 0.726 ac Runoff Volume = 0.146 af Average Runoff Depth = 2.42"
44.59% Pervious = 0.324 ac 55.41% Impervious = 0.402 ac

Summary for Subcatchment 10S: Sheet Flow to Mechanic

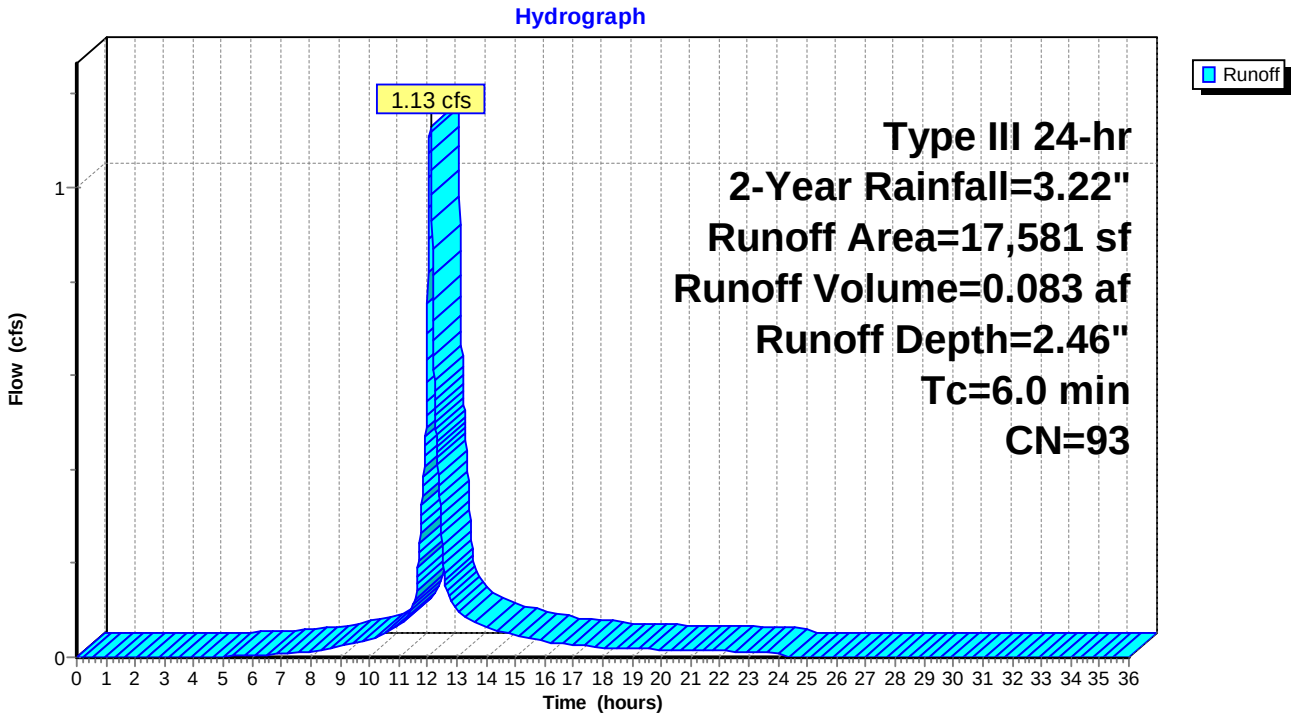
Runoff = 1.13 cfs @ 12.09 hrs, Volume= 0.083 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
6,839	86	<50% Grass cover, Poor, HSG C
10,742	98	Paved parking, HSG C
17,581	93	Weighted Average
6,839		38.90% Pervious Area
10,742		61.10% Impervious Area

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

Subcatchment 10S: Sheet Flow to Mechanic



Summary for Subcatchment 20S: Sheet Flow to West

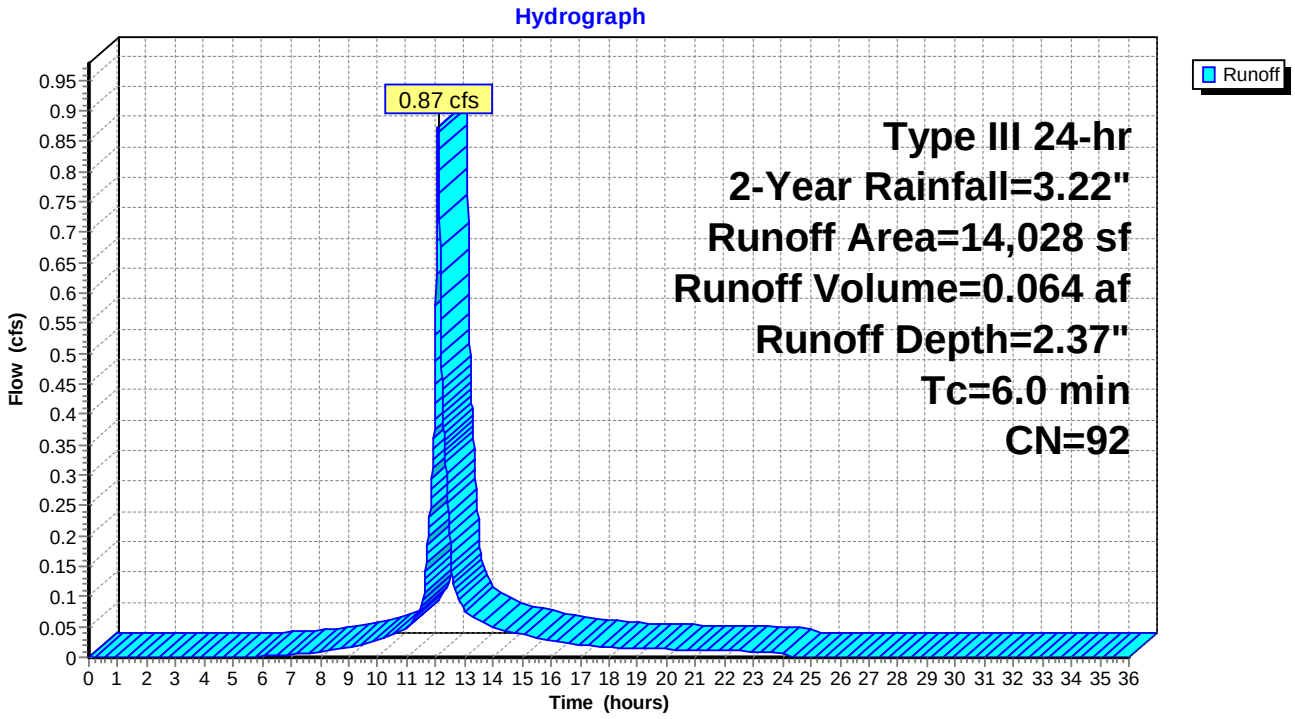
Runoff = 0.87 cfs @ 12.09 hrs, Volume= 0.064 af, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
7,257	86	<50% Grass cover, Poor, HSG C
6,771	98	Paved parking, HSG C
14,028	92	Weighted Average
7,257		51.73% Pervious Area
6,771		48.27% Impervious Area

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

Subcatchment 20S: Sheet Flow to West

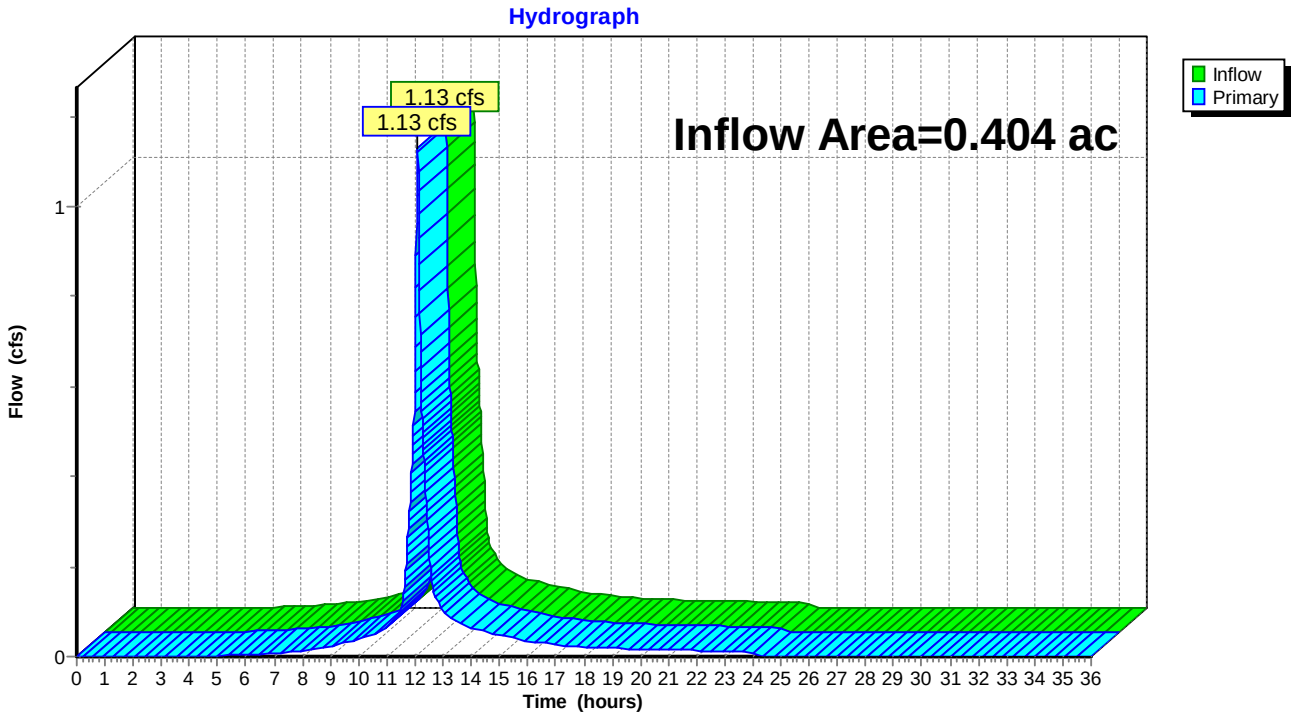


Summary for Link 10L: Mechanic Street

Inflow Area = 0.404 ac, 61.10% Impervious, Inflow Depth = 2.46" for 2-Year event
Inflow = 1.13 cfs @ 12.09 hrs, Volume= 0.083 af
Primary = 1.13 cfs @ 12.09 hrs, Volume= 0.083 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

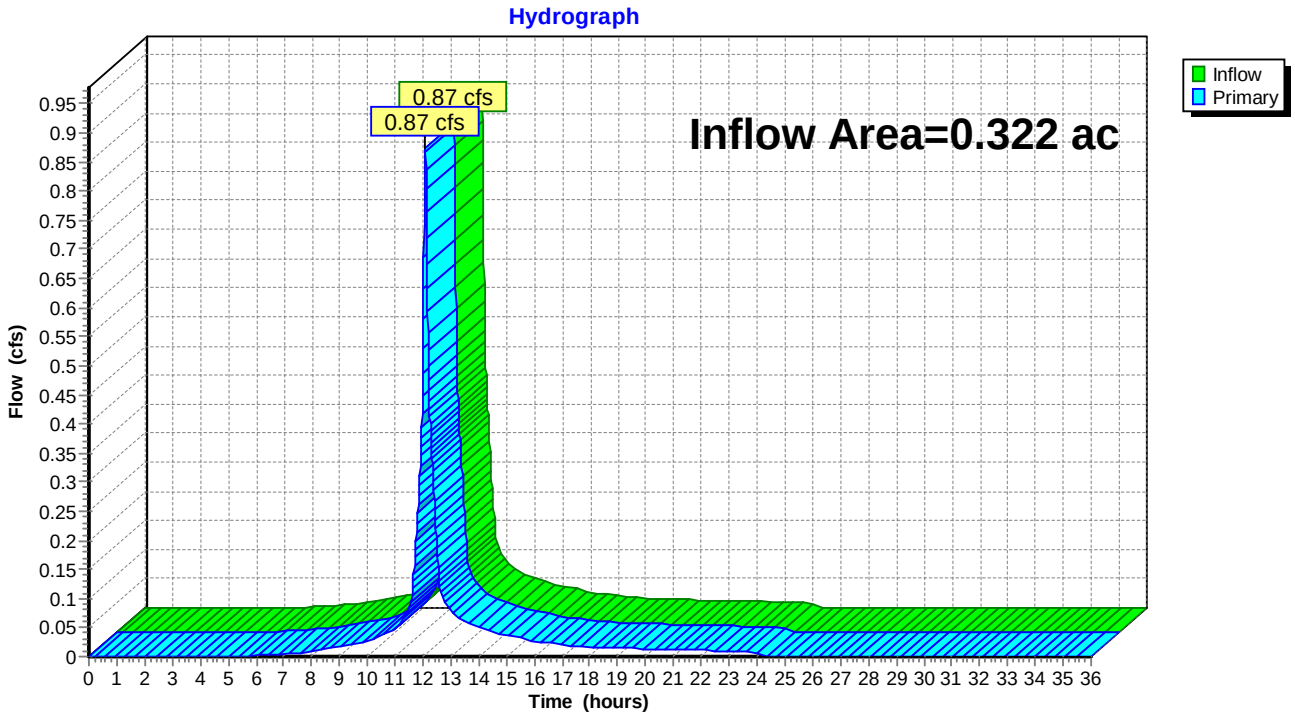


Summary for Link 20L: Off Site West

Inflow Area = 0.322 ac, 48.27% Impervious, Inflow Depth = 2.37" for 2-Year event
Inflow = 0.87 cfs @ 12.09 hrs, Volume= 0.064 af
Primary = 0.87 cfs @ 12.09 hrs, Volume= 0.064 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Mechanic Runoff Area=17,581 sf 61.10% Impervious Runoff Depth=4.03"
Tc=6.0 min CN=93 Runoff=1.80 cfs 0.136 af

Subcatchment 20S: Sheet Flow to West Runoff Area=14,028 sf 48.27% Impervious Runoff Depth=3.92"
Tc=6.0 min CN=92 Runoff=1.41 cfs 0.105 af

Link 10L: Mechanic Street Inflow=1.80 cfs 0.136 af
Primary=1.80 cfs 0.136 af

Link 20L: Off Site West Inflow=1.41 cfs 0.105 af
Primary=1.41 cfs 0.105 af

Total Runoff Area = 0.726 ac Runoff Volume = 0.241 af Average Runoff Depth = 3.98"
44.59% Pervious = 0.324 ac 55.41% Impervious = 0.402 ac

Summary for Subcatchment 10S: Sheet Flow to Mechanic

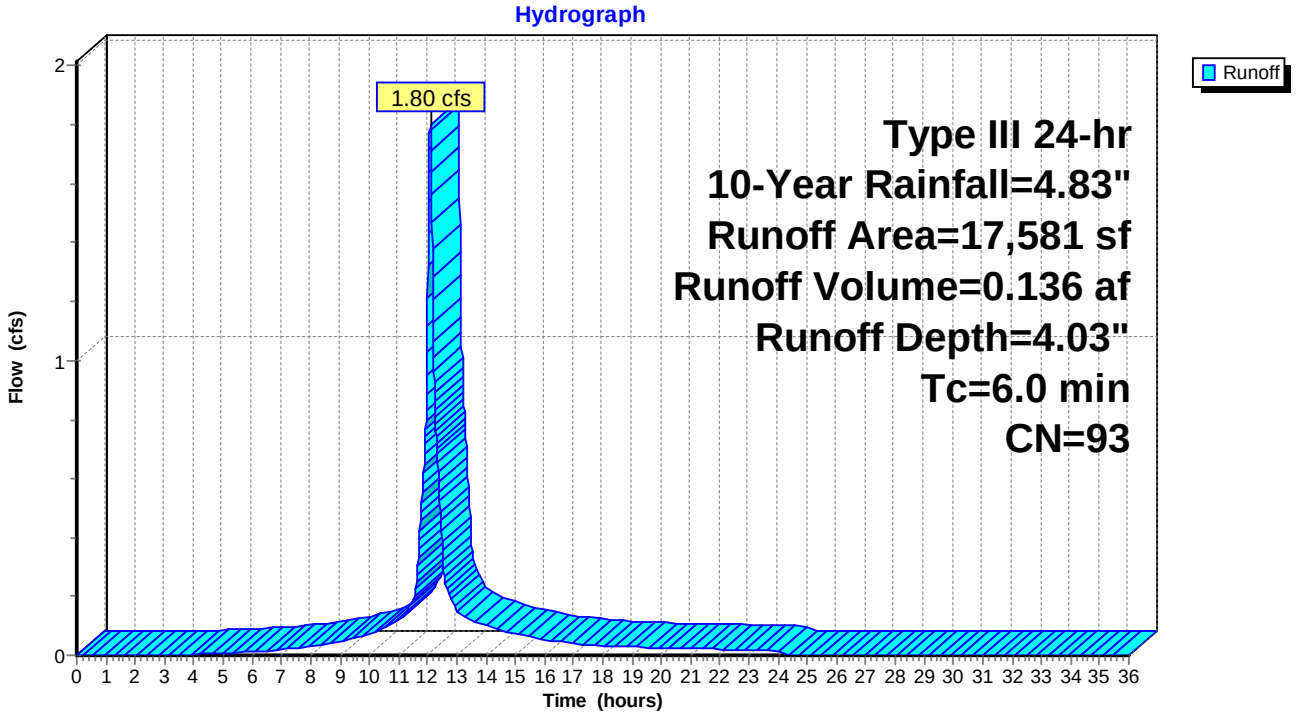
Runoff = 1.80 cfs @ 12.08 hrs, Volume= 0.136 af, Depth= 4.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
6,839	86	<50% Grass cover, Poor, HSG C
10,742	98	Paved parking, HSG C
17,581	93	Weighted Average
6,839		38.90% Pervious Area
10,742		61.10% Impervious Area

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

Subcatchment 10S: Sheet Flow to Mechanic



Summary for Subcatchment 20S: Sheet Flow to West

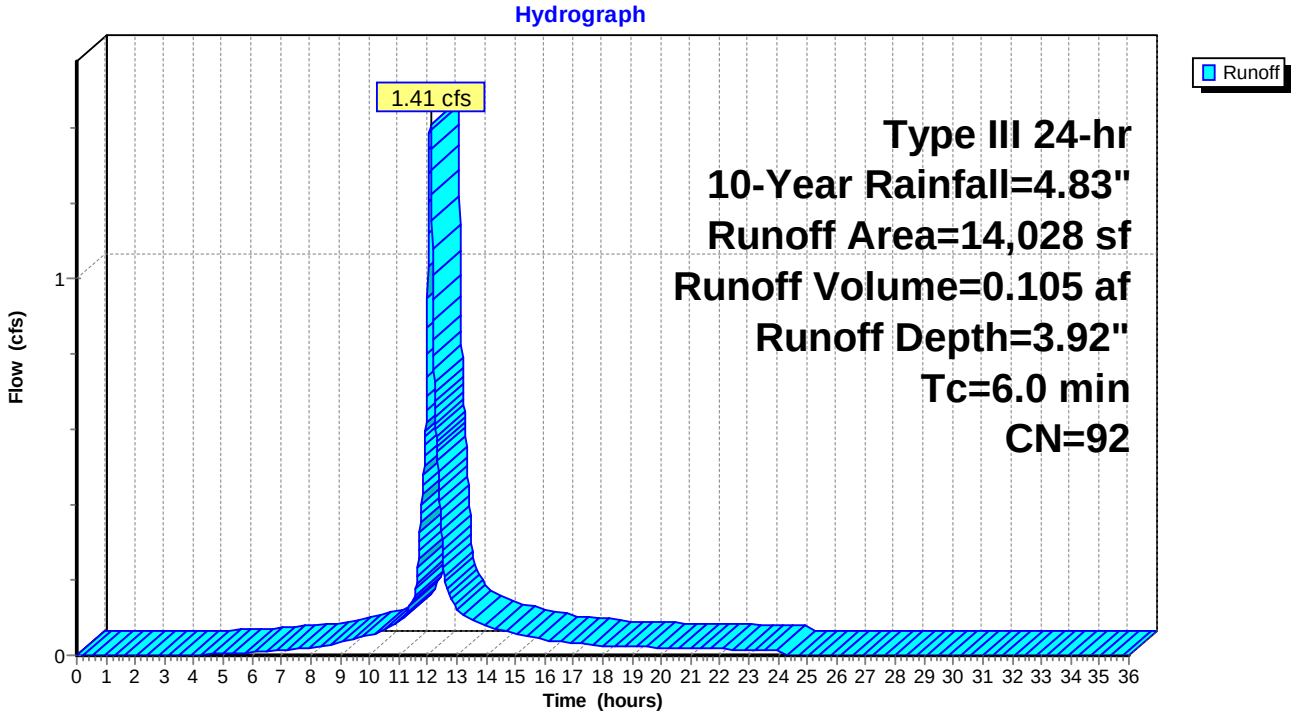
Runoff = 1.41 cfs @ 12.08 hrs, Volume= 0.105 af, Depth= 3.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
7,257	86	<50% Grass cover, Poor, HSG C
6,771	98	Paved parking, HSG C
14,028	92	Weighted Average
7,257		51.73% Pervious Area
6,771		48.27% Impervious Area

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

Subcatchment 20S: Sheet Flow to West

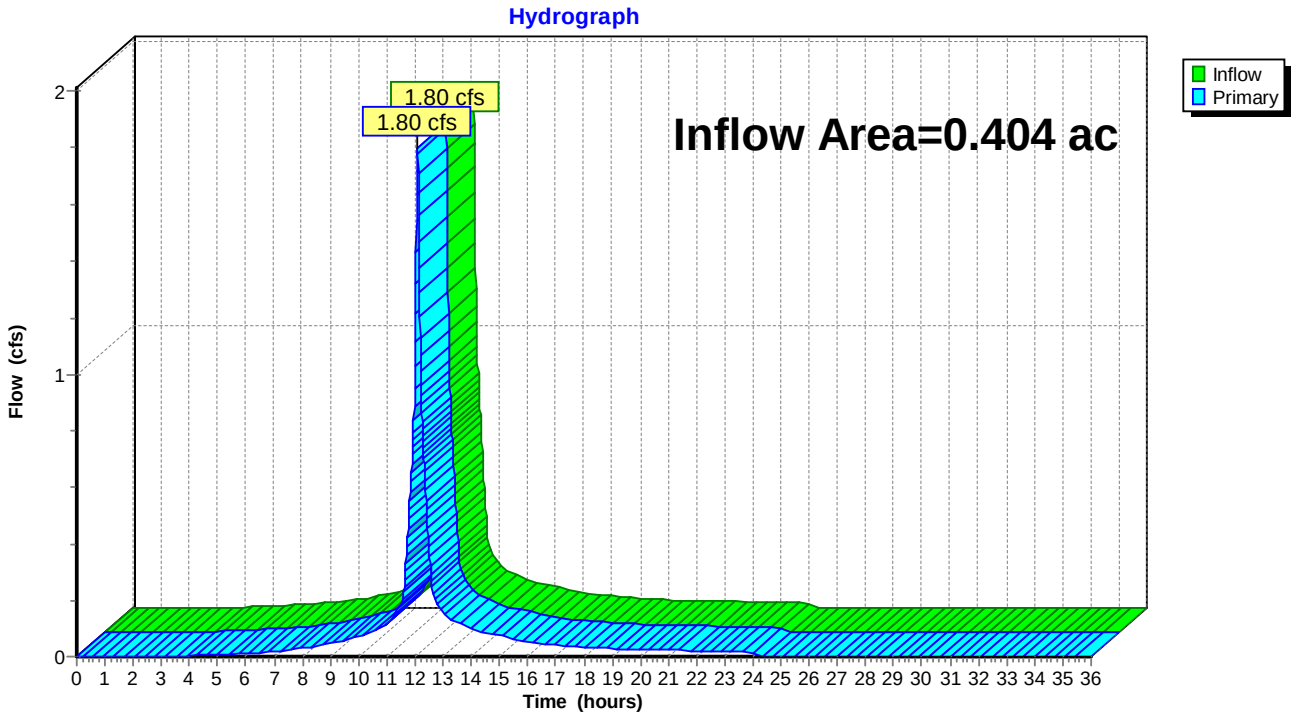


Summary for Link 10L: Mechanic Street

Inflow Area = 0.404 ac, 61.10% Impervious, Inflow Depth = 4.03" for 10-Year event
Inflow = 1.80 cfs @ 12.08 hrs, Volume= 0.136 af
Primary = 1.80 cfs @ 12.08 hrs, Volume= 0.136 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

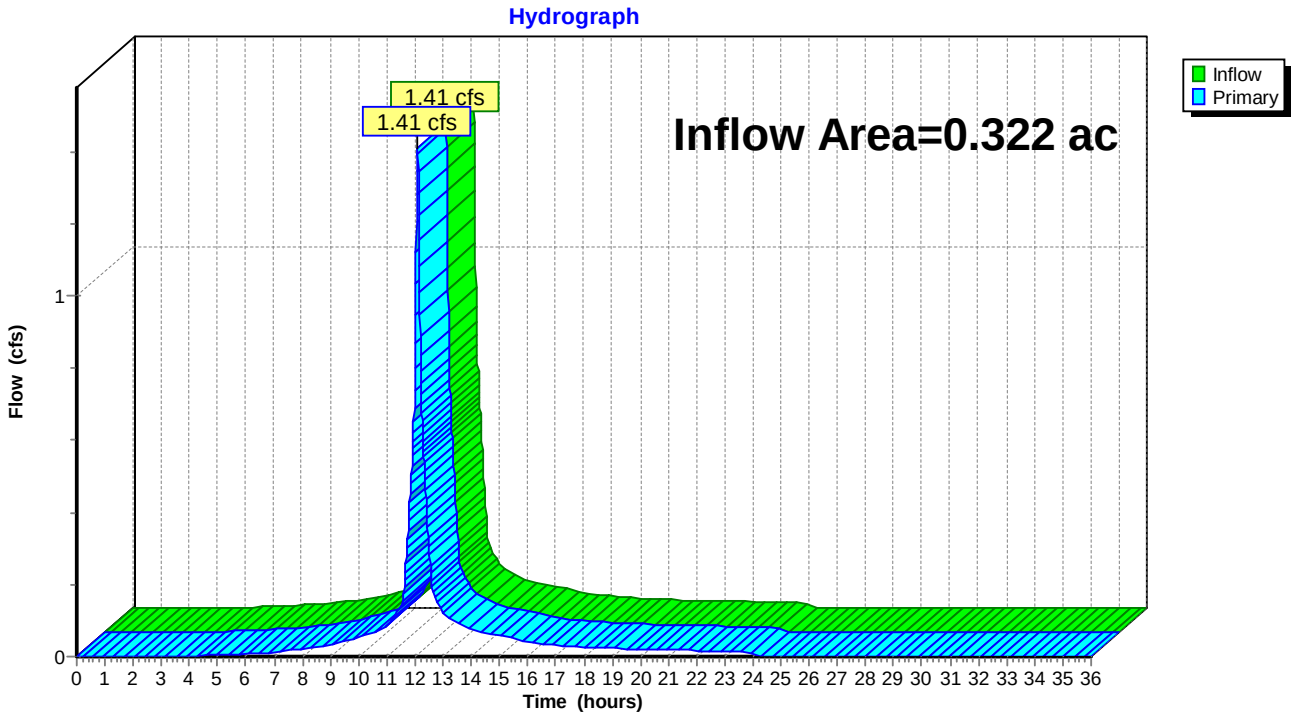


Summary for Link 20L: Off Site West

Inflow Area = 0.322 ac, 48.27% Impervious, Inflow Depth = 3.92" for 10-Year event
Inflow = 1.41 cfs @ 12.08 hrs, Volume= 0.105 af
Primary = 1.41 cfs @ 12.08 hrs, Volume= 0.105 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Mechanic Runoff Area=17,581 sf 61.10% Impervious Runoff Depth=5.26"
Tc=6.0 min CN=93 Runoff=2.31 cfs 0.177 af

Subcatchment 20S: Sheet Flow to West Runoff Area=14,028 sf 48.27% Impervious Runoff Depth=5.15"
Tc=6.0 min CN=92 Runoff=1.82 cfs 0.138 af

Link 10L: Mechanic Street Inflow=2.31 cfs 0.177 af
Primary=2.31 cfs 0.177 af

Link 20L: Off Site West Inflow=1.82 cfs 0.138 af
Primary=1.82 cfs 0.138 af

Total Runoff Area = 0.726 ac Runoff Volume = 0.315 af Average Runoff Depth = 5.21"
44.59% Pervious = 0.324 ac 55.41% Impervious = 0.402 ac

Summary for Subcatchment 10S: Sheet Flow to Mechanic

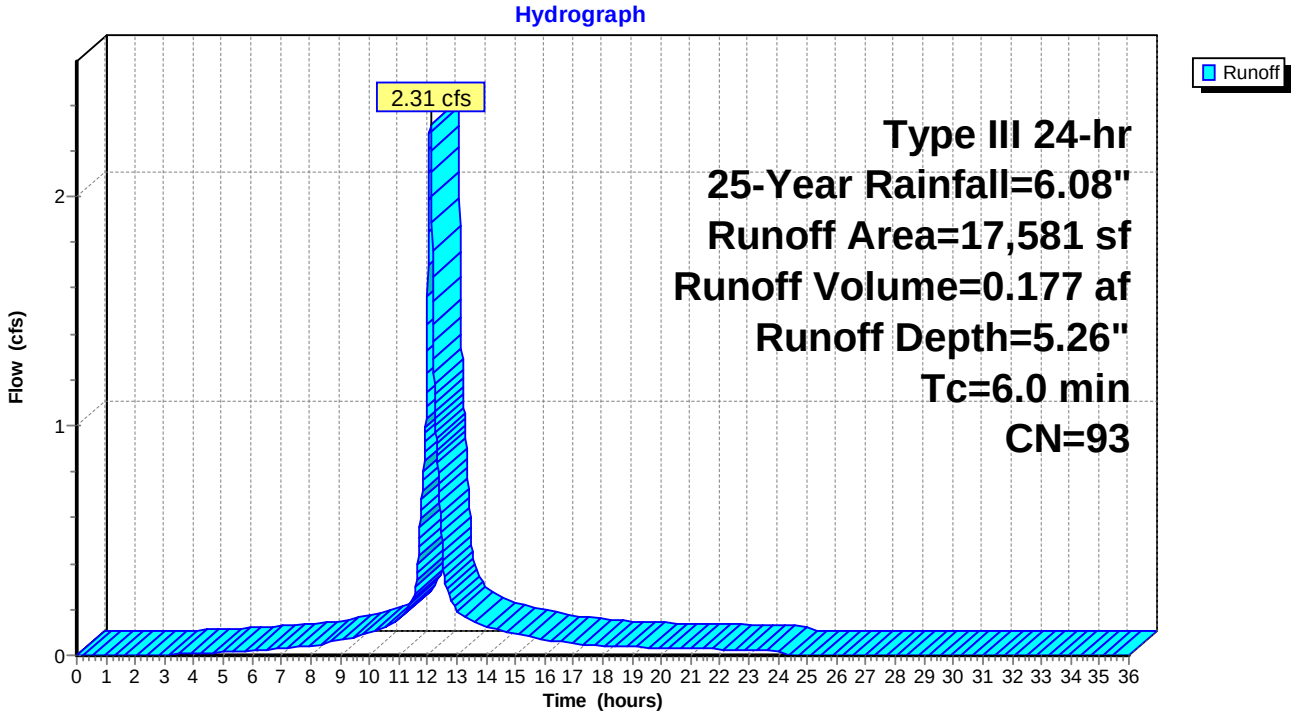
Runoff = 2.31 cfs @ 12.08 hrs, Volume= 0.177 af, Depth= 5.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
6,839	86	<50% Grass cover, Poor, HSG C
10,742	98	Paved parking, HSG C
17,581	93	Weighted Average
6,839		38.90% Pervious Area
10,742		61.10% Impervious Area

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

Subcatchment 10S: Sheet Flow to Mechanic



Summary for Subcatchment 20S: Sheet Flow to West

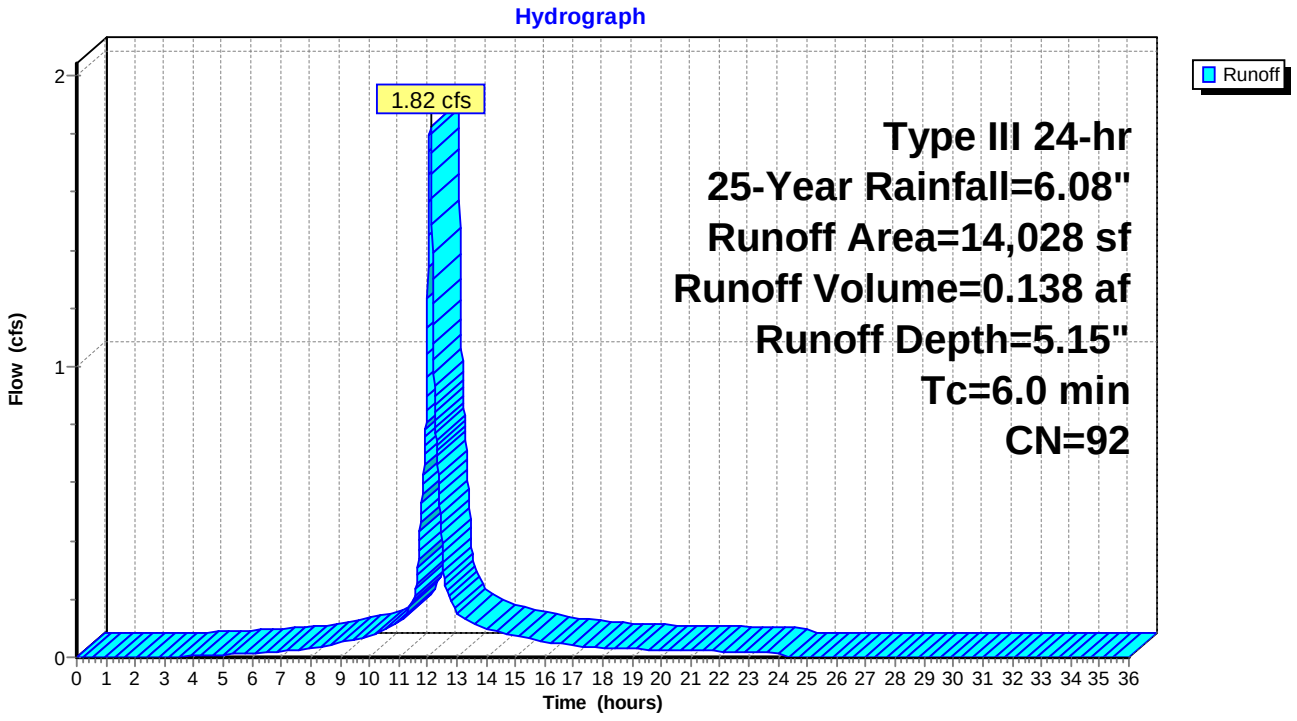
Runoff = 1.82 cfs @ 12.08 hrs, Volume= 0.138 af, Depth= 5.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
7,257	86	<50% Grass cover, Poor, HSG C
6,771	98	Paved parking, HSG C
14,028	92	Weighted Average
7,257		51.73% Pervious Area
6,771		48.27% Impervious Area

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

Subcatchment 20S: Sheet Flow to West

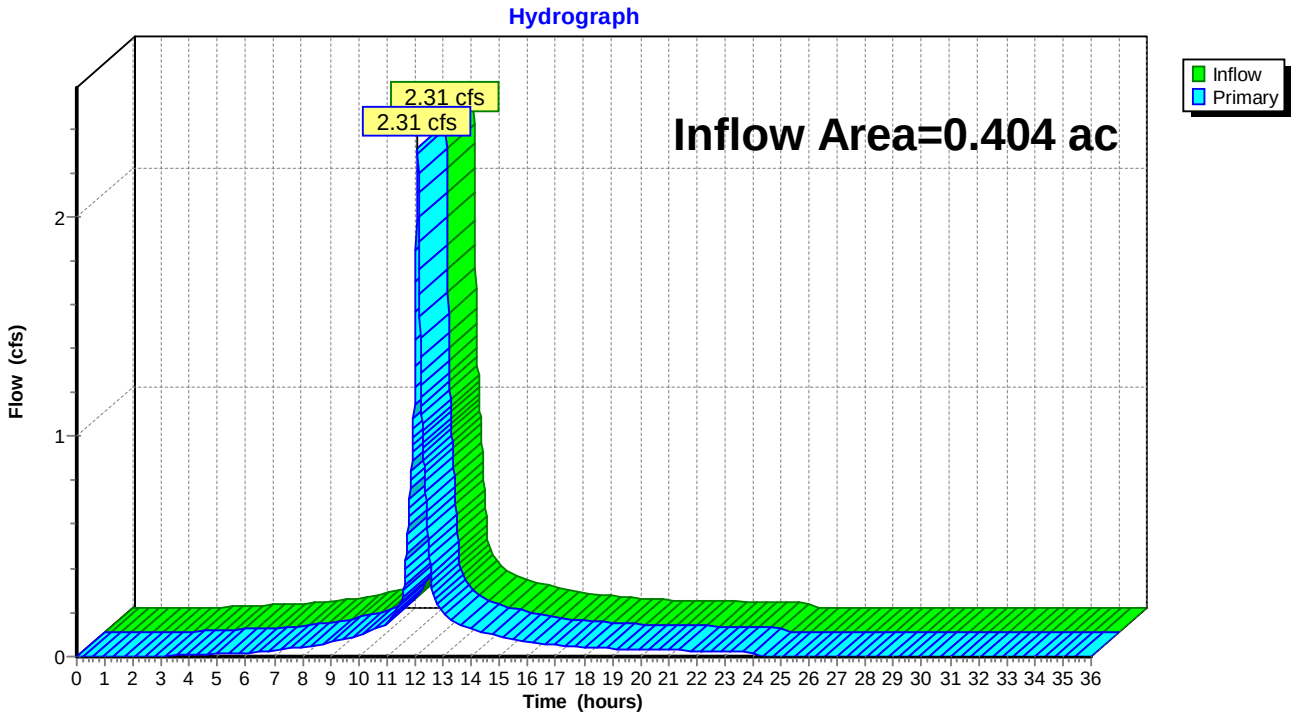


Summary for Link 10L: Mechanic Street

Inflow Area = 0.404 ac, 61.10% Impervious, Inflow Depth = 5.26" for 25-Year event
Inflow = 2.31 cfs @ 12.08 hrs, Volume= 0.177 af
Primary = 2.31 cfs @ 12.08 hrs, Volume= 0.177 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

