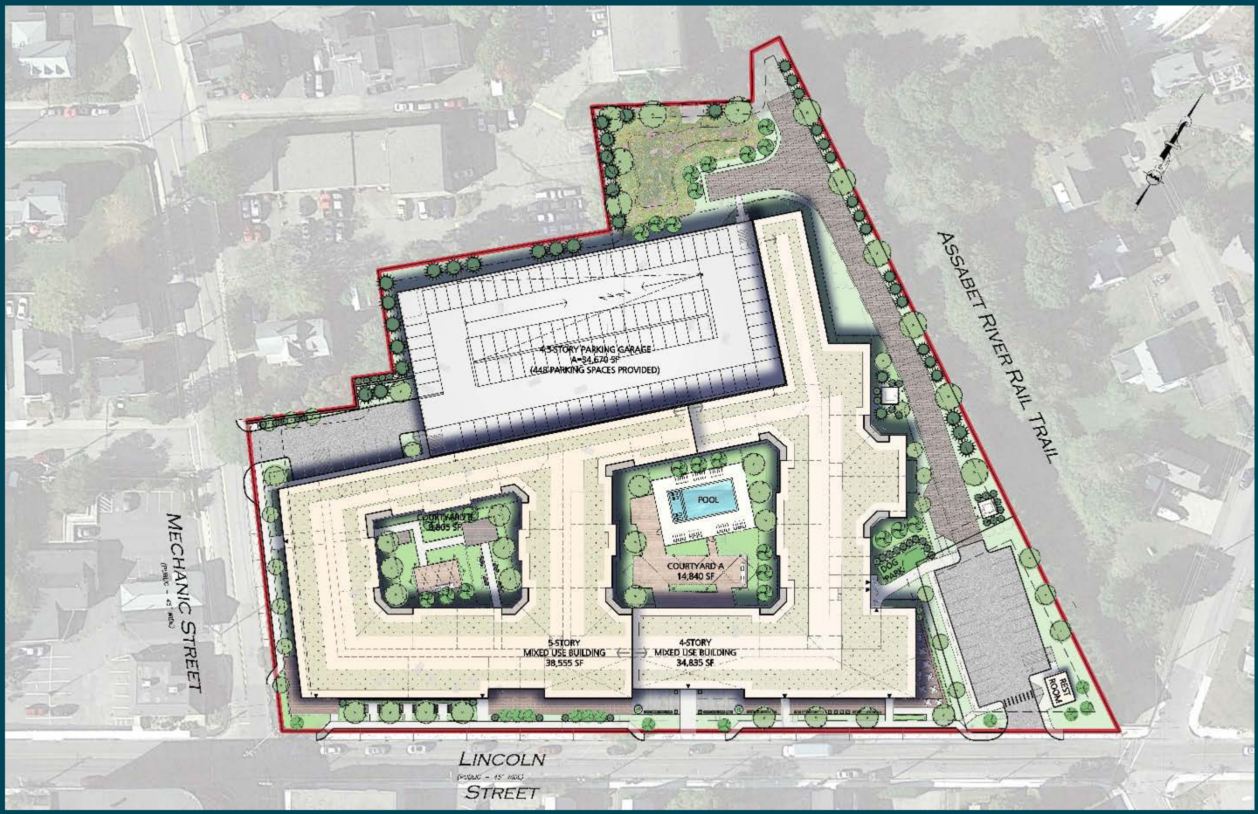
PROJECT NARRATIVE & DRAINAGE REPORT TO ACCOMPANY SPECIAL PERMIT APPLICATION

Mixed-Use Development
Lincoln St. & Mechanic St.
Marlborough, MA
Prepared: April 1, 2022



Site Locus

CLIENT:
ALTA Marlborough, LLC
91 Hartwell Avenue
Lexington, MA 02421

PREPARED BY:
Allen & Major Associates, Inc.
10 Main Street
Lakeville, Massachusetts 02347

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ISSUED:
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REVISED:
-

A&M PROJECT NO.:
1670-20

PROJECT TEAM	
OWNERS BPD Realty Trust (Parcel ID 69-345) Koby, Inc. (Parcel ID 69-343, 56-85, 69-341, 69-342, 69-340) Marlborough Economic Development Corp. (Parcel ID 69-339A, 69-339, 69-338, 69-338A, 69-337) Portion of Old Rail Spur	**APPLICANT** ALTA Marlborough, LLC 91 Hartwell Avenue Lexington, MA 02421 Contact: Jim Lambert Tel: 781-541-5822 E-mail: jim.lambert@woodpartners.com
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The information presented herein this report has been a collaborative effort from the various members/personnel of the Project Team.	

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SECTION 1.0 PROJECT SUMMARY

1.1 INTRODUCTION

The applicant, ALTA Marlborough, LLC, is submitting a special permit for the construction of a mixed-use development located at the intersection of Lincoln and Mechanic Streets in the City of Marlborough, Massachusetts consisting of a total of 276 residential units on approximately 4.53 acres as shown on the Site Development Drawings. The proposed project will include a complete site demolition of all existing structures and the construction of a 4/5 story building, a 4.5-story parking garage, exterior surface parking areas, amenities and all supporting site features and infrastructure required to support the proposed development. The project will be serviced by municipal water and sewer, and private underground utilities consisting of gas services, electrical service and underground tele-communication/cable services from various utility companies. The proposed project is proposing parallel parking spaces along Lincoln Street and Mechanic Street to be utilized by the residents of Marlborough and patrons of the mixed use retail space.

The purpose of this project narrative and drainage report is to provide a detailed review of the locus, potential project impacts, and stormwater as it pertains to the existing conditions and proposed redevelopment. The report will show by means of narrative, calculations, and exhibits that appropriate best management practices have been used to mitigate the impacts from the proposed development. The report will demonstrate that the proposed site development reduces the peak stormwater discharge rates and the overall site runoff volume during all storm events at the existing design points. Further, the report will show that the proposed stormwater management system complies with the ten (10) stormwater standards as presented in the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Regulations and MA MS4 General Permit regulations.

1.2 SITE CATEGORIZATION FOR STORMWATER REGULATIONS

The proposed project, ALTA Marlborough, is considered redevelopment under the MassDEP Stormwater Management Standards and therefore is required to meet the Stormwater Management Standards to the maximum extent practicable and provide an improvement over existing conditions. The proposed project will reduce the overall impervious coverage, improve the quantity and quality of stormwater by implementing Low Impact Development Techniques which will include the installation of a green roof, expansion of the existing stormwater outfall to include wetland species, installation of water quality structures and the installation of a sub-surface recharge system.

SECTION 2.0
EXISTING CONDITIONS

2.1 SITE LOCATION AND ACCESS

The subject property (the "Property") is located at the intersection of Mechanic Street, Lincoln Street and the Assabet River Rail Trail in the City of Marlborough which is located in central Massachusetts in the western edge of Middlesex County. Marlborough is located between Boston and Worcester, approximately 26 miles Westerly of Boston and 15 miles easterly of Worcester. The Property has legal frontage on both Mechanic and Lincoln Streets. Lincoln Street runs east/west and Mechanic Street north/south. Refer to Figure 1, which shows the entire Property, outlined in red. The outline represents the intended combination of multiple parcels as completed through an Approval Not Required through the Marlborough Planning Board.

Figure 1 – Locus Map (Bing Map)

The Property is located in the Neighborhood Business (NB) Zoning District and a small portion of the old rail spur is in the Commercial Automotive (CA) Zoning District. The surrounding properties are also located within the Neighborhood Business (NB), Commercial Automotive (CA) and/or the Residence B (RB).

2.2 EXISTING SITE CONDITIONS

The Property is approximately 4.9 acres in size and a majority of the land is currently developed or has been previously altered/disturbed. The front and easterly portion of the property is currently developed with several building/structures, which are currently being used as a car dealership, commercial use, manufacturing use or warehouse storage.

Pavement and hard packed gravel surfaces are located adjacent to and around the existing buildings. The westerly portion of the property consists of hard packed gravel surfaces and the northerly portion remains wooded, refer to Figure 2 below, which shows the entire property, outlined in red. The individual lots are shown in a light, thin grayscale.

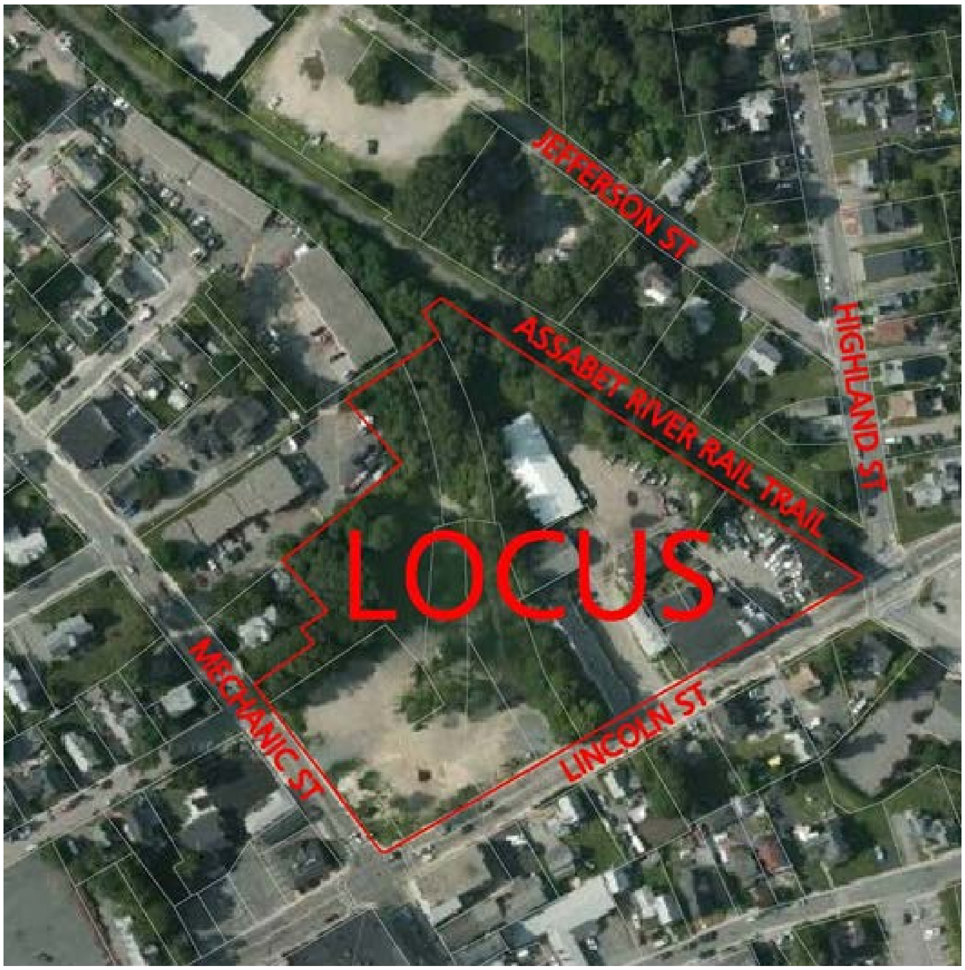


Figure 2 - Locus Map (Bing Aerial)

Lincoln and Mechanic Streets are both public ways maintained by the City of Marlborough. Lincoln Street is paved, approximately 31 feet wide with vertical granite curbing and cement concrete sidewalks along both sides of the roadway. Mechanic Street is also paved, approximately 30 feet wide with vertical granite curbing and cement concrete sidewalks along both sides of the roadway. This intersection is currently signalized. The Property currently has multiple existing curb cuts along both streets.

Lincoln Street has been recently reconstructed in the Fall 2021 and work remains ongoing. According to the proposed record drawings, provided by the City of Marlborough, Lincoln

Street will provide 2-11' wide lanes and some parallel parking spaces along the southerly side.

The site is located on the Marlborough USGS Quadrangle map. The site topography is moderately sloped, throughout the site. The site slopes in a southerly direction starting at the northwesterly property line, adjacent to Mechanic Street with a high point elevation of 451± to a low point elevation of 438± at Lincoln Street. The northerly portion of the site contains a drainage outfall which receives runoff from the municipal drainage system, the northerly property as well as properties located on Jefferson Street. The drainage ditch has a 24" inlet pipe from Jefferson Street and a 24" outlet pipe which connects into a drain manhole on the Property. This manhole also receives runoff from the municipal drainage system on Pleasant, Chestnut, Mechanic & Manning Streets. Eventually all stormwater is routed to the municipal drainage system in Lincoln Street. Please refer to the site survey for site specific elevations and details and drainage routing.

2.3 WATERSHED

The property falls within the Concord Watershed with a drainage area of approximately 400 square miles. The Concord Watershed is part of a larger watershed identified as the Sudbury, Assabet and Concord (SuAsCo) Watershed. The Assabet and Sudbury Rivers start in Westborough and flow northerly until they merge at Egg Rock in Concord, MA. The Concord flows northerly to the Merrimack River in Lowell, MA and eventually into the ocean at Plum Island in Newburyport, MA.

2.4 EXISTING SOIL CONDITIONS

The underlying soils have been mapped by the U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS) and consist of the following:

- 622C Paxton-Urban land complex, 3 to 15% slopes;
- 629C Canton-Charlton-Urban land complex, 3 to 15% slopes;
- 654 Udorthents, loamy.

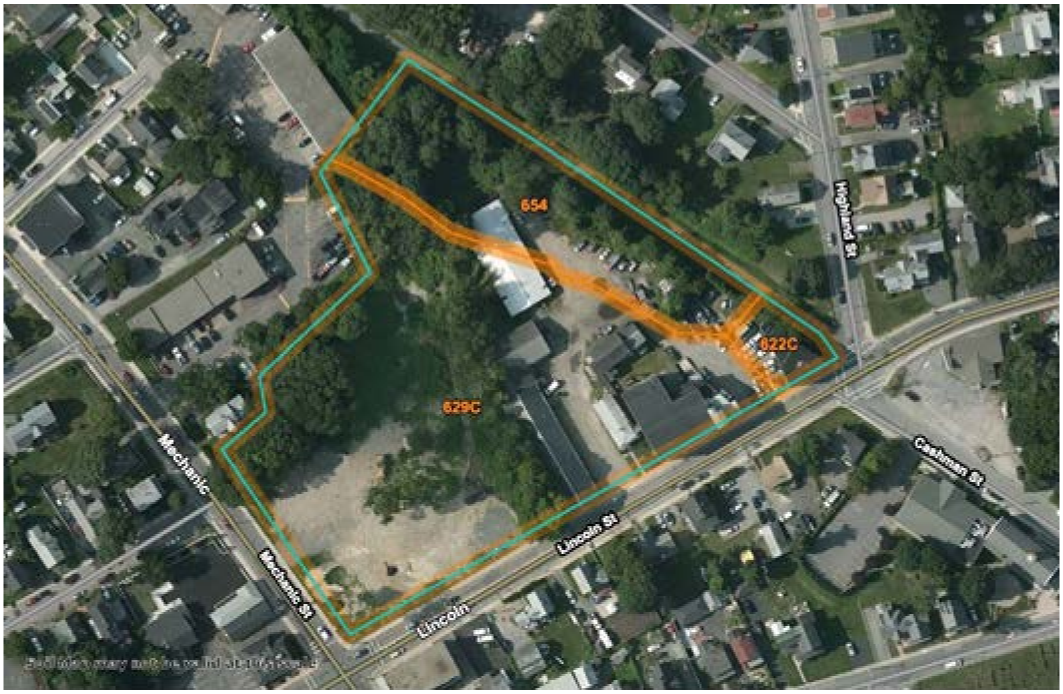


Figure 3 – Soil's Map

Paxton soils consists of fine sandy loam underlined by gravelly fine sandy loam. Paxton soils are part of the Hydrologic Soil Group (HSG) C. HSG C soils have a slow infiltration rate and a relatively high water table. Canton-Charlton soils consist of fine sandy loam underlain by gravelly loamy sand. Canton-Charlton soils are part of the HSG A. HSG A soils are well drained soils with a moderate infiltration rate and a high water table greater than 80 inches. Udorthents, loamy soils are also well drained soils with a moderate infiltration rate and a high water table greater than 80 inches.

Preliminary on-site soil investigations have been conducted by Haley & Aldrich, Vertex and Allen & Major Associates, Inc in December 2021 and January 2022. Test pits and borings were done to determine the existing soil strata, bearing capacity, depth to ground water, estimated seasonal high water table and the infiltration capacity of the underlying soils for the design of footings, foundation, utilities, and the drainage system. A&M was present on December 16 to witness/observe preliminary test pits for stormwater. All four test pits had fill present to depths of 7 to 10 feet. The underlying, natural material consisted of a fine silt loam to a fine silt clay loam. Minimal infiltration is expected, due to the underlying soil. Refer to the geotechnical report entitled “Final Preliminary Geotechnical Report Proposed Multi-Family Residential Development 283 to 325 Lincoln Street Marlborough, Massachusetts prepared by Haley Aldrich, Inc prepared for WP East Acquisitions, LLC dated February 2022, attached hereafter for testing locations and additional soil details.

2.5 FEMA FLOODPLAIN

The Flood Insurance Rate Map (FIRM) (Map Number 25017C0481F) for the City of Marlborough dated July 7, 2014 indicates the property lies within a FEMA Zone X, refer to Figure below. The FEMA Zone X which is defined as "areas determined to be outside the 0.2% annual chance floodplain". There are no development restrictions and performance standards associated with work within a Zone X.

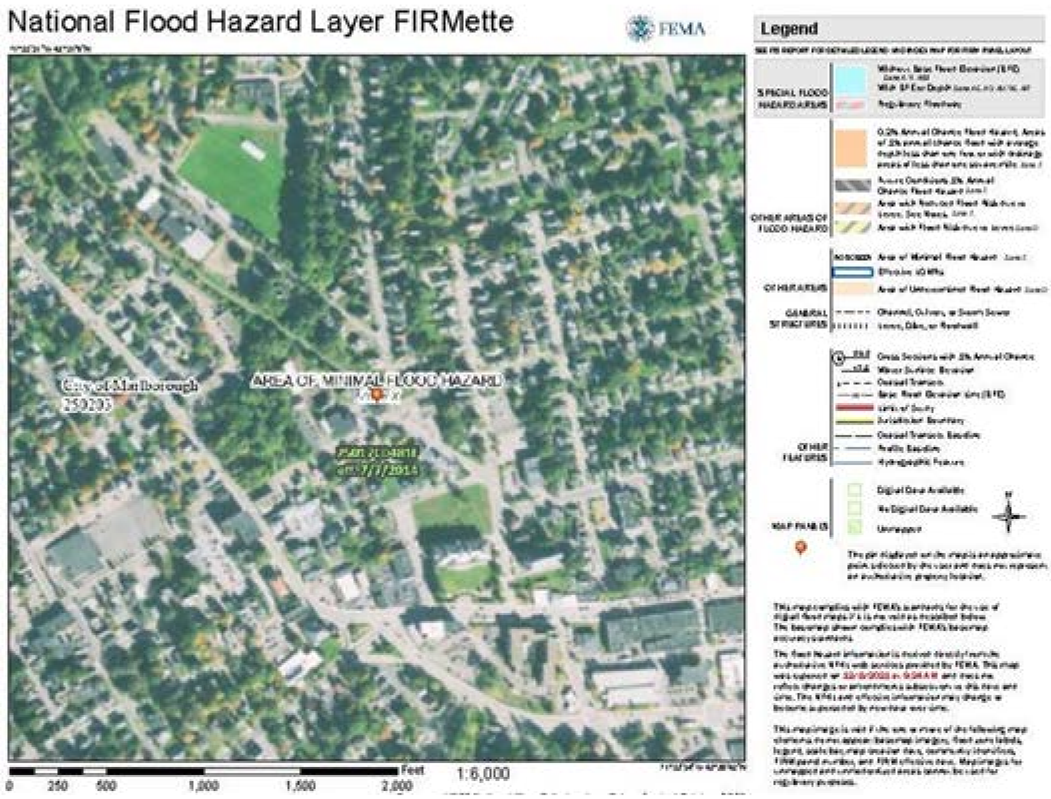


Figure 4 – FEMA FIRMette (Map 25023C0181K)

2.6 ENVIRONMENTALLY SENSITIVE ZONES

The Commonwealth of Massachusetts asserts control over numerous protected and regulated areas including: Areas of Critical Environmental Concern (ACEC); Outstanding Resource Waters (ORWs); areas protected under the Wetlands Protection Act and the Rivers Protection Act, as well as Natural Heritage & Endangered Species Program (NHESP) Priority and Protected Habitat for rare and endangered species..

According to the MassGIS website, via the interactive MassMapper, the site has the following environmental sensitive zones on the property;

- Outstanding Resource Water (ORW) to a Public Water Supply (PWS) watershed to Sudbury Reservoir in the SuAsCo Watershed Basin. PWS source ID 6000000-03S, PWS type Emergency Surface Water (ESW);

- Outstanding Resource Water (ORW) to a PWS watershed to Reservoir No. 3 (Framingham) in the SuAsCo Watershed Basin. PWS source ID 6000000-04S, PWS type ESW;
- The site is not located within, or adjacent to, an ACEC, ORW, or estimated or priority habitat areas defined by NHESP.

2.7 EXISTING STORMWATER PATTERNS

In order to compare the difference between pre- and post-development peak flows and run-off volumes, existing and proposed watersheds were developed. The design points for existing watersheds were established as the outer limits of the property and/or the municipal drainage system to ensure proper analysis from pre- and post-development conditions. All flow paths represent the longest time of concentration for stormwater runoff. The site topography is well defined, and all runoff is directed towards the existing drainage ditch and into the municipal drainage system via several pipes. A total of six (6) watersheds have been defined for the site and are as follows:

- Watershed E-1 is located on the northerly side of the property and is 68,848 sf in size. Watershed E-1 consists of some woodlands, with good groundcover, grass with good groundcover, hard packed gravel surfaces, pavement and roof area. Stormwater currently drains by overland flow to the existing drainage ditch and eventually into the municipal drainage system via a 24" culvert;
- Watershed E-2 is also located on the easterly side of the property and is 7,064 sf in size. Watershed E-2 consists of woodlands, with good groundcover and grass with good groundcover. Stormwater currently drains by overland flow offsite to the Assabet River Rail Trail and eventually into the municipal drainage system via an existing culvert;
- Watershed E-3 is located on the southerly side of the property and is 155,355 sf in size. Watershed E-3 consists of woodlands, with good groundcover, grass with good groundcover, hard packed gravel, pavement and several buildings. Stormwater currently drains by overland flow into several drainage structures and eventually into the municipal drainage system;
- Watershed E-4 is located off-site on the westerly side and is approximately 703,961 sf in size. The limits of the watershed was approximated via the City of Marlborough's GIS map, drainage maps and aerial photography. Watershed E-4 consists of commercial development and residential lots. Stormwater currently drains by overland flow into several drainage structures within the right of way, into the existing drainage ditch and eventually into the municipal drainage system via a 24" culvert;
- Watershed E-5 is located off-site on the easterly side and is approximately 28,241 sf in size. Watershed E-5 consists of grass with good groundcover and hard packed gravel parking lot. Stormwater currently drains by overland flow to the Assabet

River Rail Trail and eventually into the municipal drainage system via an existing culvert;

- Watershed E-4 is located off-site on the easterly side and is approximately 265,943 sf in size. The limits of the watershed was approximated via the City of Marlborough's GIS map, drainage maps and aerial photography. Watershed E-5 consists of the athletic field and residential lots. Stormwater currently drains by overland flow into several drainage structures within the right of way, into the existing drainage ditch and eventually into the municipal drainage system via a 24" culvert.

See the rear of this report for a copy of the Existing Watershed Plan (EWS-1).

2.8 EXISTING SITE UTILITIES

Lincoln and Mechanic Streets both have existing utilities installed within the right-of-way, consisting of water, sewer, drainage, gas and electrical services. The municipal sewer system consists of a six (6) inch main within Lincoln Street, an eight (8) inch main within Mechanic Street and a six (6) inch main on the easterly side of the property. The sewer is eventually routed into the City of Marlborough's Easterly Wastewater Treatment Plant located at 860 Boston Post Road East. The Easterly Wastewater Treatment Plant is an advanced wastewater treatment facility designed to handle a daily average flow of 5.5 million gallons per day. The facility treats sewage from the easterly portion of Marlborough, east of Route 495.

Based on inverts obtained from the existing conditions survey, the flattest piece of 6" sewer lateral exists along the northerly portion of the site adjacent to the abandoned rail with a slope of 0.40%. The carrying capacity, flowing half full, is approximately 115,690 gallons per day. There are no known service issues along this line. The governing regulations for sewer pipes, TR-16 Guides for the Design of Wastewater Treatment Works, dictate a minimum service size of 8". Continued use of the line shall be coordinated through the City Engineer.

The municipal water system consists of a twelve (12) inch main on the northerly side of Lincoln Street, a ten (10) inch main on the southerly side of Lincoln Street and a ten (10) inch main on the westerly side of Mechanic Street. An eight (8) inch main is located on the northerly side of the property. The City of Marlborough gets its water from the Massachusetts Water Resource Authority (MWRA). Several fire hydrants are located within close proximity to the site including at the northwest (rear) corner of the Property.

Utility poles and overhead wires are located on the southerly side of Lincoln Street and on the westerly side of Mechanic Street. National Grid-Electric is the electrical service provider for the City of Marlborough. Verizon and Comcast supply the City with communication services that are either overhead cables or underground conduits. A six (6) to eight (8) inch low pressure gas main is located on the southerly side of Lincoln Street and a four (4) inch low pressure gas main is located on the easterly side of Mechanic Street. Eversource Gas is the gas provider for the City of Marlborough

SECTION 3.0
PROPOSED CONDITIONS

3.1 PROPOSED OVERVIEW

The applicant, ALTA Marlborough, LLC is submitting this special permit application for construction of a mixed-use development located at the intersection of Lincoln & Mechanic Street in the City of Marlborough, Massachusetts consisting of a total of 276 residential units with approximately 10,074 sf of retail space on approximately 4.53 acres as shown on the Site Development Drawings. The proposed project will include a complete site demolition of all existing structures and the construction of a 4/5 story building, a 4.5-story parking garage, exterior surface parking areas, amenities, and all supporting site features and infrastructure required to support the proposed development.

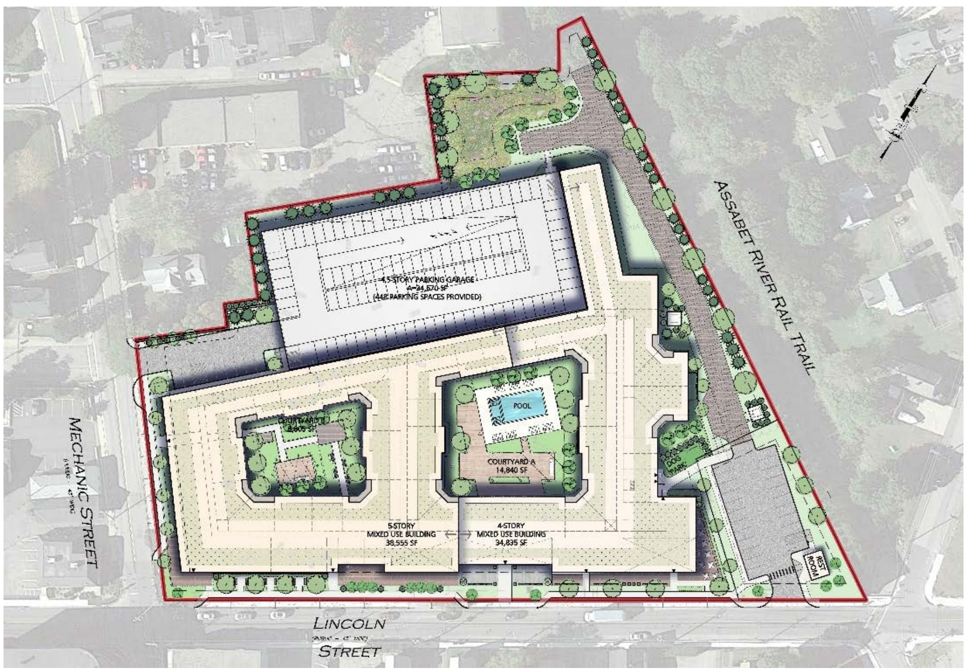


Figure 5 – Aerial Map with Proposed Overlay

The proposed retail space will be located along the front of the building on Mechanic Street and Lincoln Street. The residential units will be located behind the retail uses on the first floor and on the upper floors. The parking garage will be located on the northerly side of the proposed mixed-use building with access off of Mechanic Street. The access off Mechanic Street will also provide access to a small exterior parking lot for the retail use on Mechanic Street. The proposed project is also proposing an exterior parking lot off of Lincoln Street, adjacent to the Assabet River Rail Trail, with a restroom which will be conveyed to the City of Marlborough. A 20 foot wide fire access road will be located at the end of the parking area, providing access to the back of the building. The fire road is equipped with a turnaround area for emergency apparatus in accordance with the

National Fire Protection Association Fire Code ("NFPA 1"). The fire access road will also be used for routine deliveries, move-in accommodations, and trash pickup.

Accessibly compliant ramps are provided along the intended accessible site path to provide full accommodations for pedestrians. Connectivity to parking fields and across roadways are marked with pedestrian crosswalks in conformance with the Manual on Uniform Traffic Control Devices (MUTCD). Trash rooms will be provided internally within the buildings. Direction signage will be included for internal navigation of the site.

Parking spaces are dispersed throughout the site and within reasonable distances to the residential units and retail spaces. 481 total parking spaces are provided comprised of 33 surface spaces (standard and parallel) and 448 parking space within the parking garage. 440 spaces, within the garage are being designated for residential use resulting in a parking ratio of 1.59 spaces per unit. 41 parking spaces are designated for retail use, consisting of 25 parallel spaces along Mechanic and Lincoln Streets, 8 exterior spaces and 8 garage spaces. All standard parking spaces are designed at 9′ by 18′and parallel spaces are designed at 9′ by 20′ in accordance with the Zoning Code. Parking spaces in compliance with the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB) are distributed throughout the site adjacent to accessible entrances and/or amenities.

Other site improvements include landscape areas, underground utilities, municipal sewer and water and new stormwater management systems. The proposed stormwater management plan calls for the use of Low Impact Development techniques which include the use of a green roof, enlarging the existing drainage outfall receiving area and planting it with wetland mix, deep sump hooded catch basins, water quality structures, a Stormtech Isolator Row and a subsurface infiltration systems. The subsurface infiltration systems will consist of Stormtech SC-740 chambers. The system has been designed with high frequency, low volume infiltration and an outlet control structure for high volume events. The outlet control structures have been designed to match pre-development conditions for peak discharge rates and runoff volumes. The combination of these BMP's will remove greater than 80% of Total Suspended Solids from anticipated stormwater runoff where a large portion of the runoff generation is clean roof runoff. Discharges from the parking garage shall be routed to the sewer system through an appropriately sized oil and gas separator.

3.2 PROPOSED STORMWATER PATTERNS

The drainage patterns under proposed conditions will maintain the same design points and designations under existing conditions with a sub-watershed breakdown including a total of twelve (12) drainage areas. Some of the existing watershed areas have been modified due to grading of the proposed development. The study concluded that the proposed rates of runoff and runoff volumes at the design points is less than the existing conditions analysis. The breakdown is as follows:

- Watershed E-4, unchanged, see description under Section 2.7 above;
- Watershed E-5, unchanged, see description under Section 2.7 above;
- Watershed E-6, unchanged, see description under Section 2.7 above;
- Watershed P-1 is associated with the northerly portion of the property that will continue to drain by overland flow into the modified drainage outfall and is 37,808 sf in size. Watershed P-1 consists of woodlands with good groundcover, grass/landscape area with good groundcover and impervious surfaces (existing roof, portion of fire access road, sidewalk). Stormwater will be directed into the modified drainage ditch. A new outlet control structure is being proposed to reroute the existing drainage around the building and back into the municipal drainage system as originally designed and intended utilizing similarly sized and sloped closed drainage piping;
- Watershed P-2 is located on the easterly side of the property and is 6,239 sf in size. Watershed P-2 consists of grass/landscape area with good groundcover and a small portion of roof from the restroom building. Stormwater will continue to drain by overland flow to Assabet River Rail Trail and eventually into the municipal system via the existing culvert;
- Watershed P-3 is also located on the easterly side of the property and is 31,850 sf in size. Watershed P-3 consists of grass/landscape area with good groundcover and impervious surface (fire access road, parking, sidewalk, a small portion if roof (restroom)). Stormwater will drain by overland to one of several deep sump hooded catch basins and eventually into the municipal system;
- Watershed P-4 is associated with the proposed parking garage and is 34,671 sf in size. Stormwater from the rooftop level will be directed through a water quality structure (hydrodynamic separator) and eventually into the municipal drainage system via the relocated drainage pipe;
- Watershed P-5 is located on the westerly side, associated with the small exterior parking lot off Mechanic Street and is 6,610 sf in size. Watershed P-5 consists of grass/landscape area with good groundcover and impervious surfaces (parking, drive aisle, sidewalk). Stormwater will be directed to deep sump and hooded catch basins, through the Stormtech Isolator Row and into the subsurface infiltration system. An outlet control structure will be provided to allow stormwater to overflow into the municipal system within Mechanic Street;
- Watershed P-6 is associated with the mixed-use building and is 74,887 sf in size. 30,000 sf of green roof area is being proposed utilizing approximately 40% of the available roof surface. Final layout and sizing shall be determined in coordination

with the mechanical rooftop equipment and access paths. A green roof is a permanent rooftop planting system containing live plants in a lightweight engineered soil medium designed to retain precipitation where the water is taken up by plants and transpired into the air. Underdrains and overflows will be provided and will be connected into the municipal drainage system via various connection points for high volume precipitation events;

- Watershed P-7 is associated with Courtyard B and is 8,175 sf. Watershed P-7 consists of grass/landscape area with good groundcover and impervious surfaces (patio, sidewalk). Stormwater will be directed into landscape beds. Area drains will be provided in the landscape beds which will eventually overflow into a collection system that will be connected into the municipal drainage system;
- Watershed P-8 is associated with Courtyard A and is 14,260 sf. Watershed P-8 consists of grass/landscape area with good groundcover and impervious surfaces (patio, sidewalk). Stormwater will be directed into landscape beds. Area drains will be provided in the landscape beds which will eventually overflow into a collection system that will be connected into the municipal drainage system;
- Watershed P-9 is associated with the front landscape areas and is 16,653 sf in size. Stormwater will drain by overland routing to one of several deep sump and hooded catch basins within the right of way and into the municipal system;

See the rear of this report for a copy of the Proposed Watershed Plan (PWS-1).

Design Point #1 – Municipal Drainage System

Table 3.2.A – Design Point 1 Existing vs Proposed peak rate of runoff to Municipal Drainage System

Design Storm	Existing (cfs)	Proposed (cfs)	Difference (cfs)
2-year	30.92	29.25	-1.67 (5.4%)
10-year	68.73	65.82	-2.91 (4.2%)
25-year	94.28	90.94	-3.34 (3.5%)
100-year	135.45	135.30	-0.15 (0.1%)

Table 3.2.B – Design Point 1 Existing vs Proposed runoff volume to Municipal Drainage System

Design Storm	Existing (ac-ft)	Proposed (ac-ft)	Difference (ac-ft)
2-year	2.794	2.650	-0.144 (5.1%)
10-year	5.910	5.713	-0.197 (3.3%)
25-year	8.049	7.829	-0.22 (2.7%)
100-year	11.546	11.296	-0.25 (2.2%)

3.3 DRAINAGE ANALYSIS METHODOLOGY

The peak rate of runoff was determined using techniques and data found in the following:

1. Urban Hydrology for Small Watersheds – Technical Release 55 by the United States

Department of Agriculture Soils Conservation Service, June 1986. Runoff curve numbers and 24-hour precipitation values were obtained from this reference.

2. HydroCAD© Stormwater Modeling System by HydroCAD Software Solutions LLC, version 10.10. The HydroCAD program was used to generate the runoff hydrographs for the watershed areas, to determine discharge/stage/storage characteristics for the infiltration systems, to perform drainage routing and to combine the results of the runoff hydrographs.

3. Soil Survey of Middlesex County, Massachusetts by United States Department of Agriculture, National Resource Conservation Service. Soil types and boundaries were obtained from this reference.

4. Rainfall Data for each of the storm events was based on data published by NOAA National Weather Service Atlas 14 point precipitation frequency estimates for Marlborough, MA. The precipitation values are shown in the following table:

Table 3.3.1 – Rainfall (NOAA Atlas 14)

	2-year	10-year	25-year	100-year
	3.30 inches	5.09 inches	6.20 inches	7.92 inches

3.4 CLOSED DRAINAGE SYSTEM COMPUTATIONAL METHODS

The closed drainage system calculations determine the rate of runoff, the time of concentration and the rainfall intensity for the drainage basin. The calculations will be performed for a 25-year storm event and analyzed for effects during the 100-year event. The following standards will be used:

1. The Rational Formula (Q =CIA) was used to determine the flow to each structure.
   Q = Flow cubic feet per second (CFS)
   C = Runoff coefficients
   I = Rainfall Intensity (inches per hour)
   A = Drainage Area (acres)

2. The runoff coefficients used are as follows:
   Impervious (pavement and roofs) = 0.9
   Grassed = 0.30
   Bare Ground and gravel = 0.50
   Landscape = 0.3
   Wooded = 0.2

3. The intensity for each area was determined by the Steel Formula for a 25-year frequency storm. The Steel Formula is:

   I = k/(t+b)
   I = Intensity
   k = 230 (25 yr)
   t = Time of Concentration
   b = 30 (25 yr)

4. The times of concentration were calculated using a nomograph provided in "Design, Volume 1," by Seelye, 1960. A minimum time of concentration of six (6) minutes was utilized.

5. The Manning's formula was utilized to calculate the capacity of the individual pipes in the closed drainage system. The Manning's formula is:

   $Q = (Ap)\ (1.486/n)\ (s^{1/2})\ (h^{2/3})$
   Q = Flow in CFS
   Ap = Cross-sectional area of the pipe (square feet)
   n = Roughness coefficient
   s = slope of the pipe (ft/ft)
   h = hydraulic radius

The closed drainage system shall be designed to handle the design flow as calculated, as well as maintaining a design velocity of between 2.0 feet per second (fps) (cleansing velocity at pipe half full conditions) and 12.0 fps.

3.5 EROSION AND SEDIMENT CONTROL

The site will be enclosed with a straw wattle and/or fiber roll barrier to prevent incidental conveyance of sediment from disturbed areas off-site or into the existing drainage system during construction. All existing drainage inlets within the public right of way adjacent to the site that are to remain shall have silt sacks installed prior to any construction activities. Stabilized construction entrances shall be installed as part of the construction and will be maintained until the site has been stabilized. The erosion control measures will remain in place until all construction activities are complete and all disturbed areas have been stabilized. The contractor will be required to inspect all controls regularly to ensure that they are working properly and to see if they need to be cleaned and/or replaced on an as-needed basis. The proposed project will disturb greater than one (1) acre of land and discharge into a municipal system, therefore the project will require the filing of a National Pollutant Discharge Elimination System (NPDES) Stormwater Construction General Permit. A stormwater Pollution Prevention

Plan (SWPPP) will be prepared prior to any construction activity. The SWPPP will prescribe in detail the performance standards the contractor will be required to implement, as needed, during construction. The SWPPP will be maintained at the construction trailer on-site throughout the duration of construction. The SWPPP shall outline acceptable temporary stabilization measures to prevent incidental transport of sediment to off-site areas.

3.6 SITE UTILITIES

Sanitary Sewer System

The project site is located in an area that is served by a municipal sewer system; therefore the proposed development is proposing to connect into the municipal system located within Lincoln Street and within the property. All existing sewer service connections will be removed and coordinated with the Sewer Department. To accommodate the proposed development, the existing six (6) inch sewer main along the easterly portion of the site will need to be relocated further easterly and new easements will be provided to the City of Marlborough.

The proposed residential development is anticipated to have 161 one-bedroom units, 105 two-bedroom units, and 10 three-bedroom units; totaling 401 bedrooms. The amenity space/office is approximately 8,472 sf and the retail space is approximately 10,074 sf. The proposed sewer flows are estimated to be 45,250 gallons per day based on 314 CMR 7.00 and 310 CMR 15.00. The sewage flows were calculated as follows:

Calculated Sewage Flows per The State Environmental Code, Title V (Proposed Development)

Type of Establishment	Min. Flow	Size	Calculated Flow	Design Flow
Residential	110 gpd/bedroom	401 bedrooms	44,110 gpd	44,110 gpd
Office (Clubhouse)	75 gpd/1000 sf min of 200 gpd	8,472 sf	635.4 gpd	636 gpd
Retail	50 gpd/1000 sf min of 200 gpd	10,074	503.7 gpd	504 gpd
Total Flow				**45,250 gpd**

The proposed parking garage will have the floor drains directed into an oil/gas separator prior to connection into the municipal sewer. The residential units will have a separate sanitary waste line that will also be connected into the municipal sewer main. Final sewer service building discharge locations will need to be determined in conjunction with the plumbing engineers during design development.

Water
The project site is located in an area that is serviced by the City of Marlborough's water system which is supplied by the Massachusetts Water Resource Authority (MWRA). The proposed development is proposing to connect to the existing 12" water main located within Lincoln Street. All existing water service connections will be removed and coordinated with the Water Department. The proposed project water consumption is calculated at 49,775 gpd based on average sewage flow noted above plus 10%. Final fire and water services size and locations will need to be determined in conjunction with the plumbing engineers during design development.

Other Utilities
The proposed development will connect to the existing utility poles along Lincoln Street with a new riser pole and underground conduits installed within the development. Transformers and underground conduit locations are conceptually shown on the proposed site plan, but the final location will be coordinated with National Grid Electric and determined by the various utility providers. All existing services will be disconnected, removed and coordinated with the various utility companies.

Several gas service connections will be made off the existing gas main within Mechanic & Lincoln Street. The new services will be routed to several gas meter banks located along the face of the building and parking garage. Final locations will be coordinated with the plumbing engineers, architect and Eversource Gas. All existing gas services will be disconnected, removed, and coordinated with the Eversource Gas.

SECTION 4.0
STORMWATER MANAGEMENT

4.1 MASSDEP STORMWATER PERFORMANCE STANDARDS

The MassDEP Stormwater Management Policy was developed to improve water quality by implementing performance standards for storm water management. The following section outlines how the proposed Stormwater Management System meets the standards set forth by the Policy.

BMP's implemented in the design include –

- Deep Sump and Hooded Catch Basins
- Green Roof
- Stormtech Isolator Row
- Subsurface Infiltration Systems (Stormtech SC-740 Chambers)
- Water Quality Structures/Hydrodynamic separators
- Drainage Basin
- Specific maintenance schedule

Stormwater Best Management Practices have been incorporated into the design of the project to mitigate the anticipated pollutant loading. An Operations and Maintenance Plan has been developed for the project, which addresses the long-term maintenance requirements of the proposed system.

Temporary erosion and sedimentation controls will be incorporated into the construction phase of the project. These temporary controls may include straw wattles and/or silt fence barriers, inlet sediment traps, slope stabilization, and stabilized construction entrances.

The Massachusetts Department of Environmental Protection has established ten (10) Stormwater Management Standards. A project that meets or exceeds the standards is presumed to satisfy the regulatory requirements regarding stormwater management. The proposed development is considered a redevelopment under the MassDEP Stormwater Management Standards.

The Standards are enumerated below as well as descriptions and supporting calculations as to how the Project will comply with the 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.

The proposed development will not introduce any new stormwater conveyances (e.g. outfalls) that discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. The existing site currently has several connections into the municipal drainage system and the proposed project is proposing to improve the water quality and quantity leaving the development. The proposed stormwater management system will consists of deep sump and hooded catch basins, a green roof, water quality structures, a Stormtech Isolator Row, a subsurface infiltration system and an improved vegetated stormwater outfall area. All discharges from impervious surfaces within the development (parking and drive aisles) will be treated prior to discharging into the municipal system.

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.

The proposed development has been designed so that the post-development peak discharge rates do not exceed the pre-development condition. Calculations have been provided to show that the proposed development will not cause an increase in peak discharge rates. Refer to the HydroCAD calculations provided within Appendix A of this report for detailed breakdowns.

Standard 3

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

The existing annual recharge for the site will be exceeded in the developed condition. Subsurface infiltration chambers will be designed to meet this requirement. All Infiltration Systems were designed using the "Simple Dynamic" Method per the MassDEP Stormwater Management Standards, Volume 3, Chapter 1.

