STORMWATER REPORT

Proposed Single Family Dwelling
41 Kelsey Road
Boxford, Massachusetts

February 25, 2020

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W&S Project Data
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SWPPPkelsey#41.dwg
Existing.hcp
Proposed.hcp
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WILLIAMS & SPARAGES
ENGINEERS | PLANNERS | SURVEYORS

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1 | Mitigative Drainage Analysis

1.1 Purpose

The purpose of this analysis is to compare the pre-development watershed condition to the post development watershed condition for the project located at 41 Kelsey Road in Boxford, MA. This is accomplished by analyzing the surface runoff rates as well as surface runoff volume to the limit of watershed analysis as shown on the accompanying watershed comparison map. The result of this analysis is presented below in the summary tables.

1.2 Introduction

The subject property is located just south of the intersection of Killam Hill and Kelsey Road. The property boundary is bounded by residential properties in all direction, with frontage and an existing driveway located on Kelsey Road. The property and all of the development is located within the (RA) Residence – Agricultural zoning district.

The property was previously comprised of lawn area, driveway and a vegetated border made of deciduous and coniferous tree cover along the rear and side property lines. Site work has recently begun, and tree clearing has taken place in the rear of the property, along with the removal of the old foundation of the burned-down home.

The proposal is to redevelop the subject lot with a new single-family home with a paved driveway, new potable drinking water well, stone infiltration trench for driveway runoff and new septic system.

The amount of impervious area of the previously existing lot was approximately 6,700 square feet (digitized from aerial photos) which has been entirely removed. The proposed impervious area for the propose driveway and dwelling amounts to approximately 6,690 square feet, or, a 10 square foot reduction overall for the project. However, as mentioned above, the existing impervious area was digitized and is approximate only, therefore we are treating this project as new construction and not as a Redevelopment project under the 10 DEP Stormwater Standards which will be explained further below.

1.3 Existing Condition Soils Analysis

In order to model the excess runoff for both the existing and proposed watershed condition, the parent soils on site were mapped using the Web Soil Survey (WSS) made available on the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) website. The WSS provides vital soil data and information such as Hydrologic Soil Group (HSG), which is then input into a mathematical model to generate runoff curve numbers.

The user inputs soil cover type as well as the hydrologic soil group to generate a weighted curve number (CN) and also uses the topography of the land to generate a time of concentration (Tc) from which the stormwater runoff rate and volume can be calculated for a given watershed for comparison.
The soils present on site are comprised of Charlton fine sandy loam, 3 to 8 percent slopes, very stony with assigned HSG rating of "B" by the NRCS.

As part of the septic system design process, Williams & Sparages performed deep observation holes and percolation tests on January 14, 2020. We observed a consistent top soil and subsoil comprised of fine sandy loam as well as sandy loam overlaying a substratum comprised of gravelly sandy loam which is consistent with the information presented by the NRCS.

1.4 Stormwater Modeling Methodology

The mathematical model used in this analysis is computed using the stormwater modeling software HydroCAD, v10.00-25.00, developed by HydroCAD Software Solutions LLC. HydroCAD is a program used to model the hydrology and hydraulics of stormwater runoff and is based largely on programs and techniques developed by the NRCS, specifically TR-20 and TR-55 as well as other hydraulic calculation methods.

HydroCAD allows the user, for a given rainfall event, to generate runoff hydrographs for single or multiple watersheds and is used to determine if a given drainage system is adequate under the desired conditions and to predict flooding or other hydraulic impacts at specified locations such as erosion.

Although the DEP Stormwater standards require three (3) design storm events, the Boxford Stormwater Regulations require five (5) design storm events which are analyzed and the results presented below for the 2-year, 10 year, 25-year, 50-year and 100-year storm events for comparison.

It should also be noted that although the Town of Boxford has not yet adopted the use of the NOAA Atlas 14 precipitation frequency estimates, we have utilized that data for generating the results presented in this report, see attached point precipitation frequency estimates sheet.

1.5 Pre-Development Watershed

In the pre-development condition, the limit of watershed analysis is divided into two (2) sub catchments for comparison with the post-development condition. Link 3L represents the entire limit of the watershed analysis from the property was well as the up-gradient tributary areas from off-site that ultimately reaches Kelsey Road. Once the flow reaches Kelsey Road the runoff travels in a southerly direction in a swale along the easterly side of the roadway which eventually terminates at an existing catch basin located on the northerly side of Trask Road. Total area equals 201,329 s.f.

It should be noted that there is a pipe along the northern property line discharging runoff to an existing 12" corrugated metal pipe which discharges the runoff under Kelsey Road to the west side. The contractor has been made aware that they should keep heavy machinery away from the property line by the Superintendent of the DPW.

Using the methods described in the stormwater modeling methodology above, runoff curve numbers and times of concentration are generated for each watershed for the pre-development condition to be used for comparison with the post-development condition described below. A schematic of the mathematical model and the results of the calculations for the 2-year, 10-year, 25-year, 50-year and 100-year Type III, 24-hour storm events are included in this analysis.

1.6 Post-Development Watershed

In the post-development condition, the limit of the watershed analysis is divided into three (3) sub-catchments. "POST-1" and "POST-2" represents the area tributary to edge 3L which is the total flow reaching Kelsey Road and "POST-DRIVE" represents the proposed driveway area that is tributary to the stone infiltration trench which will be directly infiltrated shown as link 5L.

Post-development provides for the construction of a Low Impact Development (LID) stormwater management system which will provide peak rate of runoff mitigation and water quality volume

provided in the stone infiltration trench along the southern edge of the driveway and will not discharge across the surface of the lot.

Using the methods described in the stormwater modeling methodology above, runoff curve numbers and times of concentration were generated for each watershed for the proposed condition to be used for comparison with the existing condition. A schematic of the mathematical model and the results of the calculations for the 2-year, 10-year, 25-year, 50 year and 100-year, Type III, 24-hour storm events are included in this analysis.

1.7 Compliance with DEP Stormwater Management Standards

Standard 1

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

There are no new stormwater conveyances, e.g., outfalls, associated with this project.

Standard 2

Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

See Table 1 below which demonstrate the post-development peak discharge rates are less than or equal to the pre-development peak discharge rates. It should also be noted that although the DEP standards do not require mitigation for the volume of runoff, it is a requirement found in the Boxford Stormwater Management Regulations, therefore, see Table 2 which demonstrate a reduction in volume for the five (5) design storms.

Standard 3

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

The proposed infiltration trench will provide the required groundwater recharge volume.

Standard 4

Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:
a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook

The stone infiltration trench will provide a minimum of 80% TSS removal for the proposed paved driveway.

Standard 5

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow melt, and stormwater runoff, the proponent shall use specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated there under at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

This project does not meet the criteria for a LUHPPL.

Standard 6

Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2) (a) (1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of public water supply.

The project does not fall within a Zone II or Interim Wellhead Protection Area.

Standard 7

A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Although we have calculated a 10 s.f. decrease in the amount of impervious area, we have considered this project a new development.

Standard 8

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

Refer to the Construction Period Erosion, Sedimentation and Pollution Prevention Plan.

Standard 9

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

Refer to Section 4 Long Term Operation and Maintenance Plan (O&M).

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

Illicit Discharge Compliance Statement
No connection between the stormwater and wastewater management systems is proposed. Per requirements of Standard 10 it is herein stated that there are no proposed illicit discharges into the Stormwater Management System to be constructed as shown on the site plan.

1.8 Conclusion

Examining the following Peak Rate of Runoff and Basin Performance tables, the proposed stormwater management system is effective for mitigating the peak flow rates and volume of runoff from the limit of the watershed analysis for the 2, 10, 25, 50 and 100-year storm events using the NOAA Atlas 14 rainfall data.

Table 1.0: Peak Rate of Runoff | Comparison Location 3L (Total flow from watershed)

Description	2 Year	10 Year	25 Year	50 Year	100 Year
Existing Peak Rate of Runoff (cfs)	1.77	6.92	10.81	13.89	17.40
Proposed Peak Rate of Runoff (cfs)	1.55	6.46	10.20	13.18	16.58
Decrease	**-0.22**	**-0.46**	**-0.61**	**-0.71**	**-0.82**

Table 2.0: Peak Rate of Runoff | Comparison Location 3L (Total flow from watershed)

Description	2 Year	10 Year	25 Year	50 Year	100 Year
Existing volume of Runoff (ac-ft)	0.207	0.610	0.918	1.163	1.444
Proposed Peak Rate of Runoff (cfs)	0.189	0.572	0.867	1.103	1.374
Decrease	**-0.018**	**-0.038**	**-0.051**	**-0.060**	**-0.07**

NOAA Atlas 14, Volume 10, Version 3
Location name: Boxford, Massachusetts, USA*
Latitude: 42.6853°, Longitude: -70.9828°
Elevation: 133.01 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.311 (0.244-0.386)	0.372 (0.291-0.463)	0.472 (0.367-0.589)	0.555 (0.430-0.696)	0.670 (0.502-0.878)	0.756 (0.555-1.01)	0.846 (0.602-1.17)	0.946 (0.638-1.34)	1.09 (0.706-1.60)	1.20 (0.762-1.81)
10-min	0.441 (0.345-0.548)	0.528 (0.412-0.656)	0.670 (0.523-0.836)	0.787 (0.610-0.988)	0.949 (0.711-1.24)	1.07 (0.786-1.43)	1.20 (0.853-1.66)	1.34 (0.905-1.91)	1.54 (1.00-2.27)	1.71 (1.08-2.56)
15-min	0.519 (0.406-0.644)	0.621 (0.485-0.772)	0.788 (0.614-0.983)	0.926 (0.717-1.16)	1.12 (0.837-1.46)	1.26 (0.925-1.69)	1.41 (1.00-1.96)	1.58 (1.06-2.24)	1.81 (1.18-2.67)	2.01 (1.27-3.01)
30-min	0.715 (0.560-0.888)	0.854 (0.668-1.06)	1.08 (0.843-1.35)	1.27 (0.984-1.59)	1.53 (1.15-2.00)	1.73 (1.27-2.31)	1.93 (1.37-2.68)	2.16 (1.46-3.06)	2.48 (1.61-3.65)	2.74 (1.74-4.12)
60-min	0.912 (0.714-1.13)	1.09 (0.851-1.35)	1.38 (1.07-1.72)	1.61 (1.25-2.03)	1.94 (1.46-2.55)	2.19 (1.61-2.93)	2.45 (1.74-3.40)	2.74 (1.85-3.89)	3.15 (2.04-4.63)	3.48 (2.20-5.23)
2-hr	1.18 (0.930-1.45)	1.42 (1.12-1.75)	1.82 (1.43-2.25)	2.14 (1.68-2.67)	2.60 (1.97-3.40)	2.93 (2.18-3.92)	3.29 (2.38-4.59)	3.73 (2.52-5.27)	4.38 (2.85-6.41)	4.94 (3.14-7.37)
3-hr	1.36 (1.08-1.68)	1.65 (1.31-2.03)	2.13 (1.68-2.62)	2.52 (1.98-3.13)	3.06 (2.33-3.99)	3.46 (2.58-4.62)	3.89 (2.83-5.43)	4.42 (3.00-6.23)	5.24 (3.42-7.64)	5.95 (3.78-8.84)
6-hr	1.75 (1.40-2.13)	2.13 (1.70-2.60)	2.75 (2.20-3.38)	3.27 (2.59-4.03)	3.98 (3.06-5.17)	4.51 (3.40-6.00)	5.08 (3.73-7.06)	5.79 (3.95-8.11)	6.90 (4.51-10.00)	7.86 (5.01-11.6)
12-hr	2.20 (1.78-2.67)	2.70 (2.18-3.27)	3.50 (2.82-4.26)	4.17 (3.33-5.10)	5.08 (3.93-6.55)	5.76 (4.37-7.60)	6.50 (4.79-8.95)	7.40 (5.07-10.3)	8.81 (5.78-12.7)	10.0 (6.41-14.7)
24-hr	2.63 (2.15-3.17)	3.26 (2.66-3.93)	4.29 (3.49-5.20)	5.15 (4.16-6.27)	6.33 (4.95-8.12)	7.20 (5.51-9.46)	8.15 (6.06-11.2)	9.35 (6.43-12.9)	11.2 (7.38-16.0)	12.8 (8.24-18.7)
2-day	2.98 (2.46-3.57)	3.78 (3.11-4.52)	5.07 (4.16-6.10)	6.15 (5.01-7.43)	7.63 (6.02-9.76)	8.71 (6.73-11.4)	9.91 (7.47-13.7)	11.5 (7.93-15.8)	14.0 (9.25-19.9)	16.2 (10.5-23.5)
3-day	3.28 (2.72-3.91)	4.13 (3.43-4.93)	5.53 (4.56-6.62)	6.69 (5.48-8.06)	8.29 (6.57-10.6)	9.45 (7.34-12.4)	10.7 (8.13-14.8)	12.4 (8.62-17.0)	15.2 (10.1-21.5)	17.7 (11.4-25.5)
4-day	3.56 (2.97-4.23)	4.44 (3.70-5.29)	5.88 (4.87-7.02)	7.08 (5.82-8.50)	8.72 (6.94-11.1)	9.92 (7.73-12.9)	11.3 (8.54-15.4)	13.0 (9.03-17.8)	15.9 (10.5-22.4)	18.4 (11.9-26.5)
7-day	4.34 (3.65-5.13)	5.25 (4.40-6.21)	6.74 (5.63-8.00)	7.98 (6.61-9.52)	9.67 (7.75-12.2)	10.9 (8.55-14.1)	12.3 (9.36-16.7)	14.1 (9.83-19.1)	17.0 (11.3-23.9)	19.6 (12.7-28.0)
10-day	5.04 (4.25-5.94)	5.97 (5.03-7.04)	7.50 (6.29-8.87)	8.77 (7.30-10.4)	10.5 (8.44-13.2)	11.8 (9.25-15.1)	13.2 (10.0-17.7)	15.0 (10.5-20.3)	17.9 (11.9-25.0)	20.4 (13.2-29.1)
20-day	7.01 (5.97-8.19)	8.03 (6.84-9.40)	9.71 (8.23-11.4)	11.1 (9.34-13.1)	13.0 (10.5-16.1)	14.4 (11.3-18.2)	16.0 (12.1-20.9)	17.7 (12.5-23.7)	20.3 (13.6-28.1)	22.5 (14.6-31.8)
30-day	8.63 (7.40-10.0)	9.73 (8.33-11.3)	11.5 (9.83-13.5)	13.0 (11.0-15.3)	15.1 (12.2-18.5)	16.7 (13.1-20.8)	18.3 (13.7-23.6)	20.0 (14.2-26.6)	22.4 (15.1-30.8)	24.2 (15.8-34.1)
45-day	10.7 (9.21-12.4)	11.9 (10.2-13.8)	13.8 (11.8-16.1)	15.4 (13.1-18.1)	17.6 (14.3-21.4)	19.4 (15.3-24.0)	21.1 (15.8-26.9)	22.7 (16.2-30.1)	24.9 (16.9-34.2)	26.6 (17.3-37.2)
60-day	12.4 (10.8-14.4)	13.7 (11.8-15.8)	15.7 (13.5-18.3)	17.4 (14.9-20.4)	19.8 (16.1-23.9)	21.6 (17.1-26.6)	23.4 (17.6-29.6)	25.0 (17.9-33.0)	27.1 (18.4-37.1)	28.6 (18.7-40.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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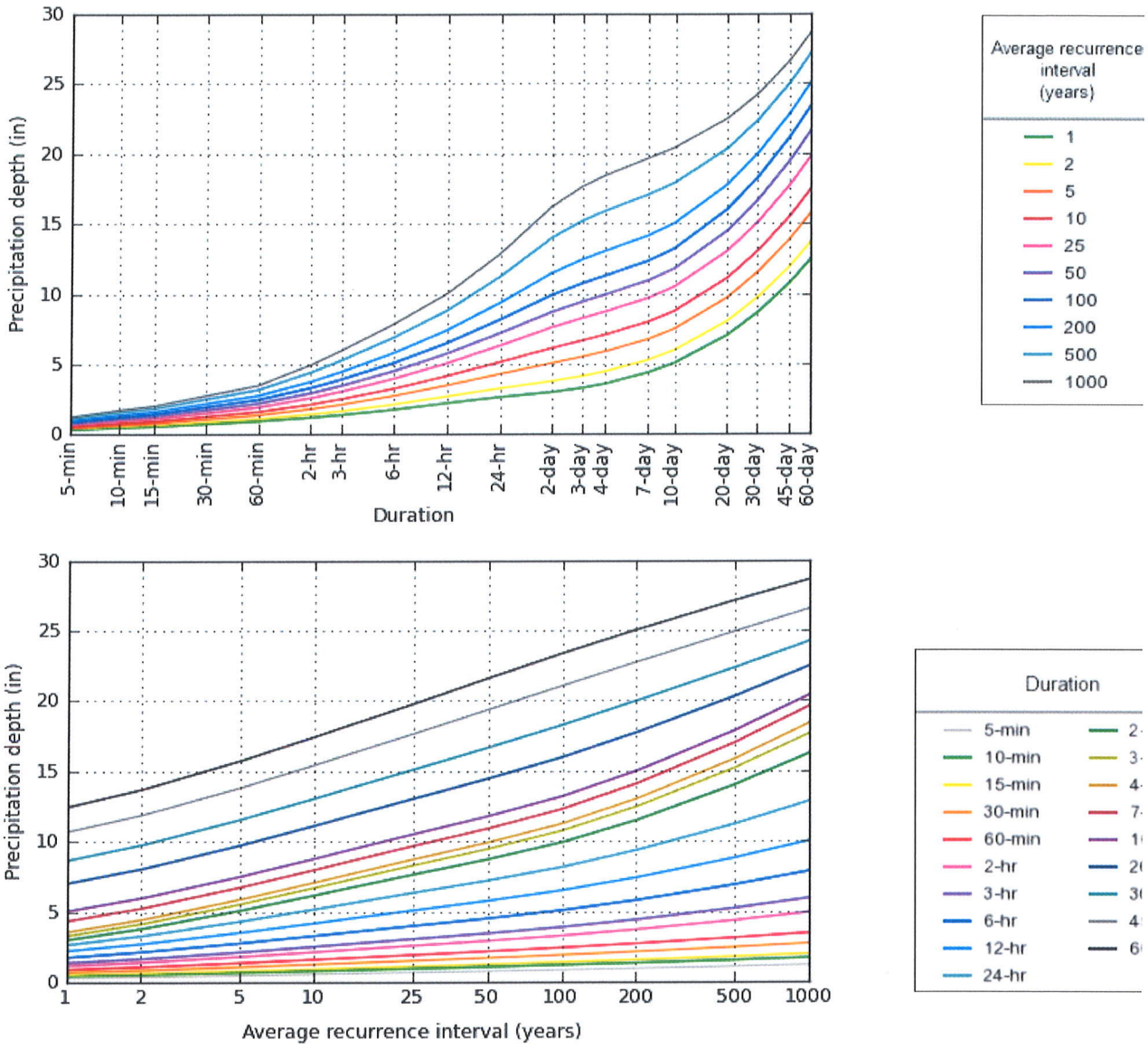
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.6853°, Longitude: -70.9828°



NOAA Atlas 14, Volume 10, Version 3 Created (GMT): Mon Mar 2 14:46:36 2020

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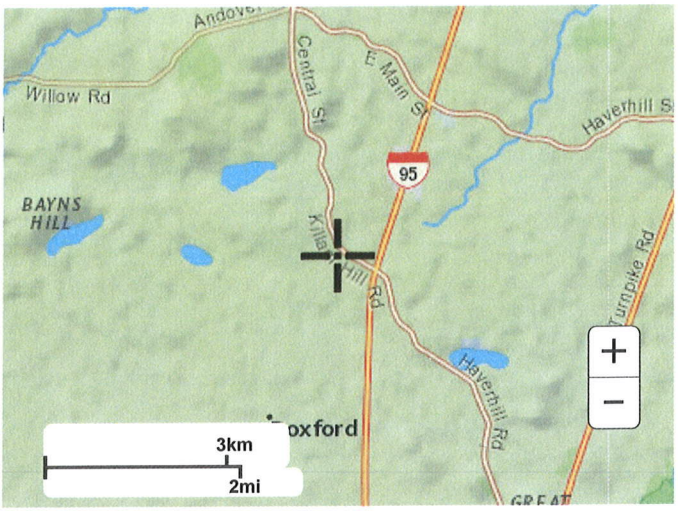
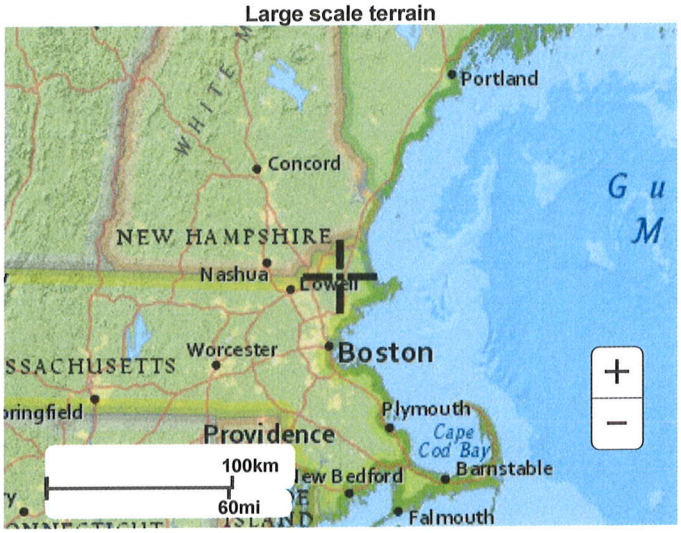
Maps & aerials

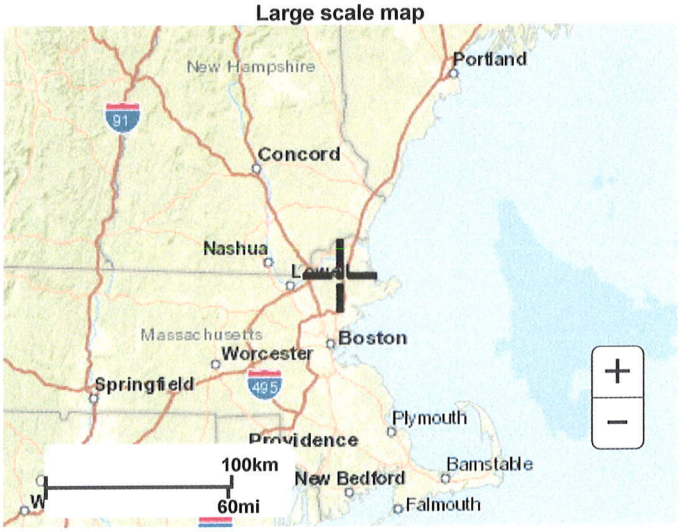
Small scale terrain



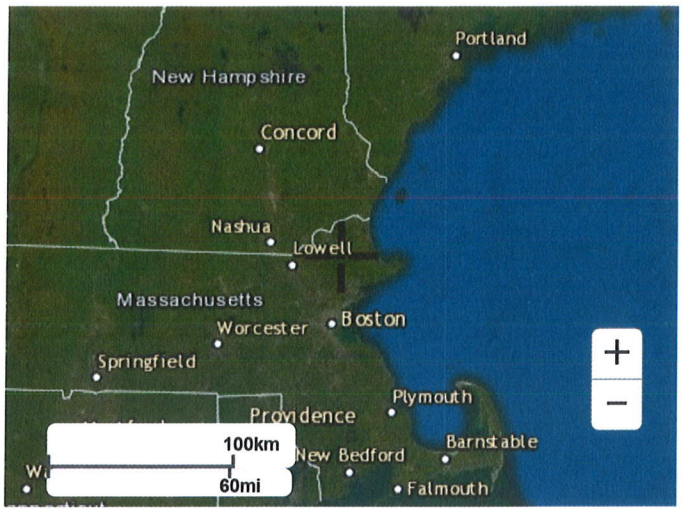
Large scale terrain



Large scale map



Large scale aerial



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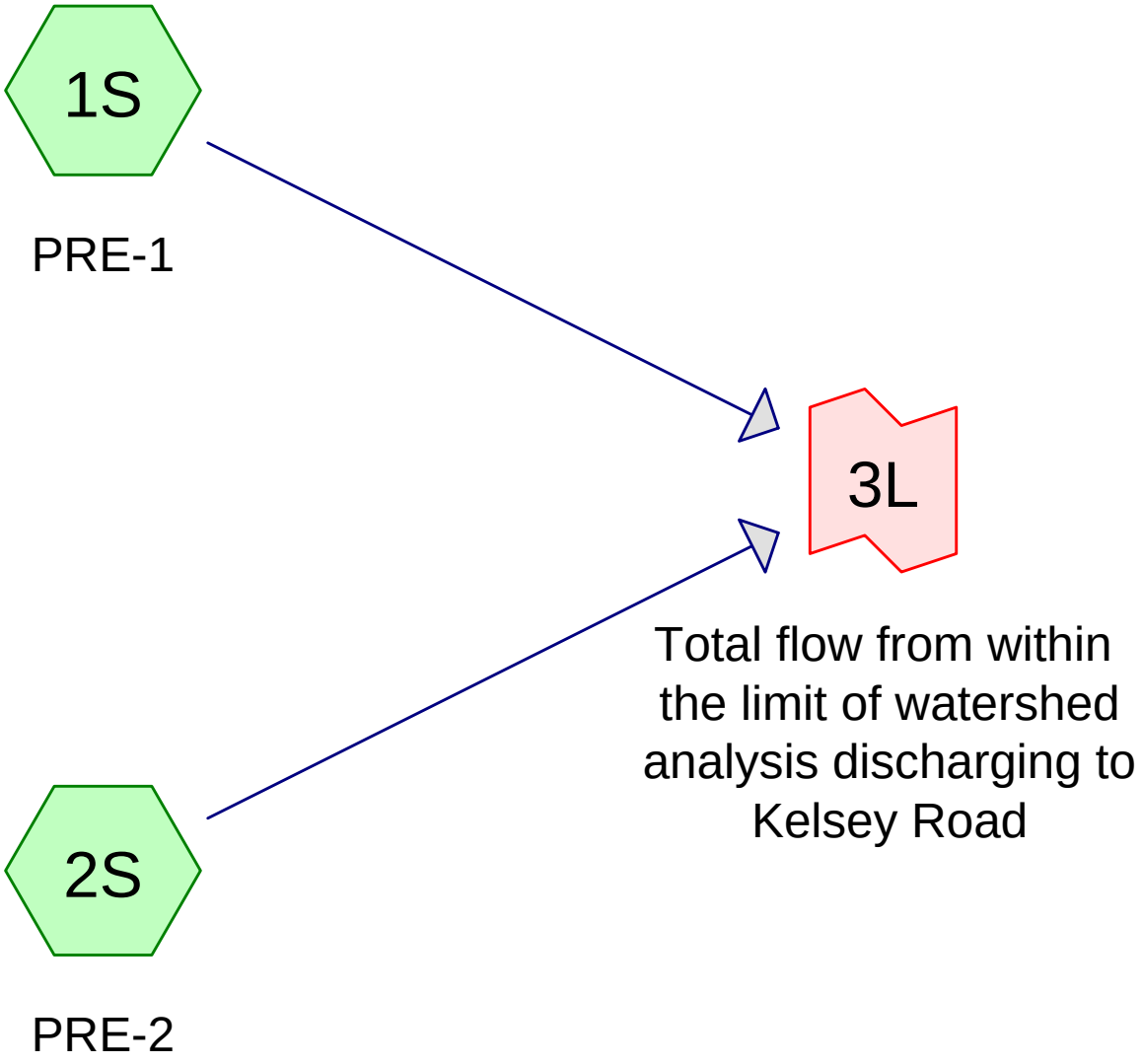
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