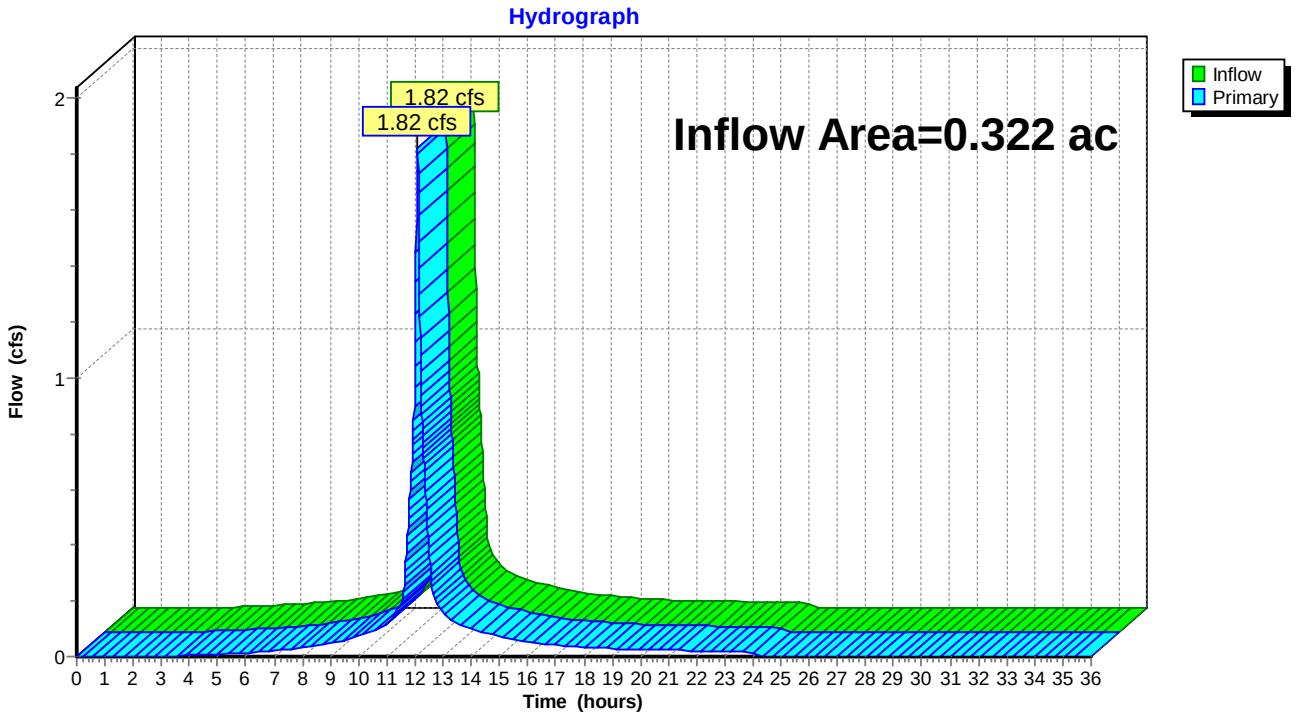


Summary for Link 20L: Off Site West

Inflow Area = 0.322 ac, 48.27% Impervious, Inflow Depth = 5.15" for 25-Year event
Inflow = 1.82 cfs @ 12.08 hrs, Volume= 0.138 af
Primary = 1.82 cfs @ 12.08 hrs, Volume= 0.138 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Mechanic Runoff Area=17,581 sf 61.10% Impervious Runoff Depth=7.80"
Tc=6.0 min CN=93 Runoff=3.35 cfs 0.262 af

Subcatchment 20S: Sheet Flow to West Runoff Area=14,028 sf 48.27% Impervious Runoff Depth=7.68"
Tc=6.0 min CN=92 Runoff=2.65 cfs 0.206 af

Link 10L: Mechanic Street Inflow=3.35 cfs 0.262 af
Primary=3.35 cfs 0.262 af

Link 20L: Off Site West Inflow=2.65 cfs 0.206 af
Primary=2.65 cfs 0.206 af

Total Runoff Area = 0.726 ac Runoff Volume = 0.468 af Average Runoff Depth = 7.74"
44.59% Pervious = 0.324 ac 55.41% Impervious = 0.402 ac

Summary for Subcatchment 10S: Sheet Flow to Mechanic

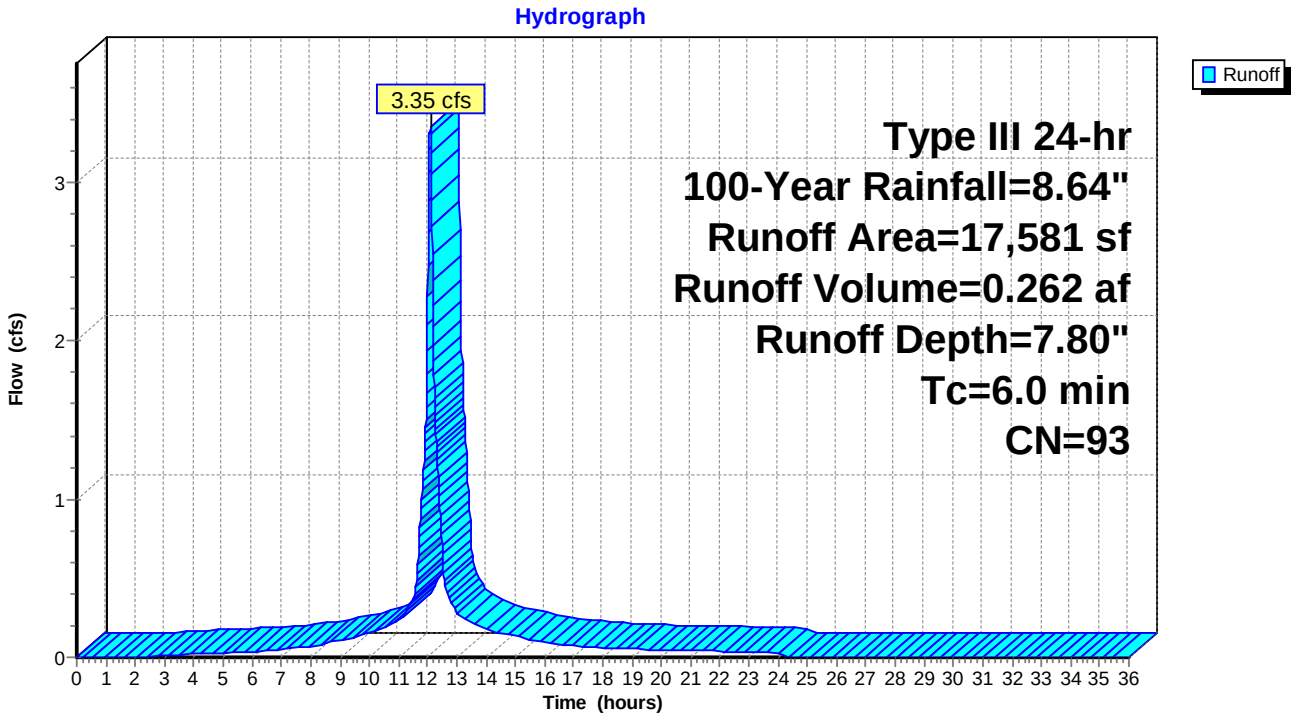
Runoff = 3.35 cfs @ 12.08 hrs, Volume= 0.262 af, Depth= 7.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
6,839	86	<50% Grass cover, Poor, HSG C
10,742	98	Paved parking, HSG C
17,581	93	Weighted Average
6,839		38.90% Pervious Area
10,742		61.10% Impervious Area

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

Subcatchment 10S: Sheet Flow to Mechanic



Summary for Subcatchment 20S: Sheet Flow to West

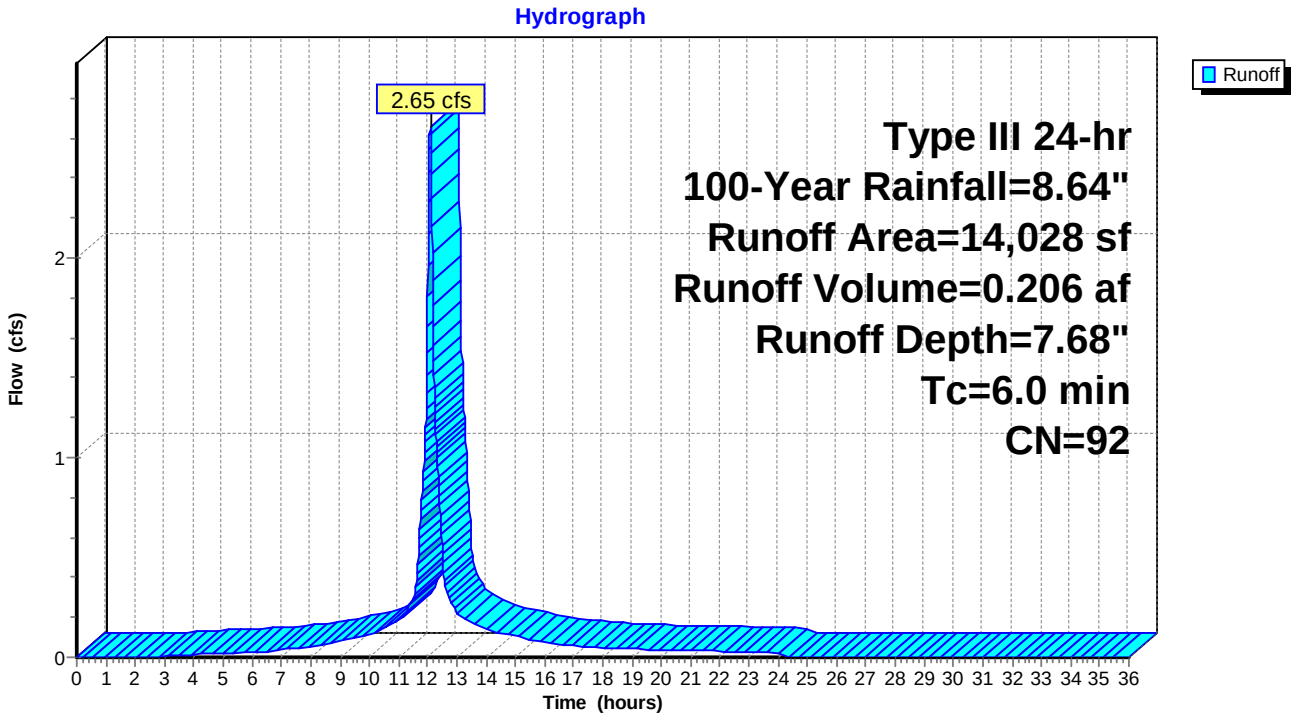
Runoff = 2.65 cfs @ 12.08 hrs, Volume= 0.206 af, Depth= 7.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
7,257	86	<50% Grass cover, Poor, HSG C
6,771	98	Paved parking, HSG C
14,028	92	Weighted Average
7,257		51.73% Pervious Area
6,771		48.27% Impervious Area

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

Subcatchment 20S: Sheet Flow to West

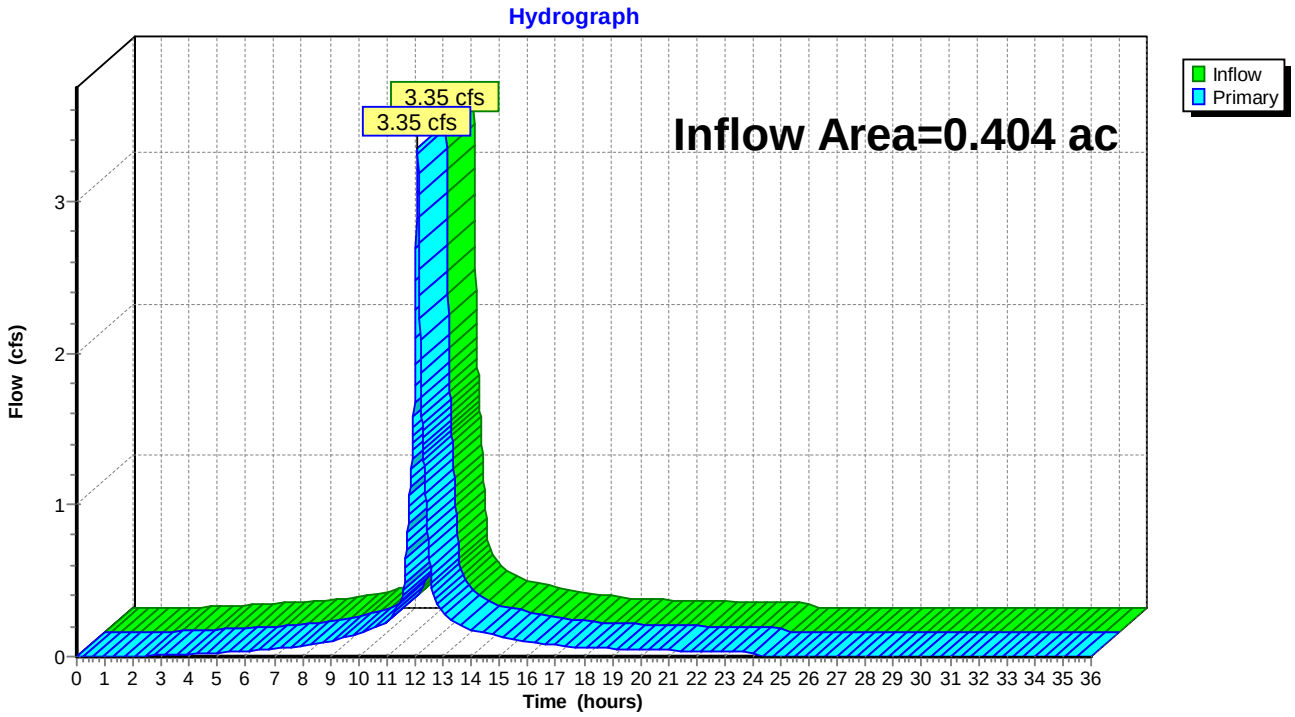


Summary for Link 10L: Mechanic Street

Inflow Area = 0.404 ac, 61.10% Impervious, Inflow Depth = 7.80" for 100-Year event
Inflow = 3.35 cfs @ 12.08 hrs, Volume= 0.262 af
Primary = 3.35 cfs @ 12.08 hrs, Volume= 0.262 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

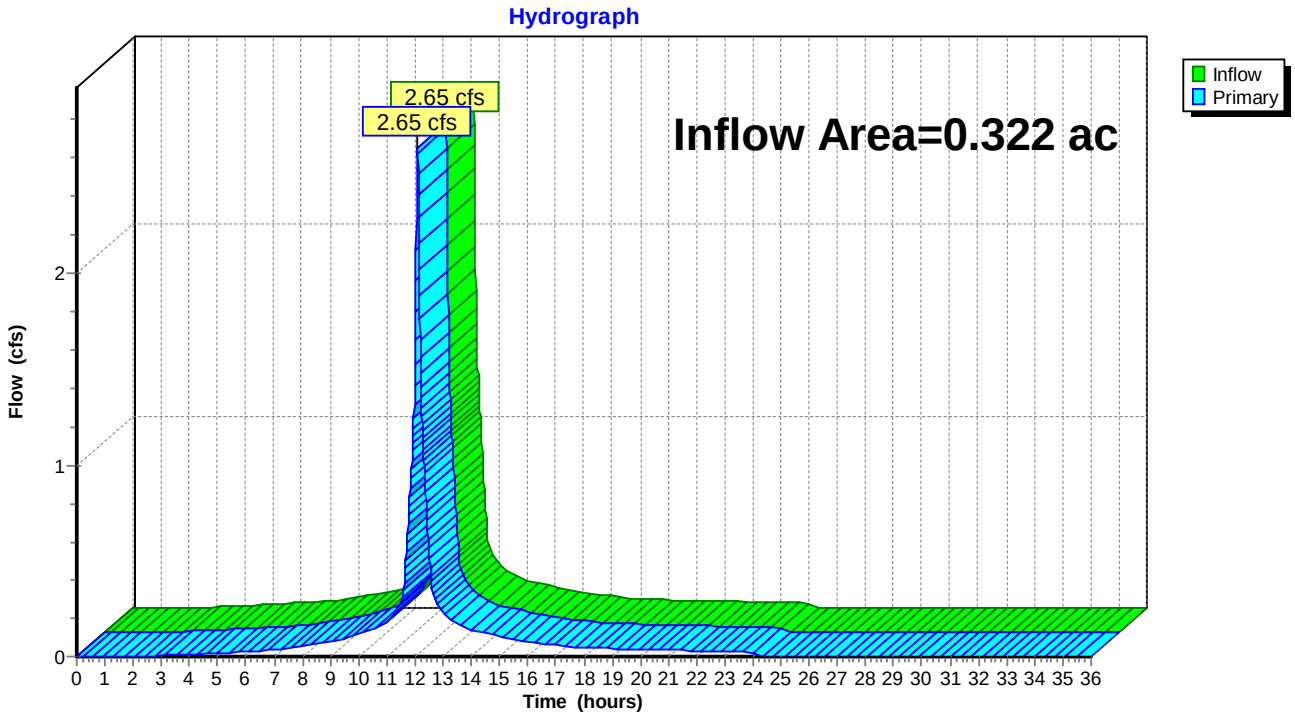


Summary for Link 20L: Off Site West

Inflow Area = 0.322 ac, 48.27% Impervious, Inflow Depth = 7.68" for 100-Year event
Inflow = 2.65 cfs @ 12.08 hrs, Volume= 0.206 af
Primary = 2.65 cfs @ 12.08 hrs, Volume= 0.206 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

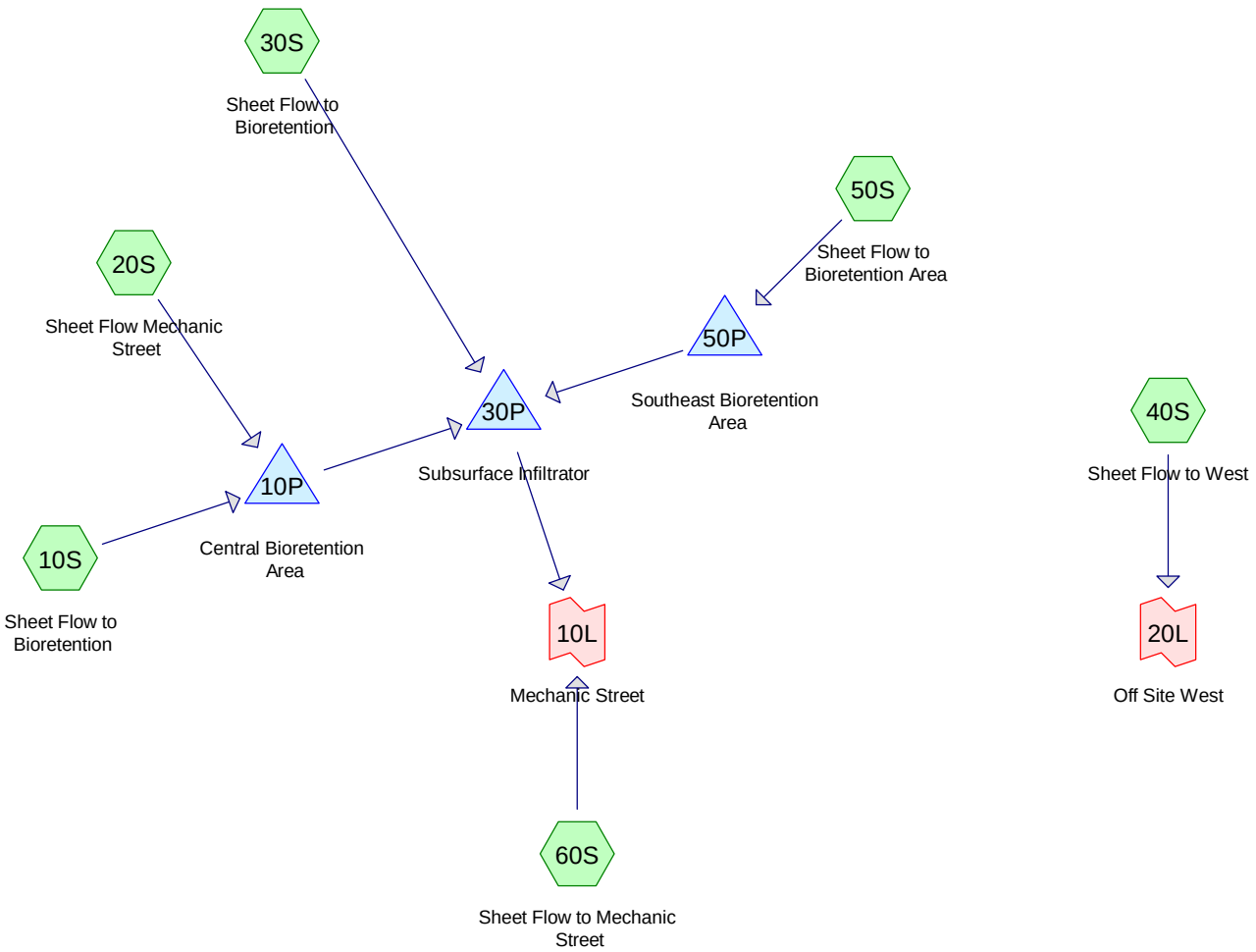
Link 20L: Off Site West



FUSS & O'NEILL

Appendix C

Post-Development Watershed Analysis



Subcat Reach Pond Link

Routing Diagram for 20170390.D51_PROPOSED
Prepared by Fuss and O'Neill, Printed 2/21/2020

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.139	74	>75% Grass cover, Good, HSG C (10S, 30S, 40S, 50S, 60S)
0.577	98	Paved parking, HSG C (10S, 20S, 30S, 50S, 60S)
0.017	98	Water Surface, HSG C (10S, 50S)
0.734	**93**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.734	HSG C	10S, 20S, 30S, 40S, 50S, 60S
0.000	HSG D	
0.000	Other	
0.734		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.139	0.000	0.000	0.139	>75% Grass cover, Good	10S, 30S, 40S, 50S, 60S
0.000	0.000	0.577	0.000	0.000	0.577	Paved parking	10S, 20S, 30S, 50S, 60S
0.000	0.000	0.017	0.000	0.000	0.017	Water Surface	10S, 50S
0.000	**0.000**	**0.734**	**0.000**	**0.000**	**0.734**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Bioretention Runoff Area=8,095 sf 72.23% Impervious Runoff Depth=2.28"
Tc=6.0 min CN=91 Runoff=0.49 cfs 0.035 af

Subcatchment 20S: Sheet Flow Mechanic Runoff Area=6,298 sf 100.00% Impervious Runoff Depth=2.99"
Tc=6.0 min CN=98 Runoff=0.45 cfs 0.036 af

Subcatchment 30S: Sheet Flow to Bioretention Runoff Area=9,236 sf 96.10% Impervious Runoff Depth=2.88"
Tc=6.0 min CN=97 Runoff=0.65 cfs 0.051 af

Subcatchment 40S: Sheet Flow to West Runoff Area=2,802 sf 0.00% Impervious Runoff Depth=1.05"
Tc=6.0 min CN=74 Runoff=0.08 cfs 0.006 af

Subcatchment 50S: Sheet Flow to Bioretention Runoff Area=2,559 sf 83.08% Impervious Runoff Depth=2.56"
Tc=6.0 min CN=94 Runoff=0.17 cfs 0.013 af

Subcatchment 60S: Sheet Flow to Mechanic Runoff Area=2,978 sf 92.21% Impervious Runoff Depth=2.77"
Tc=6.0 min CN=96 Runoff=0.21 cfs 0.016 af

Pond 10P: Central Bioretention Area Peak Elev=802.67' Storage=146 cf Inflow=0.94 cfs 0.071 af
Discarded=0.05 cfs 0.037 af Primary=0.88 cfs 0.034 af Outflow=0.93 cfs 0.071 af

Pond 30P: Subsurface Infiltrator Peak Elev=798.96' Storage=658 cf Inflow=1.53 cfs 0.086 af
Discarded=0.61 cfs 0.086 af Primary=0.00 cfs 0.000 af Outflow=0.61 cfs 0.086 af

Pond 50P: Southeast Bioretention Area Peak Elev=801.53' Storage=80 cf Inflow=0.17 cfs 0.013 af
Discarded=0.05 cfs 0.012 af Primary=0.09 cfs 0.001 af Outflow=0.14 cfs 0.013 af

Link 10L: Mechanic Street Inflow=0.21 cfs 0.016 af
Primary=0.21 cfs 0.016 af

Link 20L: Off Site West Inflow=0.08 cfs 0.006 af
Primary=0.08 cfs 0.006 af

Total Runoff Area = 0.734 ac Runoff Volume = 0.156 af Average Runoff Depth = 2.55"
19.00% Pervious = 0.139 ac 81.00% Impervious = 0.594 ac

Summary for Subcatchment 10S: Sheet Flow to Bioretention

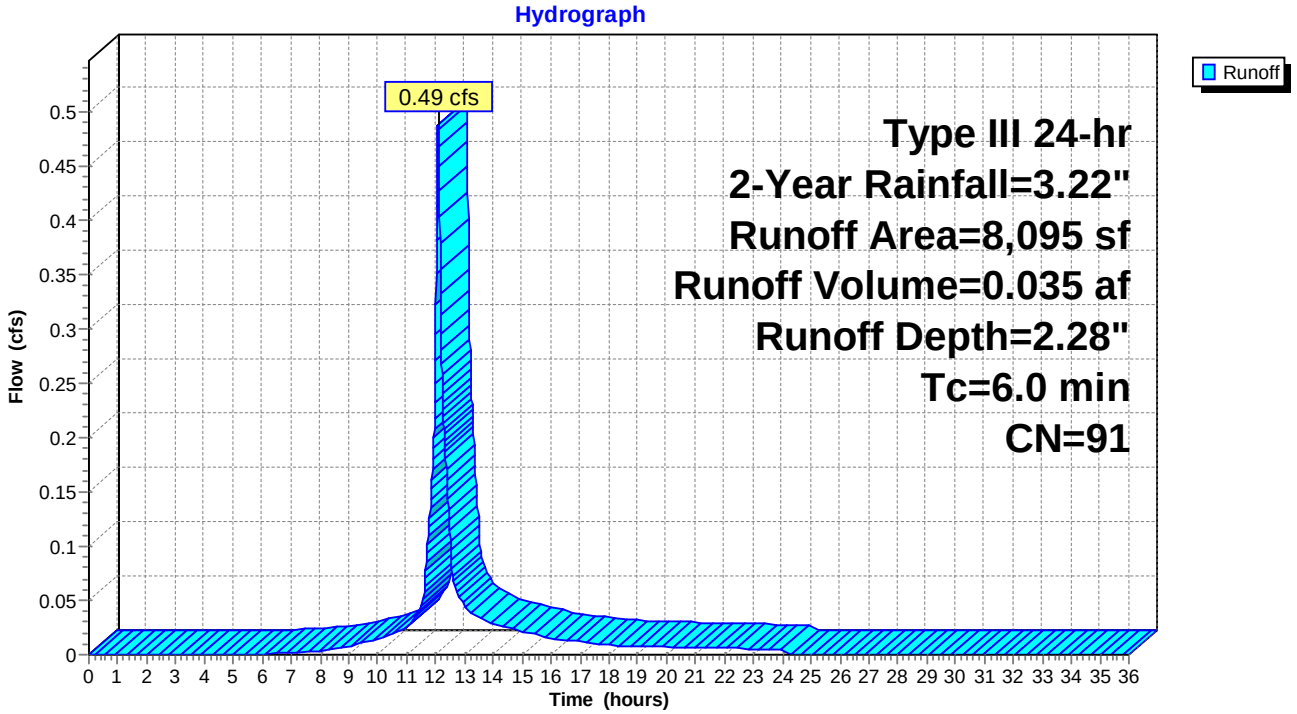
Runoff = 0.49 cfs @ 12.09 hrs, Volume= 0.035 af, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
2,248	74	>75% Grass cover, Good, HSG C
5,388	98	Paved parking, HSG C
459	98	Water Surface, HSG C
8,095	91	Weighted Average
2,248		27.77% Pervious Area
5,847		72.23% Impervious Area

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

Subcatchment 10S: Sheet Flow to Bioretention



Summary for Subcatchment 20S: Sheet Flow Mechanic Street

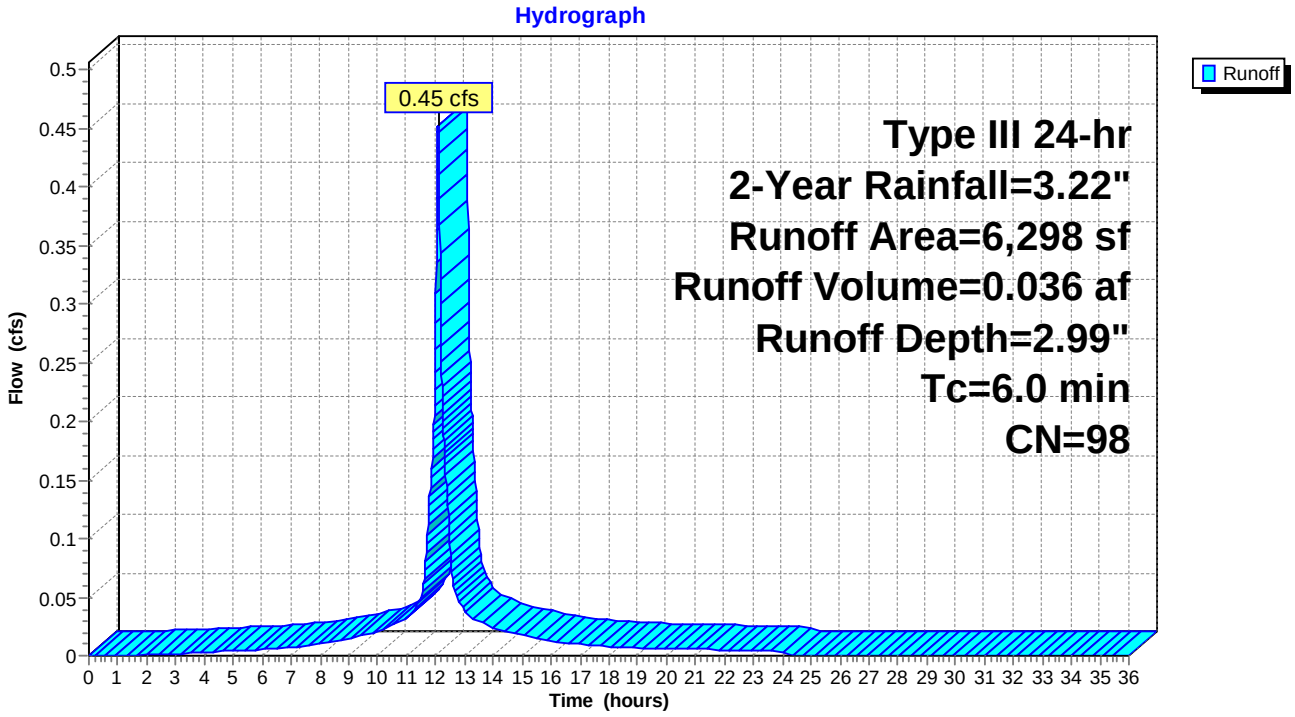
Runoff = 0.45 cfs @ 12.08 hrs, Volume= 0.036 af, Depth= 2.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
6,298	98	Paved parking, HSG C
6,298		100.00% Impervious Area

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

Subcatchment 20S: Sheet Flow Mechanic Street



Summary for Subcatchment 30S: Sheet Flow to Bioretention

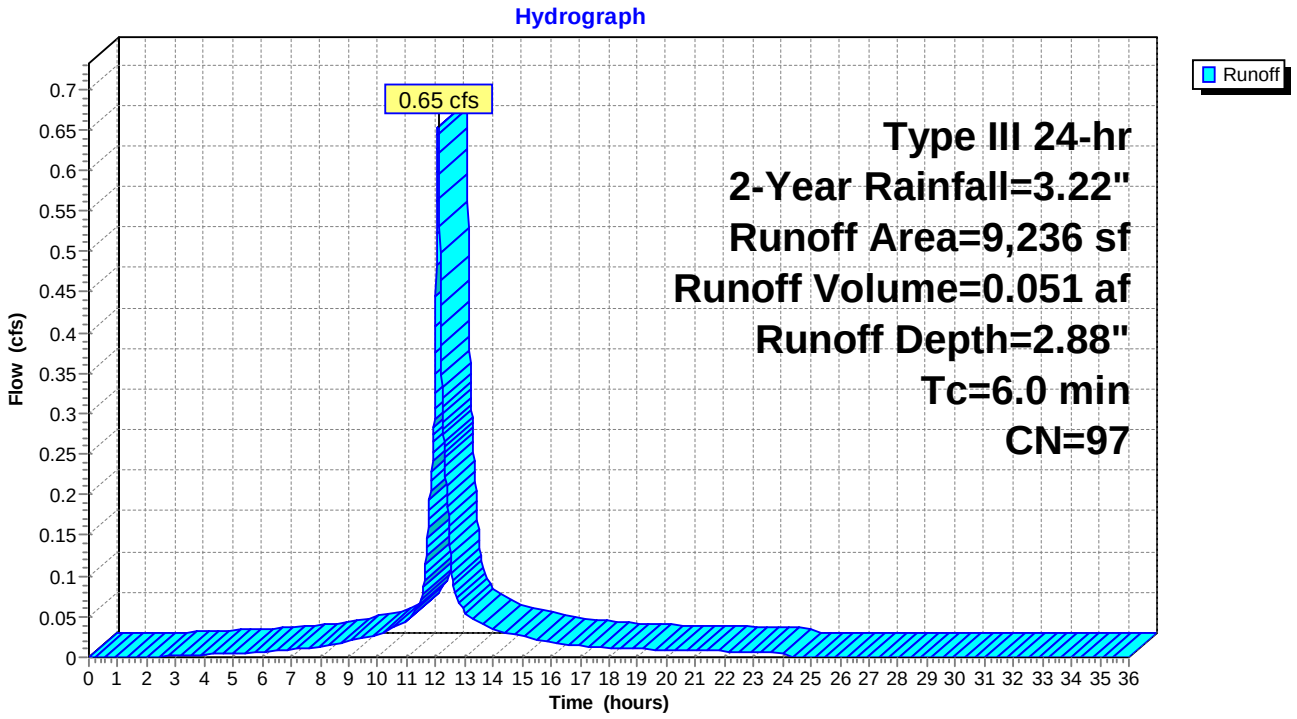
Runoff = 0.65 cfs @ 12.08 hrs, Volume= 0.051 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
360	74	>75% Grass cover, Good, HSG C
8,876	98	Paved parking, HSG C
9,236	97	Weighted Average
360		3.90% Pervious Area
8,876		96.10% Impervious Area

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

Subcatchment 30S: Sheet Flow to Bioretention



Summary for Subcatchment 40S: Sheet Flow to West

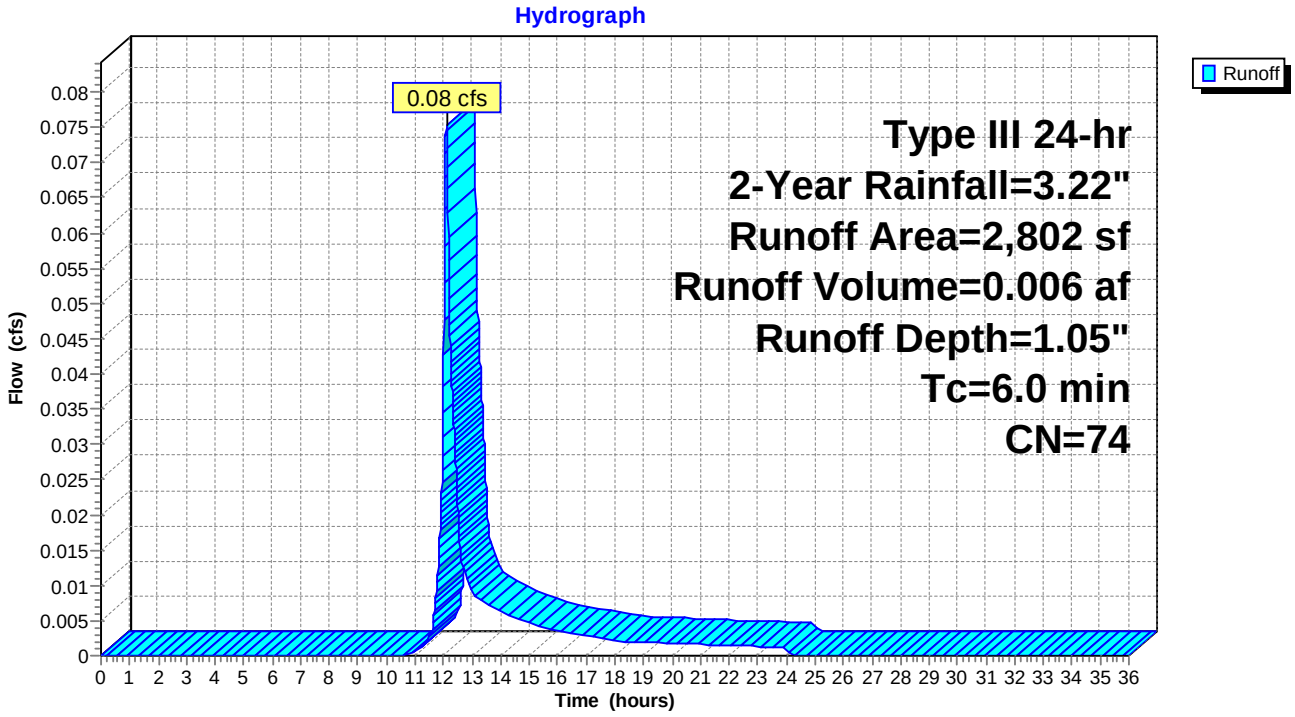
Runoff = 0.08 cfs @ 12.10 hrs, Volume= 0.006 af, Depth= 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
2,802	74	>75% Grass cover, Good, HSG C
2,802		100.00% Pervious Area