The USDA Soil Survey of Middlesex County was used to determine soil types on site.

The required recharge rates for each soil classification are as follows:

Table 4.1 – Recharge Volume per Hydrologic Soil Group (HSG)

	HSG A	HSG B	HSG C	HSG D
Required Recharge	0.60 inches	0.35 inches	0.25 inches	0.10 inches

Table 4.2 – Proposed Impervious Surface

Site	Total Area	HSG A	HSG B	HSG C	HSG D
Building Roof	109,952 sf	101,240 sf-	-	8,712 sf	-
Pavement/sidewalk	37,867 sf	23,800 sf-	-	14,067 sf	-
Total Impervious Area	147,819 sf	125,040 sf-	-	22,779 sf	-

The project is considered a redevelopment and new development. Under existing conditions, there is approximately 156,319 sf of existing impervious surfaces (pavement/hard packed gravel/roof). Under proposed conditions, the project will have a total of 147,819 sf of impervious surface area, therefore a decrease of 8,500 sf. Per the Massachusetts Stormwater Handbook, the project is only required to recharge the increase in impervious surface above existing conditions. The proposed project is proposing a 30,000 sf green roof area on approximately 40% of the roof area associated with the mixed-use building. Other improvements include the installation of a sub-surface infiltration system and modifications to the existing drainage ditch by expanding the footprint and seeding it with a wetland mix:

Since the proposed project is considered a redevelopment project and due to the amount of fill and a high water table throughout the site, only a small portion on the westerly side will be used to provide recharge associated with the runoff from the exterior parking lot located off of Mechanic Street.

MA MS4 General Permit requires the project to retain and infiltrate the volume of 0.8 inches for redevelopment or remove 80% of the average annual post-construction impervious area on the site and 50% of the average annual load of Total Phosphorous (TP) generated from the post-construction impervious area on the site. The calculated recharge is V= (0.8")(1'/12")(147,819 sf) = 9,855 cf.

Since the proposed project is considered a redevelopment project and due to the amount of fill and a high water table throughout the site, only a small portion on the westerly side will be used to provide recharge associated with the runoff from the exterior parking lot located off of Mechanic Street. The proposed project is improving the stormwater leaving the site by implementing Low Impact Development techniques which includes the installation of a 30,000 sf green roof on the building. The project has reduced the amount of impervious area on the site and also minimized the amount of impervious area subject to vehicles and pollutant loading due to the proposed parking garage. The existing drainage ditch, which receives runoff from the municipal drainage system is being expanded to increase the volume, planted with a wetland mix, installing an outlet control structure with trash racks and installing a new rip rap energy dissipater.

The basin drawdown time is defined as:

$Time_{drawdown} = R_v / (K)(\text{bottom area})$

where R_v = Required Recharge Volume, ft3

K = Saturated Hydraulic Conductivity (Rawls Table)

Bottom area = Bottom area of recharge structure

Table 4.3 – Drawdown Calculation

System	R_v	K	Bottom Area	$Time_{drawdown}$
Sub-surface Sys 1	1,175 cf	0.17 in/hr	1,152 sf	72 hrs
Note: Volume for drawdown is based on the volume from HydroCAD below the lowest outlet.				

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:

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

The proposed stormwater management systems are designed so that the 80% TSS removal standard will be met for each drainage area. Standard #4 is met when structural stormwater best management practices are sized to capture and treat the required water quality volume and pretreatment is provided in accordance with the Massachusetts Stormwater Handbook. Standard #4 also requires that suitable source control measures are identified in the Long Term Pollution Prevention Plan. The 80% TSS removal standard will be met using some combination of the following: street sweeping, deep sump hooded catch basins, green roof, a Stormtech Isolator Row, a subsurface infiltration systems consisting of Stormtech chambers and a water quality structure (hydrodynamic separator).

The green roof will be sized to meet the water quality flow rate for the 1” storm event.

TSS Removal Credits for Street Sweeping (Massachusetts Stormwater Handbook Volume 2 Chapter 1)

TSS Removal Rate	High Efficiency Vacuum Sweeper – Frequency of Sweeping	Regenerative Air Sweeper – Frequency of Sweeping	Mechanical Sweeper (Rotary Broom)
5%	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Monthly Average, with sweeping scheduled primarily in spring and fall.

TSS Removal Calculation Worksheet – Sub-Surface Infiltration System 1				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Deep Sump Hooded Catch Basin	25%	1.00	0.25	0.75
Subsurface Infiltration with Isolator Row	80%	0.75	0.60	0.15
			Total TSS Removal	**85.0%**

TSS Removal Calculation Worksheet – Easterly side				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Water Quality Structure (Stormceptor 450i)	80%	1.00	0.80	0.20
			Total TSS Removal	**80.0%**

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, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The proposed redevelopment is considered a source of higher potential pollutant loads because the proposed parking area is considered a high-intensity parking area (over 1,000 vehicle trips per day). Pre-treatment and source reduction are provided to the maximum extent practicable. The drainage system will be designed to treat 1″ water quality volume and provide a minimum 44% TSS removal prior to discharge to an infiltration device. The SMS will be designed with deep-sump hooded catch basins and a Stormtech Isolator Row to provide the 44% TSS removal prior to recharge.

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 a public water supply.

The project redevelopment is located within an Outstanding Resource Water (ORW) to a Public Water Supply (PWS) watershed to Sudbury Reservoir in the SuAsCo Watershed Basin (PWS source ID 6000000-03S, PWS type Emergency Surface Water ESW) and an Outstanding Resource Water (ORW) to a PWS watershed to Reservoir No. 3 (Framingham) in the SuAsCo Watershed Basin (PWS source ID 6000000-04S, PWS type ESW). The drainage system will be designed to treat 1" water quality volume and provide a minimum 44% TSS removal prior to discharge to an infiltration device. The SMS will be designed with deep-sump and hooded catch basins and a Stormtech Isolator Row to provide the 44% TSS removal prior to recharge.

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.

Under existing conditions, there is approximately 156,319 sf of existing impervious surfaces (pavement/hard packed gravel/roof). Under proposed conditions, the project will have a total of 147,819 sf of impervious surface area, therefore a decrease of 8,500 sf. The proposed redevelopment project is an improvement over existing conditions by reducing the overall impervious surfaces, implementing best management practices and

Low Impact Development techniques into the overall design. The project is proposing a 30,000 sf green roof area on approximately 40% of the total roof area associated with the mixed-use building. Other improvements include the installation deep sump and hooded catch basins, water quality structures and a sub-surface infiltration system. The existing drainage ditch is being modified by expanding the footprint, increase the volume capacity, installation of a rip rap energy dissipater and the installation of an outlet control structure with trash racks. The new basin will be seeded with a wetland mix. Since a majority of the development will consist of a building footprint, the proposed project will introduce clean roof runoff into the municipal system versus the existing stormwater from paved and hard packed gravel areas that were subject to vehicle parking and pollutants.

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.

A plan to control construction-related impacts, including erosion, sedimentation and other pollutant sources during construction and land disturbance activities will be developed. The proponent will prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) prior to commencement of construction activities.

Standard 9

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

A Long-Term Operation & Maintenance (O&M) Plan has been developed for the proposed stormwater management system and is included within this document. See Appendix C of this report.

Standard 10

All illicit discharges to the stormwater management system are prohibited.

There are no expected illicit discharges to the stormwater management system. The applicant will submit the Illicit Discharge Compliance Statement prior to the discharge of stormwater runoff to the post-construction stormwater best management practices.

See the next page for the MassDEP Stormwater Checklist.

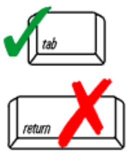
MassDEP Stormwater Checklist

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

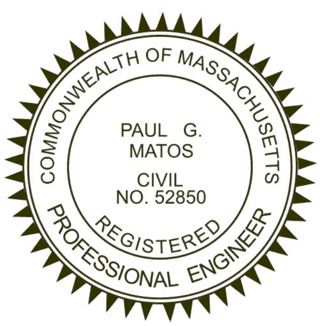
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature



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Signature and Date

Checklist

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

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ 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): Water Quality Structure (Hydrodynamic Seperator)

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

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

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

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

☐ is within the Zone II or Interim Wellhead Protection Area

☒ is near or to other critical areas

☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

☒ involves runoff from land uses with higher potential pollutant loads.

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

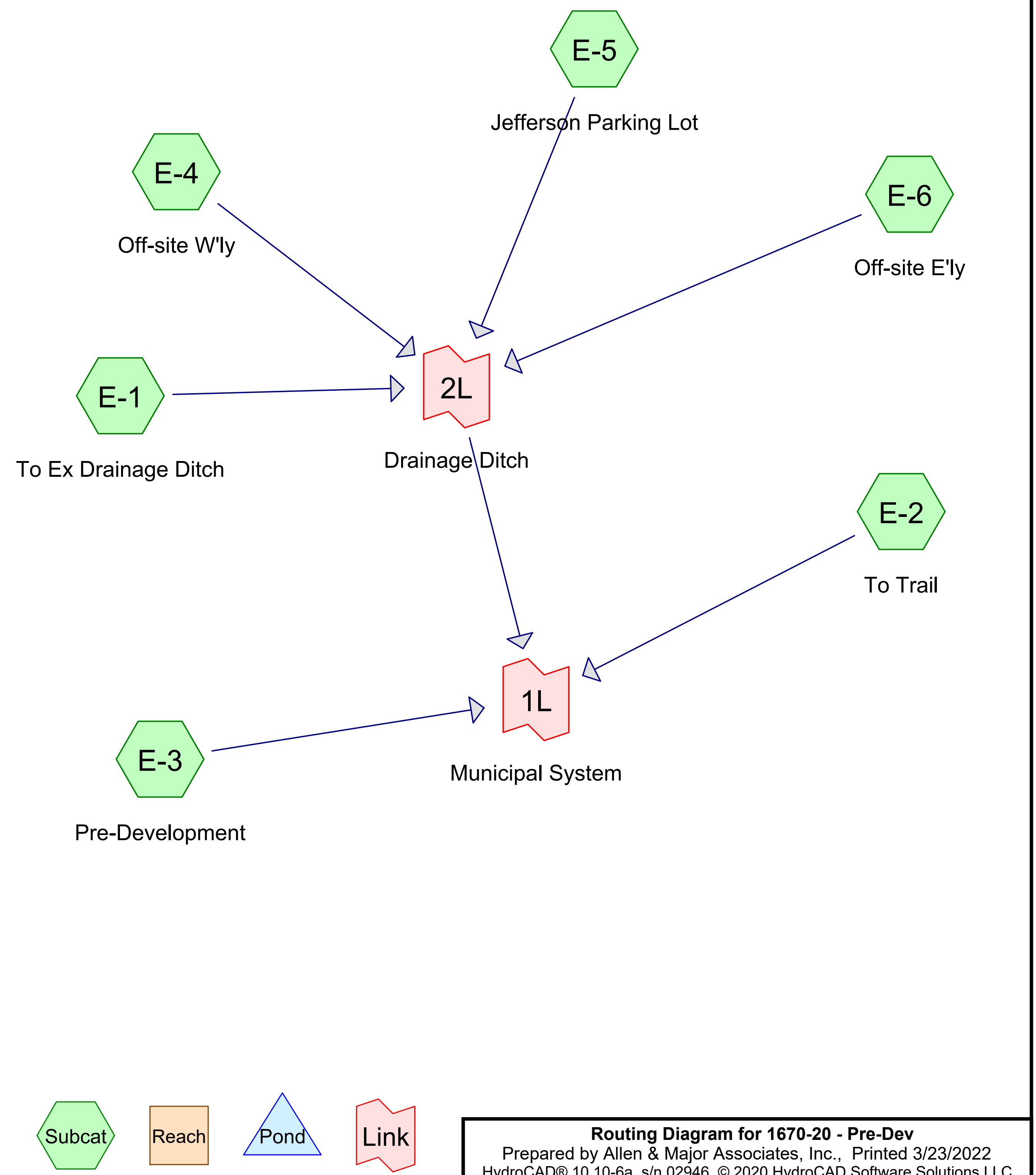
☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

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

APPENDIX A
HYDROCAD

PRE-DEVELOPMENT



Routing Diagram for 1670-20 - Pre-Dev
Prepared by Allen & Major Associates, Inc., Printed 3/23/2022
HydroCAD® 10.10-6a s/n 02946 © 2020 HydroCAD Software Solutions LLC

Project Notes

Rainfall events imported from "TP-40-Rain.txt" for 437 MA Berkshire

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.30	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.09	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.20	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.92	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
10.131	61	1/4 acre lots, 38% imp, HSG A (E-4)
7.289	83	1/4 acre lots, 38% imp, HSG C (E-4, E-6)
0.316	39	>75% Grass cover, Good, HSG A (E-1, E-3)
2.916	74	>75% Grass cover, Good, HSG C (E-1, E-2, E-3, E-5, E-6)
2.240	96	Gravel surface, HSG A (E-1, E-3)
0.935	96	Gravel surface, HSG C (E-3, E-5)
0.816	98	Paved parking, HSG A (E-1, E-3)
0.196	98	Paved parking, HSG C (E-2, E-3)
1.090	89	Urban commercial, 85% imp, HSG A (E-4)
0.909	94	Urban commercial, 85% imp, HSG C (E-4)
0.730	30	Woods, Good, HSG A (E-1, E-3)
0.656	70	Woods, Good, HSG C (E-1, E-2, E-3)
28.223	**75**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
15.323	HSG A	E-1, E-3, E-4
0.000	HSG B	
12.901	HSG C	E-1, E-2, E-3, E-4, E-5, E-6
0.000	HSG D	
0.000	Other	
28.223		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
10.131	0.000	7.289	0.000	0.000	17.421	1/4 acre lots, 38% imp	E-4, E-6
0.316	0.000	2.916	0.000	0.000	3.231	>75% Grass cover, Good	E-1, E-2, E-3, E-5, E-6
2.240	0.000	0.935	0.000	0.000	3.175	Gravel surface	E-1, E-3, E-5
0.816	0.000	0.196	0.000	0.000	1.011	Paved parking	E-1, E-2, E-3
1.090	0.000	0.909	0.000	0.000	1.999	Urban commercial, 85% imp	E-4
0.730	0.000	0.656	0.000	0.000	1.386	Woods, Good	E-1, E-2, E-3
15.323	**0.000**	**12.901**	**0.000**	**0.000**	**28.223**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: To Ex Drainage Ditch Runoff Area=68,848 sf 1.34% Impervious Runoff Depth>0.45"
Flow Length=308' Tc=11.2 min CN=60 Runoff=0.42 cfs 0.059 af

Subcatchment E-2: To Trail Runoff Area=7,064 sf 0.75% Impervious Runoff Depth>0.89"
Flow Length=42' Slope=0.0950 '/' Tc=5.7 min CN=70 Runoff=0.15 cfs 0.012 af

Subcatchment E-3: Pre-Development Runoff Area=155,355 sf 27.73% Impervious Runoff Depth>2.26"
Flow Length=586' Tc=5.3 min CN=90 Runoff=9.27 cfs 0.672 af

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>0.88"
Tc=10.0 min CN=70 Runoff=13.10 cfs 1.191 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 0.00% Impervious Runoff Depth>2.64"
Tc=6.0 min CN=94 Runoff=1.88 cfs 0.143 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>1.41"
Tc=10.0 min CN=79 Runoff=8.61 cfs 0.717 af

Link 1L: Municipal System Inflow=30.92 cfs 2.794 af
Primary=30.92 cfs 2.794 af

Link 2L: Drainage Ditch Inflow=23.50 cfs 2.110 af
Primary=23.50 cfs 2.110 af

Total Runoff Area = 28.223 ac Runoff Volume = 2.794 af Average Runoff Depth = 1.19"
66.94% Pervious = 18.893 ac 33.06% Impervious = 9.330 ac

Summary for Subcatchment E-1: To Ex Drainage Ditch

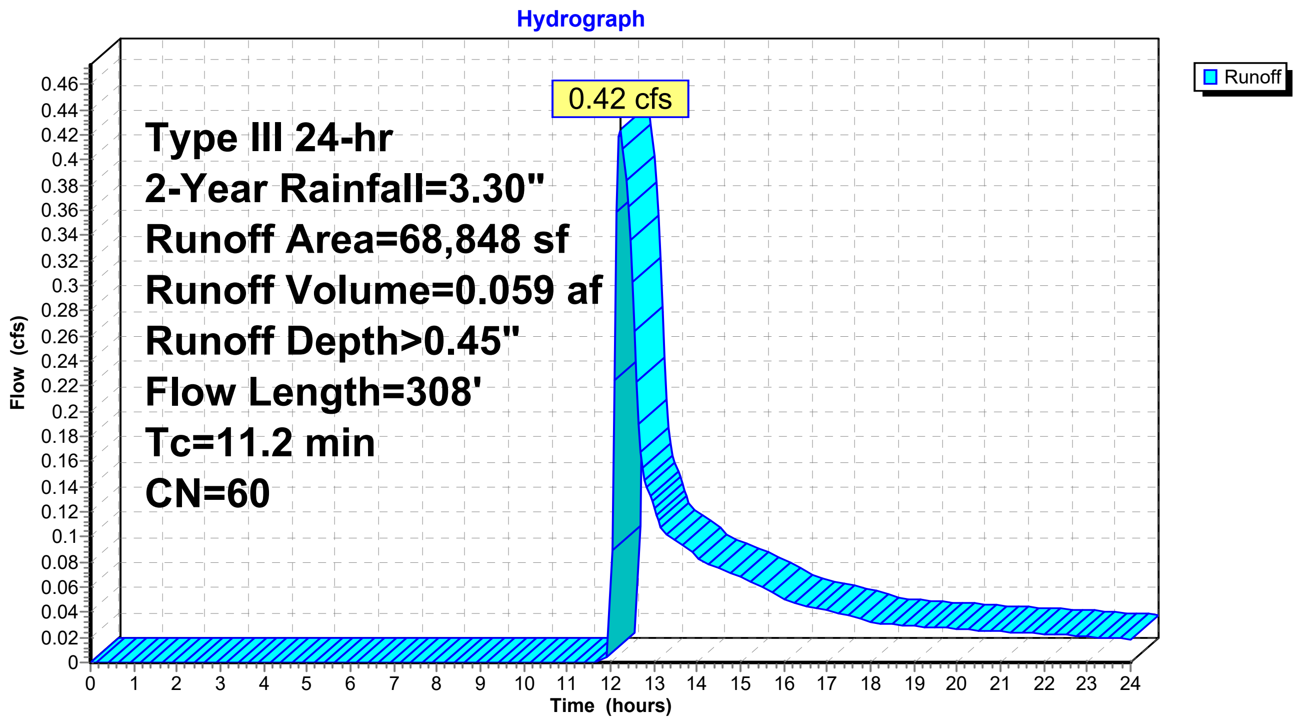
Runoff = 0.42 cfs @ 12.22 hrs, Volume= 0.059 af, Depth> 0.45"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
21,344	30	Woods, Good, HSG A
15,239	70	Woods, Good, HSG C
19,186	96	Gravel surface, HSG A
923	98	Paved parking, HSG A
11,742	39	>75% Grass cover, Good, HSG A
414	74	>75% Grass cover, Good, HSG C
68,848	60	Weighted Average
67,925		98.66% Pervious Area
923		1.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"
5.0	258	0.0299	0.86		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.2	308	Total			

Subcatchment E-1: To Ex Drainage Ditch



Summary for Subcatchment E-2: To Trail

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

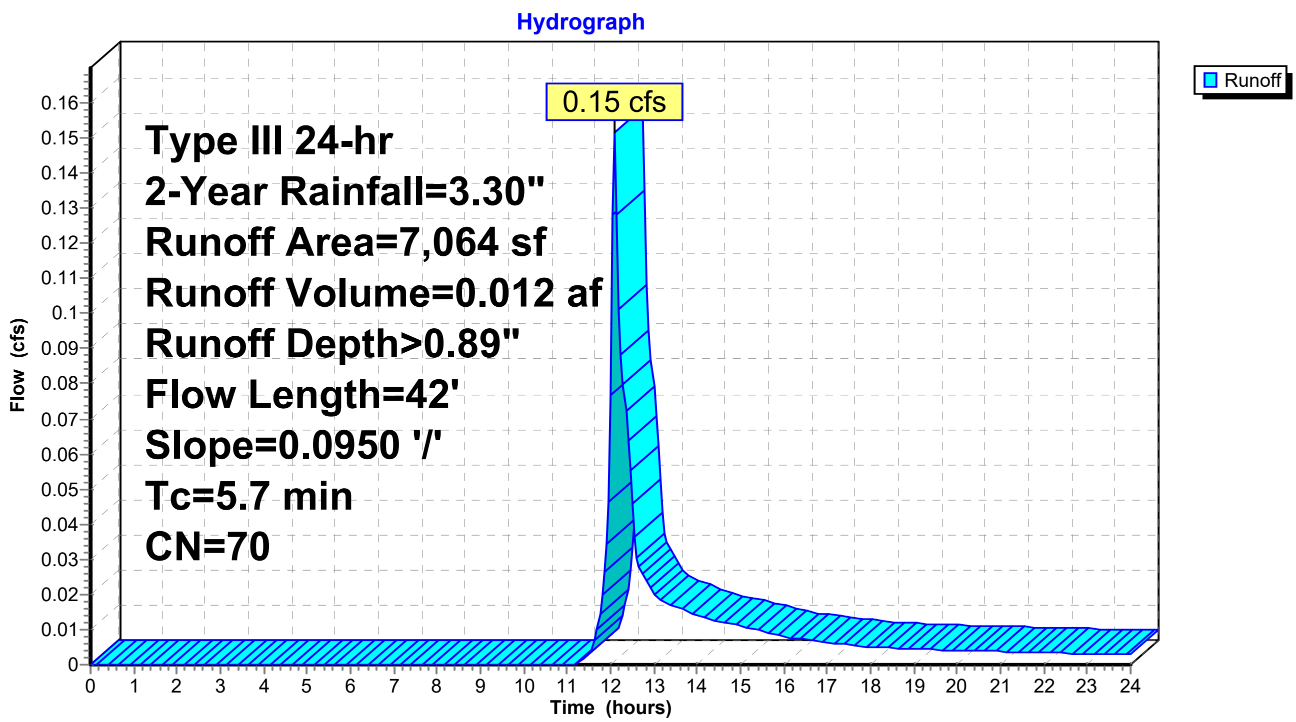
Runoff = 0.15 cfs @ 12.10 hrs, Volume= 0.012 af, Depth> 0.89"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
6,657	70	Woods, Good, HSG C
53	98	Paved parking, HSG C
354	74	>75% Grass cover, Good, HSG C
7,064	70	Weighted Average
7,011		99.25% Pervious Area
53		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	42	0.0950	0.12		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"

Subcatchment E-2: To Trail



Summary for Subcatchment E-3: Pre-Development

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

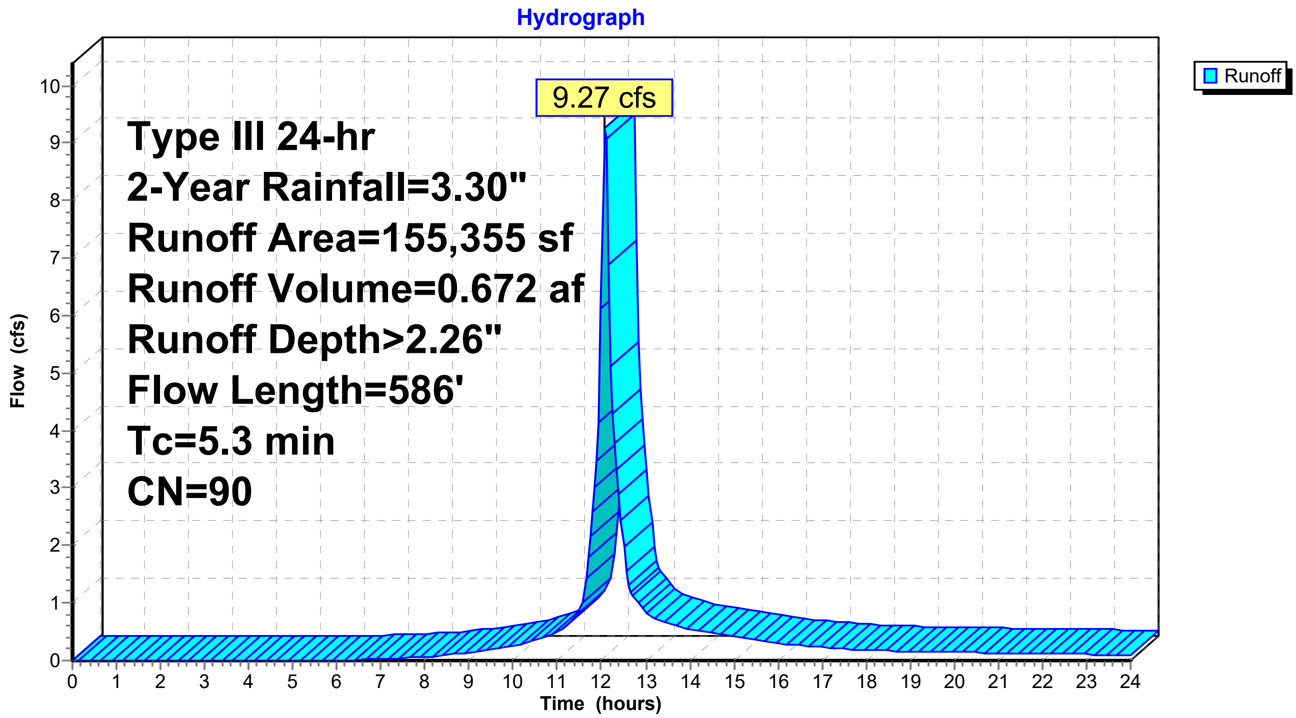
Runoff = 9.27 cfs @ 12.08 hrs, Volume= 0.672 af, Depth> 2.26"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
10,466	30	Woods, Good, HSG A
6,688	70	Woods, Good, HSG C
34,605	98	Paved parking, HSG A
8,479	98	Paved parking, HSG C
2,006	39	>75% Grass cover, Good, HSG A
38	74	>75% Grass cover, Good, HSG C
78,389	96	Gravel surface, HSG A
14,684	96	Gravel surface, HSG C
155,355	90	Weighted Average
112,271		72.27% Pervious Area
43,084		27.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	50	0.0076	0.83		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.8	277	0.0246	2.53		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.6	34	0.0394	0.99		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
1.9	225	0.0152	1.98		**Shallow Concentrated Flow, D-E** Unpaved Kv= 16.1 fps
5.3	586	Total			

Subcatchment E-3: Pre-Development



Summary for Subcatchment E-4: Off-site W'ly

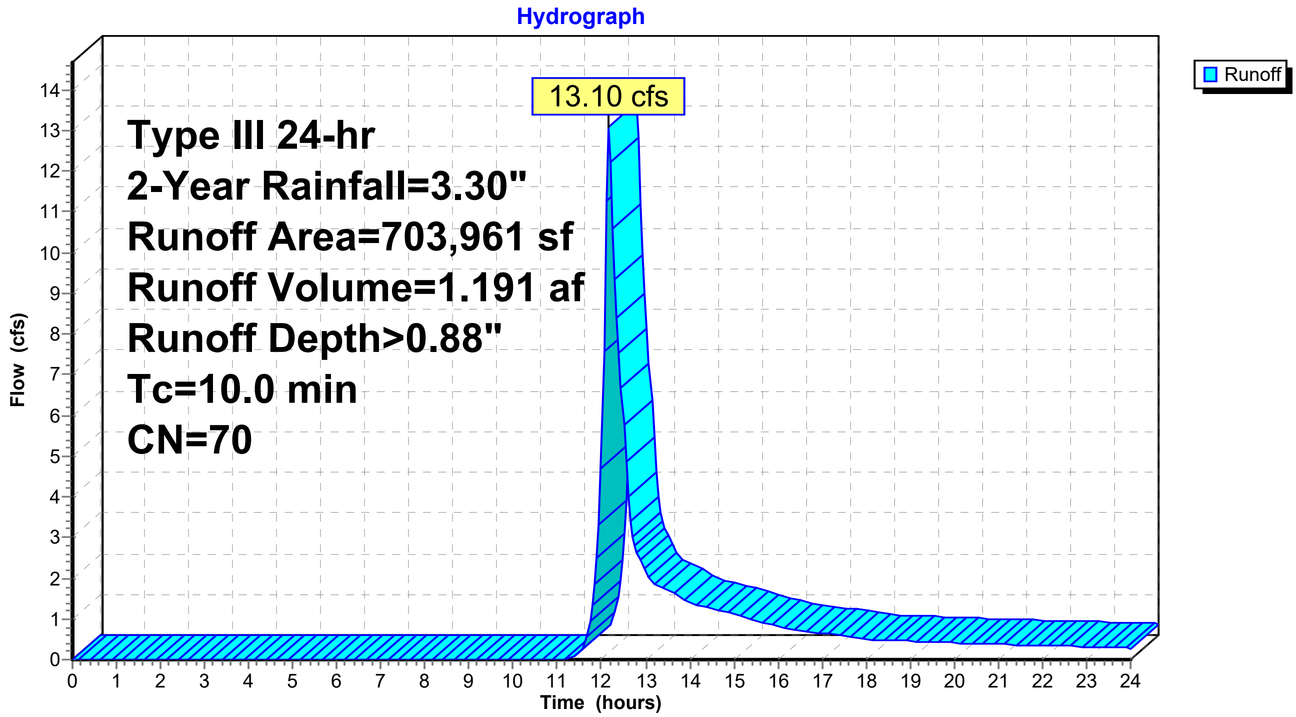
Runoff = 13.10 cfs @ 12.16 hrs, Volume= 1.191 af, Depth> 0.88"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

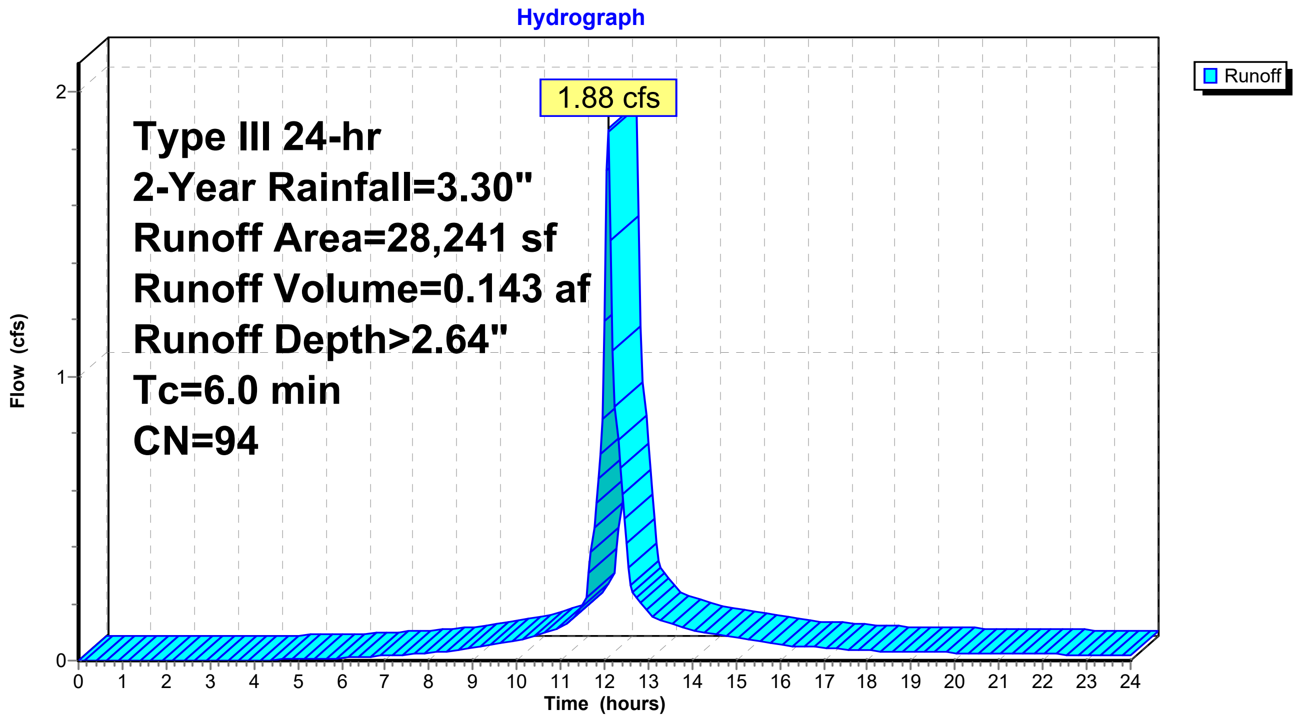
Runoff = 1.88 cfs @ 12.09 hrs, Volume= 0.143 af, Depth> 2.64"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
26,032	96	Gravel surface, HSG C
2,209	74	>75% Grass cover, Good, HSG C
28,241	94	Weighted Average
28,241		100.00% Pervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

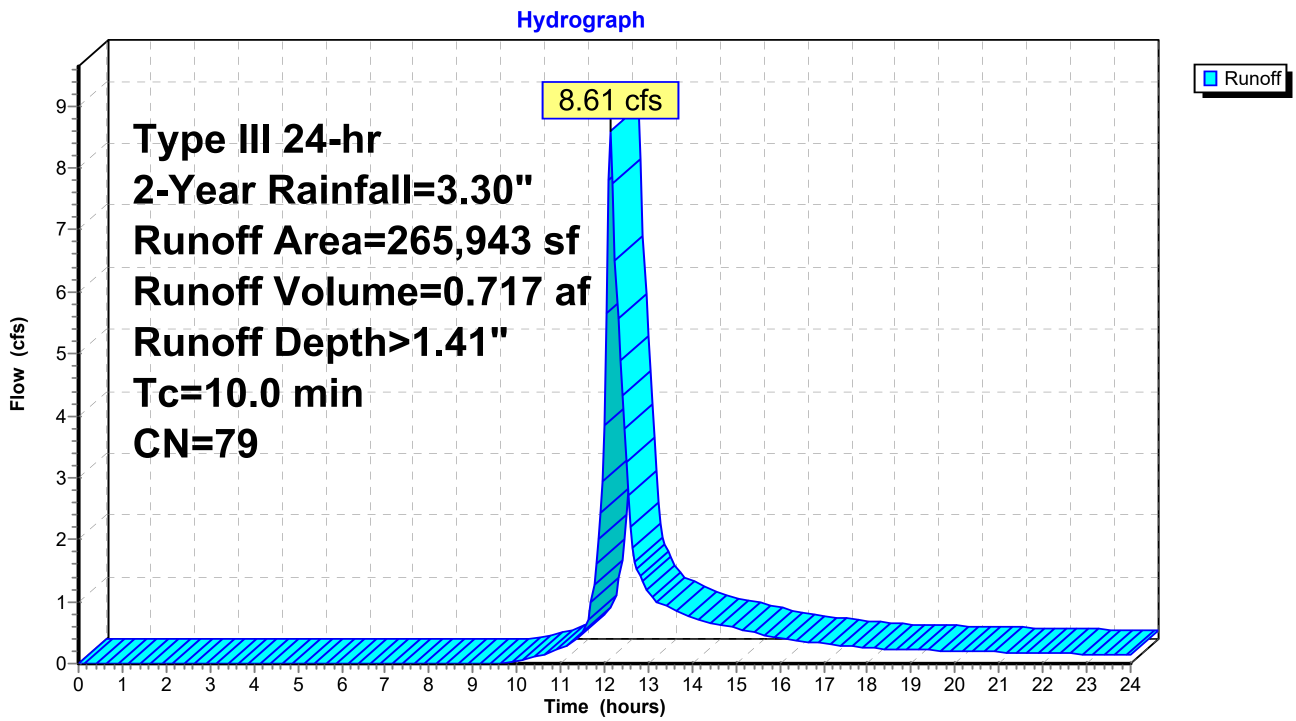
Runoff = 8.61 cfs @ 12.15 hrs, Volume= 0.717 af, Depth> 1.41"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly

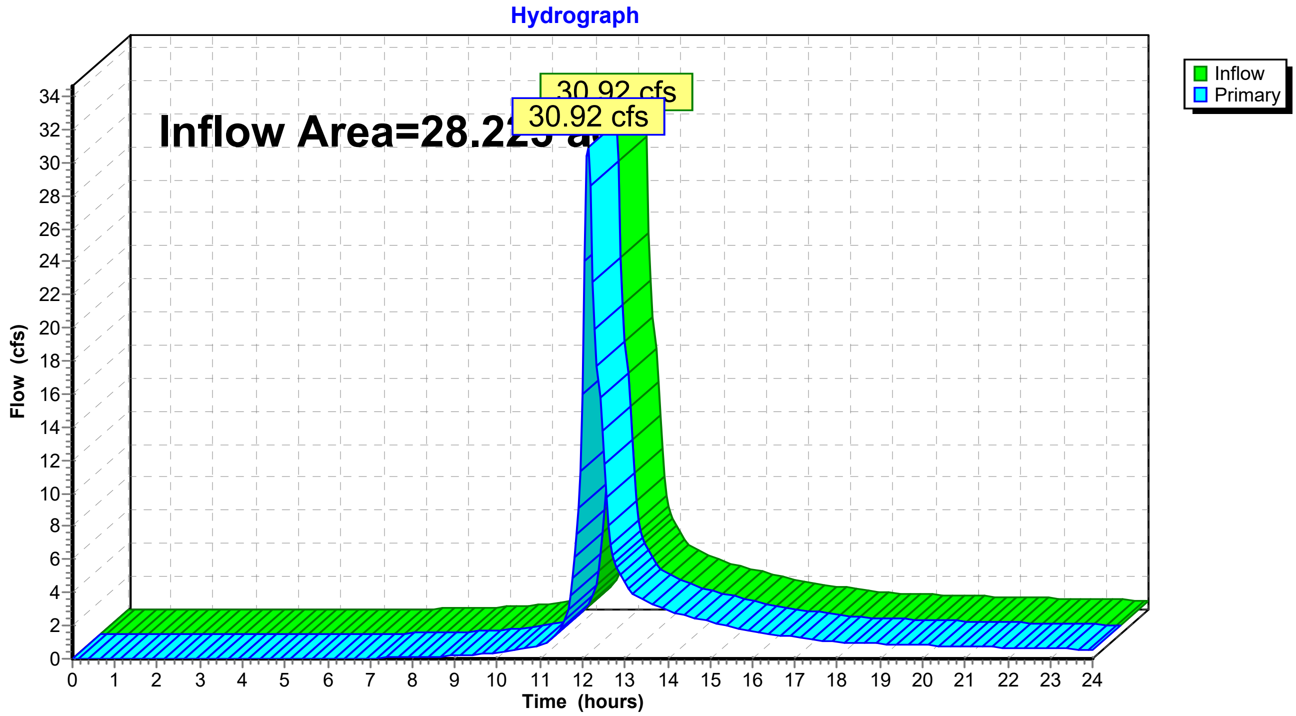


Summary for Link 1L: Municipal System

Inflow Area = 28.223 ac, 33.06% Impervious, Inflow Depth > 1.19" for 2-Year event
Inflow = 30.92 cfs @ 12.13 hrs, Volume= 2.794 af
Primary = 30.92 cfs @ 12.13 hrs, Volume= 2.794 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

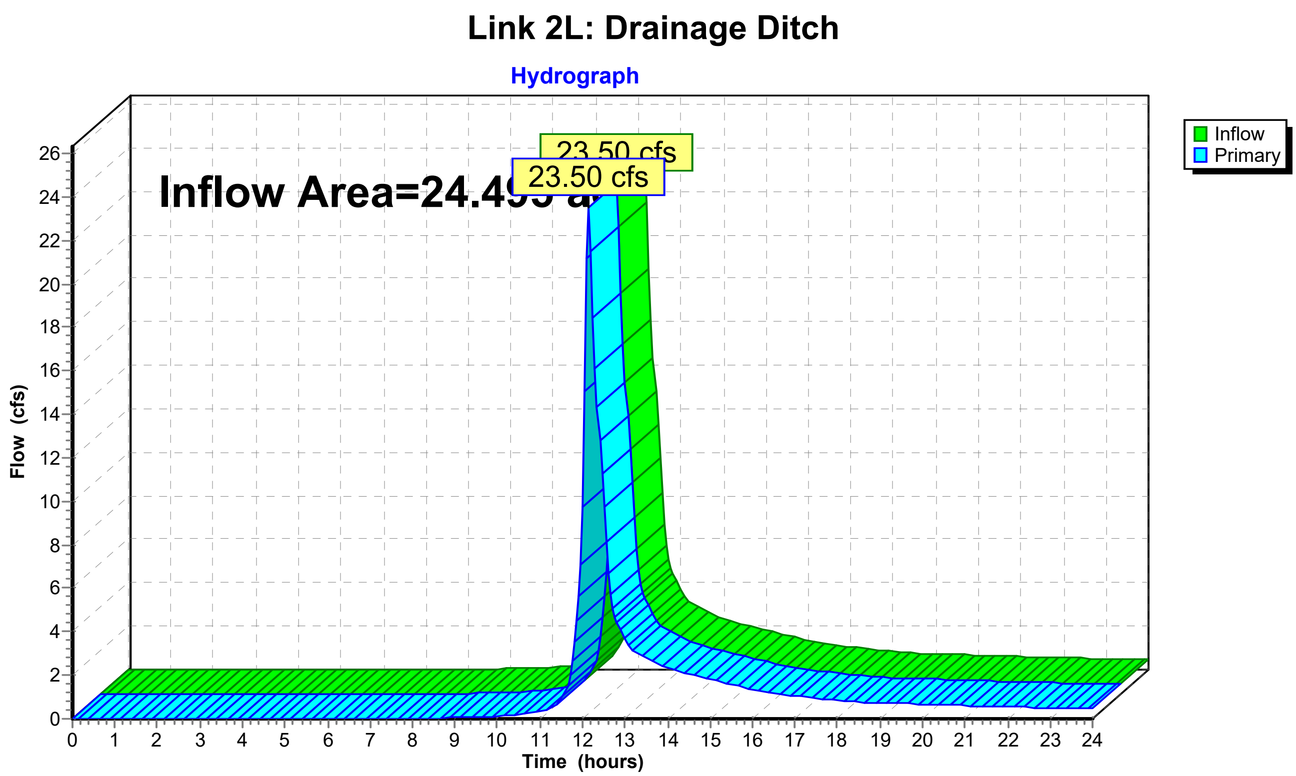
Link 1L: Municipal System



Summary for Link 2L: Drainage Ditch

Inflow Area = 24.495 ac, 34.05% Impervious, Inflow Depth > 1.03" for 2-Year event
Inflow = 23.50 cfs @ 12.15 hrs, Volume= 2.110 af
Primary = 23.50 cfs @ 12.15 hrs, Volume= 2.110 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: To Ex Drainage Ditch Runoff Area=68,848 sf 1.34% Impervious Runoff Depth>1.35"
Flow Length=308' Tc=11.2 min CN=60 Runoff=1.88 cfs 0.178 af

Subcatchment E-2: To Trail Runoff Area=7,064 sf 0.75% Impervious Runoff Depth>2.10"
Flow Length=42' Slope=0.0950 '/' Tc=5.7 min CN=70 Runoff=0.39 cfs 0.028 af

Subcatchment E-3: Pre-Development Runoff Area=155,355 sf 27.73% Impervious Runoff Depth>3.96"
Flow Length=586' Tc=5.3 min CN=90 Runoff=15.83 cfs 1.177 af

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>2.10"
Tc=10.0 min CN=70 Runoff=33.82 cfs 2.827 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 0.00% Impervious Runoff Depth>4.39"
Tc=6.0 min CN=94 Runoff=3.03 cfs 0.237 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>2.87"
Tc=10.0 min CN=79 Runoff=17.80 cfs 1.462 af

Link 1L: Municipal System Inflow=68.73 cfs 5.910 af
Primary=68.73 cfs 5.910 af

Link 2L: Drainage Ditch Inflow=55.84 cfs 4.704 af
Primary=55.84 cfs 4.704 af

Total Runoff Area = 28.223 ac Runoff Volume = 5.910 af Average Runoff Depth = 2.51"
66.94% Pervious = 18.893 ac 33.06% Impervious = 9.330 ac