1.9 HydroCAD Data

Existing Condition



Subcat Reach Pond Link

Routing Diagram for PRE-DEVELOPMENT
Prepared by HP Inc., Printed 3/2/2020

Summary for Subcatchment 1S: PRE-1

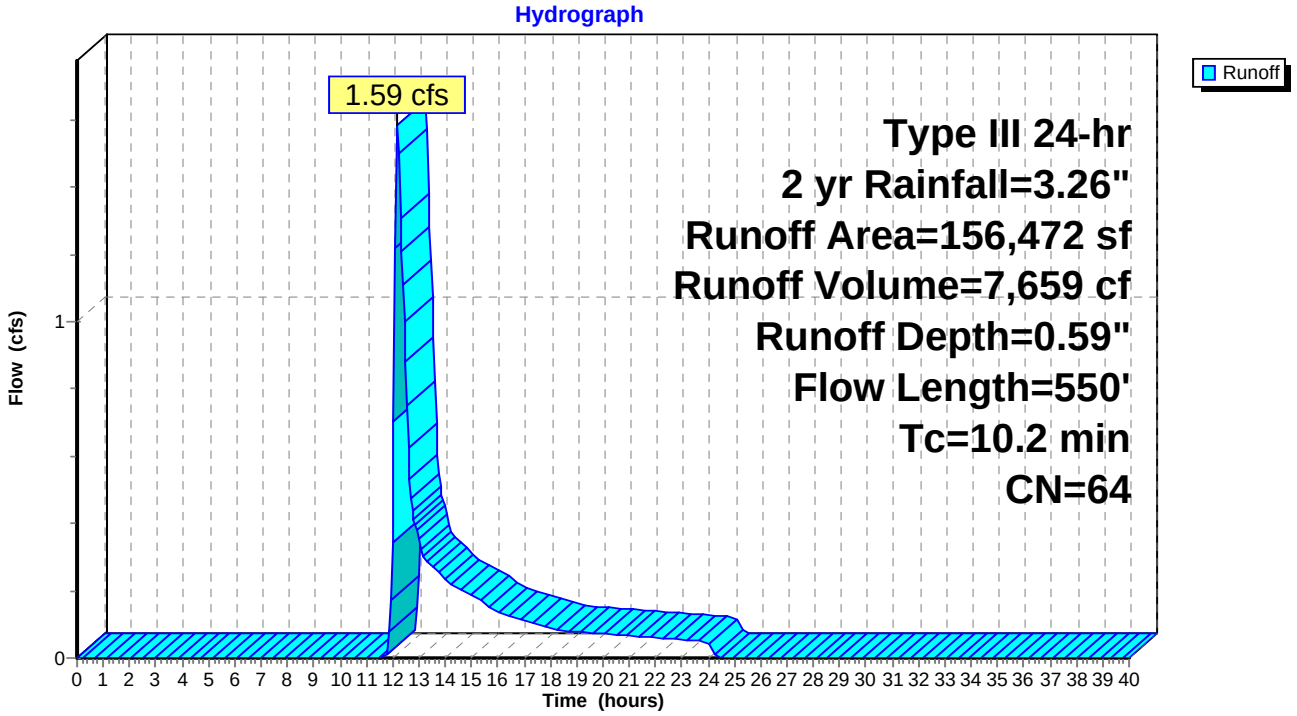
Runoff = 1.59 cfs @ 12.18 hrs, Volume= 7,659 cf, Depth= 0.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.26"

Area (sf)	CN	Description
111,282	65	2 acre lots, 12% imp, HSG B
31,490	55	Woods, Good, HSG B
3,700	98	Paved parking, HSG B
10,000	61	>75% Grass cover, Good, HSG B
156,472	64	Weighted Average
139,418		89.10% Pervious Area
17,054		10.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	200	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	115	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.2	550	Total			

Subcatchment 1S: PRE-1



Summary for Subcatchment 2S: PRE-2

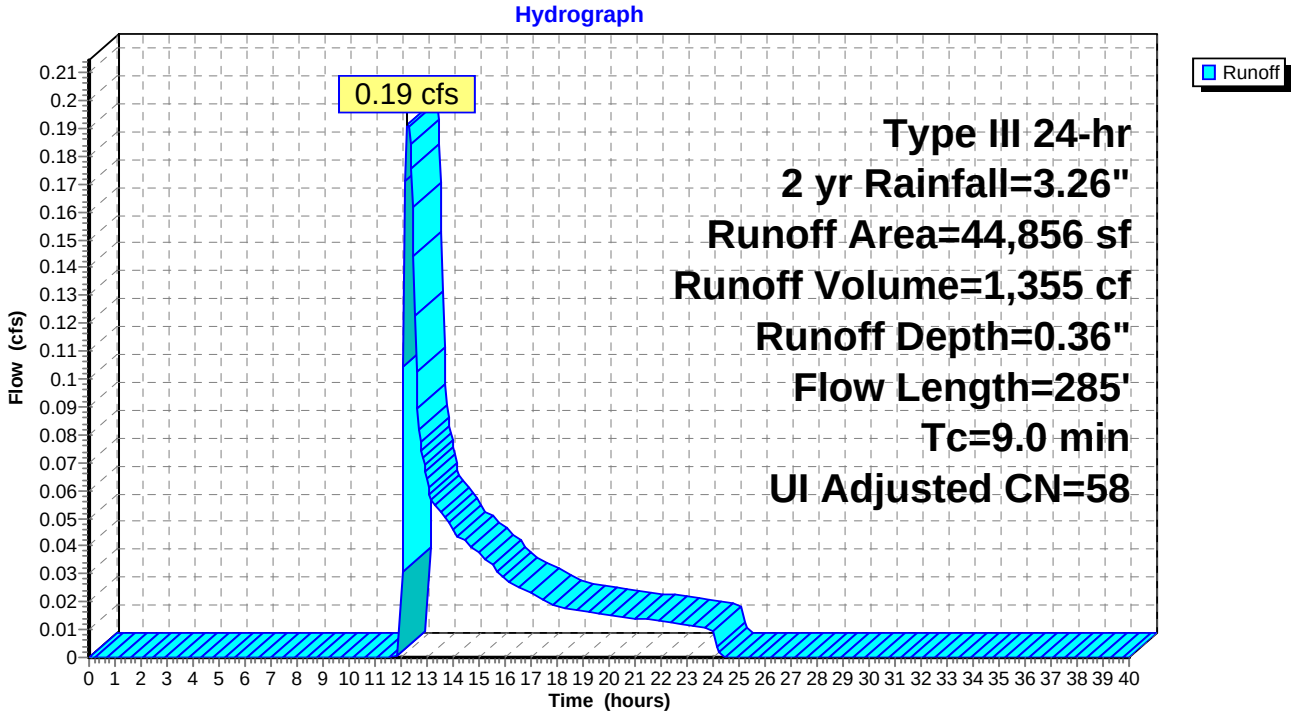
Runoff = 0.19 cfs @ 12.20 hrs, Volume= 1,355 cf, Depth= 0.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.26"

Area (sf)	CN	Adj	Description
29,856	55		Woods, Good, HSG B
12,000	61		>75% Grass cover, Good, HSG B
3,000	98		Unconnected roofs, HSG B
44,856	59	58	Weighted Average, UI Adjusted
41,856			93.31% Pervious Area
3,000			6.69% Impervious Area
3,000			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	235	0.0860	4.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.0	285	Total			

Subcatchment 2S: PRE-2

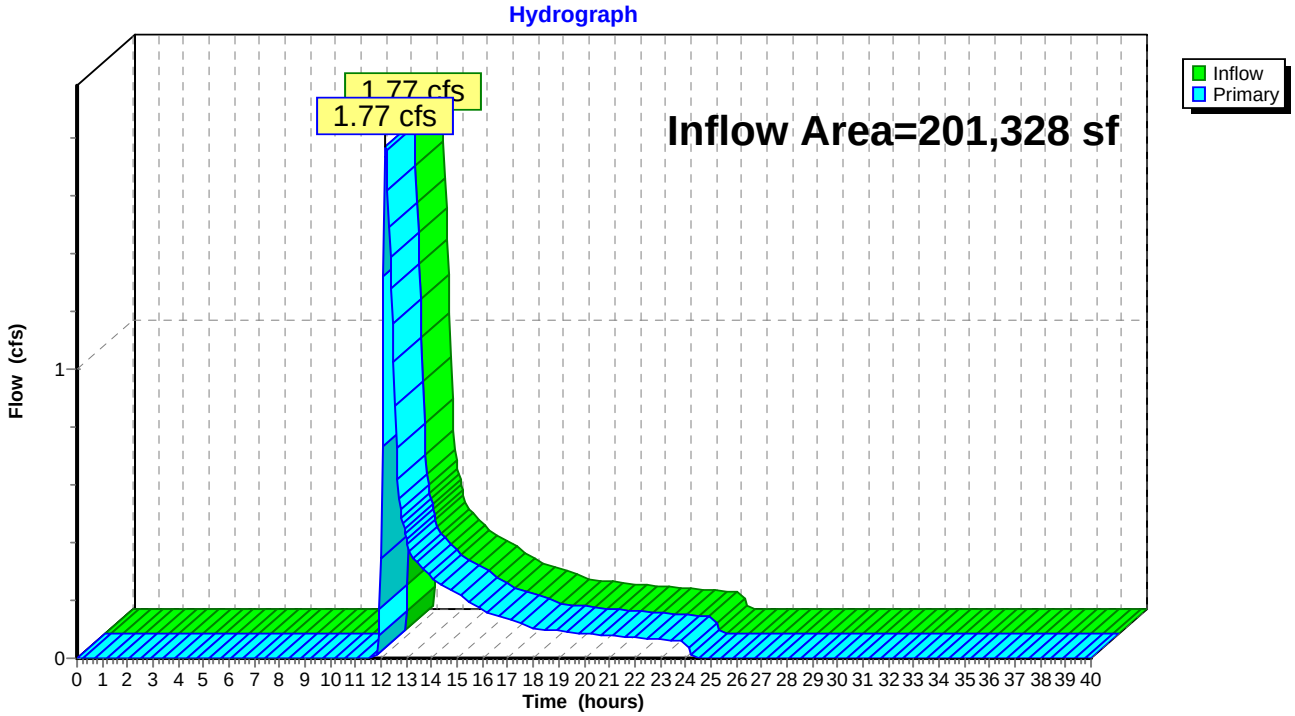


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 201,328 sf, 9.96% Impervious, Inflow Depth = 0.54" for 2 yr event
Inflow = 1.77 cfs @ 12.18 hrs, Volume= 9,015 cf
Primary = 1.77 cfs @ 12.18 hrs, Volume= 9,015 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road



Summary for Subcatchment 1S: PRE-1

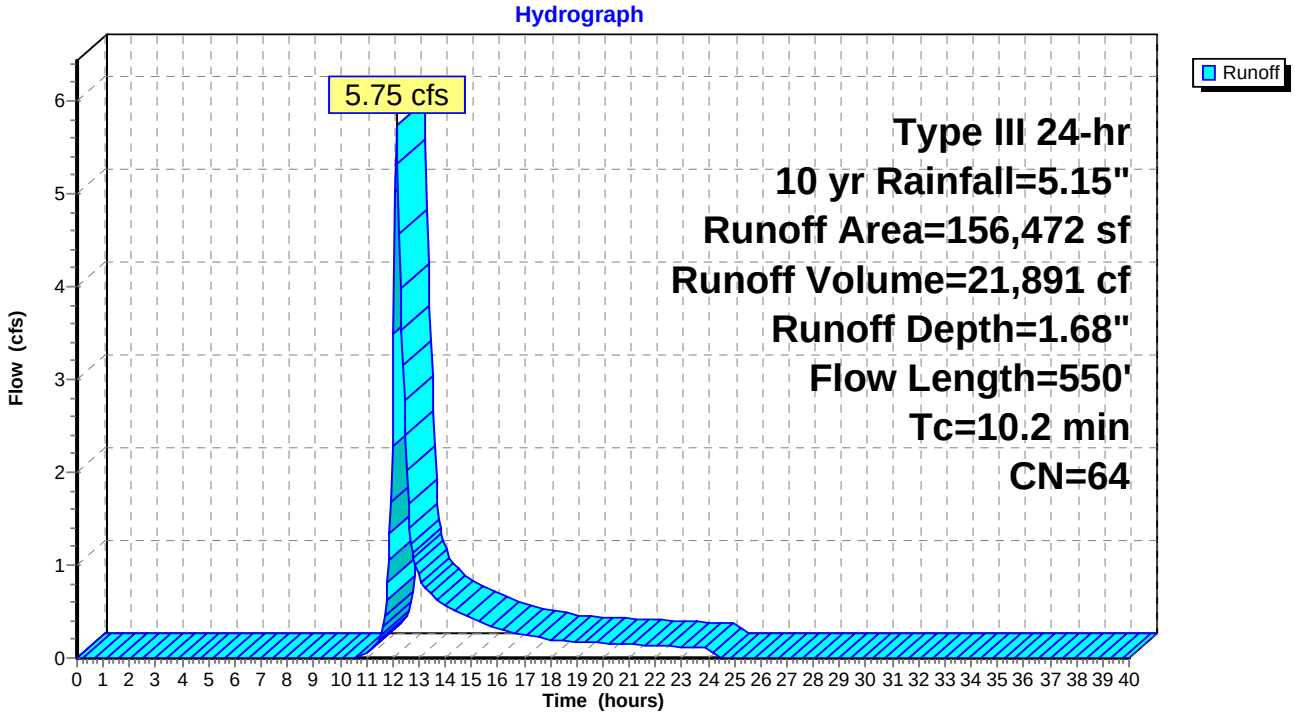
Runoff = 5.75 cfs @ 12.16 hrs, Volume= 21,891 cf, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.15"

Area (sf)	CN	Description
111,282	65	2 acre lots, 12% imp, HSG B
31,490	55	Woods, Good, HSG B
3,700	98	Paved parking, HSG B
10,000	61	>75% Grass cover, Good, HSG B
156,472	64	Weighted Average
139,418		89.10% Pervious Area
17,054		10.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	200	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	115	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.2	550	Total			

Subcatchment 1S: PRE-1



Summary for Subcatchment 2S: PRE-2

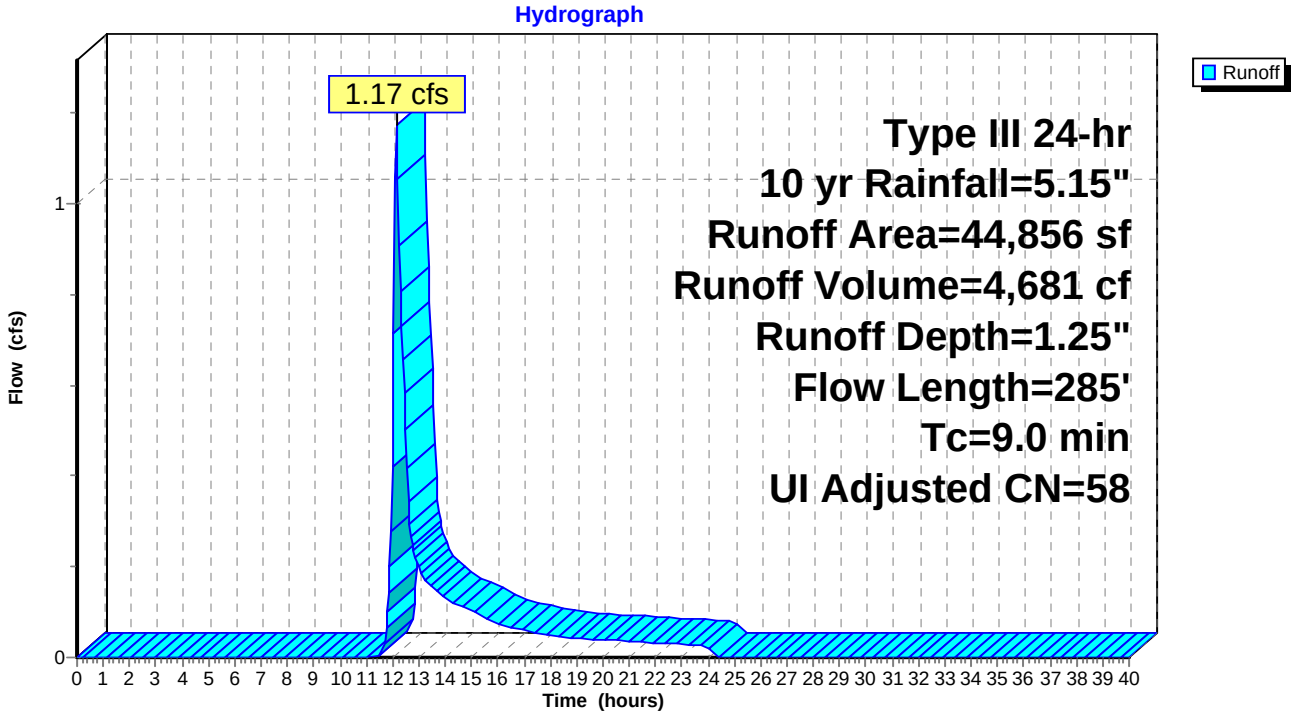
Runoff = 1.17 cfs @ 12.15 hrs, Volume= 4,681 cf, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.15"

Area (sf)	CN	Adj	Description
29,856	55		Woods, Good, HSG B
12,000	61		>75% Grass cover, Good, HSG B
3,000	98		Unconnected roofs, HSG B
44,856	59	58	Weighted Average, UI Adjusted
41,856			93.31% Pervious Area
3,000			6.69% Impervious Area
3,000			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	235	0.0860	4.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.0	285	Total			

Subcatchment 2S: PRE-2

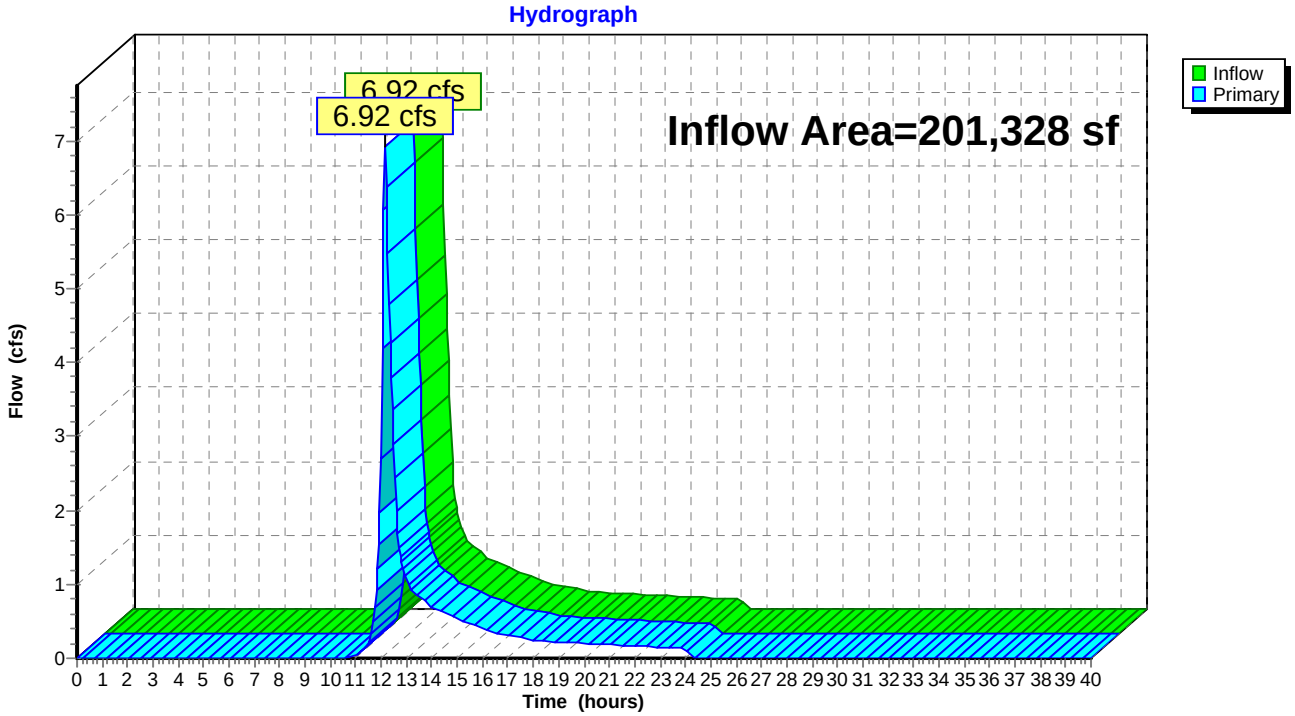


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 201,328 sf, 9.96% Impervious, Inflow Depth = 1.58" for 10 yr event
Inflow = 6.92 cfs @ 12.16 hrs, Volume= 26,571 cf
Primary = 6.92 cfs @ 12.16 hrs, Volume= 26,571 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road



Summary for Subcatchment 1S: PRE-1

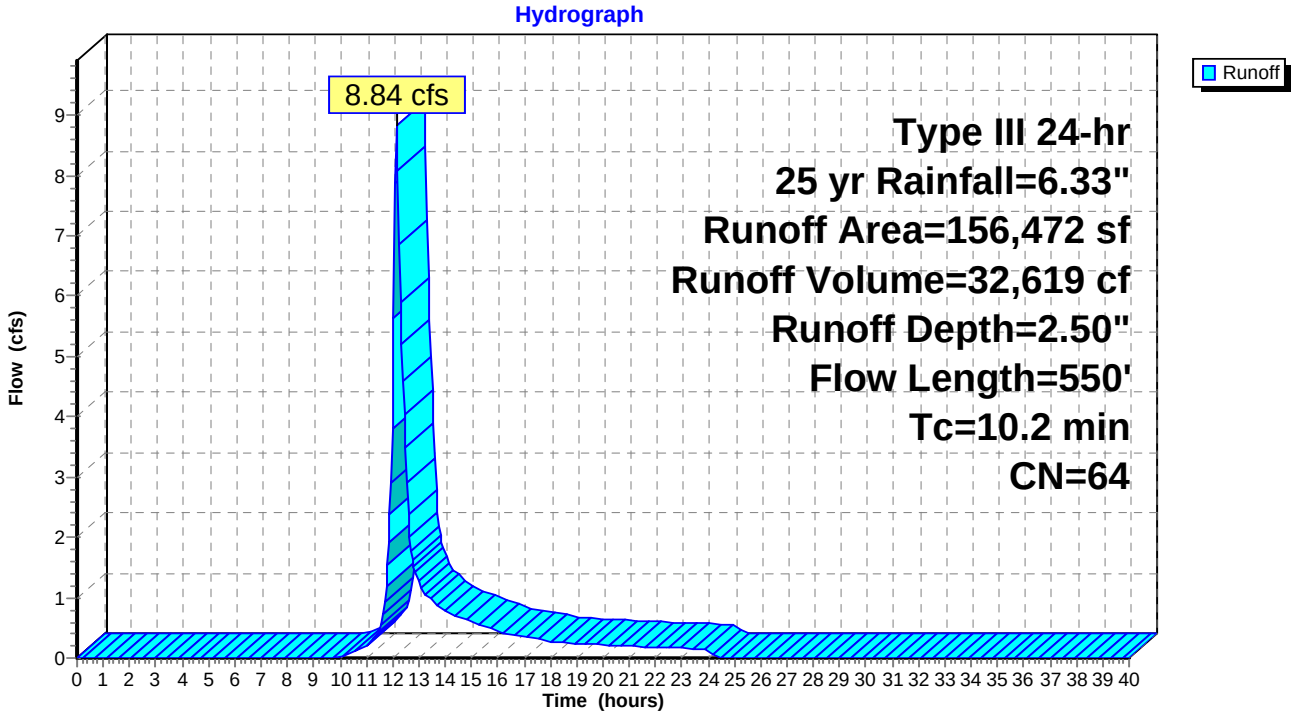
Runoff = 8.84 cfs @ 12.15 hrs, Volume= 32,619 cf, Depth= 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.33"

Area (sf)	CN	Description
111,282	65	2 acre lots, 12% imp, HSG B
31,490	55	Woods, Good, HSG B
3,700	98	Paved parking, HSG B
10,000	61	>75% Grass cover, Good, HSG B
156,472	64	Weighted Average
139,418		89.10% Pervious Area
17,054		10.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	200	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	115	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.2	550	Total			

Subcatchment 1S: PRE-1



Summary for Subcatchment 2S: PRE-2

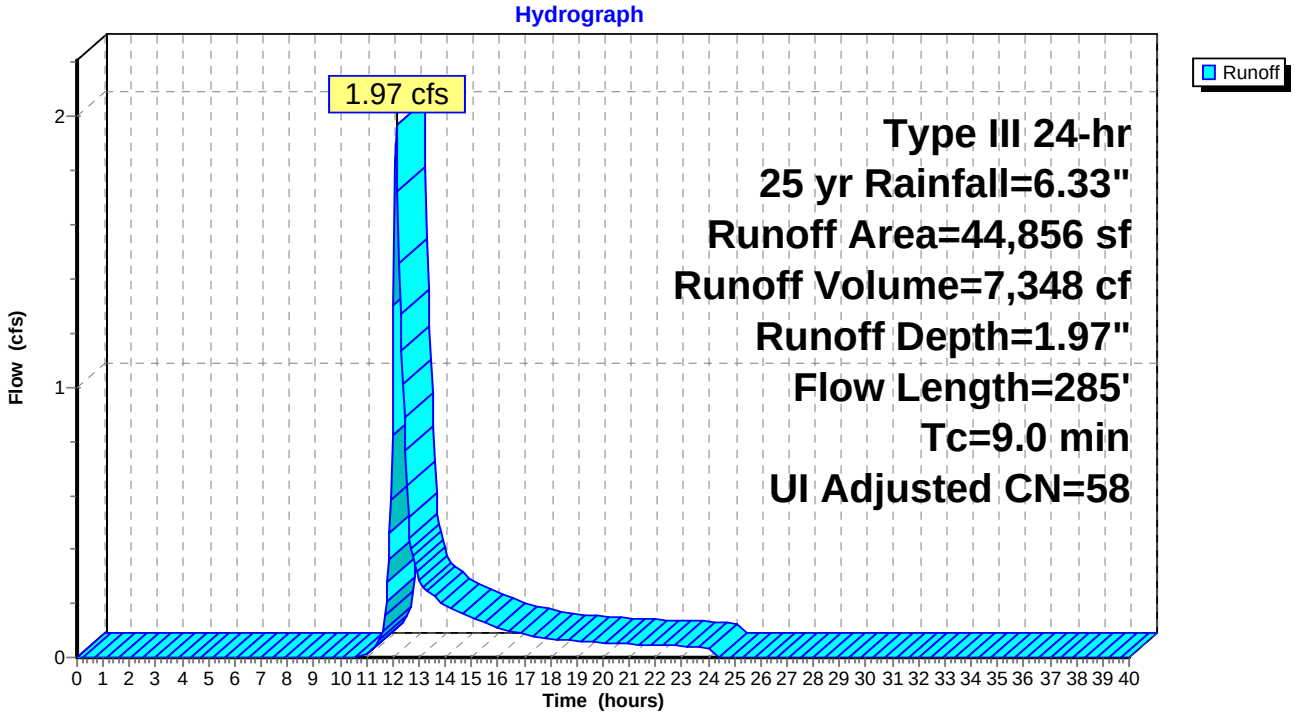
Runoff = 1.97 cfs @ 12.14 hrs, Volume= 7,348 cf, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.33"

Area (sf)	CN	Adj	Description
29,856	55		Woods, Good, HSG B
12,000	61		>75% Grass cover, Good, HSG B
3,000	98		Unconnected roofs, HSG B
44,856	59	58	Weighted Average, UI Adjusted
41,856			93.31% Pervious Area
3,000			6.69% Impervious Area
3,000			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	235	0.0860	4.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.0	285	Total			

Subcatchment 2S: PRE-2

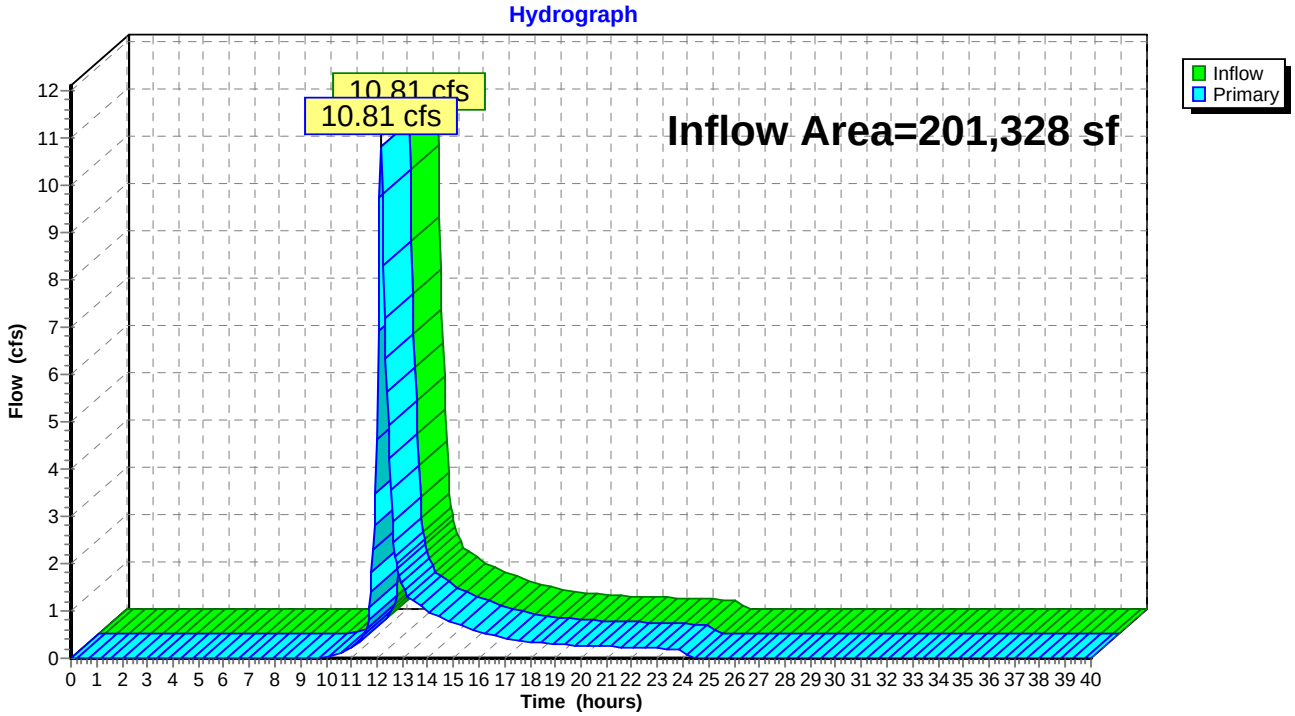


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 201,328 sf, 9.96% Impervious, Inflow Depth = 2.38" for 25 yr event
Inflow = 10.81 cfs @ 12.15 hrs, Volume= 39,967 cf
Primary = 10.81 cfs @ 12.15 hrs, Volume= 39,967 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road