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

Subcatchment 40S: Sheet Flow to West



Summary for Subcatchment 50S: Sheet Flow to Bioretention Area

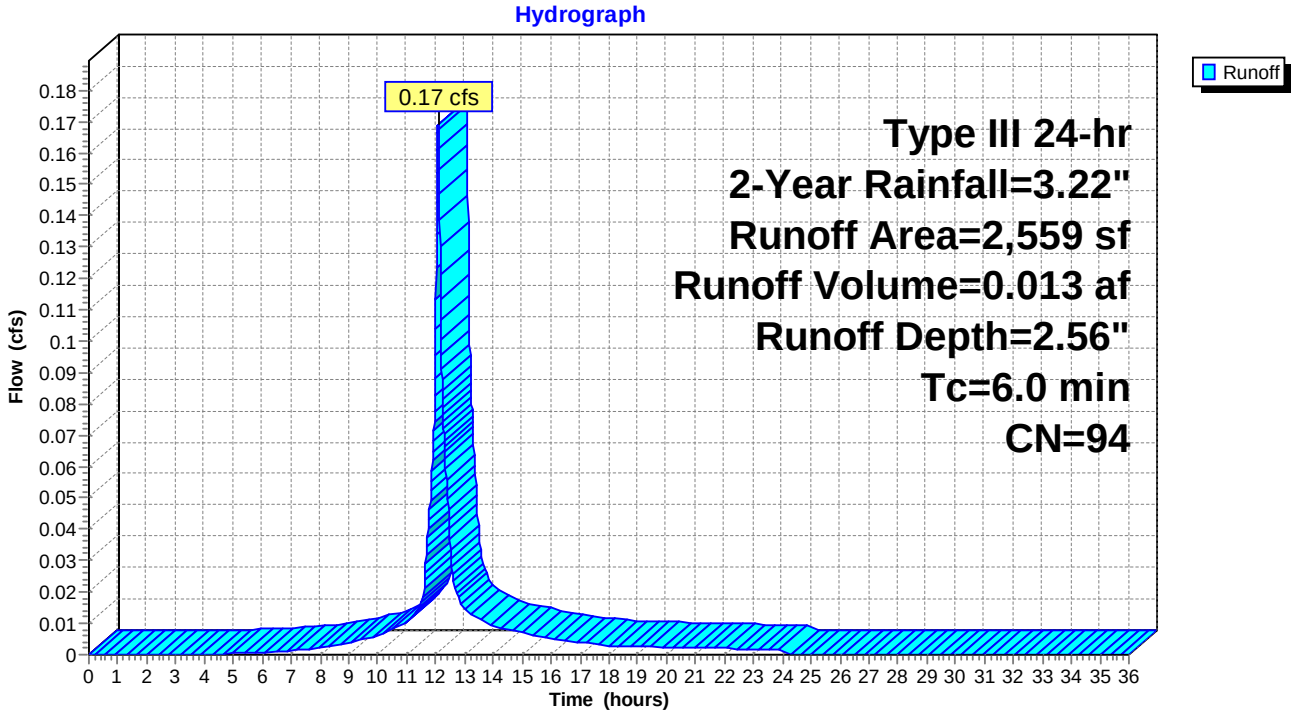
Runoff = 0.17 cfs @ 12.08 hrs, Volume= 0.013 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
433	74	>75% Grass cover, Good, HSG C
1,832	98	Paved parking, HSG C
294	98	Water Surface, HSG C
2,559	94	Weighted Average
433		16.92% Pervious Area
2,126		83.08% Impervious Area

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

Subcatchment 50S: Sheet Flow to Bioretention Area



Summary for Subcatchment 60S: Sheet Flow to Mechanic Street

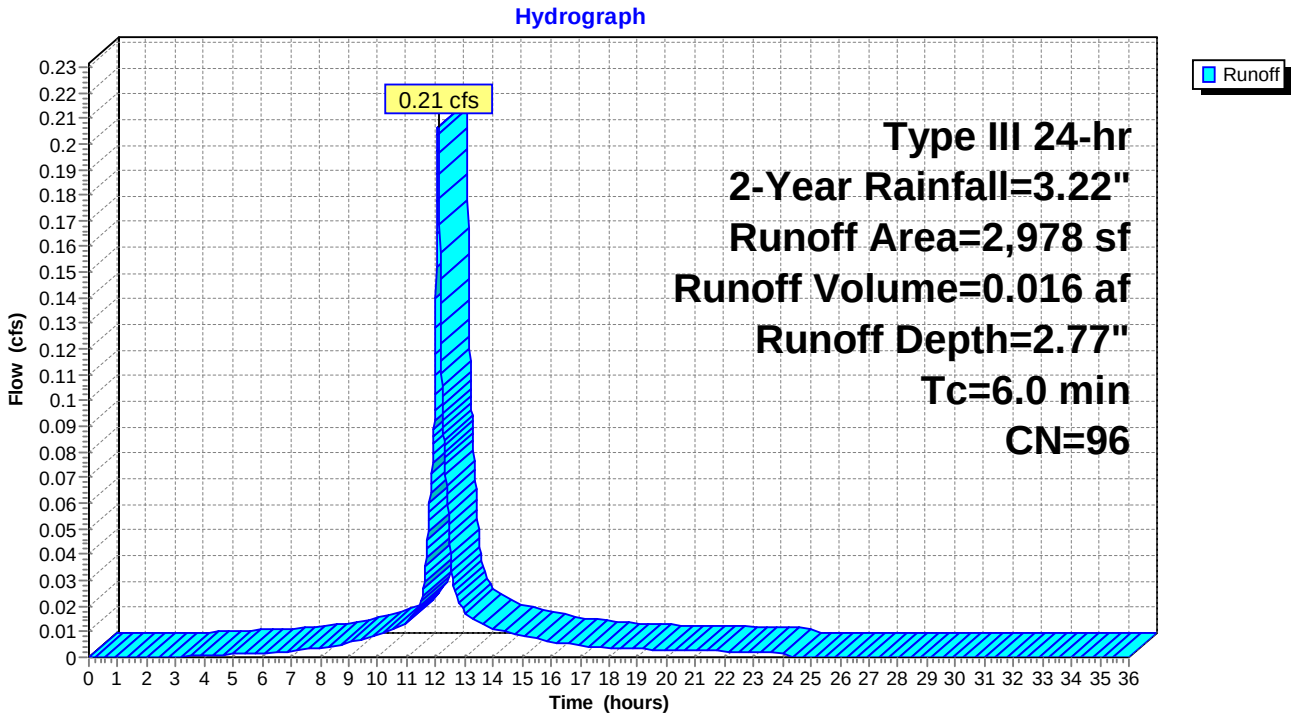
Runoff = 0.21 cfs @ 12.08 hrs, Volume= 0.016 af, Depth= 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.22"

Area (sf)	CN	Description
232	74	>75% Grass cover, Good, HSG C
2,746	98	Paved parking, HSG C
2,978	96	Weighted Average
232		7.79% Pervious Area
2,746		92.21% Impervious Area

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

Subcatchment 60S: Sheet Flow to Mechanic Street



Summary for Pond 10P: Central Bioretention Area

Inflow Area = 0.330 ac, 84.38% Impervious, Inflow Depth = 2.59" for 2-Year event
Inflow = 0.94 cfs @ 12.08 hrs, Volume= 0.071 af
Outflow = 0.93 cfs @ 12.09 hrs, Volume= 0.071 af, Atten= 1%, Lag= 0.6 min
Discarded = 0.05 cfs @ 12.09 hrs, Volume= 0.037 af
Primary = 0.88 cfs @ 12.09 hrs, Volume= 0.034 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 802.67' @ 12.09 hrs Surf.Area= 366 sf Storage= 146 cf

Plug-Flow detention time= 15.9 min calculated for 0.071 af (100% of inflow)
Center-of-Mass det. time= 15.9 min (794.9 - 779.0)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	296 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

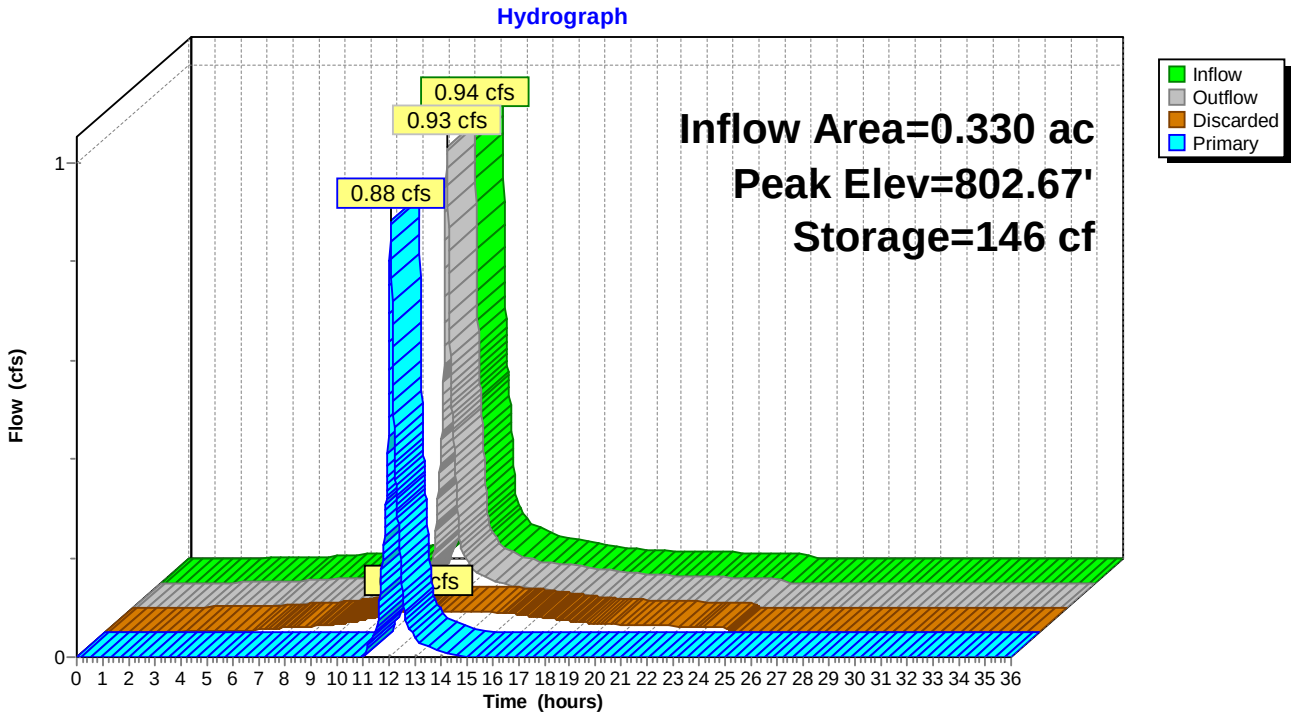
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	96	65.0	0	0	96
803.00	560	158.0	296	296	1,750

Device	Routing	Invert	Outlet Devices
#1	Primary	799.40'	**10.0" Round Culvert** L= 19.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.40' / 799.00' S= 0.0211 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	802.55'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	802.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00'

Discarded OutFlow Max=0.05 cfs @ 12.09 hrs HW=802.67' (Free Discharge)
↑└**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.88 cfs @ 12.09 hrs HW=802.67' TW=798.73' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 0.88 cfs of 4.44 cfs potential flow)
↑└**2=Orifice/Grate** (Weir Controls 0.88 cfs @ 1.14 fps)

Pond 10P: Central Bioretention Area



Summary for Pond 30P: Subsurface Infiltrator

Inflow Area = 0.601 ac, 88.39% Impervious, Inflow Depth = 1.71" for 2-Year event
Inflow = 1.53 cfs @ 12.09 hrs, Volume= 0.086 af
Outflow = 0.61 cfs @ 12.31 hrs, Volume= 0.086 af, Atten= 60%, Lag= 13.1 min
Discarded = 0.61 cfs @ 12.31 hrs, Volume= 0.086 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 798.96' @ 12.31 hrs Surf.Area= 3,579 sf Storage= 658 cf

Plug-Flow detention time= 6.3 min calculated for 0.086 af (100% of inflow)
Center-of-Mass det. time= 6.3 min (758.9 - 752.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	798.50'	2,544 cf	**34.00'W x 105.25'L x 2.54'H Field A** 9,095 cf Overall - 2,735 cf Embedded = 6,360 cf x 40.0% Voids
#2A	799.00'	2,735 cf	**Cultec R-150XLHD** x 100 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 10 rows
		5,279 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 3	799.00'	**12.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.00' / 798.40' S= 0.0240 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Discarded	798.50'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 796.50' Phase-In= 0.01'
#3	Primary	801.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.61 cfs @ 12.31 hrs HW=798.96' (Free Discharge)
↑└**2=Exfiltration** (Controls 0.61 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.50' TW=0.00' (Dynamic Tailwater)
↑└**3=Orifice/Grate** (Controls 0.00 cfs)
↑└**1=Culvert** (Controls 0.00 cfs)

Pond 30P: Subsurface Infiltrator - Chamber Wizard Field A

Chamber Model = Cultec R-150XLHD (Cultec Recharger® 150XLHD)
Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf
Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap
Row Length Adjustment= +0.75' x 2.65 sf x 10 rows

33.0" Wide + 6.0" Spacing = 39.0" C-C Row Spacing

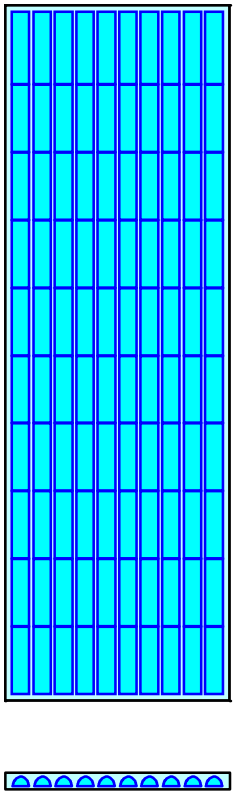
10 Chambers/Row x 10.25' Long +0.75' Row Adjustment = 103.25' Row Length +12.0" End Stone x 2 = 105.25' Base Length
10 Rows x 33.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 34.00' Base Width
6.0" Base + 18.5" Chamber Height + 6.0" Cover = 2.54' Field Height

100 Chambers x 27.2 cf +0.75' Row Adjustment x 2.65 sf x 10 Rows = 2,735.1 cf Chamber Storage

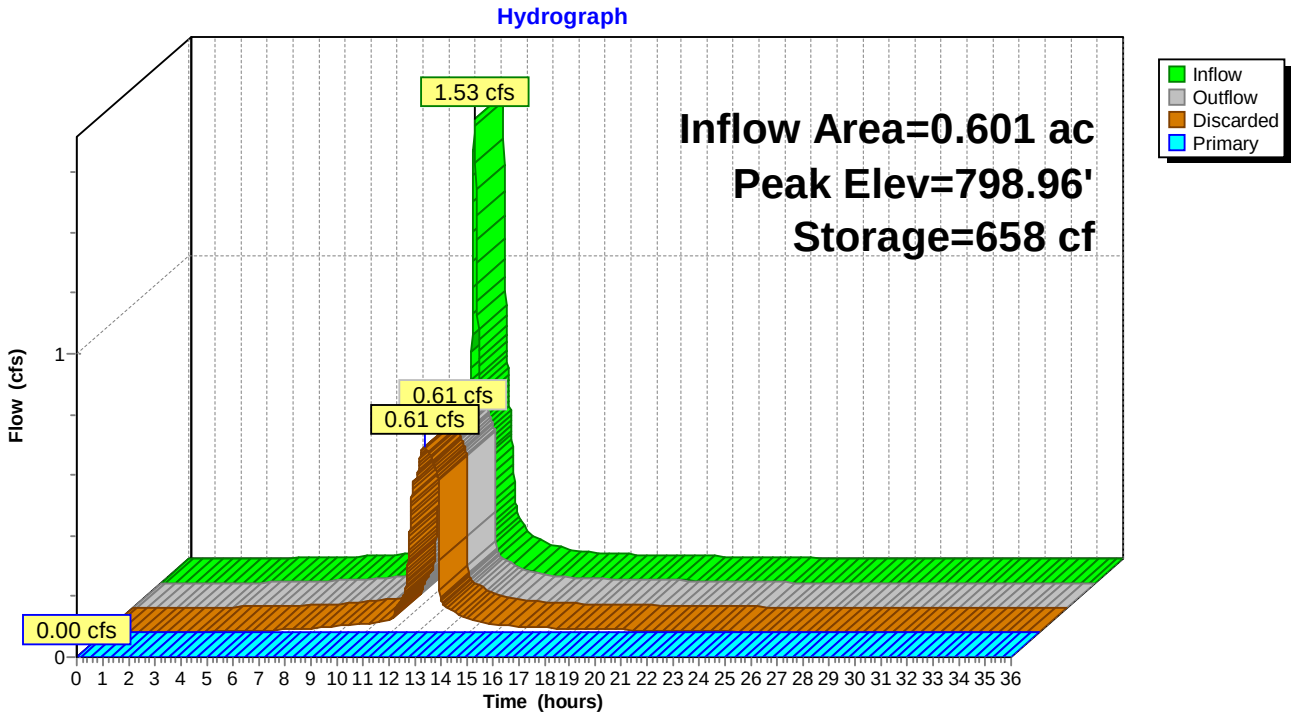
9,095.4 cf Field - 2,735.1 cf Chambers = 6,360.3 cf Stone x 40.0% Voids = 2,544.1 cf Stone Storage

Chamber Storage + Stone Storage = 5,279.2 cf = 0.121 af
Overall Storage Efficiency = 58.0%
Overall System Size = 105.25' x 34.00' x 2.54'

100 Chambers
336.9 cy Field
235.6 cy Stone



Pond 30P: Subsurface Infiltrator



Summary for Pond 50P: Southeast Bioretention Area

Inflow Area = 0.059 ac, 83.08% Impervious, Inflow Depth = 2.56" for 2-Year event
Inflow = 0.17 cfs @ 12.08 hrs, Volume= 0.013 af
Outflow = 0.14 cfs @ 12.14 hrs, Volume= 0.013 af, Atten= 15%, Lag= 3.0 min
Discarded = 0.05 cfs @ 12.14 hrs, Volume= 0.012 af
Primary = 0.09 cfs @ 12.14 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 801.53' @ 12.14 hrs Surf.Area= 197 sf Storage= 80 cf

Plug-Flow detention time= 9.1 min calculated for 0.013 af (100% of inflow)
Center-of-Mass det. time= 9.1 min (796.0 - 786.9)

Volume	Invert	Avail.Storage	Storage Description
#1	801.00'	196 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

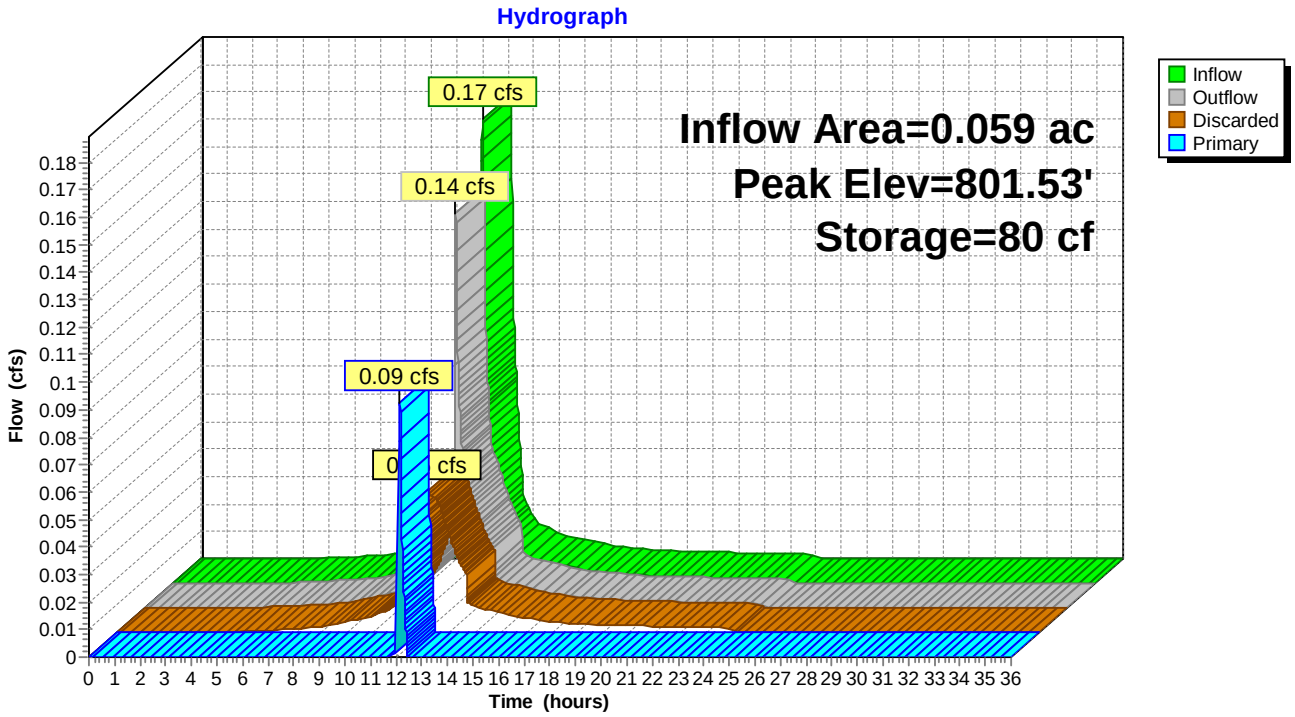
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.00	112	43.0	0	0	112
802.00	294	69.0	196	196	350

Device	Routing	Invert	Outlet Devices
#1	Primary	799.10'	**10.0" Round Culvert** L= 6.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.10' / 799.00' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	801.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	801.00'	**8.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00' Phase-In= 0.01'

Discarded OutFlow Max=0.05 cfs @ 12.14 hrs HW=801.53' (Free Discharge)
↑—**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.09 cfs @ 12.14 hrs HW=801.53' TW=798.83' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.09 cfs of 3.72 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 0.09 cfs @ 0.54 fps)

Pond 50P: Southeast Bioretention Area

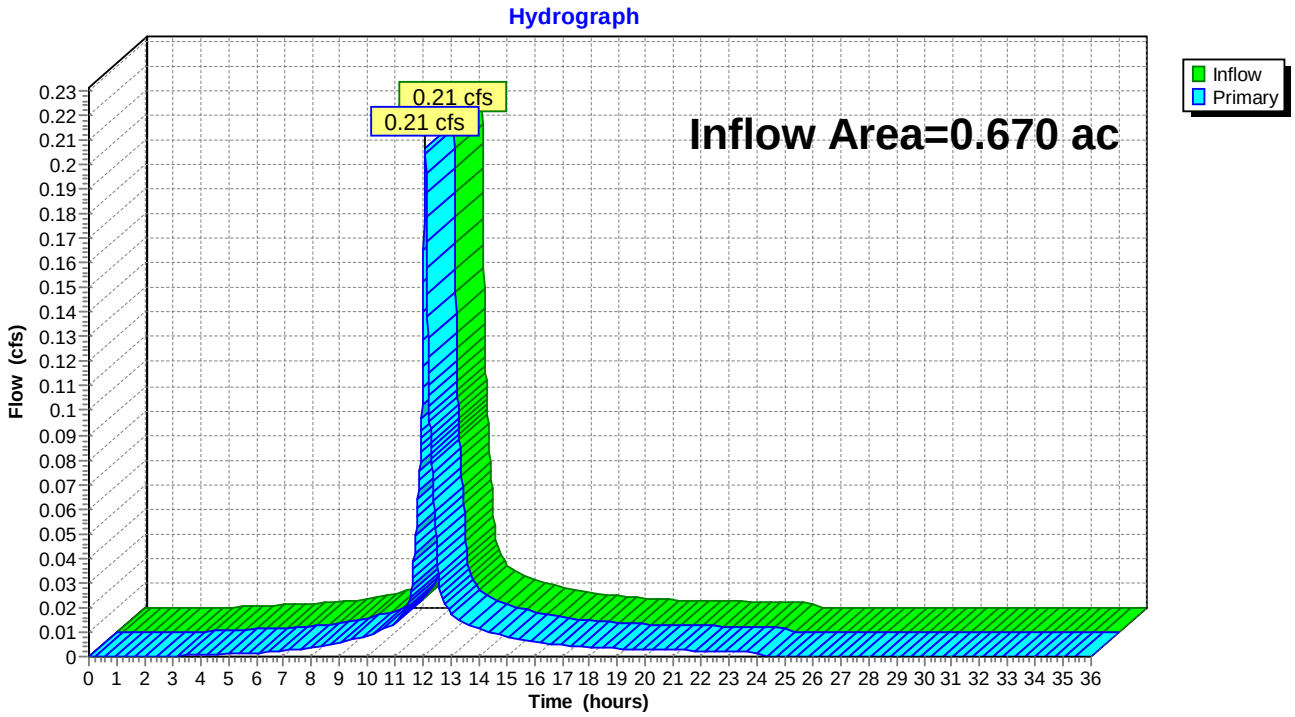


Summary for Link 10L: Mechanic Street

Inflow Area = 0.670 ac, 88.78% Impervious, Inflow Depth = 0.28" for 2-Year event
Inflow = 0.21 cfs @ 12.08 hrs, Volume= 0.016 af
Primary = 0.21 cfs @ 12.08 hrs, Volume= 0.016 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

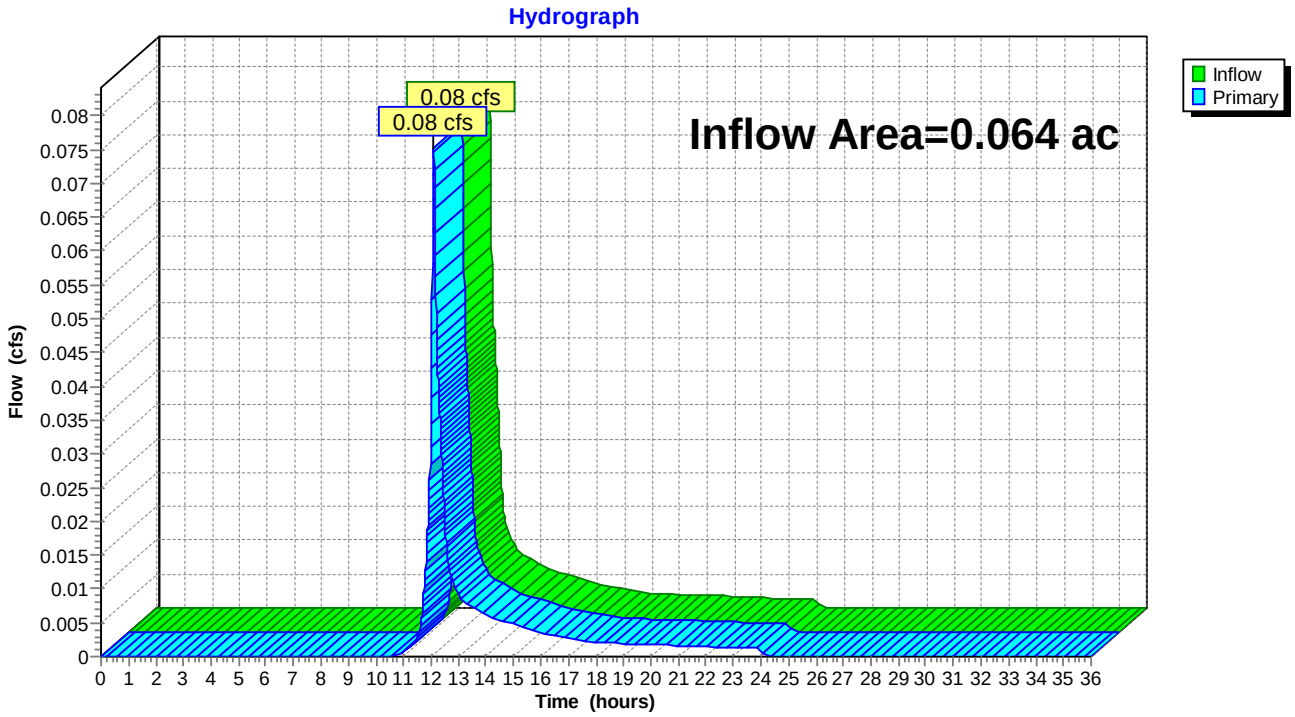


Summary for Link 20L: Off Site West

Inflow Area = 0.064 ac, 0.00% Impervious, Inflow Depth = 1.05" for 2-Year event
Inflow = 0.08 cfs @ 12.10 hrs, Volume= 0.006 af
Primary = 0.08 cfs @ 12.10 hrs, Volume= 0.006 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Bioretention Runoff Area=8,095 sf 72.23% Impervious Runoff Depth=3.82"
Tc=6.0 min CN=91 Runoff=0.80 cfs 0.059 af

Subcatchment 20S: Sheet Flow Mechanic Runoff Area=6,298 sf 100.00% Impervious Runoff Depth=4.59"
Tc=6.0 min CN=98 Runoff=0.68 cfs 0.055 af

Subcatchment 30S: Sheet Flow to Bioretention Runoff Area=9,236 sf 96.10% Impervious Runoff Depth=4.48"
Tc=6.0 min CN=97 Runoff=0.99 cfs 0.079 af

Subcatchment 40S: Sheet Flow to West Runoff Area=2,802 sf 0.00% Impervious Runoff Depth=2.23"
Tc=6.0 min CN=74 Runoff=0.17 cfs 0.012 af

Subcatchment 50S: Sheet Flow to Bioretention Runoff Area=2,559 sf 83.08% Impervious Runoff Depth=4.14"
Tc=6.0 min CN=94 Runoff=0.27 cfs 0.020 af

Subcatchment 60S: Sheet Flow to Mechanic Runoff Area=2,978 sf 92.21% Impervious Runoff Depth=4.36"
Tc=6.0 min CN=96 Runoff=0.32 cfs 0.025 af

Pond 10P: Central Bioretention Area Peak Elev=802.72' Storage=163 cf Inflow=1.48 cfs 0.114 af
Discarded=0.05 cfs 0.049 af Primary=1.42 cfs 0.066 af Outflow=1.47 cfs 0.114 af

Pond 30P: Subsurface Infiltrator Peak Elev=799.33' Storage=1,672 cf Inflow=2.62 cfs 0.149 af
Discarded=0.70 cfs 0.149 af Primary=0.00 cfs 0.000 af Outflow=0.70 cfs 0.149 af

Pond 50P: Southeast Bioretention Area Peak Elev=801.55' Storage=84 cf Inflow=0.27 cfs 0.020 af
Discarded=0.05 cfs 0.016 af Primary=0.21 cfs 0.004 af Outflow=0.26 cfs 0.020 af

Link 10L: Mechanic Street Inflow=0.32 cfs 0.025 af
Primary=0.32 cfs 0.025 af

Link 20L: Off Site West Inflow=0.17 cfs 0.012 af
Primary=0.17 cfs 0.012 af

Total Runoff Area = 0.734 ac Runoff Volume = 0.251 af Average Runoff Depth = 4.10"
19.00% Pervious = 0.139 ac 81.00% Impervious = 0.594 ac

Summary for Subcatchment 10S: Sheet Flow to Bioretention

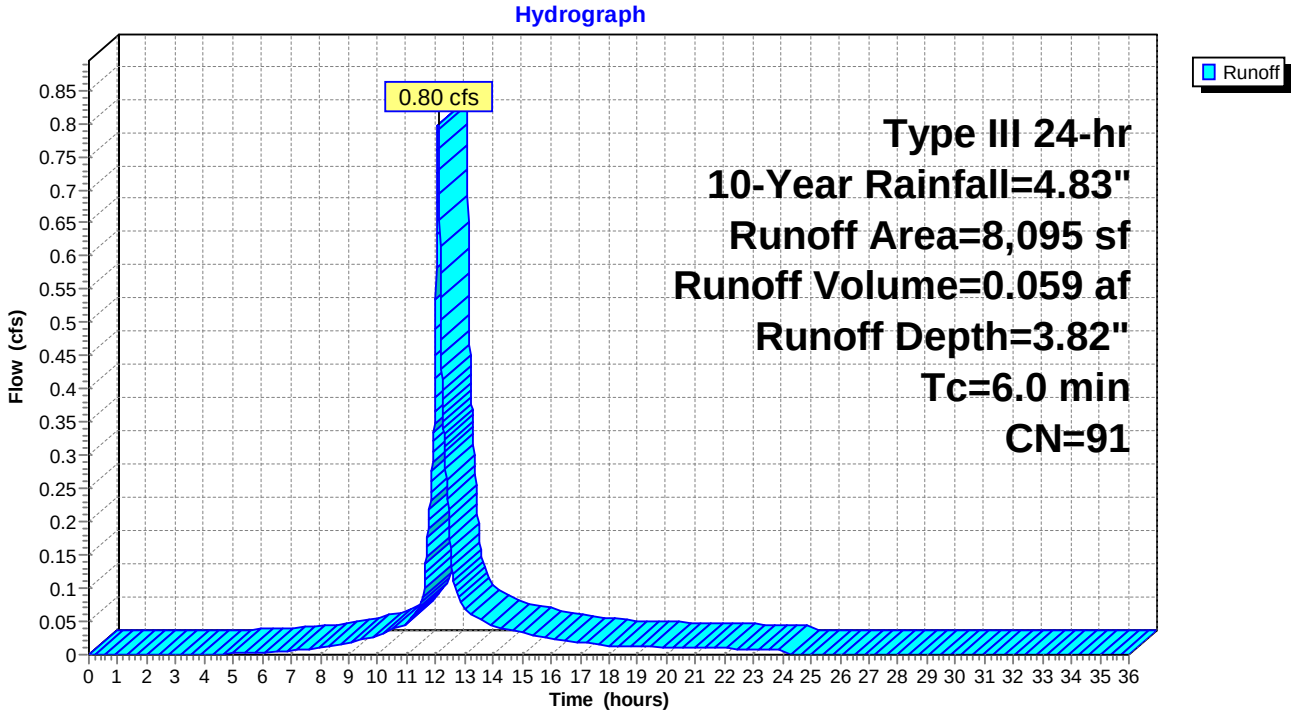
Runoff = 0.80 cfs @ 12.08 hrs, Volume= 0.059 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
2,248	74	>75% Grass cover, Good, HSG C
5,388	98	Paved parking, HSG C
459	98	Water Surface, HSG C
8,095	91	Weighted Average
2,248		27.77% Pervious Area
5,847		72.23% Impervious Area

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

Subcatchment 10S: Sheet Flow to Bioretention



Summary for Subcatchment 20S: Sheet Flow Mechanic Street

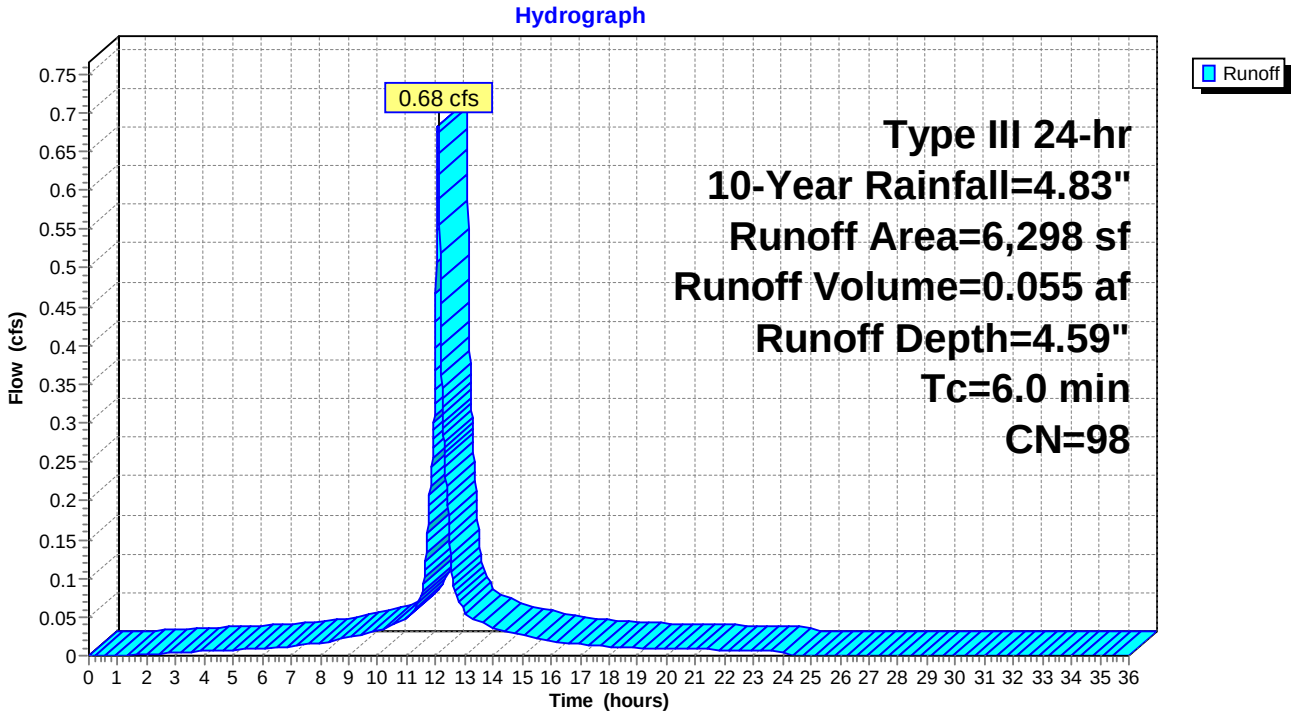
Runoff = 0.68 cfs @ 12.08 hrs, Volume= 0.055 af, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
6,298	98	Paved parking, HSG C
6,298		100.00% Impervious Area

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

Subcatchment 20S: Sheet Flow Mechanic Street



Summary for Subcatchment 30S: Sheet Flow to Bioretention

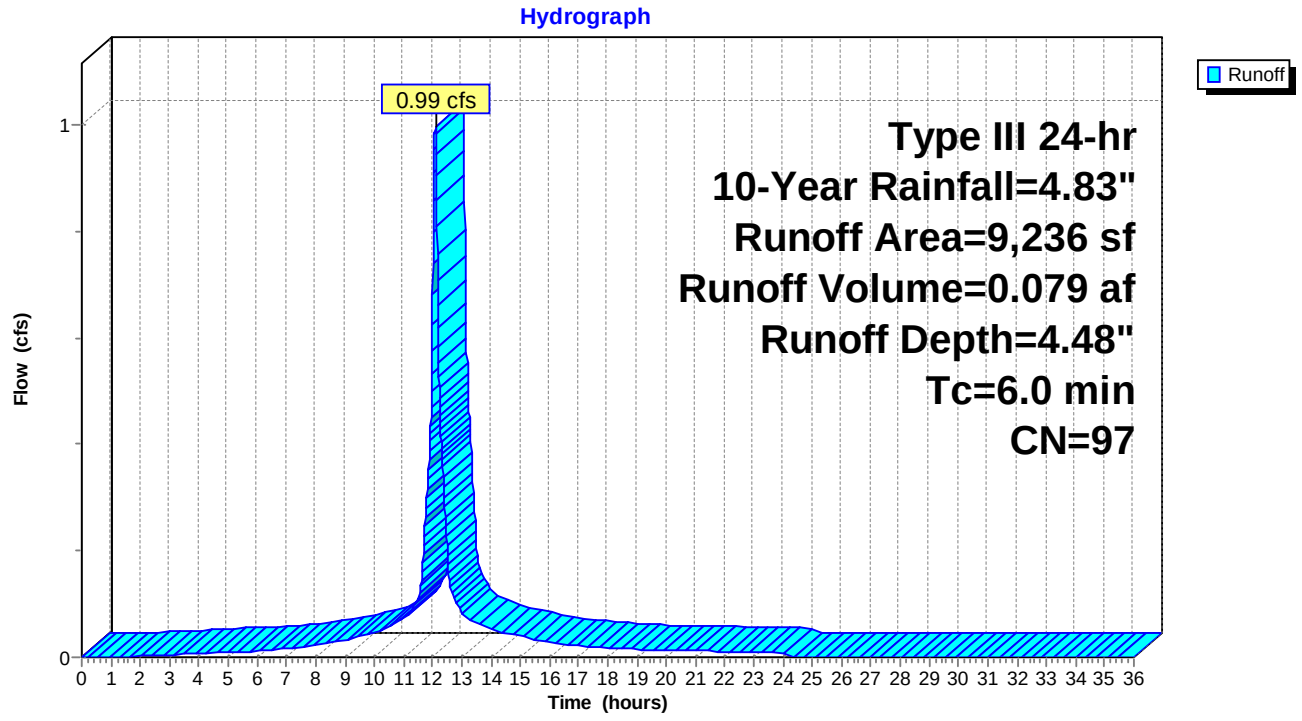
Runoff = 0.99 cfs @ 12.08 hrs, Volume= 0.079 af, Depth= 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
360	74	>75% Grass cover, Good, HSG C
8,876	98	Paved parking, HSG C
9,236	97	Weighted Average
360		3.90% Pervious Area
8,876		96.10% Impervious Area