Summary for Subcatchment E-1: To Ex Drainage Ditch

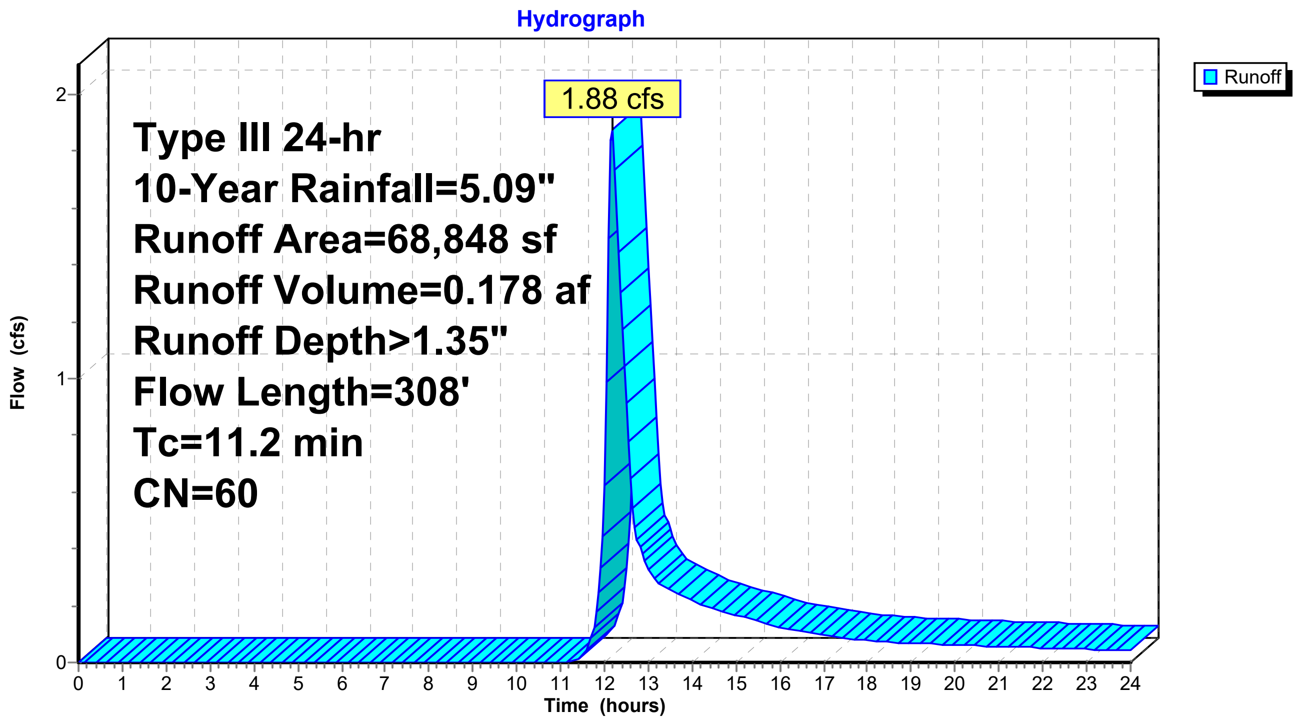
Runoff = 1.88 cfs @ 12.17 hrs, Volume= 0.178 af, Depth> 1.35"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
21,344	30	Woods, Good, HSG A
15,239	70	Woods, Good, HSG C
19,186	96	Gravel surface, HSG A
923	98	Paved parking, HSG A
11,742	39	>75% Grass cover, Good, HSG A
414	74	>75% Grass cover, Good, HSG C
68,848	60	Weighted Average
67,925		98.66% Pervious Area
923		1.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"
5.0	258	0.0299	0.86		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.2	308	Total			

Subcatchment E-1: To Ex Drainage Ditch



Summary for Subcatchment E-2: To Trail

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

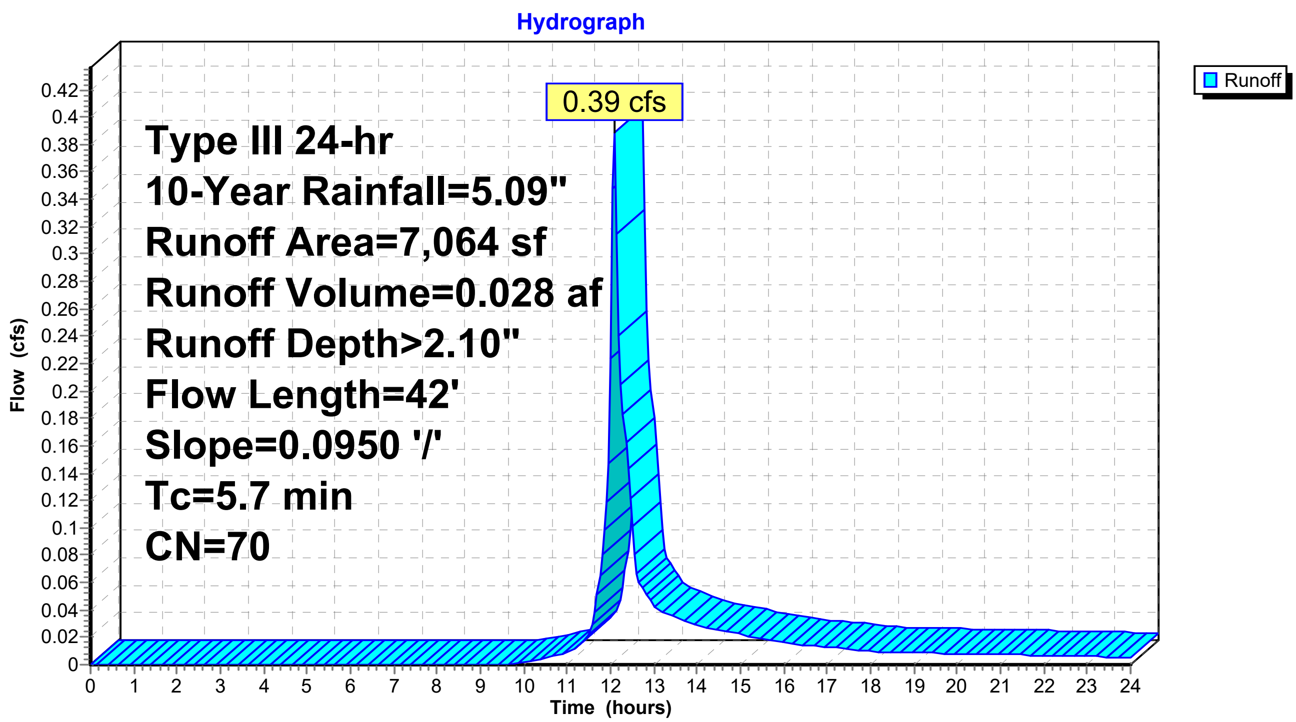
Runoff = 0.39 cfs @ 12.09 hrs, Volume= 0.028 af, Depth> 2.10"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
6,657	70	Woods, Good, HSG C
53	98	Paved parking, HSG C
354	74	>75% Grass cover, Good, HSG C
7,064	70	Weighted Average
7,011		99.25% Pervious Area
53		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	42	0.0950	0.12		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"

Subcatchment E-2: To Trail



Summary for Subcatchment E-3: Pre-Development

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

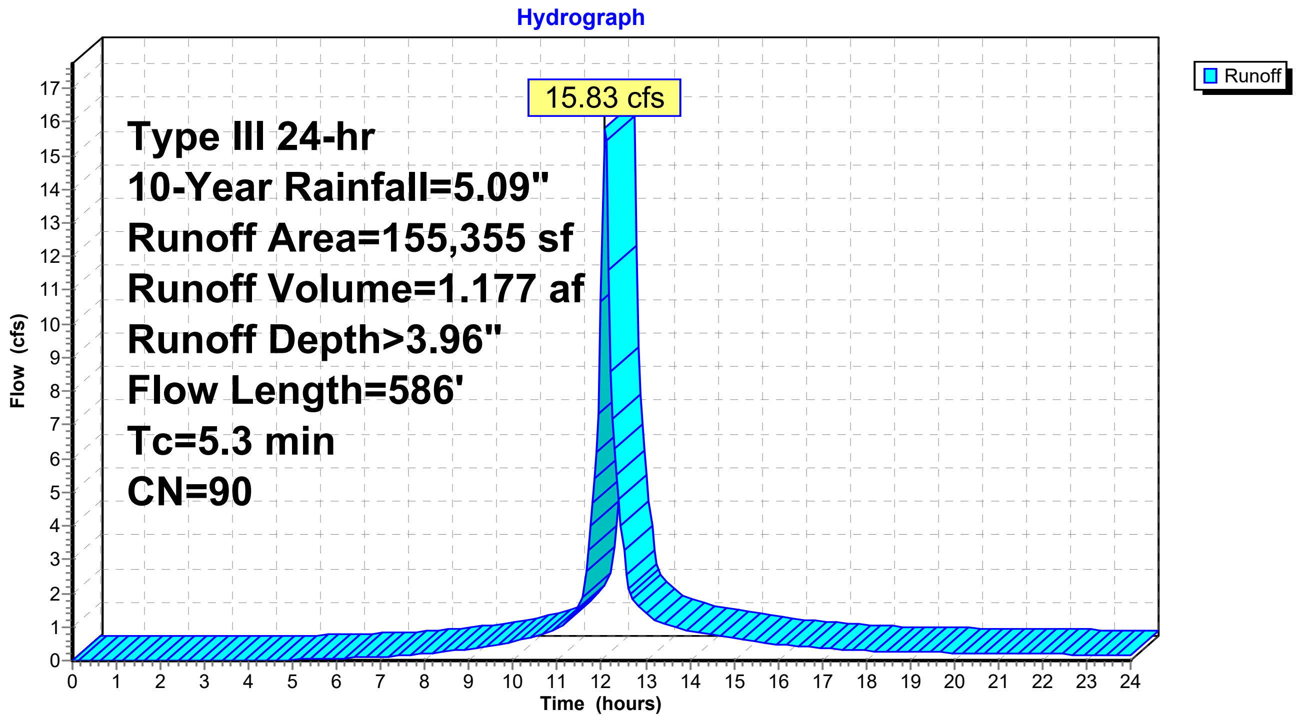
Runoff = 15.83 cfs @ 12.08 hrs, Volume= 1.177 af, Depth> 3.96"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
10,466	30	Woods, Good, HSG A
6,688	70	Woods, Good, HSG C
34,605	98	Paved parking, HSG A
8,479	98	Paved parking, HSG C
2,006	39	>75% Grass cover, Good, HSG A
38	74	>75% Grass cover, Good, HSG C
78,389	96	Gravel surface, HSG A
14,684	96	Gravel surface, HSG C
155,355	90	Weighted Average
112,271		72.27% Pervious Area
43,084		27.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	50	0.0076	0.83		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.8	277	0.0246	2.53		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.6	34	0.0394	0.99		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
1.9	225	0.0152	1.98		**Shallow Concentrated Flow, D-E** Unpaved Kv= 16.1 fps
5.3	586	Total			

Subcatchment E-3: Pre-Development



Summary for Subcatchment E-4: Off-site W'ly

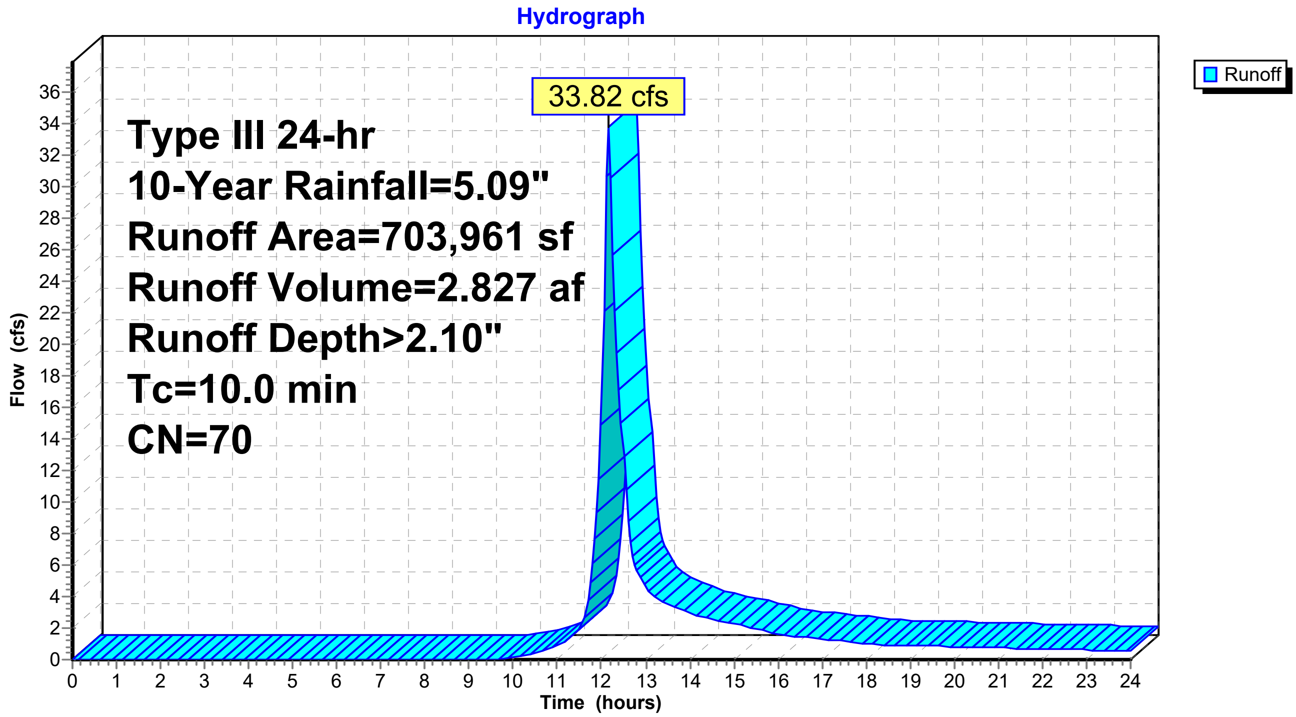
Runoff = 33.82 cfs @ 12.15 hrs, Volume= 2.827 af, Depth> 2.10"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

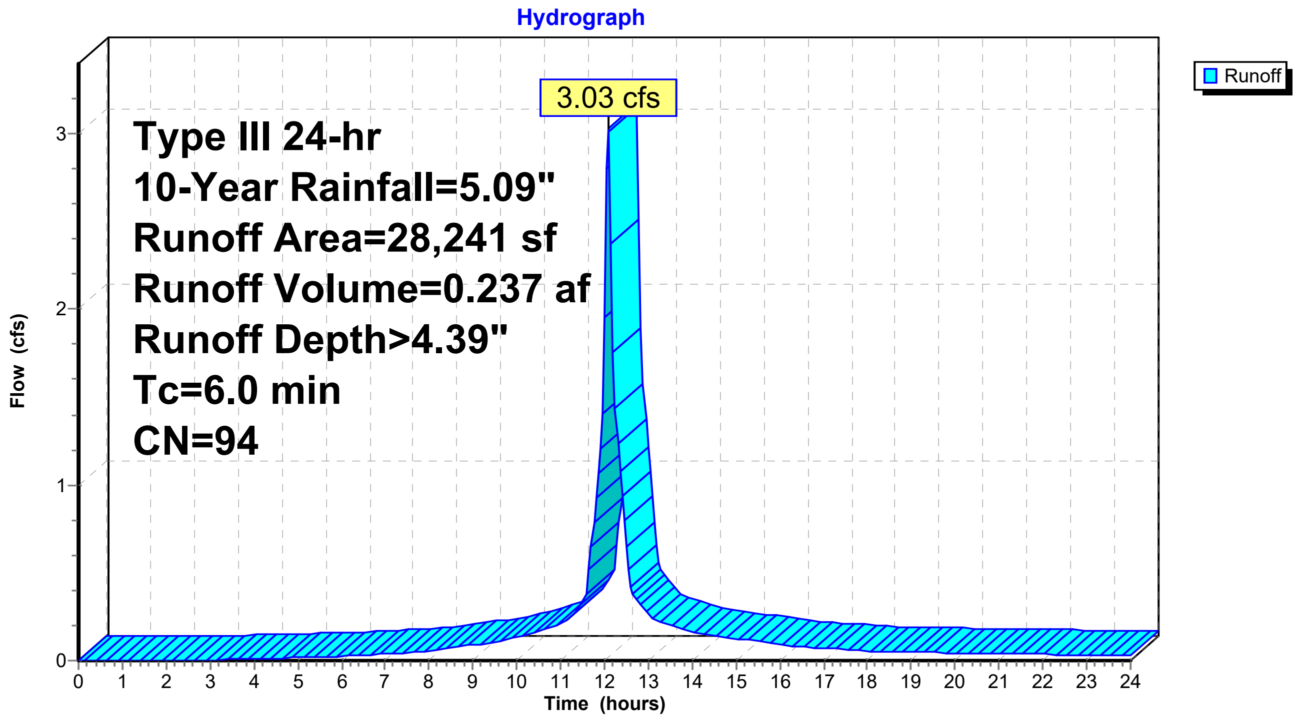
Runoff = 3.03 cfs @ 12.09 hrs, Volume= 0.237 af, Depth> 4.39"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
26,032	96	Gravel surface, HSG C
2,209	74	>75% Grass cover, Good, HSG C
28,241	94	Weighted Average
28,241		100.00% Pervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

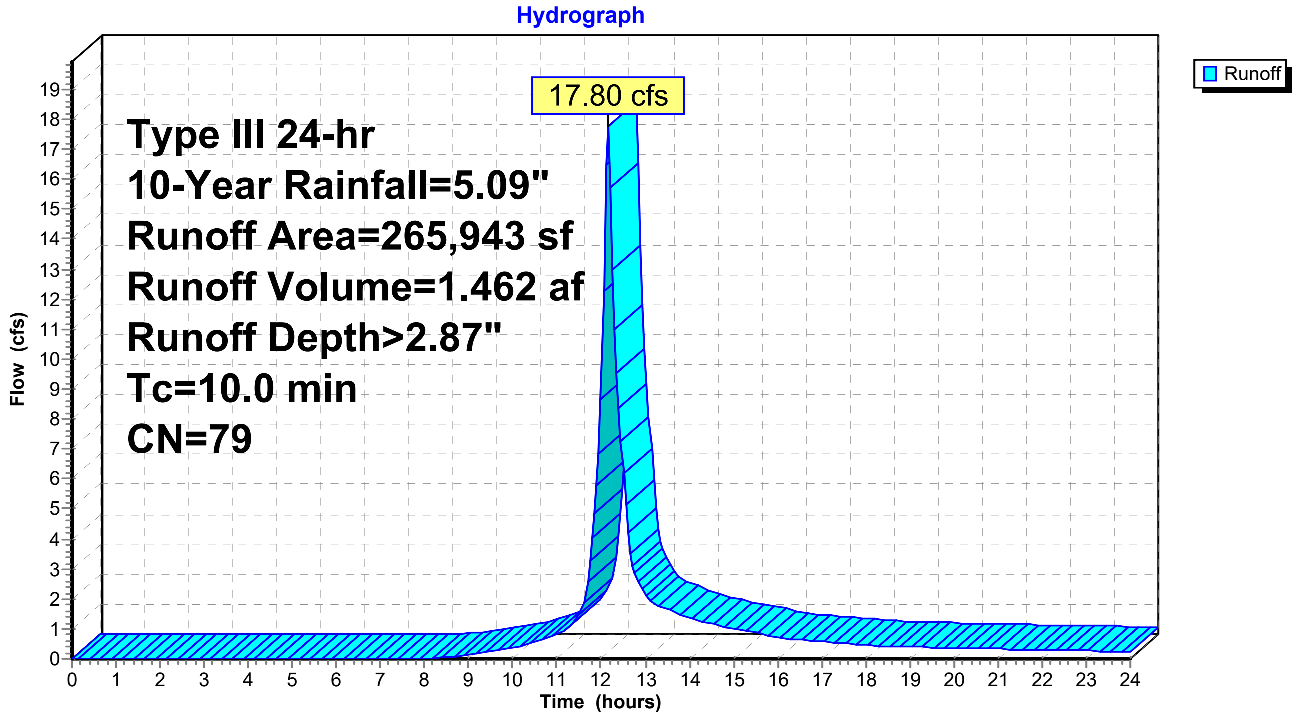
Runoff = 17.80 cfs @ 12.14 hrs, Volume= 1.462 af, Depth> 2.87"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly

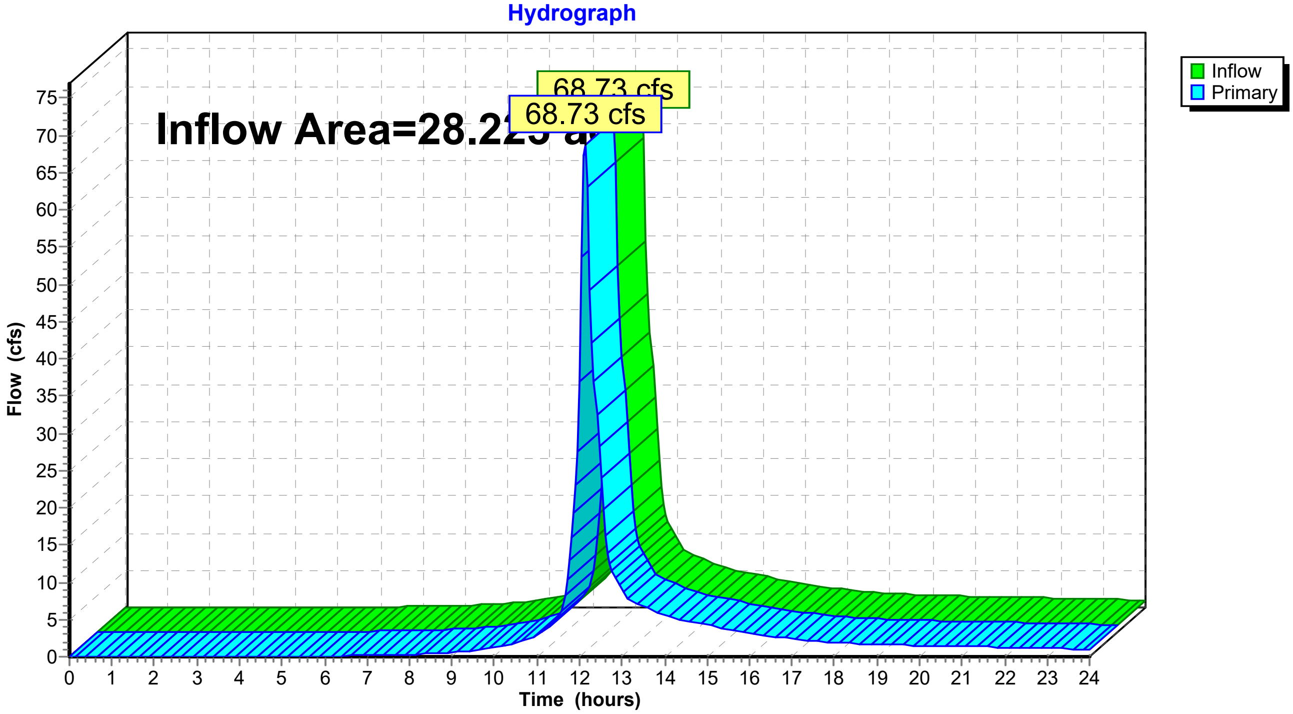


Summary for Link 1L: Municipal System

Inflow Area = 28.223 ac, 33.06% Impervious, Inflow Depth > 2.51" for 10-Year event
Inflow = 68.73 cfs @ 12.13 hrs, Volume= 5.910 af
Primary = 68.73 cfs @ 12.13 hrs, Volume= 5.910 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

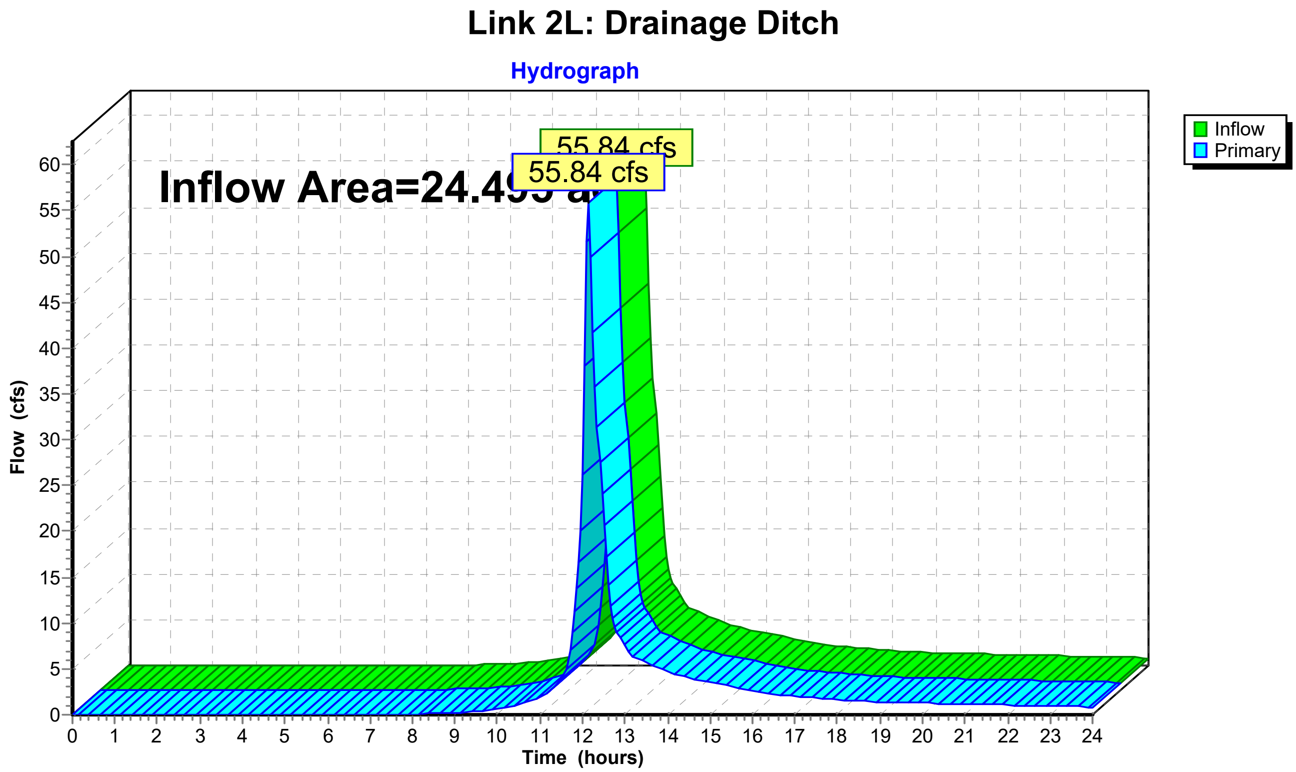
Link 1L: Municipal System



Summary for Link 2L: Drainage Ditch

Inflow Area = 24.495 ac, 34.05% Impervious, Inflow Depth > 2.30" for 10-Year event
Inflow = 55.84 cfs @ 12.15 hrs, Volume= 4.704 af
Primary = 55.84 cfs @ 12.15 hrs, Volume= 4.704 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: To Ex Drainage Ditch Runoff Area=68,848 sf 1.34% Impervious Runoff Depth>2.05"
Flow Length=308' Tc=11.2 min CN=60 Runoff=3.01 cfs 0.270 af

Subcatchment E-2: To Trail Runoff Area=7,064 sf 0.75% Impervious Runoff Depth>2.96"
Flow Length=42' Slope=0.0950 '/' Tc=5.7 min CN=70 Runoff=0.55 cfs 0.040 af

Subcatchment E-3: Pre-Development Runoff Area=155,355 sf 27.73% Impervious Runoff Depth>5.04"
Flow Length=586' Tc=5.3 min CN=90 Runoff=19.87 cfs 1.497 af

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>2.96"
Tc=10.0 min CN=70 Runoff=48.28 cfs 3.985 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 0.00% Impervious Runoff Depth>5.49"
Tc=6.0 min CN=94 Runoff=3.74 cfs 0.297 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>3.85"
Tc=10.0 min CN=79 Runoff=23.78 cfs 1.960 af

Link 1L: Municipal System Inflow=94.28 cfs 8.049 af
Primary=94.28 cfs 8.049 af

Link 2L: Drainage Ditch Inflow=78.00 cfs 6.512 af
Primary=78.00 cfs 6.512 af

Total Runoff Area = 28.223 ac Runoff Volume = 8.049 af Average Runoff Depth = 3.42"
66.94% Pervious = 18.893 ac 33.06% Impervious = 9.330 ac

Summary for Subcatchment E-1: To Ex Drainage Ditch

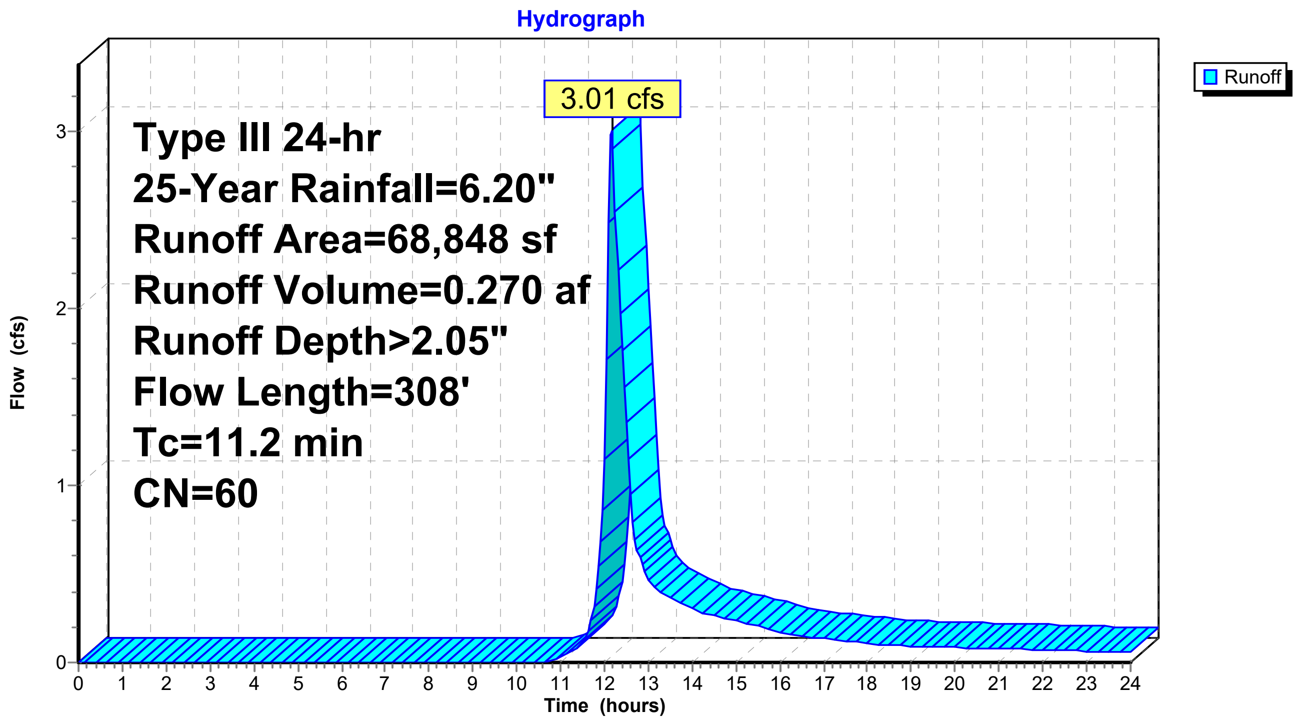
Runoff = 3.01 cfs @ 12.17 hrs, Volume= 0.270 af, Depth> 2.05"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
21,344	30	Woods, Good, HSG A
15,239	70	Woods, Good, HSG C
19,186	96	Gravel surface, HSG A
923	98	Paved parking, HSG A
11,742	39	>75% Grass cover, Good, HSG A
414	74	>75% Grass cover, Good, HSG C
68,848	60	Weighted Average
67,925		98.66% Pervious Area
923		1.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"
5.0	258	0.0299	0.86		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.2	308	Total			

Subcatchment E-1: To Ex Drainage Ditch



Summary for Subcatchment E-2: To Trail

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

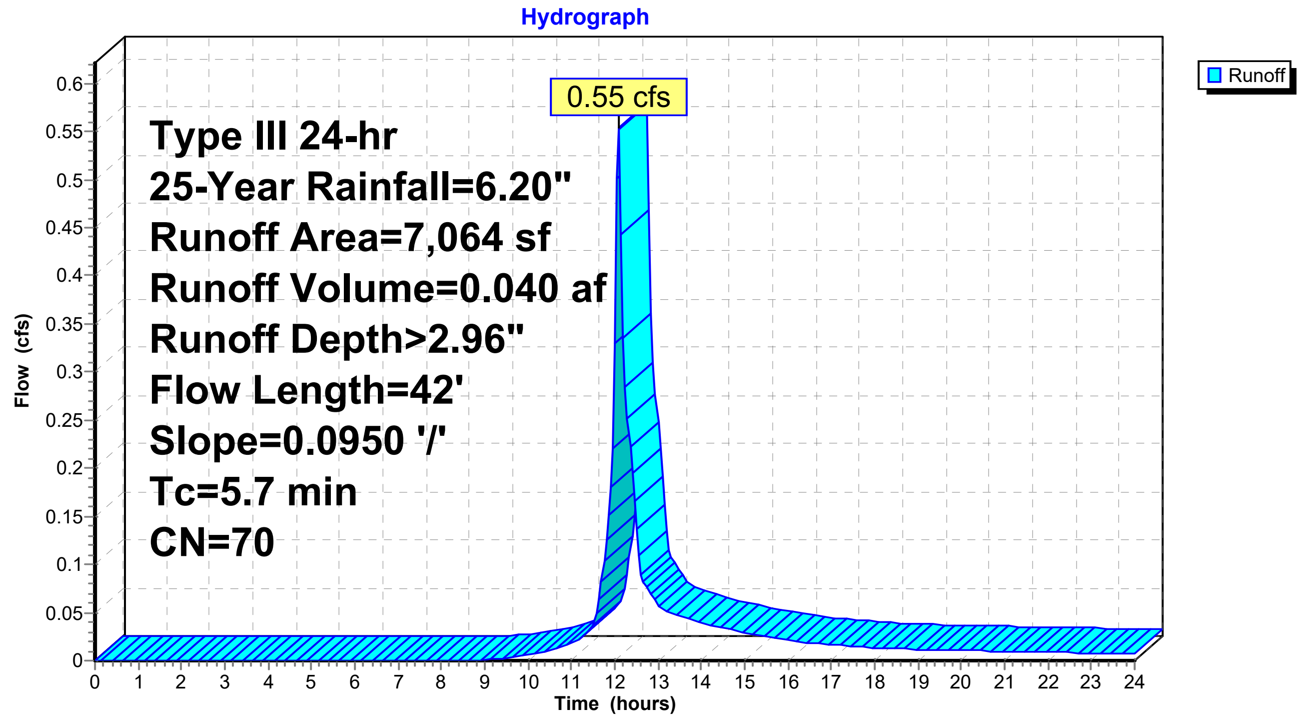
Runoff = 0.55 cfs @ 12.09 hrs, Volume= 0.040 af, Depth> 2.96"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
6,657	70	Woods, Good, HSG C
53	98	Paved parking, HSG C
354	74	>75% Grass cover, Good, HSG C
7,064	70	Weighted Average
7,011		99.25% Pervious Area
53		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	42	0.0950	0.12		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"

Subcatchment E-2: To Trail



Summary for Subcatchment E-3: Pre-Development

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

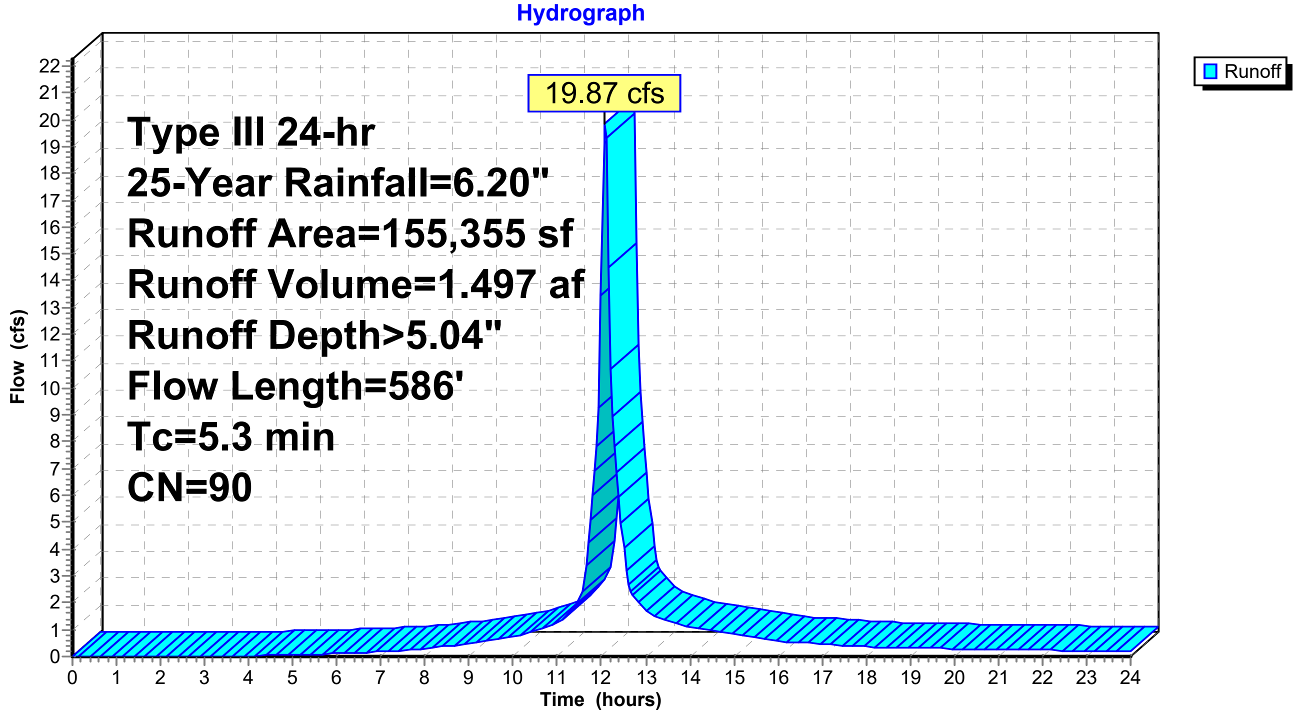
Runoff = 19.87 cfs @ 12.08 hrs, Volume= 1.497 af, Depth> 5.04"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
10,466	30	Woods, Good, HSG A
6,688	70	Woods, Good, HSG C
34,605	98	Paved parking, HSG A
8,479	98	Paved parking, HSG C
2,006	39	>75% Grass cover, Good, HSG A
38	74	>75% Grass cover, Good, HSG C
78,389	96	Gravel surface, HSG A
14,684	96	Gravel surface, HSG C
155,355	90	Weighted Average
112,271		72.27% Pervious Area
43,084		27.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	50	0.0076	0.83		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.8	277	0.0246	2.53		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.6	34	0.0394	0.99		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
1.9	225	0.0152	1.98		**Shallow Concentrated Flow, D-E** Unpaved Kv= 16.1 fps
5.3	586	Total			

Subcatchment E-3: Pre-Development



Summary for Subcatchment E-4: Off-site W'ly

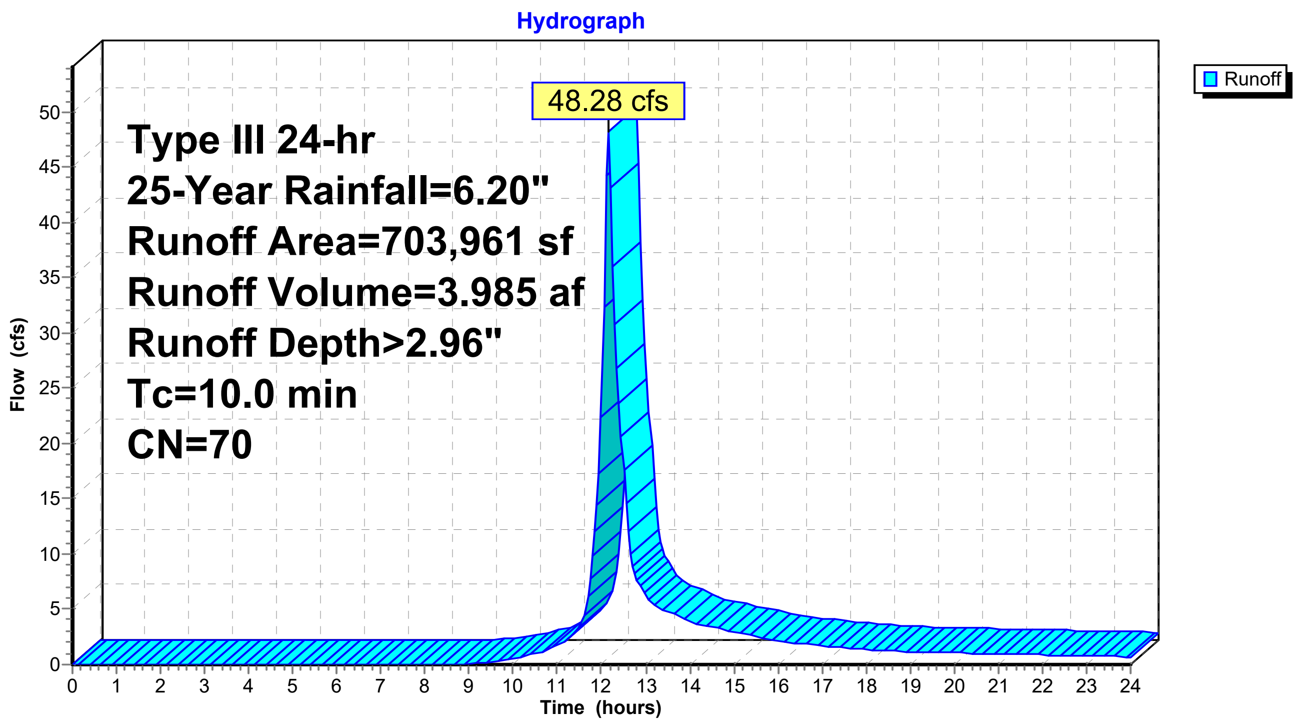
Runoff = 48.28 cfs @ 12.15 hrs, Volume= 3.985 af, Depth> 2.96"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

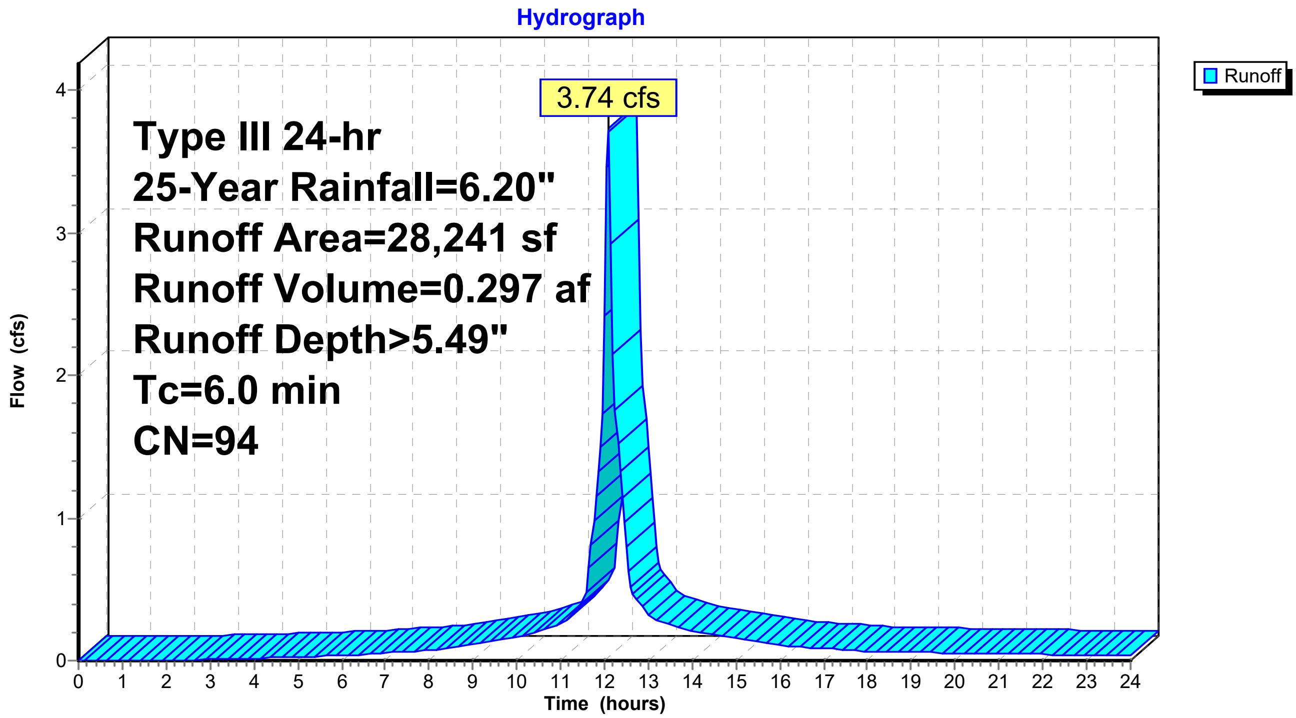
Runoff = 3.74 cfs @ 12.09 hrs, Volume= 0.297 af, Depth> 5.49"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
26,032	96	Gravel surface, HSG C
2,209	74	>75% Grass cover, Good, HSG C
28,241	94	Weighted Average
28,241		100.00% Pervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