Summary for Subcatchment 1S: PRE-1

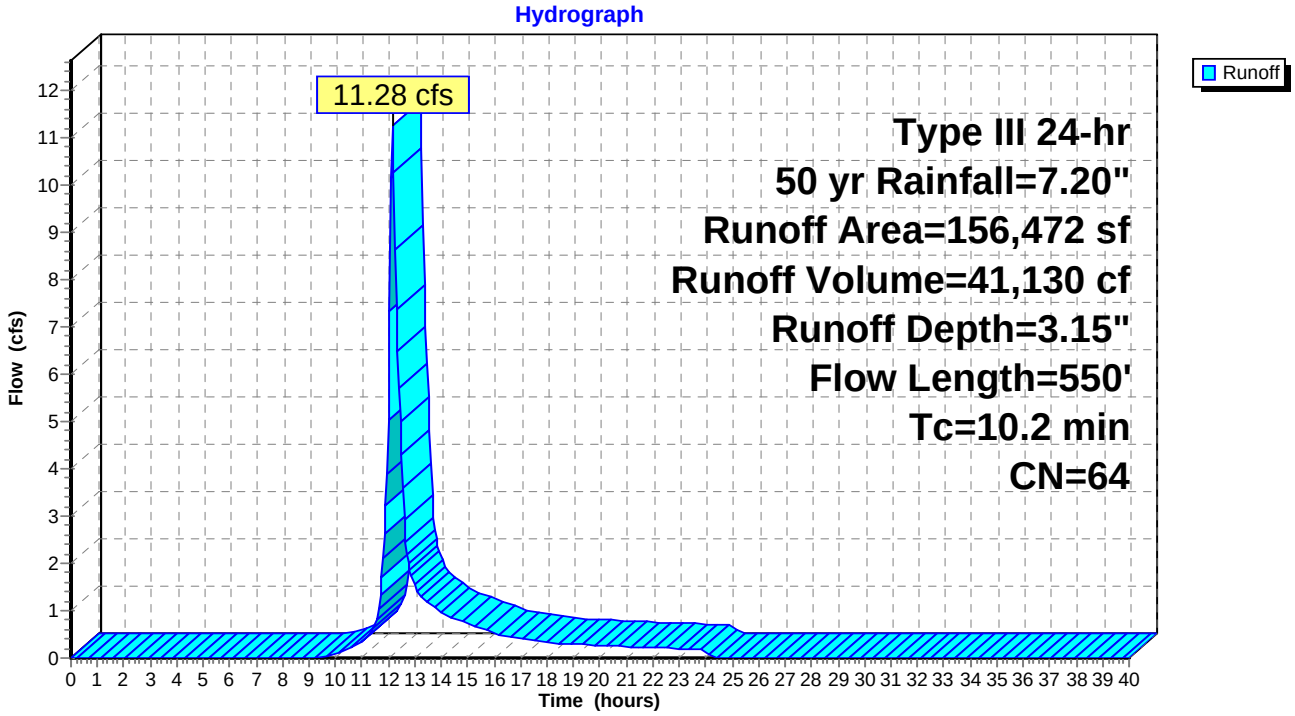
Runoff = 11.28 cfs @ 12.15 hrs, Volume= 41,130 cf, Depth= 3.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=7.20"

Area (sf)	CN	Description
111,282	65	2 acre lots, 12% imp, HSG B
31,490	55	Woods, Good, HSG B
3,700	98	Paved parking, HSG B
10,000	61	>75% Grass cover, Good, HSG B
156,472	64	Weighted Average
139,418		89.10% Pervious Area
17,054		10.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	200	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	115	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.2	550	Total			

Subcatchment 1S: PRE-1



Summary for Subcatchment 2S: PRE-2

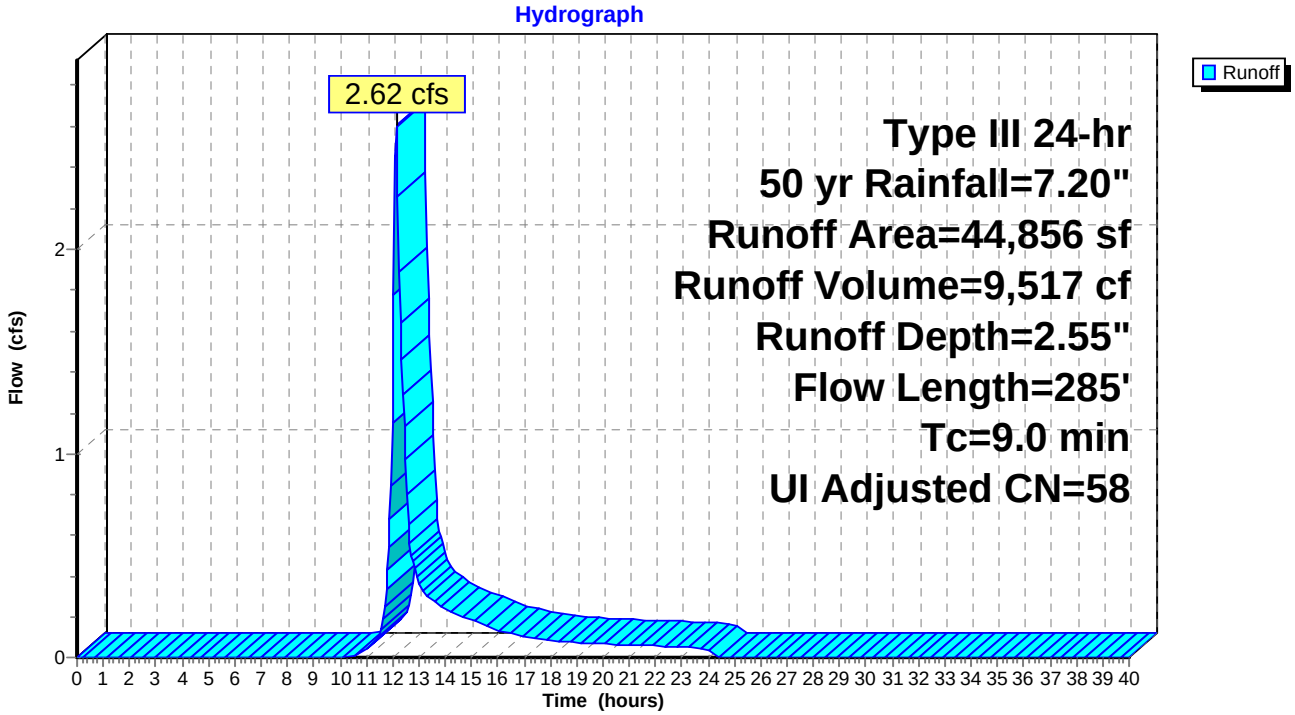
Runoff = 2.62 cfs @ 12.14 hrs, Volume= 9,517 cf, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=7.20"

Area (sf)	CN	Adj	Description
29,856	55		Woods, Good, HSG B
12,000	61		>75% Grass cover, Good, HSG B
3,000	98		Unconnected roofs, HSG B
44,856	59	58	Weighted Average, UI Adjusted
41,856			93.31% Pervious Area
3,000			6.69% Impervious Area
3,000			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	235	0.0860	4.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.0	285	Total			

Subcatchment 2S: PRE-2

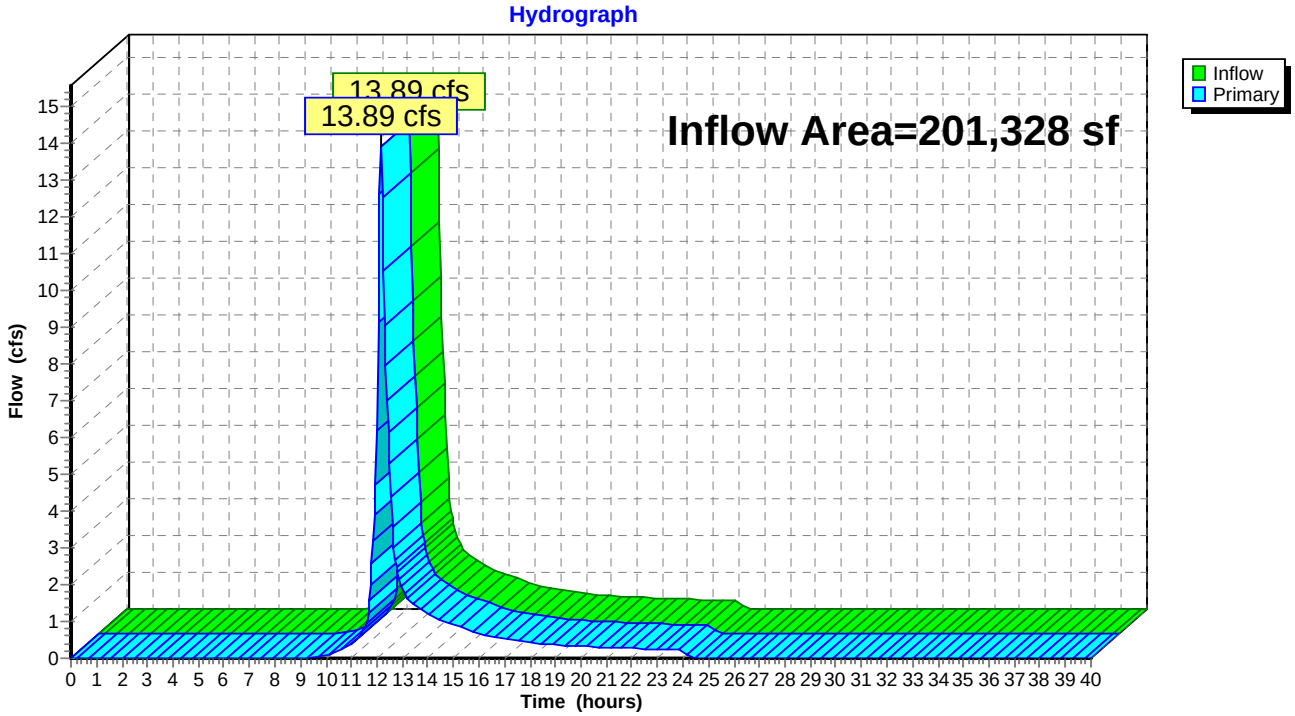


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 201,328 sf, 9.96% Impervious, Inflow Depth = 3.02" for 50 yr event
Inflow = 13.89 cfs @ 12.15 hrs, Volume= 50,648 cf
Primary = 13.89 cfs @ 12.15 hrs, Volume= 50,648 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road



Summary for Subcatchment 1S: PRE-1

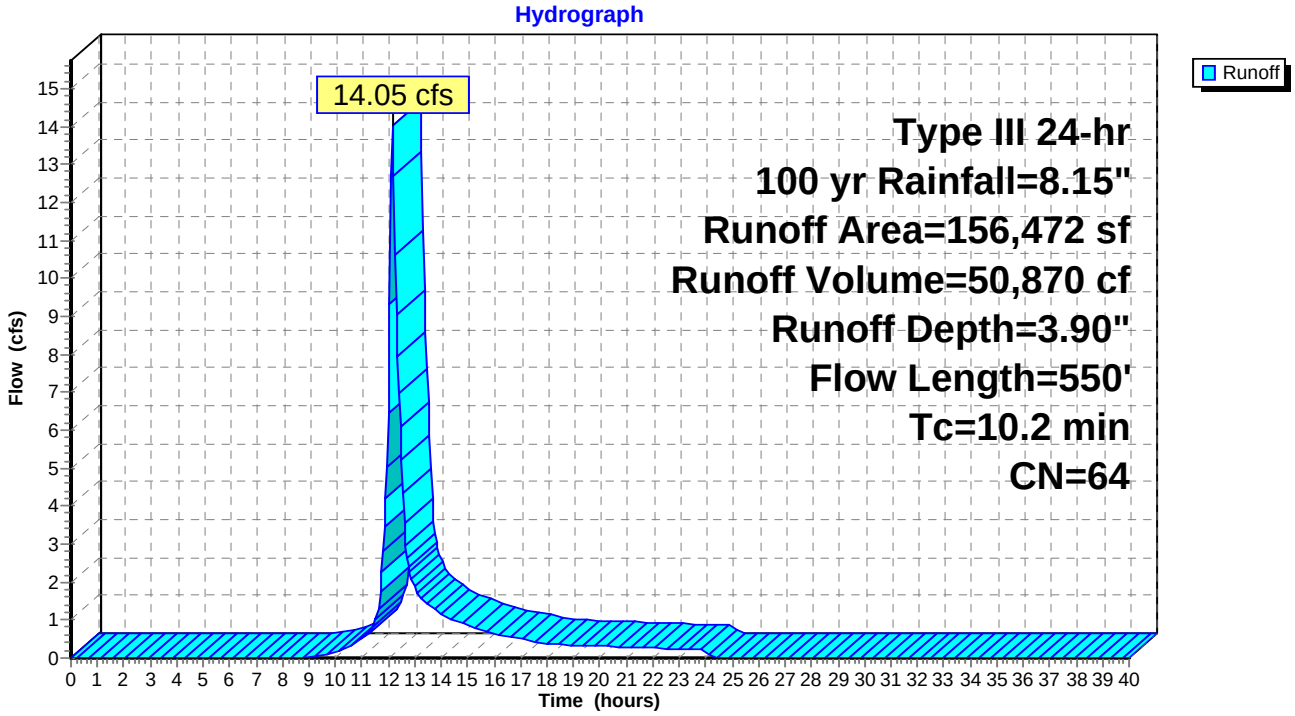
Runoff = 14.05 cfs @ 12.15 hrs, Volume= 50,870 cf, Depth= 3.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.15"

Area (sf)	CN	Description
111,282	65	2 acre lots, 12% imp, HSG B
31,490	55	Woods, Good, HSG B
3,700	98	Paved parking, HSG B
10,000	61	>75% Grass cover, Good, HSG B
156,472	64	Weighted Average
139,418		89.10% Pervious Area
17,054		10.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	200	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	115	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.2	550	Total			

Subcatchment 1S: PRE-1



Summary for Subcatchment 2S: PRE-2

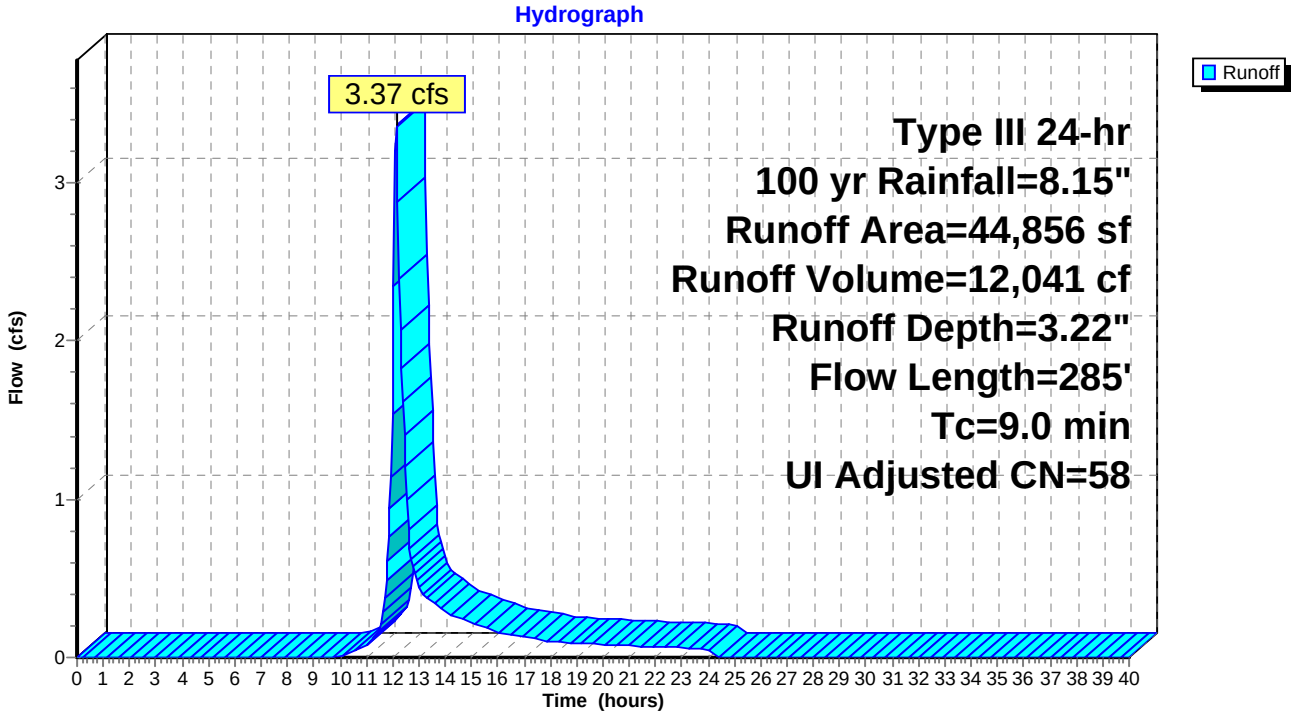
Runoff = 3.37 cfs @ 12.14 hrs, Volume= 12,041 cf, Depth= 3.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.15"

Area (sf)	CN	Adj	Description
29,856	55		Woods, Good, HSG B
12,000	61		>75% Grass cover, Good, HSG B
3,000	98		Unconnected roofs, HSG B
44,856	59	58	Weighted Average, UI Adjusted
41,856			93.31% Pervious Area
3,000			6.69% Impervious Area
3,000			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0540	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	235	0.0860	4.72		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.0	285	Total			

Subcatchment 2S: PRE-2

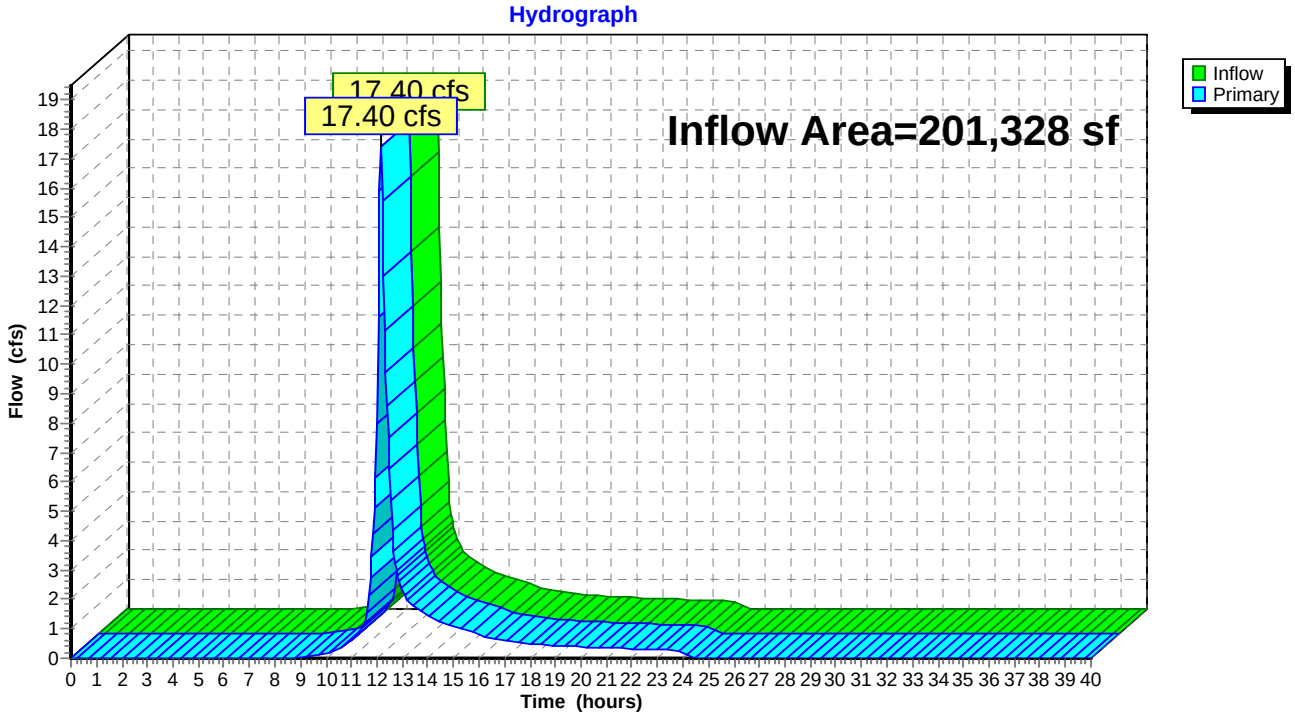


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

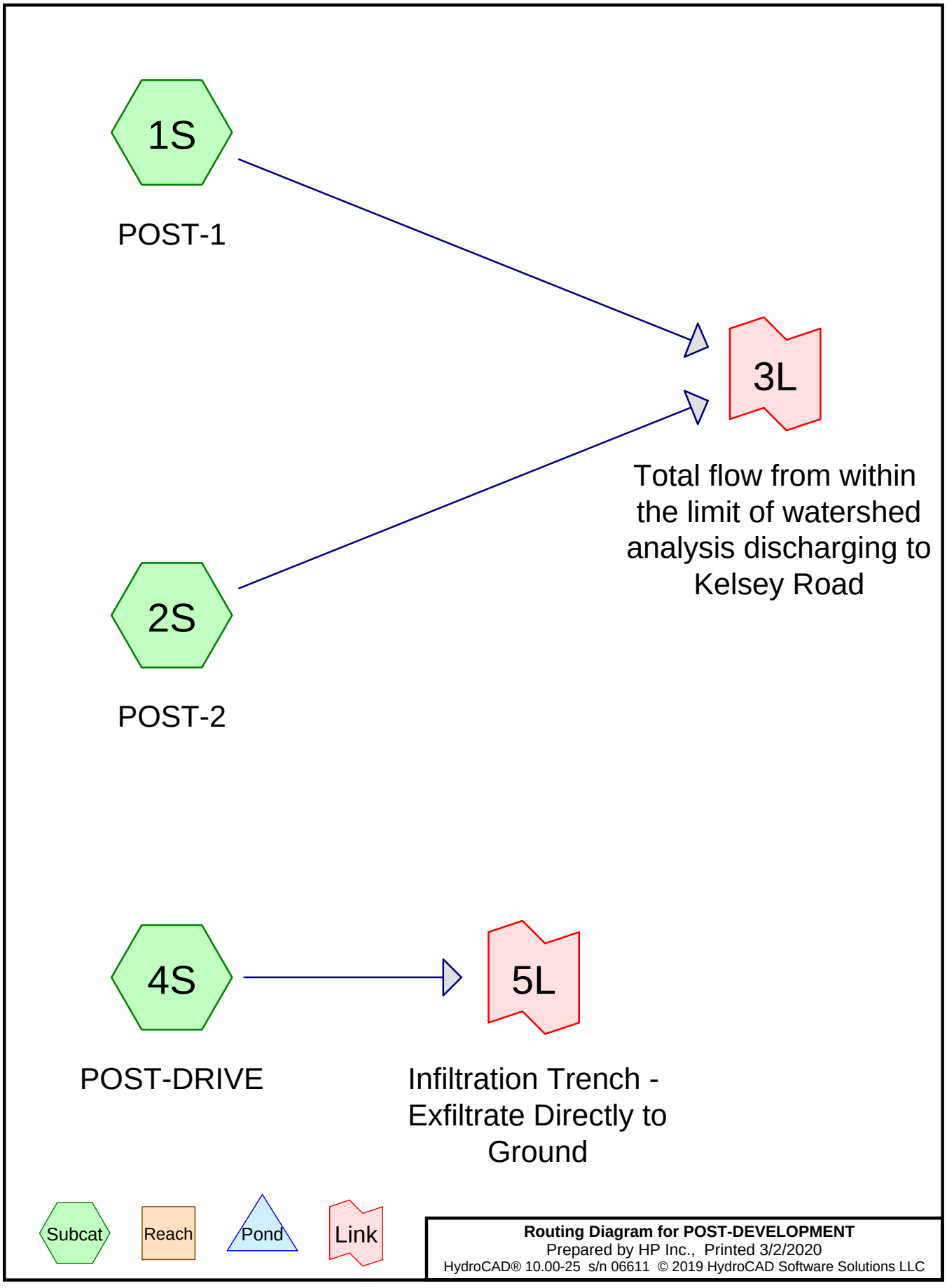
Inflow Area = 201,328 sf, 9.96% Impervious, Inflow Depth = 3.75" for 100 yr event
Inflow = 17.40 cfs @ 12.15 hrs, Volume= 62,910 cf
Primary = 17.40 cfs @ 12.15 hrs, Volume= 62,910 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road



Proposed Condition



Routing Diagram for POST-DEVELOPMENT
Prepared by HP Inc., Printed 3/2/2020

Summary for Subcatchment 1S: POST-1

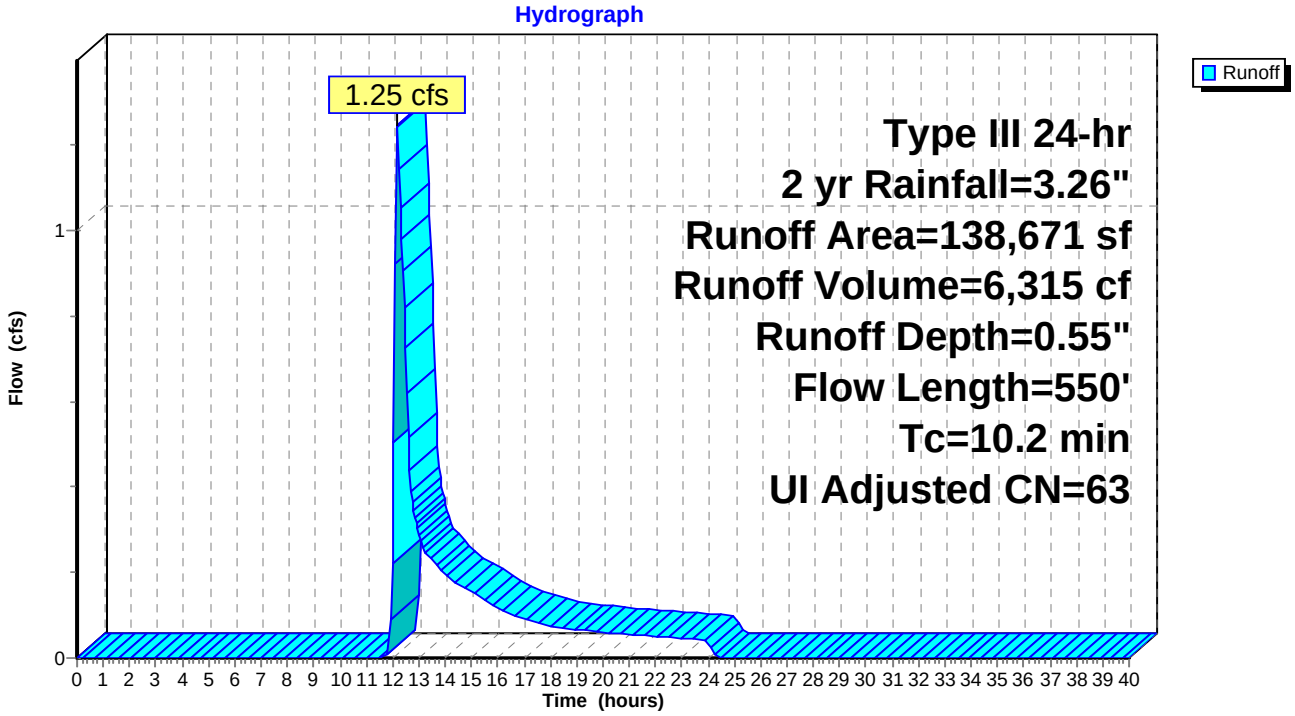
Runoff = 1.25 cfs @ 12.19 hrs, Volume= 6,315 cf, Depth= 0.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.26"

Area (sf)	CN	Adj	Description
111,282	65		2 acre lots, 12% imp, HSG B
18,972	55		Woods, Good, HSG B
417	98		Unconnected roofs, HSG B
8,000	61		>75% Grass cover, Good, HSG B
138,671	64	63	Weighted Average, UI Adjusted
124,900			90.07% Pervious Area
13,771			9.93% Impervious Area
417			3.03% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.5	315	0.0460	3.45		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	550	Total			