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

Subcatchment 30S: Sheet Flow to Bioretention



Summary for Subcatchment 40S: Sheet Flow to West

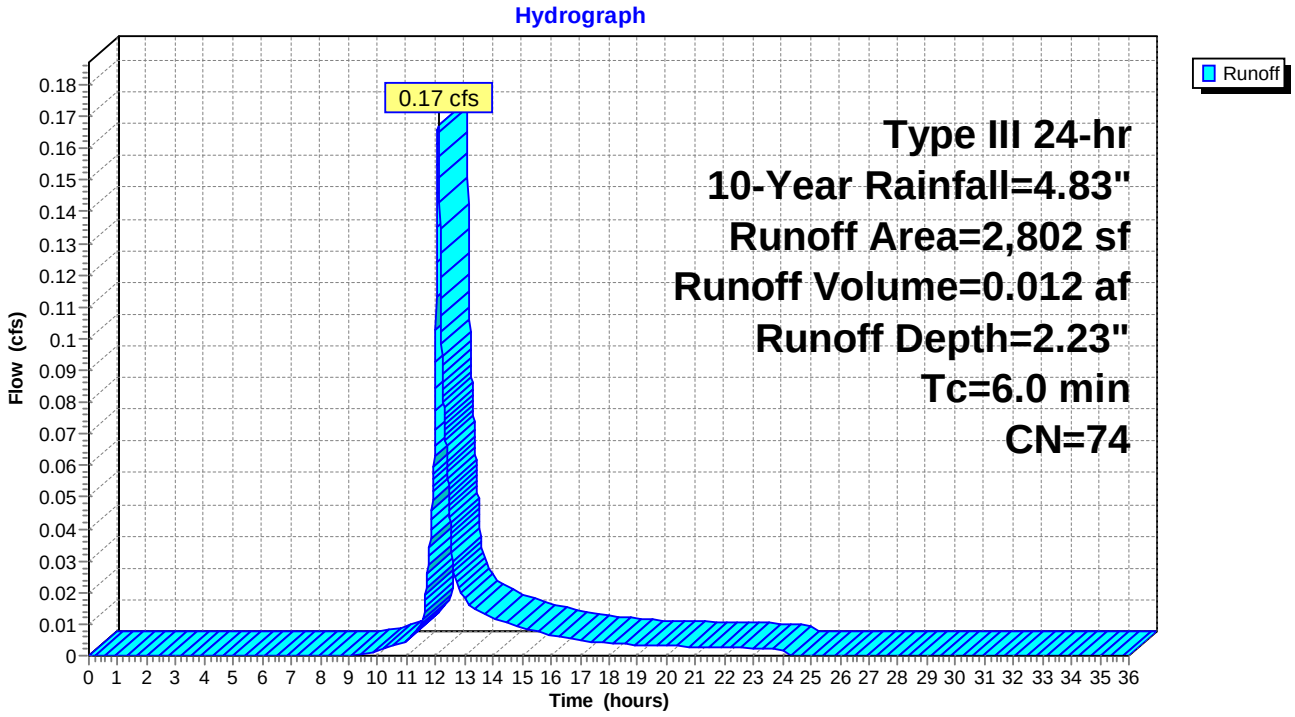
Runoff = 0.17 cfs @ 12.09 hrs, Volume= 0.012 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
2,802	74	>75% Grass cover, Good, HSG C
2,802		100.00% Pervious Area

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

Subcatchment 40S: Sheet Flow to West



Summary for Subcatchment 50S: Sheet Flow to Bioretention Area

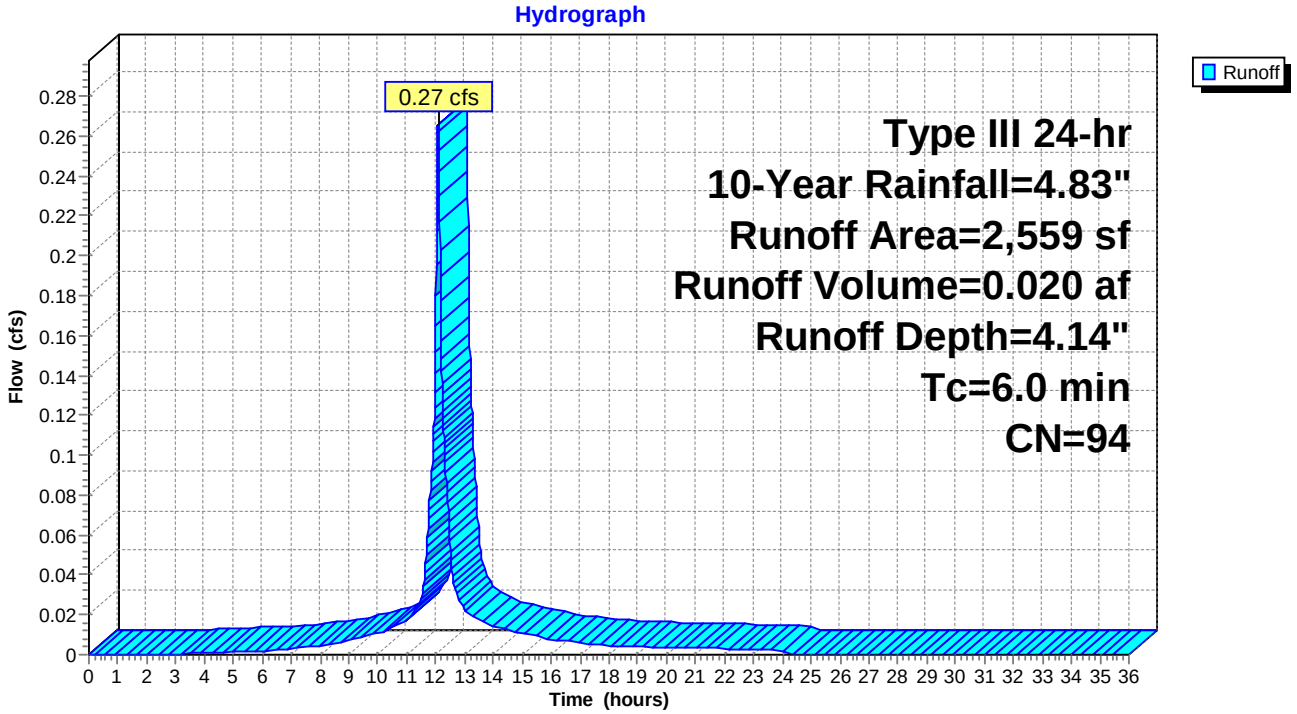
Runoff = 0.27 cfs @ 12.08 hrs, Volume= 0.020 af, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
433	74	>75% Grass cover, Good, HSG C
1,832	98	Paved parking, HSG C
294	98	Water Surface, HSG C
2,559	94	Weighted Average
433		16.92% Pervious Area
2,126		83.08% Impervious Area

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

Subcatchment 50S: Sheet Flow to Bioretention Area



Summary for Subcatchment 60S: Sheet Flow to Mechanic Street

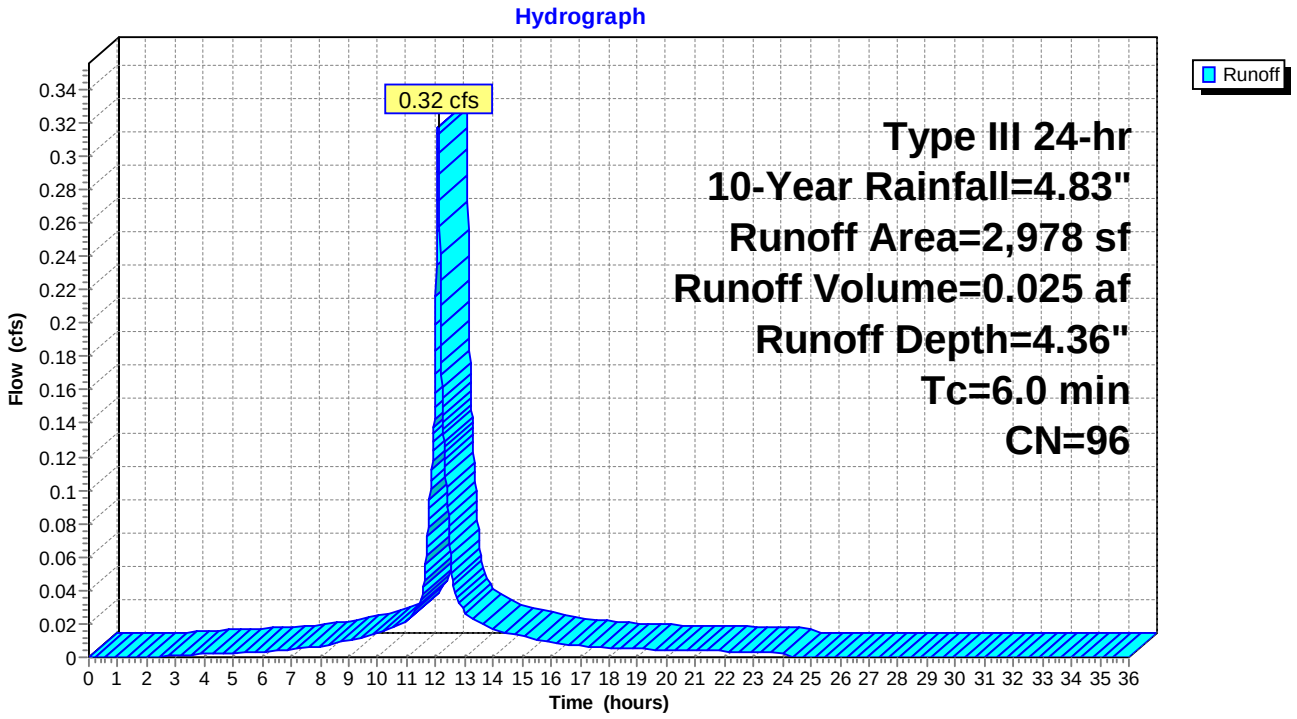
Runoff = 0.32 cfs @ 12.08 hrs, Volume= 0.025 af, Depth= 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
232	74	>75% Grass cover, Good, HSG C
2,746	98	Paved parking, HSG C
2,978	96	Weighted Average
232		7.79% Pervious Area
2,746		92.21% Impervious Area

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

Subcatchment 60S: Sheet Flow to Mechanic Street



Summary for Pond 10P: Central Bioretention Area

Inflow Area = 0.330 ac, 84.38% Impervious, Inflow Depth = 4.16" for 10-Year event
Inflow = 1.48 cfs @ 12.08 hrs, Volume= 0.114 af
Outflow = 1.47 cfs @ 12.09 hrs, Volume= 0.114 af, Atten= 1%, Lag= 0.5 min
Discarded = 0.05 cfs @ 12.09 hrs, Volume= 0.049 af
Primary = 1.42 cfs @ 12.09 hrs, Volume= 0.066 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 802.72' @ 12.09 hrs Surf.Area= 390 sf Storage= 163 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 14.8 min (783.7 - 768.9)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	296 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

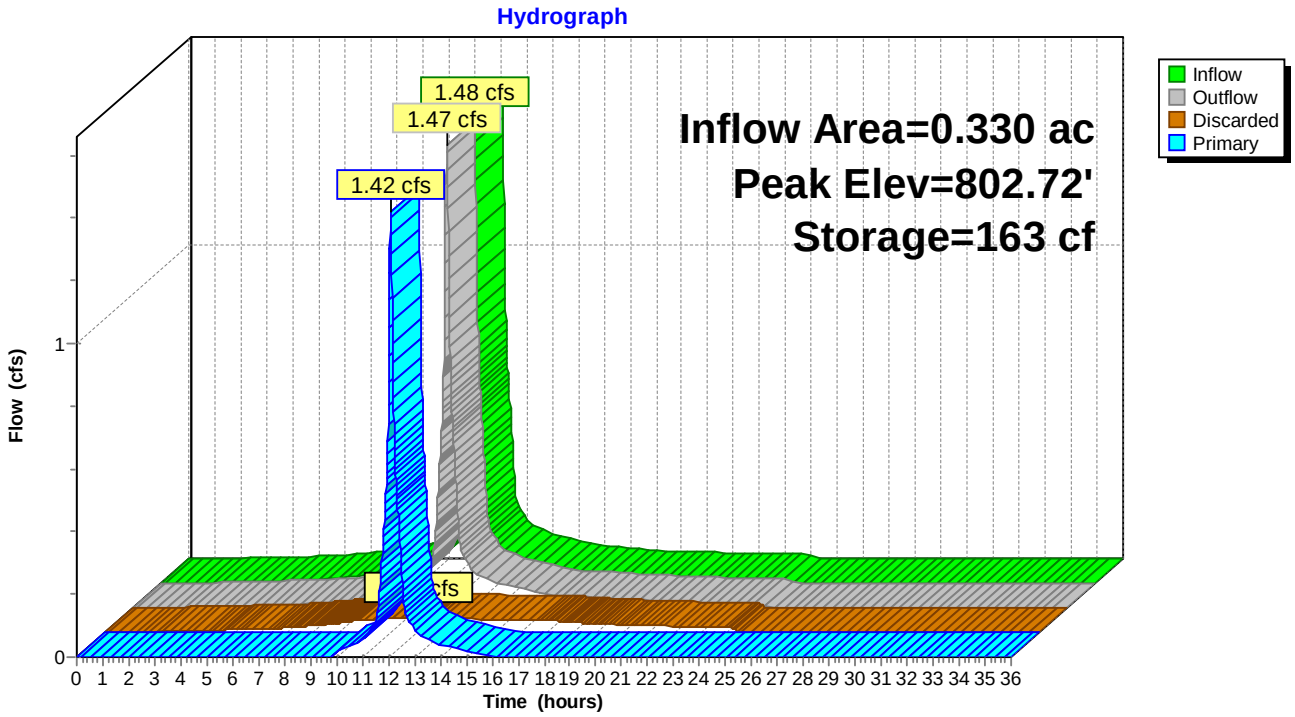
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	96	65.0	0	0	96
803.00	560	158.0	296	296	1,750

Device	Routing	Invert	Outlet Devices
#1	Primary	799.40'	**10.0" Round Culvert** L= 19.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.40' / 799.00' S= 0.0211 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	802.55'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	802.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00'

Discarded OutFlow Max=0.05 cfs @ 12.09 hrs HW=802.72' (Free Discharge)
↑└**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=1.42 cfs @ 12.09 hrs HW=802.72' TW=799.05' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 1.42 cfs of 4.47 cfs potential flow)
↑└**2=Orifice/Grate** (Weir Controls 1.42 cfs @ 1.34 fps)

Pond 10P: Central Bioretention Area



Summary for Pond 30P: Subsurface Infiltrator

Inflow Area = 0.601 ac, 88.39% Impervious, Inflow Depth = 2.97" for 10-Year event
Inflow = 2.62 cfs @ 12.09 hrs, Volume= 0.149 af
Outflow = 0.70 cfs @ 12.42 hrs, Volume= 0.149 af, Atten= 73%, Lag= 19.7 min
Discarded = 0.70 cfs @ 12.42 hrs, Volume= 0.149 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 799.33' @ 12.42 hrs Surf.Area= 3,579 sf Storage= 1,672 cf

Plug-Flow detention time= 14.9 min calculated for 0.149 af (100% of inflow)
Center-of-Mass det. time= 14.9 min (761.3 - 746.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	798.50'	2,544 cf	**34.00'W x 105.25'L x 2.54'H Field A** 9,095 cf Overall - 2,735 cf Embedded = 6,360 cf x 40.0% Voids
#2A	799.00'	2,735 cf	**Cultec R-150XLHD** x 100 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 10 rows
		5,279 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 3	799.00'	**12.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.00' / 798.40' S= 0.0240 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Discarded	798.50'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 796.50' Phase-In= 0.01'
#3	Primary	801.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.70 cfs @ 12.42 hrs HW=799.33' (Free Discharge)
↑└**2=Exfiltration** (Controls 0.70 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.50' TW=0.00' (Dynamic Tailwater)
↑└**3=Orifice/Grate** (Controls 0.00 cfs)
↑└**1=Culvert** (Controls 0.00 cfs)

Pond 30P: Subsurface Infiltrator - Chamber Wizard Field A

Chamber Model = Cultec R-150XLHD (Cultec Recharger® 150XLHD)
Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf
Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap
Row Length Adjustment= +0.75' x 2.65 sf x 10 rows

33.0" Wide + 6.0" Spacing = 39.0" C-C Row Spacing

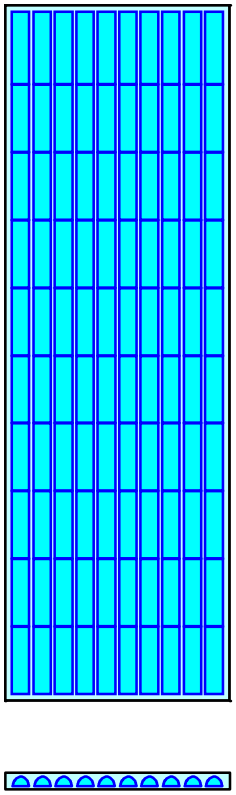
10 Chambers/Row x 10.25' Long +0.75' Row Adjustment = 103.25' Row Length +12.0" End Stone x 2 = 105.25' Base Length
10 Rows x 33.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 34.00' Base Width
6.0" Base + 18.5" Chamber Height + 6.0" Cover = 2.54' Field Height

100 Chambers x 27.2 cf +0.75' Row Adjustment x 2.65 sf x 10 Rows = 2,735.1 cf Chamber Storage

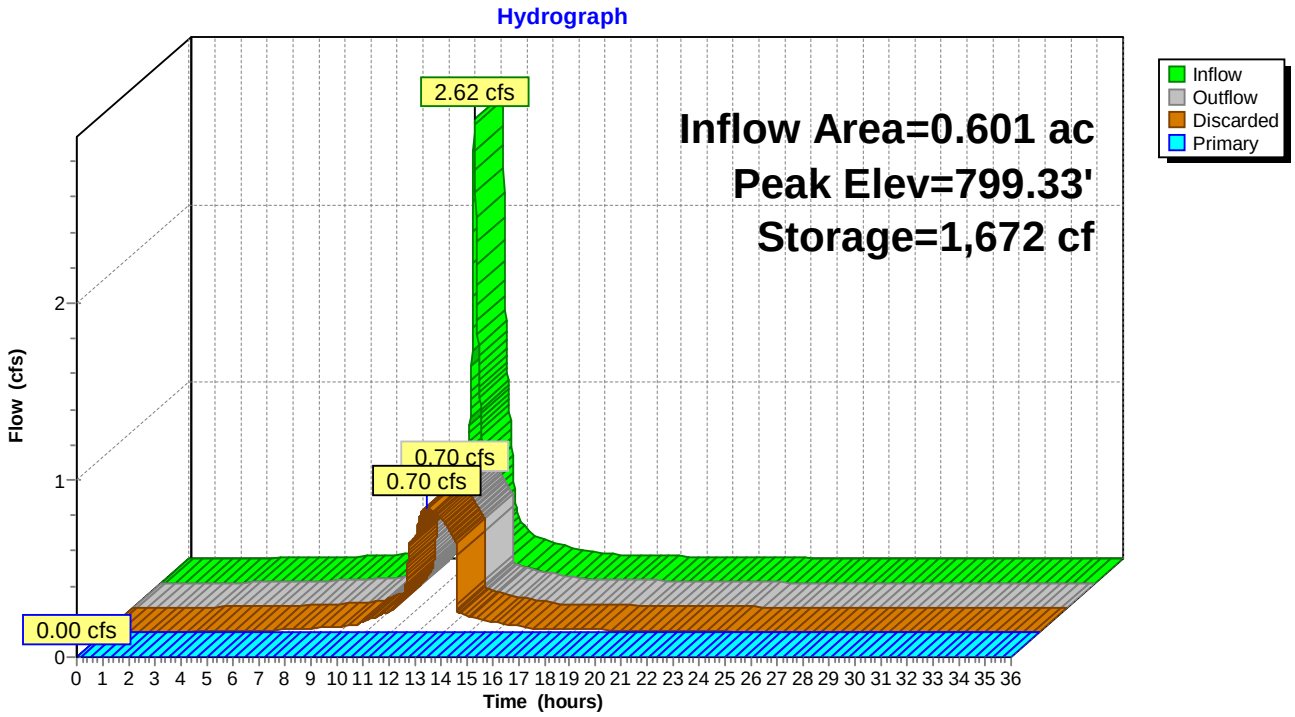
9,095.4 cf Field - 2,735.1 cf Chambers = 6,360.3 cf Stone x 40.0% Voids = 2,544.1 cf Stone Storage

Chamber Storage + Stone Storage = 5,279.2 cf = 0.121 af
Overall Storage Efficiency = 58.0%
Overall System Size = 105.25' x 34.00' x 2.54'

100 Chambers
336.9 cy Field
235.6 cy Stone



Pond 30P: Subsurface Infiltrator



Summary for Pond 50P: Southeast Bioretention Area

Inflow Area = 0.059 ac, 83.08% Impervious, Inflow Depth = 4.14" for 10-Year event
Inflow = 0.27 cfs @ 12.08 hrs, Volume= 0.020 af
Outflow = 0.26 cfs @ 12.09 hrs, Volume= 0.020 af, Atten= 1%, Lag= 0.5 min
Discarded = 0.05 cfs @ 12.09 hrs, Volume= 0.016 af
Primary = 0.21 cfs @ 12.09 hrs, Volume= 0.004 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 801.55' @ 12.09 hrs Surf.Area= 201 sf Storage= 84 cf

Plug-Flow detention time= 7.9 min calculated for 0.020 af (100% of inflow)
Center-of-Mass det. time= 7.9 min (782.4 - 774.5)

Volume	Invert	Avail.Storage	Storage Description
#1	801.00'	196 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

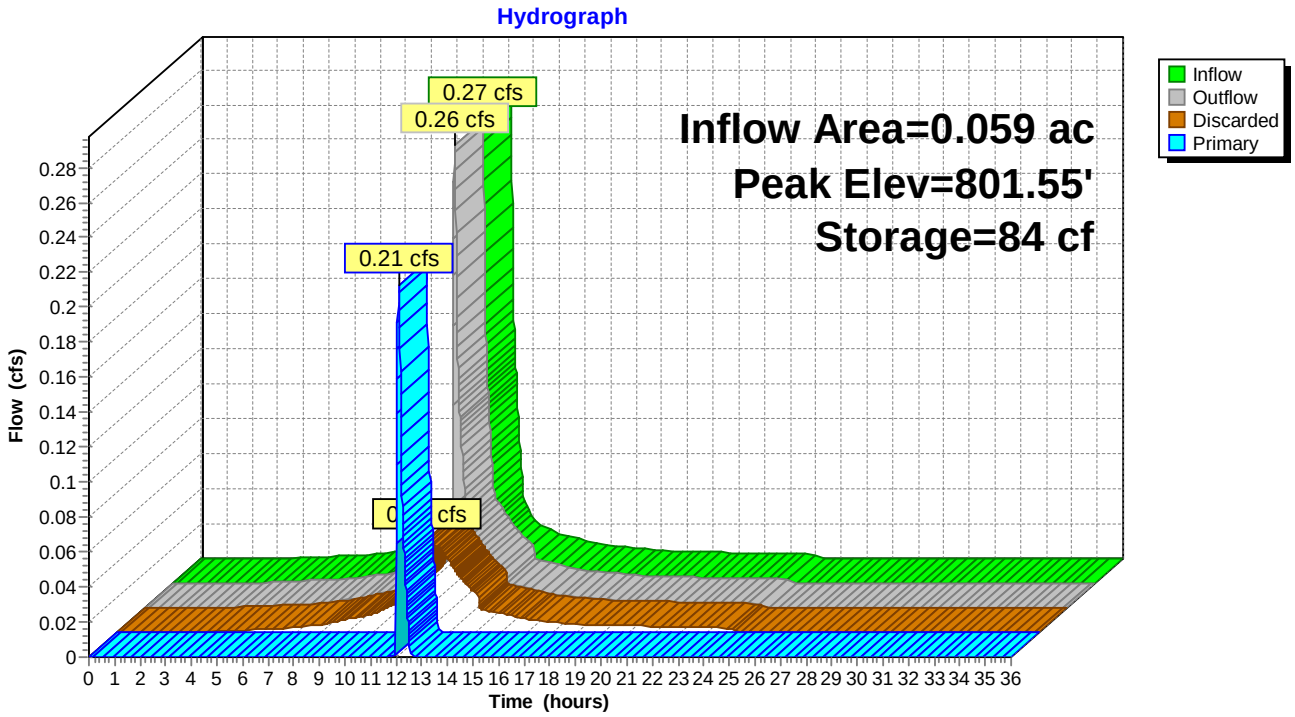
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.00	112	43.0	0	0	112
802.00	294	69.0	196	196	350

Device	Routing	Invert	Outlet Devices
#1	Primary	799.10'	**10.0" Round Culvert** L= 6.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.10' / 799.00' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	801.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	801.00'	**8.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00' Phase-In= 0.01'

Discarded OutFlow Max=0.05 cfs @ 12.09 hrs HW=801.55' (Free Discharge)
↑—**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.21 cfs @ 12.09 hrs HW=801.55' TW=799.05' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.21 cfs of 3.74 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 0.21 cfs @ 0.71 fps)

Pond 50P: Southeast Bioretention Area

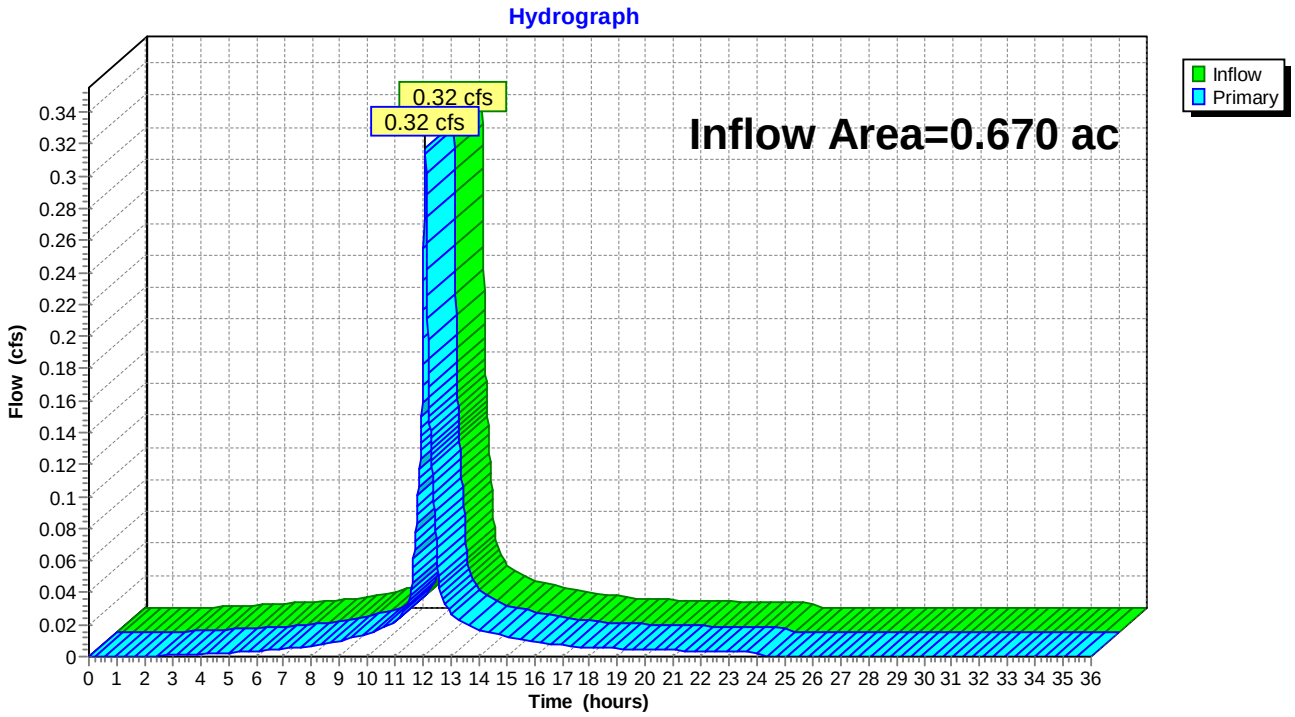


Summary for Link 10L: Mechanic Street

Inflow Area = 0.670 ac, 88.78% Impervious, Inflow Depth = 0.45" for 10-Year event
Inflow = 0.32 cfs @ 12.08 hrs, Volume= 0.025 af
Primary = 0.32 cfs @ 12.08 hrs, Volume= 0.025 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

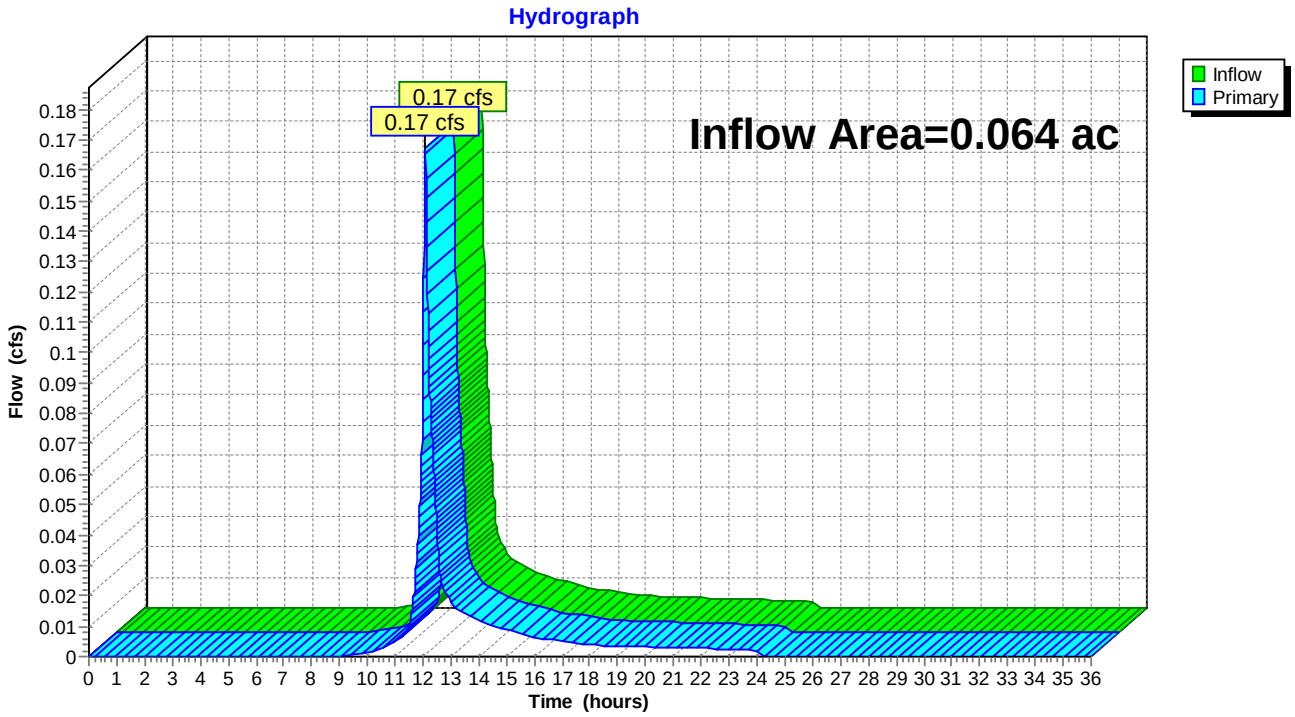


Summary for Link 20L: Off Site West

Inflow Area = 0.064 ac, 0.00% Impervious, Inflow Depth = 2.23" for 10-Year event
Inflow = 0.17 cfs @ 12.09 hrs, Volume= 0.012 af
Primary = 0.17 cfs @ 12.09 hrs, Volume= 0.012 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Bioretention Runoff Area=8,095 sf 72.23% Impervious Runoff Depth=5.04"
Tc=6.0 min CN=91 Runoff=1.04 cfs 0.078 af

Subcatchment 20S: Sheet Flow Mechanic Runoff Area=6,298 sf 100.00% Impervious Runoff Depth=5.84"
Tc=6.0 min CN=98 Runoff=0.86 cfs 0.070 af

Subcatchment 30S: Sheet Flow to Bioretention Runoff Area=9,236 sf 96.10% Impervious Runoff Depth=5.72"
Tc=6.0 min CN=97 Runoff=1.26 cfs 0.101 af

Subcatchment 40S: Sheet Flow to West Runoff Area=2,802 sf 0.00% Impervious Runoff Depth=3.25"
Tc=6.0 min CN=74 Runoff=0.25 cfs 0.017 af

Subcatchment 50S: Sheet Flow to Bioretention Runoff Area=2,559 sf 83.08% Impervious Runoff Depth=5.38"
Tc=6.0 min CN=94 Runoff=0.34 cfs 0.026 af

Subcatchment 60S: Sheet Flow to Mechanic Runoff Area=2,978 sf 92.21% Impervious Runoff Depth=5.61"
Tc=6.0 min CN=96 Runoff=0.40 cfs 0.032 af

Pond 10P: Central Bioretention Area Peak Elev=802.75' Storage=175 cf Inflow=1.90 cfs 0.148 af
Discarded=0.06 cfs 0.056 af Primary=1.83 cfs 0.092 af Outflow=1.89 cfs 0.148 af

Pond 30P: Subsurface Infiltrator Peak Elev=799.64' Storage=2,552 cf Inflow=3.37 cfs 0.200 af
Discarded=0.78 cfs 0.200 af Primary=0.00 cfs 0.000 af Outflow=0.78 cfs 0.200 af

Pond 50P: Southeast Bioretention Area Peak Elev=801.56' Storage=87 cf Inflow=0.34 cfs 0.026 af
Discarded=0.05 cfs 0.020 af Primary=0.29 cfs 0.006 af Outflow=0.34 cfs 0.026 af

Link 10L: Mechanic Street Inflow=0.40 cfs 0.032 af
Primary=0.40 cfs 0.032 af

Link 20L: Off Site West Inflow=0.25 cfs 0.017 af
Primary=0.25 cfs 0.017 af

Total Runoff Area = 0.734 ac Runoff Volume = 0.325 af Average Runoff Depth = 5.32"
19.00% Pervious = 0.139 ac 81.00% Impervious = 0.594 ac

Summary for Subcatchment 10S: Sheet Flow to Bioretention

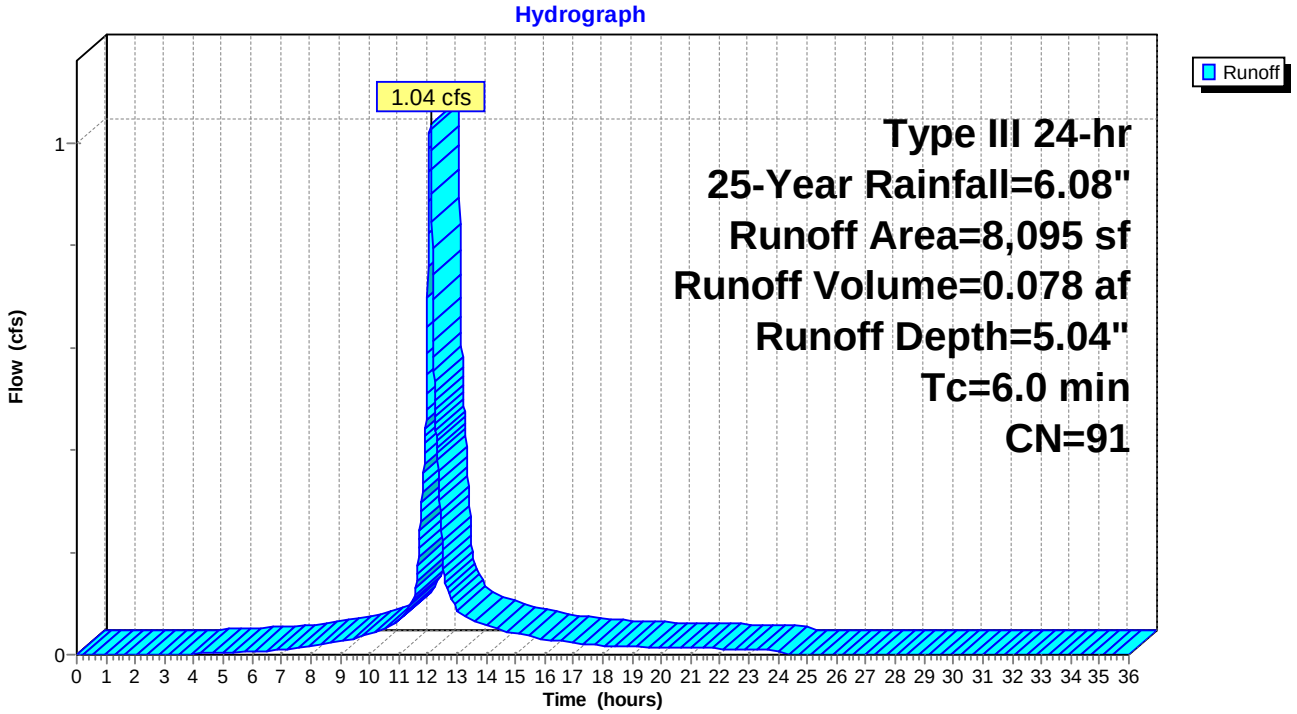
Runoff = 1.04 cfs @ 12.08 hrs, Volume= 0.078 af, Depth= 5.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
2,248	74	>75% Grass cover, Good, HSG C
5,388	98	Paved parking, HSG C
459	98	Water Surface, HSG C
8,095	91	Weighted Average
2,248		27.77% Pervious Area
5,847		72.23% Impervious Area