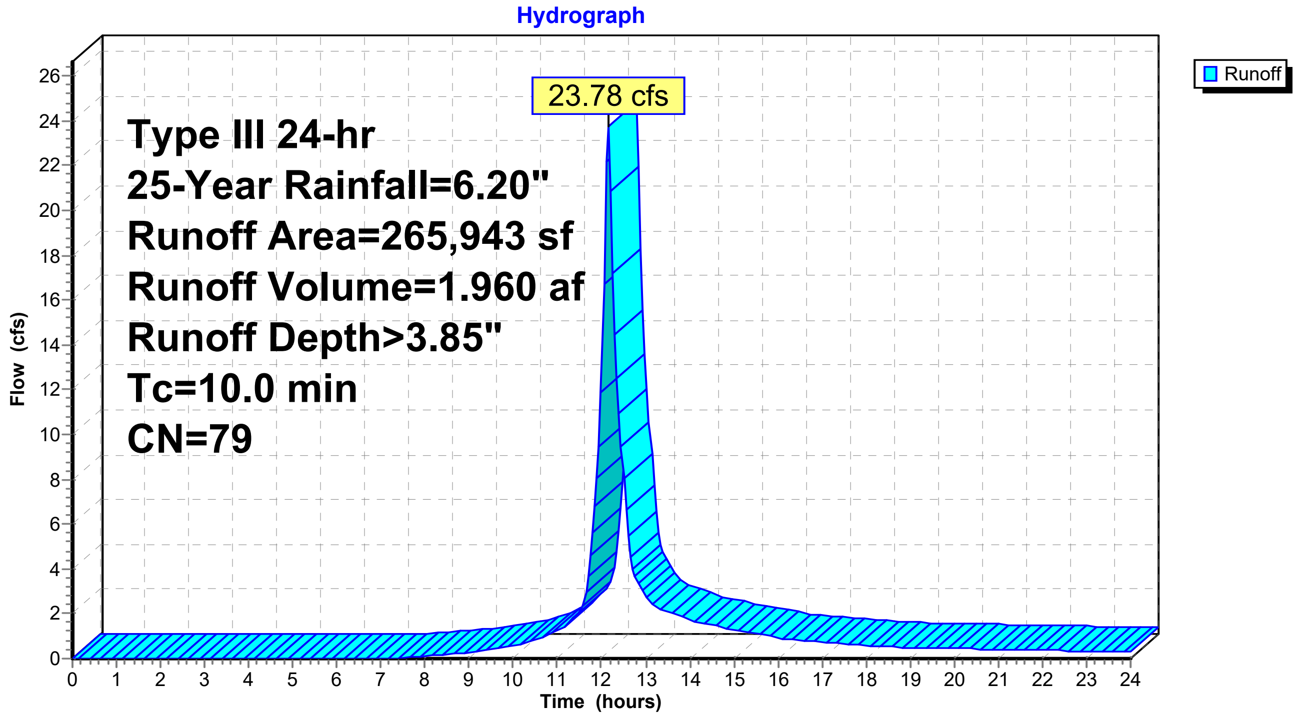
Runoff = 23.78 cfs @ 12.14 hrs, Volume= 1.960 af, Depth> 3.85"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly

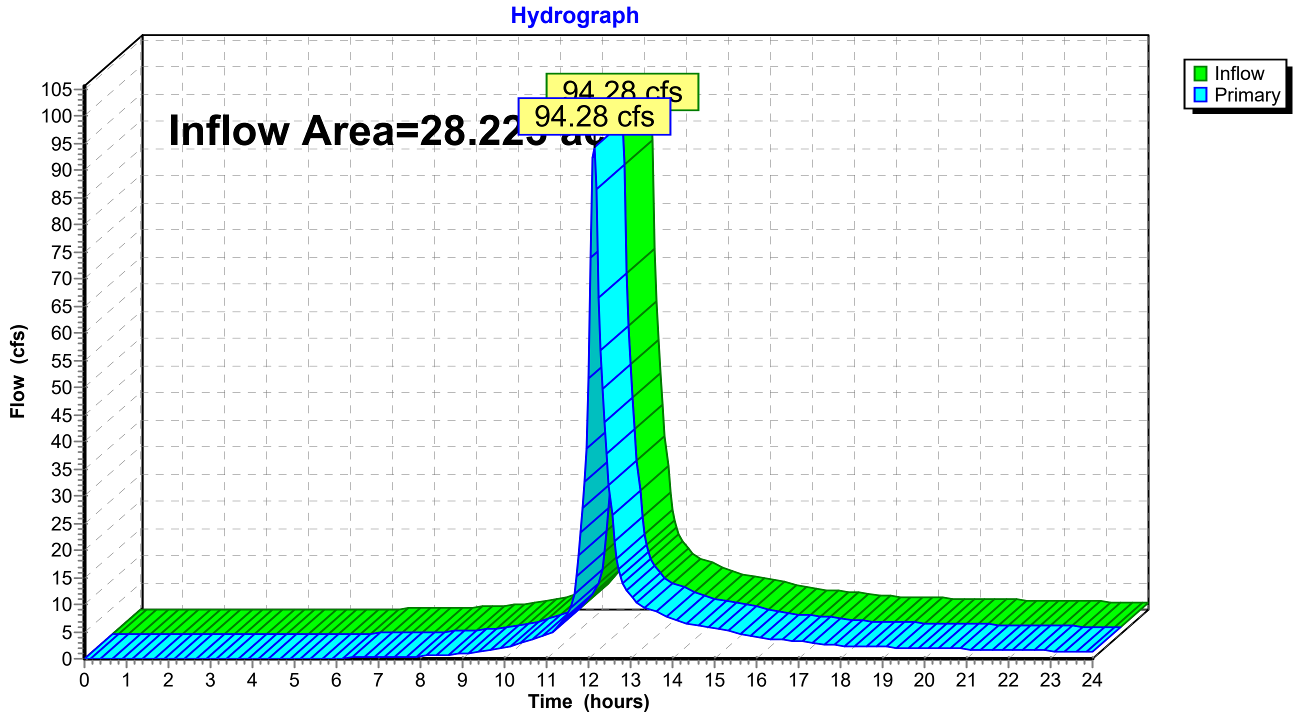


Summary for Link 1L: Municipal System

Inflow Area = 28.223 ac, 33.06% Impervious, Inflow Depth > 3.42" for 25-Year event
Inflow = 94.28 cfs @ 12.13 hrs, Volume= 8.049 af
Primary = 94.28 cfs @ 12.13 hrs, Volume= 8.049 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 1L: Municipal System

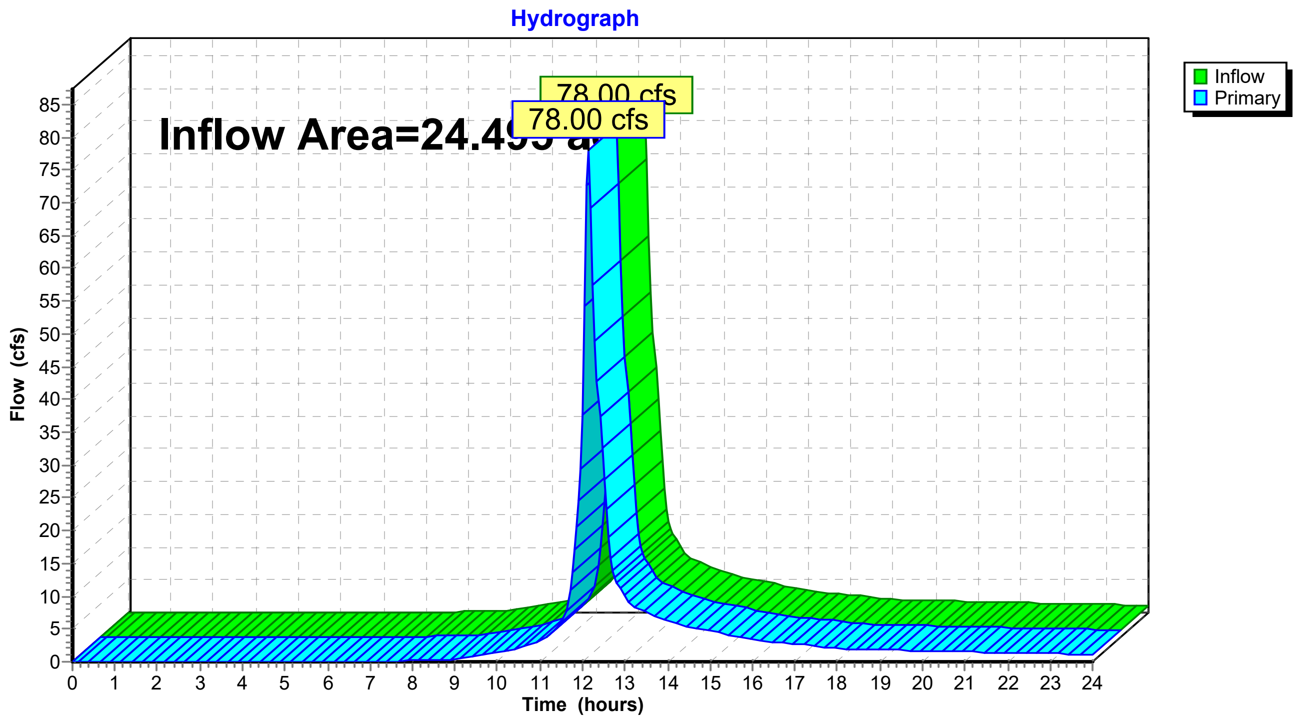


Summary for Link 2L: Drainage Ditch

Inflow Area = 24.495 ac, 34.05% Impervious, Inflow Depth > 3.19" for 25-Year event
Inflow = 78.00 cfs @ 12.14 hrs, Volume= 6.512 af
Primary = 78.00 cfs @ 12.14 hrs, Volume= 6.512 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link 2L: Drainage Ditch



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-1: To Ex Drainage Ditch Runoff Area=68,848 sf 1.34% Impervious Runoff Depth>3.27"
Flow Length=308' Tc=11.2 min CN=60 Runoff=4.97 cfs 0.430 af

Subcatchment E-2: To Trail Runoff Area=7,064 sf 0.75% Impervious Runoff Depth>4.39"
Flow Length=42' Slope=0.0950 '/' Tc=5.7 min CN=70 Runoff=0.82 cfs 0.059 af

Subcatchment E-3: Pre-Development Runoff Area=155,355 sf 27.73% Impervious Runoff Depth>6.72"
Flow Length=586' Tc=5.3 min CN=90 Runoff=26.08 cfs 1.998 af

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>4.39"
Tc=10.0 min CN=70 Runoff=71.92 cfs 5.910 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 0.00% Impervious Runoff Depth>7.20"
Tc=6.0 min CN=94 Runoff=4.83 cfs 0.389 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>5.43"
Tc=10.0 min CN=79 Runoff=33.18 cfs 2.760 af

Link 1L: Municipal System Inflow=135.45 cfs 11.546 af
Primary=135.45 cfs 11.546 af

Link 2L: Drainage Ditch Inflow=113.90 cfs 9.489 af
Primary=113.90 cfs 9.489 af

Total Runoff Area = 28.223 ac Runoff Volume = 11.546 af Average Runoff Depth = 4.91"
66.94% Pervious = 18.893 ac 33.06% Impervious = 9.330 ac

Summary for Subcatchment E-1: To Ex Drainage Ditch

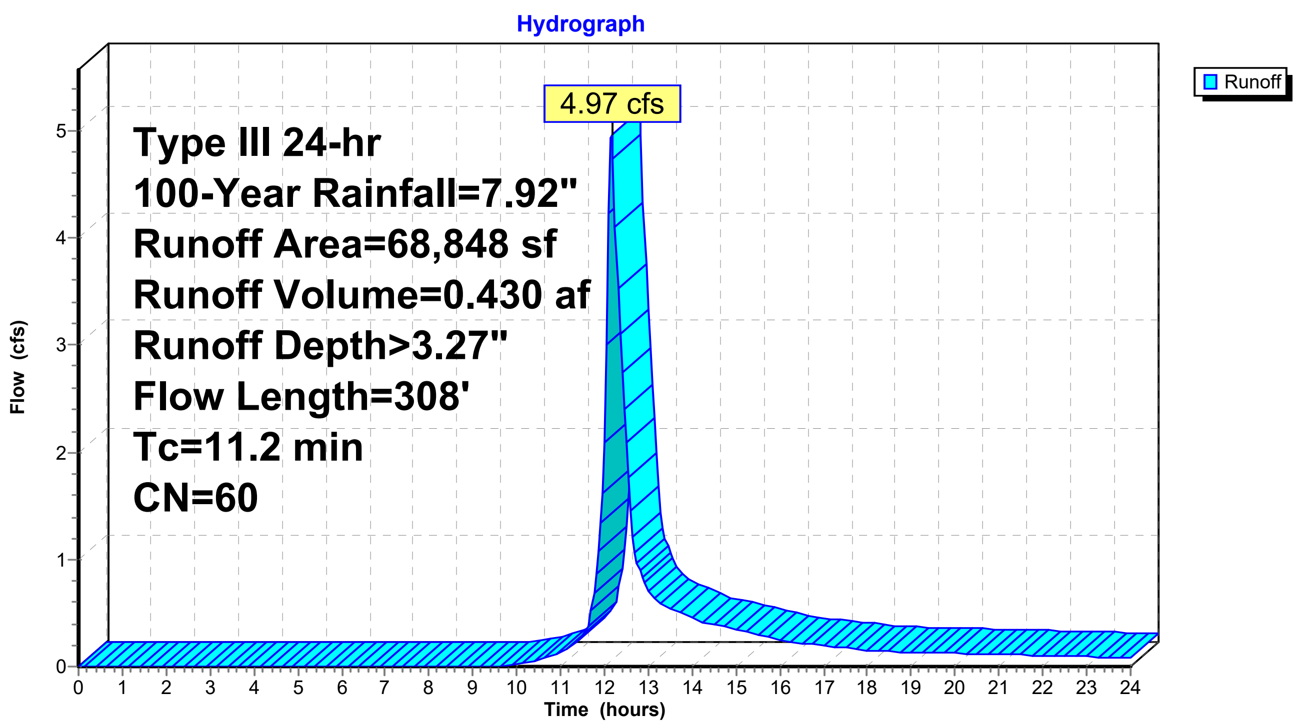
Runoff = 4.97 cfs @ 12.16 hrs, Volume= 0.430 af, Depth> 3.27"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
21,344	30	Woods, Good, HSG A
15,239	70	Woods, Good, HSG C
19,186	96	Gravel surface, HSG A
923	98	Paved parking, HSG A
11,742	39	>75% Grass cover, Good, HSG A
414	74	>75% Grass cover, Good, HSG C
68,848	60	Weighted Average
67,925		98.66% Pervious Area
923		1.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"
5.0	258	0.0299	0.86		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
11.2	308	Total			

Subcatchment E-1: To Ex Drainage Ditch



Summary for Subcatchment E-2: To Trail

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

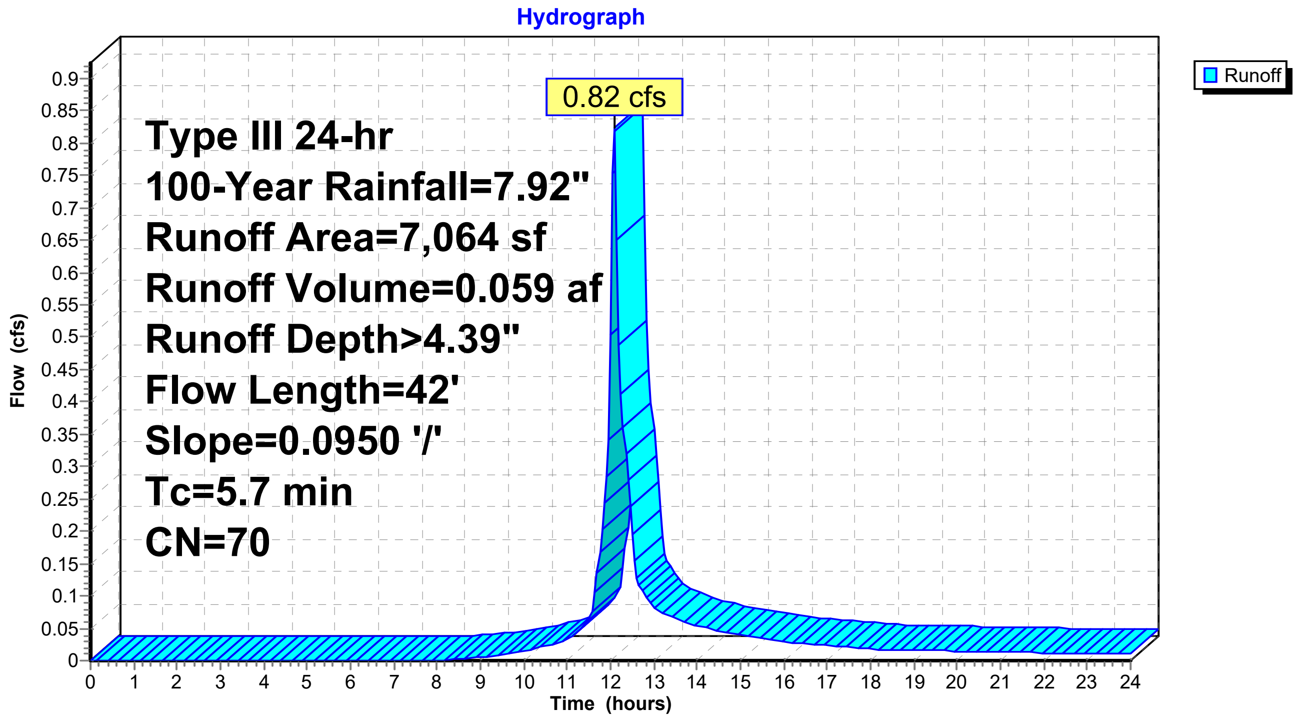
Runoff = 0.82 cfs @ 12.09 hrs, Volume= 0.059 af, Depth> 4.39"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
6,657	70	Woods, Good, HSG C
53	98	Paved parking, HSG C
354	74	>75% Grass cover, Good, HSG C
7,064	70	Weighted Average
7,011		99.25% Pervious Area
53		0.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	42	0.0950	0.12		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.30"

Subcatchment E-2: To Trail



Summary for Subcatchment E-3: Pre-Development

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

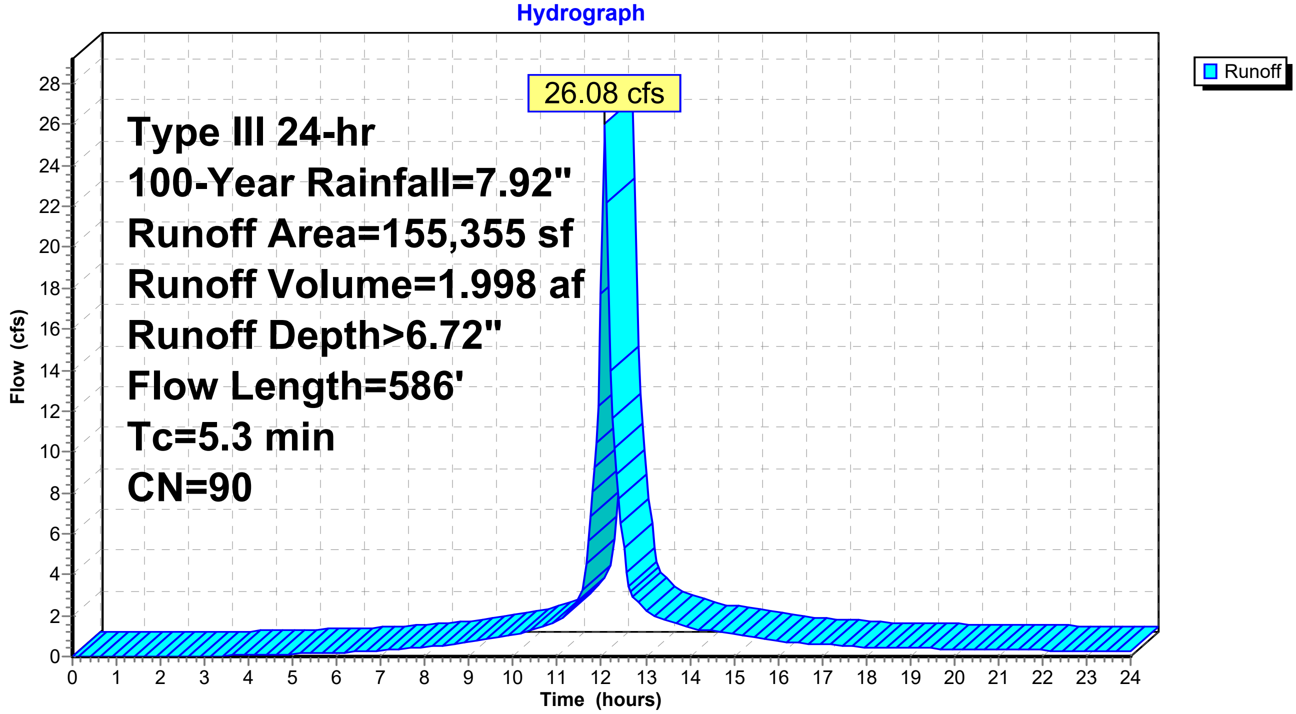
Runoff = 26.08 cfs @ 12.08 hrs, Volume= 1.998 af, Depth> 6.72"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
10,466	30	Woods, Good, HSG A
6,688	70	Woods, Good, HSG C
34,605	98	Paved parking, HSG A
8,479	98	Paved parking, HSG C
2,006	39	>75% Grass cover, Good, HSG A
38	74	>75% Grass cover, Good, HSG C
78,389	96	Gravel surface, HSG A
14,684	96	Gravel surface, HSG C
155,355	90	Weighted Average
112,271		72.27% Pervious Area
43,084		27.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	50	0.0076	0.83		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.30"
1.8	277	0.0246	2.53		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
0.6	34	0.0394	0.99		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
1.9	225	0.0152	1.98		**Shallow Concentrated Flow, D-E** Unpaved Kv= 16.1 fps
5.3	586	Total			

Subcatchment E-3: Pre-Development



Summary for Subcatchment E-4: Off-site W'ly

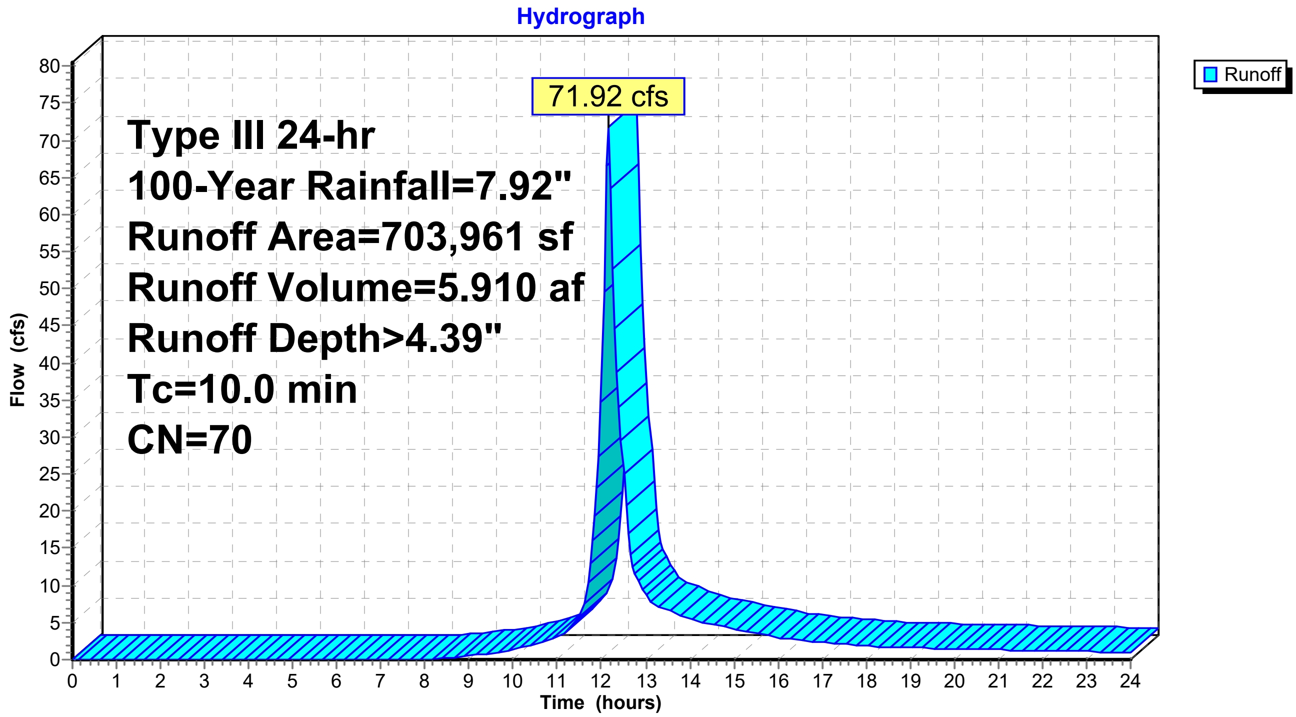
Runoff = 71.92 cfs @ 12.14 hrs, Volume= 5.910 af, Depth> 4.39"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

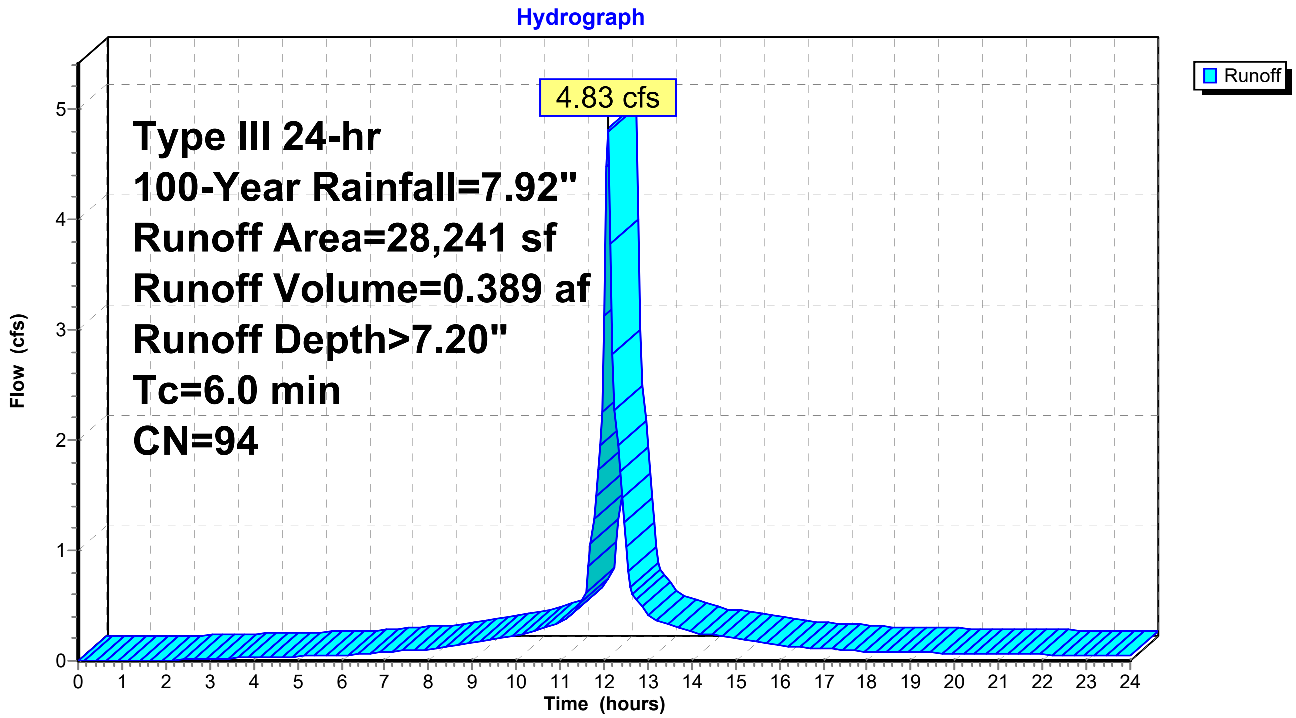
Runoff = 4.83 cfs @ 12.09 hrs, Volume= 0.389 af, Depth> 7.20"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
26,032	96	Gravel surface, HSG C
2,209	74	>75% Grass cover, Good, HSG C
28,241	94	Weighted Average
28,241		100.00% Pervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

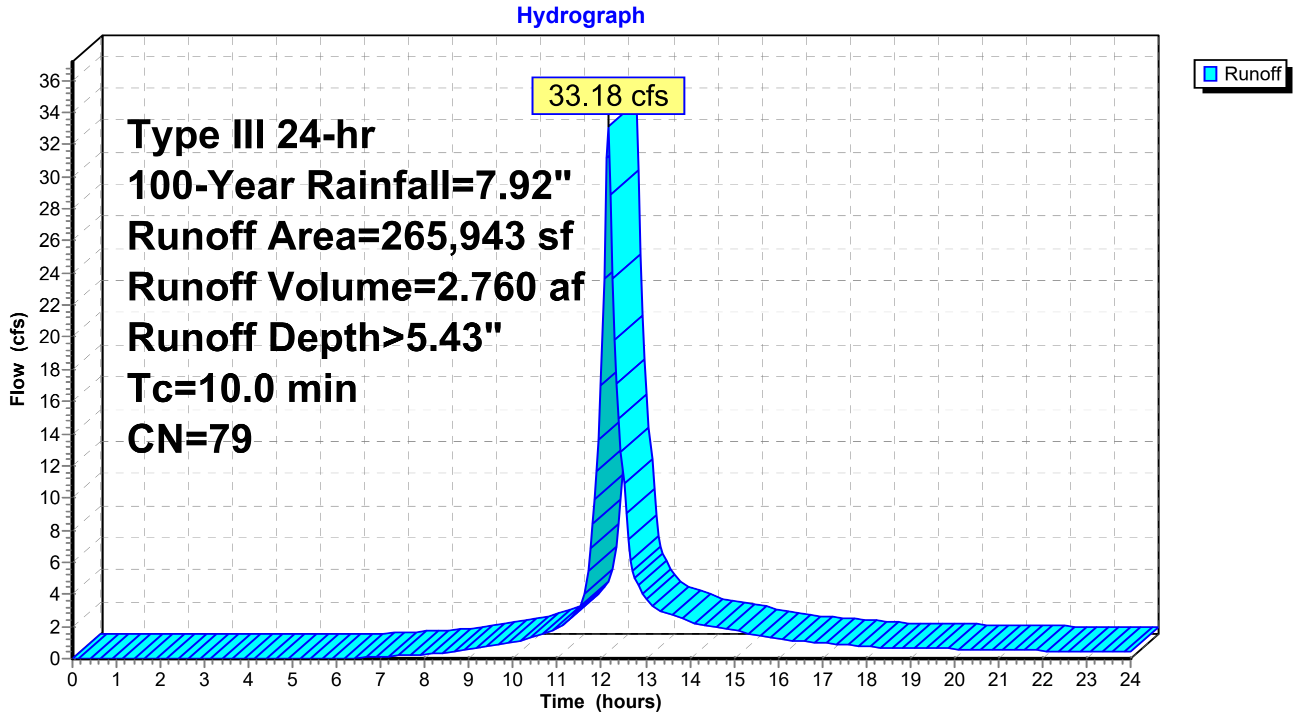
Runoff = 33.18 cfs @ 12.14 hrs, Volume= 2.760 af, Depth> 5.43"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly

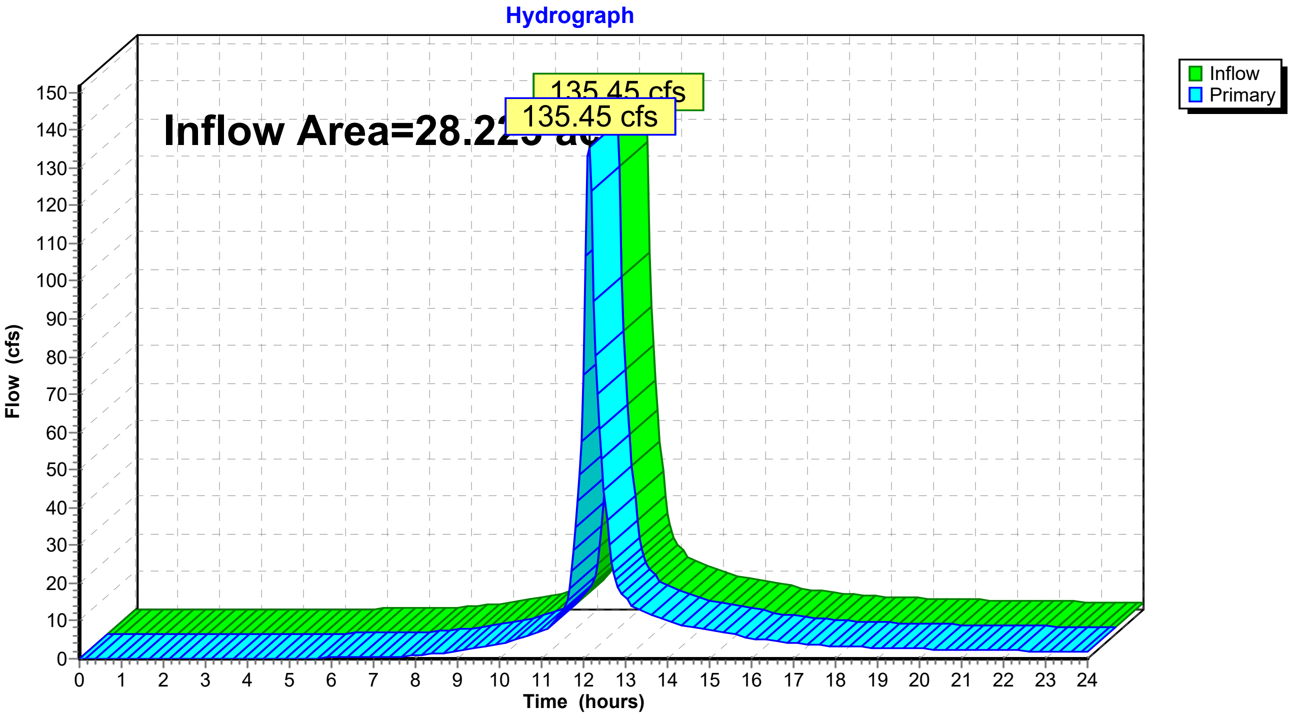


Summary for Link 1L: Municipal System

Inflow Area = 28.223 ac, 33.06% Impervious, Inflow Depth > 4.91" for 100-Year event
Inflow = 135.45 cfs @ 12.13 hrs, Volume= 11.546 af
Primary = 135.45 cfs @ 12.13 hrs, Volume= 11.546 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

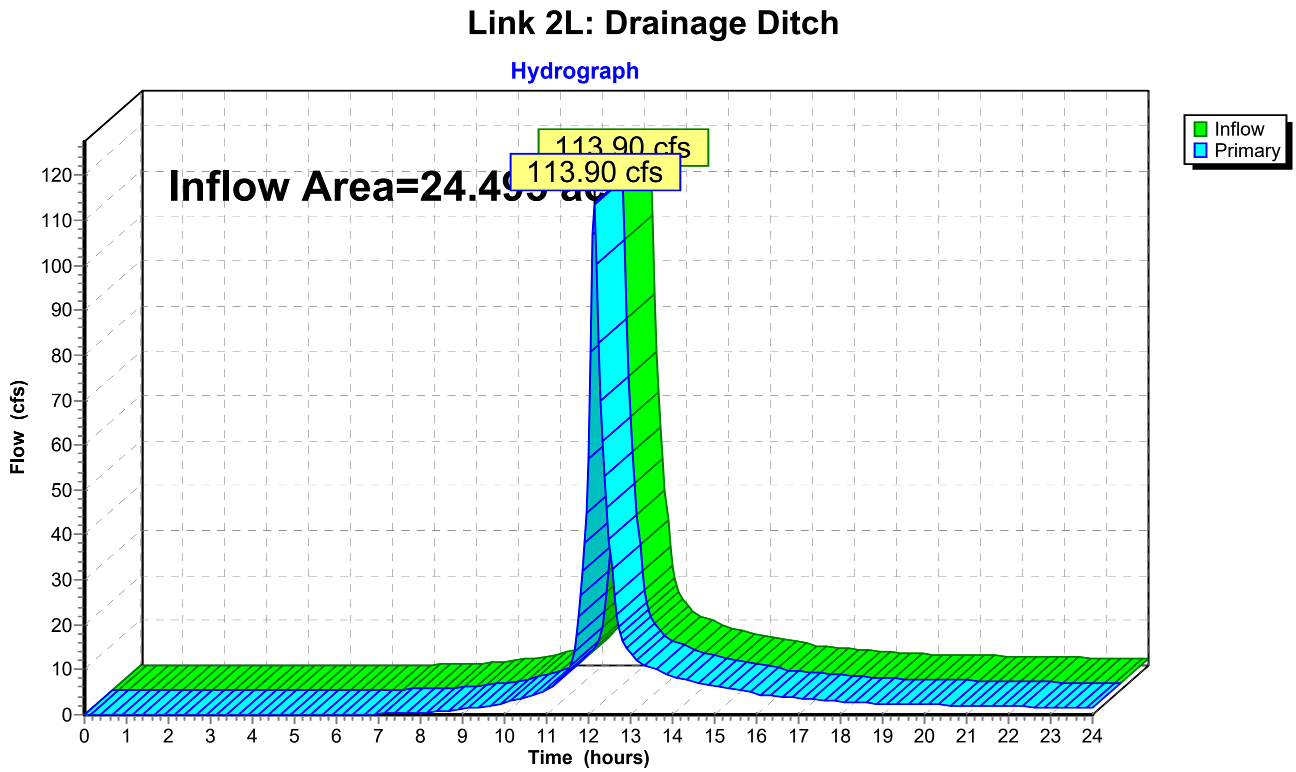
Link 1L: Municipal System



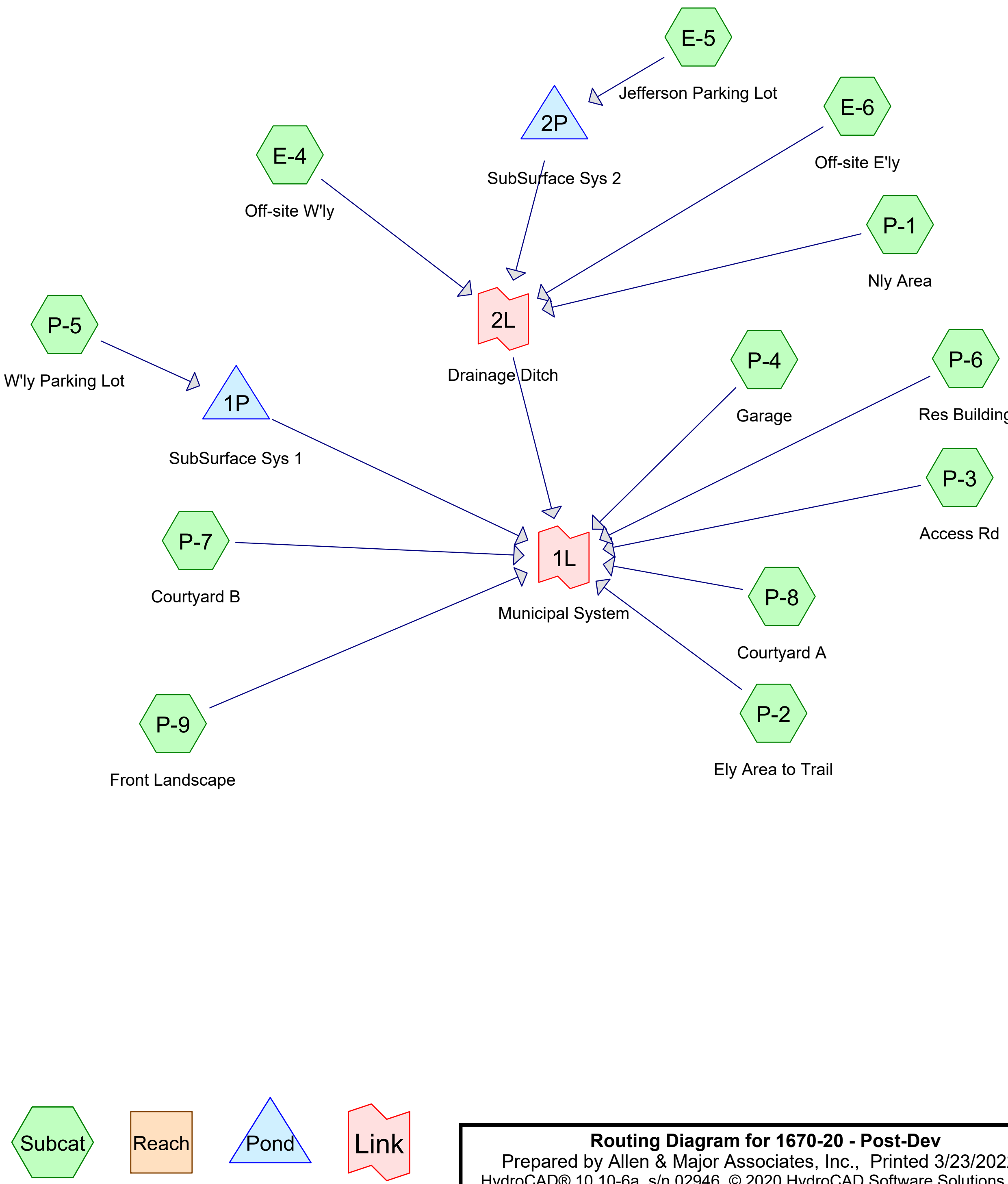
Summary for Link 2L: Drainage Ditch

Inflow Area = 24.495 ac, 34.05% Impervious, Inflow Depth > 4.65" for 100-Year event
Inflow = 113.90 cfs @ 12.14 hrs, Volume= 9.489 af
Primary = 113.90 cfs @ 12.14 hrs, Volume= 9.489 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



POST-DEVELOPMENT



Routing Diagram for 1670-20 - Post-Dev
Prepared by Allen & Major Associates, Inc., Printed 3/23/2022
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Project Notes