Subcatchment 1S: POST-1



Summary for Subcatchment 2S: POST-2

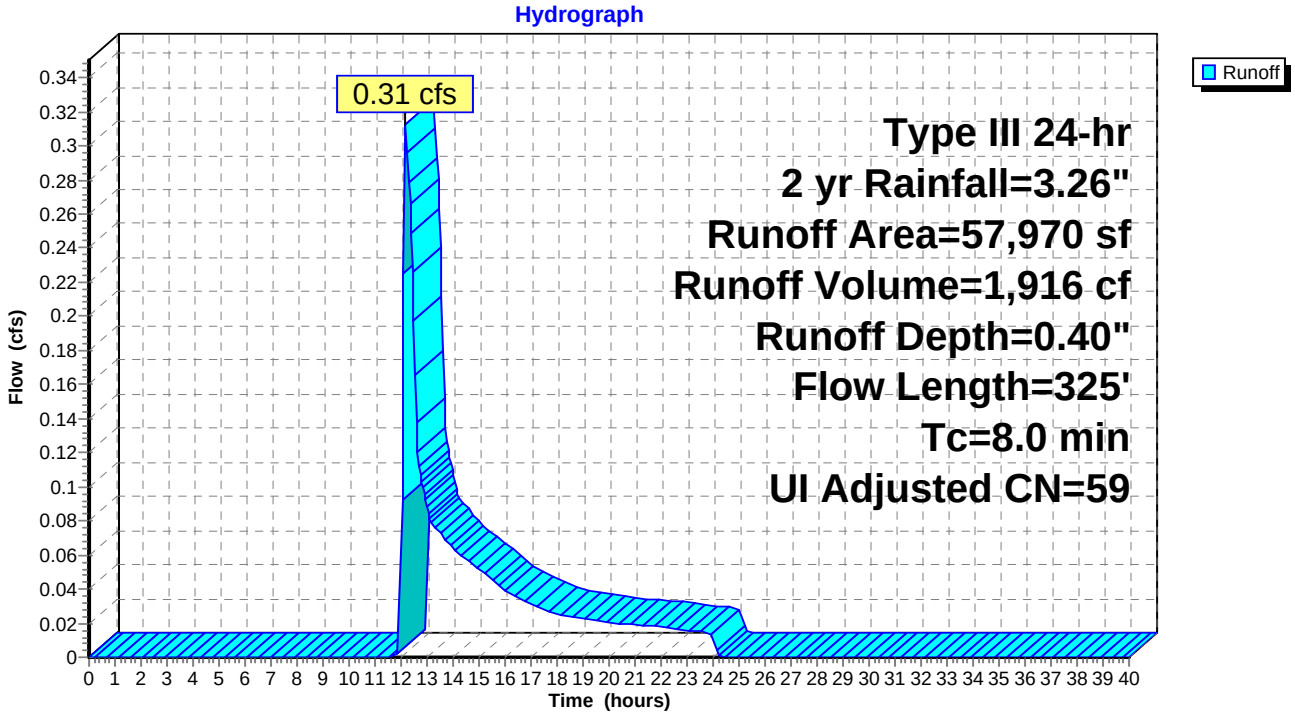
Runoff = 0.31 cfs @ 12.17 hrs, Volume= 1,916 cf, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.26"

Area (sf)	CN	Adj	Description
21,000	55		Woods, Good, HSG B
35,016	61		>75% Grass cover, Good, HSG B
1,954	98		Unconnected roofs, HSG B
57,970	60	59	Weighted Average, UI Adjusted
56,016			96.63% Pervious Area
1,954			3.37% Impervious Area
1,954			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0120	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.26"
0.5	75	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	200	0.0900	4.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	325	Total			

Subcatchment 2S: POST-2



Summary for Subcatchment 4S: POST-DRIVE

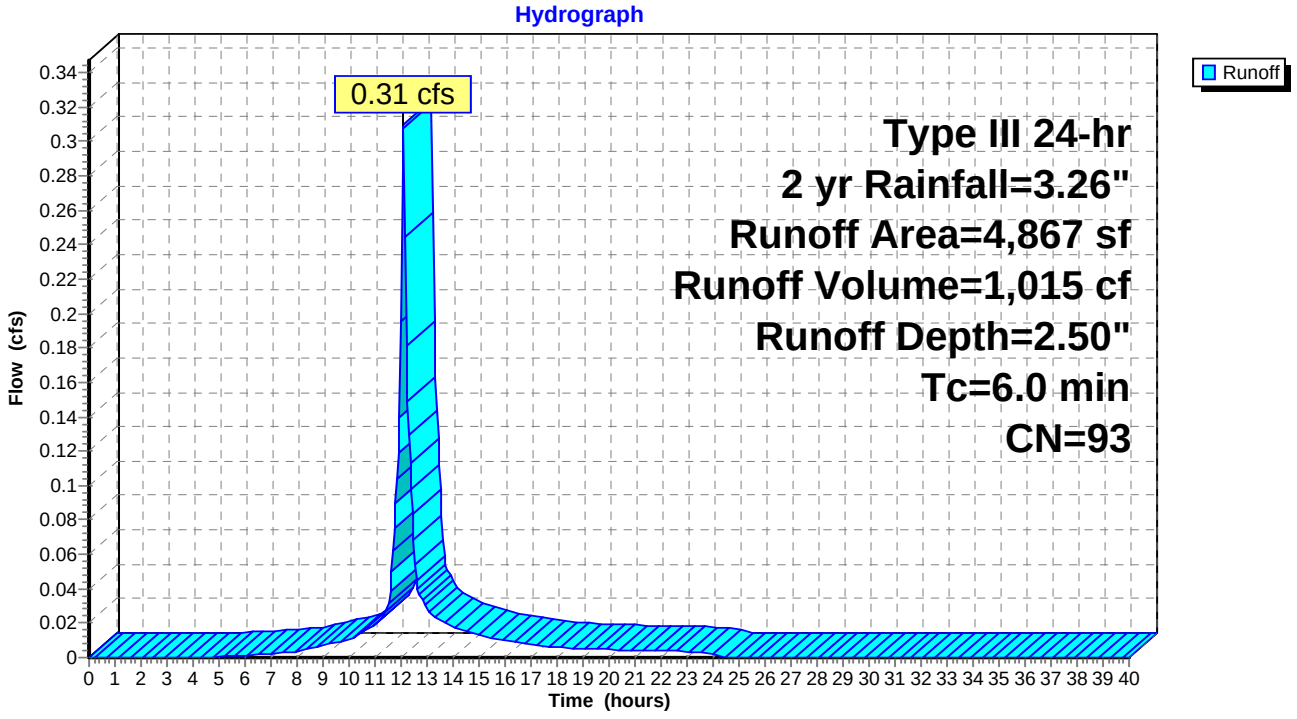
Runoff = 0.31 cfs @ 12.09 hrs, Volume= 1,015 cf, Depth= 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 yr Rainfall=3.26"

Area (sf)	CN	Description
4,232	98	Unconnected pavement, HSG B
635	61	>75% Grass cover, Good, HSG B
4,867	93	Weighted Average
635		13.05% Pervious Area
4,232		86.95% Impervious Area
4,232		100.00% Unconnected

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

Subcatchment 4S: POST-DRIVE

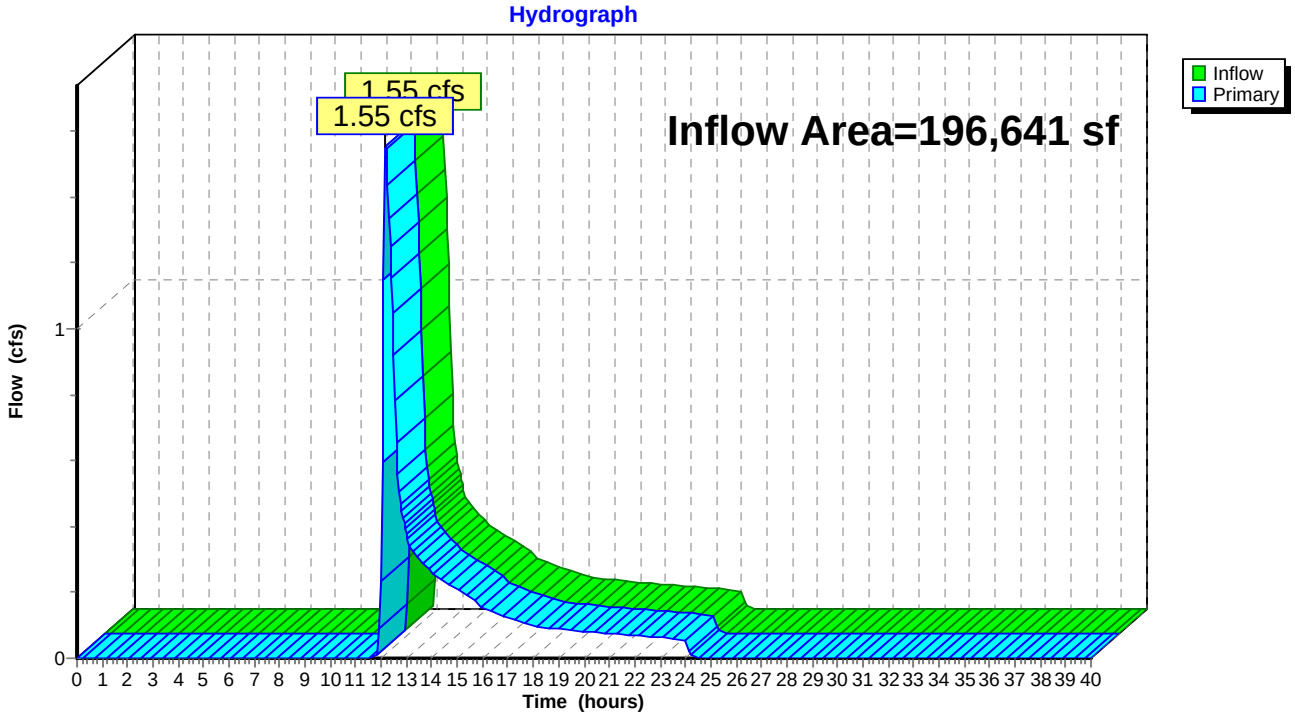


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 196,641 sf, 8.00% Impervious, Inflow Depth = 0.50" for 2 yr event
Inflow = 1.55 cfs @ 12.18 hrs, Volume= 8,231 cf
Primary = 1.55 cfs @ 12.18 hrs, Volume= 8,231 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road

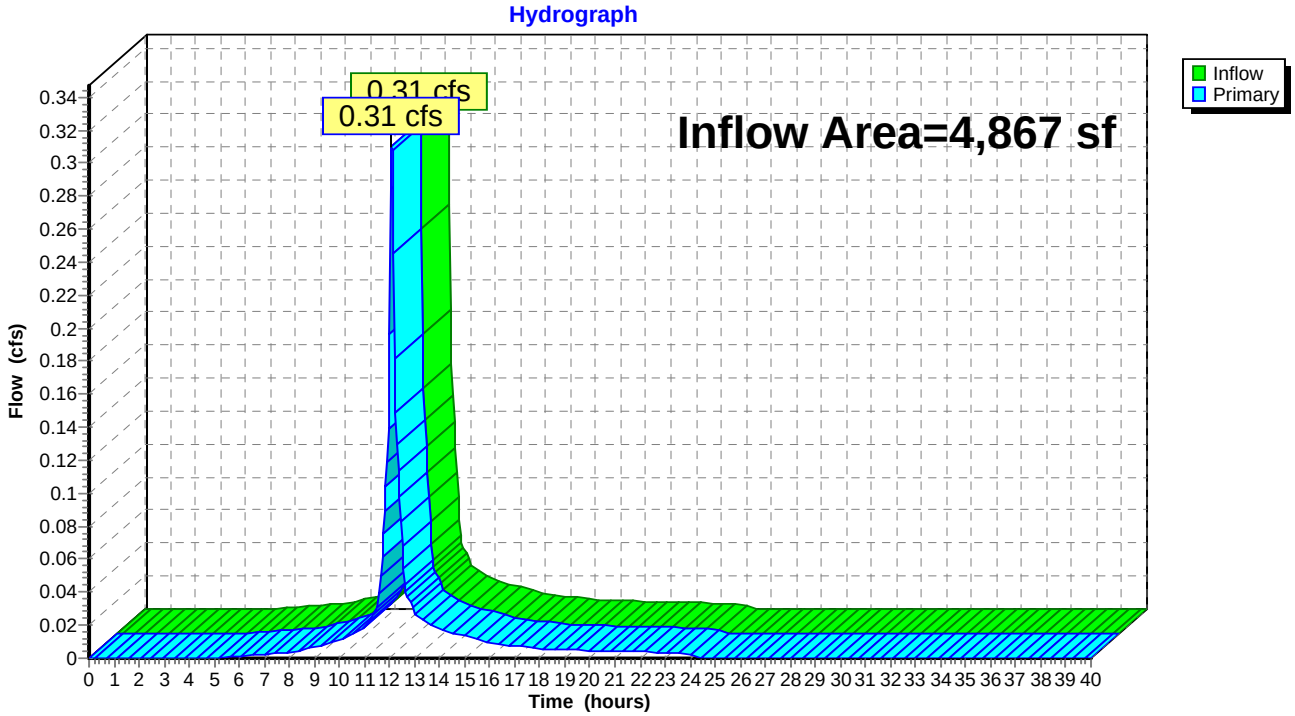


Summary for Link 5L: Infiltration Trench - Exfiltrate Directly to Ground

Inflow Area = 4,867 sf, 86.95% Impervious, Inflow Depth = 2.50" for 2 yr event
Inflow = 0.31 cfs @ 12.09 hrs, Volume= 1,015 cf
Primary = 0.31 cfs @ 12.09 hrs, Volume= 1,015 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 5L: Infiltration Trench - Exfiltrate Directly to Ground



Summary for Subcatchment 1S: POST-1

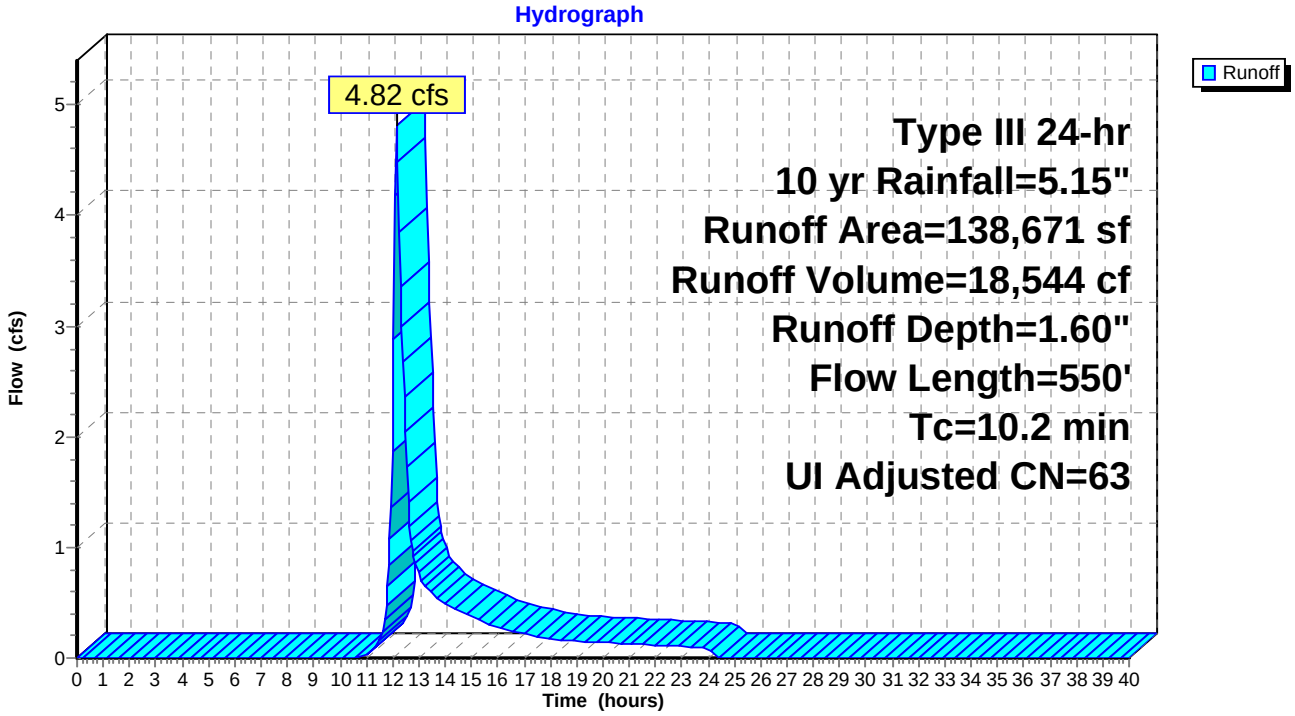
Runoff = 4.82 cfs @ 12.16 hrs, Volume= 18,544 cf, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.15"

Area (sf)	CN	Adj	Description
111,282	65		2 acre lots, 12% imp, HSG B
18,972	55		Woods, Good, HSG B
417	98		Unconnected roofs, HSG B
8,000	61		>75% Grass cover, Good, HSG B
138,671	64	63	Weighted Average, UI Adjusted
124,900			90.07% Pervious Area
13,771			9.93% Impervious Area
417			3.03% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.5	315	0.0460	3.45		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	550	Total			

Subcatchment 1S: POST-1



Summary for Subcatchment 2S: POST-2

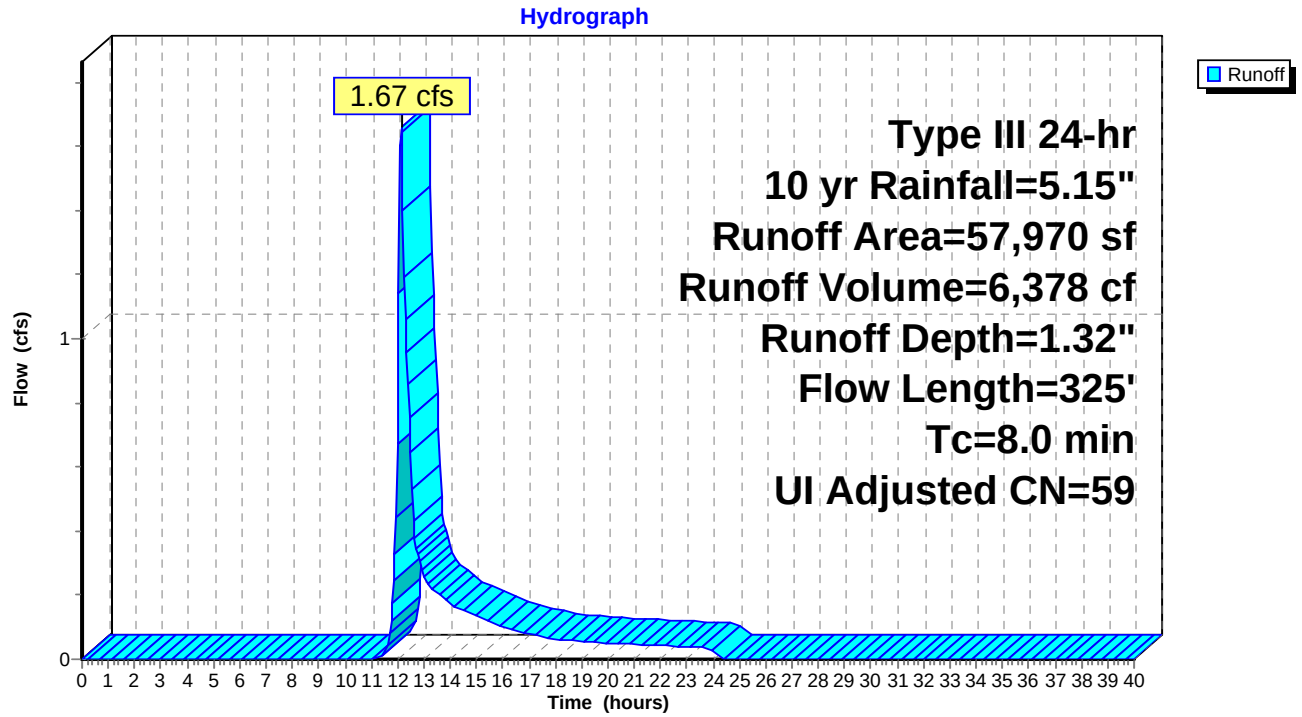
Runoff = 1.67 cfs @ 12.13 hrs, Volume= 6,378 cf, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.15"

Area (sf)	CN	Adj	Description
21,000	55		Woods, Good, HSG B
35,016	61		>75% Grass cover, Good, HSG B
1,954	98		Unconnected roofs, HSG B
57,970	60	59	Weighted Average, UI Adjusted
56,016			96.63% Pervious Area
1,954			3.37% Impervious Area
1,954			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0120	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.26"
0.5	75	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	200	0.0900	4.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	325	Total			

Subcatchment 2S: POST-2



Summary for Subcatchment 4S: POST-DRIVE

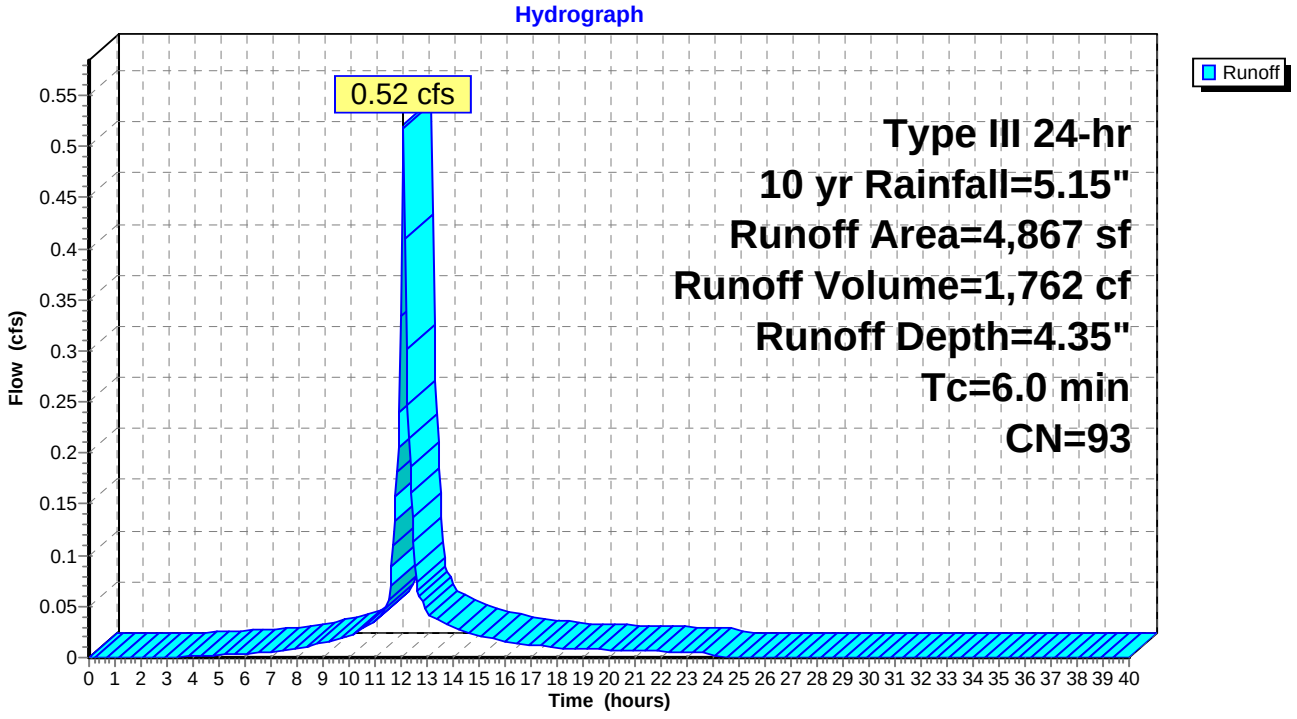
Runoff = 0.52 cfs @ 12.09 hrs, Volume= 1,762 cf, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 yr Rainfall=5.15"

Area (sf)	CN	Description
4,232	98	Unconnected pavement, HSG B
635	61	>75% Grass cover, Good, HSG B
4,867	93	Weighted Average
635		13.05% Pervious Area
4,232		86.95% Impervious Area
4,232		100.00% Unconnected

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

Subcatchment 4S: POST-DRIVE

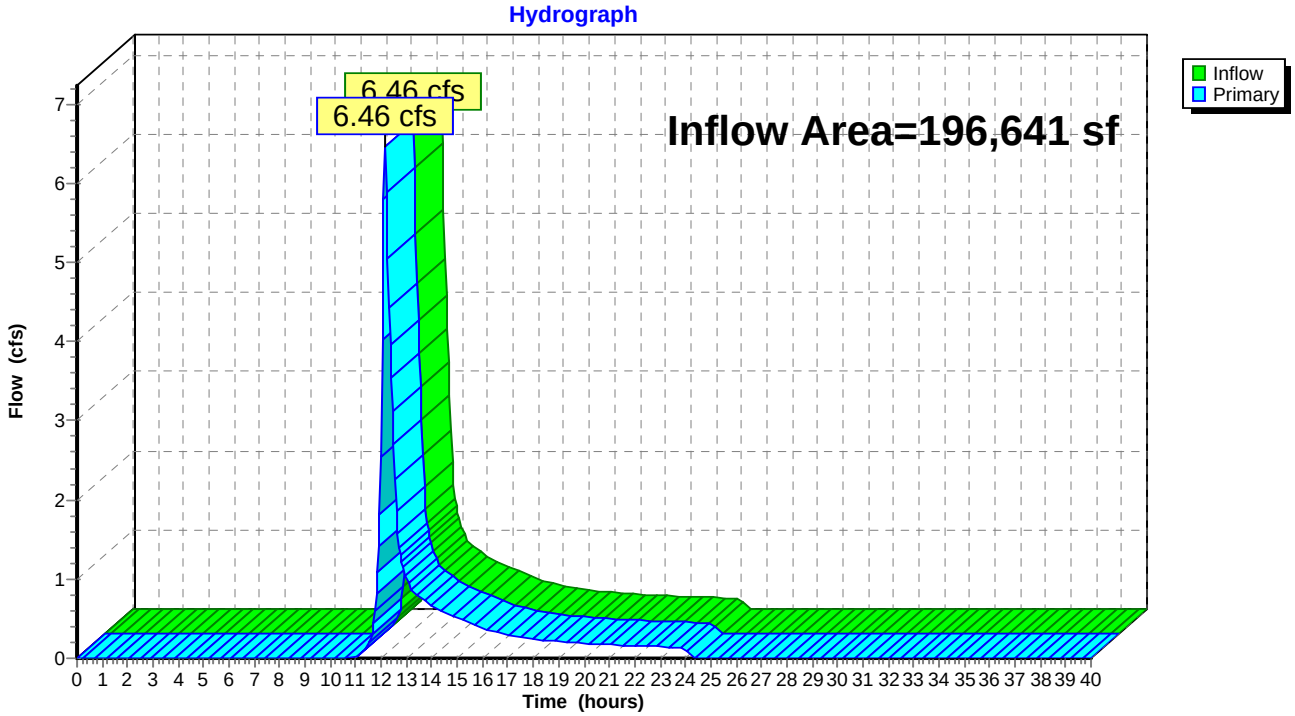


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 196,641 sf, 8.00% Impervious, Inflow Depth = 1.52" for 10 yr event
Inflow = 6.46 cfs @ 12.15 hrs, Volume= 24,922 cf
Primary = 6.46 cfs @ 12.15 hrs, Volume= 24,922 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road