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

Subcatchment 10S: Sheet Flow to Bioretention



Summary for Subcatchment 20S: Sheet Flow Mechanic Street

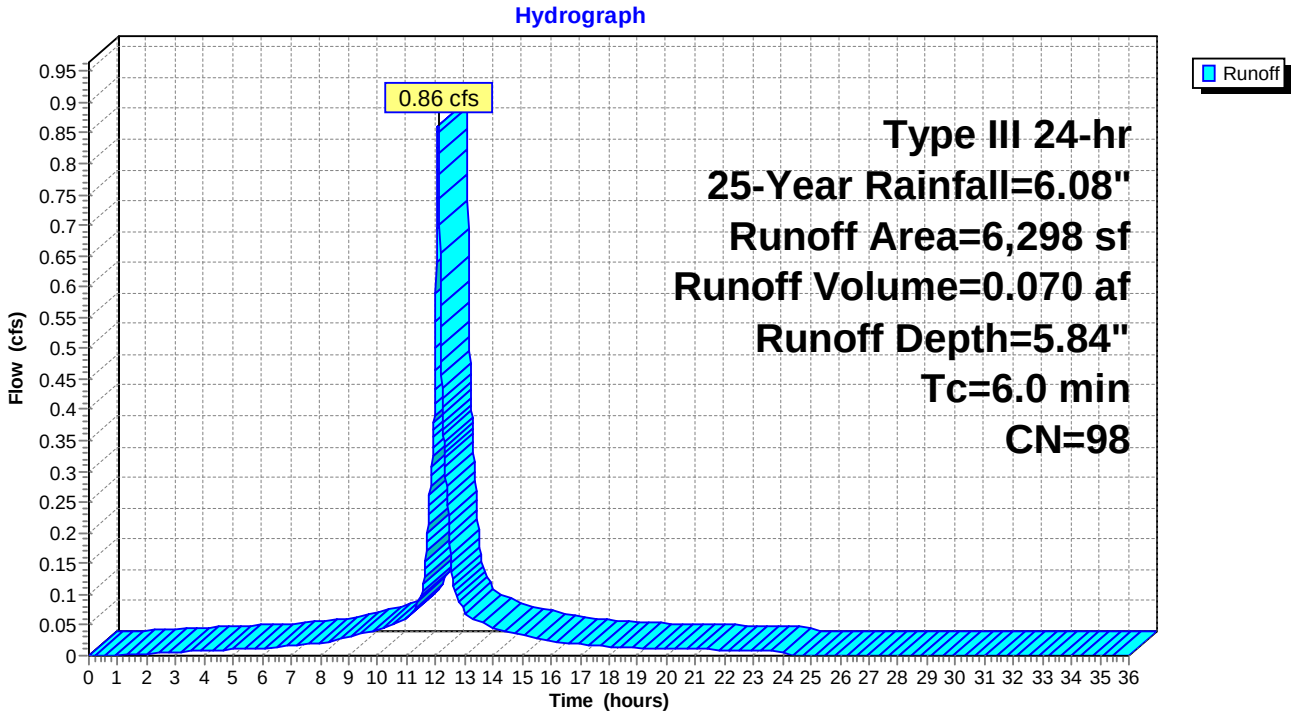
Runoff = 0.86 cfs @ 12.08 hrs, Volume= 0.070 af, Depth= 5.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
6,298	98	Paved parking, HSG C
6,298		100.00% Impervious Area

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

Subcatchment 20S: Sheet Flow Mechanic Street



Summary for Subcatchment 30S: Sheet Flow to Bioretention

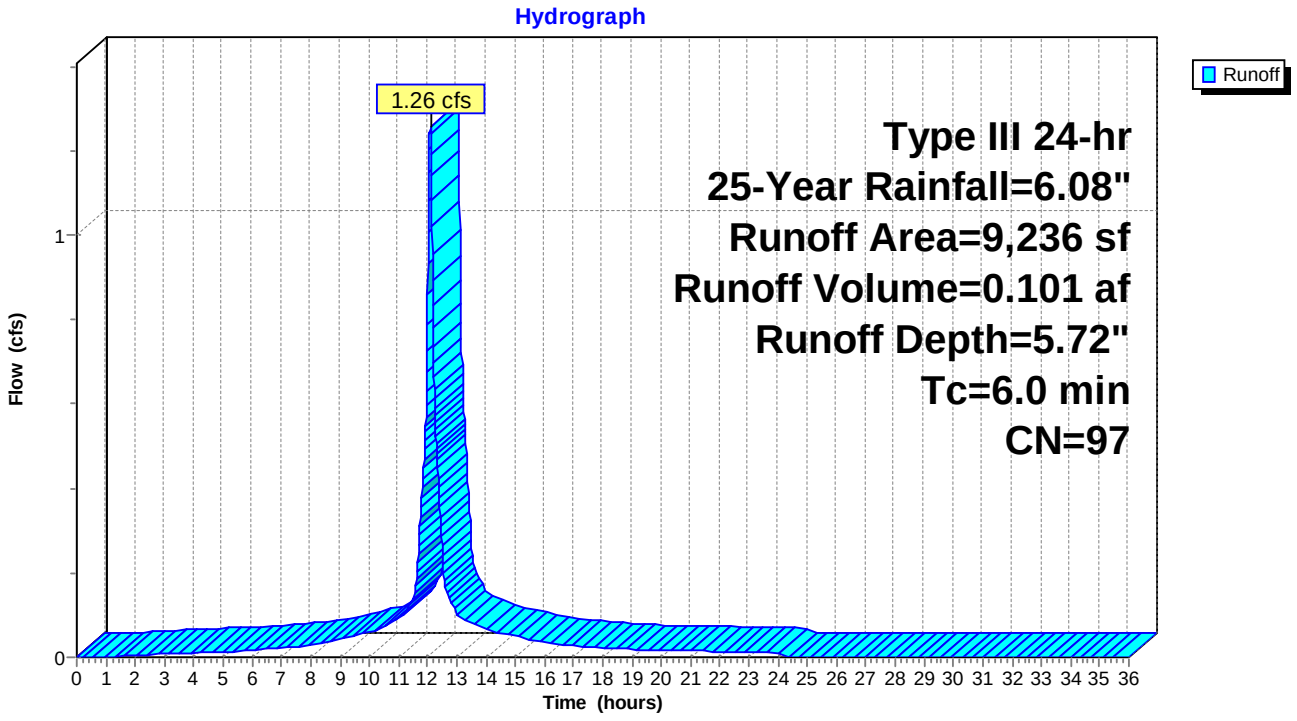
Runoff = 1.26 cfs @ 12.08 hrs, Volume= 0.101 af, Depth= 5.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
360	74	>75% Grass cover, Good, HSG C
8,876	98	Paved parking, HSG C
9,236	97	Weighted Average
360		3.90% Pervious Area
8,876		96.10% Impervious Area

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

Subcatchment 30S: Sheet Flow to Bioretention



Summary for Subcatchment 40S: Sheet Flow to West

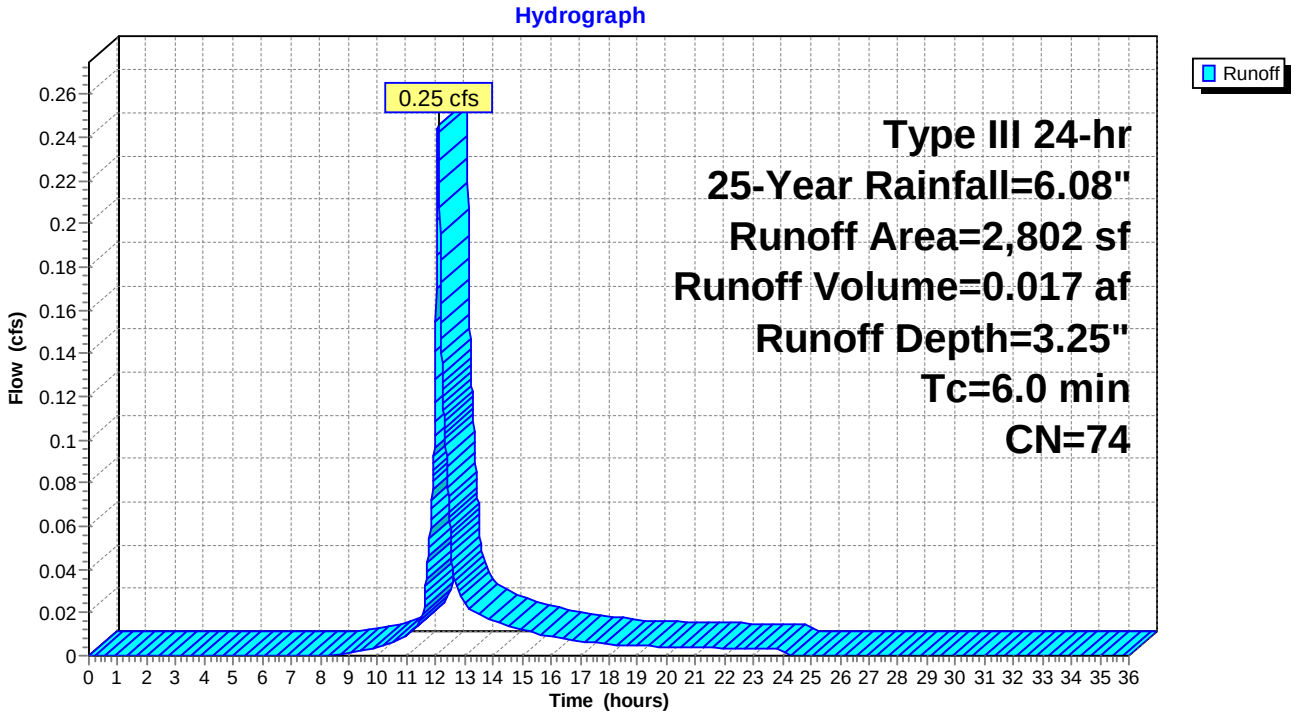
Runoff = 0.25 cfs @ 12.09 hrs, Volume= 0.017 af, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
2,802	74	>75% Grass cover, Good, HSG C
2,802		100.00% Pervious Area

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

Subcatchment 40S: Sheet Flow to West



Summary for Subcatchment 50S: Sheet Flow to Bioretention Area

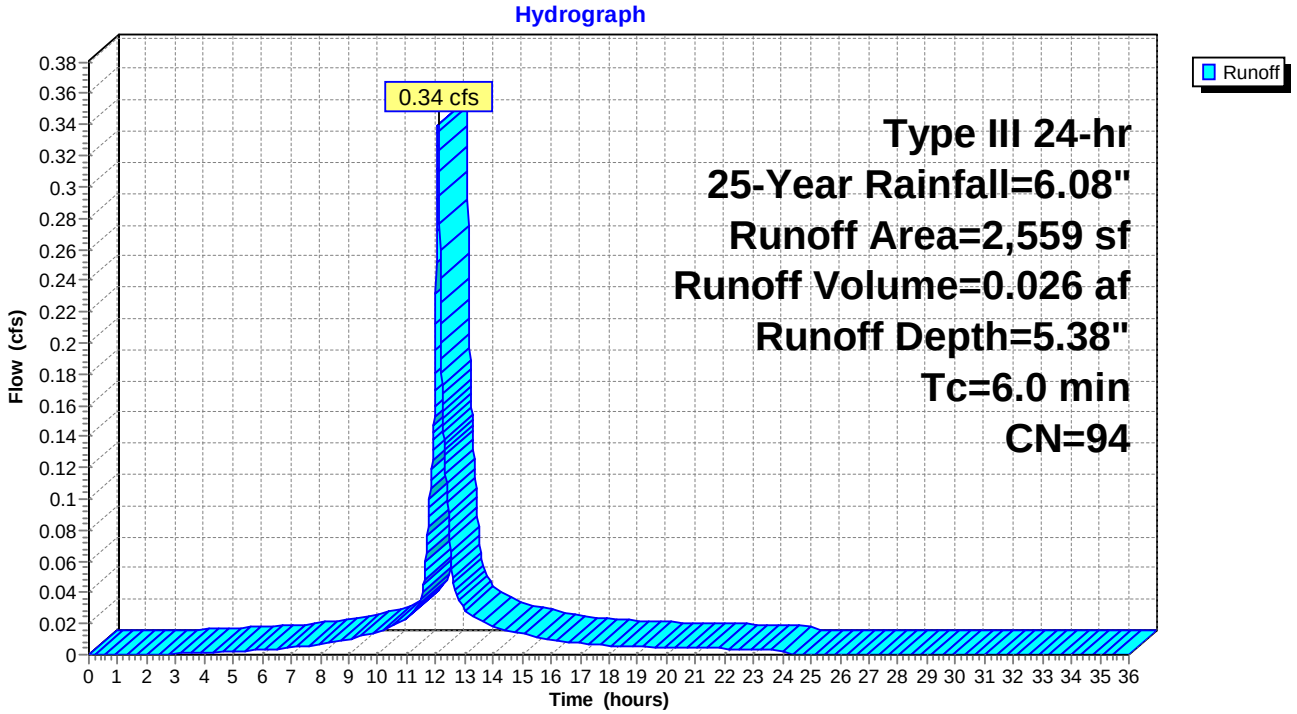
Runoff = 0.34 cfs @ 12.08 hrs, Volume= 0.026 af, Depth= 5.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
433	74	>75% Grass cover, Good, HSG C
1,832	98	Paved parking, HSG C
294	98	Water Surface, HSG C
2,559	94	Weighted Average
433		16.92% Pervious Area
2,126		83.08% Impervious Area

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

Subcatchment 50S: Sheet Flow to Bioretention Area



Summary for Subcatchment 60S: Sheet Flow to Mechanic Street

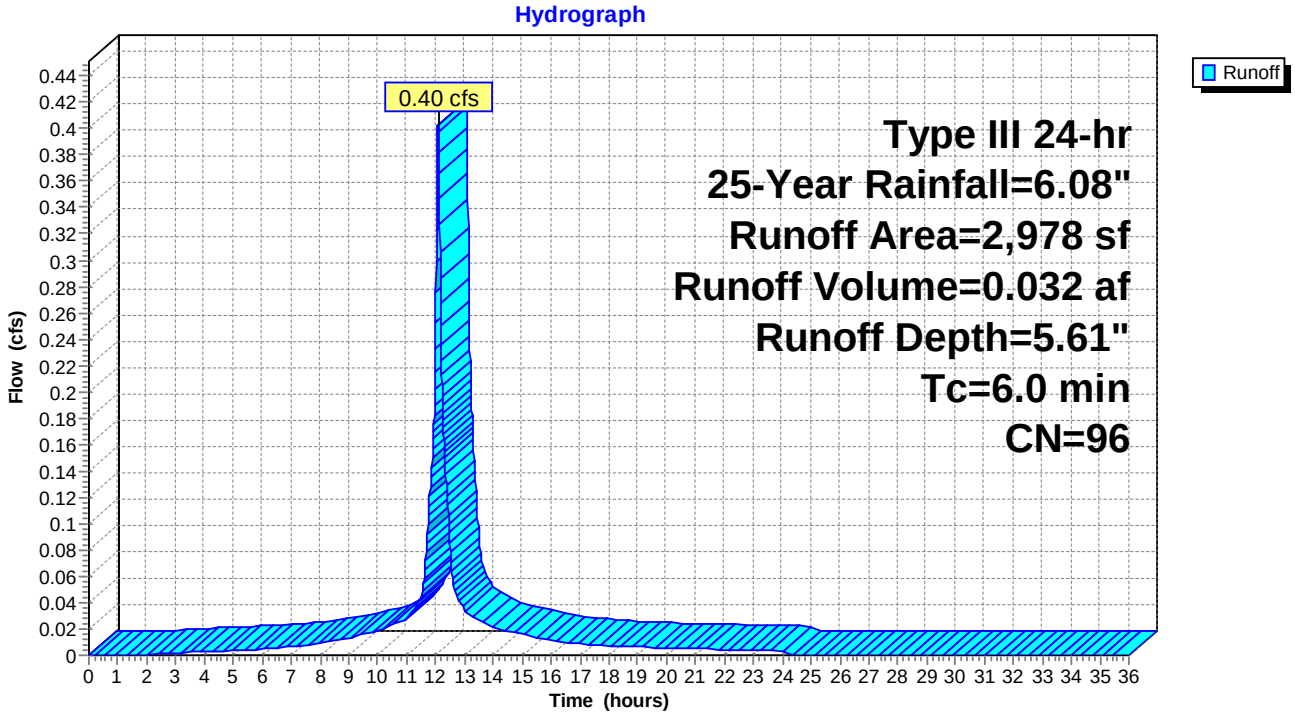
Runoff = 0.40 cfs @ 12.08 hrs, Volume= 0.032 af, Depth= 5.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.08"

Area (sf)	CN	Description
232	74	>75% Grass cover, Good, HSG C
2,746	98	Paved parking, HSG C
2,978	96	Weighted Average
232		7.79% Pervious Area
2,746		92.21% Impervious Area

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

Subcatchment 60S: Sheet Flow to Mechanic Street



Summary for Pond 10P: Central Bioretention Area

Inflow Area = 0.330 ac, 84.38% Impervious, Inflow Depth = 5.39" for 25-Year event
Inflow = 1.90 cfs @ 12.08 hrs, Volume= 0.148 af
Outflow = 1.89 cfs @ 12.09 hrs, Volume= 0.148 af, Atten= 1%, Lag= 0.5 min
Discarded = 0.06 cfs @ 12.09 hrs, Volume= 0.056 af
Primary = 1.83 cfs @ 12.09 hrs, Volume= 0.092 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 802.75' @ 12.09 hrs Surf.Area= 408 sf Storage= 175 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 13.8 min (777.5 - 763.7)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	296 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

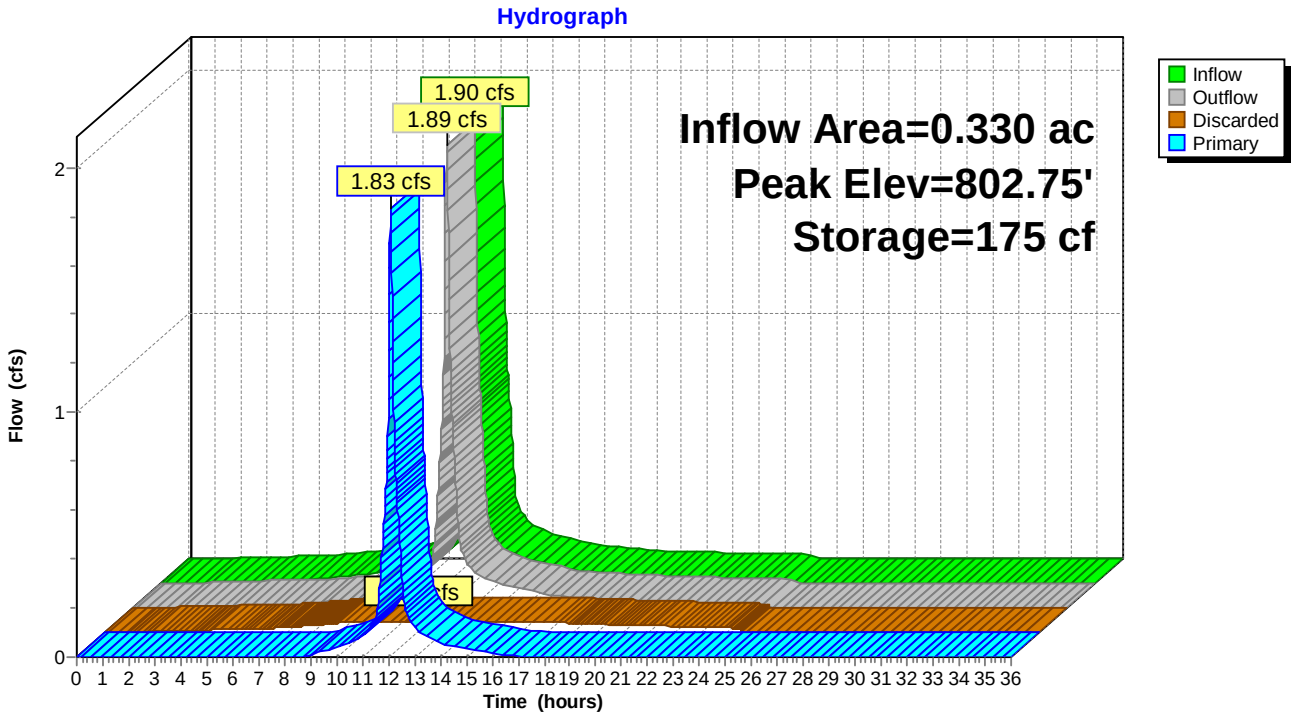
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	96	65.0	0	0	96
803.00	560	158.0	296	296	1,750

Device	Routing	Invert	Outlet Devices
#1	Primary	799.40'	**10.0" Round Culvert** L= 19.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.40' / 799.00' S= 0.0211 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	802.55'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	802.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00'

Discarded OutFlow Max=0.06 cfs @ 12.09 hrs HW=802.75' (Free Discharge)
↑└**3=Exfiltration** (Controls 0.06 cfs)

Primary OutFlow Max=1.83 cfs @ 12.09 hrs HW=802.75' TW=799.21' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 1.83 cfs of 4.50 cfs potential flow)
↑└**2=Orifice/Grate** (Weir Controls 1.83 cfs @ 1.46 fps)

Pond 10P: Central Bioretention Area



Summary for Pond 30P: Subsurface Infiltrator

Inflow Area = 0.601 ac, 88.39% Impervious, Inflow Depth = 3.99" for 25-Year event
Inflow = 3.37 cfs @ 12.09 hrs, Volume= 0.200 af
Outflow = 0.78 cfs @ 12.46 hrs, Volume= 0.200 af, Atten= 77%, Lag= 22.3 min
Discarded = 0.78 cfs @ 12.46 hrs, Volume= 0.200 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 799.64' @ 12.46 hrs Surf.Area= 3,579 sf Storage= 2,552 cf

Plug-Flow detention time= 21.6 min calculated for 0.200 af (100% of inflow)
Center-of-Mass det. time= 21.6 min (765.1 - 743.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	798.50'	2,544 cf	**34.00'W x 105.25'L x 2.54'H Field A** 9,095 cf Overall - 2,735 cf Embedded = 6,360 cf x 40.0% Voids
#2A	799.00'	2,735 cf	**Cultec R-150XLHD** x 100 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 10 rows
		5,279 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 3	799.00'	**12.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.00' / 798.40' S= 0.0240 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Discarded	798.50'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 796.50' Phase-In= 0.01'
#3	Primary	801.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.78 cfs @ 12.46 hrs HW=799.64' (Free Discharge)
↑└**2=Exfiltration** (Controls 0.78 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.50' TW=0.00' (Dynamic Tailwater)
↑└**3=Orifice/Grate** (Controls 0.00 cfs)
↑└**1=Culvert** (Controls 0.00 cfs)

Pond 30P: Subsurface Infiltrator - Chamber Wizard Field A

Chamber Model = Cultec R-150XLHD (Cultec Recharger® 150XLHD)
Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf
Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap
Row Length Adjustment= +0.75' x 2.65 sf x 10 rows

33.0" Wide + 6.0" Spacing = 39.0" C-C Row Spacing

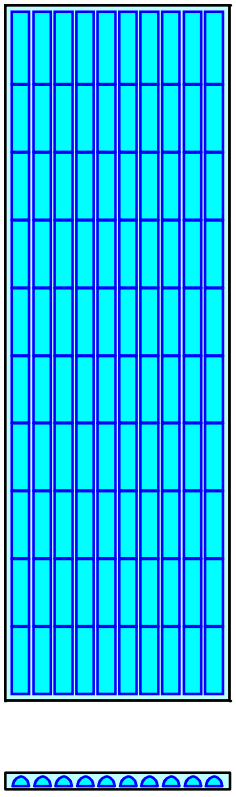
10 Chambers/Row x 10.25' Long +0.75' Row Adjustment = 103.25' Row Length +12.0" End Stone x 2 = 105.25' Base Length
10 Rows x 33.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 34.00' Base Width
6.0" Base + 18.5" Chamber Height + 6.0" Cover = 2.54' Field Height

100 Chambers x 27.2 cf +0.75' Row Adjustment x 2.65 sf x 10 Rows = 2,735.1 cf Chamber Storage

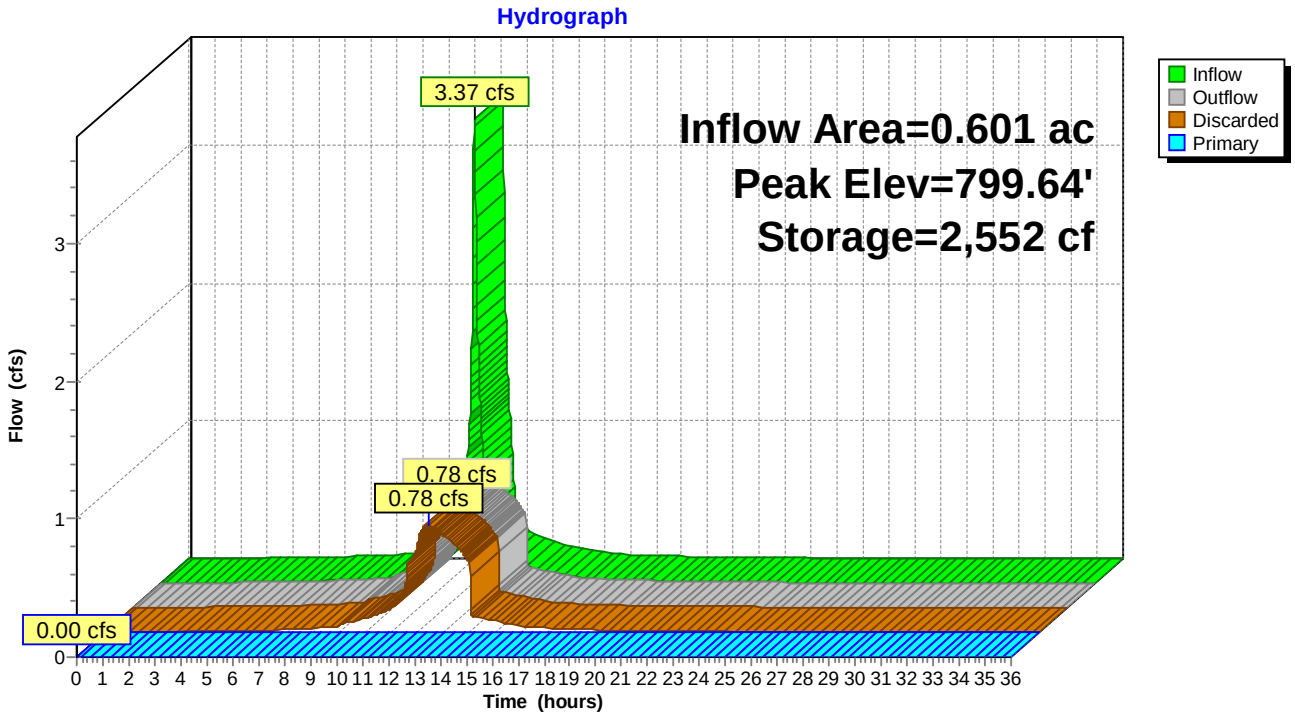
9,095.4 cf Field - 2,735.1 cf Chambers = 6,360.3 cf Stone x 40.0% Voids = 2,544.1 cf Stone Storage

Chamber Storage + Stone Storage = 5,279.2 cf = 0.121 af
Overall Storage Efficiency = 58.0%
Overall System Size = 105.25' x 34.00' x 2.54'

100 Chambers
336.9 cy Field
235.6 cy Stone



Pond 30P: Subsurface Infiltrator



Summary for Pond 50P: Southeast Bioretention Area

Inflow Area = 0.059 ac, 83.08% Impervious, Inflow Depth = 5.38" for 25-Year event
Inflow = 0.34 cfs @ 12.08 hrs, Volume= 0.026 af
Outflow = 0.34 cfs @ 12.09 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.5 min
Discarded = 0.05 cfs @ 12.09 hrs, Volume= 0.020 af
Primary = 0.29 cfs @ 12.09 hrs, Volume= 0.006 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 801.56' @ 12.09 hrs Surf.Area= 203 sf Storage= 87 cf

Plug-Flow detention time= 7.6 min calculated for 0.026 af (100% of inflow)
Center-of-Mass det. time= 7.6 min (775.8 - 768.2)

Volume	Invert	Avail.Storage	Storage Description
#1	801.00'	196 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

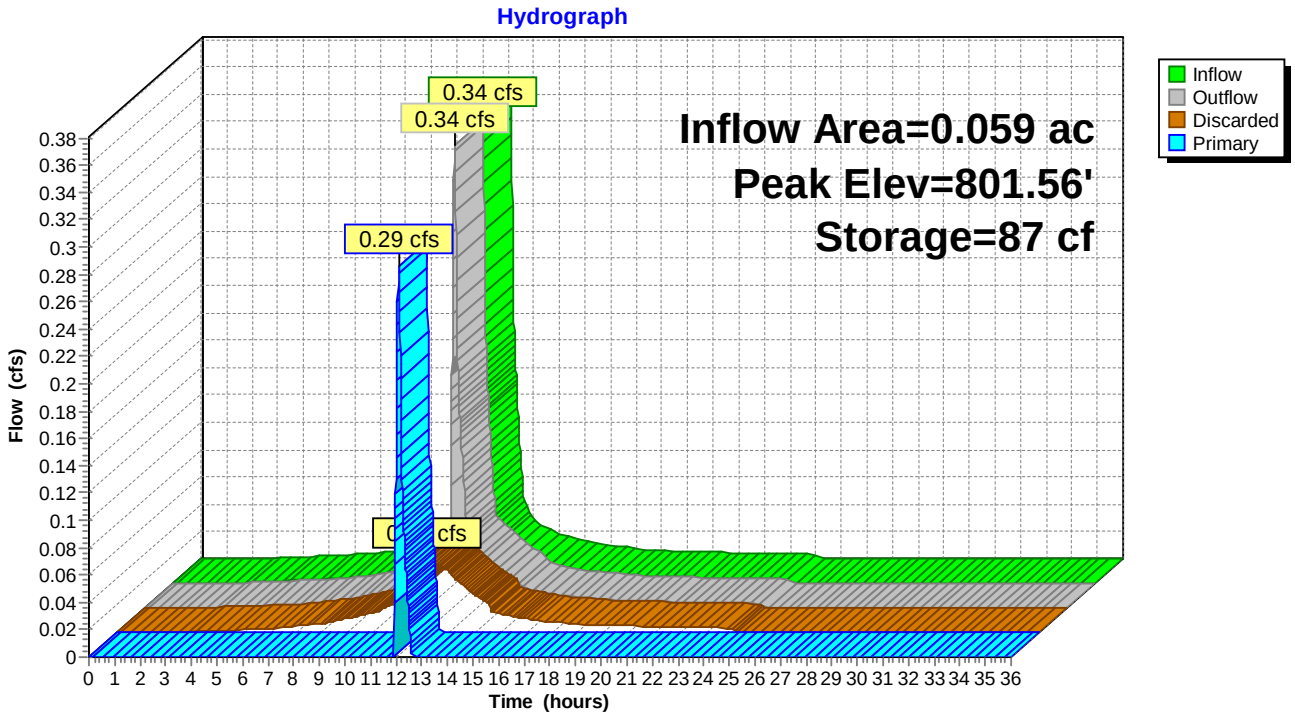
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.00	112	43.0	0	0	112
802.00	294	69.0	196	196	350

Device	Routing	Invert	Outlet Devices
#1	Primary	799.10'	**10.0" Round Culvert** L= 6.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.10' / 799.00' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	801.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	801.00'	**8.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00' Phase-In= 0.01'

Discarded OutFlow Max=0.05 cfs @ 12.09 hrs HW=801.56' (Free Discharge)
↑└**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.29 cfs @ 12.09 hrs HW=801.56' TW=799.21' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 0.29 cfs of 3.75 cfs potential flow)
↑└**2=Orifice/Grate** (Weir Controls 0.29 cfs @ 0.79 fps)

Pond 50P: Southeast Bioretention Area

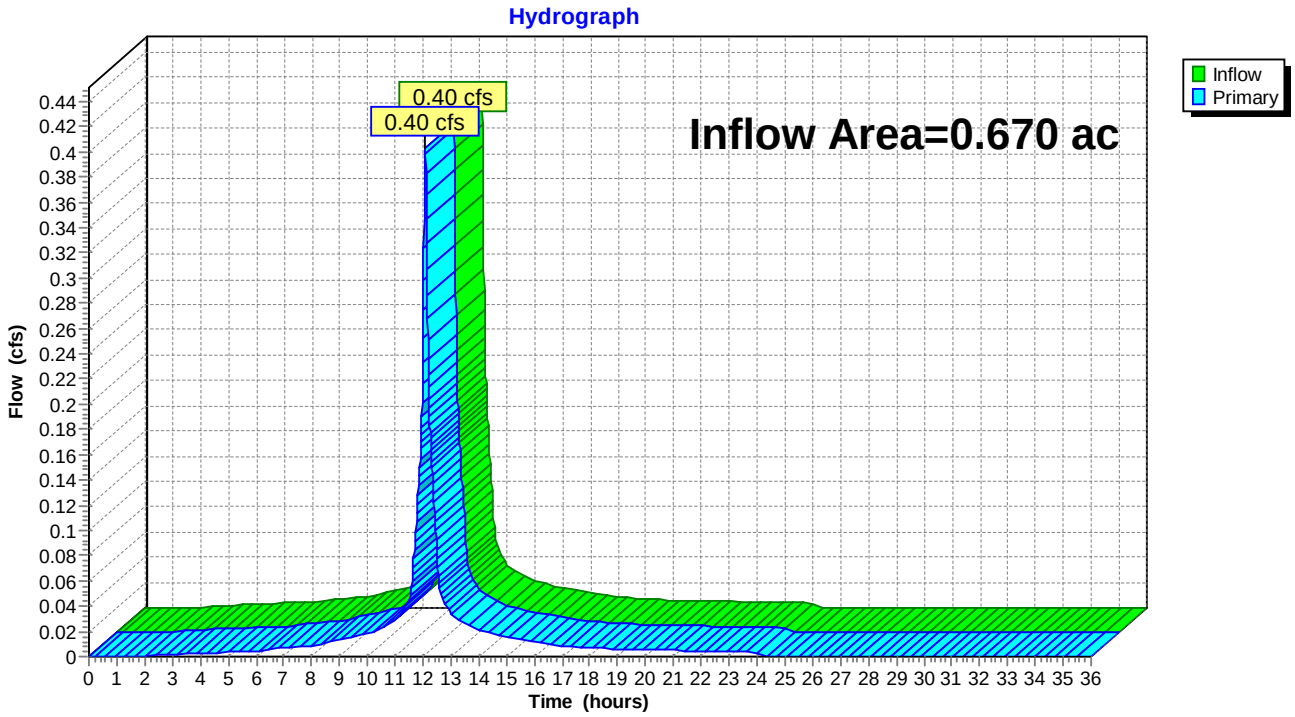


Summary for Link 10L: Mechanic Street

Inflow Area = 0.670 ac, 88.78% Impervious, Inflow Depth = 0.57" for 25-Year event
Inflow = 0.40 cfs @ 12.08 hrs, Volume= 0.032 af
Primary = 0.40 cfs @ 12.08 hrs, Volume= 0.032 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

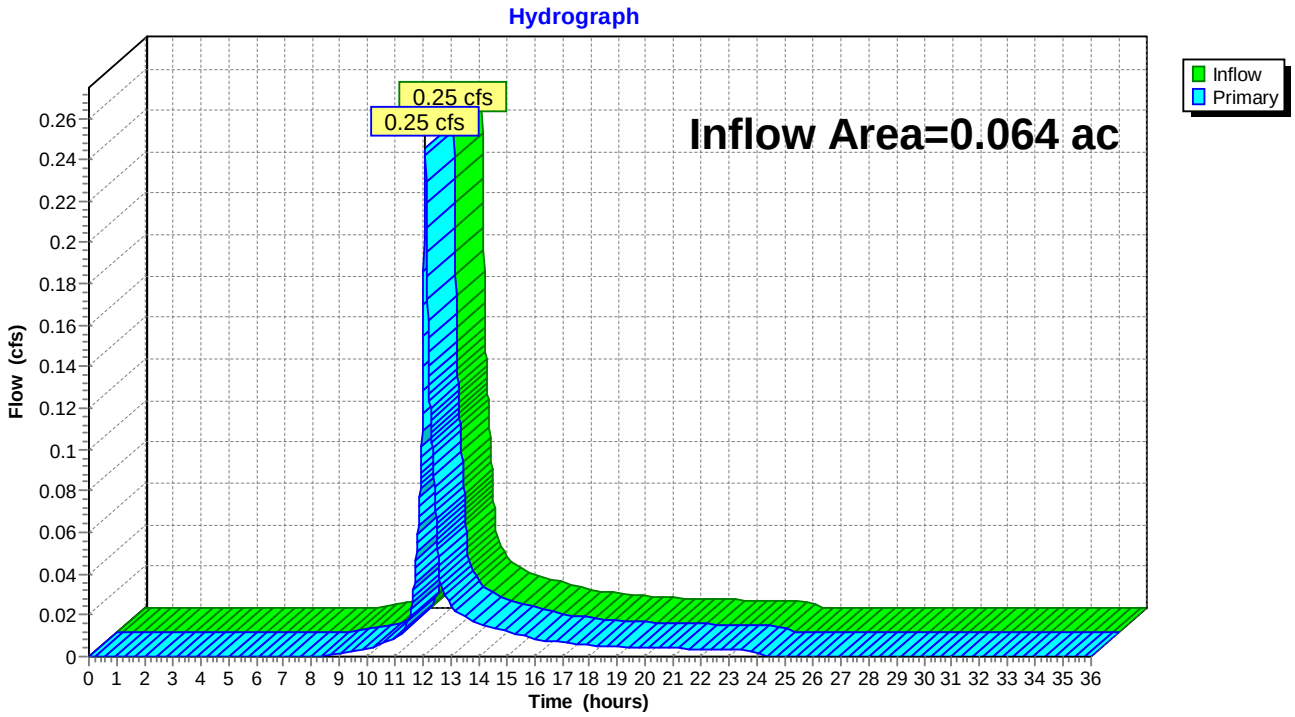


Summary for Link 20L: Off Site West

Inflow Area = 0.064 ac, 0.00% Impervious, Inflow Depth = 3.25" for 25-Year event
Inflow = 0.25 cfs @ 12.09 hrs, Volume= 0.017 af
Primary = 0.25 cfs @ 12.09 hrs, Volume= 0.017 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 20L: Off Site West



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 10S: Sheet Flow to Bioretention Runoff Area=8,095 sf 72.23% Impervious Runoff Depth=7.56"
Tc=6.0 min CN=91 Runoff=1.52 cfs 0.117 af

Subcatchment 20S: Sheet Flow Mechanic Runoff Area=6,298 sf 100.00% Impervious Runoff Depth=8.40"
Tc=6.0 min CN=98 Runoff=1.23 cfs 0.101 af

Subcatchment 30S: Sheet Flow to Bioretention Runoff Area=9,236 sf 96.10% Impervious Runoff Depth=8.28"
Tc=6.0 min CN=97 Runoff=1.79 cfs 0.146 af