Rainfall events imported from "TP-40-Rain.txt" for 437 MA Berkshire

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.30	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.09	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.20	2
4	100-Year	Type III 24-hr		Default	24.00	1	7.92	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
10.131	61	1/4 acre lots, 38% imp, HSG A (E-4)
7.289	83	1/4 acre lots, 38% imp, HSG C (E-4, E-6)
1.185	39	>75% Grass cover, Good, HSG A (P-1, P-3, P-5, P-7, P-8, P-9)
3.370	74	>75% Grass cover, Good, HSG C (E-5, E-6, P-1, P-2, P-3)
0.627	86	GreenRoof, HSG A (40% Roof Area) (P-6)
0.061	86	GreenRoof, HSG C (40% Roof Area) (P-6)
0.383	98	Paved parking, HSG A (P-1, P-3, P-5, P-9)
0.898	98	Paved parking, HSG C (E-5, P-1, P-2, P-3)
1.697	98	Roofs, HSG A (P-4, P-6)
0.135	98	Roofs, HSG C (P-3, P-4, P-6)
0.163	98	Unconnected pavement, HSG A (P-7, P-8)
0.005	98	Unconnected roofs, HSG C (P-2)
1.090	89	Urban commercial, 85% imp, HSG A (E-4)
0.909	94	Urban commercial, 85% imp, HSG C (E-4)
0.050	98	Water Surface, 0% imp, HSG A (P-1)
0.033	98	Water Surface, 0% imp, HSG C (P-1)
0.195	70	Woods, Good, HSG C (P-1)
28.221	**75**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
15.328	HSG A	E-4, P-1, P-3, P-4, P-5, P-6, P-7, P-8, P-9
0.000	HSG B	
12.893	HSG C	E-4, E-5, E-6, P-1, P-2, P-3, P-4, P-6
0.000	HSG D	
0.000	Other	
28.221		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
10.131	0.000	7.289	0.000	0.000	17.421	1/4 acre lots, 38% imp	E-4, E-6
1.185	0.000	3.370	0.000	0.000	4.555	>75% Grass cover, Good	E-5, E-6, P-1, P-2, P-3, P-5, P-7, P-8, P-9
0.627	0.000	0.061	0.000	0.000	0.688	GreenRoof	P-6
0.383	0.000	0.898	0.000	0.000	1.281	Paved parking	E-5, P-1, P-2, P-3, P-5, P-9
1.697	0.000	0.135	0.000	0.000	1.832	Roofs	P-3, P-4, P-6
0.163	0.000	0.000	0.000	0.000	0.163	Unconnected pavement	P-7, P-8
0.000	0.000	0.005	0.000	0.000	0.005	Unconnected roofs	P-2
1.090	0.000	0.909	0.000	0.000	1.999	Urban commercial, 85% imp	E-4
0.050	0.000	0.033	0.000	0.000	0.083	Water Surface, 0% imp	P-1
0.000	0.000	0.195	0.000	0.000	0.195	Woods, Good	P-1
15.328	**0.000**	**12.893**	**0.000**	**0.000**	**28.221**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1P	445.00	444.50	50.0	0.0100	0.012	0.0	12.0	0.0
2	2P	449.50	449.00	50.0	0.0100	0.012	0.0	15.0	0.0

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>0.88"
Tc=10.0 min CN=70 Runoff=13.10 cfs 1.191 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 88.75% Impervious Runoff Depth>2.74"
Tc=6.0 min CN=95 Runoff=1.92 cfs 0.148 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>1.41"
Tc=10.0 min CN=79 Runoff=8.61 cfs 0.717 af

Subcatchment P-1: Nly Area Runoff Area=37,808 sf 8.29% Impervious Runoff Depth>0.45"
Flow Length=130' Tc=7.7 min CN=60 Runoff=0.26 cfs 0.032 af

Subcatchment P-2: Ely Area to Trail Runoff Area=6,239 sf 3.38% Impervious Runoff Depth>1.10"
Tc=6.0 min UI Adjusted CN=74 Runoff=0.17 cfs 0.013 af

Subcatchment P-3: Access Rd Runoff Area=31,850 sf 55.85% Impervious Runoff Depth>1.62"
Tc=6.0 min CN=82 Runoff=1.36 cfs 0.099 af

Subcatchment P-4: Garage Runoff Area=34,671 sf 100.00% Impervious Runoff Depth>3.07"
Tc=6.0 min CN=98 Runoff=2.49 cfs 0.203 af

Subcatchment P-5: W'ly Parking Lot Runoff Area=6,610 sf 86.17% Impervious Runoff Depth>2.26"
Tc=6.0 min CN=90 Runoff=0.39 cfs 0.029 af

Subcatchment P-6: Res Building Runoff Area=74,887 sf 60.00% Impervious Runoff Depth>2.54"
Tc=6.0 min CN=93 Runoff=4.84 cfs 0.364 af

Subcatchment P-7: Courtyard B Runoff Area=8,175 sf 26.90% Impervious Runoff Depth>0.09"
Tc=6.0 min UI Adjusted CN=47 Runoff=0.00 cfs 0.001 af

Subcatchment P-8: Courtyard A Runoff Area=14,260 sf 34.49% Impervious Runoff Depth>0.41"
Tc=6.0 min CN=59 Runoff=0.09 cfs 0.011 af

Subcatchment P-9: Front Landscape Runoff Area=16,653 sf 25.90% Impervious Runoff Depth>0.25"
Tc=6.0 min CN=54 Runoff=0.04 cfs 0.008 af

Pond 1P: SubSurface Sys 1 Peak Elev=446.31' Storage=0.023 af Inflow=0.39 cfs 0.029 af
Discarded=0.00 cfs 0.006 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.006 af

Pond 2P: SubSurface Sys 2 Peak Elev=451.43' Storage=0.081 af Inflow=1.92 cfs 0.148 af
Discarded=0.06 cfs 0.085 af Primary=0.02 cfs 0.009 af Outflow=0.08 cfs 0.094 af

Link 1L: Municipal System Inflow=29.25 cfs 2.650 af
Primary=29.25 cfs 2.650 af

Link 2L: Drainage Ditch Inflow=21.94 cfs 1.950 af
Primary=21.94 cfs 1.950 af

Total Runoff Area = 28.221 ac Runoff Volume = 2.817 af Average Runoff Depth = 1.20"
58.90% Pervious = 16.621 ac 41.10% Impervious = 11.600 ac

Summary for Subcatchment E-4: Off-site W'ly

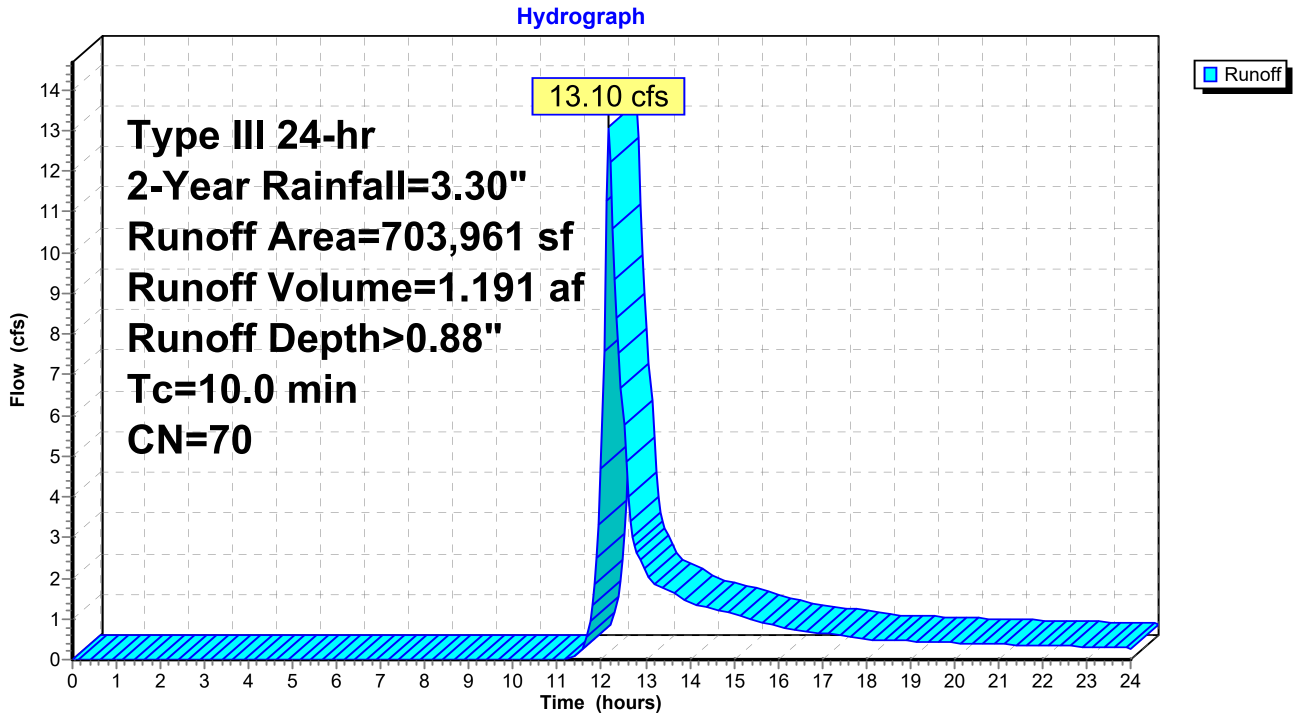
Runoff = 13.10 cfs @ 12.16 hrs, Volume= 1.191 af, Depth> 0.88"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

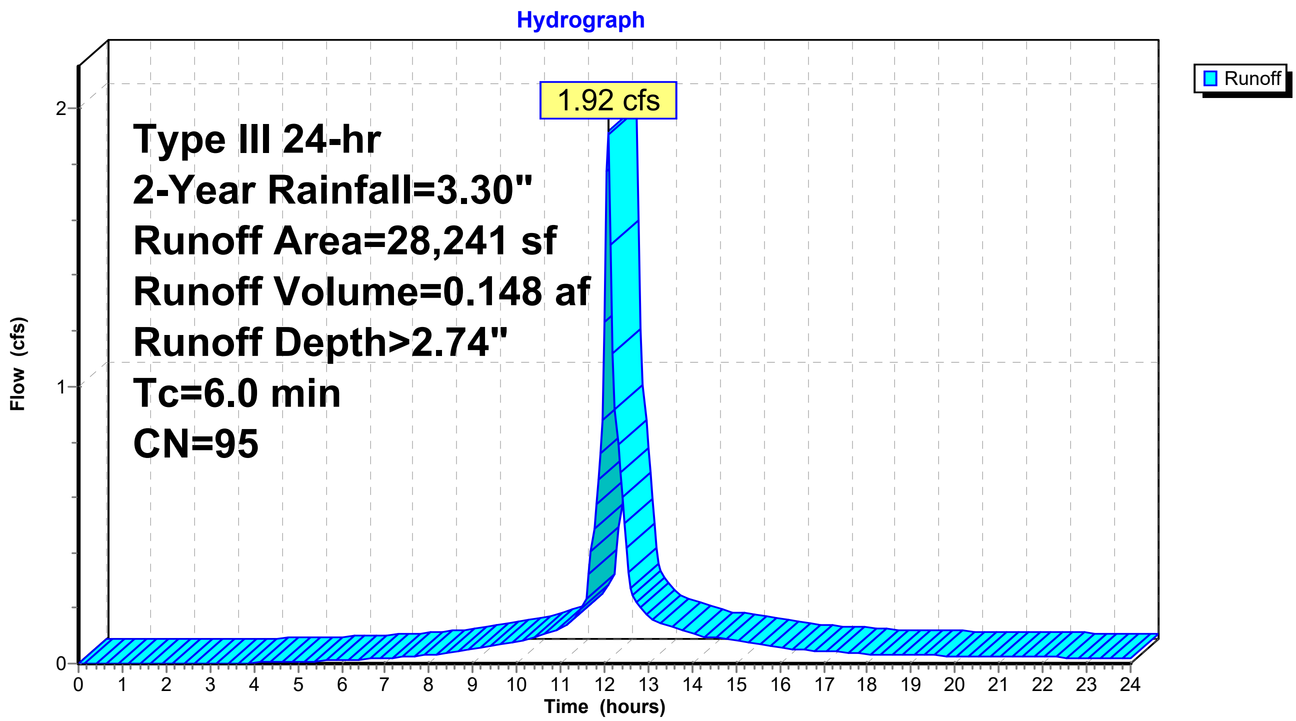
Runoff = 1.92 cfs @ 12.09 hrs, Volume= 0.148 af, Depth> 2.74"
Routed to Pond 2P : SubSurface Sys 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
25,063	98	Paved parking, HSG C
3,178	74	>75% Grass cover, Good, HSG C
28,241	95	Weighted Average
3,178		11.25% Pervious Area
25,063		88.75% Impervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

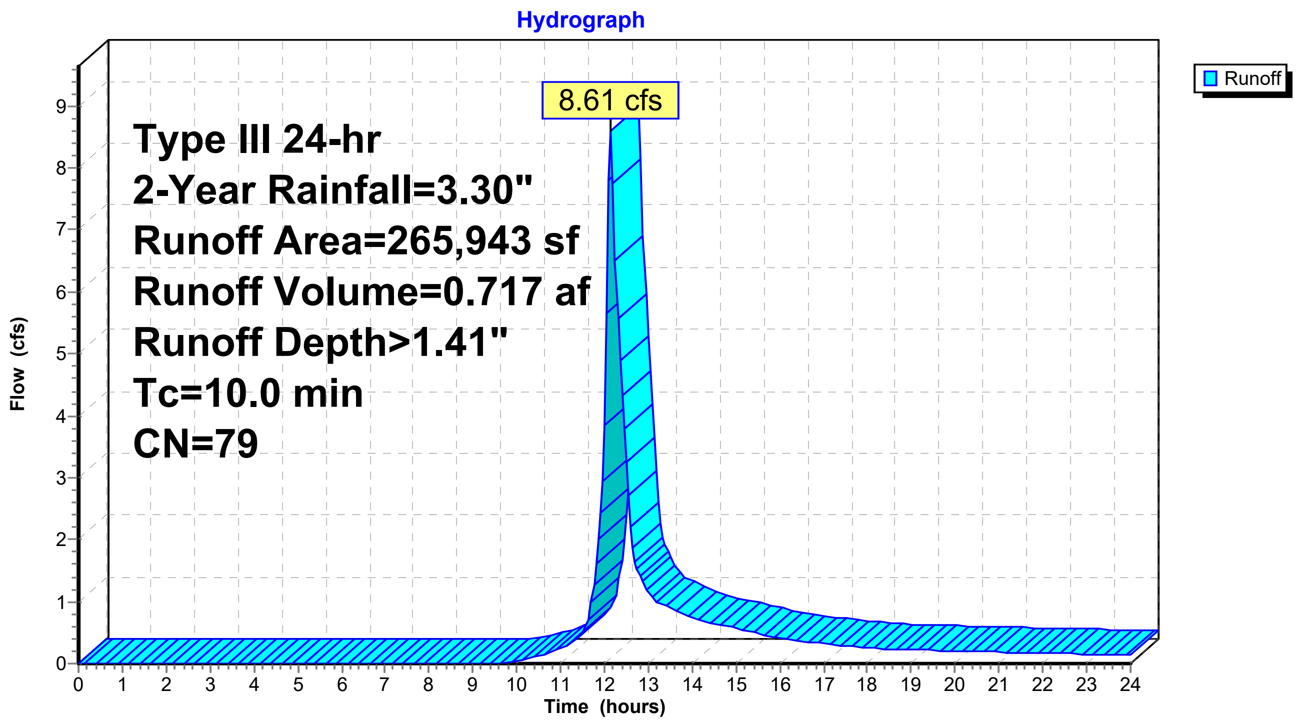
Runoff = 8.61 cfs @ 12.15 hrs, Volume= 0.717 af, Depth> 1.41"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly



Summary for Subcatchment P-1: Nly Area

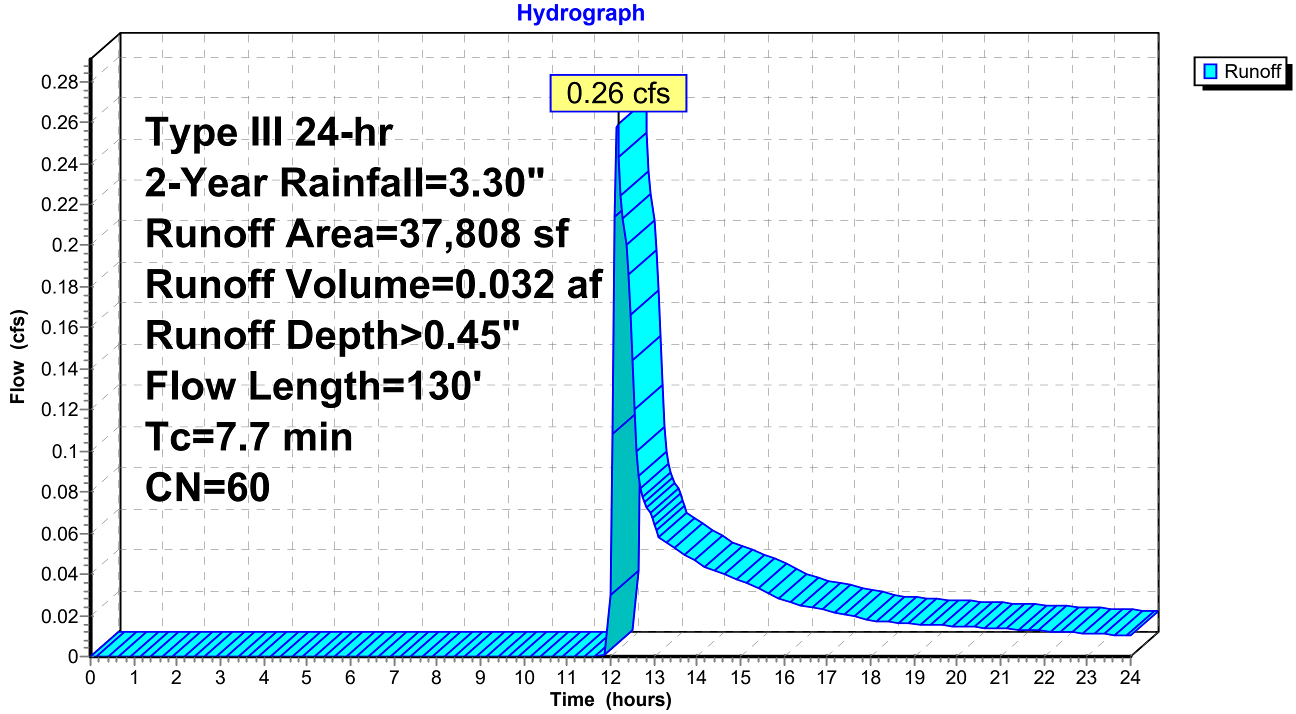
Runoff = 0.26 cfs @ 12.16 hrs, Volume= 0.032 af, Depth> 0.45"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
18,483	39	>75% Grass cover, Good, HSG A
4,093	74	>75% Grass cover, Good, HSG C
1,011	98	Paved parking, HSG A
2,124	98	Paved parking, HSG C
8,477	70	Woods, Good, HSG C
2,192	98	Water Surface, 0% imp, HSG A
1,428	98	Water Surface, 0% imp, HSG C
37,808	60	Weighted Average
34,673		91.71% Pervious Area
3,135		8.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.30"
1.5	80	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.7	130	Total			

Subcatchment P-1: Nly Area



Summary for Subcatchment P-2: Ely Area to Trail

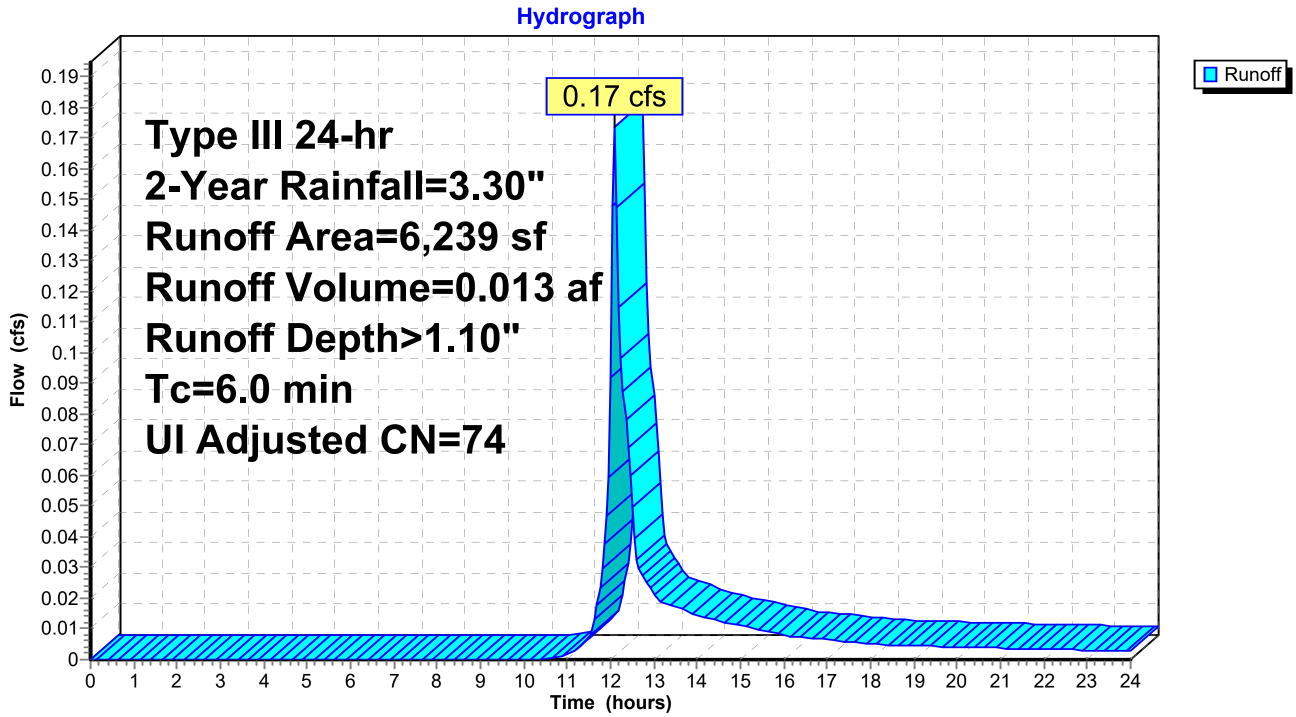
Runoff = 0.17 cfs @ 12.10 hrs, Volume= 0.013 af, Depth> 1.10"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Adj	Description
6,028	74		>75% Grass cover, Good, HSG C
14	98		Paved parking, HSG C
197	98		Unconnected roofs, HSG C
6,239	75	74	Weighted Average, UI Adjusted
6,028			96.62% Pervious Area
211			3.38% Impervious Area
197			93.36% Unconnected

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

Subcatchment P-2: Ely Area to Trail



Summary for Subcatchment P-3: Access Rd

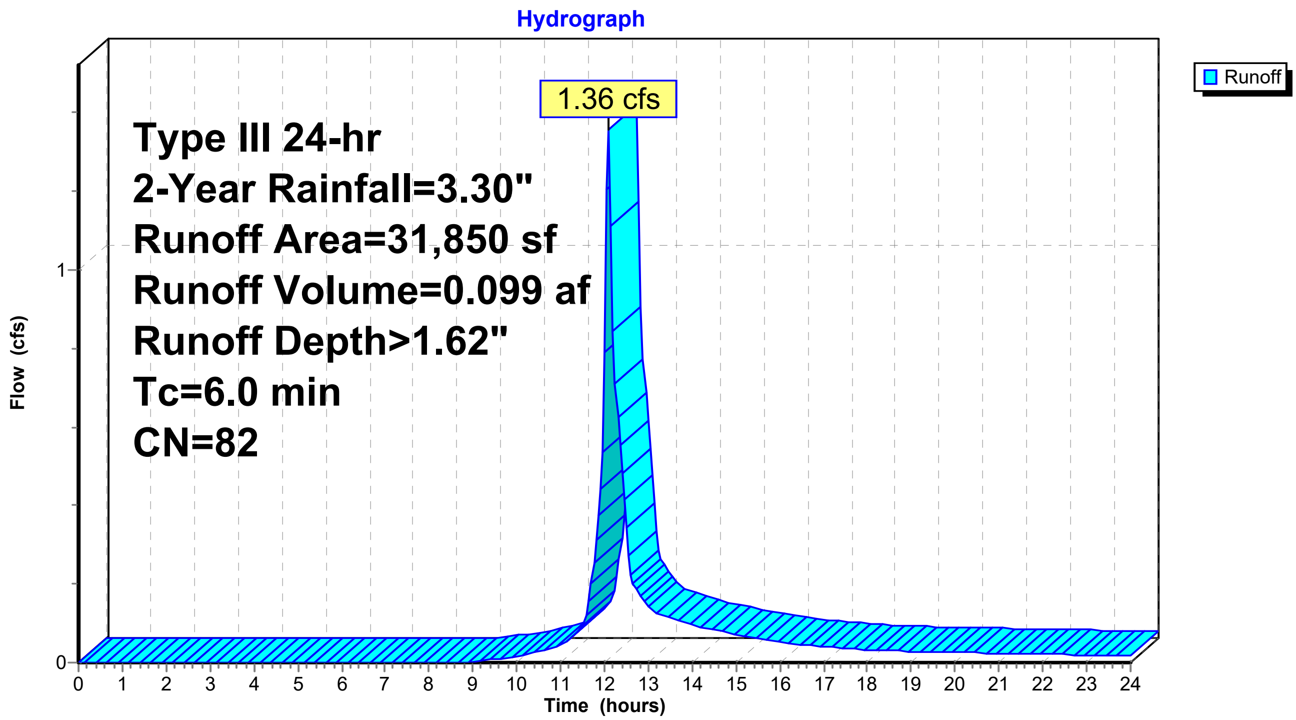
Runoff = 1.36 cfs @ 12.09 hrs, Volume= 0.099 af, Depth> 1.62"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
4,580	39	>75% Grass cover, Good, HSG A
9,481	74	>75% Grass cover, Good, HSG C
197	98	Roofs, HSG C
5,663	98	Paved parking, HSG A
11,929	98	Paved parking, HSG C
31,850	82	Weighted Average
14,061		44.15% Pervious Area
17,789		55.85% Impervious Area

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

Subcatchment P-3: Access Rd



Summary for Subcatchment P-4: Garage

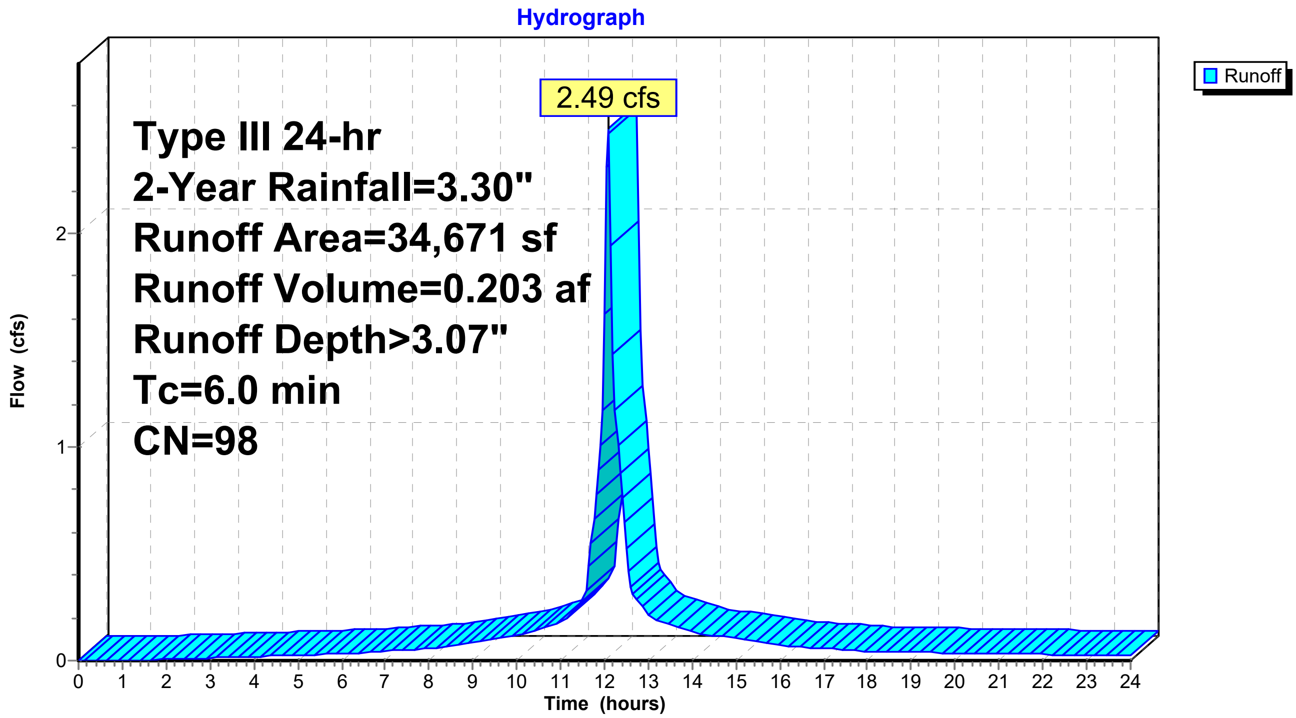
Runoff = 2.49 cfs @ 12.09 hrs, Volume= 0.203 af, Depth> 3.07"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
32,961	98	Roofs, HSG A
1,710	98	Roofs, HSG C
34,671	98	Weighted Average
34,671		100.00% Impervious Area

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

Subcatchment P-4: Garage



Summary for Subcatchment P-5: W'ly Parking Lot

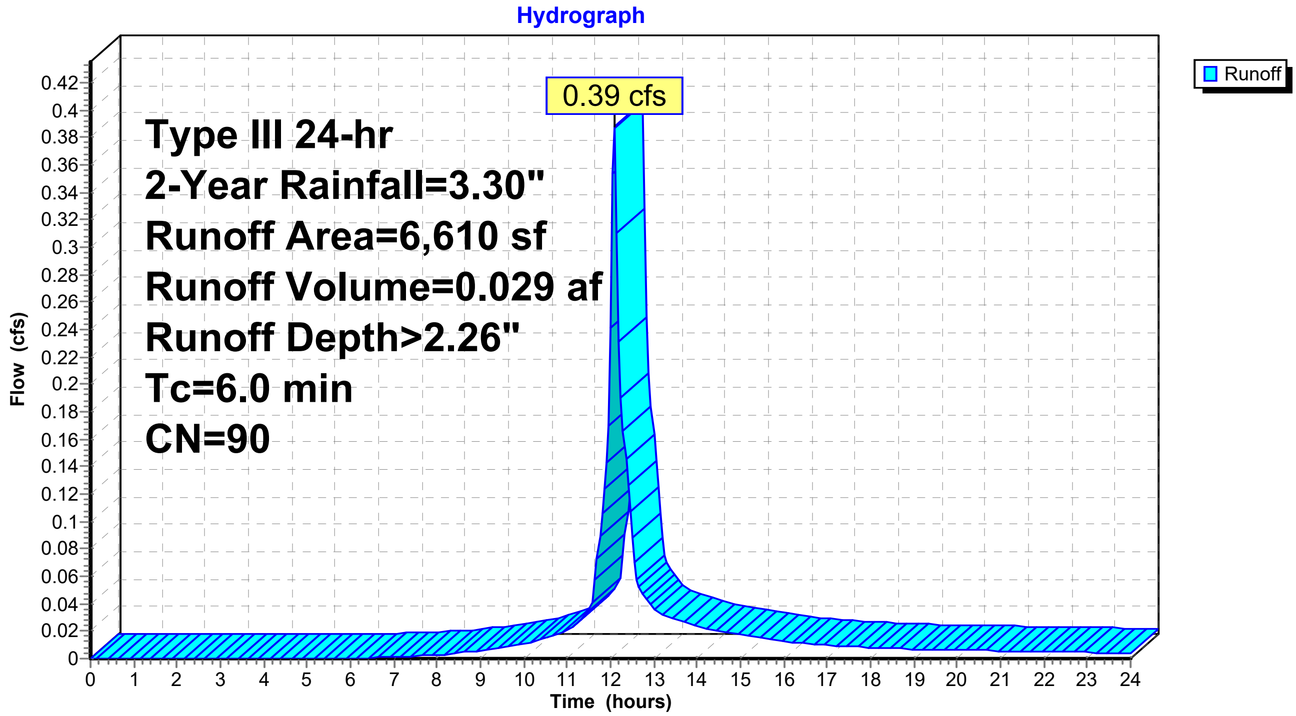
Runoff = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af, Depth> 2.26"
Routed to Pond 1P : SubSurface Sys 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
914	39	>75% Grass cover, Good, HSG A
5,696	98	Paved parking, HSG A
6,610	90	Weighted Average
914		13.83% Pervious Area
5,696		86.17% Impervious Area

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

Subcatchment P-5: W'ly Parking Lot



Summary for Subcatchment P-6: Res Building

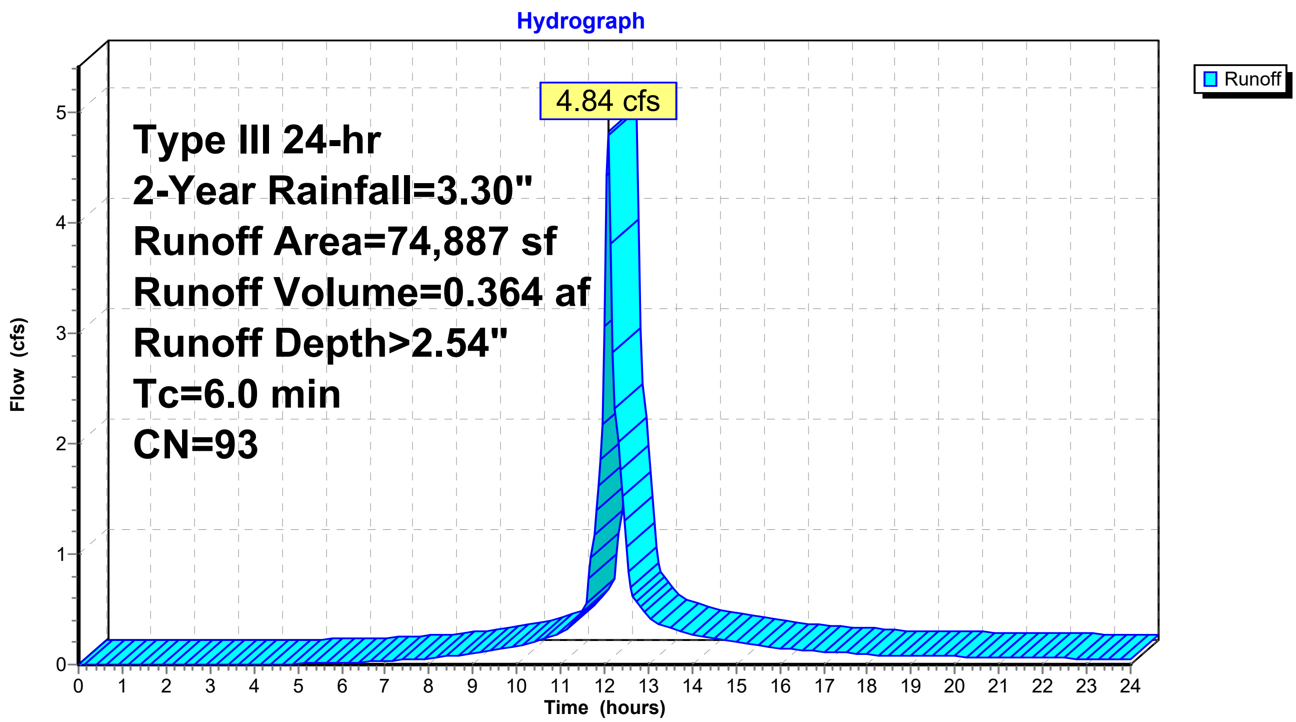
Runoff = 4.84 cfs @ 12.09 hrs, Volume= 0.364 af, Depth> 2.54"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

	Area (sf)	CN	Description
	40,967	98	Roofs, HSG A
	3,965	98	Roofs, HSG C
*	27,312	86	GreenRoof, HSG A (40% Roof Area)
*	2,643	86	GreenRoof, HSG C (40% Roof Area)
	74,887	93	Weighted Average
	29,955		40.00% Pervious Area
	44,932		60.00% Impervious Area

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

Subcatchment P-6: Res Building



Summary for Subcatchment P-7: Courtyard B

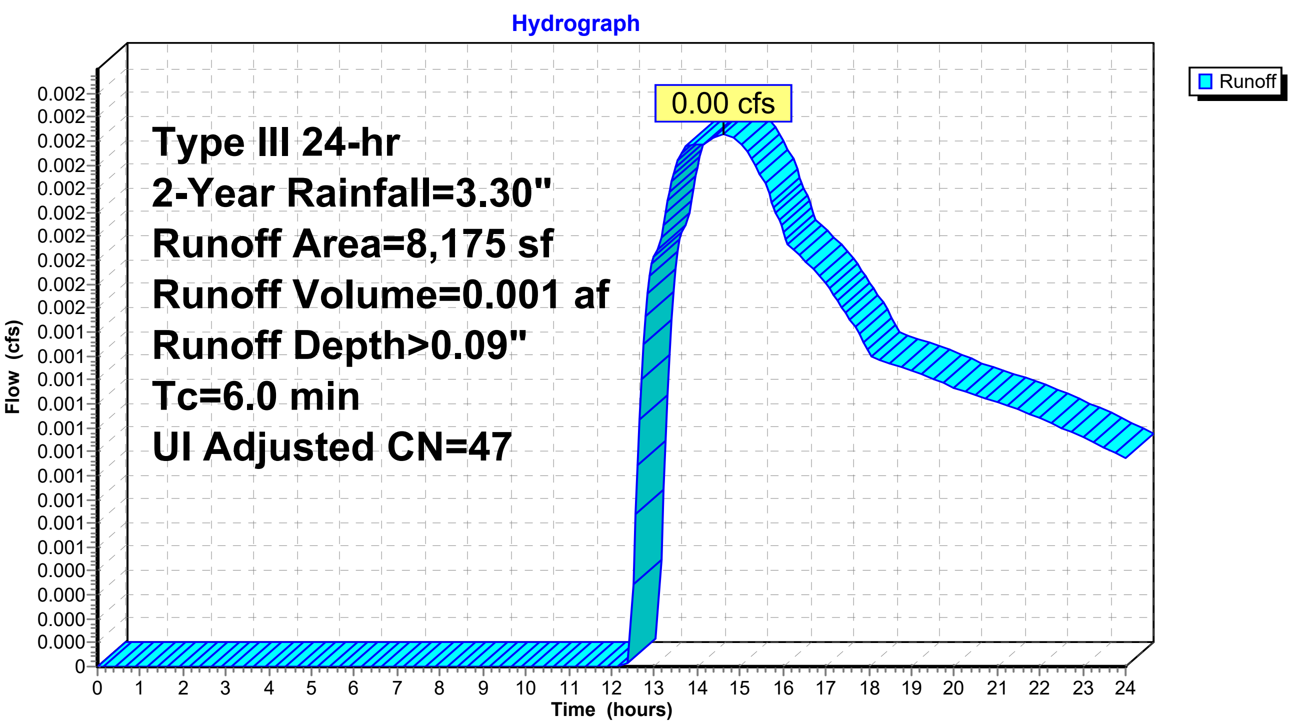
Runoff = 0.00 cfs @ 14.61 hrs, Volume= 0.001 af, Depth> 0.09"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Adj	Description
2,199	98		Unconnected pavement, HSG A
5,976	39		>75% Grass cover, Good, HSG A
8,175	55	47	Weighted Average, UI Adjusted
5,976			73.10% Pervious Area
2,199			26.90% Impervious Area
2,199			100.00% Unconnected

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

Subcatchment P-7: Courtyard B



Summary for Subcatchment P-8: Courtyard A

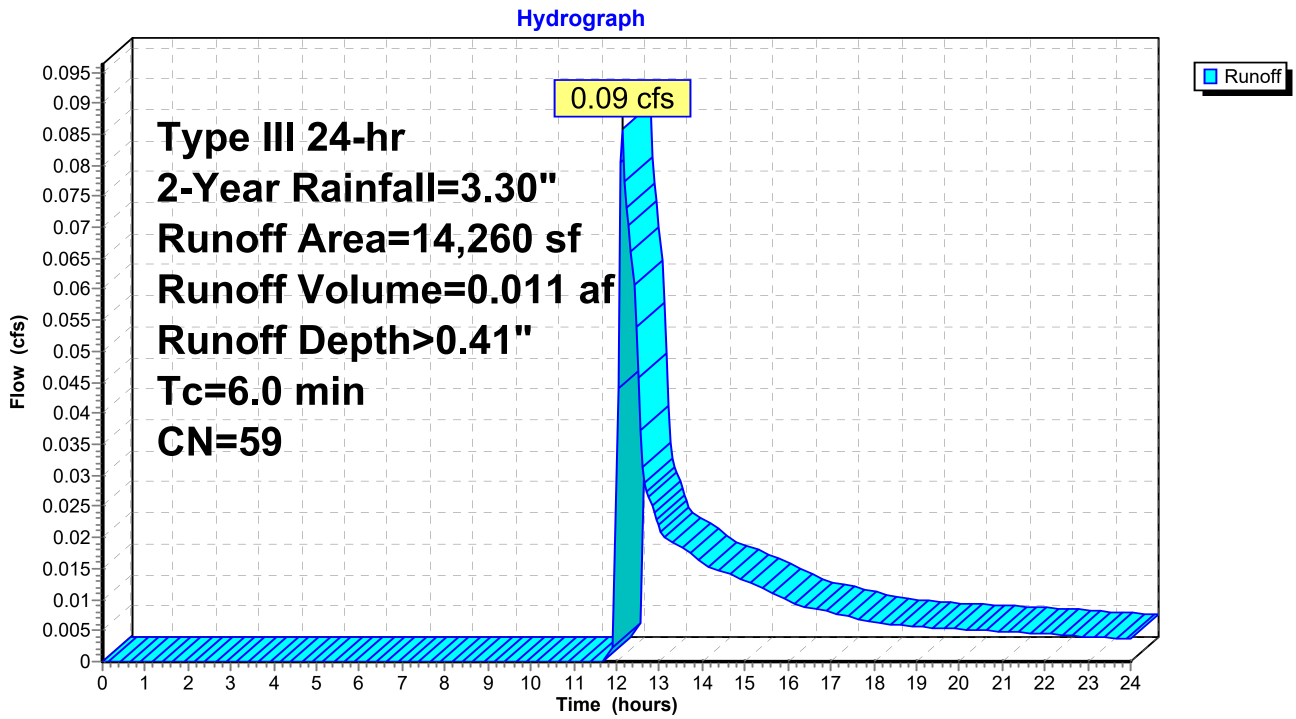
Runoff = 0.09 cfs @ 12.14 hrs, Volume= 0.011 af, Depth> 0.41"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
4,918	98	Unconnected pavement, HSG A
9,342	39	>75% Grass cover, Good, HSG A
14,260	59	Weighted Average
9,342		65.51% Pervious Area
4,918		34.49% Impervious Area
4,918		100.00% Unconnected

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

Subcatchment P-8: Courtyard A



Summary for Subcatchment P-9: Front Landscape

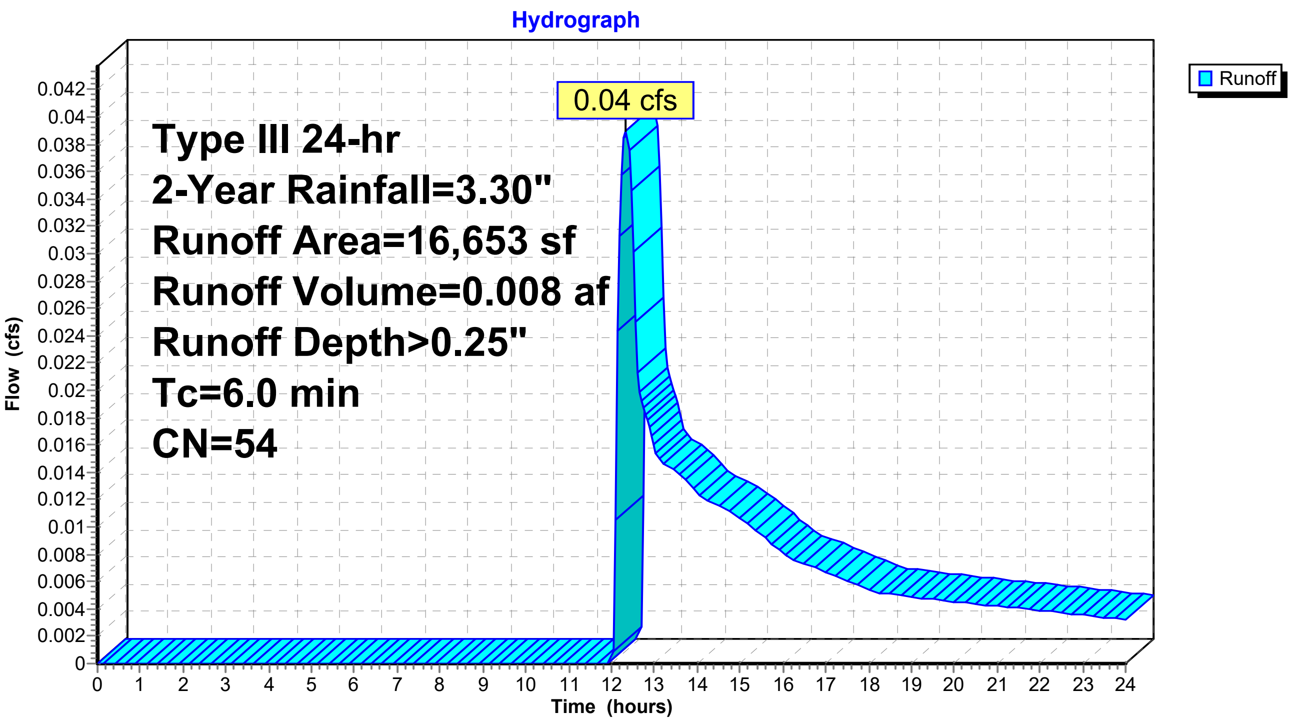
Runoff = 0.04 cfs @ 12.34 hrs, Volume= 0.008 af, Depth> 0.25"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
12,340	39	>75% Grass cover, Good, HSG A
4,313	98	Paved parking, HSG A
16,653	54	Weighted Average
12,340		74.10% Pervious Area
4,313		25.90% Impervious Area