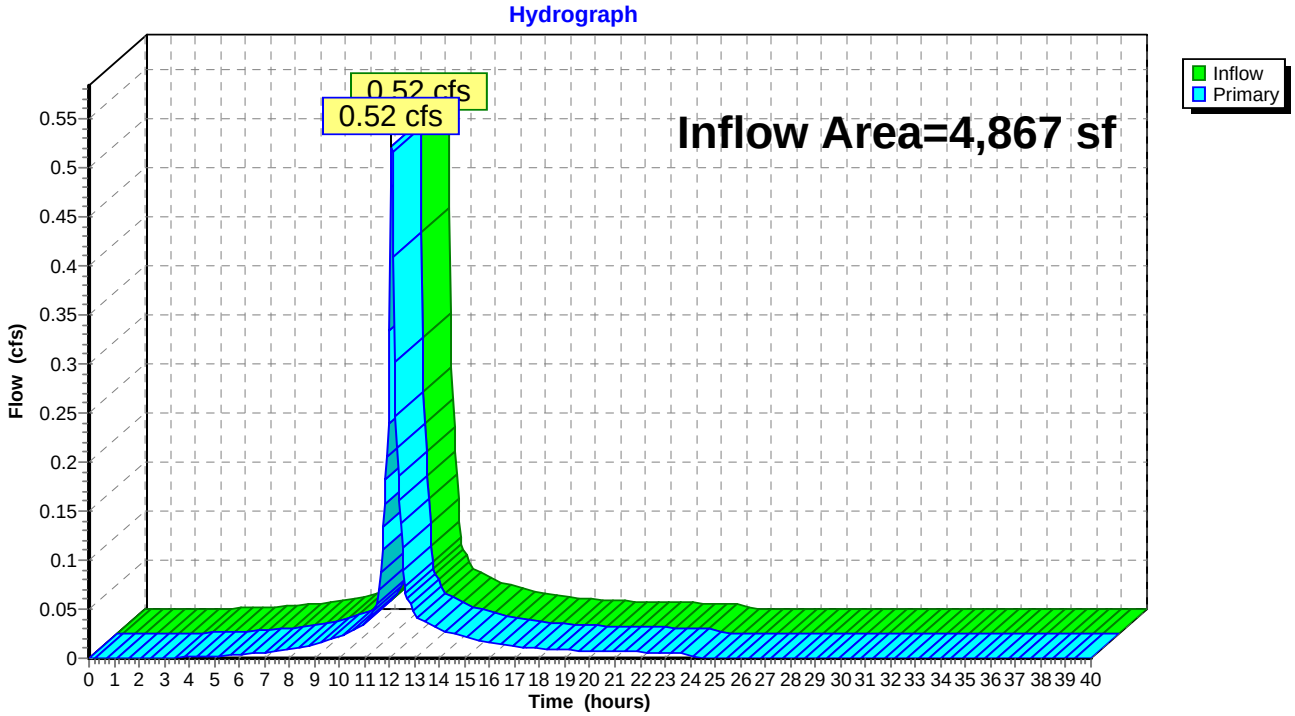


Summary for Link 5L: Infiltration Trench - Exfiltrate Directly to Ground

Inflow Area = 4,867 sf, 86.95% Impervious, Inflow Depth = 4.35" for 10 yr event
Inflow = 0.52 cfs @ 12.09 hrs, Volume= 1,762 cf
Primary = 0.52 cfs @ 12.09 hrs, Volume= 1,762 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 5L: Infiltration Trench - Exfiltrate Directly to Ground



Summary for Subcatchment 1S: POST-1

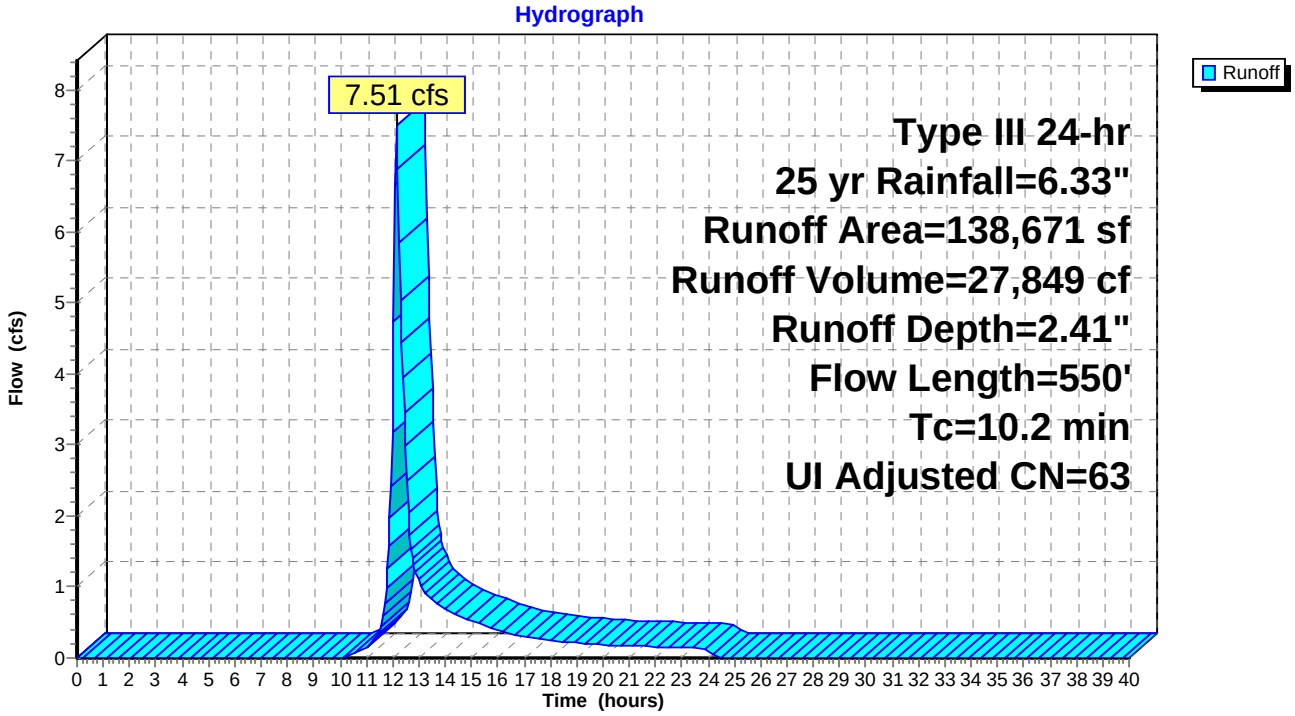
Runoff = 7.51 cfs @ 12.15 hrs, Volume= 27,849 cf, Depth= 2.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.33"

Area (sf)	CN	Adj	Description
111,282	65		2 acre lots, 12% imp, HSG B
18,972	55		Woods, Good, HSG B
417	98		Unconnected roofs, HSG B
8,000	61		>75% Grass cover, Good, HSG B
138,671	64	63	Weighted Average, UI Adjusted
124,900			90.07% Pervious Area
13,771			9.93% Impervious Area
417			3.03% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.5	315	0.0460	3.45		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	550	Total			

Subcatchment 1S: POST-1



Summary for Subcatchment 2S: POST-2

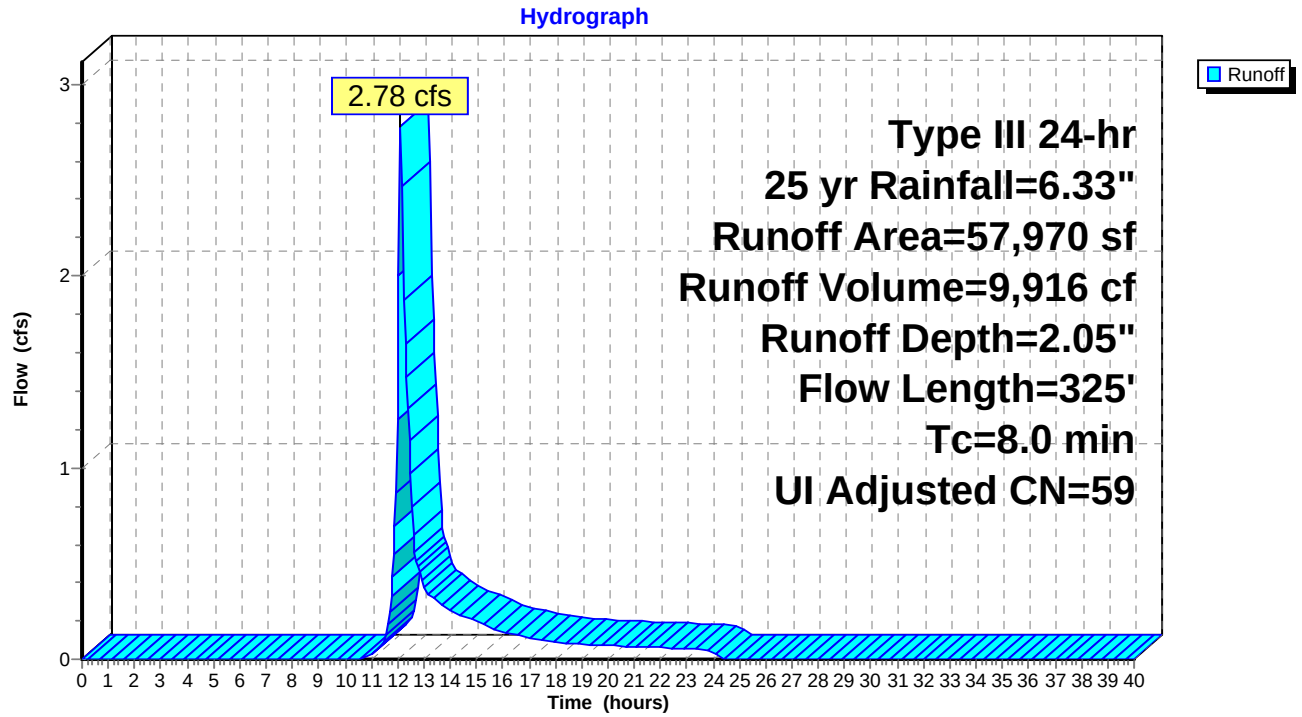
Runoff = 2.78 cfs @ 12.12 hrs, Volume= 9,916 cf, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.33"

Area (sf)	CN	Adj	Description
21,000	55		Woods, Good, HSG B
35,016	61		>75% Grass cover, Good, HSG B
1,954	98		Unconnected roofs, HSG B
57,970	60	59	Weighted Average, UI Adjusted
56,016			96.63% Pervious Area
1,954			3.37% Impervious Area
1,954			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0120	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.26"
0.5	75	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	200	0.0900	4.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	325	Total			

Subcatchment 2S: POST-2



Summary for Subcatchment 4S: POST-DRIVE

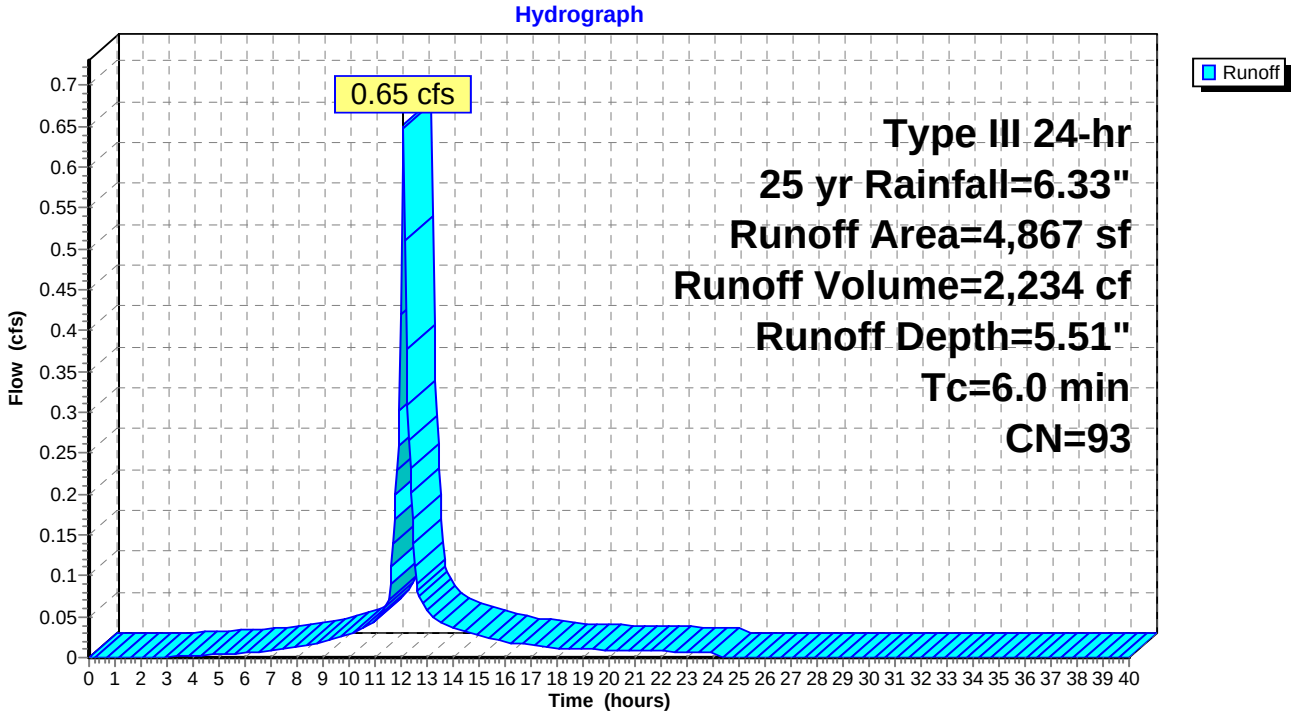
Runoff = 0.65 cfs @ 12.09 hrs, Volume= 2,234 cf, Depth= 5.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 yr Rainfall=6.33"

Area (sf)	CN	Description
4,232	98	Unconnected pavement, HSG B
635	61	>75% Grass cover, Good, HSG B
4,867	93	Weighted Average
635		13.05% Pervious Area
4,232		86.95% Impervious Area
4,232		100.00% Unconnected

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

Subcatchment 4S: POST-DRIVE

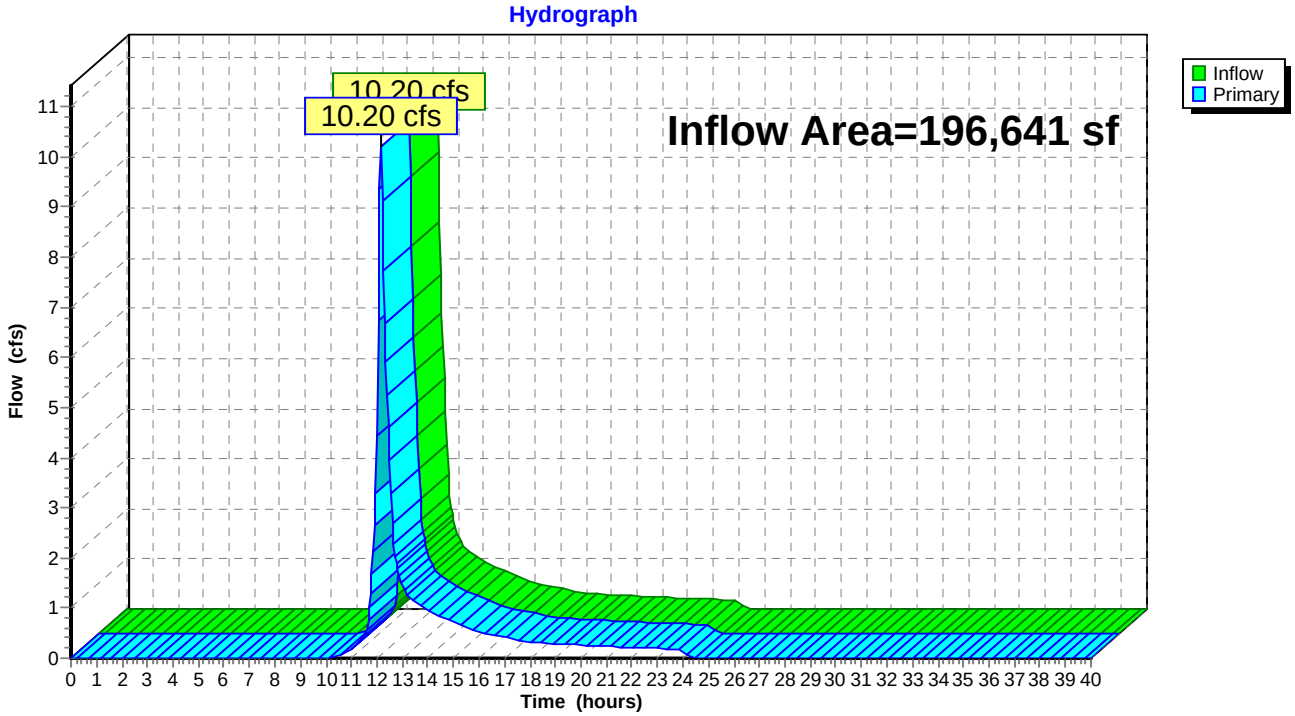


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 196,641 sf, 8.00% Impervious, Inflow Depth = 2.30" for 25 yr event
Inflow = 10.20 cfs @ 12.15 hrs, Volume= 37,766 cf
Primary = 10.20 cfs @ 12.15 hrs, Volume= 37,766 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road

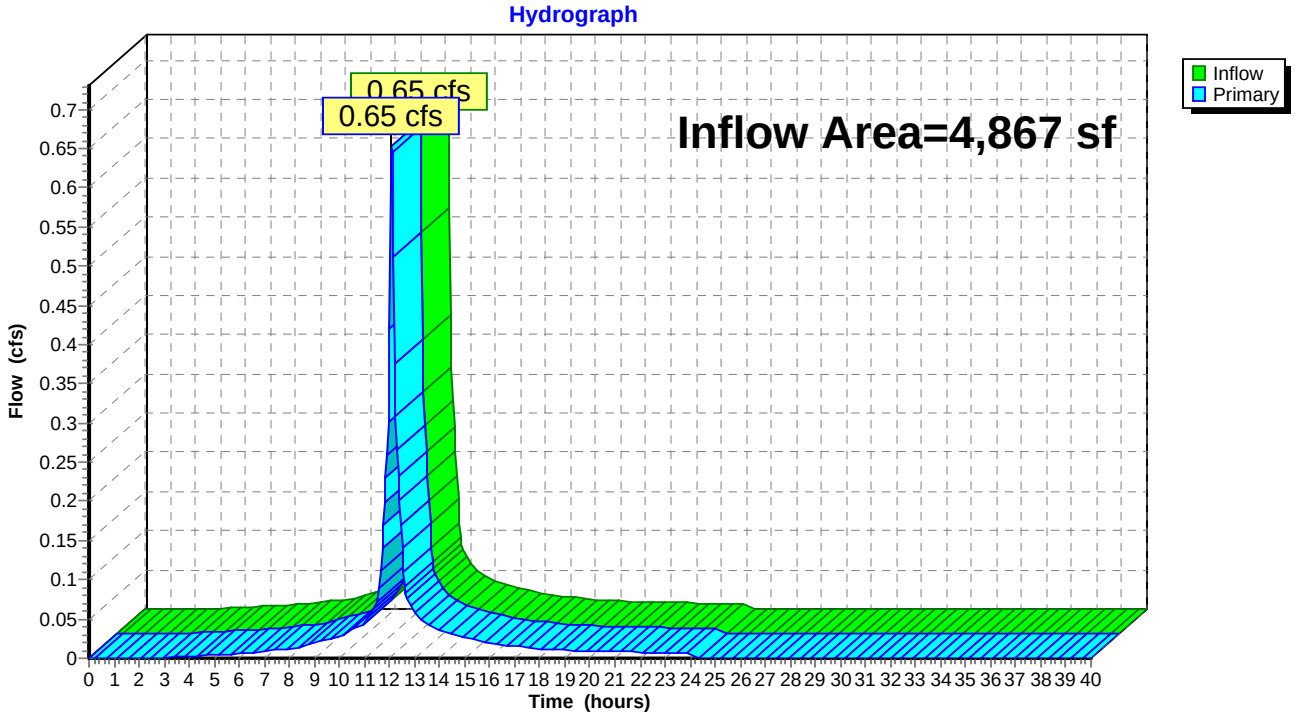


Summary for Link 5L: Infiltration Trench - Exfiltrate Directly to Ground

Inflow Area = 4,867 sf, 86.95% Impervious, Inflow Depth = 5.51" for 25 yr event
Inflow = 0.65 cfs @ 12.09 hrs, Volume= 2,234 cf
Primary = 0.65 cfs @ 12.09 hrs, Volume= 2,234 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 5L: Infiltration Trench - Exfiltrate Directly to Ground



Summary for Subcatchment 1S: POST-1

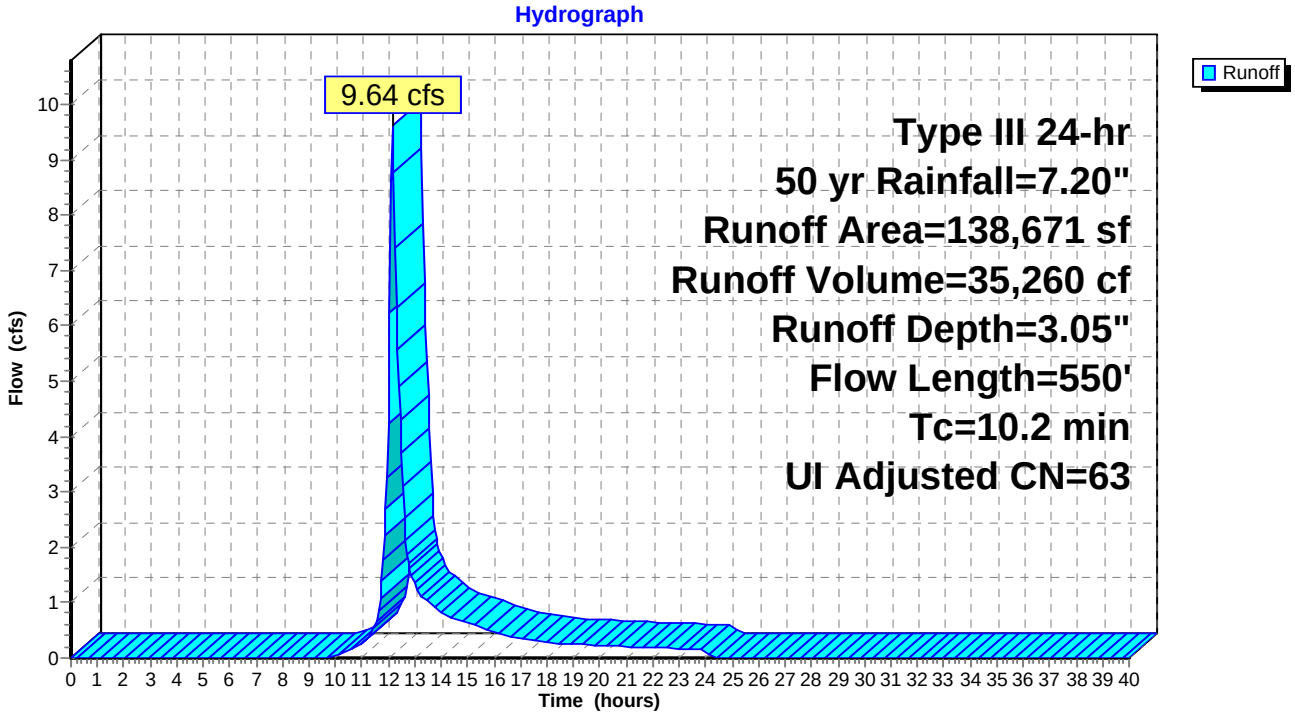
Runoff = 9.64 cfs @ 12.15 hrs, Volume= 35,260 cf, Depth= 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=7.20"

Area (sf)	CN	Adj	Description
111,282	65		2 acre lots, 12% imp, HSG B
18,972	55		Woods, Good, HSG B
417	98		Unconnected roofs, HSG B
8,000	61		>75% Grass cover, Good, HSG B
138,671	64	63	Weighted Average, UI Adjusted
124,900			90.07% Pervious Area
13,771			9.93% Impervious Area
417			3.03% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.5	315	0.0460	3.45		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	550	Total			

Subcatchment 1S: POST-1



Summary for Subcatchment 2S: POST-2

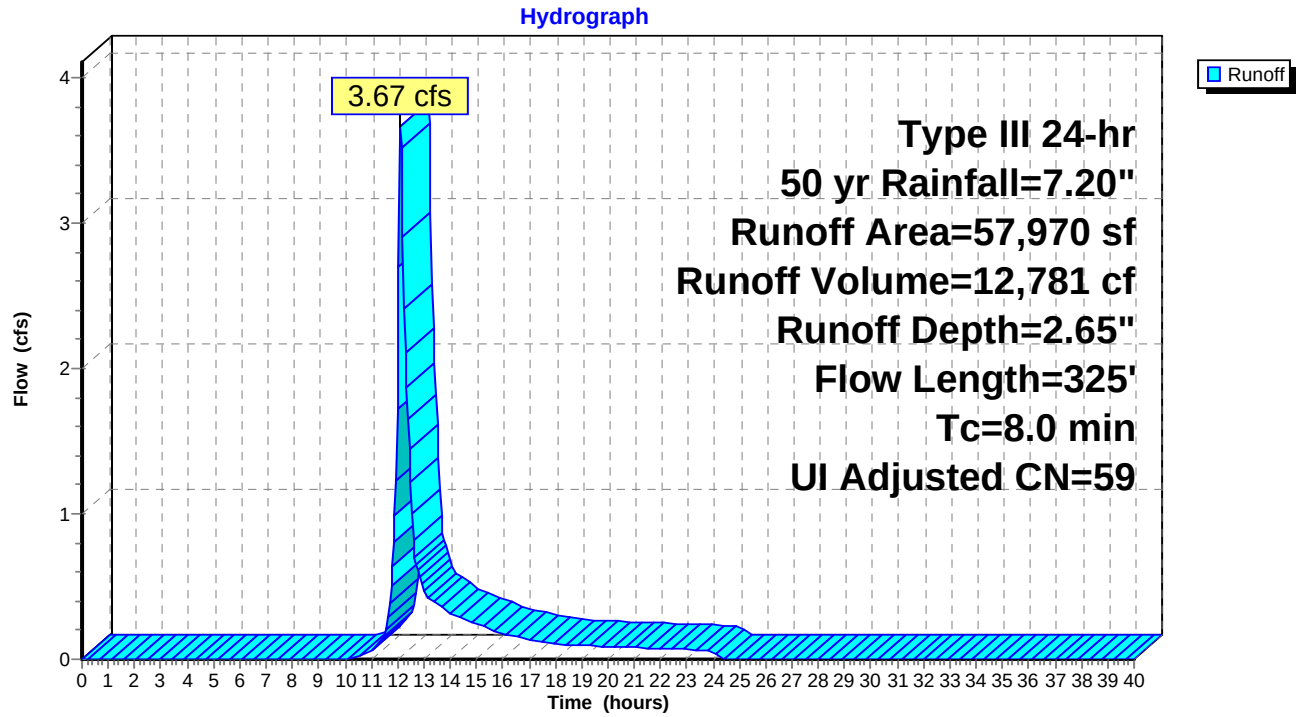
Runoff = 3.67 cfs @ 12.12 hrs, Volume= 12,781 cf, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=7.20"

Area (sf)	CN	Adj	Description
21,000	55		Woods, Good, HSG B
35,016	61		>75% Grass cover, Good, HSG B
1,954	98		Unconnected roofs, HSG B
57,970	60	59	Weighted Average, UI Adjusted
56,016			96.63% Pervious Area
1,954			3.37% Impervious Area
1,954			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0120	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.26"
0.5	75	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	200	0.0900	4.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	325	Total			

Subcatchment 2S: POST-2



Summary for Subcatchment 4S: POST-DRIVE

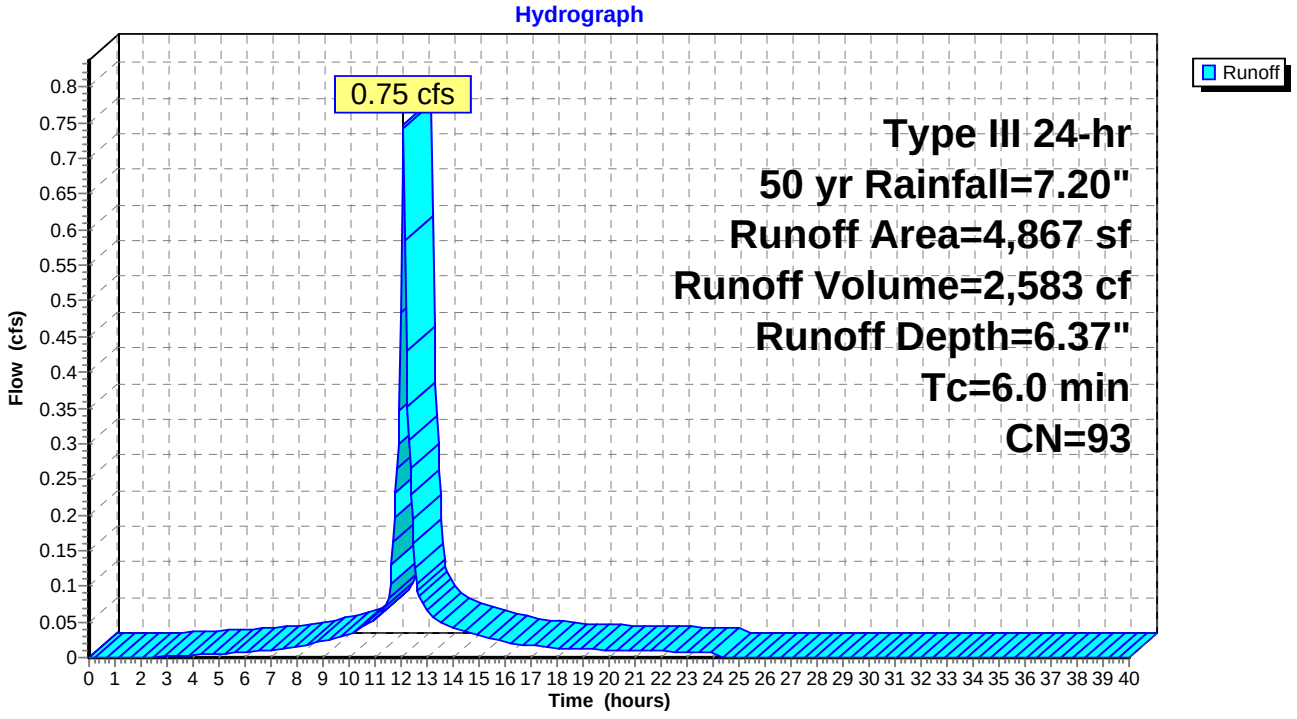
Runoff = 0.75 cfs @ 12.09 hrs, Volume= 2,583 cf, Depth= 6.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 50 yr Rainfall=7.20"