Subcatchment 40S: Sheet Flow to West Runoff Area=2,802 sf 0.00% Impervious Runoff Depth=5.50"
Tc=6.0 min CN=74 Runoff=0.41 cfs 0.029 af

Subcatchment 50S: Sheet Flow to Bioretention Runoff Area=2,559 sf 83.08% Impervious Runoff Depth=7.92"
Tc=6.0 min CN=94 Runoff=0.49 cfs 0.039 af

Subcatchment 60S: Sheet Flow to Mechanic Runoff Area=2,978 sf 92.21% Impervious Runoff Depth=8.16"
Tc=6.0 min CN=96 Runoff=0.58 cfs 0.046 af

Pond 10P: Central Bioretention Area Peak Elev=802.81' Storage=200 cf Inflow=2.75 cfs 0.218 af
Discarded=0.06 cfs 0.067 af Primary=2.67 cfs 0.151 af Outflow=2.73 cfs 0.218 af

Pond 30P: Subsurface Infiltrator Peak Elev=800.44' Storage=4,417 cf Inflow=4.90 cfs 0.310 af
Discarded=0.98 cfs 0.310 af Primary=0.00 cfs 0.000 af Outflow=0.98 cfs 0.310 af

Pond 50P: Southeast Bioretention Area Peak Elev=801.58' Storage=90 cf Inflow=0.49 cfs 0.039 af
Discarded=0.05 cfs 0.027 af Primary=0.43 cfs 0.012 af Outflow=0.49 cfs 0.039 af

Link 10L: Mechanic Street Inflow=0.58 cfs 0.046 af
Primary=0.58 cfs 0.046 af

Link 20L: Off Site West Inflow=0.41 cfs 0.029 af
Primary=0.41 cfs 0.029 af

Total Runoff Area = 0.734 ac Runoff Volume = 0.479 af Average Runoff Depth = 7.84"
19.00% Pervious = 0.139 ac 81.00% Impervious = 0.594 ac

Summary for Subcatchment 10S: Sheet Flow to Bioretention

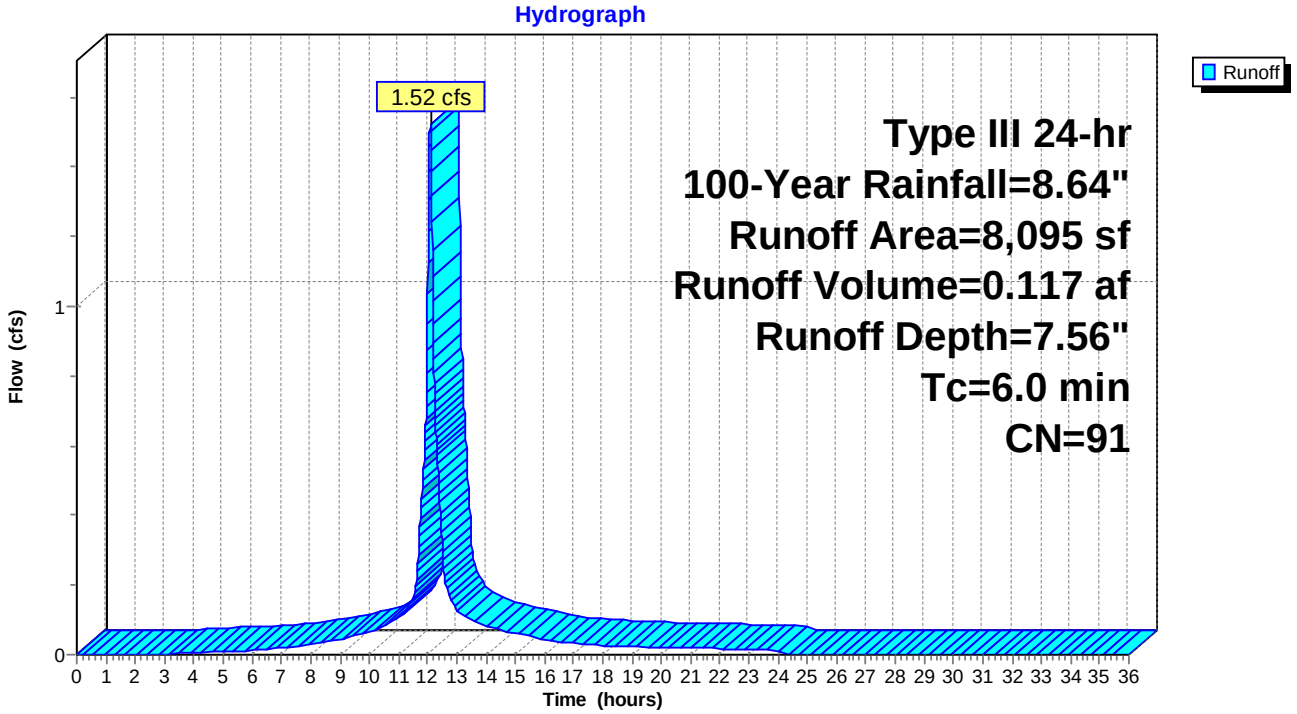
Runoff = 1.52 cfs @ 12.08 hrs, Volume= 0.117 af, Depth= 7.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
2,248	74	>75% Grass cover, Good, HSG C
5,388	98	Paved parking, HSG C
459	98	Water Surface, HSG C
8,095	91	Weighted Average
2,248		27.77% Pervious Area
5,847		72.23% Impervious Area

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

Subcatchment 10S: Sheet Flow to Bioretention



Summary for Subcatchment 20S: Sheet Flow Mechanic Street

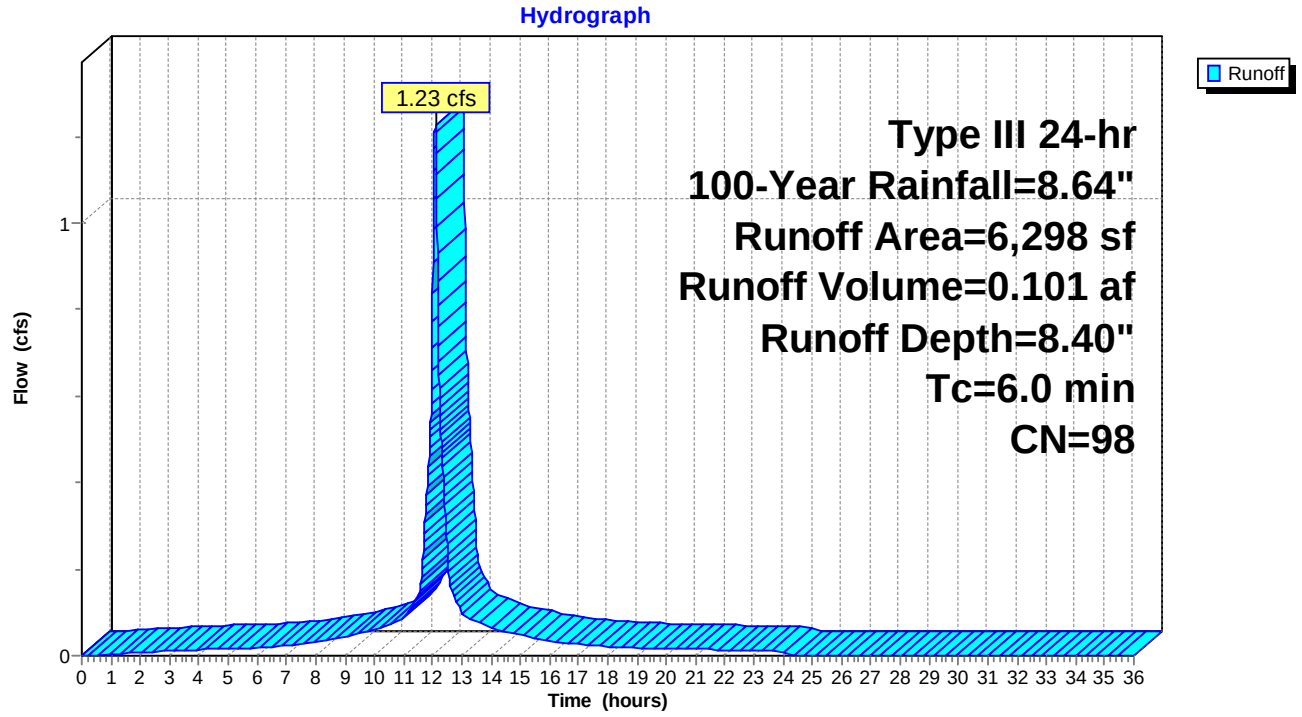
Runoff = 1.23 cfs @ 12.08 hrs, Volume= 0.101 af, Depth= 8.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
6,298	98	Paved parking, HSG C
6,298		100.00% Impervious Area

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

Subcatchment 20S: Sheet Flow Mechanic Street



Summary for Subcatchment 30S: Sheet Flow to Bioretention

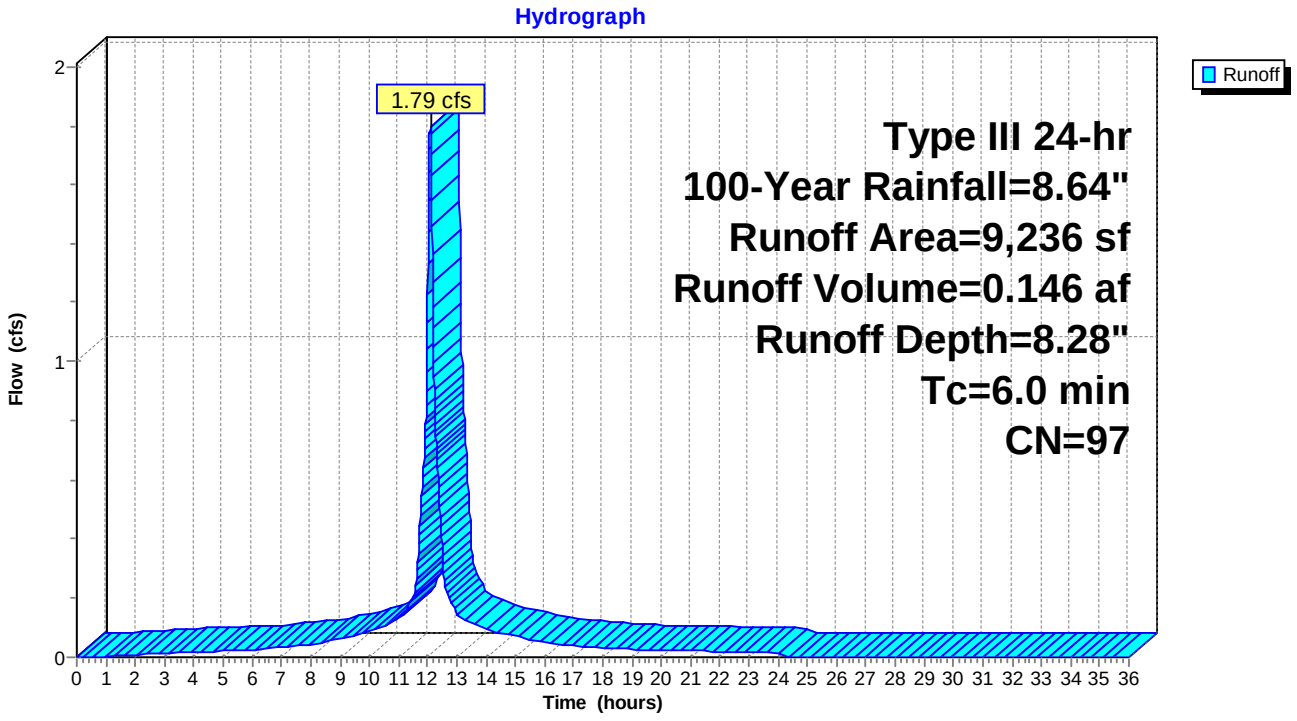
Runoff = 1.79 cfs @ 12.08 hrs, Volume= 0.146 af, Depth= 8.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
360	74	>75% Grass cover, Good, HSG C
8,876	98	Paved parking, HSG C
9,236	97	Weighted Average
360		3.90% Pervious Area
8,876		96.10% Impervious Area

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

Subcatchment 30S: Sheet Flow to Bioretention



Summary for Subcatchment 40S: Sheet Flow to West

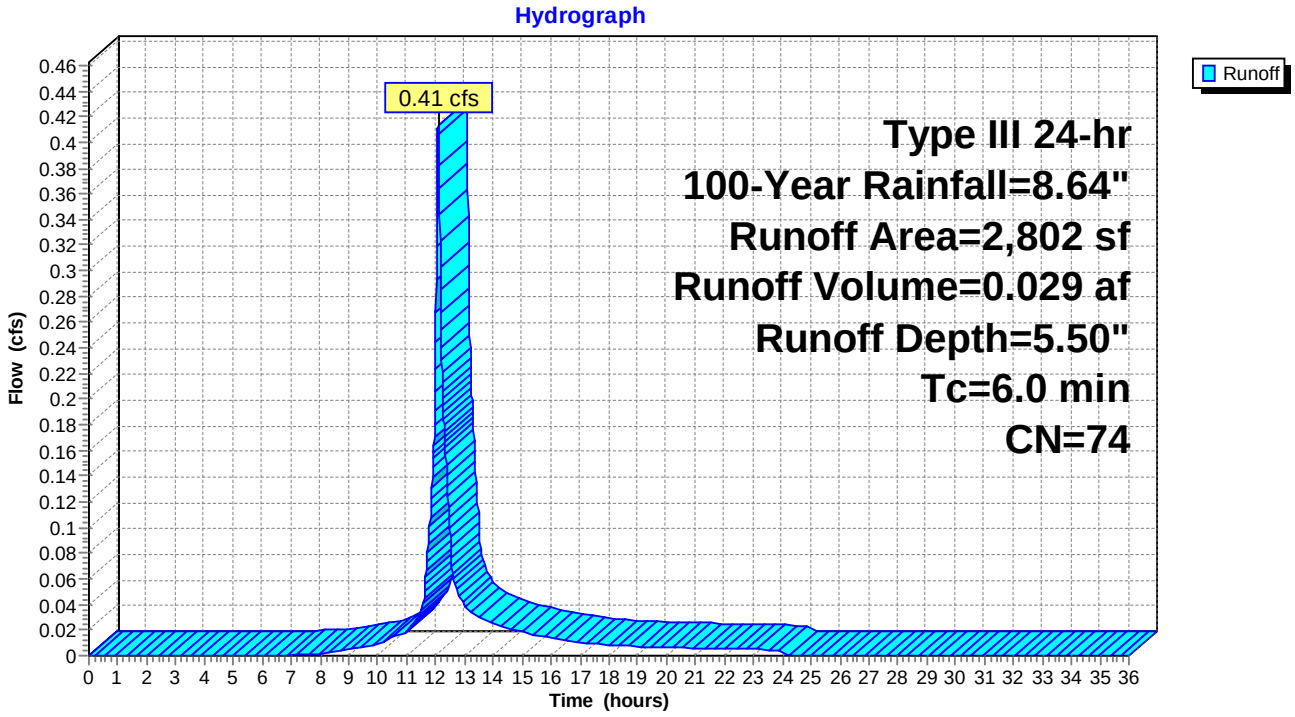
Runoff = 0.41 cfs @ 12.09 hrs, Volume= 0.029 af, Depth= 5.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
2,802	74	>75% Grass cover, Good, HSG C
2,802		100.00% Pervious Area

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

Subcatchment 40S: Sheet Flow to West



Summary for Subcatchment 50S: Sheet Flow to Bioretention Area

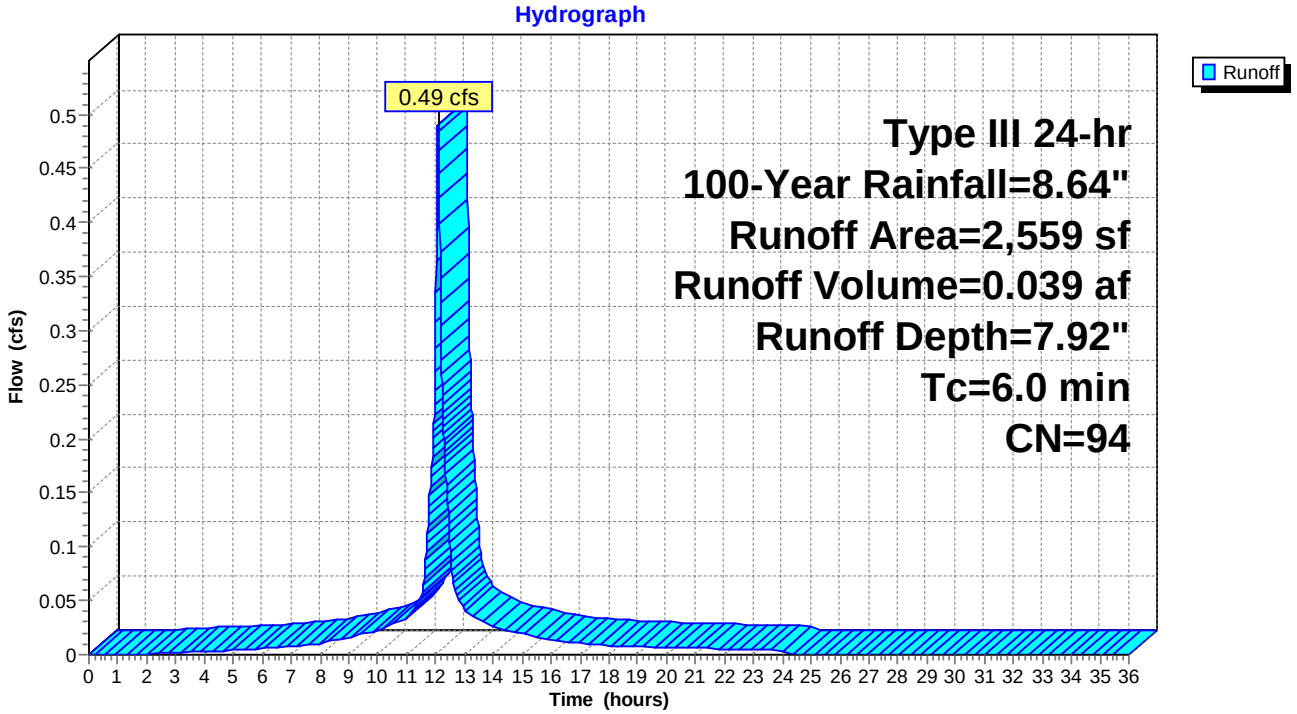
Runoff = 0.49 cfs @ 12.08 hrs, Volume= 0.039 af, Depth= 7.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
433	74	>75% Grass cover, Good, HSG C
1,832	98	Paved parking, HSG C
294	98	Water Surface, HSG C
2,559	94	Weighted Average
433		16.92% Pervious Area
2,126		83.08% Impervious Area

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

Subcatchment 50S: Sheet Flow to Bioretention Area



Summary for Subcatchment 60S: Sheet Flow to Mechanic Street

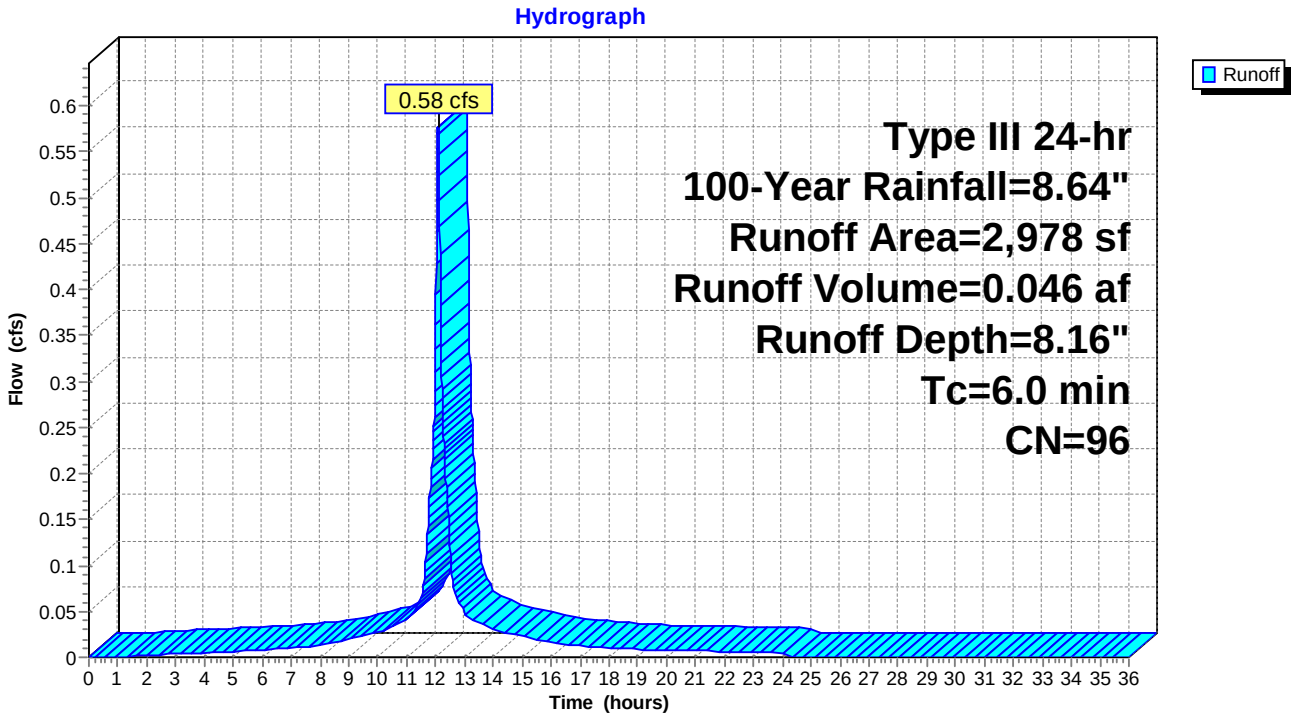
Runoff = 0.58 cfs @ 12.08 hrs, Volume= 0.046 af, Depth= 8.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.64"

Area (sf)	CN	Description
232	74	>75% Grass cover, Good, HSG C
2,746	98	Paved parking, HSG C
2,978	96	Weighted Average
232		7.79% Pervious Area
2,746		92.21% Impervious Area

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

Subcatchment 60S: Sheet Flow to Mechanic Street



Summary for Pond 10P: Central Bioretention Area

Inflow Area = 0.330 ac, 84.38% Impervious, Inflow Depth = 7.93" for 100-Year event
Inflow = 2.75 cfs @ 12.08 hrs, Volume= 0.218 af
Outflow = 2.73 cfs @ 12.09 hrs, Volume= 0.218 af, Atten= 0%, Lag= 0.5 min
Discarded = 0.06 cfs @ 12.09 hrs, Volume= 0.067 af
Primary = 2.67 cfs @ 12.09 hrs, Volume= 0.151 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 802.81' @ 12.09 hrs Surf.Area= 440 sf Storage= 200 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 12.1 min (768.6 - 756.5)

Volume	Invert	Avail.Storage	Storage Description
#1	802.00'	296 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

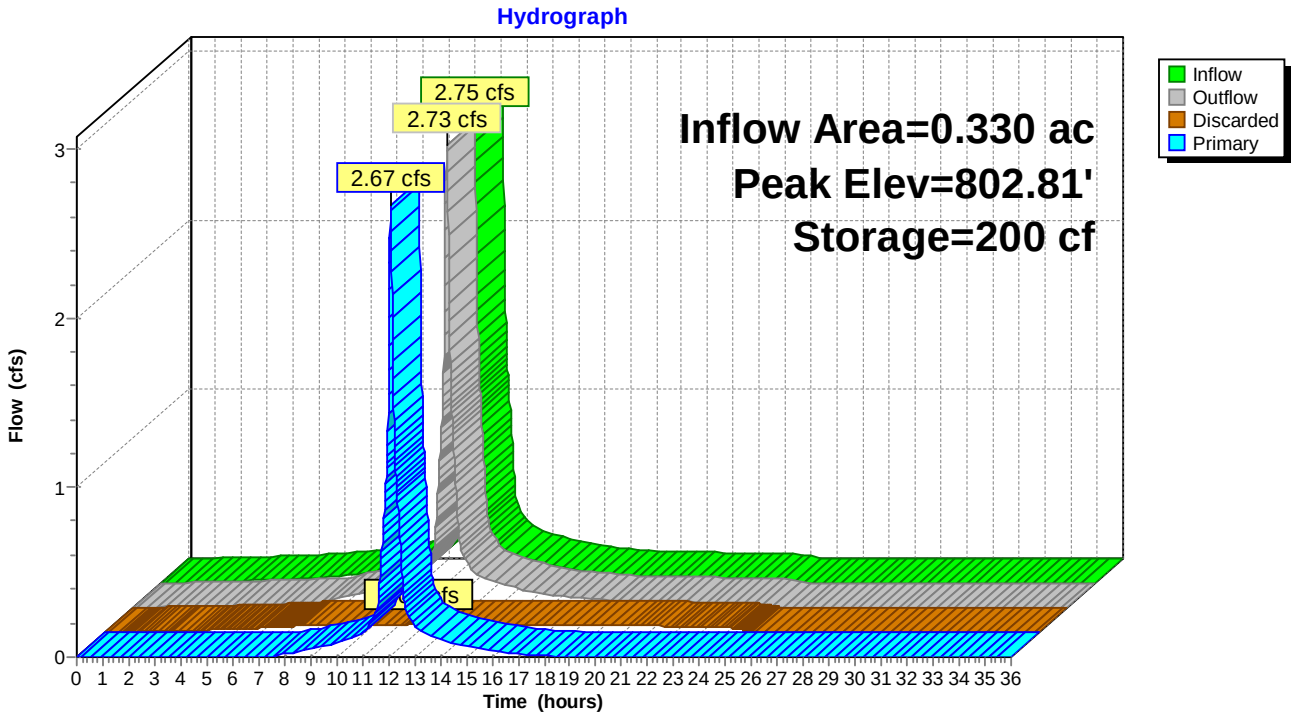
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
802.00	96	65.0	0	0	96
803.00	560	158.0	296	296	1,750

Device	Routing	Invert	Outlet Devices
#1	Primary	799.40'	**10.0" Round Culvert** L= 19.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.40' / 799.00' S= 0.0211 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	802.55'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	802.00'	**5.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00'

Discarded OutFlow Max=0.06 cfs @ 12.09 hrs HW=802.81' (Free Discharge)
↑└**3=Exfiltration** (Controls 0.06 cfs)

Primary OutFlow Max=2.67 cfs @ 12.09 hrs HW=802.81' TW=799.58' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 2.67 cfs of 4.54 cfs potential flow)
↑└**2=Orifice/Grate** (Weir Controls 2.67 cfs @ 1.66 fps)

Pond 10P: Central Bioretention Area



Summary for Pond 30P: Subsurface Infiltrator

Inflow Area = 0.601 ac, 88.39% Impervious, Inflow Depth = 6.18" for 100-Year event
Inflow = 4.90 cfs @ 12.09 hrs, Volume= 0.310 af
Outflow = 0.98 cfs @ 12.50 hrs, Volume= 0.310 af, Atten= 80%, Lag= 24.6 min
Discarded = 0.98 cfs @ 12.50 hrs, Volume= 0.310 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 800.44' @ 12.50 hrs Surf.Area= 3,579 sf Storage= 4,417 cf

Plug-Flow detention time= 33.4 min calculated for 0.310 af (100% of inflow)
Center-of-Mass det. time= 33.4 min (773.5 - 740.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	798.50'	2,544 cf	**34.00'W x 105.25'L x 2.54'H Field A** 9,095 cf Overall - 2,735 cf Embedded = 6,360 cf x 40.0% Voids
#2A	799.00'	2,735 cf	**Cultec R-150XLHD** x 100 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 10 rows
		5,279 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 3	799.00'	**12.0" Round Culvert** L= 25.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.00' / 798.40' S= 0.0240 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf
#2	Discarded	798.50'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 796.50' Phase-In= 0.01'
#3	Primary	801.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.98 cfs @ 12.50 hrs HW=800.44' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.98 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=798.50' TW=0.00' (Dynamic Tailwater)
↑—**3=Orifice/Grate** (Controls 0.00 cfs)
↑—**1=Culvert** (Controls 0.00 cfs)

Pond 30P: Subsurface Infiltrator - Chamber Wizard Field A

Chamber Model = Cultec R-150XLHD (Cultec Recharger® 150XLHD)
Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf
Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap
Row Length Adjustment= +0.75' x 2.65 sf x 10 rows

33.0" Wide + 6.0" Spacing = 39.0" C-C Row Spacing

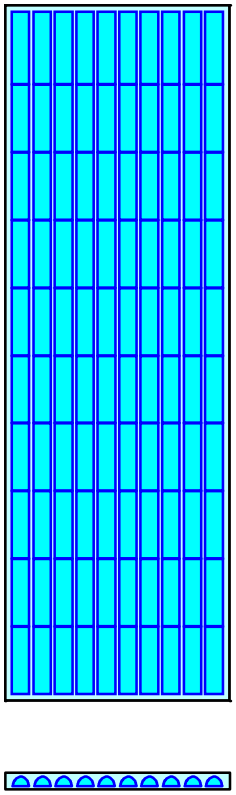
10 Chambers/Row x 10.25' Long +0.75' Row Adjustment = 103.25' Row Length +12.0" End Stone x 2 = 105.25' Base Length
10 Rows x 33.0" Wide + 6.0" Spacing x 9 + 12.0" Side Stone x 2 = 34.00' Base Width
6.0" Base + 18.5" Chamber Height + 6.0" Cover = 2.54' Field Height

100 Chambers x 27.2 cf +0.75' Row Adjustment x 2.65 sf x 10 Rows = 2,735.1 cf Chamber Storage

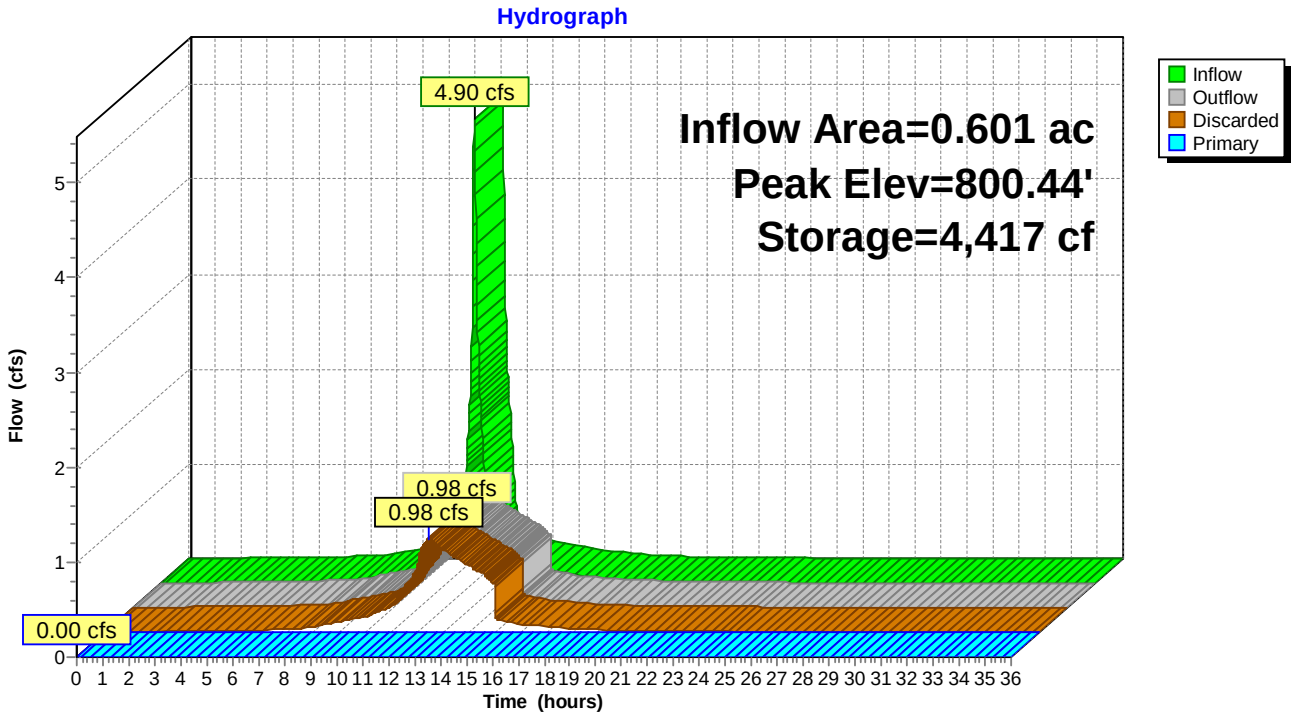
9,095.4 cf Field - 2,735.1 cf Chambers = 6,360.3 cf Stone x 40.0% Voids = 2,544.1 cf Stone Storage

Chamber Storage + Stone Storage = 5,279.2 cf = 0.121 af
Overall Storage Efficiency = 58.0%
Overall System Size = 105.25' x 34.00' x 2.54'

100 Chambers
336.9 cy Field
235.6 cy Stone



Pond 30P: Subsurface Infiltrator



Summary for Pond 50P: Southeast Bioretention Area

Inflow Area = 0.059 ac, 83.08% Impervious, Inflow Depth = 7.92" for 100-Year event
Inflow = 0.49 cfs @ 12.08 hrs, Volume= 0.039 af
Outflow = 0.49 cfs @ 12.09 hrs, Volume= 0.039 af, Atten= 0%, Lag= 0.4 min
Discarded = 0.05 cfs @ 12.09 hrs, Volume= 0.027 af
Primary = 0.43 cfs @ 12.09 hrs, Volume= 0.012 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 801.58' @ 12.09 hrs Surf.Area= 206 sf Storage= 90 cf

Plug-Flow detention time= 7.9 min calculated for 0.039 af (100% of inflow)
Center-of-Mass det. time= 7.9 min (767.5 - 759.6)

Volume	Invert	Avail.Storage	Storage Description
#1	801.00'	196 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

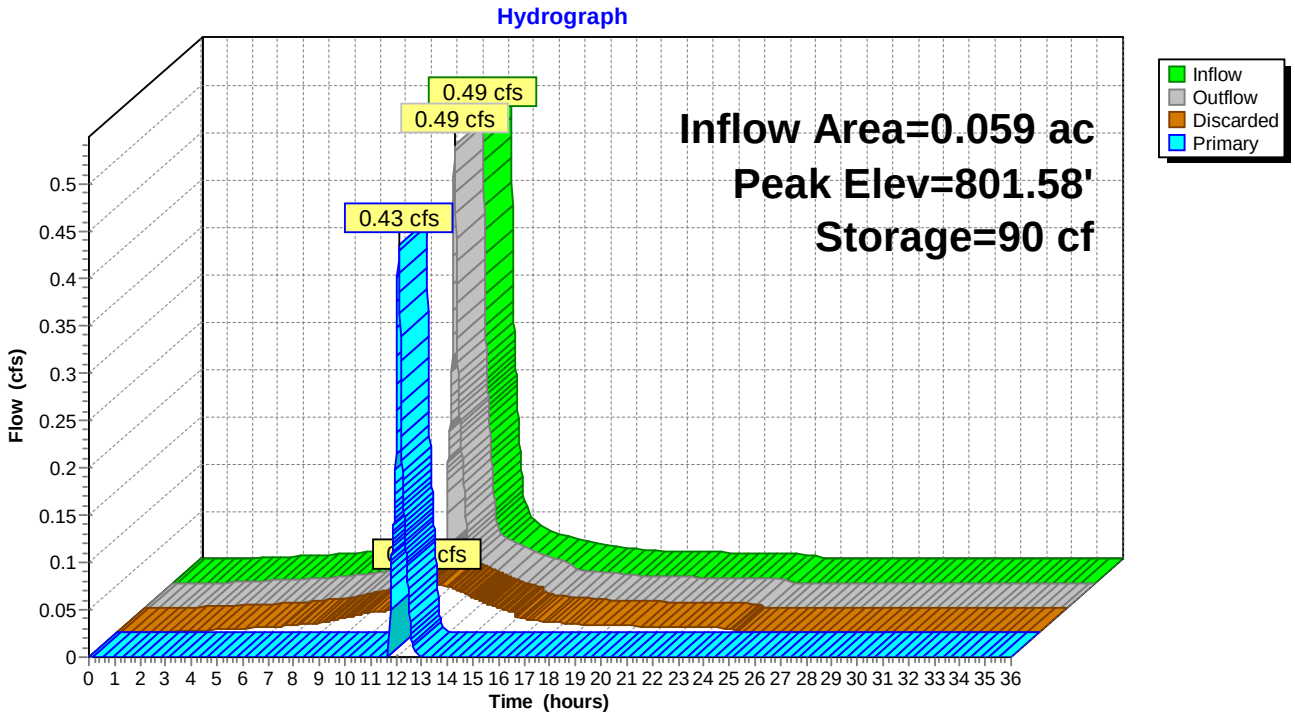
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
801.00	112	43.0	0	0	112
802.00	294	69.0	196	196	350

Device	Routing	Invert	Outlet Devices
#1	Primary	799.10'	**10.0" Round Culvert** L= 6.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 799.10' / 799.00' S= 0.0167 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Device 1	801.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	801.00'	**8.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 800.00' Phase-In= 0.01'

Discarded OutFlow Max=0.05 cfs @ 12.09 hrs HW=801.58' (Free Discharge)
↑—**3=Exfiltration** (Controls 0.05 cfs)

Primary OutFlow Max=0.43 cfs @ 12.09 hrs HW=801.58' TW=799.57' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.43 cfs of 3.72 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 0.43 cfs @ 0.90 fps)