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

Subcatchment P-9: Front Landscape



Summary for Pond 1P: SubSurface Sys 1

Inflow Area = 0.152 ac, 86.17% Impervious, Inflow Depth > 2.26" for 2-Year event
Inflow = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af
Outflow = 0.00 cfs @ 9.40 hrs, Volume= 0.006 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.00 cfs @ 9.40 hrs, Volume= 0.006 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link 1L : Municipal System

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 446.31' @ 22.86 hrs Surf.Area= 0.027 ac Storage= 0.023 af

Plug-Flow detention time= 319.0 min calculated for 0.006 af (21% of inflow)
Center-of-Mass det. time= 163.2 min (968.4 - 805.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	445.00'	0.025 af	**15.75'W x 74.82'L x 3.50'H Field A**
			0.095 af Overall - 0.032 af Embedded = 0.063 af x 40.0% Voids
#2A	445.50'	0.032 af	**ADS_StormTech SC-740 +Cap** x 30 Inside #1
			Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
			Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
			30 Chambers in 3 Rows
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	445.00'	**0.170 in/hr Exfiltration over Surface area**
#2	Primary	445.00'	**12.0" Round Culvert**
			L= 50.0' CPP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 445.00' / 444.50' S= 0.0100 '/' Cc= 0.900
			n= 0.012, Flow Area= 0.79 sf
#3	Device 2	446.50'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	447.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	447.75'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00
			Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.00 cfs @ 9.40 hrs HW=445.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=445.00' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  ├─**4=Orifice/Grate** (Controls 0.00 cfs)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: SubSurface Sys 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

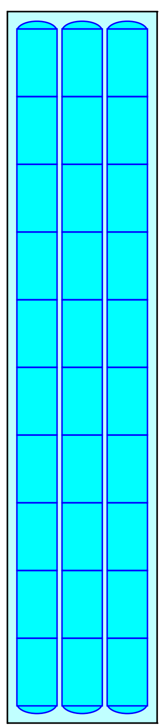
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
3 Rows x 51.0" Wide + 6.0" Spacing x 2 + 12.0" Side Stone x 2 = 15.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

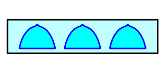
30 Chambers x 45.9 cf = 1,378.2 cf Chamber Storage

4,124.3 cf Field - 1,378.2 cf Chambers = 2,746.1 cf Stone x 40.0% Voids = 1,098.4 cf Stone Storage

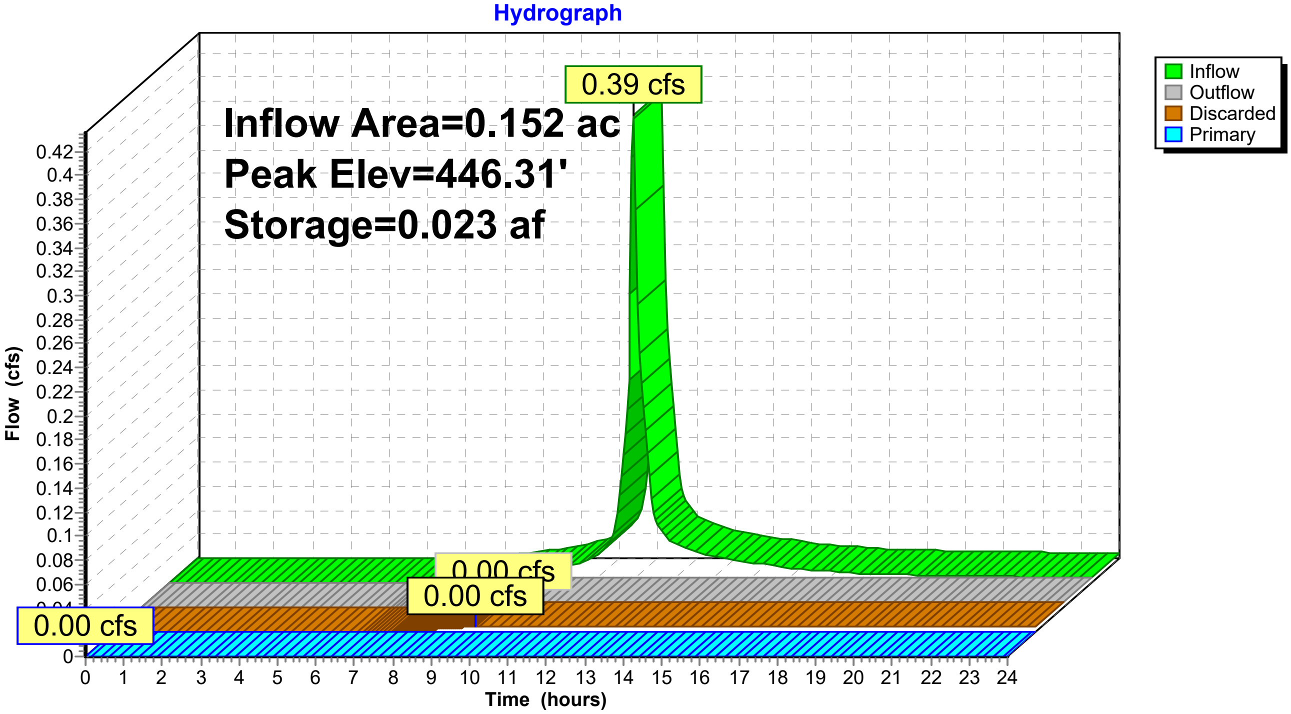
Chamber Storage + Stone Storage = 2,476.6 cf = 0.057 af
Overall Storage Efficiency = 60.1%
Overall System Size = 74.82' x 15.75' x 3.50'

30 Chambers
152.8 cy Field
101.7 cy Stone





Pond 1P: SubSurface Sys 1



Summary for Pond 2P: SubSurface Sys 2

Inflow Area = 0.648 ac, 88.75% Impervious, Inflow Depth > 2.74" for 2-Year event
Inflow = 1.92 cfs @ 12.09 hrs, Volume= 0.148 af
Outflow = 0.08 cfs @ 15.07 hrs, Volume= 0.094 af, Atten= 96%, Lag= 178.8 min
Discarded = 0.06 cfs @ 9.70 hrs, Volume= 0.085 af
Primary = 0.02 cfs @ 15.07 hrs, Volume= 0.009 af
Routed to Link 2L : Drainage Ditch

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 451.43' @ 15.07 hrs Surf.Area= 0.061 ac Storage= 0.081 af

Plug-Flow detention time= 267.0 min calculated for 0.094 af (64% of inflow)
Center-of-Mass det. time= 168.9 min (948.5 - 779.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	449.50'	0.055 af	**30.00'W x 89.06'L x 3.50'H Field A** 0.215 af Overall - 0.076 af Embedded = 0.139 af x 40.0% Voids
#2A	450.00'	0.076 af	**ADS_StormTech SC-740 +Cap** x 72 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 72 Chambers in 6 Rows
		0.131 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	449.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	449.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 449.50' / 449.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#3	Device 2	451.00'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	451.50'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	452.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 9.70 hrs HW=449.54' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.02 cfs @ 15.07 hrs HW=451.43' (Free Discharge)
└─**2=Culvert** (Passes 0.02 cfs of 6.74 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.02 cfs @ 2.99 fps)
  ├─**4=Orifice/Grate** (Controls 0.00 cfs)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: SubSurface Sys 2 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

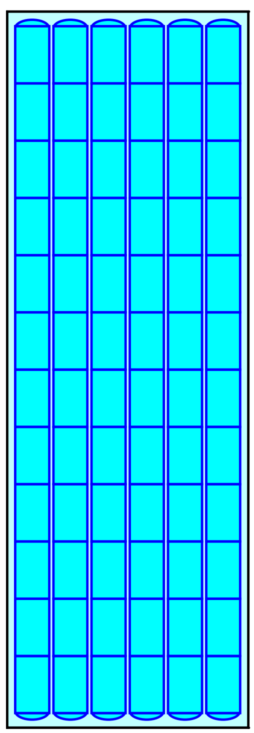
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

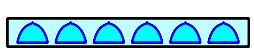
72 Chambers x 45.9 cf = 3,307.7 cf Chamber Storage

9,351.0 cf Field - 3,307.7 cf Chambers = 6,043.3 cf Stone x 40.0% Voids = 2,417.3 cf Stone Storage

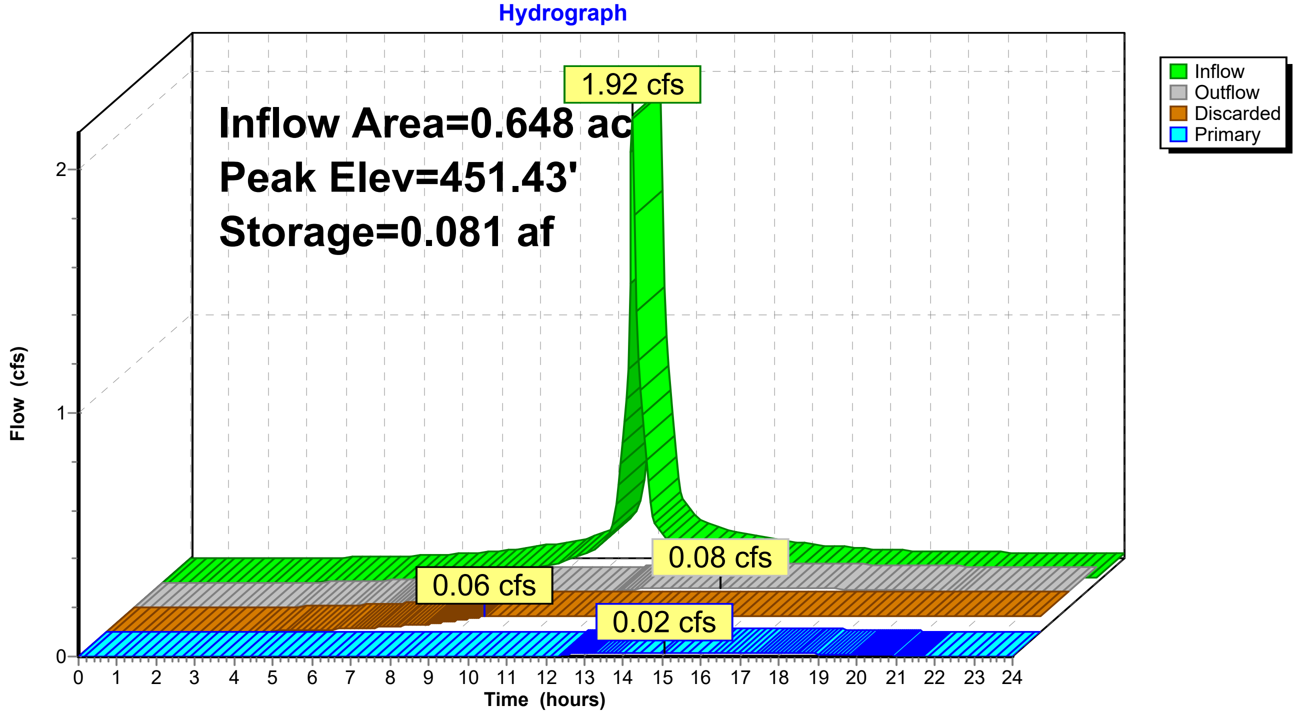
Chamber Storage + Stone Storage = 5,725.0 cf = 0.131 af
Overall Storage Efficiency = 61.2%
Overall System Size = 89.06' x 30.00' x 3.50'

72 Chambers
346.3 cy Field
223.8 cy Stone





Pond 2P: SubSurface Sys 2

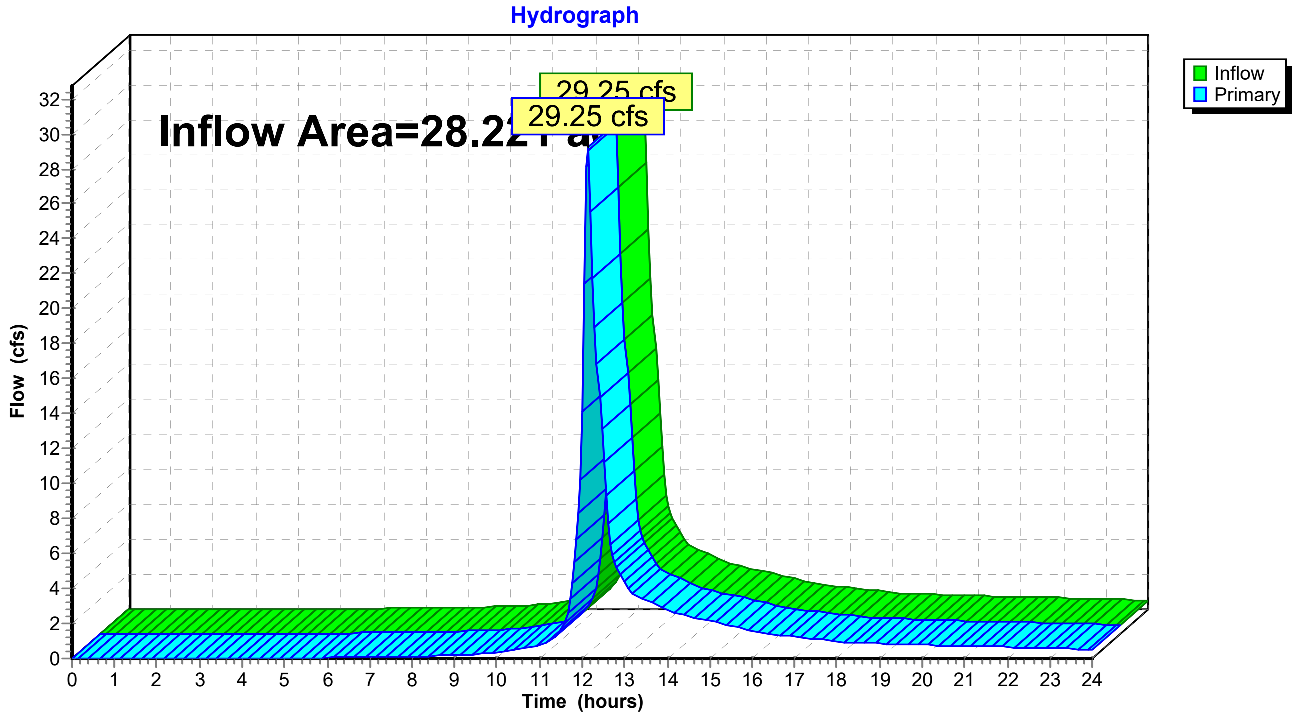


Summary for Link 1L: Municipal System

Inflow Area = 28.221 ac, 41.10% Impervious, Inflow Depth > 1.13" for 2-Year event
Inflow = 29.25 cfs @ 12.14 hrs, Volume= 2.650 af
Primary = 29.25 cfs @ 12.14 hrs, Volume= 2.650 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

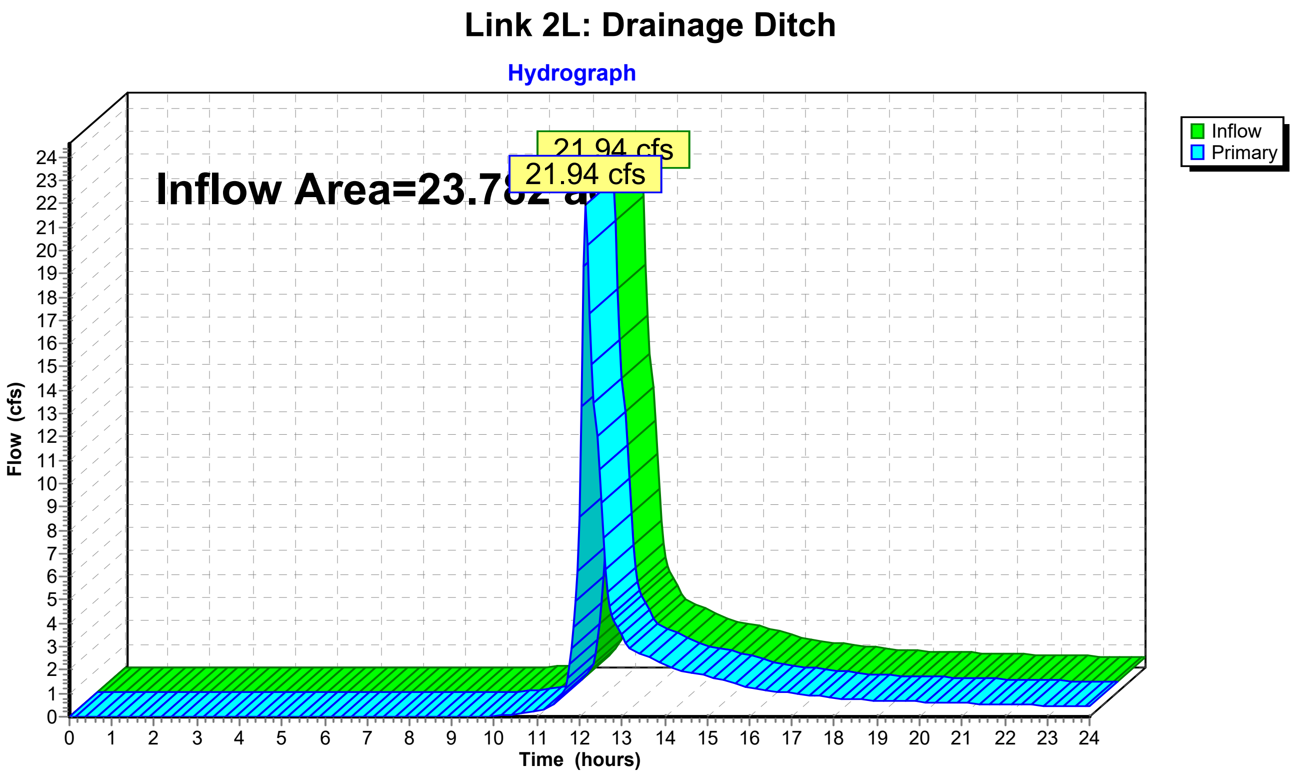
Link 1L: Municipal System



Summary for Link 2L: Drainage Ditch

Inflow Area = 23.782 ac, 37.70% Impervious, Inflow Depth > 0.98" for 2-Year event
Inflow = 21.94 cfs @ 12.16 hrs, Volume= 1.950 af
Primary = 21.94 cfs @ 12.16 hrs, Volume= 1.950 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>2.10"
Tc=10.0 min CN=70 Runoff=33.82 cfs 2.827 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 88.75% Impervious Runoff Depth>4.51"
Tc=6.0 min CN=95 Runoff=3.07 cfs 0.243 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>2.87"
Tc=10.0 min CN=79 Runoff=17.80 cfs 1.462 af

Subcatchment P-1: Nly Area Runoff Area=37,808 sf 8.29% Impervious Runoff Depth>1.35"
Flow Length=130' Tc=7.7 min CN=60 Runoff=1.15 cfs 0.098 af

Subcatchment P-2: Ely Area to Trail Runoff Area=6,239 sf 3.38% Impervious Runoff Depth>2.43"
Tc=6.0 min UI Adjusted CN=74 Runoff=0.40 cfs 0.029 af

Subcatchment P-3: Access Rd Runoff Area=31,850 sf 55.85% Impervious Runoff Depth>3.16"
Tc=6.0 min CN=82 Runoff=2.64 cfs 0.192 af

Subcatchment P-4: Garage Runoff Area=34,671 sf 100.00% Impervious Runoff Depth>4.85"
Tc=6.0 min CN=98 Runoff=3.87 cfs 0.322 af

Subcatchment P-5: W'ly Parking Lot Runoff Area=6,610 sf 86.17% Impervious Runoff Depth>3.96"
Tc=6.0 min CN=90 Runoff=0.66 cfs 0.050 af

Subcatchment P-6: Res Building Runoff Area=74,887 sf 60.00% Impervious Runoff Depth>4.28"
Tc=6.0 min CN=93 Runoff=7.92 cfs 0.614 af

Subcatchment P-7: Courtyard B Runoff Area=8,175 sf 26.90% Impervious Runoff Depth>0.57"
Tc=6.0 min UI Adjusted CN=47 Runoff=0.06 cfs 0.009 af

Subcatchment P-8: Courtyard A Runoff Area=14,260 sf 34.49% Impervious Runoff Depth>1.28"
Tc=6.0 min CN=59 Runoff=0.43 cfs 0.035 af

Subcatchment P-9: Front Landscape Runoff Area=16,653 sf 25.90% Impervious Runoff Depth>0.96"
Tc=6.0 min CN=54 Runoff=0.34 cfs 0.031 af

Pond 1P: SubSurface Sys 1 Peak Elev=446.94' Storage=0.035 af Inflow=0.66 cfs 0.050 af
Discarded=0.00 cfs 0.007 af Primary=0.02 cfs 0.013 af Outflow=0.02 cfs 0.020 af

Pond 2P: SubSurface Sys 2 Peak Elev=452.36' Storage=0.116 af Inflow=3.07 cfs 0.243 af
Discarded=0.06 cfs 0.094 af Primary=0.64 cfs 0.082 af Outflow=0.70 cfs 0.176 af

Link 1L: Municipal System Inflow=65.82 cfs 5.713 af
Primary=65.82 cfs 5.713 af

Link 2L: Drainage Ditch Inflow=52.76 cfs 4.469 af
Primary=52.76 cfs 4.469 af

Total Runoff Area = 28.221 ac Runoff Volume = 5.912 af Average Runoff Depth = 2.51"
58.90% Pervious = 16.621 ac 41.10% Impervious = 11.600 ac

Summary for Subcatchment E-4: Off-site W'ly

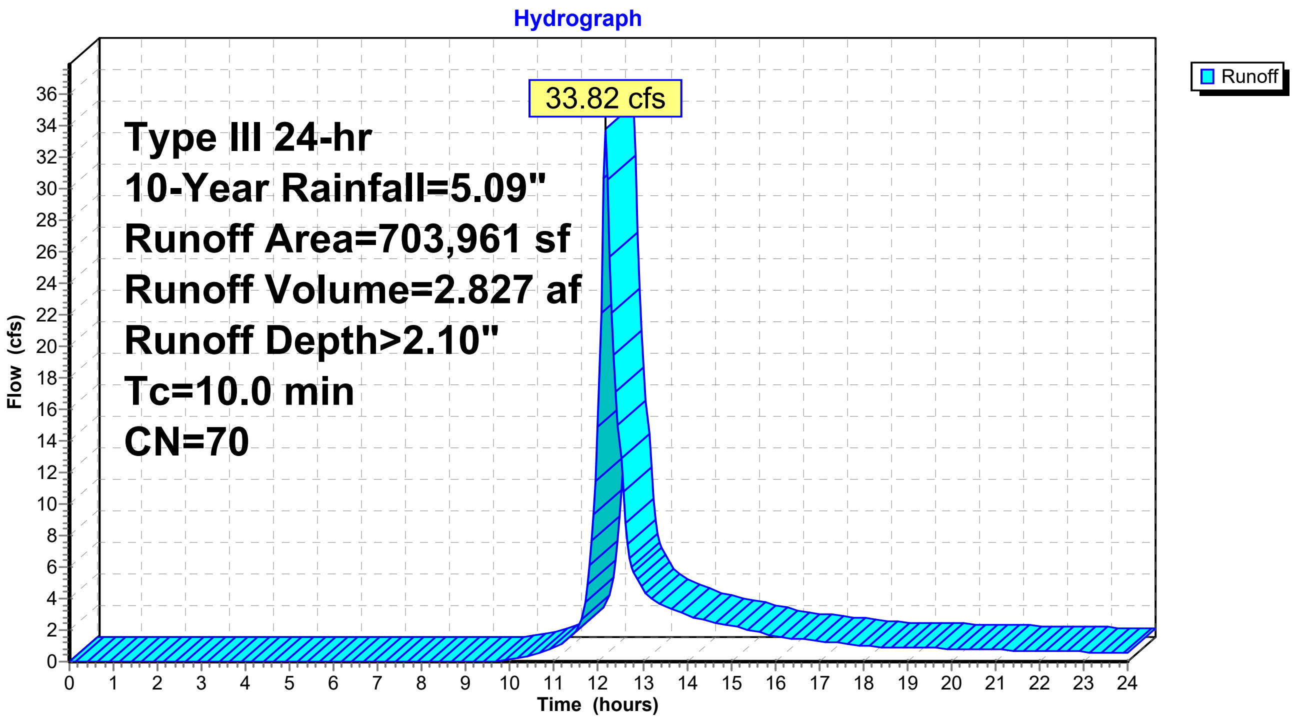
Runoff = 33.82 cfs @ 12.15 hrs, Volume= 2.827 af, Depth> 2.10"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

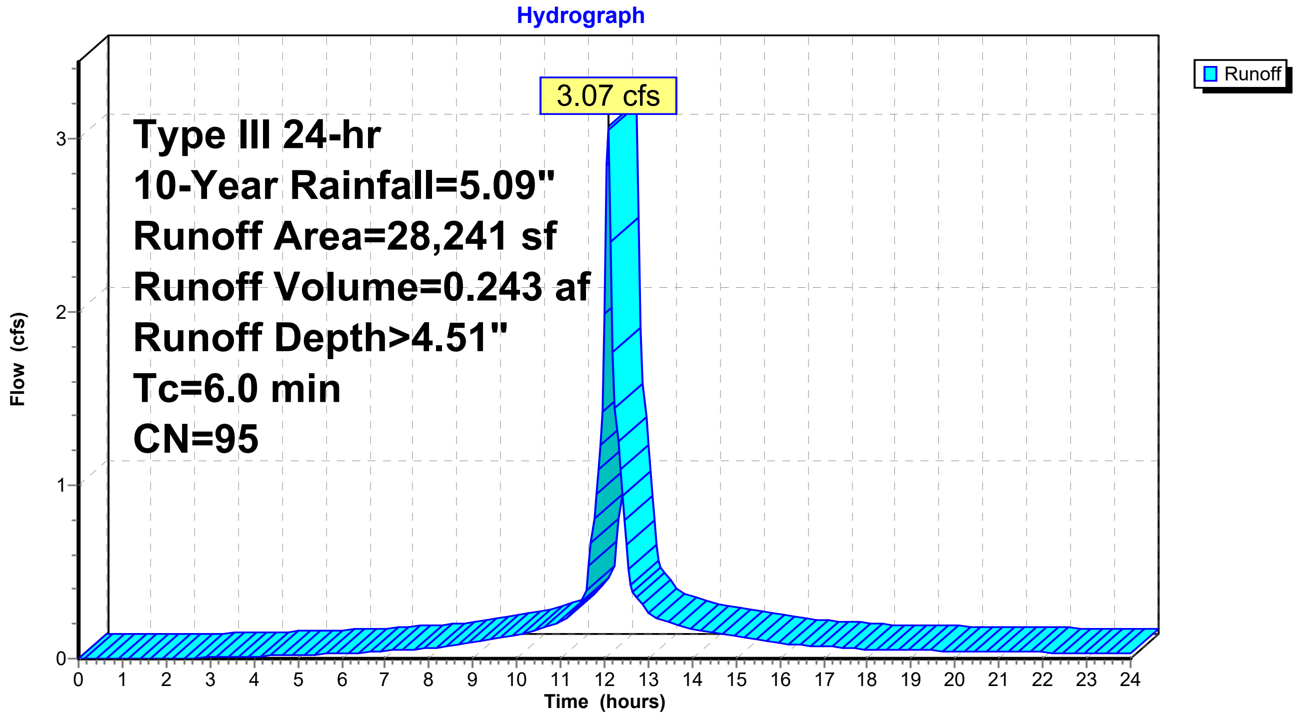
Runoff = 3.07 cfs @ 12.09 hrs, Volume= 0.243 af, Depth> 4.51"
Routed to Pond 2P : SubSurface Sys 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
25,063	98	Paved parking, HSG C
3,178	74	>75% Grass cover, Good, HSG C
28,241	95	Weighted Average
3,178		11.25% Pervious Area
25,063		88.75% Impervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

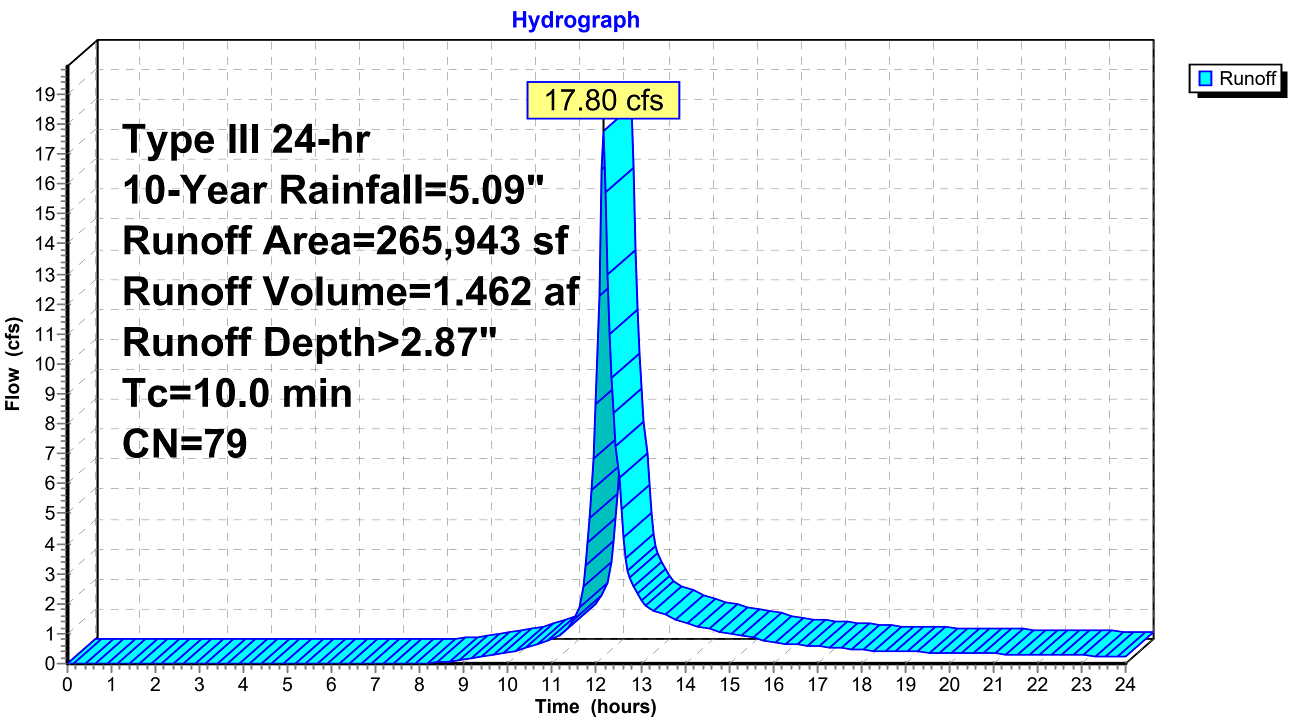
Runoff = 17.80 cfs @ 12.14 hrs, Volume= 1.462 af, Depth> 2.87"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly



Summary for Subcatchment P-1: Nly Area

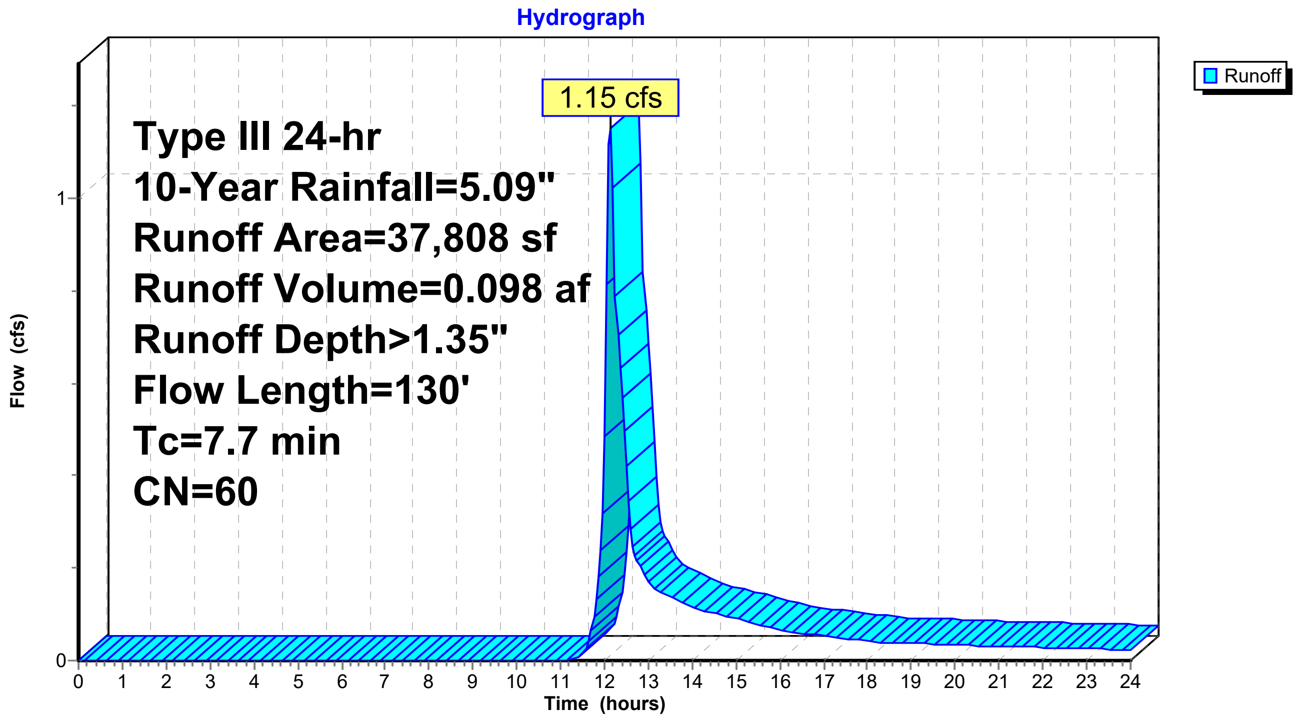
Runoff = 1.15 cfs @ 12.12 hrs, Volume= 0.098 af, Depth> 1.35"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
18,483	39	>75% Grass cover, Good, HSG A
4,093	74	>75% Grass cover, Good, HSG C
1,011	98	Paved parking, HSG A
2,124	98	Paved parking, HSG C
8,477	70	Woods, Good, HSG C
2,192	98	Water Surface, 0% imp, HSG A
1,428	98	Water Surface, 0% imp, HSG C
37,808	60	Weighted Average
34,673		91.71% Pervious Area
3,135		8.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.30"
1.5	80	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.7	130	Total			

Subcatchment P-1: Nly Area



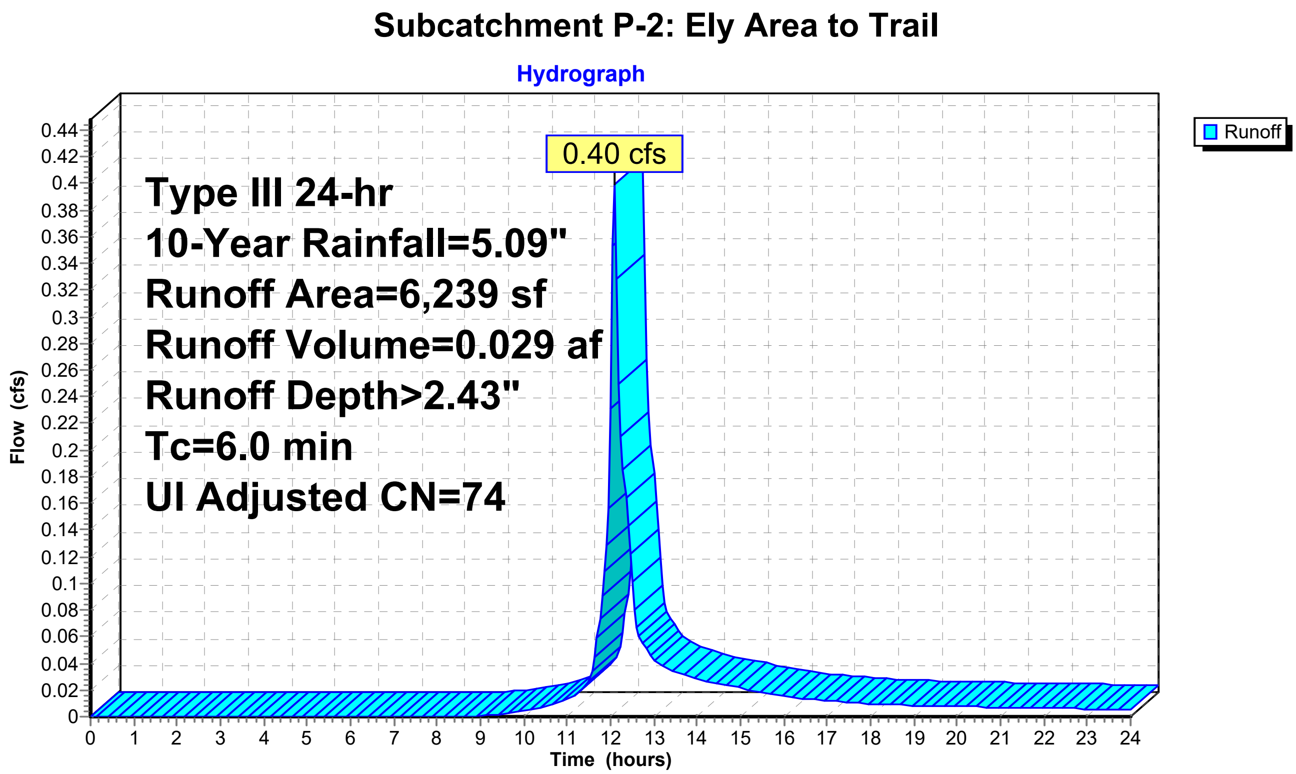
Summary for Subcatchment P-2: Ely Area to Trail

Runoff = 0.40 cfs @ 12.09 hrs, Volume= 0.029 af, Depth> 2.43"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Adj	Description
6,028	74		>75% Grass cover, Good, HSG C
14	98		Paved parking, HSG C
197	98		Unconnected roofs, HSG C
6,239	75	74	Weighted Average, UI Adjusted
6,028			96.62% Pervious Area
211			3.38% Impervious Area
197			93.36% Unconnected

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



Summary for Subcatchment P-3: Access Rd

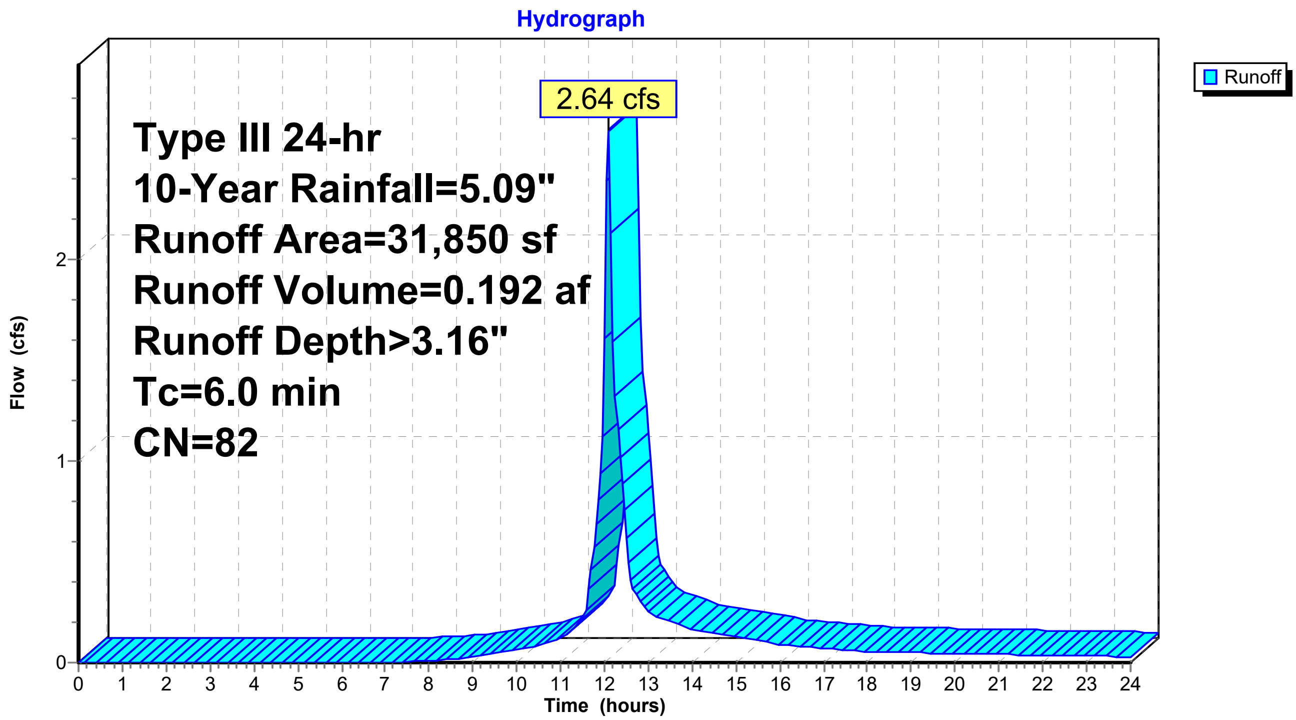
Runoff = 2.64 cfs @ 12.09 hrs, Volume= 0.192 af, Depth> 3.16"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
4,580	39	>75% Grass cover, Good, HSG A
9,481	74	>75% Grass cover, Good, HSG C
197	98	Roofs, HSG C
5,663	98	Paved parking, HSG A
11,929	98	Paved parking, HSG C
31,850	82	Weighted Average
14,061		44.15% Pervious Area
17,789		55.85% Impervious Area

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

Subcatchment P-3: Access Rd



Summary for Subcatchment P-4: Garage

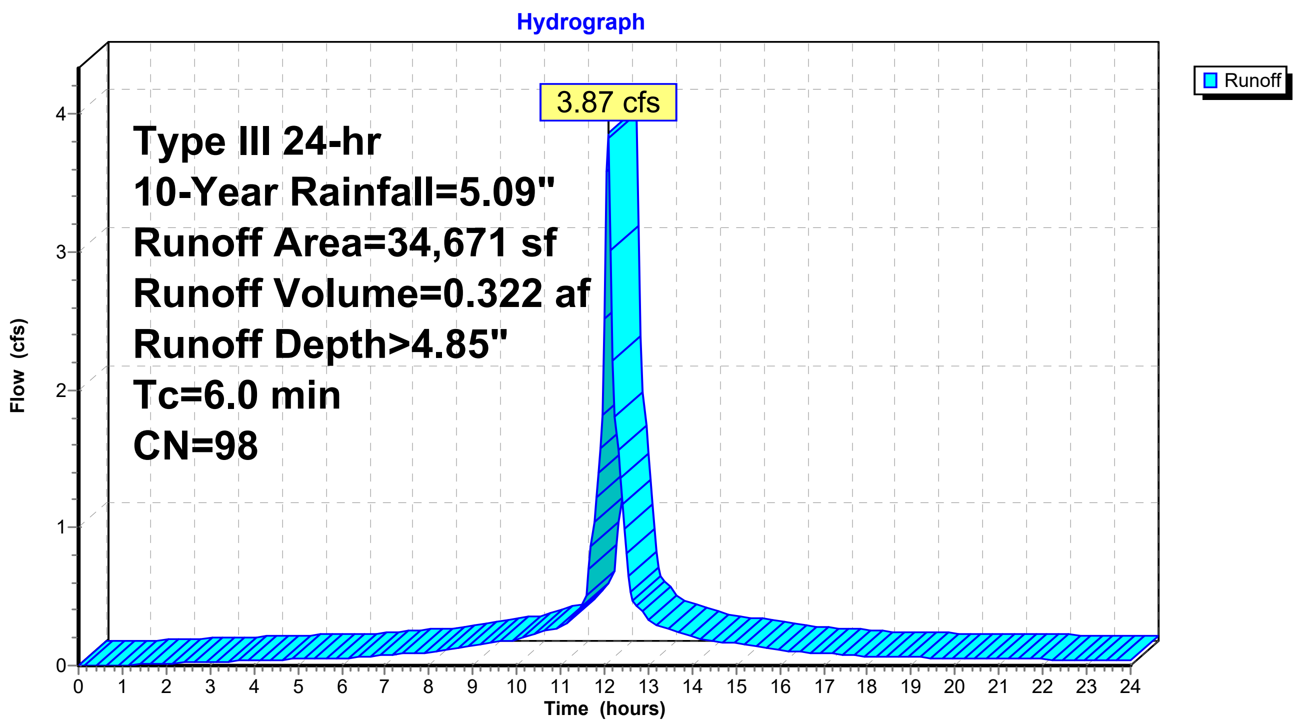
Runoff = 3.87 cfs @ 12.09 hrs, Volume= 0.322 af, Depth> 4.85"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
32,961	98	Roofs, HSG A
1,710	98	Roofs, HSG C
34,671	98	Weighted Average
34,671		100.00% Impervious Area