Area (sf)	CN	Description
4,232	98	Unconnected pavement, HSG B
635	61	>75% Grass cover, Good, HSG B
4,867	93	Weighted Average
635		13.05% Pervious Area
4,232		86.95% Impervious Area
4,232		100.00% Unconnected

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

Subcatchment 4S: POST-DRIVE

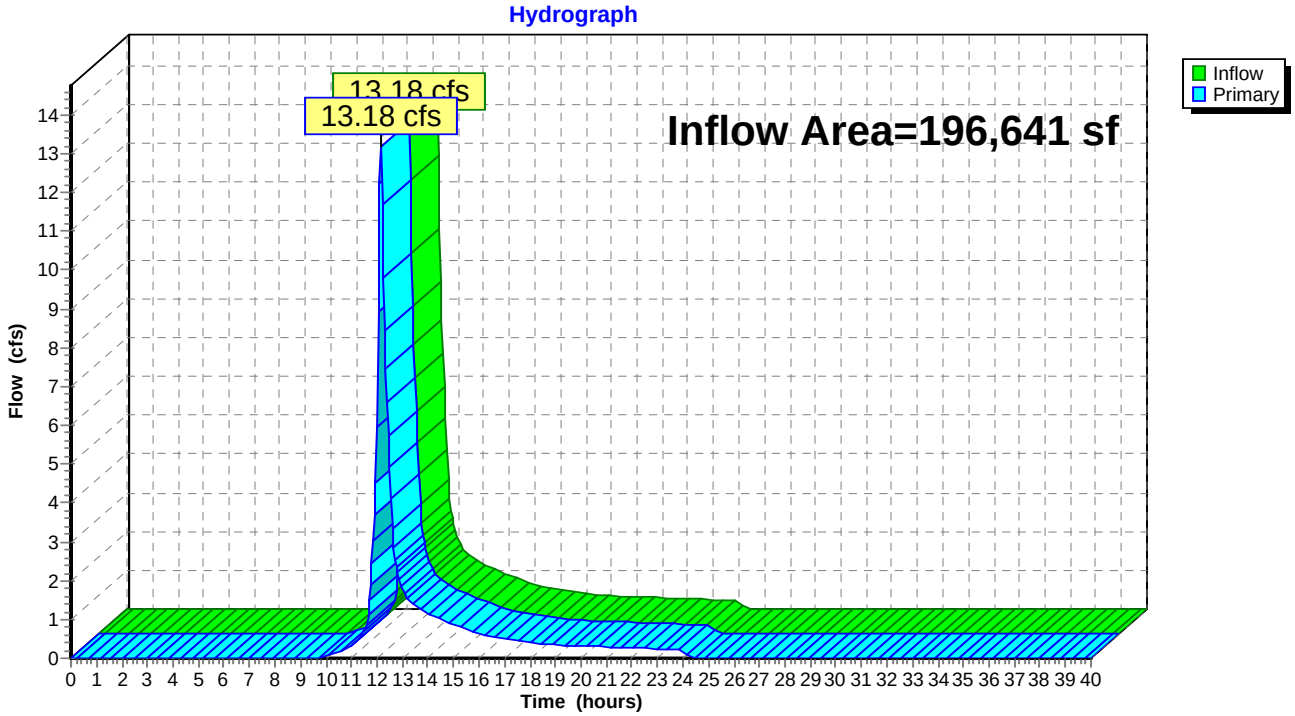


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 196,641 sf, 8.00% Impervious, Inflow Depth = 2.93" for 50 yr event
Inflow = 13.18 cfs @ 12.14 hrs, Volume= 48,042 cf
Primary = 13.18 cfs @ 12.14 hrs, Volume= 48,042 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road

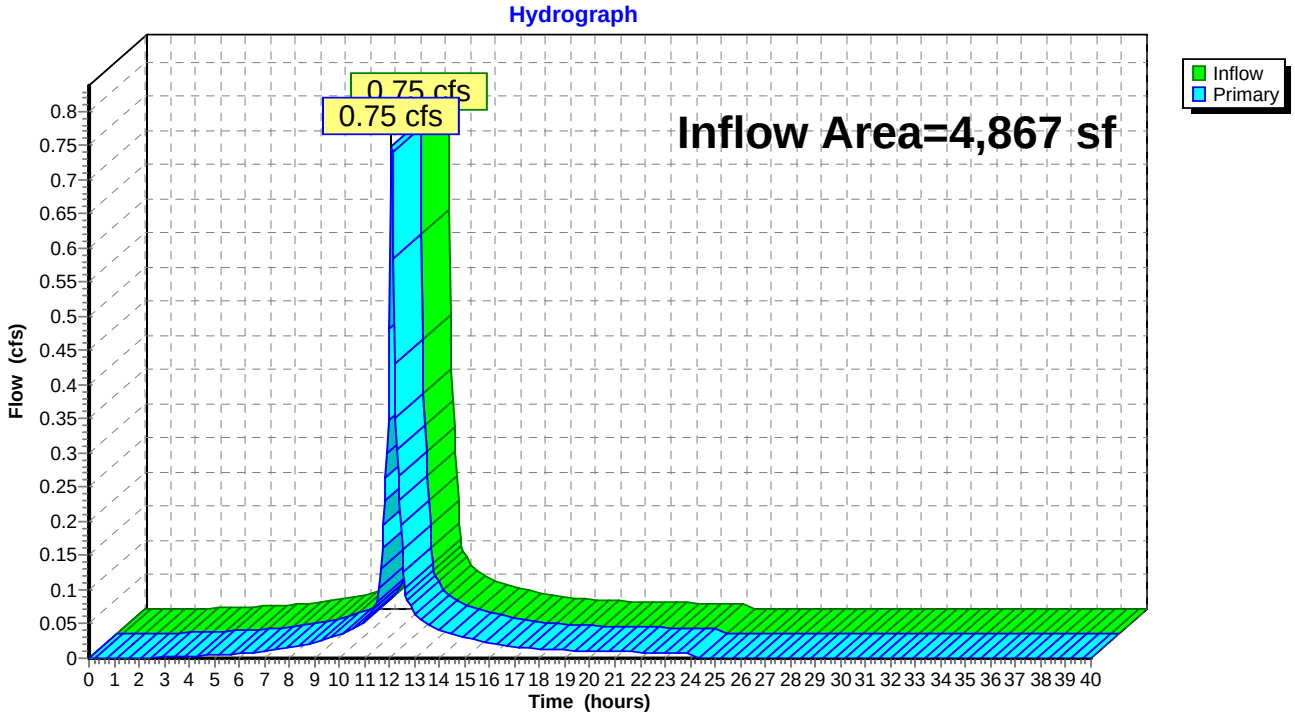


Summary for Link 5L: Infiltration Trench - Exfiltrate Directly to Ground

Inflow Area = 4,867 sf, 86.95% Impervious, Inflow Depth = 6.37" for 50 yr event
Inflow = 0.75 cfs @ 12.09 hrs, Volume= 2,583 cf
Primary = 0.75 cfs @ 12.09 hrs, Volume= 2,583 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 5L: Infiltration Trench - Exfiltrate Directly to Ground



Summary for Subcatchment 1S: POST-1

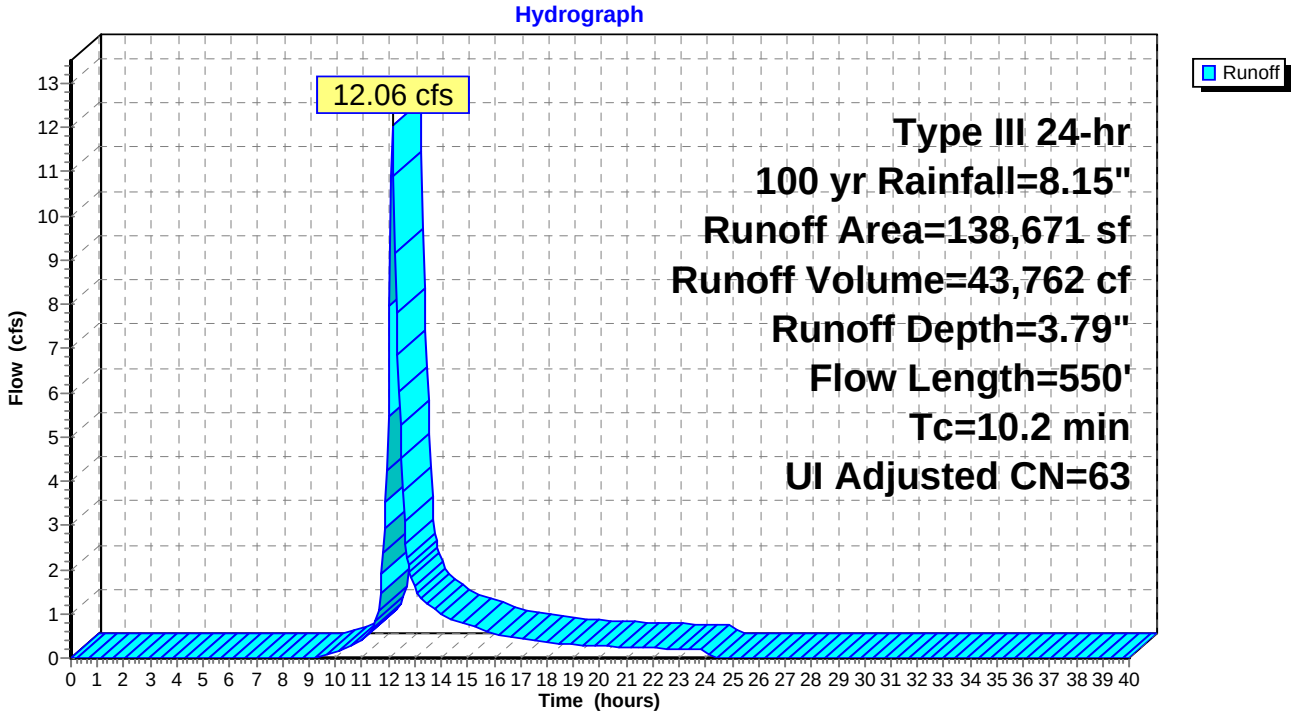
Runoff = 12.06 cfs @ 12.15 hrs, Volume= 43,762 cf, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.15"

Area (sf)	CN	Adj	Description
111,282	65		2 acre lots, 12% imp, HSG B
18,972	55		Woods, Good, HSG B
417	98		Unconnected roofs, HSG B
8,000	61		>75% Grass cover, Good, HSG B
138,671	64	63	Weighted Average, UI Adjusted
124,900			90.07% Pervious Area
13,771			9.93% Impervious Area
417			3.03% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.9	50	0.0600	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.26"
0.8	185	0.0600	3.94		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.5	315	0.0460	3.45		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
10.2	550	Total			

Subcatchment 1S: POST-1



Summary for Subcatchment 2S: POST-2

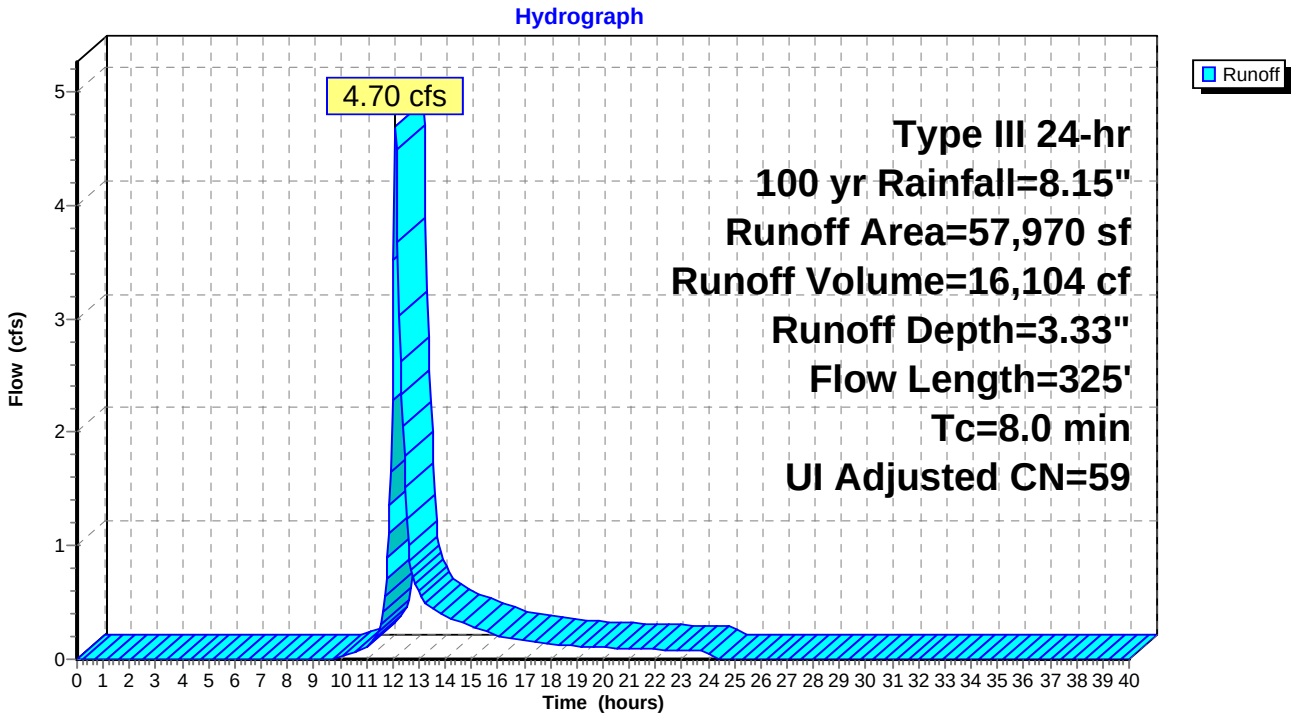
Runoff = 4.70 cfs @ 12.12 hrs, Volume= 16,104 cf, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.15"

Area (sf)	CN	Adj	Description
21,000	55		Woods, Good, HSG B
35,016	61		>75% Grass cover, Good, HSG B
1,954	98		Unconnected roofs, HSG B
57,970	60	59	Weighted Average, UI Adjusted
56,016			96.63% Pervious Area
1,954			3.37% Impervious Area
1,954			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0120	0.12		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.26"
0.5	75	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	200	0.0900	4.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.0	325	Total			

Subcatchment 2S: POST-2



Summary for Subcatchment 4S: POST-DRIVE

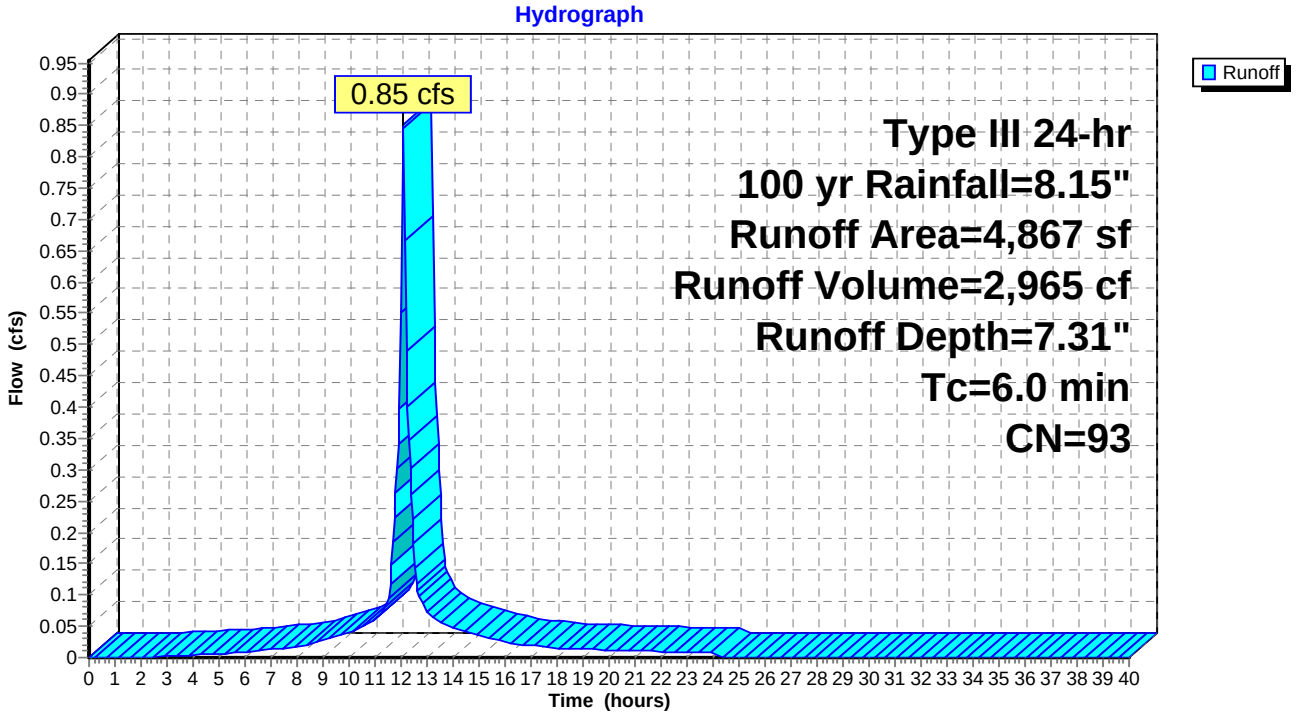
Runoff = 0.85 cfs @ 12.09 hrs, Volume= 2,965 cf, Depth= 7.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 yr Rainfall=8.15"

Area (sf)	CN	Description
4,232	98	Unconnected pavement, HSG B
635	61	>75% Grass cover, Good, HSG B
4,867	93	Weighted Average
635		13.05% Pervious Area
4,232		86.95% Impervious Area
4,232		100.00% Unconnected

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

Subcatchment 4S: POST-DRIVE

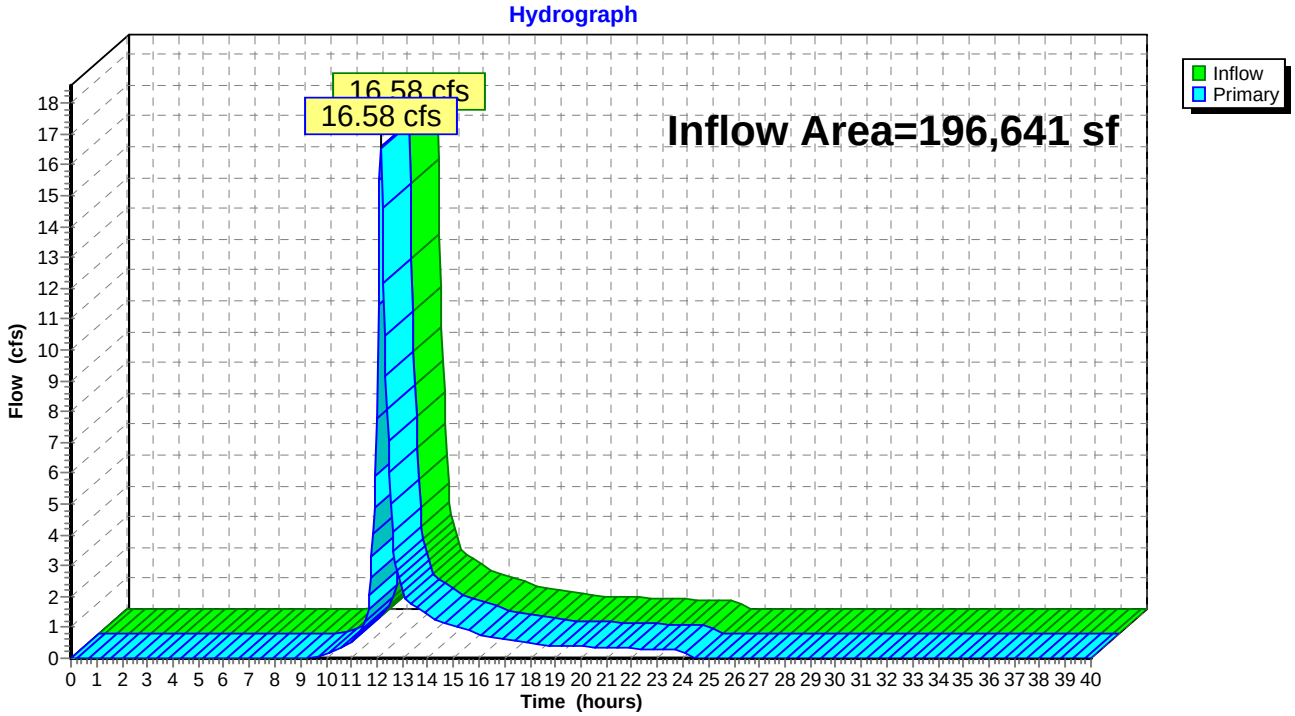


Summary for Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Roa

Inflow Area = 196,641 sf, 8.00% Impervious, Inflow Depth = 3.65" for 100 yr event
Inflow = 16.58 cfs @ 12.14 hrs, Volume= 59,865 cf
Primary = 16.58 cfs @ 12.14 hrs, Volume= 59,865 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 3L: Total flow from within the limit of watershed analysis discharging to Kelsey Road

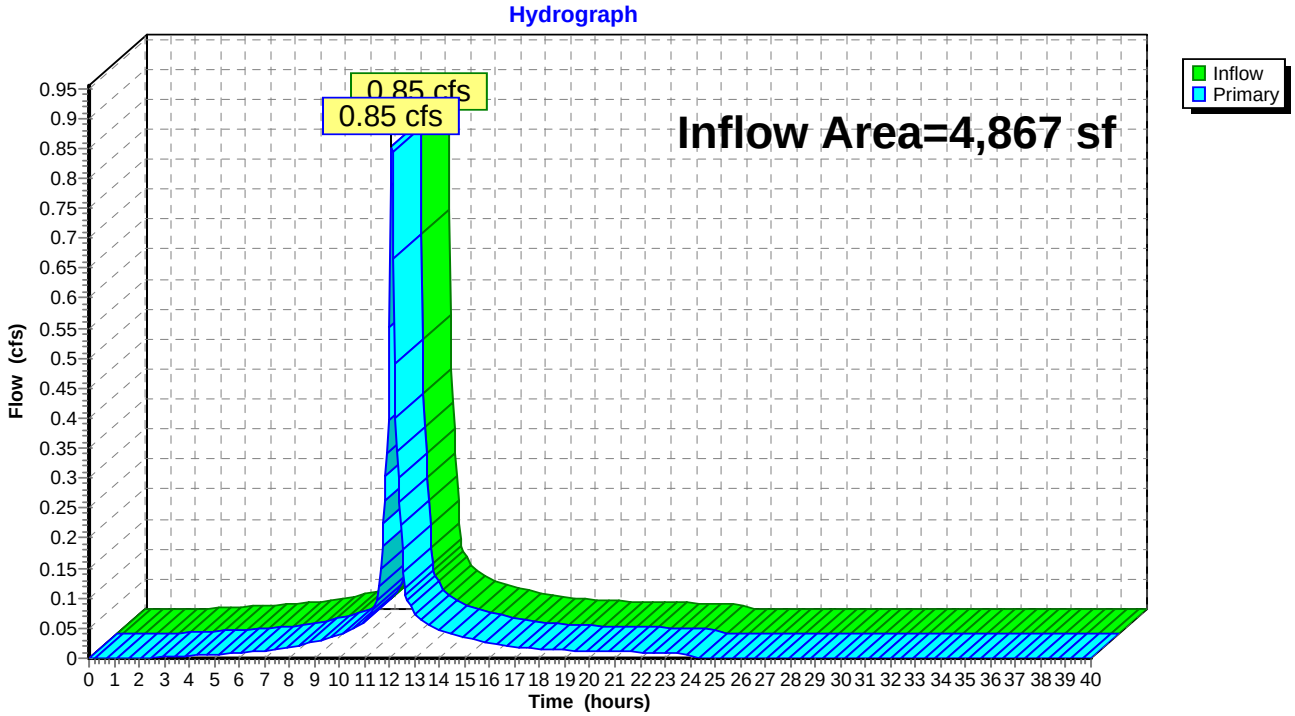


Summary for Link 5L: Infiltration Trench - Exfiltrate Directly to Ground

Inflow Area = 4,867 sf, 86.95% Impervious, Inflow Depth = 7.31" for 100 yr event
Inflow = 0.85 cfs @ 12.09 hrs, Volume= 2,965 cf
Primary = 0.85 cfs @ 12.09 hrs, Volume= 2,965 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.05 hrs

Link 5L: Infiltration Trench - Exfiltrate Directly to Ground



2 | Stormwater Report Compliance Calculations

2.1 Standard 1 | No Untreated Discharges or Erosion to Wetlands

Untreated Discharges
To document compliance that new discharges are adequately treated refer to calculations for DEP Stormwater Management Standards 4 through 6.

2.2 Standard 2 | Peak Rate Attenuation

Refer to Peak Rate of Runoff table above

2.3 Standard 3 | Stormwater Recharge

Groundwater Recharge:
Groundwater Recharge quality is provided through one (1) stormwater best management practice.

1) Stone Infiltration Trench

Groundwater Volume:
$Vgw_{required} = (Dgw)(A_{imp})$
D = 0.35 in
Total GW required = (6,690 $ft^{2)}$ (0.35)/12=195.1 ft^3

Volume provided in the Stone Infiltration Trench = 528 s.f.; Okay

2.4 Standard 4 | Water Quality

Water Quality:
Water quality is provided through one (1) stormwater best management practice.

1) Stone Infiltration Trench

Water Quality Volume:
$V_{wq\ required} = (D_{wq})(A_{imp})$
D_{wq} = 0.5 in
Total WQV required = (6690 $ft^{2)}$ (0.5)/12=278.8 ft^3

Volume provided in the Stone Infiltration Trench = 528 s.f.; Okay

TSS Removal:
- Stone Infiltration Trench= 80% (per Stormwater Handbook)

2.5 Standard 5 | Land Uses with Higher Potential Pollutant Loading

This project is not considered a LUHPPL.

2.6 Standard 6 | Critical Areas

The project site is not a LUHPPL or within a Zone II or Interim Wellhead Protection Area.

2.7 Standard 7 |Redevelopment

This project is not considered a redevelopment.

2.8 Standard 8 | Construction Period Controls

Refer to Section 6 Construction Period Erosion, Sedimentation and Pollution Prevention Plan.

2.9 Standard 9 | Long Term Operation And Maintenance Plan

Refer to Section 4 Long Term Operation and Maintenance Plan.

2.10 Standard 10 |Illicit Discharges To Drainage System

There are no proposed illicit discharges into the Stormwater Management Systems to be constructed as shown on the site plan.

3 | MassDEP Stormwater Checklist

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

Checklist for Stormwater Report

A. Introduction

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.

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.

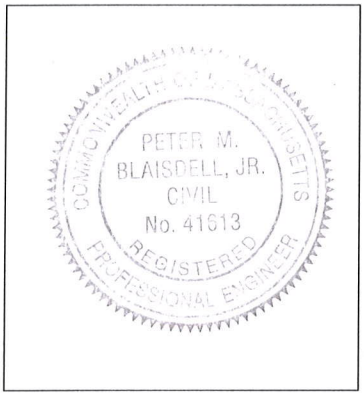
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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 3/2/2020

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

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

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☒ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Stone infiltration Trench

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

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.

☐ 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.

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

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.

☒ 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. (see Massachusetts Stormwater Handbook, Volume 2, Chapter 2, page 86)

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.

(Not Applicable)

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.

(Not Applicable)

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.

(Not Applicable)

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.

☐ 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. (SWPPP is attached with this 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; (See Operation and Maintenance Plan in Appendix B – Site Maps)

☐ 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; (See Appendix P)

☐ 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; (See section 1.7 of the Mitigative Drainage Analysis)

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

4 | Long Term Operation & Maintenance Plan

This Operation & Maintenance Plan is prepared to comply with provisions set forth in the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

Structural Best Management Practices (BMPs) require periodic maintenance to ensure proper function and efficiency in pollutant removal from stormwater discharges that would otherwise reach wetland resource areas untreated. Maintenance schedules found below are as recommended in MassDEP's Massachusetts Stormwater Handbook and as recommended in the manufacturer's specifications.

The stormwater management system owner and the party responsible for maintenance of the stormwater management system within the right of way shall be the Owner and its designated employees.

4.1 The following BMPs provide pollutant removal and groundwater recharge

Stone Infiltration Trench
Inspect and clean every six months and afar every major storm event (2-year return frequency)

Remove accumulated sediment, trash, debris, leaves and grass clippings.

Remove tree seedlings before they become firmly established.

Inspect the trench 24 hours or several days after a rain event to look for ponded water. If there is ponded water at the surface of the trench, it is likely that the trench surface is clogged.

To address surface clogging, remove and replace the first layer of stone aggregate and filter fabric. If the water is ponded inside the trench, it may indicate that the bottom of the trench has failed.