Pond 50P: Southeast Bioretention Area

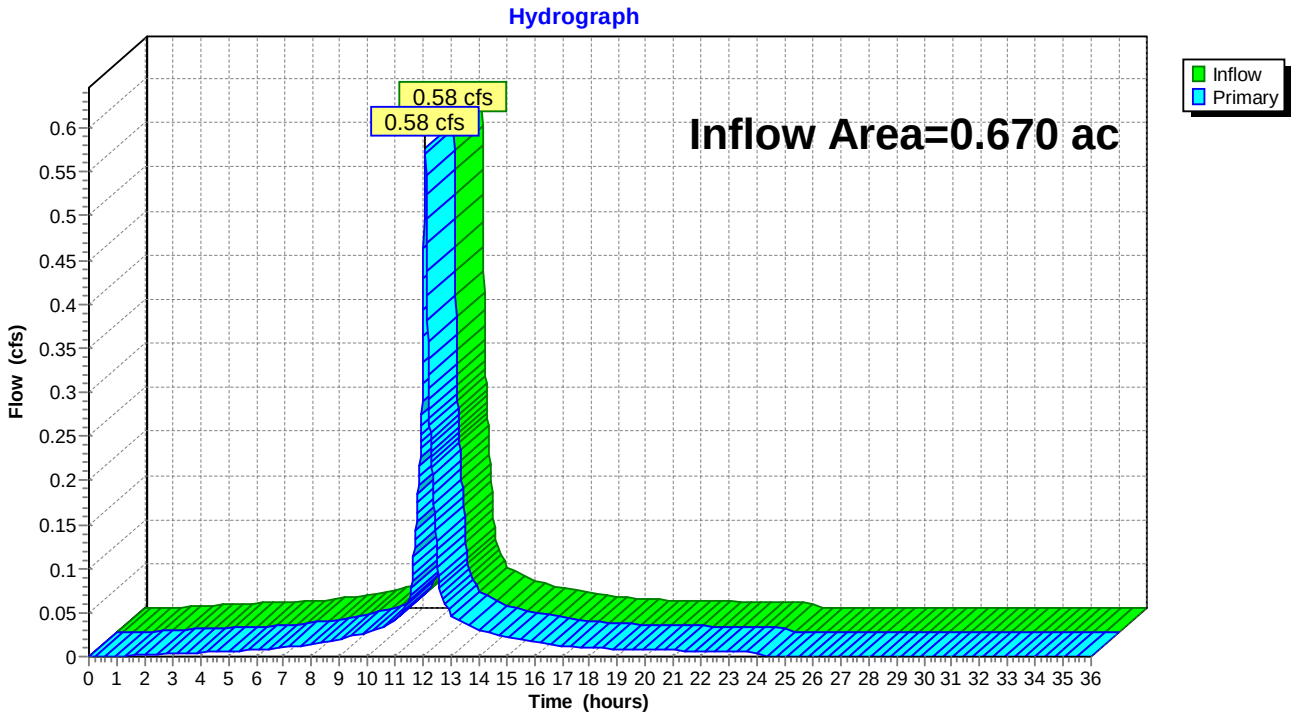


Summary for Link 10L: Mechanic Street

Inflow Area = 0.670 ac, 88.78% Impervious, Inflow Depth = 0.83" for 100-Year event
Inflow = 0.58 cfs @ 12.08 hrs, Volume= 0.046 af
Primary = 0.58 cfs @ 12.08 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 10L: Mechanic Street

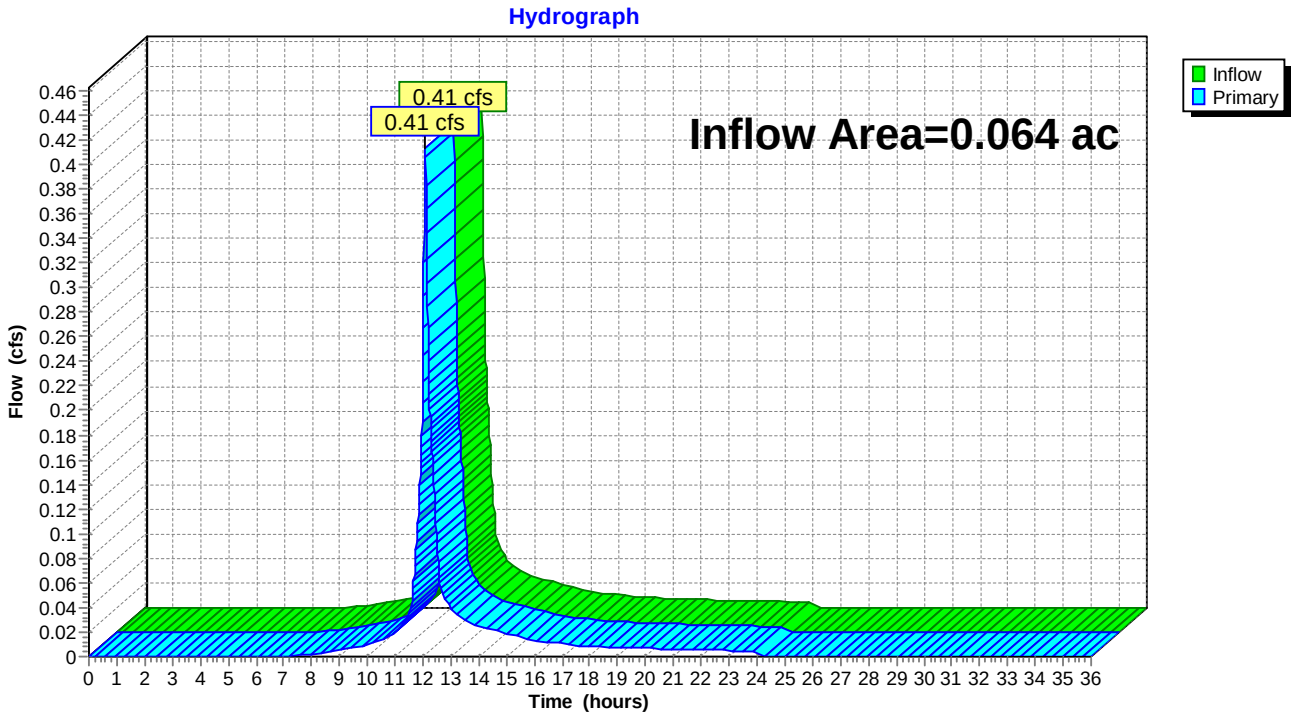


Summary for Link 20L: Off Site West

Inflow Area = 0.064 ac, 0.00% Impervious, Inflow Depth = 5.50" for 100-Year event
Inflow = 0.41 cfs @ 12.09 hrs, Volume= 0.029 af
Primary = 0.41 cfs @ 12.09 hrs, Volume= 0.029 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

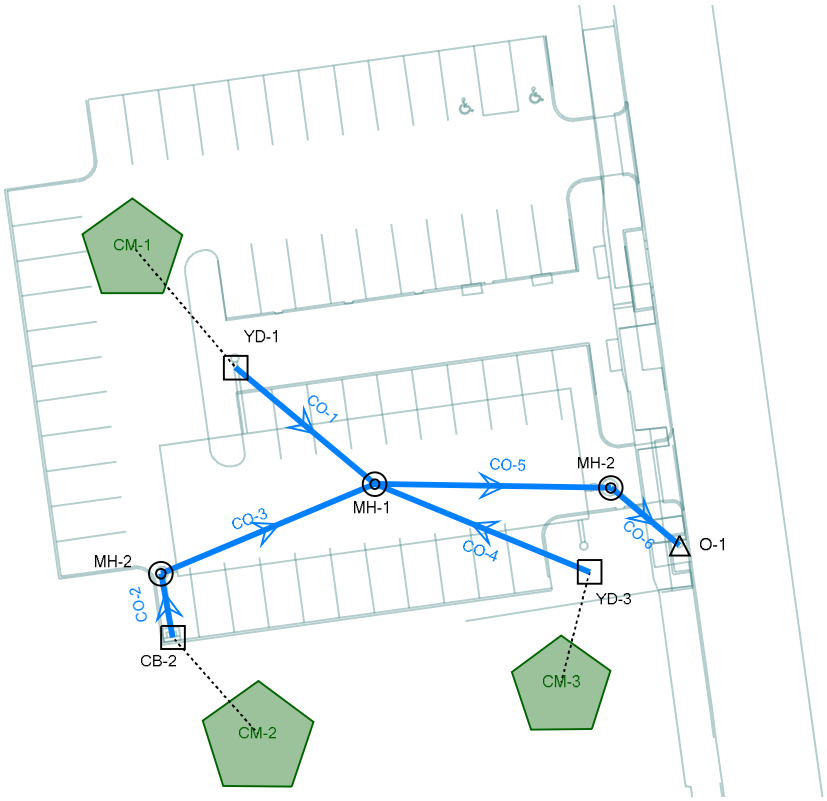
Link 20L: Off Site West



Appendix D

Storm Sewer Pipe Sizing Calculations

Scenario: 25-YR



FlexTable: Catchment Table

Label	Area (User Defined) (ft^2)	Runoff Coefficient (Rational)	Time of Concentration (min)	Outflow Element	Catchment Intensity (in/h)	Catchment Rational Flow (cfs)
CM-1	14,382.928	0.768	5.000	YD-1	8.240	2.11
CM-2	9,236.000	0.873	5.000	CB-2	8.240	1.54
CM-3	2,559.000	0.730	5.000	YD-3	8.240	0.36

FlexTable: Catch Basin Table

Label	Elevation (Rim) (ft)	Inlet Drainage Area (ft^2)	Inlet C	Local Flow Time (min)	Flow (Captured) (cfs)	Inlet Location	Elevation (Invert) (ft)	Elevation (Invert Out) (ft)
CB-2	801.90	9,236.000	0.873	5.000	1.54	In Sag	795.30	799.30
YD-1	802.55	14,382.928	0.768	5.000	2.11	In Sag	799.40	799.40
YD-3	801.50	2,559.000	0.730	5.000	0.36	In Sag	799.10	799.10

FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Manning's n	Material	System CA (ft²)	System Intensity (in/h)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Capacity (Design) (cfs)	Flow / Capacity (Design) (%)
CO-1	YD-1	MH-1	799.40	799.00	19.0	0.021	10.0	0.012	Corrugated HDPE (Smooth Interior)	11,051.653	8.240	2.11	6.63	800.05	799.85	3.44	61.2
CO-2	CB-2	MH-2	799.30	799.15	13.0	0.012	12.0	0.012	Corrugated HDPE (Smooth Interior)	8,060.257	8.240	1.54	4.89	799.83	799.84	4.15	37.1
CO-3	MH-2	MH-1	799.05	799.00	3.0	0.017	12.0	0.012	Corrugated HDPE (Smooth Interior)	8,060.257	8.219	1.53	5.59	799.84	799.85	4.98	30.8
CO-4	YD-3	MH-1	799.10	799.00	6.0	0.017	10.0	0.012	Corrugated HDPE (Smooth Interior)	1,867.046	8.240	0.36	3.75	799.85	799.85	3.06	11.6
CO-5	MH-1	MH-2	799.00	798.90	5.0	0.020	12.0	0.012	Corrugated HDPE (Smooth Interior)	20,978.956	8.214	3.99	7.58	799.85	799.64	5.46	73.1
CO-6	MH-2	O-1	798.90	798.50	20.0	0.020	12.0	0.012	Corrugated HDPE (Smooth Interior)	20,978.956	8.209	3.99	7.58	799.75	799.18	5.46	73.0

FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Flow (Total Out) (cfs)	Local Flow Time (min)	Elevation (Invert) (ft)	Elevation (Invert Out) (ft)
MH-1	803.00	3.99	5.000	799.00	799.00
MH-2	802.10	1.53	5.000	799.05	799.05
MH-2	802.70	3.99	5.000	798.90	798.90

Appendix E

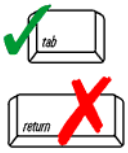
Stormwater Management Checklist

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.

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

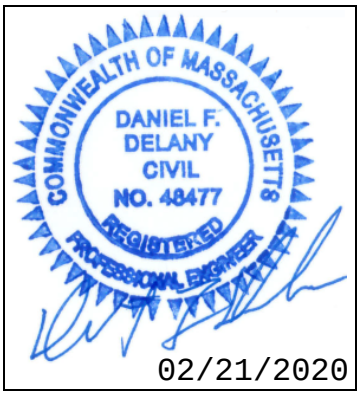
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



Signature and Date

Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

- [x] 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
- [x] Use of "country drainage" versus curb and gutter conveyance and pipe
- [x] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [ ] Grass Channel
- [ ] Green Roof
- [x] Other (describe): Subsurface Infiltration System

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☐ An Illicit Discharge Compliance Statement is attached;

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

Appendix F

BMP Sizing Calculations

Bioretention Basin 10P

Objective: Size Best Management Practice (BMP) in accordance with Standards 3 and 4 of the MA Stormwater Handbook. BMP shall be sized to infiltrate the required recharge volume (Standard 3) and provide treatment for the required water quality volume (Standard 4).

1) Calculate Drawdown Time (Standard 3)

T_d=Storage Volume / (K*(1'/12")*Bottom Area)= 49 hours

Storage Volume	105	cf	(from HydroCAD, lowest orifice ele. 802.55)
K (sat. hydraulic conductivity)	0.27	in/hr	(Rawls Rate C Table 2.3.3 of MA Stormwater Handbook)
Bottom Area	96	sf	(from HydroCAD)

49 < 72 hrs

2) Calculate Pretreatment Water Quality Volume (WQv) (Standard 4)

V_{WQ} =(D_{WQ}/ 12)*(A_{IMP})= 97 cf

D_{WQ} (water quality depth)	0.1	in	(0.1" for pretreatment BMP)
A_{IMP} (impervious area)	11,686	sf	

3) Size BMP to store required volume

V_{WQ}= 97 cf

R_V= 0 cf

Actual Storage= 105 cf

105 > 97

Bioretention Basin 50P

Objective: Size Best Management Practice (BMP) in accordance with Standards 3 and 4 of the MA Stormwater Handbook. BMP shall be sized to infiltrate the required recharge volume (Standard 3) and provide treatment for the required water quality volume (Standard 4).

1) Calculate Drawdown Time (Standard 3)

T_d=Storage Volume / (K*(1'/12")*Bottom Area)= 30 hours

Storage Volume	75	cf (from HydroCAD, lowest orifice ele. 801.50)
K (sat. hydraulic conductivity)	0.27	in/hr (Rawls Rate C Table 2.3.3 of MA Stormwater Handbook)
Bottom Area	112	sf (from HydroCAD)

30 < 72 hrs

2) Calculate Pretreatment Water Quality Volume (WQv) (Standard 4)

V_{WQ} =(D_{WQ}/ 12)*(A_{IMP})= 15 cf

D_{WQ} (water quality depth)	0.1	in	(0.1" for pretreatment BMP)
A_{IMP} (impervious area)	1,832	sf	

3) Size BMP to store required volume

V_{WQ}= 15 cf

R_V= 0 cf

Actual Storage= 75 cf

75 > 15

Subsurface Infiltration System 50P

Objective: Size Best Management Practice (BMP) in accordance with Standards 3 and 4 of the MA Stormwater Handbook. BMP shall be sized to infiltrate the required recharge volume (Standard 3) and provide treatment for the required water quality volume (Standard 4).

1) Calculate Required Recharge Volume (Standard 3)

$Rv = (F/12)*(A_{IMP})$ 467 cf

F (target depth factor)	0.25	in (soil group C, Table 2.3.2 of MA Stormwater Handbook)
A_{IMP} (impervious area)	22,394	sf

2) Calculate Drawdown Time (Standard 3)

T_d=Storage Volume / (K*(1'/12")*Bottom Area)= 65 hours

Storage Volume	5,136	cf (from HydroCAD ele. 801.00)
K (sat. hydraulic conductivity)	0.27	in/hr (Rawls Rate C, Table 2.3.3 of MA Stormwater Handbook)
Bottom Area	3,534	sf (from HydroCAD)

65 < 72 hrs

3) Calculate Water Quality Volume (WQv) (Standard 4)

$V_{WQ} = (D_{WQ}/12)*(A_{IMP})$= 933 cf

D_{WQ} (water quality depth)	0.5	in (1" for LUHPPL, Zone II, or critical area, 0.5" other)
A_{IMP} (impervious area)	22,394	sf (double contributing area, equivalent of 1" of water quality depth)

4) Size BMP to store greater of V_{WQ} and R_V

V_{WQ}=	933	cf
R_V=	467	cf
Actual Storage=	5,136	cf

5,136 > 933

Stage-Area-Storage for Pond 10P: Central Bioretention Area

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
802.00	96	0
802.01	99	1
802.02	102	2
802.03	104	3
802.04	107	4
802.05	110	5
802.06	113	6
802.07	116	7
802.08	119	9
802.09	122	10
802.10	125	11
802.11	128	12
802.12	131	14
802.13	135	15
802.14	138	16
802.15	141	18
802.16	144	19
802.17	148	21
802.18	151	22
802.19	155	24
802.20	158	25
802.21	162	27
802.22	165	28
802.23	169	30
802.24	172	32
802.25	176	33
802.26	180	35
802.27	183	37
802.28	187	39
802.29	191	41
802.30	195	43
802.31	199	45
802.32	203	47
802.33	207	49
802.34	211	51
802.35	215	53
802.36	219	55
802.37	223	57
802.38	227	60
802.39	231	62
802.40	235	64
802.41	240	67
802.42	244	69
802.43	248	71
802.44	253	74
802.45	257	77
802.46	262	79
802.47	266	82
802.48	271	84
802.49	275	87
802.50	280	90
802.51	285	93
802.52	289	96
802.53	294	99
802.54	299	102
802.55	304	105
802.56	308	108
802.57	313	111
802.58	318	114
802.59	323	117
802.60	328	120
802.61	333	124
802.62	338	127
802.63	344	130
802.64	349	134
802.65	354	137
802.66	359	141
802.67	364	145
802.68	370	148
802.69	375	152
802.70	380	156
802.71	386	160
802.72	391	163
802.73	397	167
802.74	402	171
802.75	408	175
802.76	414	180
802.77	419	184
802.78	425	188
802.79	431	192
802.80	436	197
802.81	442	201
802.82	448	205
802.83	454	210
802.84	460	214
802.85	466	219
802.86	472	224
802.87	478	229
802.88	484	233
802.89	490	238
802.90	496	243
802.91	502	248
802.92	509	253
802.93	515	258
802.94	521	264
802.95	528	269
802.96	534	274
802.97	540	279
802.98	547	285
802.99	553	290
803.00	**560**	**296**

Stage-Area-Storage for Pond 30P: Subsurface Infiltrator

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
798.50	**3,534**	0	799.04	3,534	823
798.51	3,534	14	799.05	3,534	852
798.52	3,534	28	799.06	3,534	881
798.53	3,534	42	799.07	3,534	910
798.54	3,534	57	799.08	3,534	939
798.55	3,534	71	799.09	3,534	968
798.56	3,534	85	799.10	3,534	996
798.57	3,534	99	799.11	3,534	1,025
798.58	3,534	113	799.12	3,534	1,054
798.59	3,534	127	799.13	3,534	1,082
798.60	3,534	141	799.14	3,534	1,111
798.61	3,534	156	799.15	3,534	1,139
798.62	3,534	170	799.16	3,534	1,168
798.63	3,534	184	799.17	3,534	1,196
798.64	3,534	198	799.18	3,534	1,224
798.65	3,534	212	799.19	3,534	1,253
798.66	3,534	226	799.20	3,534	1,281
798.67	3,534	240	799.21	3,534	1,309
798.68	3,534	254	799.22	3,534	1,338
798.69	3,534	269	799.23	3,534	1,366
798.70	3,534	283	799.24	3,534	1,394
798.71	3,534	297	799.25	3,534	1,422
798.72	3,534	311	799.26	3,534	1,450
798.73	3,534	325	799.27	3,534	1,479
798.74	3,534	339	799.28	3,534	1,507
798.75	3,534	353	799.29	3,534	1,535
798.76	3,534	368	799.30	3,534	1,563
798.77	3,534	382	799.31	3,534	1,591
798.78	3,534	396	799.32	3,534	1,619
798.79	3,534	410	799.33	3,534	1,647
798.80	3,534	424	799.34	3,534	1,675
798.81	3,534	438	799.35	3,534	1,704
798.82	3,534	452	799.36	3,534	1,732
798.83	3,534	467	799.37	3,534	1,760
798.84	3,534	481	799.38	3,534	1,788
798.85	3,534	495	799.39	3,534	1,816
798.86	3,534	509	799.40	3,534	1,843
798.87	3,534	523	799.41	3,534	1,871
798.88	3,534	537	799.42	3,534	1,899
798.89	3,534	551	799.43	3,534	1,927
798.90	3,534	565	799.44	3,534	1,955
798.91	3,534	580	799.45	3,534	1,983
798.92	3,534	594	799.46	3,534	2,011
798.93	3,534	608	799.47	3,534	2,038
798.94	3,534	622	799.48	3,534	2,066
798.95	3,534	636	799.49	3,534	2,094
798.96	3,534	650	799.50	3,534	2,121
798.97	3,534	664	799.51	3,534	2,149
798.98	3,534	679	799.52	3,534	2,177
798.99	3,534	693	799.53	3,534	2,204
799.00	3,534	707	799.54	3,534	2,232
799.01	3,534	736	799.55	3,534	2,259
799.02	3,534	765	799.56	3,534	2,286
799.03	3,534	794	799.57	3,534	2,314

Stage-Area-Storage for Pond 30P: Subsurface Infiltrator (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
799.58	3,534	2,341	800.12	3,534	3,716
799.59	3,534	2,368	800.13	3,534	3,739
799.60	3,534	2,396	800.14	3,534	3,761
799.61	3,534	2,423	800.15	3,534	3,784
799.62	3,534	2,450	800.16	3,534	3,806
799.63	3,534	2,477	800.17	3,534	3,828
799.64	3,534	2,504	800.18	3,534	3,850
799.65	3,534	2,531	800.19	3,534	3,872
799.66	3,534	2,558	800.20	3,534	3,894
799.67	3,534	2,585	800.21	3,534	3,915
799.68	3,534	2,612	800.22	3,534	3,936
799.69	3,534	2,639	800.23	3,534	3,957
799.70	3,534	2,665	800.24	3,534	3,978
799.71	3,534	2,692	800.25	3,534	3,999
799.72	3,534	2,718	800.26	3,534	4,020
799.73	3,534	2,745	800.27	3,534	4,040
799.74	3,534	2,771	800.28	3,534	4,060
799.75	3,534	2,798	800.29	3,534	4,079
799.76	3,534	2,824	800.30	3,534	4,098
799.77	3,534	2,850	800.31	3,534	4,117
799.78	3,534	2,877	800.32	3,534	4,136
799.79	3,534	2,903	800.33	3,534	4,154
799.80	3,534	2,929	800.34	3,534	4,172
799.81	3,534	2,955	800.35	3,534	4,190
799.82	3,534	2,981	800.36	3,534	4,208
799.83	3,534	3,007	800.37	3,534	4,225
799.84	3,534	3,032	800.38	3,534	4,242
799.85	3,534	3,058	800.39	3,534	4,259
799.86	3,534	3,084	800.40	3,534	4,275
799.87	3,534	3,109	800.41	3,534	4,291
799.88	3,534	3,135	800.42	3,534	4,307
799.89	3,534	3,160	800.43	3,534	4,323
799.90	3,534	3,185	800.44	3,534	4,339
799.91	3,534	3,210	800.45	3,534	4,354
799.92	3,534	3,236	800.46	3,534	4,370
799.93	3,534	3,261	800.47	3,534	4,385
799.94	3,534	3,285	800.48	3,534	4,400
799.95	3,534	3,310	800.49	3,534	4,415
799.96	3,534	3,335	800.50	3,534	4,430
799.97	3,534	3,360	800.51	3,534	4,444
799.98	3,534	3,384	800.52	3,534	4,458
799.99	3,534	3,409	800.53	3,534	4,472
800.00	3,534	3,433	800.54	3,534	4,486
800.01	3,534	3,457	800.55	3,534	4,500
800.02	3,534	3,481	800.56	3,534	4,514
800.03	3,534	3,505	800.57	3,534	4,528
800.04	3,534	3,529	800.58	3,534	4,543
800.05	3,534	3,553	800.59	3,534	4,557
800.06	3,534	3,577	800.60	3,534	4,571
800.07	3,534	3,600	800.61	3,534	4,585
800.08	3,534	3,624	800.62	3,534	4,599
800.09	3,534	3,647	800.63	3,534	4,613
800.10	3,534	3,670	800.64	3,534	4,627
800.11	3,534	3,693	800.65	3,534	4,642

Stage-Area-Storage for Pond 30P: Subsurface Infiltrator (continued)

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
800.66	3,534	4,656
800.67	3,534	4,670
800.68	3,534	4,684
800.69	3,534	4,698
800.70	3,534	4,712
800.71	3,534	4,726
800.72	3,534	4,741
800.73	3,534	4,755
800.74	3,534	4,769
800.75	3,534	4,783
800.76	3,534	4,797
800.77	3,534	4,811
800.78	3,534	4,825
800.79	3,534	4,839
800.80	3,534	4,854
800.81	3,534	4,868
800.82	3,534	4,882
800.83	3,534	4,896
800.84	3,534	4,910
800.85	3,534	4,924
800.86	3,534	4,938
800.87	3,534	4,953
800.88	3,534	4,967
800.89	3,534	4,981
800.90	3,534	4,995
800.91	3,534	5,009
800.92	3,534	5,023
800.93	3,534	5,037
800.94	3,534	5,052
800.95	3,534	5,066
800.96	3,534	5,080
800.97	3,534	5,094
800.98	3,534	5,108
800.99	3,534	5,122
801.00	3,534	5,136
801.01	3,534	5,151
801.02	3,534	5,165
801.03	3,534	5,179
801.04	3,534	**5,193**

Stage-Area-Storage for Pond 50P: Southeast Bioretention Area

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
801.00	112	0
801.01	113	1
801.02	115	2
801.03	116	3
801.04	118	5
801.05	119	6
801.06	120	7
801.07	122	8
801.08	123	9
801.09	125	11
801.10	126	12
801.11	128	13
801.12	129	14
801.13	131	16
801.14	132	17
801.15	134	18
801.16	135	20
801.17	137	21
801.18	138	22
801.19	140	24
801.20	142	25
801.21	143	27
801.22	145	28
801.23	146	30
801.24	148	31
801.25	149	33
801.26	151	34
801.27	153	36
801.28	154	37
801.29	156	39
801.30	158	40
801.31	159	42
801.32	161	43
801.33	163	45
801.34	164	47
801.35	166	48
801.36	168	50
801.37	169	52
801.38	171	53
801.39	173	55
801.40	174	57
801.41	176	59
801.42	178	60
801.43	180	62
801.44	181	64
801.45	183	66
801.46	185	68
801.47	187	69
801.48	189	71
801.49	190	73
801.50	192	75
801.51	194	77
801.52	196	79
801.53	198	81
801.54	200	83
801.55	201	85
801.56	203	87
801.57	205	89
801.58	207	91
801.59	209	93
801.60	211	95
801.61	213	97
801.62	215	100
801.63	217	102
801.64	219	104
801.65	220	106
801.66	222	108
801.67	224	111
801.68	226	113
801.69	228	115
801.70	230	117
801.71	232	120
801.72	234	122
801.73	236	124
801.74	238	127
801.75	240	129
801.76	242	132
801.77	245	134
801.78	247	136
801.79	249	139
801.80	251	141
801.81	253	144
801.82	255	146
801.83	257	149
801.84	259	152
801.85	261	154
801.86	263	157
801.87	265	159
801.88	268	162
801.89	270	165
801.90	272	168
801.91	274	170
801.92	276	173
801.93	278	176
801.94	281	179
801.95	283	181
801.96	285	184
801.97	287	187
801.98	290	190
801.99	292	193
802.00	**294**	**196**

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Sizing VortSentryHS
Water Quality Volume to Discharge Rate

Q_1 = (qu)(A)(WQV)

Q_1 = flow rate associated with first 1/2-inch of runoff
qu = the unit peak discharge, in csm/in
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1/2 or 1 inch)

Flow Rate		
Equations		
CN		98
WQV	inch	0.5
Area	sq ft	8,876
	acres	0.20
	sq miles	0.00
Tc	min.	6
Tc	hours	0.100
qu	csm/in	773
Q_1	cfs	0.12

from Figure 2 of the Mass DEP Q Rate - Sept. 10, 2013

Per Contech VortSentryHS Specifications
Model HS36 is required

Appendix G

TSS Removal Calculations

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Subsurface infiltration System

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Subsurface Infiltration Structure	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

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

Project: **Spencer Municipal Parking Lot**

Prepared By: **Fuss & O'Neill**

Date: **2/21/2020**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

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

Version 1, Automated: Mar. 4, 2008

Location: Basin 10P to subsurface infiltration system

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Sediment Forebay	**0.25**	**1.00**	**0.25**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**

Total TSS Removal = **25%**

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

Project: **Spencer Municipal Parking Lot**
Prepared By: **Fuss & O'Neill**
Date: **2/21/2020**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Basin 50P to subsurface infiltration system

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Sediment Forebay	**0.25**	**1.00**	**0.25**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**

Total TSS Removal = **25%**

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

Project: **Spencer Municipal Parking Lot**

Prepared By: **Fuss & O'Neill**

Date: **2/21/2020**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Deep sump catch basin to subsurface infiltration

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary Treatment Practice	**0.00**	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**
	0.00	**0.75**	**0.00**	**0.75**

Total TSS Removal = **25%**

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

Project: **Spencer Municipal Parking Lot**

Prepared By: **Fuss & O'Neill**

Date: **2/21/2020**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Appendix H

Long-Term Operation and Maintenance Plan

Long Term Operation & Maintenance Plan
Municipal Parking Lot & Green infrastructure Project

Mechanic Street
Spencer, MA

Owner:
Town of Spencer

January 6, 2019

Revised
February 21, 2020

PREPARED BY

FUSS & O'NEILL

1550 Main Street, Suite 400
Springfield, MA 01103

Project No. 20170390.D51

Table of Contents

Long-Term Operation and Maintenance Plan
Mechanic Street

1 Introduction

This Long Term Operation and Maintenance Plan (O&M) is for the Municipal Parking Lot and Site Improvements located on Mechanic Street in Spencer, Massachusetts. A Site Location Map is provided in Figure 1.

The project consist of constructions of a new parking with associate driveway and sidewalks. The overall drainage patterns of the site will be unchanged by the project.

One Subsurface infiltration system, two Bioretention Basins and a proprietary water quality unit are proposed to improve the quality of the water leaving the site. A map depicting the location of the BMPs is provided in Figure 2.

The long-term requirements include following proper site operation procedures and implementing an inspection and maintenance program to ensure the success and minimize the deterioration of the stormwater system over time. The Contractor is responsible for implementing this O&M Plan during construction. The Owner is responsible thereafter. Maintenance operations shall be funded by the Owner. In the event the facility becomes owned by different entities, this Long-Term Operation and Maintenance Plan shall be transferred to the future owners/operators. Checklists to assist with the inspection and maintenance activities are provided in Appendix A.

This plan has been prepared in accordance with the requirements set forth in Standard 9 of the Massachusetts Stormwater Handbook.

2 Pollution Prevention

The following pollution prevention activities shall be conducted to minimize potential impacts on stormwater runoff quality. The Contractor is responsible for all activities during construction. The Owner is responsible thereafter.

2.1 Good Housekeeping

Good housekeeping shall be implemented to minimize the impacts to protected areas by pollutants, soil, and fugitive sediment. The site shall be kept in good working order. Trash shall be kept in covered containers (i.e., dumpsters) to prevent waste from escaping. Fugitive litter that is deposited on the site shall be removed and placed in a proper enclosed container.

2.2 Chemical and Petroleum Products

No chemical or petroleum products are expected to be stored on site.

2.2.1 Spill Control Practices

Any discharge of waste oil or other pollutant to the stormwater system will be reported immediately to the Massachusetts Department of Environmental Protection (MassDEP). The Owner will be responsible for any incident of groundwater contamination resulting from the improper discharge of pollutants to the stormwater system, and may be required by MassDEP to remediate incidents that may impact groundwater quality. Should property ownership be transferred, the subsequent owner/operator will be informed of the legal responsibilities associated with operation of the stormwater system, as indicated above.

The following practices shall be implemented to mitigate spills of material and prevent their release to the waters of the Commonwealth:

- Manufacturers' recommended methods for spill cleanup shall be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.
- Spills will be cleaned up immediately after discovery.
- Spills of toxic or hazardous material will be reported to the appropriate State and local government agency, regardless of size.

2.3 Landscaped Areas

Lawn areas will be mowed during the growing seasons as required to maintain a health stand of vegetation. This is typically once a week but can vary depending on weather conditions. If bagged, grass clippings are to be removed from the site and legally disposed of at an off-site location.

Fertilizers, if required for the maintenance of lawn areas, will be applied only in the amounts recommended by the manufacturer. If kept on site, fertilizers will be stored in a covered area. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

2.4 Pet Waste Management

There are no provisions for accommodating pets as part of the site's operation.

2.5 Snow Management

Stormwater runoff caused by snow melt must be properly managed to prevent erosion and pollution. Therefore, a snow management plan has been developed to identify storage areas throughout the site.

Snow management operations can vary depending on current weather patterns, available equipment, and previous storm events. Below is a general description of how snow will be managed on the site.

- Keep pedestrian and emergency routes cleared. Ensure stockpiles do not obstruct sight lines at driveway or road intersections.
- Snow removed from the parking lot and drive aisles will be stockpiled in the marked location on the grassed area next to parking lot.
- Snow removed from the sidewalks be stored in the adjacent lawn areas.
- Snow will be stockpiled onsite until the available capacity is exceed at which point it will be loaded into trucks and properly disposed of at an off-site location.

A Snow Storage Plan is provided as Figure 3.

3 Inspection and Maintenance Requirements for Permanent Stormwater Controls

The following inspection and maintenance activities shall be conducted to ensure the success and minimize the deterioration of the stormwater system over time. A map depicting the location of the components of the stormwater management system is provided in Figure 2. Checklists to assist with the inspection and maintenance activities are provided in Appendix A.

3.1 Bioretention Basins

3.1.1 Post-Construction Inspections

Following construction, the bioretention basins shall be inspected after every storm event larger than one-inch in the first six months.

Vegetation shall be watered once every two to three days for first two months, then sporadically after establishment during the first year after installation. If droughty, watering after the initial year may be required.

If at least 25 percent vegetation coverage is not established after the first growing season, reinforcement planting should be installed. If the surface of the basins becomes clogged to the point that standing water is observed on the surface 72 hours after precipitation events, remove accumulated sediment or till the surface to breakup any hard-packed soil and then vegetate.

3.1.2 Monthly Periodic Inspections

The bioretention basin shall be inspected monthly for evidence for vegetation health and the presence of trash (e.g., litter, debris, etc.). Trash deposited on the surface of the basins shall be removed manually and shall be disposed of in accordance with applicable local, state, and federal guidelines and regulations.

Mowing shall occur when vegetation reaches a height at which it cannot support its own weight (typically two (2) to twelve (12) times per year). Inspect soil and repair erode areas monthly. Sediment should be disposed of in accordance with applicable guidelines and regulations.

3.1.3 Annual Inspection

The annual inspection of the basin should include checking for standing water or other evidence of clogging by accumulated sediments, checking inlets and outlets for signs of erosion and damage, checking the overflow structures for blockage and structural integrity, and checking the slopes of the basins for erosion or gullying.

Sediment shall be removed from the basins when the accumulation exceeds one inch or when there is evidence that the infiltration capacity has been significantly reduced. Sediment and debris must be removed manually with rakes rather than heavy equipment to avoid compacting. Removed sediments shall be dewatered (if necessary) and disposed of in an acceptable manner.

The top six (6) inches of the bioretention basin soil shall be removed and replaced when the filtering capacity of the filter diminishes substantially (i.e., when water ponds on the surface of the filter bed for more than 72 hours). If discolored material is found below this removed surface then that material should also be removed and replaced until all discolored material has been removed.

Any areas within the extents of the basins that are subject to erosion or gullying shall be replenished with the original design material and re-vegetated according to design drawings. Prune vegetated areas and remove any dead materials. Separation of herbaceous vegetation rootstock should occur when over-crowding is observed, or approximately once every three years. If required, apply fertilizer to areas where vegetation is not fully established.

3.2 Drainage Structures

3.2.1 Post-Construction Inspections

Immediately prior to the end of construction and acceptance by the Owner, the Contractor shall clean all drainage structures.

3.2.2 Quarterly Inspections

Drainage structures shall be inspected at minimum of four times per year. Sediment shall be removed at least twice per year, or when the depth reaches half the height between the bottom of the structure and the lowest pipe invert elevation. Inspections shall include checking for debris, sediment, and hydrocarbons, and structural integrity or damage. Deficiencies must be corrected immediately. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations. Grates shall not be welded to the frame so the structures can be easily inspected and maintained.

3.3 Subsurface Infiltration System

Manufacturers operation and maintenance guidelines for specifications on inspection and maintenance are attached in Appendix B.

3.4 Proprietary water quality unit

Manufacturers operation and maintenance guidelines for specifications on inspection and maintenance are attached in Appendix B.

3.5 Anticipated Costs

The annual cost for the inspections and maintenance for the property is estimated to be from $9,000 to $14,000 per year, if performed by an independent third party. A budgetary opinion of cost for the maintenance is included in Appendix C.