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

Subcatchment P-4: Garage



Summary for Subcatchment P-5: W'ly Parking Lot

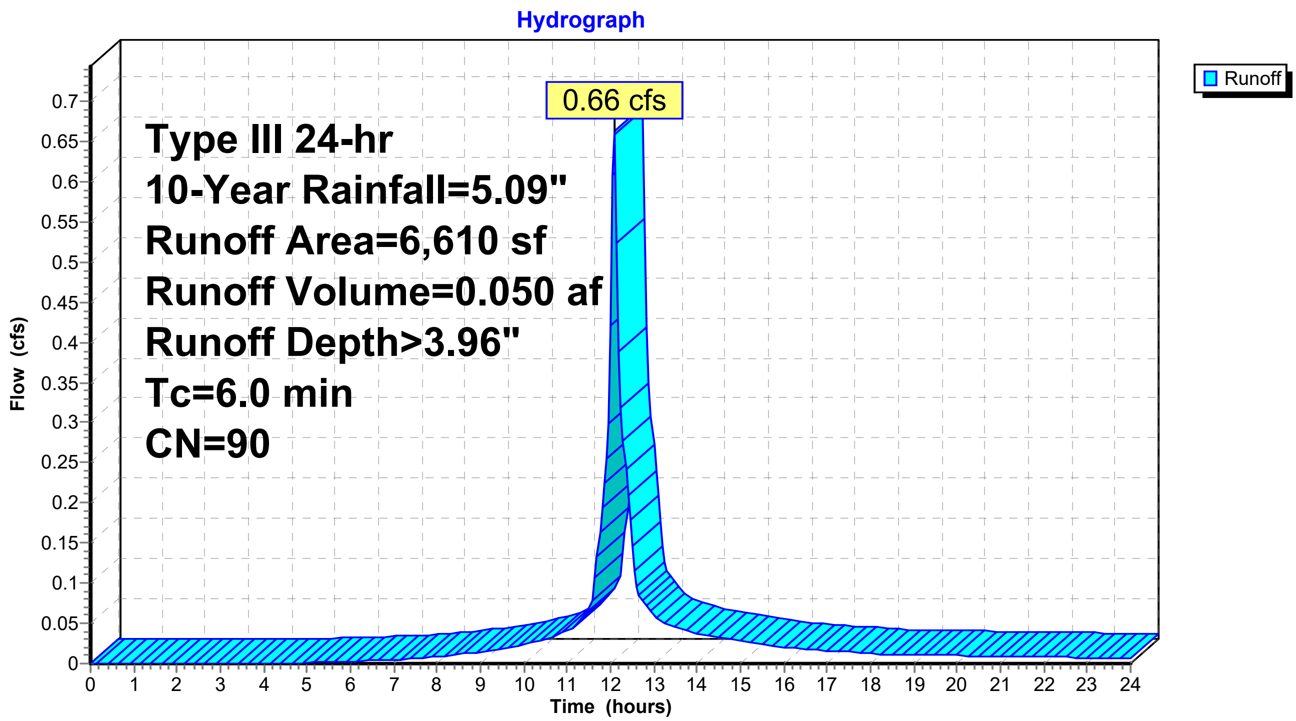
Runoff = 0.66 cfs @ 12.09 hrs, Volume= 0.050 af, Depth> 3.96"
Routed to Pond 1P : SubSurface Sys 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
914	39	>75% Grass cover, Good, HSG A
5,696	98	Paved parking, HSG A
6,610	90	Weighted Average
914		13.83% Pervious Area
5,696		86.17% Impervious Area

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

Subcatchment P-5: W'ly Parking Lot



Summary for Subcatchment P-6: Res Building

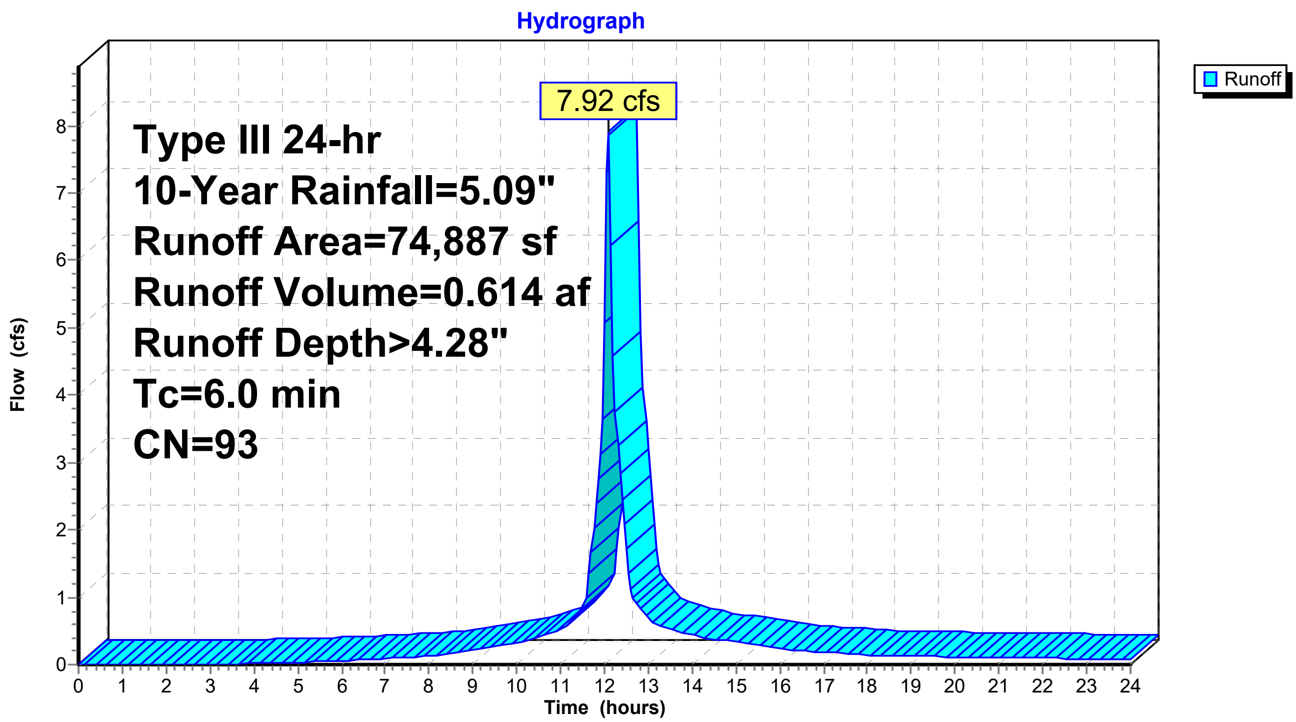
Runoff = 7.92 cfs @ 12.09 hrs, Volume= 0.614 af, Depth> 4.28"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

	Area (sf)	CN	Description
	40,967	98	Roofs, HSG A
	3,965	98	Roofs, HSG C
*	27,312	86	GreenRoof, HSG A (40% Roof Area)
*	2,643	86	GreenRoof, HSG C (40% Roof Area)
	74,887	93	Weighted Average
	29,955		40.00% Pervious Area
	44,932		60.00% Impervious Area

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

Subcatchment P-6: Res Building



Summary for Subcatchment P-7: Courtyard B

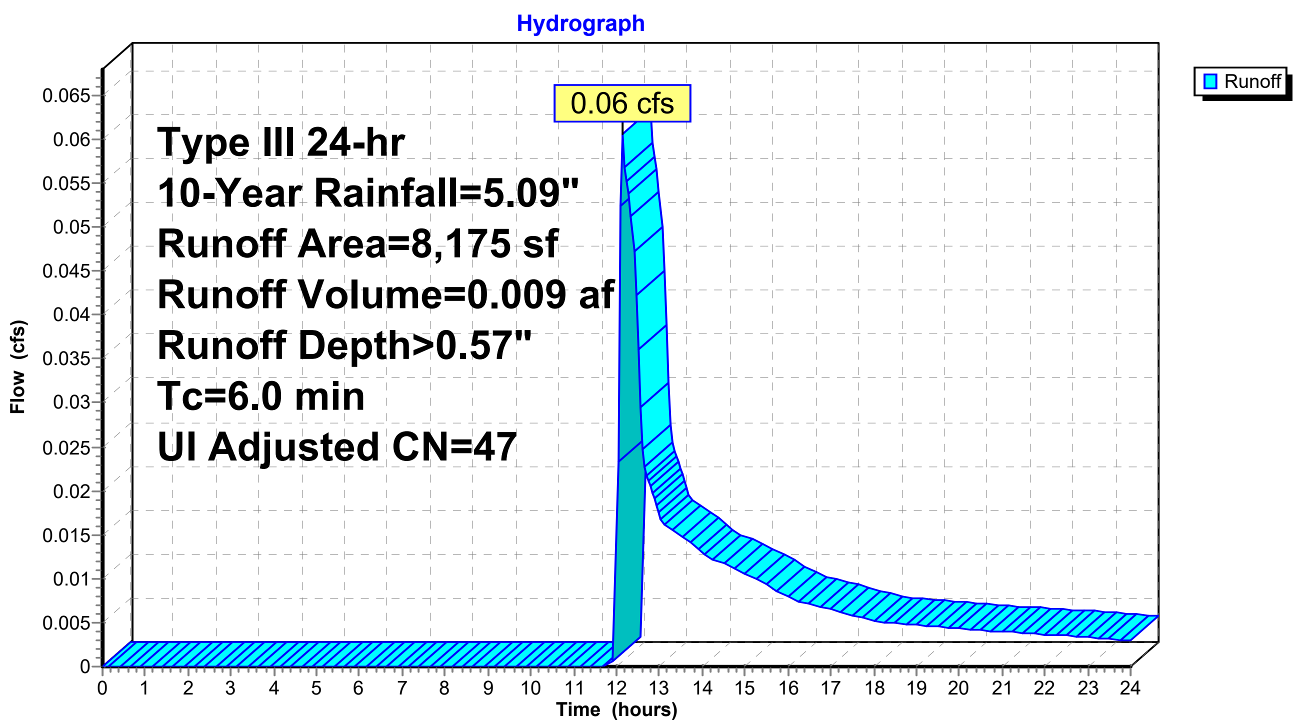
Runoff = 0.06 cfs @ 12.16 hrs, Volume= 0.009 af, Depth> 0.57"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Adj	Description
2,199	98		Unconnected pavement, HSG A
5,976	39		>75% Grass cover, Good, HSG A
8,175	55	47	Weighted Average, UI Adjusted
5,976			73.10% Pervious Area
2,199			26.90% Impervious Area
2,199			100.00% Unconnected

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

Subcatchment P-7: Courtyard B



Summary for Subcatchment P-8: Courtyard A

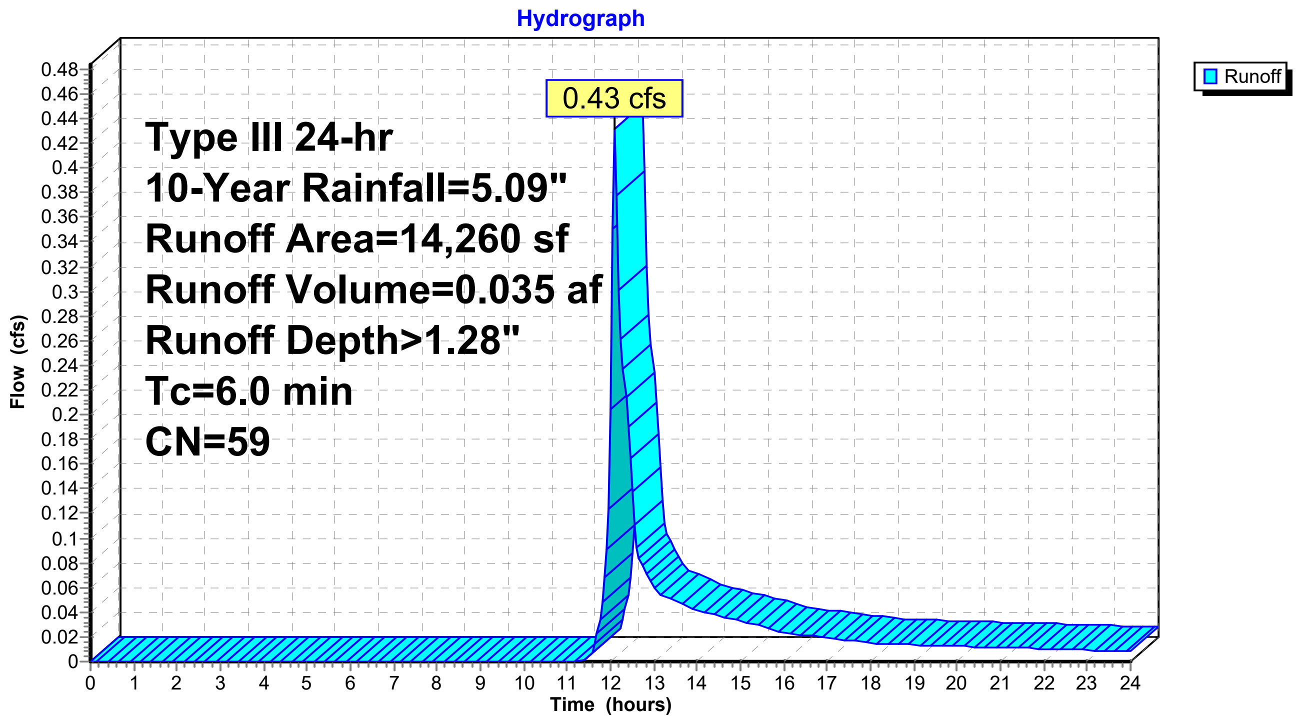
Runoff = 0.43 cfs @ 12.10 hrs, Volume= 0.035 af, Depth> 1.28"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
4,918	98	Unconnected pavement, HSG A
9,342	39	>75% Grass cover, Good, HSG A
14,260	59	Weighted Average
9,342		65.51% Pervious Area
4,918		34.49% Impervious Area
4,918		100.00% Unconnected

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

Subcatchment P-8: Courtyard A



Summary for Subcatchment P-9: Front Landscape

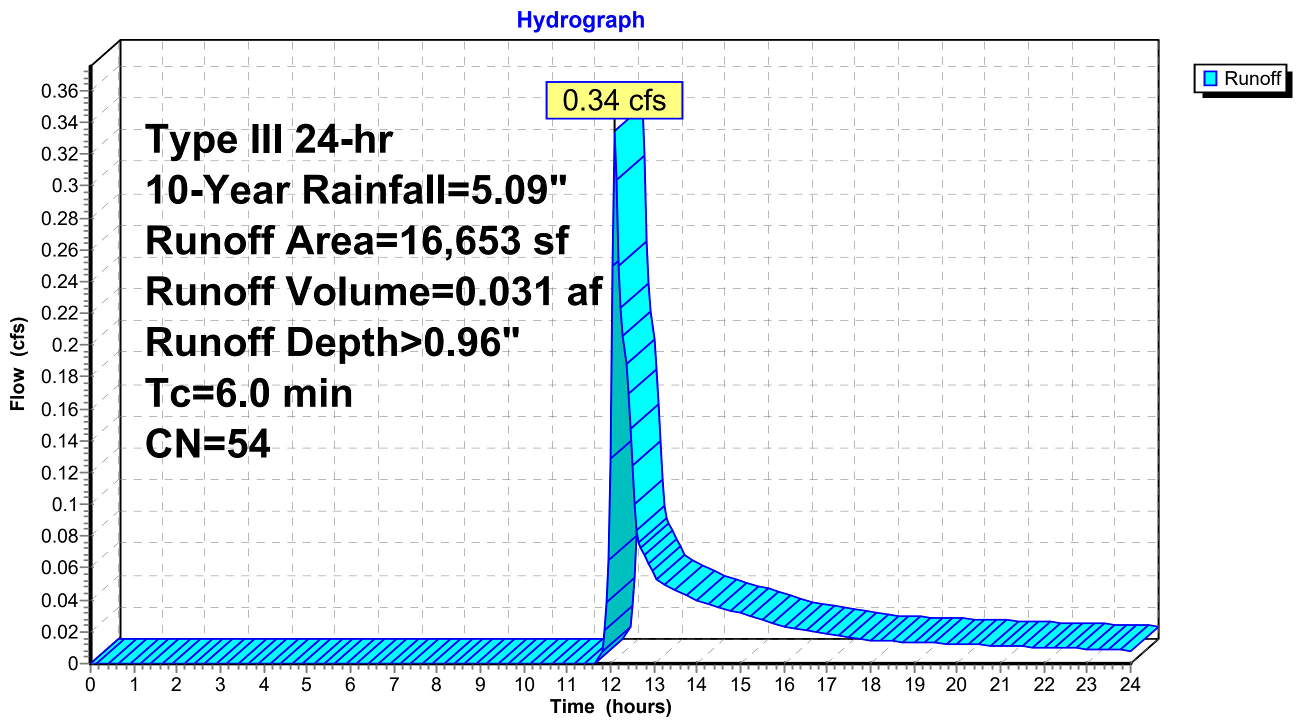
Runoff = 0.34 cfs @ 12.11 hrs, Volume= 0.031 af, Depth> 0.96"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.09"

Area (sf)	CN	Description
12,340	39	>75% Grass cover, Good, HSG A
4,313	98	Paved parking, HSG A
16,653	54	Weighted Average
12,340		74.10% Pervious Area
4,313		25.90% Impervious Area

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

Subcatchment P-9: Front Landscape



Summary for Pond 1P: SubSurface Sys 1

Inflow Area = 0.152 ac, 86.17% Impervious, Inflow Depth > 3.96" for 10-Year event
Inflow = 0.66 cfs @ 12.09 hrs, Volume= 0.050 af
Outflow = 0.02 cfs @ 15.89 hrs, Volume= 0.020 af, Atten= 97%, Lag= 227.8 min
Discarded = 0.00 cfs @ 7.75 hrs, Volume= 0.007 af
Primary = 0.02 cfs @ 15.89 hrs, Volume= 0.013 af
Routed to Link 1L : Municipal System

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 446.94' @ 15.89 hrs Surf.Area= 0.027 ac Storage= 0.035 af

Plug-Flow detention time= 359.3 min calculated for 0.020 af (40% of inflow)
Center-of-Mass det. time= 233.9 min (1,023.5 - 789.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	445.00'	0.025 af	**15.75'W x 74.82'L x 3.50'H Field A** 0.095 af Overall - 0.032 af Embedded = 0.063 af x 40.0% Voids
#2A	445.50'	0.032 af	**ADS_StormTech SC-740 +Cap** x 30 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 30 Chambers in 3 Rows
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	445.00'	**0.170 in/hr Exfiltration over Surface area**
#2	Primary	445.00'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 445.00' / 444.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	446.50'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	447.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	447.75'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.00 cfs @ 7.75 hrs HW=445.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.02 cfs @ 15.89 hrs HW=446.94' (Free Discharge)
└─**2=Culvert** (Passes 0.02 cfs of 4.49 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.02 cfs @ 3.03 fps)
  ├─**4=Orifice/Grate** (Controls 0.00 cfs)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: SubSurface Sys 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

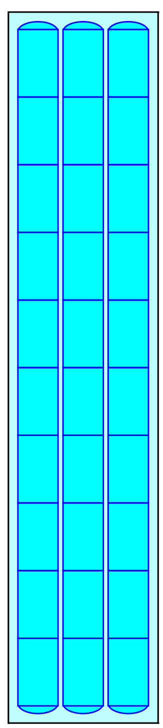
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
3 Rows x 51.0" Wide + 6.0" Spacing x 2 + 12.0" Side Stone x 2 = 15.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

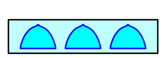
30 Chambers x 45.9 cf = 1,378.2 cf Chamber Storage

4,124.3 cf Field - 1,378.2 cf Chambers = 2,746.1 cf Stone x 40.0% Voids = 1,098.4 cf Stone Storage

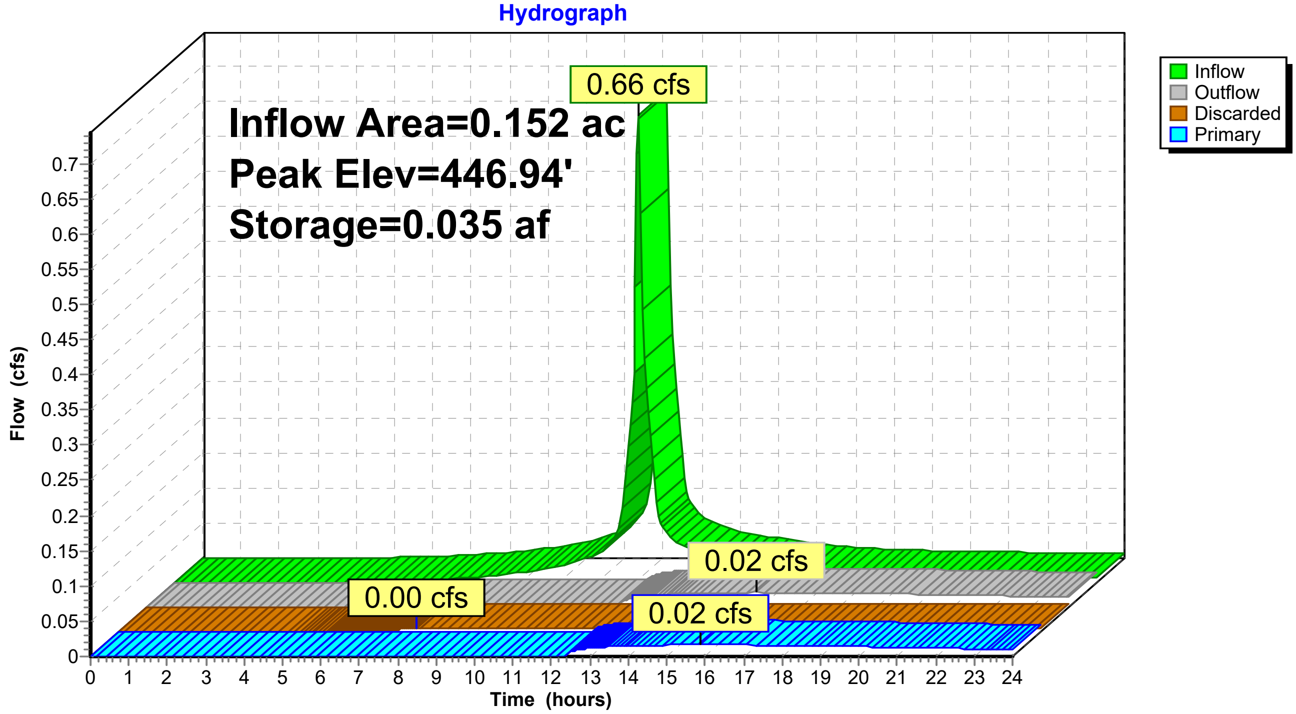
Chamber Storage + Stone Storage = 2,476.6 cf = 0.057 af
Overall Storage Efficiency = 60.1%
Overall System Size = 74.82' x 15.75' x 3.50'

30 Chambers
152.8 cy Field
101.7 cy Stone





Pond 1P: SubSurface Sys 1



Summary for Pond 2P: SubSurface Sys 2

Inflow Area = 0.648 ac, 88.75% Impervious, Inflow Depth > 4.51" for 10-Year event
Inflow = 3.07 cfs @ 12.09 hrs, Volume= 0.243 af
Outflow = 0.70 cfs @ 12.49 hrs, Volume= 0.176 af, Atten= 77%, Lag= 24.3 min
Discarded = 0.06 cfs @ 8.25 hrs, Volume= 0.094 af
Primary = 0.64 cfs @ 12.49 hrs, Volume= 0.082 af
Routed to Link 2L : Drainage Ditch

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 452.36' @ 12.49 hrs Surf.Area= 0.061 ac Storage= 0.116 af

Plug-Flow detention time= 207.8 min calculated for 0.176 af (72% of inflow)
Center-of-Mass det. time= 118.9 min (886.2 - 767.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	449.50'	0.055 af	**30.00'W x 89.06'L x 3.50'H Field A** 0.215 af Overall - 0.076 af Embedded = 0.139 af x 40.0% Voids
#2A	450.00'	0.076 af	**ADS_StormTech SC-740 +Cap** x 72 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 72 Chambers in 6 Rows
		0.131 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	449.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	449.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 449.50' / 449.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#3	Device 2	451.00'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	451.50'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	452.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 8.25 hrs HW=449.54' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.63 cfs @ 12.49 hrs HW=452.36' (Free Discharge)
└─**2=Culvert** (Passes 0.63 cfs of 8.83 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.03 cfs @ 5.52 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.20 cfs @ 4.12 fps)
  └─**5=Broad-Crested Rectangular Weir** (Weir Controls 0.40 cfs @ 0.92 fps)

Pond 2P: SubSurface Sys 2 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

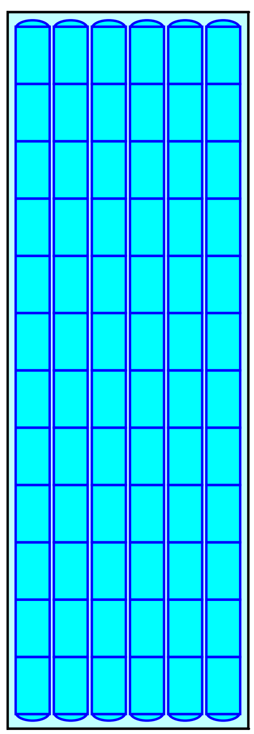
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

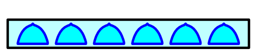
72 Chambers x 45.9 cf = 3,307.7 cf Chamber Storage

9,351.0 cf Field - 3,307.7 cf Chambers = 6,043.3 cf Stone x 40.0% Voids = 2,417.3 cf Stone Storage

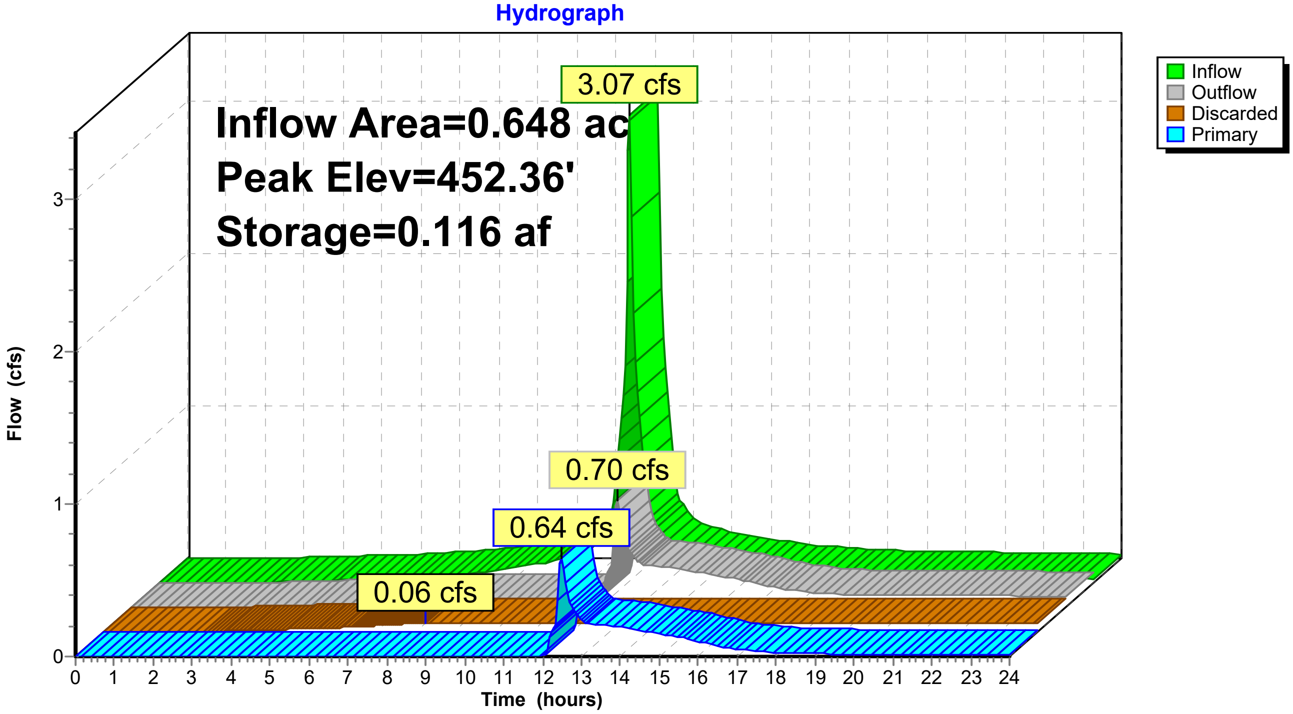
Chamber Storage + Stone Storage = 5,725.0 cf = 0.131 af
Overall Storage Efficiency = 61.2%
Overall System Size = 89.06' x 30.00' x 3.50'

72 Chambers
346.3 cy Field
223.8 cy Stone





Pond 2P: SubSurface Sys 2

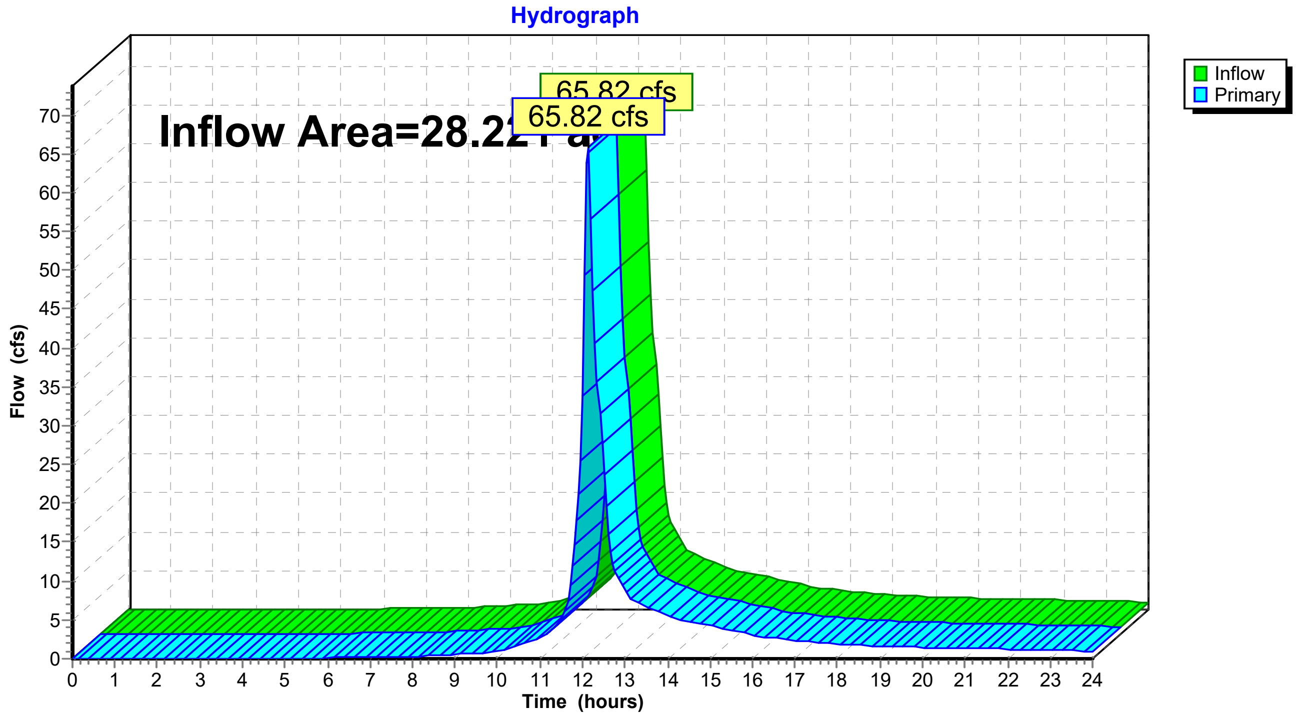


Summary for Link 1L: Municipal System

Inflow Area = 28.221 ac, 41.10% Impervious, Inflow Depth > 2.43" for 10-Year event
Inflow = 65.82 cfs @ 12.13 hrs, Volume= 5.713 af
Primary = 65.82 cfs @ 12.13 hrs, Volume= 5.713 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

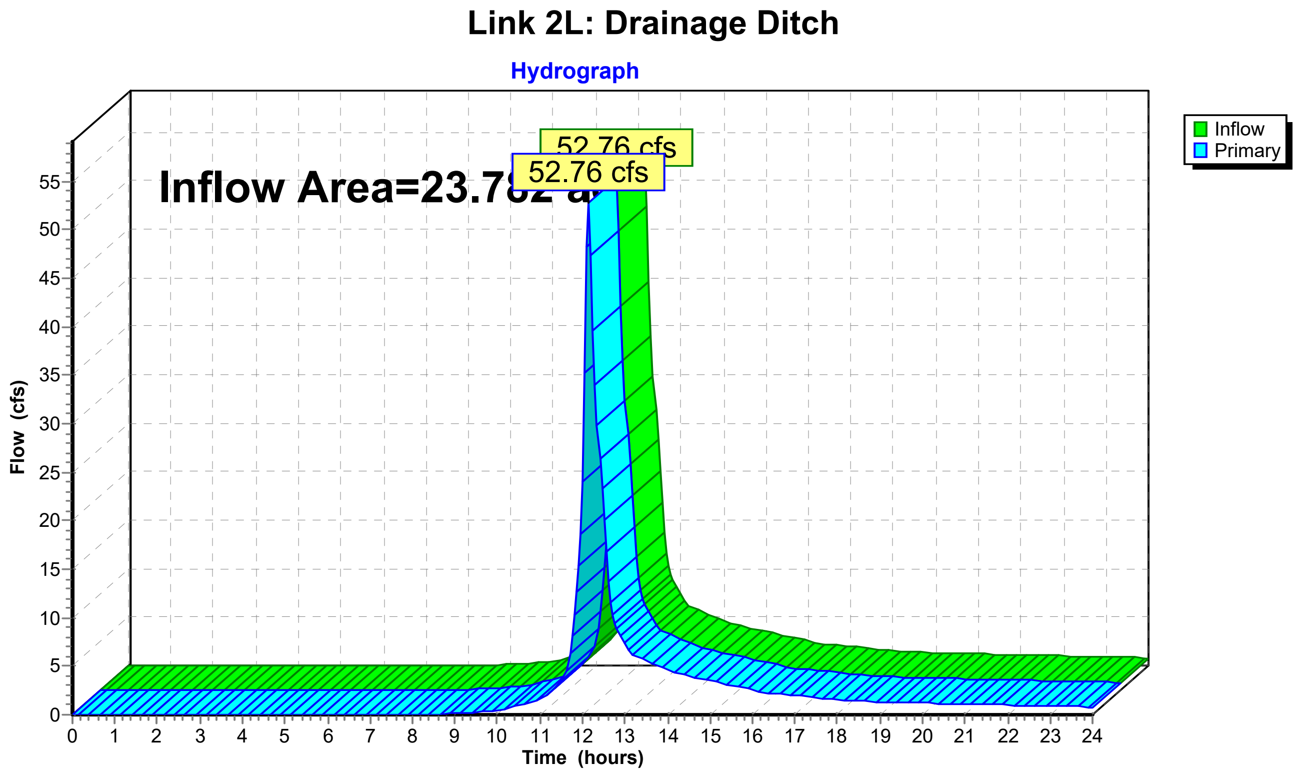
Link 1L: Municipal System



Summary for Link 2L: Drainage Ditch

Inflow Area = 23.782 ac, 37.70% Impervious, Inflow Depth > 2.25" for 10-Year event
Inflow = 52.76 cfs @ 12.15 hrs, Volume= 4.469 af
Primary = 52.76 cfs @ 12.15 hrs, Volume= 4.469 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>2.96"
Tc=10.0 min CN=70 Runoff=48.28 cfs 3.985 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 88.75% Impervious Runoff Depth>5.61"
Tc=6.0 min CN=95 Runoff=3.78 cfs 0.303 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>3.85"
Tc=10.0 min CN=79 Runoff=23.78 cfs 1.960 af

Subcatchment P-1: Nly Area Runoff Area=37,808 sf 8.29% Impervious Runoff Depth>2.05"
Flow Length=130' Tc=7.7 min CN=60 Runoff=1.85 cfs 0.148 af

Subcatchment P-2: Ely Area to Trail Runoff Area=6,239 sf 3.38% Impervious Runoff Depth>3.35"
Tc=6.0 min UI Adjusted CN=74 Runoff=0.55 cfs 0.040 af

Subcatchment P-3: Access Rd Runoff Area=31,850 sf 55.85% Impervious Runoff Depth>4.17"
Tc=6.0 min CN=82 Runoff=3.46 cfs 0.254 af

Subcatchment P-4: Garage Runoff Area=34,671 sf 100.00% Impervious Runoff Depth>5.96"
Tc=6.0 min CN=98 Runoff=4.72 cfs 0.395 af

Subcatchment P-5: W'ly Parking Lot Runoff Area=6,610 sf 86.17% Impervious Runoff Depth>5.04"
Tc=6.0 min CN=90 Runoff=0.83 cfs 0.064 af

Subcatchment P-6: Res Building Runoff Area=74,887 sf 60.00% Impervious Runoff Depth>5.38"
Tc=6.0 min CN=93 Runoff=9.82 cfs 0.770 af

Subcatchment P-7: Courtyard B Runoff Area=8,175 sf 26.90% Impervious Runoff Depth>1.02"
Tc=6.0 min UI Adjusted CN=47 Runoff=0.16 cfs 0.016 af

Subcatchment P-8: Courtyard A Runoff Area=14,260 sf 34.49% Impervious Runoff Depth>1.97"
Tc=6.0 min CN=59 Runoff=0.70 cfs 0.054 af

Subcatchment P-9: Front Landscape Runoff Area=16,653 sf 25.90% Impervious Runoff Depth>1.55"
Tc=6.0 min CN=54 Runoff=0.61 cfs 0.049 af

Pond 1P: SubSurface Sys 1 Peak Elev=447.15' Storage=0.039 af Inflow=0.83 cfs 0.064 af
Discarded=0.00 cfs 0.007 af Primary=0.06 cfs 0.025 af Outflow=0.07 cfs 0.032 af

Pond 2P: SubSurface Sys 2 Peak Elev=452.56' Storage=0.121 af Inflow=3.78 cfs 0.303 af
Discarded=0.06 cfs 0.099 af Primary=2.18 cfs 0.132 af Outflow=2.24 cfs 0.231 af

Link 1L: Municipal System Inflow=90.94 cfs 7.829 af
Primary=90.94 cfs 7.829 af

Link 2L: Drainage Ditch Inflow=74.31 cfs 6.226 af
Primary=74.31 cfs 6.226 af

Total Runoff Area = 28.221 ac Runoff Volume = 8.039 af Average Runoff Depth = 3.42"
58.90% Pervious = 16.621 ac 41.10% Impervious = 11.600 ac

Summary for Subcatchment E-4: Off-site W'ly

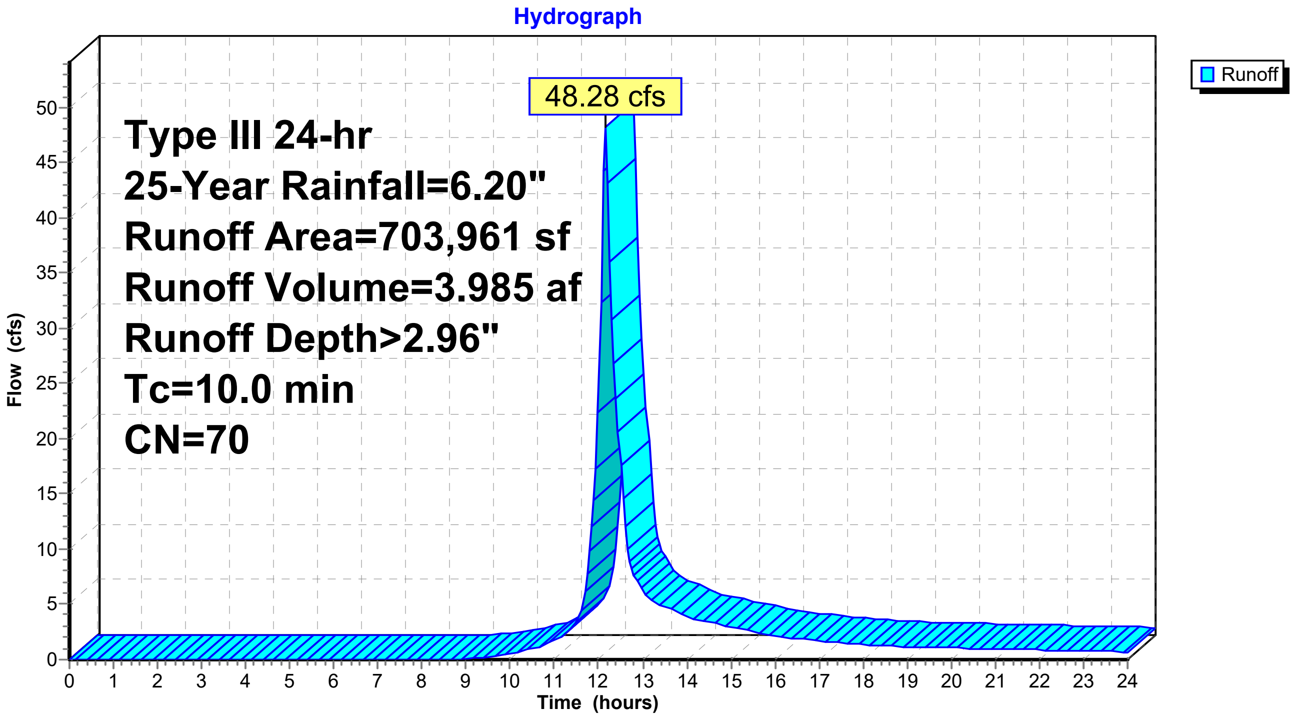
Runoff = 48.28 cfs @ 12.15 hrs, Volume= 3.985 af, Depth> 2.96"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