To rehabilitate a failed trench, all accumulated sediment must be stripped from the bottom, the bottom of the trench must be scarified and tilled to induce infiltration, and all of the stone aggregate and filter fabric or media must be removed and replaced.

4.2 The following BMPs are utilized to minimize impacts to wetland resource areas

Street Lot Sweeping
Not Applicable

4.3 Permanent Seeding

Permanent Seeding & Plantings

Once final grades have been established and the weather permits, every effort shall be made to establish permanent vegetation on disturbed and exposed areas no later than September of that year, otherwise temporary seeding practices shall be used until permanent seeding practices can resume the following spring, April 1st through May 31st.

In addition to grass seed, tree and shrub plantings shall be an integral part of the permanent stabilization plan. Care shall be taken by the owner, builder, and/or site contractor to select trees, shrubs, and seed mixes that are best suited to the soil conditions on the site. Soil moisture, depth to seasonal groundwater, and exposure to sunlight shall be carefully considered when selecting species. In recent years, the emphasis on using plant species native to Massachusetts has grown. Information on the use of non-native and native species can be found on the web and in many local nursery catalogs.

Permanent seeding shall be performed in accordance with the guidelines set forth in the "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, May 2003, prepared by Franklin, Hampden, and Hampshire Conservation Districts."

Inspection and Maintenance Form

Refer to Sections 1.0 & 2.0 above for frequency of inspection

Inspector: Date:

Inspector Title:

Days since last rainfall: Amount of last rainfall:

Structural Controls: Infiltration Trench					
Structure Identification	**Location**	**Installed at proposed grade**	**Filter Fabric Installed**	**Sediment buildup (in.)**	**Overall condition**
Infiltration Trench	Southside of driveway	Yes/No	Yes/No		Poor Fair Good

Maintenance required

To be performed by: On or before:

5 | Long Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan is prepared to comply with the provisions set forth in the Massachusetts Department of Environmental Protection (DEP) Stormwater Management Standards. Structural Best Management Practices (BMPs) require periodic maintenance to ensure proper function and efficiency in pollutant removal from stormwater discharges that would otherwise reach wetland resource areas untreated.

Maintenance schedules found below are as recommended in Department of Environmental Protection's Massachusetts Stormwater Handbook and as recommended in manufacturer's specifications.

5.1 Street Sweeping

Not Applicable, private driveway

5.2 Trash and Litter Cleanup

The owner(s) shall perform trash and litter cleanup in and around the site as needed.

5.3 Ownership and Maintenance Responsibilities

After project completion the Owner(s) shall assume full responsibility of continuing the operation and maintenance of the stormwater management system as well as the long-term pollution prevention plan outlined below. The exception would be if a legal agreement is made with another party to perform such duties for the owner(s).

5.4 DEP Standard 4 Water Quality

The Long-Term Pollution Prevention Plan includes the following:

Good housekeeping practices
Prevent or reduce pollutant runoff from reaching the wetland resource areas through street sweeping, stabilizing all disturbed areas with vegetative cover and catch basin cleaning.

Provisions for storing materials and waste products inside or under cover
All materials on site are to be stored in a neat and orderly fashion in their appropriate containers and, if possible, under a roof or other secure enclosure. All waste products are to be placed in secure receptacles until they are emptied by a solid waste management company licensed in the Commonwealth of Massachusetts.

Vehicle washing controls
Not applicable, private residence

Requirements for routine inspections and maintenance of Stormwater BMP's
Follow the procedures outlined in Section 4 Long Term Operation and Maintenance Plan and the provided Inspection and Maintenance Forms.

Spill prevention and response plans
Spill Prevention: As mentioned previously, all materials on site are to be stored in a neat and orderly fashion in their appropriate containers and, if possible, under a roof or other secure enclosure. Products

shall be kept in their original containers with the original manufacturer's label. Products should not be mixed unless recommended by the manufacturer. The manufacturer's recommendations for proper use, storage and disposal shall be followed at all times and, if possible, all of the product should be used up before proper disposal.

Response: The manufacturer's recommended methods for cleanup must be followed and spills cleaned up immediately after discovery. Spills shall be kept well ventilated and personnel must wear appropriate protective gear to prevent injury from contact with hazardous substances. Spills of toxic or hazardous material must be reported to the appropriate local and/or State agencies in accordance with the local and/or Commonwealth of Massachusetts regulations.

Requirements for storage and use of fertilizers, herbicides and pesticides
Consult the Manufacturer's Instructions for any questions regarding these materials.

Fertilizers: Fertilizers are to be applied at the minimum amounts recommended by the manufacturer and once applied shall be worked into the soil to limit the possibility of entering the storm drains. Storage procedures are to be followed as previously stated and the contents of any partially used bags should be transferred to a sealable container, either bag or bin to avoid spilling.

Herbicides and Pesticides: Storage of these materials are to be as outlined previously and especially out of the reach of pets and children, away from damp areas where their containers may succumb to moisture or rust and should not be stored near food. These materials must not be placed in the trash or washed down the drain. Handle using rubber gloves and use an appropriate mask when using these products for extensive periods of time.

Provisions for maintenance of lawns, gardens, and other landscaped areas
These activities are left to the owner(s) to schedule and perform.

Pet waste management provisions
These activities are to be left up to the residents to schedule and perform.

Provisions for solid waste management
All waste products are to be placed in secure receptacles until they are emptied by a solid waste management company licensed in the Commonwealth of Massachusetts.

Snow disposal and plowing plans relative to Wetland Resource Areas
Snow disposal/removal shall be in compliance with MassDEP's Bureau of Water Resources guidelines, effective December 21, 2015. See Section 8 Snow Disposal Guidelines.

Winter Road Salt and/or Sand Use and Storage restrictions
Road Salt use must be in compliance with the Guidelines on Deicing Chemical (Road Salt) Storage effective date December 19, 1997, Guideline No. DWSG97-1 found in the BRP's Drinking Water Program. Sand Use: Encourage the use of environmentally friendly alternatives such as calcium chloride and/or sand instead of road salt for melting ice whenever possible.

Street Sweeping schedules
Not applicable

Provisions for prevention of illicit discharges to the stormwater management systems

According to Standard 10 in the Massachusetts Stormwater Handbook, Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Notwithstanding the foregoing, an illicit discharge does not include discharges from the following activities or facilities: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

Documentation that Stormwater BMP's are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from land uses with higher potential pollutant loads (LUHPPL)

Not applicable as this project does not meet the criteria for a LUHPPL.

Training for staff or personnel involved with implementing LTPPP

This responsibility lies with the owner(s) unless a legally-binding agreement is made with another party to perform such duties for the owner(s).

List of Emergency contacts for implementing Long-Term Pollution Prevention Plan

This responsibility lies with the owner(s) unless a legally-binding agreement is made with another party to perform such duties for the owner(s).

7 | NRCS Web Soil Survey

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part
(41 Kelsey Road Boxford MA)

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 1:15,800.

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: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 15, 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: Sep 13, 2019—Oct 5, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
406B	Charlton fine sandy loam, 3 to 8 percent slopes, very stony	B	5.7	100.0%
Totals for Area of Interest			**5.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

8 | Snow Disposal Guidelines

The following Snow Disposal Guidance is reproduced from the Mass.gov website:
https://www.mass.gov/guides/snow-disposal-guidance

The Massachusetts Department of Environmental Protection's Snow Disposal Guidance offers information on the proper steps to take when locating sites for the disposal of snow. Finding a place to dispose of collected snow poses a challenge to municipalities and businesses as they clear roads, parking lots, bridges, and sidewalks. Public safety is of the utmost importance. However, care must be taken to ensure that collected snow, which may be contaminated with road salt, sand, litter, and automotive pollutants such as oil, is disposed of in a manner that will minimize threats to nearby sensitive resource areas.

In order to avoid potential contamination to wetlands, water supplies, and waterbodies, MassDEP recommends that municipalities and businesses identify and map appropriate upland snow disposal locations. To assist municipalities and businesses in this planning effort, and to avoid use of snow disposal at sites which compromise wetlands resources or public water supplies, MassDEP has developed this snow disposal mapping tool:

https://maps.env.state.ma.us/dep/arcgis/js/templates/PSF/

If a community or business demonstrates that there is no remaining capacity at upland snow disposal locations, local conservation commissions are authorized to issue Emergency Certifications under the Massachusetts Wetlands Protection Act for snow disposal in certain wetland resource areas. In such cases, Emergency Certifications can only be issued at the request of a public agency or by order of a public agency for the protection of the health or safety of citizens, and are limited to those activities necessary to abate the emergency.

In the event of a regional or statewide severe weather event, MassDEP may also issue a broader Emergency Declaration under the Wetlands Protect Act which allows greater flexibility in snow disposal practices. Details of this approval process are found below.

Snow Disposal Guidance

Effective Date: December 21, 2015

Applicability: Applies to all federal, state, regional and local agencies, as well as to private businesses.

Supersedes: BRP Snow Disposal Guideline No. BRPG01-01 issued March 8, 2001, and all previous snow disposal guidance.

Approved by: Douglas Fine, Assistant Commissioner for Water

PURPOSE: To provide guidelines to all government agencies and private businesses regarding snow disposal site selection, site preparation and maintenance, and emergency snow disposal options that are protective of wetlands, drinking water, and water bodies, and are acceptable to the Massachusetts Department of Environmental Protection (MassDEP), Bureau of Water Resources.

APPLICABILITY: These Guidelines are issued by MassDEP's Bureau of Water Resources on behalf of all Bureau Programs (including Drinking Water Supply, Wetlands and Waterways, Wastewater Management, and Watershed Planning and Permitting). They apply to public agencies and private businesses disposing of snow in the Commonwealth of Massachusetts.

INTRODUCTION

Finding a place to dispose of collected snow poses a challenge to municipalities and businesses as they clear roads, parking lots, bridges, and sidewalks. While we are all aware of the threats to public safety caused by snow, collected snow that is contaminated with road salt, sand, litter, and automotive pollutants such as oil also threatens public health and the environment.

As snow melts, road salt, sand, litter, and other pollutants are transported into surface water or through the soil where they may eventually reach the groundwater. Road salt and other pollutants can contaminate water supplies and are toxic to aquatic life at certain levels. Sand washed into waterbodies can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and affecting our use of these resources.

There are several steps that communities can take to minimize the impacts of snow disposal on public health and the environment. These steps will help communities avoid the costs of a contaminated water supply, degraded waterbodies, and flooding. Everything we do on the land has the potential to impact our water resources. Given the authority of local government over the use of the land, municipal officials and staff have a critically important role to play in protecting our water resources.

The purpose of these guidelines is to help municipalities and businesses select, prepare, and maintain appropriate snow disposal sites before the snow begins to accumulate through the winter. Following these guidelines and obtaining the necessary approvals may also help municipalities in cases when seeking reimbursement for snow disposal costs from the Federal Emergency Management Agency is possible.

RECOMMENDED GUIDELINES

These snow disposal guidelines address: (1) site selection; (2) site preparation and maintenance; and (3) emergency snow disposal.

1. SITE SELECTION

The key to selecting effective snow disposal sites is to locate them adjacent to or on pervious surfaces in upland areas or upland locations on impervious surfaces that have functioning and maintained storm water management systems away from water resources and drinking water wells. At these locations, the snow meltwater can filter in to the soil, leaving behind sand and debris which can be removed in the springtime. The following areas should be avoided:

- Avoid importing snow from outside a Zone II or Interim Wellhead Protection Area (IWPA) of a public water supply well or within 75 feet of a private well, where road salt may contaminate water supplies. Only snow from within the Zone II or IWPA should be disposed of within this resource area so as not to increase the potential for pollution of water supplies.

- Avoid dumping of snow into any waterbody, including rivers, the ocean, reservoirs, ponds, or wetlands. In addition to water quality impacts and flooding, snow disposed of in open water can cause navigational hazards when it freezes into ice blocks.
- Avoid dumping snow on MassDEP-designated high and medium-yield aquifers where it may contaminate groundwater.
- Avoid dumping snow in sanitary landfills and gravel pits. Snow meltwater will create more contaminated leachate in landfills posing a greater risk to groundwater, and in gravel pits, there is little opportunity for pollutants to be filtered out of the meltwater because groundwater is close to the land surface.
- Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage swales or ditches. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. A high volume of sand, sediment, and litter released from melting snow also may be quickly transported through the system into surface water.

Recommended Site Selection Procedures

It is important that the municipal Department of Public Works or Highway Department, Conservation Commission, and Board of Health work together to select appropriate snow disposal sites. The following steps should be taken:

1. Estimate how much snow disposal capacity may be needed for the season so that an adequate number of disposal sites can be selected and prepared.
2. Identify sites that could potentially be used for snow disposal, such as municipal open space (e.g., parking lots or parks).
3. Sites located in upland locations that are not likely to impact sensitive environmental resources should be selected first.
4. If more storage space is still needed, prioritize the sites with the least environmental impact (using the site selection criteria, and local or MassGIS maps as a guide).

Snow Disposal Mapping Assistance

MassDEP has an online mapping tool to assist municipalities and businesses in identifying possible locations to potentially dispose of snow, should the need arise. The disposal locations depicted on these maps will also aid MassDEP and the Massachusetts Emergency Management Agency assist communities with snow disposal in the event of severe winter storm emergencies. The tool identifies wetland resource areas, public drinking water supplies and other sensitive locations where snow should not be disposed. The tool may be accessed through the Internet at the following web address: **https://maps.env.state.ma.us/dep/arcgis/js/templates/PSF/**.

By clicking on the link for the OLIVER Online Data Viewer, communities can select your town and overlay different resource areas. The MassGIS site includes MassDEP orthophoto maps depicting local wetland resources, hard copies of which were mailed to each Conservation Commission in the past.

2. SITE PREPARATION AND MAINTENANCE

In addition to carefully selecting disposal sites before the winter begins, it is important to prepare and maintain these sites to maximize their effectiveness. The following maintenance measures should be undertaken for all snow disposal sites:

- A silt fence or equivalent barrier should be placed securely on the downgradient side of the snow disposal site.
- To filter pollutants out of the meltwater, wherever possible a 50-foot vegetative buffer strip should be maintained during the growth season between the disposal site and adjacent waterbodies.
- Debris should be cleared from the site prior to using the site for snow disposal.

Debris should be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.

3. SNOW DISPOSAL APPROVALS

Proper snow disposal may be undertaken through one of the following approval procedures:

1. Routine snow disposal – Minimal, if any, administrative review is required in these cases when upland and pervious snow disposal locations or upland locations on impervious surfaces that have functioning and maintained storm water management systems have been identified, mapped, and used for snow disposal following ordinary snowfalls. Use of upland and pervious snow disposal sites avoids wetland resource areas and allows snow meltwater to recharge groundwater and will help filter pollutants, sand, and other debris. This process will address the majority of snow removal efforts until a community exhausts all available upland snow disposal sites. The location and mapping of snow disposal sites will help facilitate each municipality's routine snow management efforts.
2. Emergency Certifications – If a community or business demonstrates that there is no remaining capacity at upland snow disposal locations, local conservation commissions are authorized to issue Emergency Certifications under the Massachusetts Wetlands Protection Act for snow disposal in buffer zones to wetlands, certain open water areas, and certain wetland resource areas, i.e. within flood plains. In such cases, Emergency Certifications can only be issued at the request of a public agency for the protection of the health or safety of citizens or by order of a public agency, and limited to those activities necessary to abate the emergency. Use the following guidelines in these emergency situations:
    a. Dispose of snow in open water with adequate flow and mixing to prevent ice dams from forming.
    b. Do not dispose of snow in salt marshes, vegetated wetlands, certified vernal pools, shellfish beds, mudflats, drinking water reservoirs and their tributaries, Zone IIs or IWPAs of public water supply wells, Outstanding Resource Waters, or Areas of Critical Environmental Concern.
    c. Do not dispose of snow where trucks may cause shoreline damage or erosion.
    d. Consult with the municipal Conservation Commission to ensure that snow disposal in open water complies with local ordinances and bylaws.
3. Emergency Declarations – In the event of a large-scale severe weather event, MassDEP may issue a broader Emergency Declaration under the Wetlands Protection Act which allows municipalities greater flexibility in snow disposal practices. Emergency Declarations typically authorize greater snow disposal options while protecting especially sensitive resources such as public drinking water supplies, vernal pools, land containing shellfish, FEMA designated floodways, coastal dunes, and salt marsh. In the event of severe winter storm emergencies, the snow disposal site maps created by municipalities will assist MassDEP and the Massachusetts Emergency

Management Agency in helping communities identify appropriate snow disposal locations.

If upland disposal sites have been exhausted, the Emergency Declaration issued by MassDEP allows for snow disposal near water bodies. A buffer of at least 50 feet, preferably vegetated, should still be maintained between the site and the waterbody in these situations. Furthermore, it is essential that the other guidelines for preparing and maintaining snow disposal sites be followed to minimize the threat to adjacent waterbodies.

Under extraordinary conditions, when all land-based snow disposal options are exhausted, the Emergency Declaration issued by MassDEP may allow disposal of snow in certain waterbodies under certain conditions. ***A municipality seeking to dispose of snow in a waterbody should take the following steps***:

a. Call the emergency contact phone number - 1-888-304-1133 - and notify the MEMA bunker personnel of the municipality's intent.
b. The MEMA bunker personnel will ask for some information about where the requested disposal will take place.
c. The MEMA bunker personnel will confirm that the disposal is consistent with MassDEP's Emergency Declaration and these guidelines and is therefore approved.

During declared statewide snow emergency events, MassDEP's website will also highlight the emergency contact phone number (1-888-304-1133) for authorizations and inquiries. For further non-emergency information about this Guidance you may contact your MassDEP Regional Office Service Center:

Northeast Regional Office, Wilmington, 978-694-3249
Southeast Regional Office, Lakeville, 508-946-2714
Central Regional Office, Worcester, 508-767-2722
Western Regional Office, Springfield, 413-784-1100

9 | Deicing Chemical (Road Salt) Storage

The following Snow Disposal Guidance is reproduced from the Mass.gov website:
https://www.mass.gov/guides/guidelines-on-road-salt-storage

Effective Date: December 19, 1997
Guideline No. DWSG97-1

Applicability: Applies to all parties storing road salt or other chemical deicing agents.

Supersedes: Fact Sheet: DEICING CHEMICAL (ROAD SALT) STORAGE (January 1996)

Approved by: Arleen O'Donnell, Asst. Commissioner for Resource Protection

PURPOSE: To summarize salt storage prohibition standards around drinking water supplies and current salt storage practices.

APPLICABILITY: These guidelines are issued on behalf of the Bureau of Resource Protection's Drinking Water Program. They apply to all parties storing road salt or other chemical deicing agents.

The Road Salt Problem

Historically, there have been incidents in Massachusetts where improperly stored road salt has polluted public and private drinking water supplies. Recognizing the problem, state and local governments have taken steps in recent years to remediate impacted water supplies and to protect water supplies from future contamination. As a result of properly designing storage sheds, new incidents are uncommon. These guidelines summarize salt storage prohibition standards around drinking water supplies and current salt storage practices.

Salt Pile Restrictions in Water Supply Protection Areas

Uncovered storage of salt is forbidden by Massachusetts General Law Chapter 85, section 7A in areas that would threaten water supplies. The Drinking Water Regulations, 310 CMR 22.21(2)(b), also restrict deicing chemical storage within wellhead protection areas (Zone I and Zone II) for public water supply wells, as follows: "storage of sodium chloride, chemically treated abrasives or other chemicals used for the removal of ice and snow on roads [are prohibited], unless such storage is within a structure designed to prevent the generation and escape of contaminated runoff or leachate." For drinking water reservoirs, 310 CMR 22.20C prohibits, through local bylaw, uncovered or uncontained storage of road or parking lot de-icing and sanding materials within Zone A at new reservoirs and at those reservoirs increasing their withdrawals under MGL Chapter 21G, the Water Management Act.

For people on a low-sodium diet, 20 mg/L of sodium in drinking water is consistent with the bottled water regulations' meaning of "sodium free." At 20 mg/L, sodium contributes 10% or less to the sodium level in people on a sodium-restricted diet.

Salt Storage Best Management Practices

Components of an "environment-friendly" roadway deicing salt storage facility include:
the right site = a flat site;
adequate space for salt piles;

storage on a pad (impervious/paved area);
storage under a roof; and
runoff collection/containment.
For more information, see The Salt Storage Handbook, 6th ed. Virginia: Salt Institute, 2006.

Salt Storage Practices of the Massachusetts Highway Department

The Massachusetts Highway Department (MHD) has 216 permanent salt storage sheds at 109 locations in the state. On leased land and state land under arteries and ramps, where the MHD cannot build sheds, salt piles are stored under impermeable material. This accounts for an additional 15 sites. The MHD also administers a program to assist municipalities with the construction of salt storage sheds. Of 351 communities, 201 municipalities have used state funds for salt storage facilities.

Appendix A – Soil Logs

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Tim McManus

41 Kelsey Road
Street Address

Map 20, Block 2, Parcel 3
Map/Lot #

Boxford
City

MA
State

01921
Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: NRCS WEB SOIL SURVEY 406B
Soil Map Unit

Charlton
Soil Name

Soil Limitations

Coarse-loamy melt out till
Soil Parent material

Ground moraine
Landform

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: MassGIS Oliver
Year Published/Source

Till or Bedrock
Map Unit

Till
Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer:
Wetland Type

7. Current Water Resource Conditions (USGS): 1/14/20
Month/Day/ Year
Range: ☒ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed:

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: 20-2 (Hole #) | 1/14/20 (Date) | 9:00AM (Time) | Overcast, 40 (Weather) | 42.685300 (Latitude) | -70.982790 (Longitude:)

1. Land Use: Single family house lot (e.g., woodland, agricultural field, vacant lot, etc.) | None – recently cleared (Vegetation) | Minimal (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 5-8% (Slope (%))

Description of Location: Parking lot behind existing restaurant

2. Soil Parent Material: Coarse-loamy melt out till | Ground moraine (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100+ feet | Drainage Way 100+ feet | Wetlands 100+ feet | Property Line 10+ feet | Drinking Water Well 100+ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 81" Depth Weeping from Pit _ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-10	A	FSL	10YR 3/2								
10-30	Bw	SL	7.5YR 5/8								
30-118	C	gSL	5Y 6/4	46	10YR 6/8	>15					
				46	5Y 5/1	15%					

Additional Notes:

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: 20-3 (Hole #) | 1/14/20 (Date) | 9:00AM (Time) | Overcast, 40 (Weather) | 42.685300 (Latitude) | -70.982790 (Longitude:)

1. Land Use: Single family house lot (e.g., woodland, agricultural field, vacant lot, etc.) | None – recently cleared (Vegetation) | Minimal (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 5-8% (Slope (%))

Description of Location: Parking lot behind existing restaurant

2. Soil Parent Material: Coarse-loamy melt out till | Ground moraine (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100+ feet | Drainage Way 100+ feet | Wetlands 100+ feet | Property Line 10+ feet | Drinking Water Well 100+ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 91" Depth Weeping from Pit _ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-20	A	FSL	10YR 3/2								
20-35	Bw	SL	7.5YR 5/8								
35-108	C	gSL	5Y 6/4	54	10YR 6/8	>15					
				54	5Y 5/1	15%					

Additional Notes:

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used:

	Obs. Hole # 20-2	Obs. Hole # 20-3
☐ Depth observed standing water in observation hole	_____ inches	_____ inches
☐ Depth weeping from side of observation hole	_____ inches	_____ inches
☒ Depth to soil redoximorphic features (mottles)	46 inches	54 inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

_____ Index Well Number

_____ Reading Date

$S_h = S_c – [S_r \times (OW_c – OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater: _____ inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)?	Upper boundary:	10 inches	Lower boundary:	118 inches
c. If no, at what depth was impervious material observed?	Upper boundary:	_____ inches	Lower boundary:	_____ inches

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: 20-4 (Hole #) | 1/14/20 (Date) | 10:00AM (Time) | Overcast, 40 (Weather) | 42.685300 (Latitude) | -70.982790 (Longitude:)

1. Land Use: Single family house lot (e.g., woodland, agricultural field, vacant lot, etc.) | None – recently cleared (Vegetation) | Minimal (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 5-8% (Slope (%))

Description of Location: Parking lot behind existing restaurant

2. Soil Parent Material: Coarse-loamy melt out till | Ground moraine (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100+ feet | Drainage Way 100+ feet | Wetlands 100+ feet | Property Line 10+ feet | Drinking Water Well 100+ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 90" Depth Weeping from Pit _ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-9	A	FSL	10YR 3/2								
9-26	Bw	SL	7.5YR 5/8								
26-112	C	gSL	5Y 6/4	56	10YR 6/8	>15					
				56	5Y 5/1	15%					

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (minimum of two holes required at every proposed primary and reserve disposal area)

Deep Observation Hole Number: 20-5 (Hole #) | 1/14/20 (Date) | 10:00AM (Time) | Overcast, 40 (Weather) | 42.685300 (Latitude) | -70.982790 (Longitude:)

1. Land Use: Single family house lot (e.g., woodland, agricultural field, vacant lot, etc.) | None – recently cleared (Vegetation) | Minimal (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 5-8% (Slope (%))

Description of Location: Parking lot behind existing restaurant

2. Soil Parent Material: Coarse-loamy melt out till | Ground moraine (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body 100+ feet | Drainage Way 100+ feet | Wetlands 100+ feet | Property Line 10+ feet | Drinking Water Well 100+ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 92" Depth Weeping from Pit _ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	A	FSL	10YR 3/2								
12-28	Bw	SL	7.5YR 5/8								
28-108	C	gSL	5Y 6/4	52	10YR 6/8	>15					
				52	5Y 5/1	15%					

Additional Notes:

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used:	Obs. Hole # 20-4	Obs. Hole # 20-5
☐ Depth observed standing water in observation hole	__ inches	__ inches
☐ Depth weeping from side of observation hole	_____ inches	_____ inches
☒ Depth to soil redoximorphic features (mottles)	56 inches	52 inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

Index Well Number _____ Reading Date _____

$S_h = S_c – [S_r \times (OW_c – OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater: _____ inches

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)?	Upper boundary:	9 inches	Lower boundary:	112 inches
c. If no, at what depth was impervious material observed?	Upper boundary:	_____ inches	Lower boundary:	_____ inches

Commonwealth of Massachusetts
City/Town of Boxford

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

	1/14/2020
Signature of Soil Evaluator	Date
Thorsen Akerley / #14016	6/30/2022
Typed or Printed Name of Soil Evaluator / License #	Expiration Date of License
Kendell Longo	Boxford Health Department
Name of Approving Authority Witness	Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Appendix B – Permanent and Temporary Seeding Guidelines

Seeding, Permanent

The establishment of perennial vegetative cover on disturbed areas.

Purpose

Permanent seeding of grass and planting trees and shrubs provides stabilization to the soil by holding soil particles in place.

Vegetation reduces sediments and runoff to downstream areas by slowing the velocity of runoff and permitting greater infiltration of the runoff.

Vegetation also filters sediments, helps the soil absorb water, improves wildlife habitats, and enhances the aesthetics of a site.

Where Practice Applies

- Permanent seeding and planting is appropriate for any graded or cleared area where long-lived plant cover is needed to stabilize the soil.
- Areas which will not be brought to final grade for a year or more.
- Some areas where permanent seeding is especially important are filter strips, buffer areas, vegetated swales, steep slopes, and stream banks.
- This practice is effective on areas where soils are unstable because of their texture or structure, high water table, winds, or steep slope.

Advantages

Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

Seeding is usually the most economical way to stabilize large areas.

Well established grass and ground covers can give an aesthetically pleasing, finished look to a development.

Once established, the vegetation will serve to prevent erosion and retard the velocity of runoff.

Disadvantages/Problems

Disadvantages which must be dealt with are the potential for erosion during the establishment stage, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, and a need for water and appropriate climatic conditions during germination. Vegetation and mulch cannot prevent soil slippage and erosion if soil is not inherently stable.

Coarse, high grasses that are not mowed can create a fire hazard in some locales. Very short mowed grass, however, provides less stability and sediment filtering capacity.

Grass planted to the edge of a watercourse may encourage fertilizing and mowing near the water's edge and increase nutrient and pesticide contamination.

Depends initially on climate and weather for success.

May require regular irrigation to establish and maintain.

Planning considerations

Selection of the right plant materials for the site, good seedbed preparation, timing, and conscientious maintenance are important. Whenever possible, native species of plants should be used for landscaping. These plants are already adapted to the locale and survivability should be higher than with "introduced" species.

Native species are also less likely to require irrigation, which can be a large maintenance burden and is neither cost-effective nor ecologically sound.

If non-native plant species are used, they should be tolerant of a large range of growing conditions, as low-maintenance as possible, and not invasive.

Consider the microclimate within the development area. Low areas may be frost pockets and require hardier vegetation since cold air tends to sink and flow towards low spots. South-facing slopes may be more difficult to re-vegetate because they tend to be sunnier and drier.

Divert as much surface water as possible from the area to be planted.