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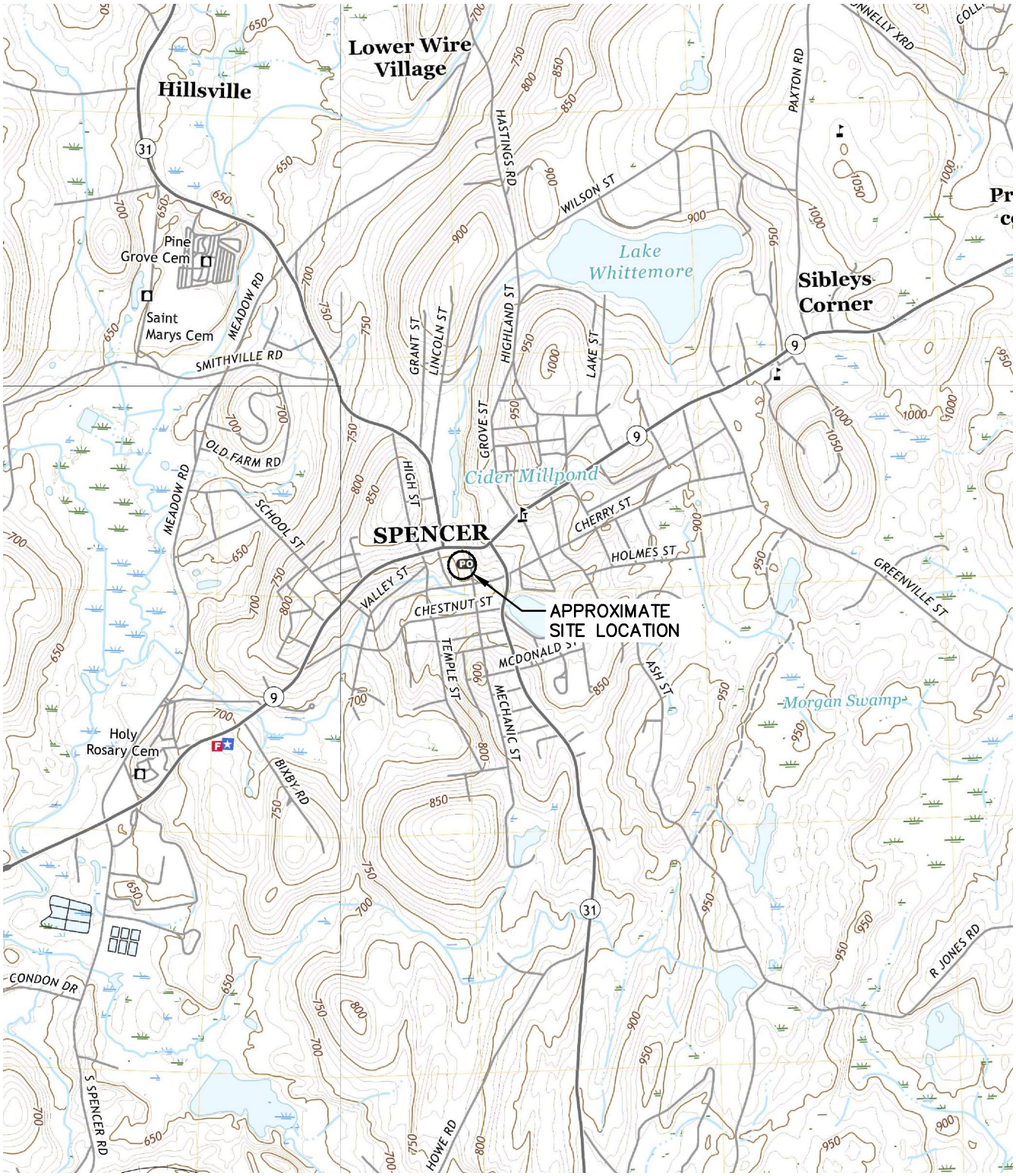
Figure 1

Site Location Map



MAP REFERENCE:
THIS MAP WAS PREPARED FROM THE FOLLOWING USGS 7.5 MINUTE SERIES TOPOGRAPHICAL MAPS:
PAXTON, PAXTON QUADRANGLE, 2018
LEICESTER, LEICESTER QUADRANGLE, 2018
EAST BROOKFIELD, EAST BROOKFIELD QUADRANGLE, 2018
NORTH BROOKFIELD, NORTH BROOKFIELD QUADRANGLE, 2018

SCALE:
HORZ.: 1" = 2000'
VERT.:
DATUM:
HORZ.:
VERT.:
0 1000 2000
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

TOWN OF SPENCER

SITE LOCATION MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

SPENCER MASSACHUSETTS

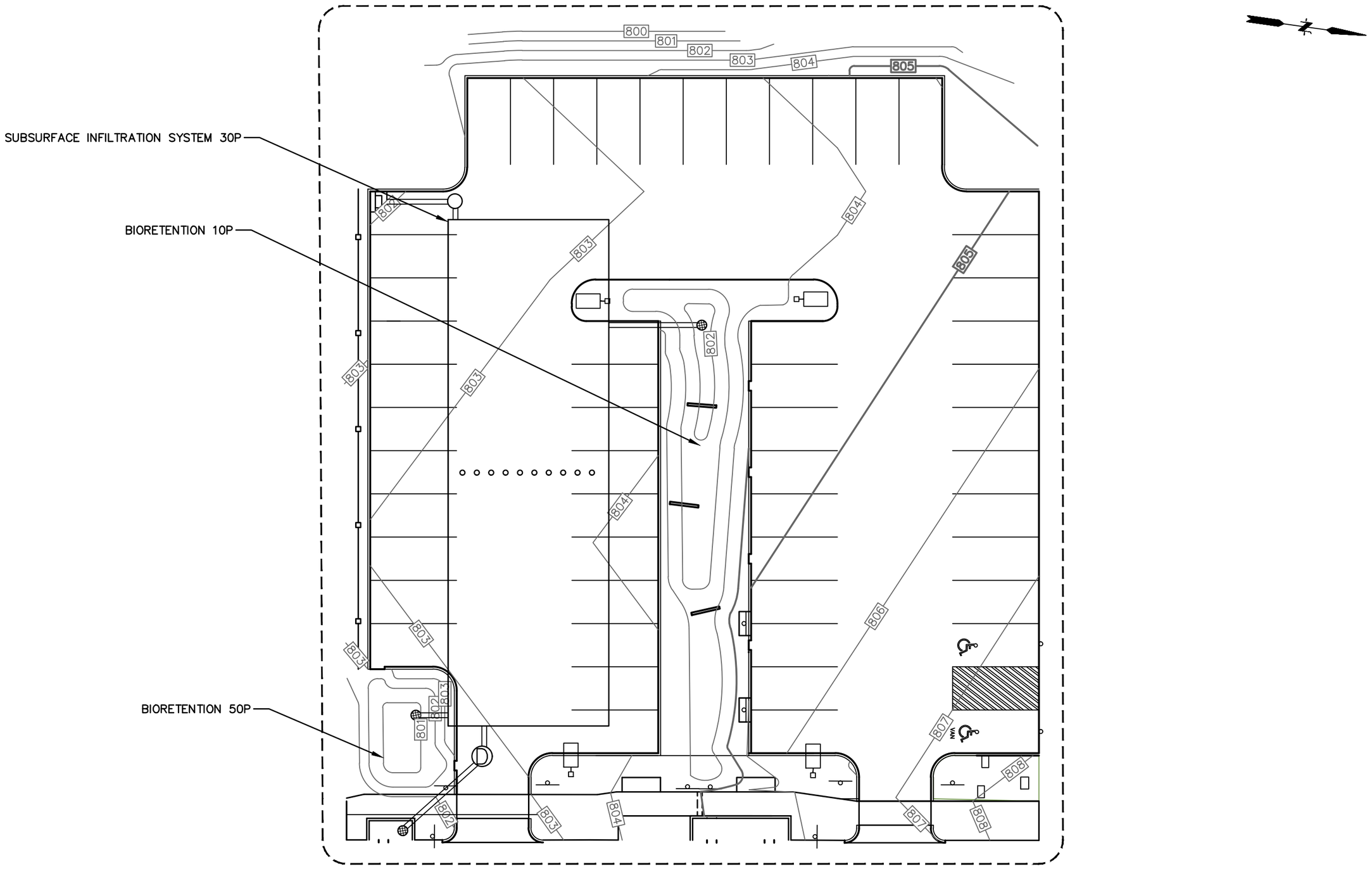
PROJ. No.: 20170390.D51
DATE: DECEMBER 2019

FIGURE 1

FUSS & O'NEILL

Figure 2

BMP Location Map



SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.:
VERT.:
0 10 20
GRAPHIC SCALE

FUSS & O'NEILL
108 MYRTLE STREET, SUITE 502
QUINCY, MA 02171
617.282.4675
www.fando.com

TOWN OF SPENCER

BMP LOCATION MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

MASSACHUSETTS

SPENCER

PROJ. No.: 20170390.51
DATE: 02/21/2020

FIG.2

File Path: J:\DWG\P2017\0390\D51\Civil\Figures\20170390D51_BMP_01.dwg Layout: BMP LOCATION Plotted: Fri, February 21, 2020 - 11:32 AM User: jvaldez
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
MS VIEW: LAYER STATE:

FUSS & O'NEILL

Figure 3

Snow Storage Map

File Path: J:\DWG\P2017\0390\D51\Civil\Figures\20170390D51_BMP_01.dwg Layout: SNOWFALL Plotted: Fri, February 21, 2020 - 11:40 AM User: jvaldez
MS VIEW: | LAYER STATE: | Plotter: DWG TO PDF.PC3 CTB File: FO.STB

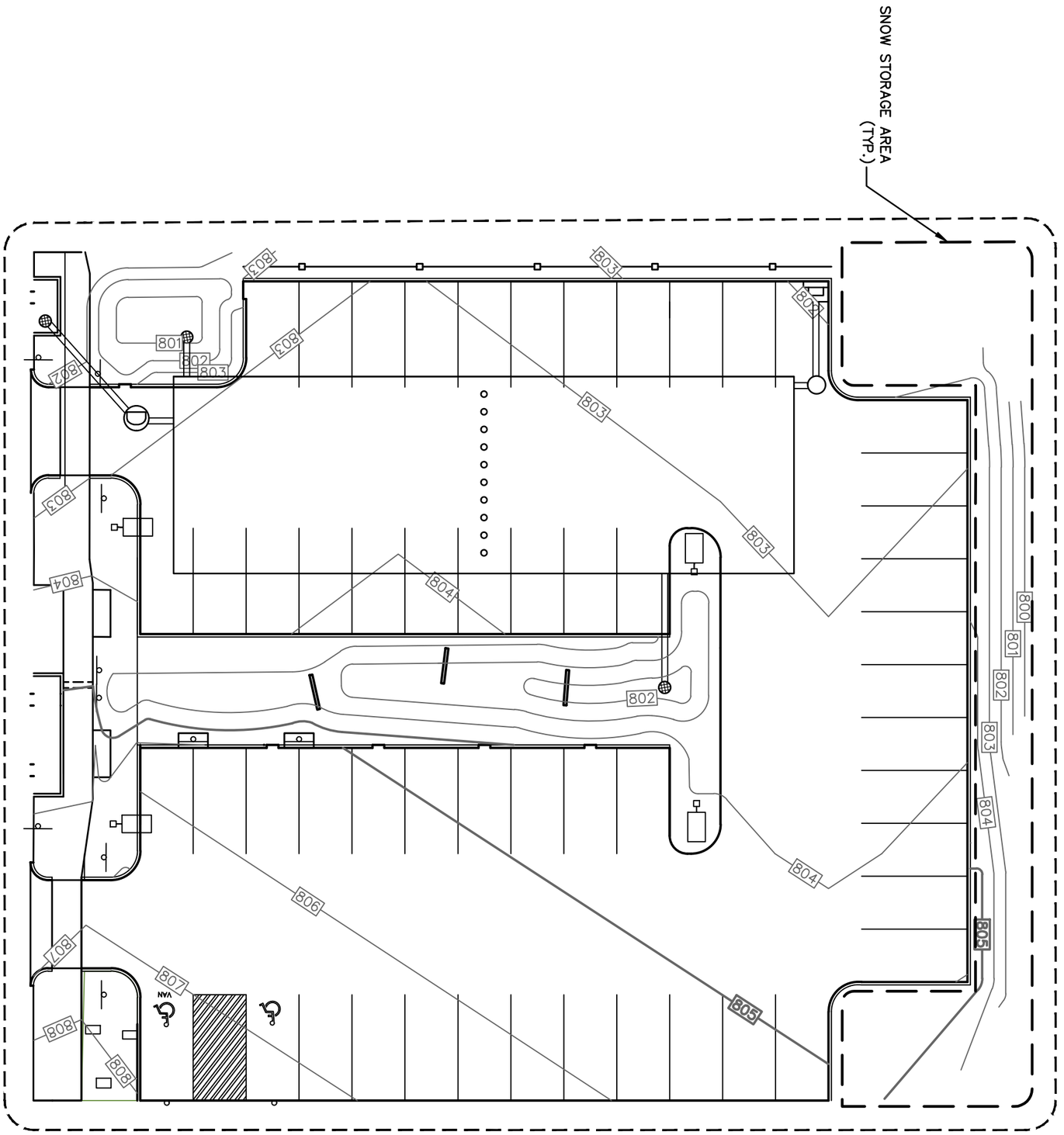


FIG.3

TOWN OF SPENCER

SNOW STORAGE MAP

MUNICIPAL PARKING LOT & GREEN INFRASTRUCTURE PROJECT

SPENCER MASSACHUSETTS

PROJ. No: 20170390.51
DATE: 02/21/2020

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SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.:
VERT.:
0 10 20
GRAPHIC SCALE

Appendix A

Operation, Maintenance and Management Inspection Checklist

Operation, Maintenance, and Management Inspection Checklists
Master Checklist
Mechanic Street Parking Lot

Inspection Year: _____

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bioretention Basins												
Inspect for and Remove Trash (monthly)												
Mow (as required)												
Annual Inspection												
Drainage Structures												
Quarterly Inspection												

Operation, Maintenance, and Management Inspection Checklists
Bioretention Basins
Mechanic Street Parking Lot

Inspector Name: _____

Inspection Date: _____

Reviewed By: _____

Review Date: _____

Type of Inspection (Circle One):

Monthly Annual

BMP Name:

_____

No.	Monthly	Annual	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1			Trash/Debris	Basin is free of debris, litter, and waste.			
2			Turf	Grass has not reached a height at which it cannot support its own weight			
3			Sediment	Depth of Sediment is less than one inch.			

4			Clogging	Basins appears to be draining freely and not clogged.			
5			Overflow Structures	Overflow structures are free of blockage and are structurally sound			
6			Erosion	There are no signs of erosion and scouring.			
7			Vegetation	Vegetation is satisfactorily pruned to remove any dead material. Rootstocks are not overcrowded.			

Operation, Maintenance, and Management Inspection Checklists
Drainage Structures
Mechanic Street Parking Lot

Inspector Name: _____

Inspection Date: _____

Reviewed By: _____

Review Date: _____

Type of Inspection (Circle One):

Quarterly

Structure Name:

_____

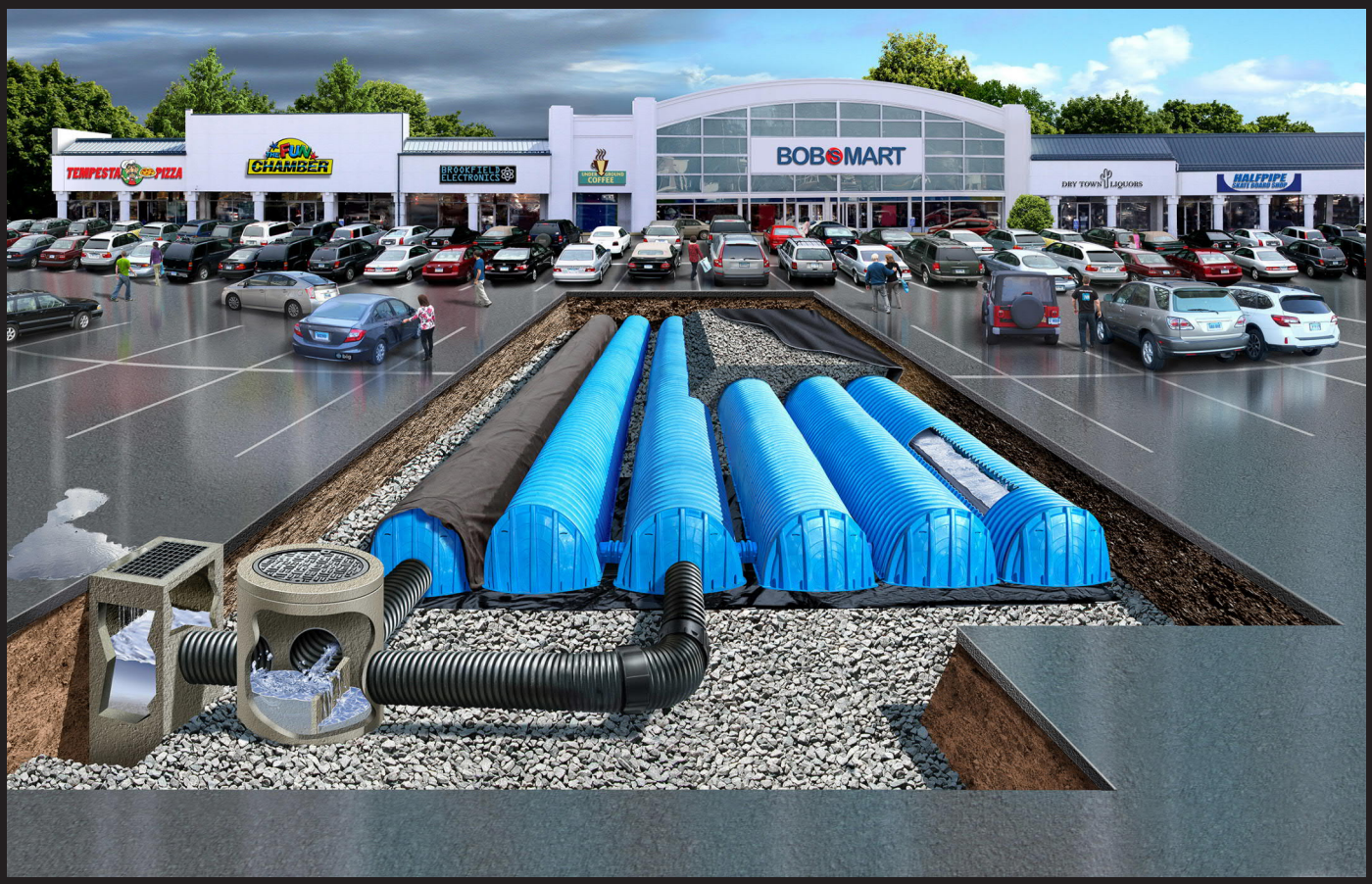
No.	Quarterly	Item	Criteria	Satisfactory	Unsatisfactory	Notes
1		Trash/Debris	Structure is free of debris, litter, and waste.			
2		Sediment	Depth of sediment is less than half the height between the bottom of the structure and the lowest pipe invert elevation and has been removed within the last six months.			
3		Concrete Surfaces	Concrete surfaces are structurally sound and have negligible spalling and cracking.			

Appendix B

Proprietary Systems O&M Manual

CONTACTOR® & RECHARGER®

STORMWATER MANAGEMENT SOLUTIONS



OPERATION & MAINTENANCE GUIDELINES

FOR CULTEC STORMWATER MANAGEMENT SYSTEMS

CULTEC®

Published by
CULTEC, Inc.
P.O. Box 280
878 Federal Road
Brookfield, Connecticut 06804 USA
www.cultec.com

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For technical support, please call (203)775-4416 ext. 203 or e-mail tech@cultec.com.

Visit www.cultec.com/downloads.html for Product Downloads and CAD details.

Doc ID: CLT057 01-20
January 2020

These instructions are for single-layer traffic applications only. For multi-layer applications, contact CULTEC.
All illustrations and photos shown herein are examples of typical situations. Be sure to follow the engineer's drawings.
Actual designs may vary.

This manual contains guidelines recommended by CULTEC, Inc. and may be used in conjunction with, but not to supersede, local regulations or regulatory authorities. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Introduction

The CULTEC Subsurface Stormwater Management System is a high-density polyethylene (HDPE) chamber system arranged in parallel rows surrounded by washed stone. The CULTEC chambers create arch-shaped voids within the washed stone to provide stormwater detention, retention, infiltration, and reclamation. Filter fabric is placed between the native soil and stone interface to prevent the intrusion of fines into the system. In order to minimize the amount of sediment which may enter the CULTEC system, a sediment collection device (stormwater pretreatment device) is recommended upstream from the CULTEC chamber system. Examples of pretreatment devices include, but are not limited to, an appropriately sized catch basin with sump, pretreatment catchment device, oil grit separator, or baffled distribution box. Manufactured pretreatment devices may also be used in accordance with CULTEC chambers. Installation, operation, and maintenance of these devices shall be in accordance with manufacturer's recommendations. Almost all of the sediment entering the stormwater management system will be collected within the pretreatment device.

Best Management Practices allow for the maintenance of the preliminary collection systems prior to feeding the CULTEC chambers. The pretreatment structures shall be inspected for any debris that will restrict inlet flow rates. Outfall structures, if any, such as outlet control must also be inspected for any obstructions that would restrict outlet flow rates. OSHA Guidelines must be followed when inspecting or cleaning any structure.

Operation and Maintenance Requirements

I. Operation

CULTEC stormwater management systems shall be operated to receive only stormwater run-off in accordance with applicable local regulations. CULTEC subsurface stormwater management chambers operate at peak performance when installed in series with pretreatment. Pretreatment of suspended solids is superior to treatment of solids once they have been introduced into the system. The use of pretreatment is adequate as long as the structure is maintained and the site remains stable with finished impervious surfaces such as parking lots, walkways, and pervious areas are properly maintained. If there is to be an unstable condition, such as improvements to buildings or parking areas, all proper silt control measures shall be implemented according to local regulations.

II. Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pretreatment device). CCTV inspection of this row can be deployed through this access port to deter mine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. Manhole Access
This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment.

2. StormFilter Access
Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

III. Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

IV. Suggested Maintenance Schedules

A. Minor Maintenance
The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris, as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris, as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris, as required.

B. Major Maintenance
The following suggested maintenance schedule shall be followed to maintain the performance of the CULTEC stormwater management chambers. Additional work may be necessary due to insufficient performance and other issues that might be found during the inspection of the stormwater management chambers. (See table on next page)

	Frequency	Action
Inlets and Outlets	Every 3 years	• Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
	Spring and Fall	• Check inlet and outlets for clogging and remove any debris as required.
CULTEC Stormwater Chambers	2 years after commissioning	• Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
	9 years after commissioning every 9 years following	• Clean stormwater management chambers and feed connectors of any debris. • Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. • Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
	45 years after commissioning	• Clean stormwater management chambers and feed connectors of any debris. • Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. • Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. • Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. • Attain the appropriate approvals as required. • Establish a new operation and maintenance schedule.
Surrounding Site	Monthly in 1st year	• Check for depressions in areas over and surrounding the stormwater management system.
	Spring and Fall	• Check for depressions in areas over and surrounding the stormwater management system.
	Yearly	• Confirm that no unauthorized modifications have been performed to the site.

For additional information concerning the maintenance of CULTEC Subsurface Stormwater Management Chambers, please contact CULTEC, Inc. at 1-800-428-5832.

WQMP
Operation & Maintenance (O&M) Plan

Project Name:_____

Prepared for:

Project Name: _____

Address:_____

City, State Zip:_____

Prepared on:

Date:_____

This O&M Plan describes the designated responsible party for implementation of this WQMP, including: operation and maintenance of all the structural BMP(s), conducting the training/educational program and duties, and any other necessary activities. The O&M Plan includes detailed inspection and maintenance requirements for all structural BMPs, including copies of any maintenance contract agreements, manufacturer's maintenance requirements, permits, etc.

8.1.1 Project Information

Project name	
Address	
City, State Zip	
Site size	
List of structural BMPs, number of each	
Other notes	

8.1.2 Responsible Party

The responsible party for implementation of this WQMP is:

Name of Person or HOA Property Manager	
Address	
City, State Zip	
Phone number	
24-Hour Emergency Contact number	
Email	

8.1.3 Record Keeping

Parties responsible for the O&M plan shall retain records for at least 5 years.

All training and educational activities and BMP operation and maintenance shall be documented to verify compliance with this O&M Plan. A sample Training Log and Inspection and Maintenance Log are included in this document.

8.1.4 Electronic Data Submittal

This document along with the Site Plan and Attachments shall be provided in PDF format. AutoCAD files and/or GIS coordinates of BMPs shall also be submitted to the City.

Appendix ____

BMP SITE PLAN

Site plan is preferred on minimum 11" by 17" colored sheets, as long as legible.

BMP OPERATION & MAINTENANCE LOG

Project Name: _____

Today's Date: _____

Name of Person Performing Activity (Printed): _____

Signature: _____

BMP Name (As Shown in O&M Plan)	Brief Description of Implementation, Maintenance, and Inspection Activity Performed

Minor Maintenance

Frequency		Action
Monthly in first year		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Month 1	Date:	
□ Month 2	Date:	
□ Month 3	Date:	
□ Month 4	Date	
□ Month 5	Date:	
□ Month 6	Date:	
□ Month 7	Date:	
□ Month 8	Date:	
□ Month 9	Date:	
□ Month 10	Date:	
□ Month 11	Date:	
□ Month 12	Date:	
Spring and Fall		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
□ Spring	Date:	
□ Fall	Date:	
One year after commissioning and every third year following		Check inlets and outlets for clogging and remove any debris, as required.
		Notes
□ Year 1	Date:	
□ Year 4	Date:	
□ Year 7	Date:	
□ Year 10	Date:	
□ Year 13	Date:	
□ Year 16	Date:	
□ Year 19	Date:	
□ Year 22	Date:	

Major Maintenance

	Frequency		Action
Inlets and Outlets	**Every 3 years**		Obtain documentation that the inlets, outlets and vents have been cleaned and will function as intended.
			Notes
	□ Year 1	Date:	
	□ Year 4	Date:	
	□ Year 7	Date:	
	□ Year 10	Date:	
	□ Year 13	Date:	
	□ Year 16	Date:	
	□ Year 19	Date:	
	□ Year 22	Date:	
	Spring and Fall		Check inlet and outlets for clogging and remove any debris, as required.
			Notes
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
CULTEC Stormwater Chambers	**2 years after commissioning**		□ Inspect the interior of the stormwater management chambers through inspection port for deficiencies using CCTV or comparable technique. □ Obtain documentation that the stormwater management chambers and feed connectors will function as anticipated.
			Notes
	□ Year 2	Date:	

Major Maintenance

	Frequency		Action
CULTEC Stormwater Chambers	**9 years after commissioning every 9 years following**		□ Clean stormwater management chambers and feed connectors of any debris. □ Inspect the interior of the stormwater management structures for deficiencies using CCTV or comparable technique. □ Obtain documentation that the stormwater management chambers and feed connectors have been cleaned and will function as intended.
			Notes
	□ Year 9	Date:	
	□ Year 18	Date:	
	□ Year 27	Date:	
	□ Year 36	Date:	
	45 years after commissioning		□ Clean stormwater management chambers and feed connectors of any debris. □ Determine the remaining life expectancy of the stormwater management chambers and recommended schedule and actions to rehabilitate the stormwater management chambers as required. □ Inspect the interior of the stormwater management chambers for deficiencies using CCTV or comparable technique. □ Replace or restore the stormwater management chambers in accordance with the schedule determined at the 45-year inspection. □ Attain the appropriate approvals as required. □ Establish a new operation and maintenance schedule.
			Notes
	□ Year 45	Date:	

Major Maintenance

	Frequency		Action
Surrounding Site	**Monthly in 1st year**		□ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	□ Month 1	Date:	
	□ Month 2	Date:	
	□ Month 3	Date:	
	□ Month 4	Date:	
	□ Month 5	Date:	
	□ Month 6	Date:	
	□ Month 7	Date:	
	□ Month 8	Date:	
	□ Month 9	Date:	
	□ Month 10	Date:	
	□ Month 11	Date:	
	□ Month 12	Date:	
	Spring and Fall		□ Check for depressions in areas over and surrounding the stormwater management system.
			Notes
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	□ Spring	Date:	
	□ Fall	Date:	
	Yearly		□ Confirm that no unauthorized modifications have been performed to the site.
			Notes
	□ Year 1	Date:	
	□ Year 2	Date:	
	□ Year 3	Date:	
	□ Year 4	Date:	
	□ Year 5	Date:	
	□ Year 6	Date:	
	□ Year 7	Date:	

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RETENTION • DETENTION • INFILTRATION • WATER QUALITY

URBANGREEN®

VortSentry® HS Guide
Operation, Design, Performance and Maintenance

CONTECH®
ENGINEERED SOLUTIONS

VortSentry® HS

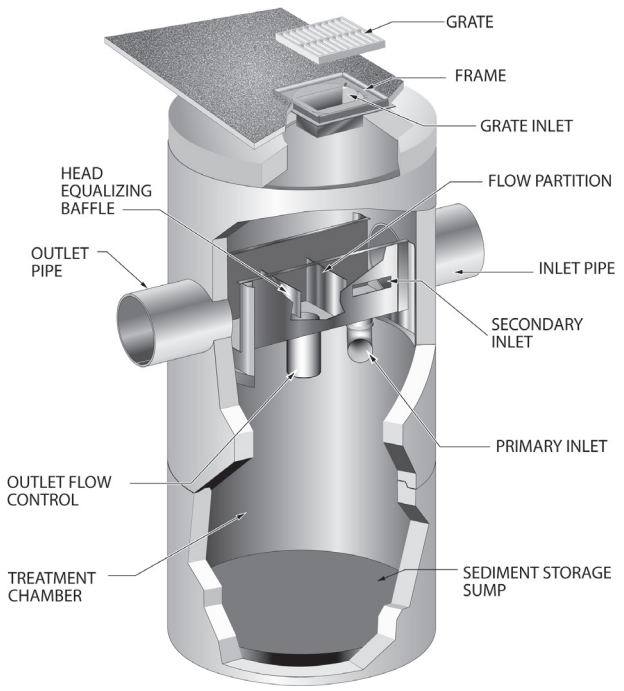
The VortSentry HS is a compact, below grade stormwater treatment system that employs helical flow technology to enhance gravitational separation of floating and settling pollutants from stormwater flows. With the ability to accept a wide range of pipe sizes, the VortSentry HS can treat and convey flows from small to large sites. A unique internal bypass design means higher flows can be diverted without the use of external bypass structures. The VortSentry HS is also available in a grate inlet configuration, which is ideal for retrofit installations.

Operation Overview

Low, frequently occurring storm flows are directed into the treatment chamber through the primary inlet. The tangentially oriented downward pipe induces a swirling motion in the treatment chamber that increases capture and containment abilities. Moderate storm flows are directed into the treatment chamber through the secondary inlet, which allows for capture of floating trash and debris. The secondary inlet also provides for treatment of higher flows without significantly increasing the velocity or turbulence in the treatment chamber. This allows for a more quiescent separation environment. Settleable solids and floating pollutants are captured and contained in the treatment chamber.

Flow exits the treatment chamber through the outlet flow control, which manages the amount of flow that is treated and helps maintain the helical flow patterns developed within the treatment chamber.

Flows exceeding the system's rated treatment flow are diverted away from the treatment chamber by the flow partition. Internal diversion of high flows eliminates the need for external bypass structures. During bypass, the head equalizing baffle applies head on the outlet flow control to limit the flow through the treatment chamber. This helps prevent re-suspension of previously captured pollutants.



Design Basics

There are two primary methods of sizing a VortSentry HS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow for a defined particle size. The summation process of the Rational Rainfall Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically, VortSentry HS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a particle gradation with an average particle size (d_{50}) of 240-microns (μm).

Water Quality Flow Rate Method

In many cases, regulations require that a specific flow rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval (i.e. the six-month storm) or a water quality depth (i.e. 1/2-inch of rainfall).

The VortSentry HS is designed to treat all flows up to the WQQ. Due to its internal bypass weir configuration, flow rates in the treatment chamber only increase minimally once the WQQ is surpassed. At influent rates higher than the WQQ, the flow partition will allow most flow exceeding the treatment flow rate to bypass the treatment chamber. This allows removal efficiency to remain relatively constant in the treatment chamber and reduces the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the VortSentry HS will remove a specific gradation of sediment at a specific removal efficiency. Therefore they are variable based on the gradation and removal efficiency specified by the design engineer and the unit size is scaled according to the project goal.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. The Rational Rainfall Method is a sizing program Contech uses to estimate a net annual sediment load reduction for a particular VortSentry HS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics. For more information on the Rational Rainfall Method, see *Vortechs Technical Bulletin 4: Modeling Long Term Load Reduction: The Rational Rainfall Method*, available at **www.ContechES.com/stormwater**

Treatment Flow Rate

The outlet flow control is sized to allow the WQQ to pass entirely through the treatment chamber at a water surface elevation equal to the crest of the flow partition. The head equalizing baffle applies head on the outlet flow control to limit the flow through the treatment chamber when bypass occurs, thus helping to prevent re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The VortSentry HS is available in three standard configurations: inline (with inlet and outlet pipes at 180° to each other), grated inlet, and a combination of grate and pipe inlets. All three configurations are available in 36-inch (900-mm) through 96-inch (2400-mm) diameter manholes.

The configuration of the system is determined by the suffix of the model name:

- A model name without a suffix denotes a standard pipe inlet (Example HS48).
- A "G" at the end of the model designation denotes a grate inlet (Example HS48G).
- A "GP" at the end of the model designation denotes a combination of grate and pipe inlets (Example HS48GP).

Performance

Full-Scale Laboratory Test Results

Laboratory testing of the VortSentry HS was conducted using F-55 Silica, a commercially available sand product with an average particle size of 240-μm (Table 1). This material was metered into a model HS48 VortSentry HS at an average concentration of between 250-mg/L and 300-mg/L at flow rates ranging from 0.50-cfs to 1.5-cfs (14-L/s to 56-L/s).

US Standard Sieve Size	Particle Size Micron (μm)	Cumulative Passing %
30	600	99.7%
40	425	95.7%
50	300	74.7%
70	212	33.7%
100	150	6.7%
140	106	0.7%

Table 1 : US Silica F-55 Particle Size Distribution

Removal efficiencies at each flow rate were calculated based on net sediment loads passing the influent and effluent sampling points. Results are illustrated in Figure 1.

Assuming that sediment in the inlet chamber is ideally mixed, removal rates through the system will decay according to the percentage of flow bypassed. This effect has been observed in the laboratory where the test system is designed to produce a thoroughly mixed inlet stream. All VortSentry HS models have the same aspect ratio regardless of system diameter (i.e. an increase in diameter results in a corresponding increase in depth). Operating rates are expressed volumetrically.

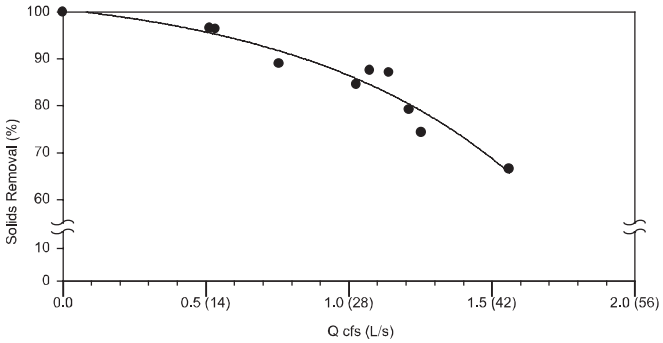


Figure 1: VortSentry HS Removal Efficiencies for 240-μm Particle Gradation

Removal efficiency at each operating rate is calculated according to the average of volumetric and Froude scaling methods and is described by Equation 1.

Equation 1: $$\left(\frac{\text{Diameter Prototype}}{\text{Diameter Model}}\right)^{2.75} = \left(\frac{\text{Flow Rate Prototype}}{\text{Flow Rate Model}}\right)$$

Equation 1 and actual laboratory test results were used to determine the flow rate which would be required for the various VortSentry HS models to remove 80% of solids.

View report at **www.ContechES.com/stormwater**

Maintenance

The VortSentry HS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit, i.e., unstable soils or heavy winter sanding will cause the treatment chamber to fill more quickly, but regular sweeping will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant deposition and transport may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall) however more frequent inspections may be necessary in equipment washdown areas and in climates where winter sanding operations may lead to rapid accumulations of a large volume of sediment. It is useful and often required as part of a permit to keep a record of each inspection. A simple inspection and maintenance log form for doing so is available for download at **www.ContechES.com/stormwater**

The VortSentry HS should be cleaned when the sediment has accumulated to a depth of two feet in the treatment chamber. This determination can be made by taking two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the distance given in Table 2, the VortSentry HS should be maintained to ensure effective treatment.

Cleaning

Cleaning of the VortSentry HS should be done during dry weather conditions when no flow is entering the system. Cleanout of the VortSentry HS with a vacuum truck is generally the most effective and convenient method of excavating pollutants from the system. Simply remove the manhole cover and insert the vacuum hose into the sump. All pollutants can be removed from this one access point from the surface with no requirements for Confined Space Entry.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use adsorbent pads, which solidify the oils. These are usually much easier to remove from the unit individually, and less expensive to dispose than the oil/water emulsion that may be

created by vacuuming the oily layer. Floating trash can be netted out if you wish to separate it from the other pollutants.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure proper safety precautions. If anyone physically enters the unit, Confined Space Entry procedures need to be followed.

Disposal of all material removed from the VortSentry HS should be done is accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

VortSentry HS Model	Diameter		Distance Between Water Surface and Top of Storage Sump		Sediment Storage		Oil Spill Storage	
	in.	m	ft.	m	yd^3	m^3	gal.	liter
HS36	36	0.9	3.6	1.1	0.5	0.4	83	314
HS48	48	1.2	4.7	1.4	0.9	0.7	158	598
HS60	60	1.5	6.0	1.8	1.5	1.1	258	978
HS72	72	1.8	7.1	2.2	2.1	1.6	372	1409
HS84	84	2.1	8.4	2.6	2.9	2.2	649	2458
HS96	96	2.4	9.5	2.9	3.7	2.8	845	3199

Table 2: VortSentry HS Maintenance Indicators and Sediment Storage Capacities.

Note: To avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile. Finer, silty particles at the top of the pile may be more difficult to feel with the measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.

Logon to **www.ContechES.com/stormwater** to download the VortSentry HS Inspection and Maintenance Log.

For assistance with maintaining your VortSentry HS, contact us regarding the Contech Maintenance compliance certification program.

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Contech Engineered Solutions LLC provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, stormwater and earth stabilization products. For information on other Contech division offerings, visit ContechES.com or call 800.338.1122

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

Support

- Drawings and specifications are available at contechstormwater.com.
- Site-specific design support is available from our engineers.

Appendix C

Annual O&M Budgetary Opinion of Cost

FUSS & O'NEILL

FUSS & O'NEILL, INC.

108 Myrtle Street, Suite 502
Quincy, MA 02171

BUDGETARY OPINION OF COST		DATE PREPARED: 02/21/20	SHEET 1 OF 1
PROJECT :	Municipal Parking Lot and Green Infrastructure	BASIS :	
LOCATION :	Spencer, MA		
DESCRIPTION:	Long Term Stormwater O&M Costs	ESTIMATOR : JEV	CHECKED BY : DD

Since Fuss & O'Neill has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, Fuss & O'Neill's opinion of probable Total Project Costs and Construction Cost are made on the basis of Fuss & O'Neill's experience and qualifications and represent Fuss & O'Neill's best judgment as an experienced and qualified professional engineer, familiar with the construction industry; but Fuss & O'Neill cannot and does not guarantee that proposals, bids or actual Total Project or Construction Costs will not vary from opinions of probable cost prepared by Fuss & O'Neill. If prior to the bidding or negotiating Phase the Owner wishes greater assurance as to Total Project or Construction Costs, the Owner shall employ an independent cost estimator.

ITEM NO.	ITEM DESCRIPTION	UNIT MEAS.	NO. UNITS	PER UNIT	TOTAL COST
1	Site Inspections[2]	EA	12	$ 250.00	$ 3,000.00
2	Monthly Removal of Trash[3]	EA	12	$ 125.00	$ 1,500.00
3	Mowing of Bio-Retention Basins[4]	EA	6	$ 300.00	$ 1,800.00
5	Sediment Removal[6]	EA	4	$ 500.00	$ 2,000.00
6	Bioretention Basin Maintenance[7]	EA	1	$ 1,000.00	$ 1,000.00
7	Vacuum Truck - Drainage Structures [8]	DAY	2	$ 700.00	$ 1,400.00
					$ 10,700.00
				TOTAL COST (-15% TO +30% ROUNDED)	**$9,000 TO $14,000**

Notes

1. The following equipment and labor rates were used for this estimate: Site Inspector - $1,000/day; Laborer - $500/day; Skidsteer & Operator - $1,000/day; Dump Truck - $500/day; Vacum Truck - $1800/day
2. Assume a Site Inspector is required for 1/4 day per inspection.
3. Assumes 1 Laborer for a 1/4 day.
4. Assumes 1 Laborer for a 1/2 day and an additional $50 for a weedwacker.
5. Assumes mowing is done as part of normal landscaping maintenance.
6. Assumes 1 Laborer, 1 Skidsteer & Operator, and 1 Dump Truck for 1/4 day.
7. Assumes 1 Laborer, 1 Skidsteer & Operator, and 1 Dump Truck for 1/2 day.
8. Assumes 2 Laborers and 1 Vaccum Truck for 1/4 Day.