Remove seepage water that would continue to have adverse effects on soil stability or the protecting vegetation. Subsurface drainage or other engineering practices may be needed. In this situation, a permit may be needed from the local Conservation Commission: check ahead of time to avoid construction delays.

Provide protection from equipment, trampling and other destructive agents.

Vegetation cannot be expected to supply an erosion control cover and prevent slippage on a soil that is not stable due to its texture, structure, water movement, or excessive slope.

Seeding Grasses and Legumes

Install needed surface runoff control measures such as gradient terraces, berms, dikes, level spreaders, waterways, and sediment basins prior to seeding or planting.

Seedbed Preparation

If infertile or coarse-textured subsoil will be exposed during land shaping, it is best to stockpile topsoil and respread it over the finished slope at a minimum 2- to 6-inch depth and roll it to provide a firm seedbed. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll.

Loosen the soil to a depth of 3-5 inches with suitable agricultural or construction equipment.

Areas not to receive top soil shall be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ - 1 inch when stepped on with a shoe. Areas to receive topsoil shall not be firmed until after topsoiling and lime and fertilizer is applied and incorporated, at which time it shall be treated to firm the seedbed as described above. This can be done by rolling or cultipacking.

Cool Season Grasses

Cool Season Grasses grow rapidly in the cool weather of spring and fall, and set seed in June and July. Cool season grasses become dormant when summer temperatures persist above 85 degrees and moisture is scarce.

Lime and Fertilizer

Apply lime and fertilizer according to soil test and current Extension Service recommendations. In absence of a soil test, apply lime (a pH of 5.5 - 6.0 is desired) at a rate of 2.5 tons per acre and 10-20-20 analysis fertilizer at a rate of 500 pounds per acre (40 % of N to be in an organic or slow release form). Incorporate lime and fertilizer into the top 2-3 inches of soil.

Seeding Dates

Seeding operations should be performed within one of the following periods:

- April 1 - May 31,
- August 1 - September 10,
- November 1 - December 15 as a dormant seeding (seeding rates shall be increased by 50% for dormant seedings).

Seeding Methods

Seeding should be performed by one of the following methods. Seed should be planted to a depth of ¼ to ½ inches.

- Drill seedings,
- Broadcast and rolled, cultipacked or tracked with a small track piece of construction equipment,
- Hydroseeding, with subsequent tracking.

Mulch

Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas.

Warm Season Grasses

Warm Season Grasses begin growth slowly in the spring, grow rapidly in the hot summer months and set seed in the fall. Many warm season grasses are sensitive to frost in the fall, and the top growth may die back. Growth begins from the plant base the following spring.

Lime and Fertilizer

Lime to attain a pH of at least 5.5. Apply a 0-10-10 analysis fertilizer at the rate of 600 lbs./acre.
Incorporate both into the top 2-3 inches of soil. (30 lbs. of slow release nitrogen should be applied after emergence of grass in the late spring.)

Seeding Dates

Seeding operations should be performed as an early spring seeding (April 1-May 15) with the use of cold treated seed. A late fall early winter dormant seeding (November 1 - December 15) can also be made, however the seeding rate will need to be increased by 50%.

Seeding Methods

Seeding should be performed by one of the following methods:

- Drill seedings (de-awned or de-bearded seed should be used unless the drill is equipped with special features to accept awned seed).
- Broadcast seeding with subsequent rolling, cultipacking or tracking the seeding with small track construction equipment. Tracking should be oriented up and down the slope.
- Hydroseeding with subsequent tracking. If wood fiber mulch is used, it should be applied as a separate operation after seeding and tracking to assure good seed to soil contact.

Mulch

Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas.

Seed Mixtures for Permanent Cover

Recommended mixtures for permanent seeding are provided on the following pages. Select plant species which are suited to the site conditions and planned use. Soil moisture conditions, often the major limiting site factor, are usually classified as follows:
Dry - Sands and gravels to sandy loams. No effective moisture supply from seepage or a high water table.
Moist - Well drained to moderately well drained sandy loams, loams, and finer; or coarser textured material with moderate influence on root zone from seepage or a high water table.
Wet - All textures with a water table at or very near the soil surface, or with enduring seepage.
When other factors strongly influence site conditions, the plants selected must also be tolerant of these conditions.

Permanent Seeding Mixtures

Mix	Site	Seed Mixture	Seed, Pounds per: Acre	1,000 sf	Remarks
1	Dry	Little Bluestem			* Use Warm Season planting procedure.
		or Broomsedge	10	0.25	* Roadsides
		Tumble Lovegrass*	1	0.10	* Sand and Gravel Stabilization
		Switchgrass	10	0.25	* Clover requires inoculation with nitrogen-fixing bacteria
		Bush Clover*	2	0.10	
		Red Top	1	0.10	* Rates for this mix are for PLS.
2	Dry	Deertongue	15	0.35	* Use Warm Season planting procedures.
		Broomsedge	10	0.25	* Acid sites/Mine spoil
		Bush Clover*	2	0.10	* Clover requires inoculation with nitrogen-fixing bacteria.
		Red Top	1	0.10	*Rates for this mix are for PLS.
3	Dry	Big Bluestem	10	0.25	* Use Warm Season planting procedures.
		Indian Grass	10	0.25	* Eastern Prairie appearance
		Switchgrass	10	0.25	* Sand and Gravel pits.
		Little Bluestem	10	0.25	* Golf Course Wild Areas
		Red Top or	1	0.10	* Sanitary Landfill Cover seeding
		Perennial Ryegrass	10	0.25	* Wildlife Areas *OK to substitute Poverty Dropseed in place of Red Top/Ryegrass. *Rates for this mix are for PLS.
4	Dry	Flat Pea	25	0.60	* Use Cool Season planting procedures
		Red Top or	2	0.10	* Utility Rights-of-Ways (tends to suppress woody growth)
		Perennial Ryegrass	15	0.35	
5	Dry	Little Bluestem	5	0.10	* Use Warm Season planting procedures.
		Switchgrass	10	0.25	* Coastal sites
		Beach Pea*	20	0.45	* Rates for Bluestein and Switchgrass are for PLS.
		Perennial Ryegrass	10	0.25	
6	Dry - Moist	Red Fescue	10	0.25	* Use Cool Season planting procedure.
		Canada Bluegrass	10	0.25	* Provides quick cover but is non-aggressive; will tend to allow indigenous plant colonization.
		Perennial Ryegrass	10	0.25	
		Red Top	1	0.10	* General erosion control on variety of sites, including forest roads, skid trails and landings.
7	Moist-Wet	Switchgrass	10	0.25	* Use Warm Season planting procedure.
		Virginia Wild Rye	5	0.10	* Coastal plain/flood plain
		Big Bluestem	15	0.35	* Rates for Bluestem and Switchgrass are for PLS.
		Red Top	1	0.10	

Permanent Seeding Mixtures

Mix	Site	Seed Mixture	Seed, Pounds per: Acre	1,000 sf	Remarks
8	Moist Wet	Creeping Bentgrass Fringed Bromegrass Fowl Meadowgrass Bluejoint Reedgrass or Rice Cutgrass Perennial Ryegrass	5 5 5 2 10	0.10 0.10 0.10 0.10 0.25	* Use Cool Season planting procedures. * Pond Banks * Waterways/ditch banks
9	Moist Wet	Red Fescue Creeping Bentgrass Switchgrass Perennial Ryegrass	5 2 8 10	0.10 0.10 0.20 0.25	*Salt Tolerant * Fescue and Bentgrass provide low growing appearance, while Switchgrass provides tall cover for wildlife.
10	Moist Wet	Red Fescue Creeping Bentgrass Virginia Wild Rye Wood Reed Grass* Showy Tick Trefoil*	5 5 8 1 1	0.10 0.10 0.20 0.10 0.10	* Use Cool Season planting procedure. * Trefoil requires inoculation with nitrogen fixing bacteria. * Suitable for forest access roads, skid trails and other partial shade situations.
11	Moist Wet	Creeping Bentgrass Bluejoint Reed Grass Virginia Wild Rye Fowl Meadow Grass Showy Tick Trefoil* Red Top	5 1 3 10 1 1	0.10 0.10 0.10 0.25 0.10 0.10	* Use Cool Season planting procedure. * Suitable for waterways, pond or ditch banks. * Trefoil requires inoculation with nitrogen fixing bacteria.
12	Wet	Blue Joint Reed Grass Canada Manna Grass Rice Cut Grass Creeping Bent Grass Fowl Meadow Grass	1 1 1 5 5	0.10 0.10 0.10 0.10 0.10	* Use Cool Season planting procedure. * OK to seed in saturated soil conditions, but not in standing water. * Suitable as stabilization seeding for created wetland. * All species in this mix are native to Massachusetts.
13	Dry - Moist	American Beachgrass	18" centers	18' centers	*Vegetative planting with dormant culms, 3-5 culms per planting
14	Inter-Tidal	Smooth Cordgrass Saltmeadow Cordgrass	12-18" centers	12-18" centers	* Vegetative planting with transplants.

Notes:
* Species such as Tumble Lovegrass, Fringed Bromegrass, Wood Reedgrass, Bush Clover and Beach Pea, while known to be commercially available from specific seed suppliers, may not always be available from your particular seed suppliers. The local Natural Resources Conservation Service office may be able to help with a source of supply. In the event a particular species listed in a mix can not be obtained, however, it may be possible to substitute another species.

Seed mixtures by courtesy of Natural Resources Conservation Service, Amherst, MA.

(PLS) Pure Live Seed

Warm Season grass seed is sold and planted on the basis of pure live seed. An adjustment is made to the bulk rate of the seed to compensate for inert material and non-viable seed. Percent of pure live seed is calculated by multiplying the percent purity by the percent germination; **(% purity) x (% germination) = percent PLS.**

For example, if the seeding rate calls for 10 lbs./acre PLS and the seed lot has a purity of 70% and germination of 75%, the PLS factor is:

(.70 x .75) =.53

10 lbs. divided by .53 = approx. 19 lbs.

Therefore, 19 lbs of seed from the particular lot will need to be applied to obtain 10 lbs. of pure live seed.

Special Note

Tall Fescue, Reed Canary Grass, Crownvetch and Birdsfoot Trefoil are no longer recommended for general erosion control use in Massachusetts due to the invasive characteristics of each. If these species are used, it is recommended that the ecosystem of the site be analyzed for the effects species invasiveness may impose. The mixes listed in the above mixtures include either species native to Massachusetts or non-native species that are not perceived to be invasive, as per the Massachusetts Native Plant Advisory Committee.

Wetlands Seed Mixtures

For newly created wetlands, a wetlands specialist should design plantings to provide the best chance of success. Do not use introduced, invasive plants like reed canarygrass (Phalaris arundinacea) or purple loosestrife (Lythrum salicaria). Using plants such as these will cause many more problems than they will solve.

The following grasses all thrive in wetland situations:

- Fresh Water Cordgrass (*Spartina pectinata*)
- Marsh/Creeping Bentgrass (*Agrostis stolonifera, var. Palustric*)
- Broomsedge (*Andropogon virginicus*)
- Fringed Bromegrass (*Bromus ciliatus*)
- Blue Joint Reed Grass (*Calamagrostis cavedensis*)
- Fowl Meadow Grass (*Glyceria striata*)
- Riverbank Wild Rye (*Elymus riparius*)
- Rice Cutgrass (*Leersia oryzoides*)
- Stout Wood Reed (*Cinna arundinacea*)
- Canada Manna Grass (*Glyceria canadensis*)

A sample wetlands seed mix developed by The New England Environmental Wetland Plant Nursery is shown on the following page.

Wetland Seed Mixture

The New England Environmental Wetland Plant Nursery has developed a seed mixture which is specifically designed to be used in wetland replication projects and stormwater detention basins. It is composed of seeds from a variety of indigenous wetland species. Establishing a native wetland plant understory in these areas provides quick erosion control, wildlife food and cover, and helps to reduce the establishment of undesirable invasive species such as Phragmites and purple loosestrife (Lythrum salicaria). The species have been selected to represent varying degrees of drought tolerance, and will establish themselves based upon microtopography and the resulting variation in soil moisture.

Common Name (*Scientific Name*)	% in Mix	Comments
Lurid Sedge (*Carex lurida*)	30	A low ground cover that tolerates mesic sites in addition to saturated areas; prolific seeder in second growing season.
Fowl Meadow Grass (*Glyceria Canadensis*)	25	Prolific seed producer that is a valuable wildlife food source.
Fringed Sedge (*Carex crinita*)	10	A medium to large sedge that tolerates saturated areas; good seed producer.
Joe-Pye Weed (*Eupatoriadelphus maculatus*)	10	Flowering plant that is valuable for wildlife cover. Grows to 4 feet.
Brook Sedge (*Carex spp., Ovales group*)	10	Tolerates a wide range of hydrologic conditions.
Woolgrass (*Scirpus cyperinus*)	5	Tolerates fluctuating hydrology.
Boneset (*Eupatorium perfoliatum*)	5	Flowering Plant that is valuable for wildlife cover. Grows to 3 feet.
Tussock Sedge (*Carex stricta*)	<5	Grows in elevated hummocks on wet sites, may grow rhizomonously on drier sites.
Blue Vervain (*Verbena hastata*)	<5	A native plant that bears attractive, blue flowers.

The recommended application rate is one pound per 5,000 square feet when used as an understory cover. This rate should be increased to one pound per 2,500 square feet for detention basins and other sites which require a very dense cover. For best results, a late fall application is recommended. This mix is not recommended for standing water.

Maintenance

Inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.

If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed.

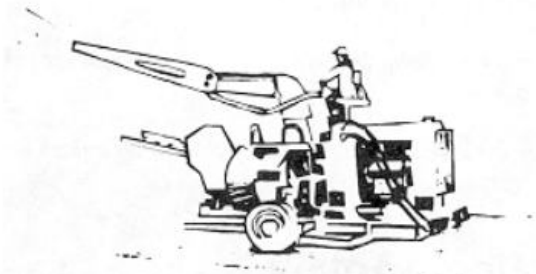
References

North Carolina Department of Environment, Health, and Natural Resources, ***Erosion and Sediment Control Field Manual***, Raleigh, NC, February 1991.

Personal communication, Richard J. DeVergilio, USDA, Natural Resources Conservation Service, Amherst, MA.

U.S. Environmental Protection Agency, ***Storm Water Management For Construction Activities***, EPA-832-R- 92-005, Washington, DC, September, 1992.

Washington State Department of Ecology, ***Stormwater Management Manual for the Puget Sound Basin***, Olympia, WA, February, 1992.



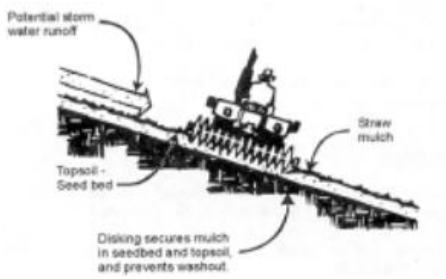
HYDRO-SEEDING

Seeding, Temporary

Planting rapid-growing annual grasses, small grains, or legumes to provide initial, temporary cover for erosion control on disturbed areas.

Purpose

To temporarily stabilize areas that will not be brought to final grade for a period of more than 30 working days.
To stabilize disturbed areas before final grading or in a season not suitable for permanent seeding.



Temporary seeding controls runoff and erosion until permanent vegetation or other erosion control measures can be established.
Root systems hold down the soils so that they are less apt to be carried offsite by storm water runoff or wind.
Temporary seeding also reduces the problems associated with mud and dust from bare soil surfaces during construction.

Where Practice Applies

On any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one year. Applications of this practice include diversions, dams, temporary sediment basins, temporary road banks, and topsoil stockpiles.

Where permanent structures are to be installed or extensive re-grading of the area will occur prior to the establishment of permanent vegetation.

Areas which will not be subjected to heavy wear by construction traffic.

Areas sloping up to 10% for 100 feet or less, where temporary seeding is the only practice used.

Advantages

This is a relatively inexpensive form of erosion control but should only be used on sites awaiting permanent planting or grading. Those sites should have permanent measures used.

Vegetation will not only prevent erosion from occurring, but will also trap sediment in runoff from other parts of the site.

Temporary seeding offers fairly rapid protection to exposed areas.

Disadvantages/Problems

Temporary seeding is only viable when there is a sufficient window in time for plants to grow and establish cover. It depends heavily on the season and rainfall rate for success.

If sown on subsoil, growth will be poor unless heavily fertilized and limed. Because overfertilization can cause pollution of stormwater runoff, other practices such as mulching alone may be more appropriate. The potential for over-fertilization is an even worse problem in or near aquatic systems.

Once seeded, areas should not be travelled over.

Irrigation may be needed for successful growth. Regular irrigation is not encouraged because of the expense and the potential for erosion in areas that are not regularly inspected.

Planning Considerations

Temporary seedings provide protective cover for less than one year. Areas must be reseeded annual or planted with perennial vegetation.

Temporary seeding is used to protect earthen sediment control practices and to stabilize denuded areas that will not be brought into final grade for several weeks or months. Temporary seeding can provide a nurse crop for permanent vegetation, provide residue for soil protection and seedbed preparation, and help prevent dust production during construction.

Use low-maintenance native species wherever possible.

Planting should be timed to minimize the need for irrigation.

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is effective when combined with construction phasing so bare areas of the site are minimized at all times.

Temporary seeding may prevent costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Soil that has been compacted by heavy traffic or machinery may need to be loosened. Successful growth usually requires that the soil be tilled before the seed is applied. Topsoiling is not necessary for temporary seeding; however, it may improve the chances of establishing temporary vegetation in an area.

Planting Procedures

Time of Planting

Planting should preferably be done between April 1 and June 30, and September 1 through September 30. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1 and March 31, mulching should be applied immediately after planting. If seeding is done during the summer months, irrigation of some sort will probably be necessary.

Site Preparation

Before seeding, install needed surface runoff control measures such as gradient terraces, interceptor dike/swales, level spreaders, and sediment basins.

Seedbed Preparation

The seedbed should be firm with a fairly fine surface.

Perform all cultural operations across or at right angles to the slope. See **Topsoiling** and **Surface Roughening** for more information on seedbed preparation. A minimum of 2 to 4 inches of tilled topsoil is required.

Liming and Fertilization

Apply uniformly 2 tons of ground limestone per acre (100 lbs. per 1,000 Sq. Ft.) or according to soil test.

Apply uniformly 10-10-10 analysis fertilizer at the rate of 400 lbs. per acre (14 lbs. per 1,000 Sq. Ft.) or as indicated by soil test. Forty percent of the nitrogen should be in organic form.

Work in lime and fertilizer to a depth of 4 inches using any suitable equipment.

Seedings for Temporary Cover

Species	Seeding Rates lbs/sq.ft. 1,000 Sq.Ft.	Seeding Rates lbs/sq.ft. Acre	Recommended Seeding Dates
Annual Ryegrass	1	40	April 1 to June 1 Aug. 15 to Sept. 15
Foxtail Millet	0.7	30	May 1 to June 30
Oats	2	80	April 1 to July 1 August 15 to Sept. 15
Winter Rye	3	120	Aug. 15 to Oct. 15

"Hydro-seeding" applications with appropriate seed-mulch-fertilizer mixtures may also be used.

Seeding

Select adapted species from the accompanying table.
Apply seed uniformly according to the rate indicated in the table by broadcasting, drilling or hydraulic application.
Cover seeds with suitable equipment as follows:

Rye grass	¼ inch
Millet	½ to ¾ inch
Oats	1 to 1-1/2 inches
Winter rye	1 to 1-1/2 inches.

Mulch

Use an effective mulch, such as clean grain straw; tacked and/or tied down with netting to protect seedbed and encourage plant growth.

Common Trouble Points

Lime and fertilizer not incorporated to at least 4 inches
May be lost to runoff or remain concentrated near the surface where they may inhibit germination.

Mulch rate inadequate or straw mulch not tacked down
Results in poor germination or failure, and erosion damage. Repair damaged areas, reseed and mulch.

Annual ryegrass used for temporary seeding
Ryegrass reseeds itself and makes it difficult to establish a good cover of permanent vegetation.

Seed not broadcast evenly or rate too low
Results in patchy growth and erosion.

Maintenance

Inspect within 6 weeks of planting to see if stands are adequate. Check for damage after heavy rains. Stands should be uniform and dense. Fertilize, reseed, and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather or on adverse sites. Water application rates should be controlled to prevent runoff.

Appendix C – Watershed Map

N

PLAN BOOK 88
PLAN 85

WILLIAMS & SPARAGES
ENGINEERS | PLANNERS | SURVEYORS
189 NORTH MAIN STREET
SUITE 101
MIDDLETON, MA 01949
PHONE: (978) 539-8088
FAX: (978) 539-8200
WSENGINEERS.COM

PETER BLAISDELL
(3/2/2020)

Watershed & Soils Map
41 KELSEY ROAD
BOXFORD, MA

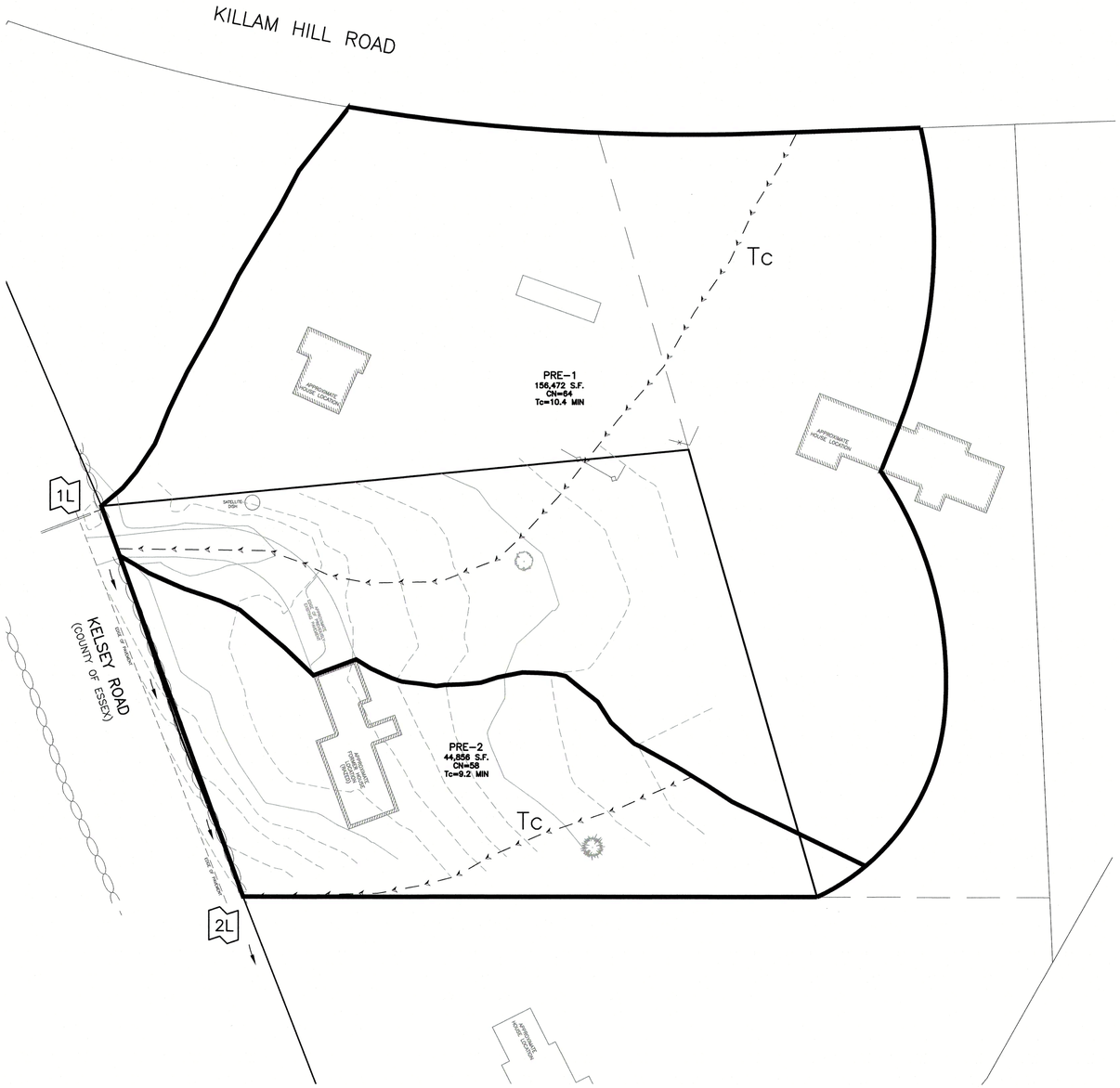
SCALE: 1" = 40' 0' 20' 40' 80' DATE: February 28, 2020

PRE & POST COMPARISON
TOTAL WATERSHED AREA=201,329 S.F.

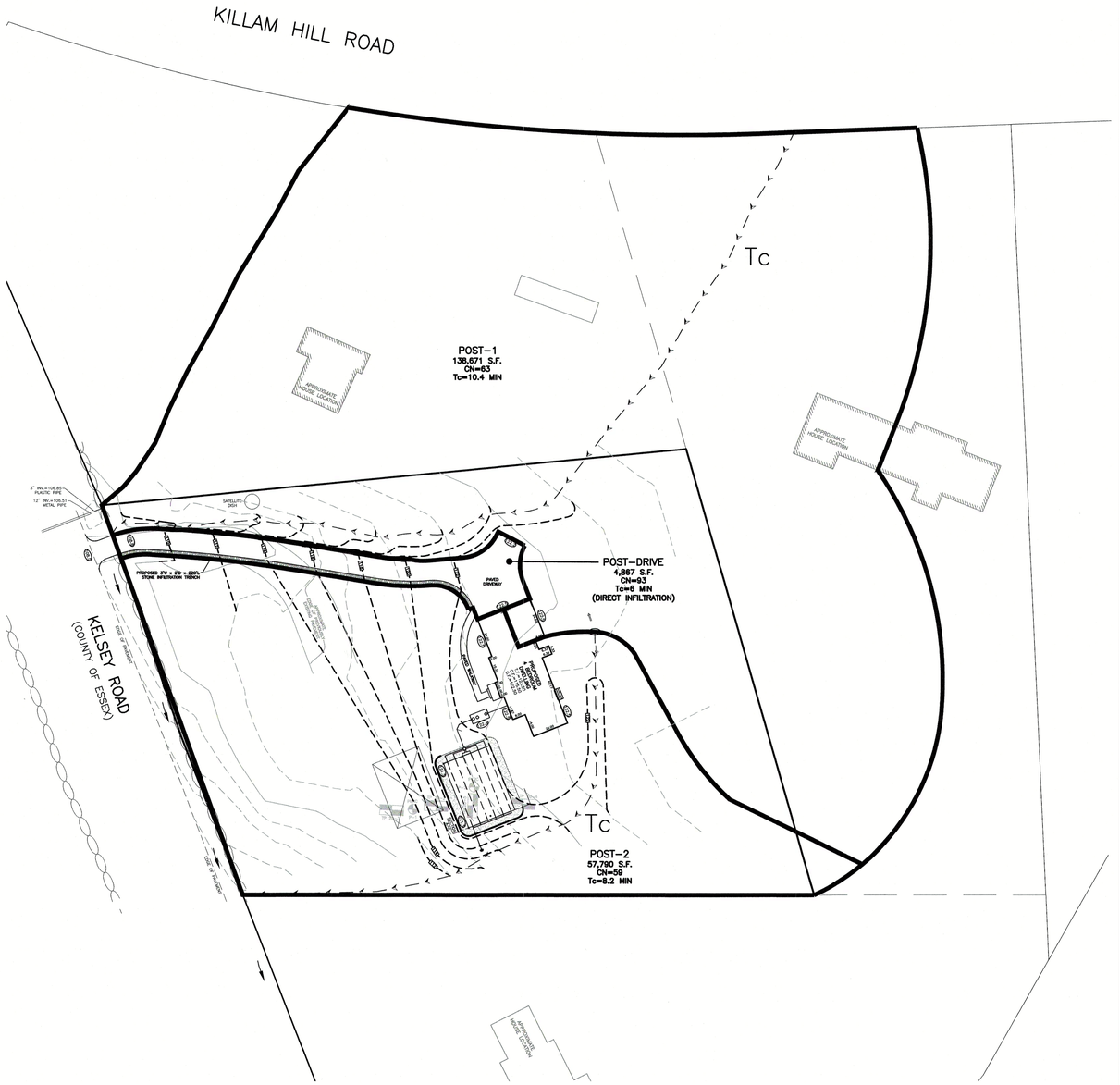
Note: All soils within the limit of the watershed analysis are comprised of Charlton fine sandy loam, 3 to 8 percent slopes, very stony with a hydrologic soil group of "B" according to the NRCS Web Soil Survey

LEGEND OF SYMBOLS
- WATERSHED BOUNDARY
- EXISTING SOIL BOUNDARY
- TIME OF CONCENTRATION FLOW PATH
- HYDROLOGIC SOIL GROUP: HSG A
- COMPARISON BOUNDARY DESIGNATION: 1L
- FLOW DIRECTION IN KELSEY ROAD

PREVIOUSLY -DEVELOPED CONDITION



POST-DEVELOPED CONDITION



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