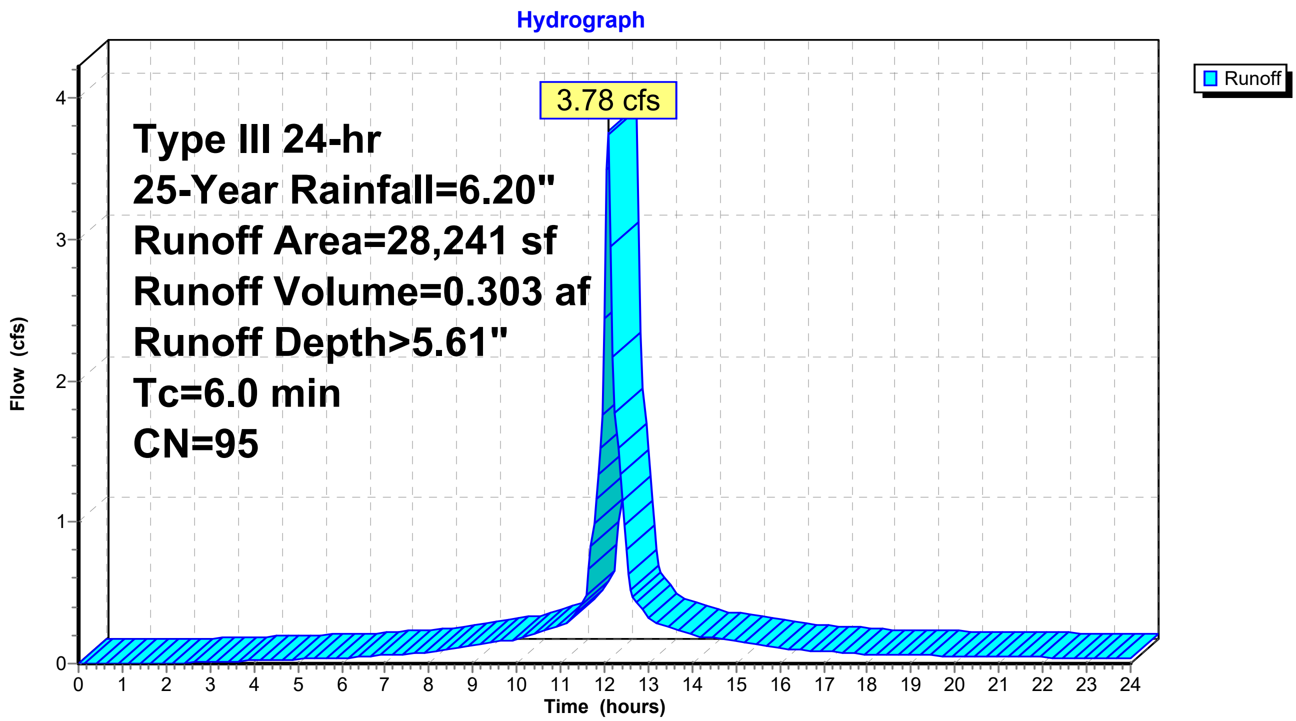
Runoff = 3.78 cfs @ 12.09 hrs, Volume= 0.303 af, Depth> 5.61"
Routed to Pond 2P : SubSurface Sys 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
25,063	98	Paved parking, HSG C
3,178	74	>75% Grass cover, Good, HSG C
28,241	95	Weighted Average
3,178		11.25% Pervious Area
25,063		88.75% Impervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

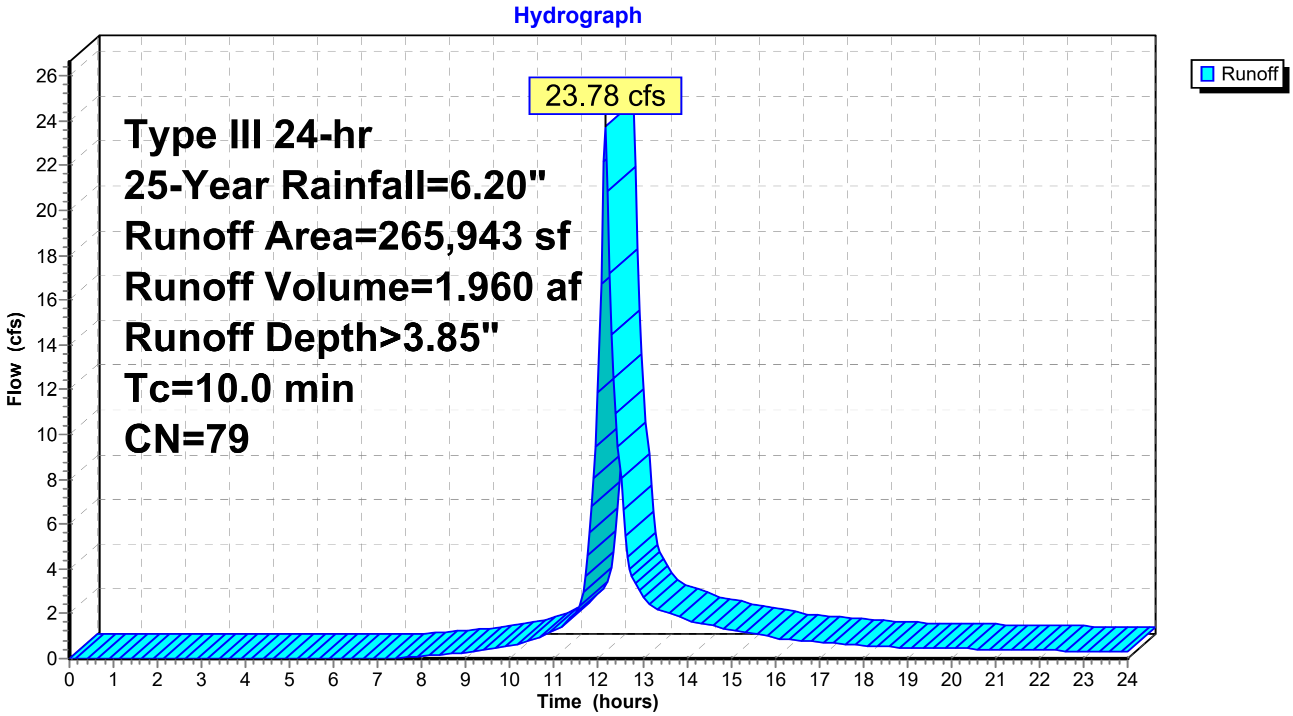
Runoff = 23.78 cfs @ 12.14 hrs, Volume= 1.960 af, Depth> 3.85"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly



Summary for Subcatchment P-1: Nly Area

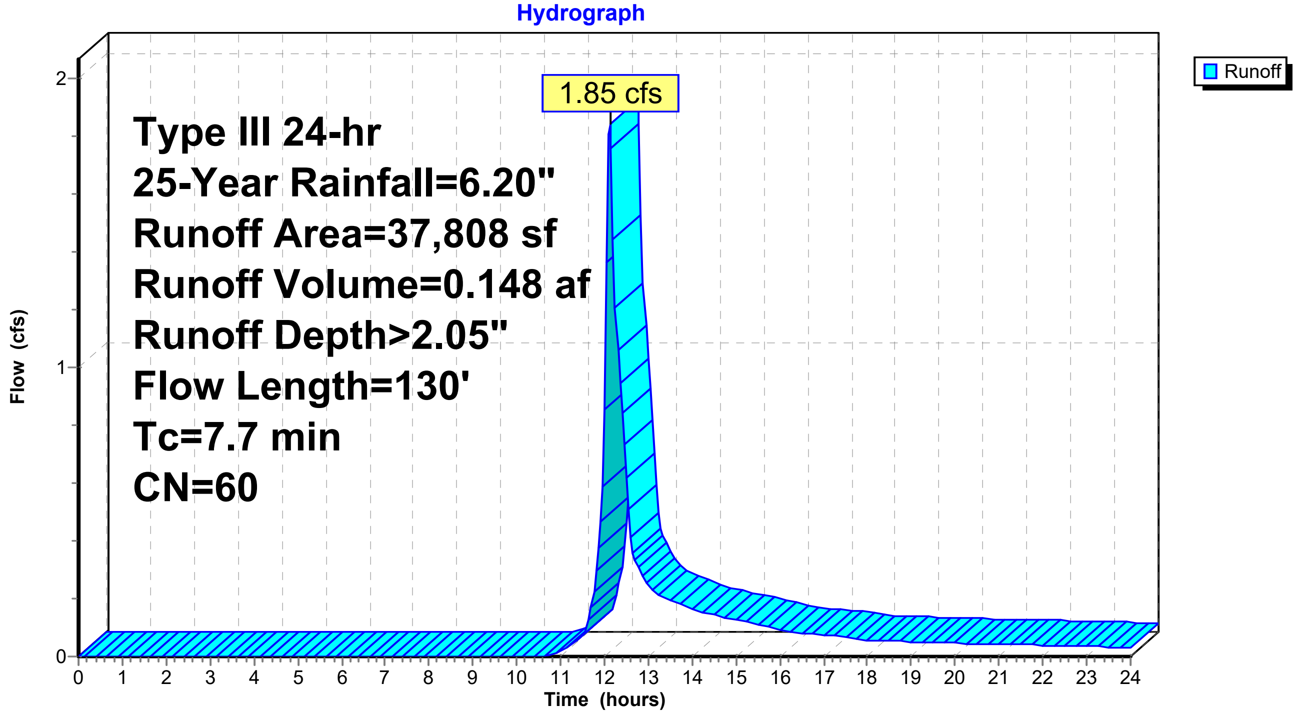
Runoff = 1.85 cfs @ 12.12 hrs, Volume= 0.148 af, Depth> 2.05"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
18,483	39	>75% Grass cover, Good, HSG A
4,093	74	>75% Grass cover, Good, HSG C
1,011	98	Paved parking, HSG A
2,124	98	Paved parking, HSG C
8,477	70	Woods, Good, HSG C
2,192	98	Water Surface, 0% imp, HSG A
1,428	98	Water Surface, 0% imp, HSG C
37,808	60	Weighted Average
34,673		91.71% Pervious Area
3,135		8.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.30"
1.5	80	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.7	130	Total			

Subcatchment P-1: Nly Area



Summary for Subcatchment P-2: Ely Area to Trail

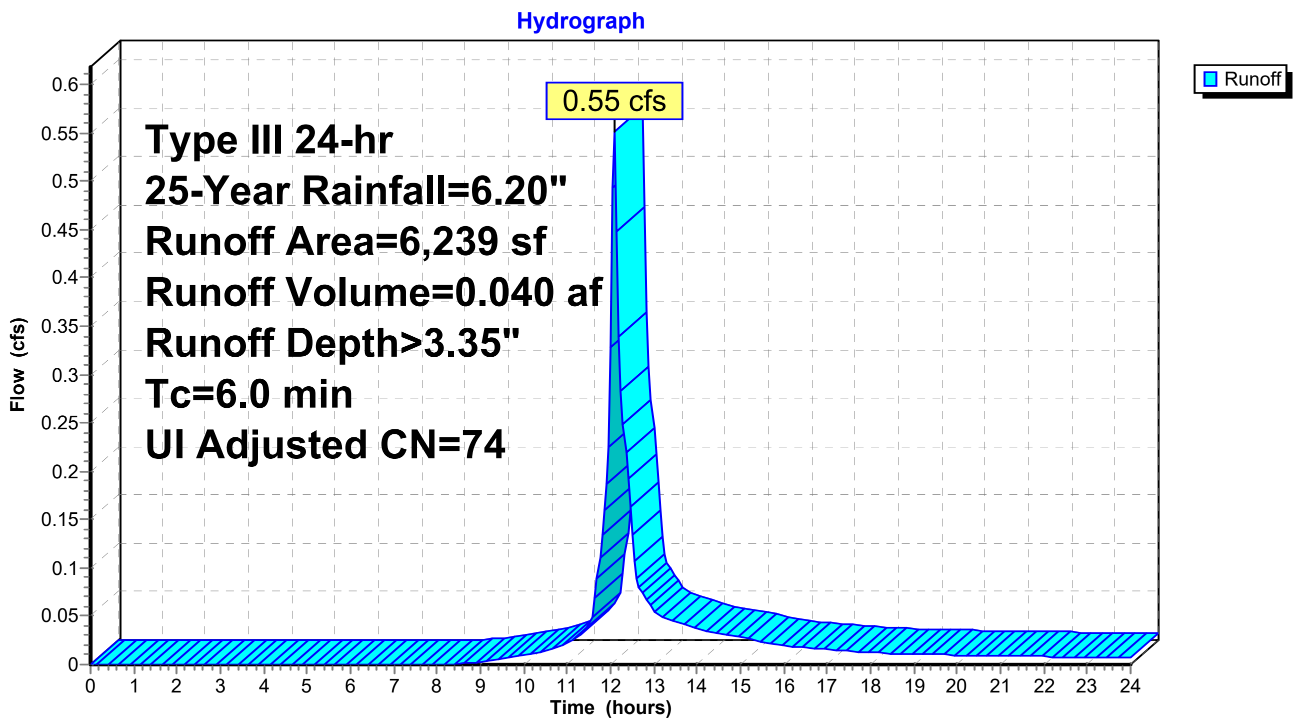
Runoff = 0.55 cfs @ 12.09 hrs, Volume= 0.040 af, Depth> 3.35"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Adj	Description
6,028	74		>75% Grass cover, Good, HSG C
14	98		Paved parking, HSG C
197	98		Unconnected roofs, HSG C
6,239	75	74	Weighted Average, UI Adjusted
6,028			96.62% Pervious Area
211			3.38% Impervious Area
197			93.36% Unconnected

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

Subcatchment P-2: Ely Area to Trail



Summary for Subcatchment P-3: Access Rd

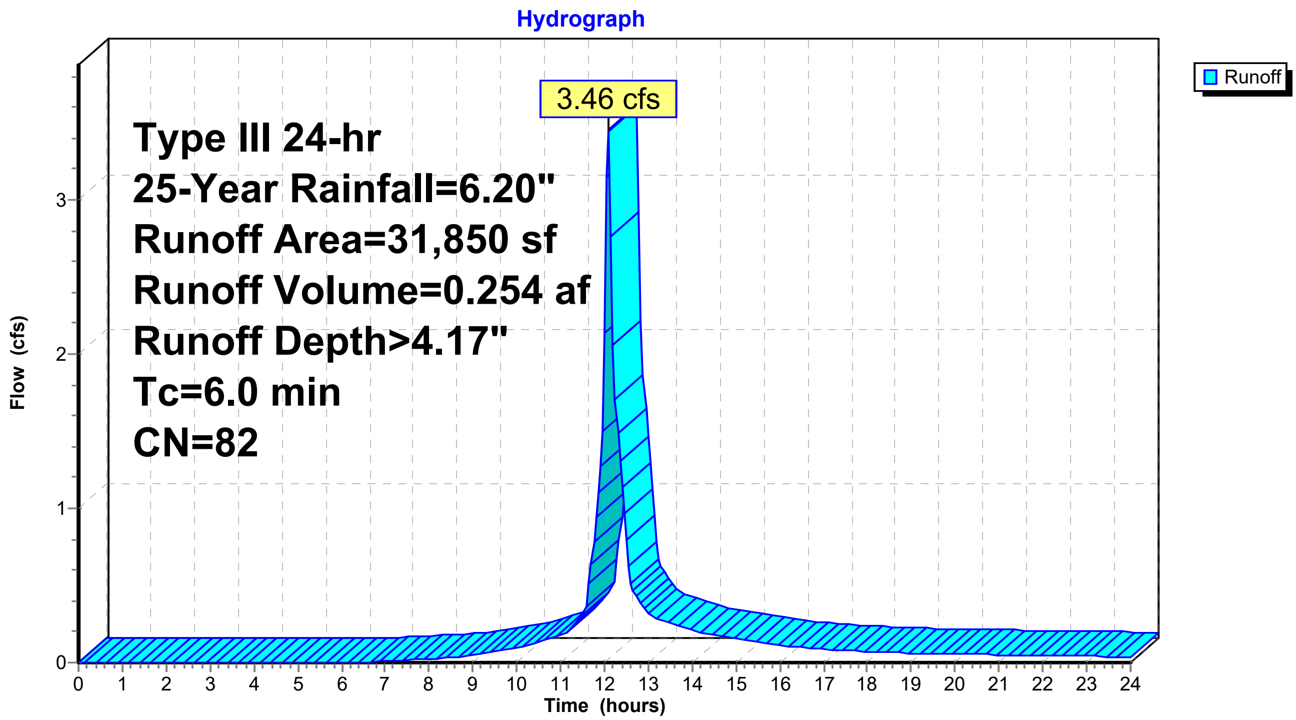
Runoff = 3.46 cfs @ 12.09 hrs, Volume= 0.254 af, Depth> 4.17"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
4,580	39	>75% Grass cover, Good, HSG A
9,481	74	>75% Grass cover, Good, HSG C
197	98	Roofs, HSG C
5,663	98	Paved parking, HSG A
11,929	98	Paved parking, HSG C
31,850	82	Weighted Average
14,061		44.15% Pervious Area
17,789		55.85% Impervious Area

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

Subcatchment P-3: Access Rd



Summary for Subcatchment P-4: Garage

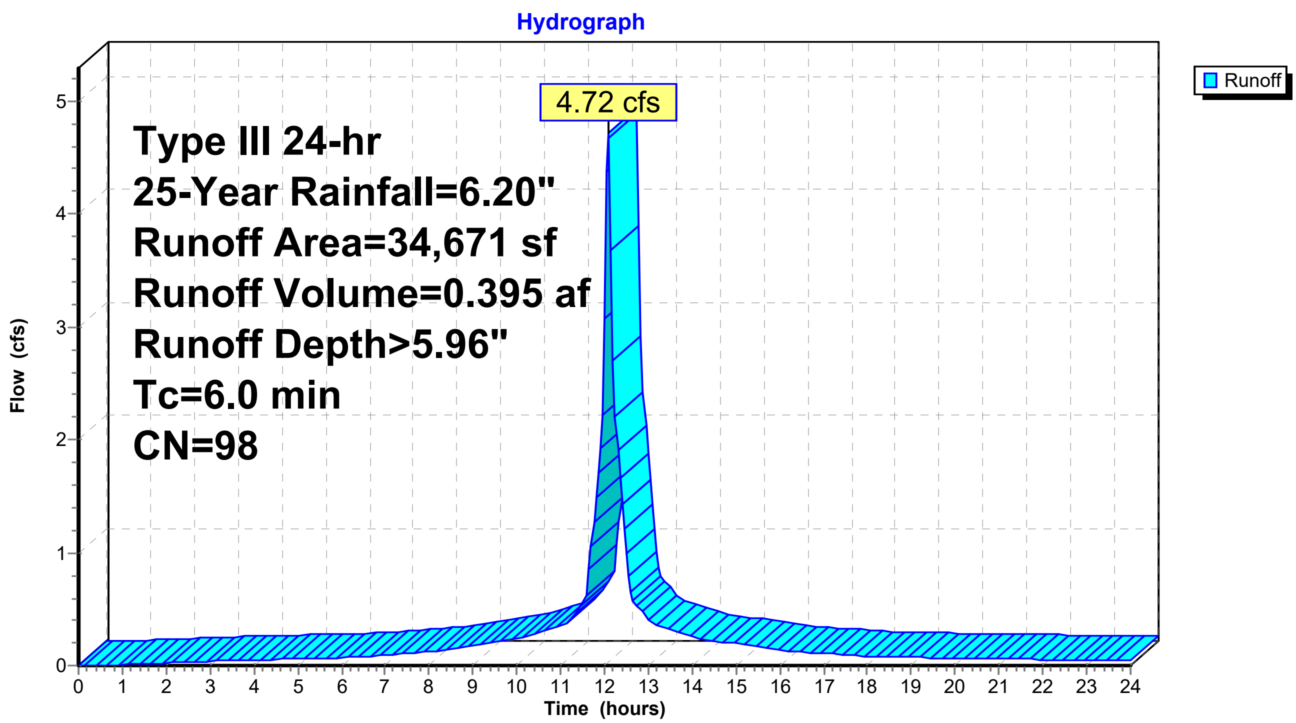
Runoff = 4.72 cfs @ 12.09 hrs, Volume= 0.395 af, Depth> 5.96"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
32,961	98	Roofs, HSG A
1,710	98	Roofs, HSG C
34,671	98	Weighted Average
34,671		100.00% Impervious Area

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

Subcatchment P-4: Garage



Summary for Subcatchment P-5: W'ly Parking Lot

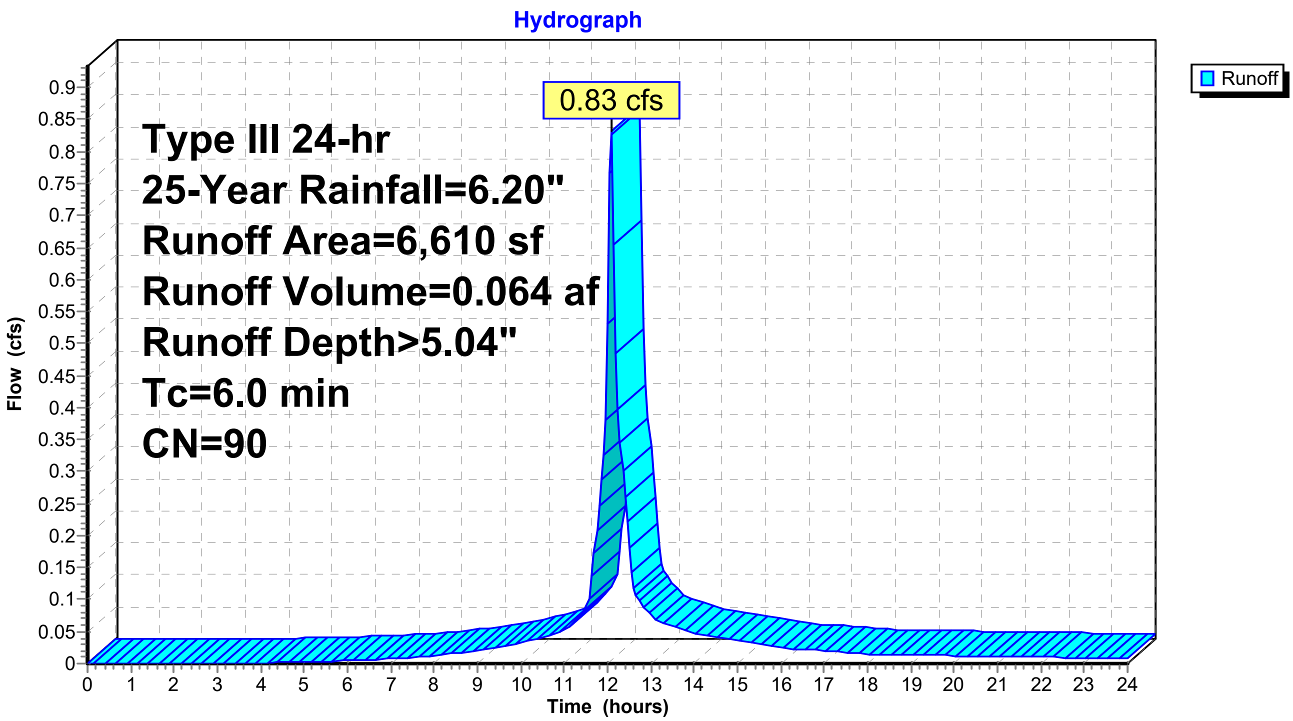
Runoff = 0.83 cfs @ 12.09 hrs, Volume= 0.064 af, Depth> 5.04"
Routed to Pond 1P : SubSurface Sys 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
914	39	>75% Grass cover, Good, HSG A
5,696	98	Paved parking, HSG A
6,610	90	Weighted Average
914		13.83% Pervious Area
5,696		86.17% Impervious Area

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

Subcatchment P-5: W'ly Parking Lot



Summary for Subcatchment P-6: Res Building

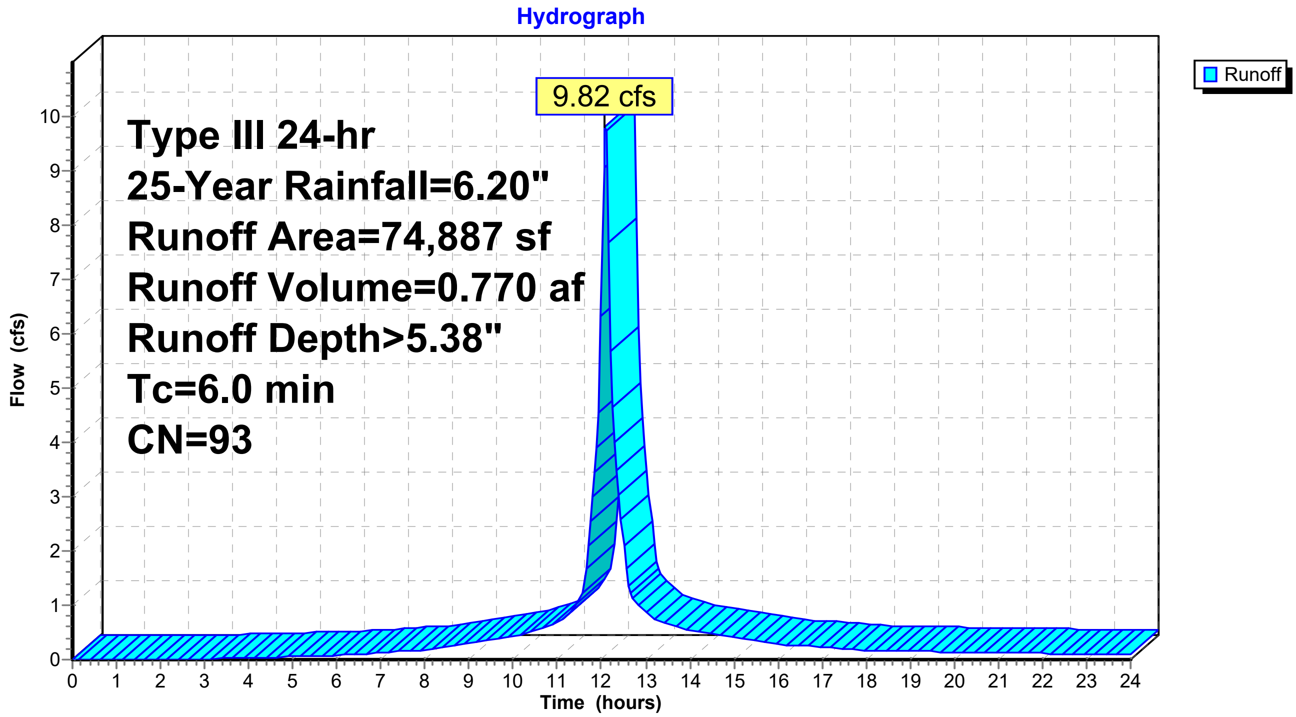
Runoff = 9.82 cfs @ 12.09 hrs, Volume= 0.770 af, Depth> 5.38"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

	Area (sf)	CN	Description
	40,967	98	Roofs, HSG A
	3,965	98	Roofs, HSG C
*	27,312	86	GreenRoof, HSG A (40% Roof Area)
*	2,643	86	GreenRoof, HSG C (40% Roof Area)
	74,887	93	Weighted Average
	29,955		40.00% Pervious Area
	44,932		60.00% Impervious Area

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

Subcatchment P-6: Res Building



Summary for Subcatchment P-7: Courtyard B

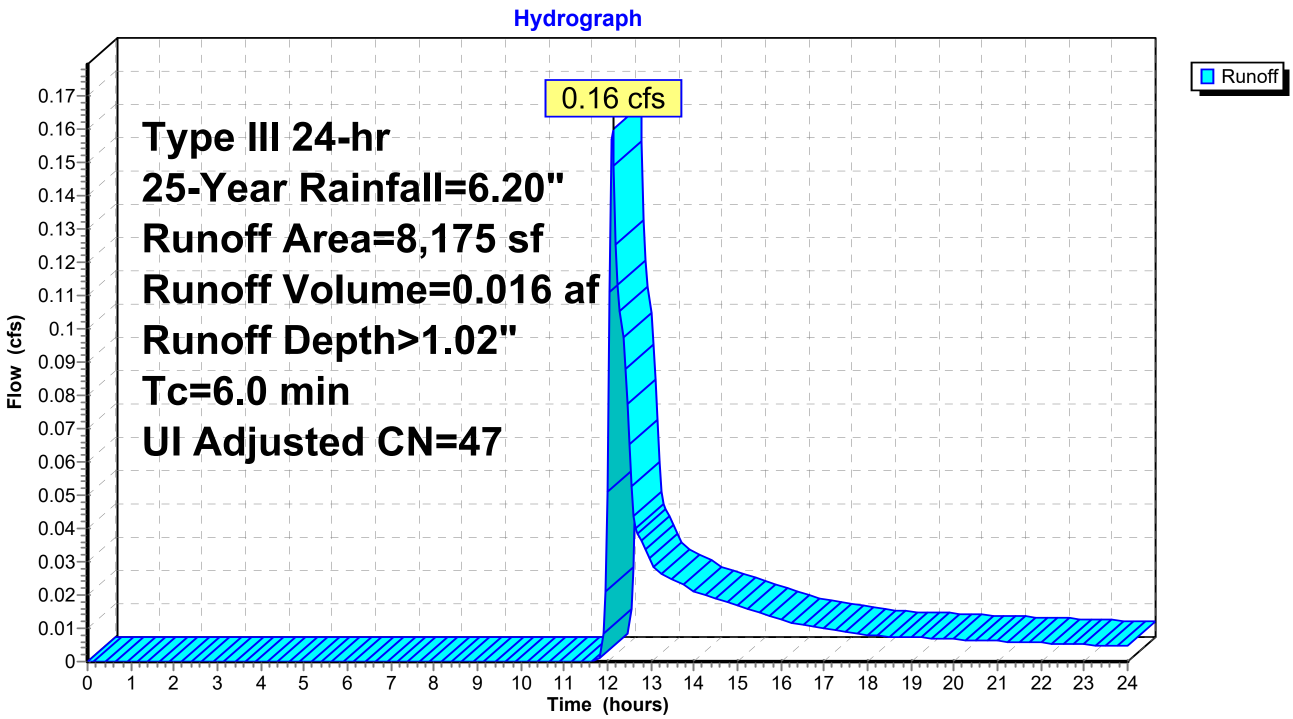
Runoff = 0.16 cfs @ 12.12 hrs, Volume= 0.016 af, Depth> 1.02"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Adj	Description
2,199	98		Unconnected pavement, HSG A
5,976	39		>75% Grass cover, Good, HSG A
8,175	55	47	Weighted Average, UI Adjusted
5,976			73.10% Pervious Area
2,199			26.90% Impervious Area
2,199			100.00% Unconnected

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

Subcatchment P-7: Courtyard B



Summary for Subcatchment P-8: Courtyard A

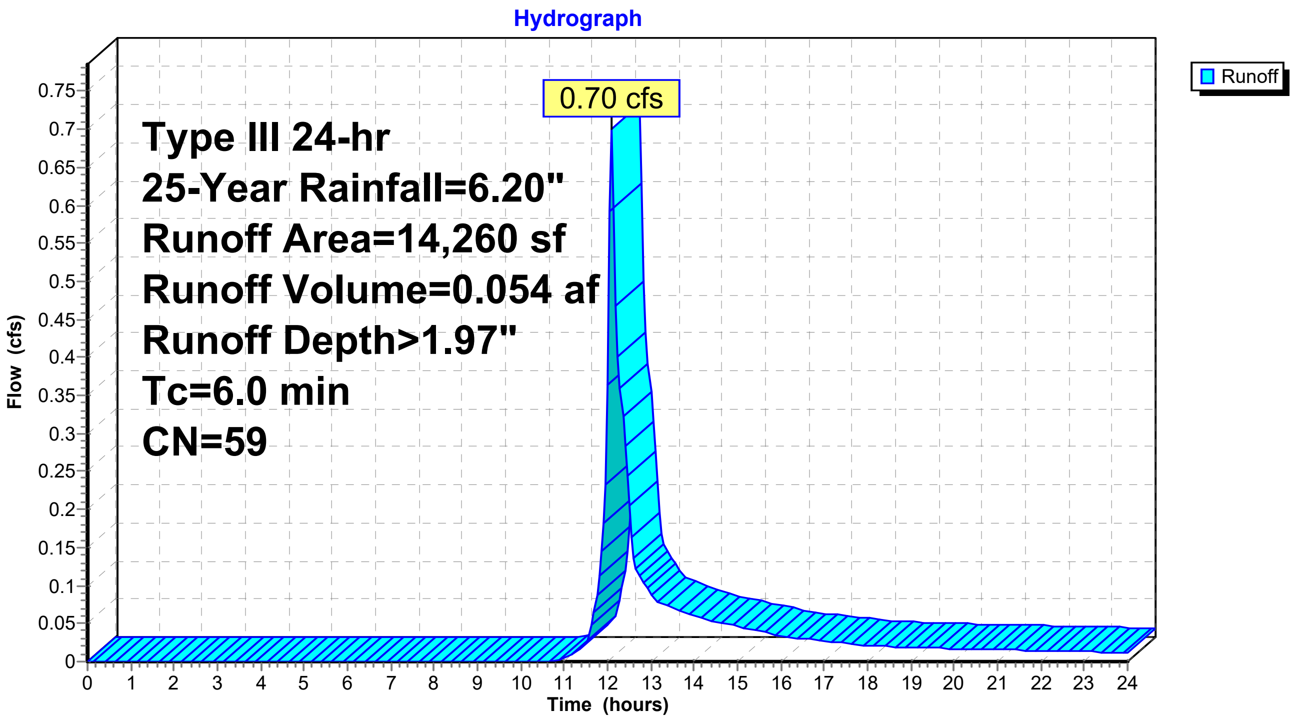
Runoff = 0.70 cfs @ 12.10 hrs, Volume= 0.054 af, Depth> 1.97"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
4,918	98	Unconnected pavement, HSG A
9,342	39	>75% Grass cover, Good, HSG A
14,260	59	Weighted Average
9,342		65.51% Pervious Area
4,918		34.49% Impervious Area
4,918		100.00% Unconnected

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

Subcatchment P-8: Courtyard A



Summary for Subcatchment P-9: Front Landscape

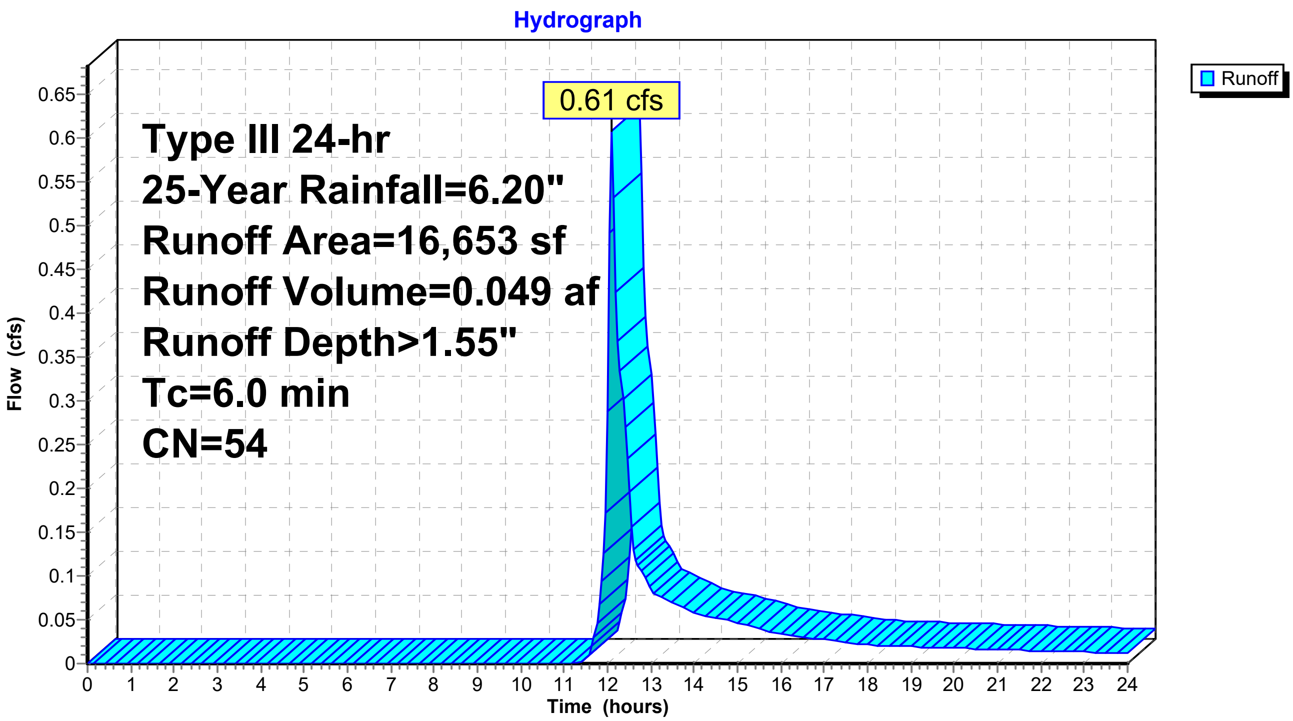
Runoff = 0.61 cfs @ 12.11 hrs, Volume= 0.049 af, Depth> 1.55"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.20"

Area (sf)	CN	Description
12,340	39	>75% Grass cover, Good, HSG A
4,313	98	Paved parking, HSG A
16,653	54	Weighted Average
12,340		74.10% Pervious Area
4,313		25.90% Impervious Area

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

Subcatchment P-9: Front Landscape



Summary for Pond 1P: SubSurface Sys 1

Inflow Area = 0.152 ac, 86.17% Impervious, Inflow Depth > 5.04" for 25-Year event
Inflow = 0.83 cfs @ 12.09 hrs, Volume= 0.064 af
Outflow = 0.07 cfs @ 13.09 hrs, Volume= 0.032 af, Atten= 92%, Lag= 60.3 min
Discarded = 0.00 cfs @ 6.90 hrs, Volume= 0.007 af
Primary = 0.06 cfs @ 13.09 hrs, Volume= 0.025 af
Routed to Link 1L : Municipal System

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 447.15' @ 13.09 hrs Surf.Area= 0.027 ac Storage= 0.039 af

Plug-Flow detention time= 299.8 min calculated for 0.032 af (50% of inflow)
Center-of-Mass det. time= 186.3 min (969.5 - 783.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	445.00'	0.025 af	**15.75'W x 74.82'L x 3.50'H Field A** 0.095 af Overall - 0.032 af Embedded = 0.063 af x 40.0% Voids
#2A	445.50'	0.032 af	**ADS_StormTech SC-740 +Cap** x 30 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 30 Chambers in 3 Rows
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	445.00'	**0.170 in/hr Exfiltration over Surface area**
#2	Primary	445.00'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 445.00' / 444.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	446.50'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	447.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	447.75'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.00 cfs @ 6.90 hrs HW=445.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.06 cfs @ 13.09 hrs HW=447.15' (Free Discharge)
└─**2=Culvert** (Passes 0.06 cfs of 4.81 cfs potential flow)
 ├─**3=Orifice/Grate** (Orifice Controls 0.02 cfs @ 3.77 fps)
 ├─**4=Orifice/Grate** (Orifice Controls 0.04 cfs @ 1.34 fps)
 └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: SubSurface Sys 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

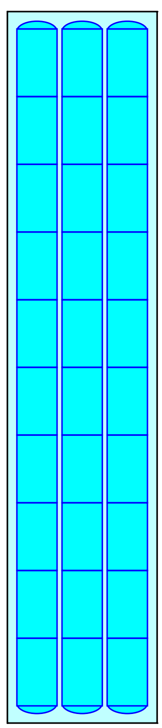
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
3 Rows x 51.0" Wide + 6.0" Spacing x 2 + 12.0" Side Stone x 2 = 15.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

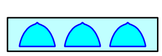
30 Chambers x 45.9 cf = 1,378.2 cf Chamber Storage

4,124.3 cf Field - 1,378.2 cf Chambers = 2,746.1 cf Stone x 40.0% Voids = 1,098.4 cf Stone Storage

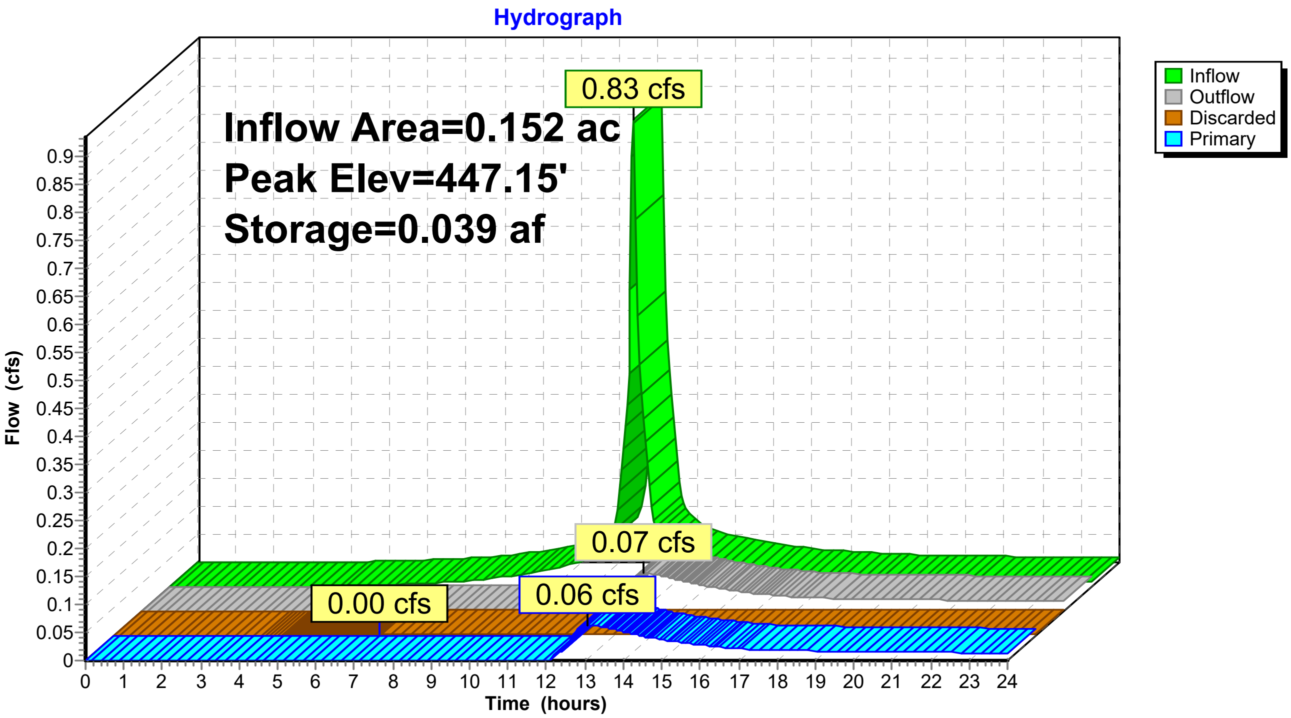
Chamber Storage + Stone Storage = 2,476.6 cf = 0.057 af
Overall Storage Efficiency = 60.1%
Overall System Size = 74.82' x 15.75' x 3.50'

30 Chambers
152.8 cy Field
101.7 cy Stone





Pond 1P: SubSurface Sys 1



Summary for Pond 2P: SubSurface Sys 2

Inflow Area = 0.648 ac, 88.75% Impervious, Inflow Depth > 5.61" for 25-Year event
Inflow = 3.78 cfs @ 12.09 hrs, Volume= 0.303 af
Outflow = 2.24 cfs @ 12.22 hrs, Volume= 0.231 af, Atten= 41%, Lag= 8.1 min
Discarded = 0.06 cfs @ 7.40 hrs, Volume= 0.099 af
Primary = 2.18 cfs @ 12.22 hrs, Volume= 0.132 af
Routed to Link 2L : Drainage Ditch

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 452.56' @ 12.22 hrs Surf.Area= 0.061 ac Storage= 0.121 af

Plug-Flow detention time= 175.0 min calculated for 0.230 af (76% of inflow)
Center-of-Mass det. time= 93.0 min (855.4 - 762.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	449.50'	0.055 af	**30.00'W x 89.06'L x 3.50'H Field A** 0.215 af Overall - 0.076 af Embedded = 0.139 af x 40.0% Voids
#2A	450.00'	0.076 af	**ADS_StormTech SC-740 +Cap** x 72 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 72 Chambers in 6 Rows
		0.131 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	449.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	449.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 449.50' / 449.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#3	Device 2	451.00'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	451.50'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	452.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 7.40 hrs HW=449.54' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=1.98 cfs @ 12.22 hrs HW=452.53' (Free Discharge)
└─**2=Culvert** (Passes 1.98 cfs of 9.17 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.03 cfs @ 5.88 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.23 cfs @ 4.59 fps)
  └─**5=Broad-Crested Rectangular Weir** (Weir Controls 1.72 cfs @ 1.52 fps)

Pond 2P: SubSurface Sys 2 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

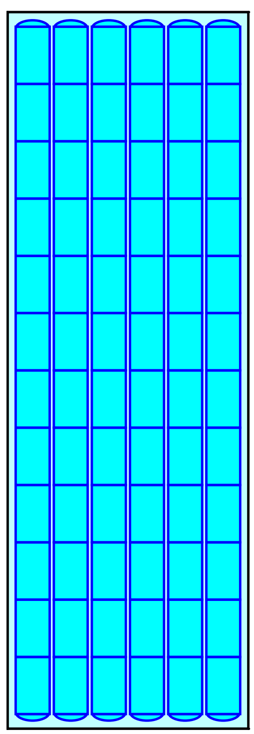
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

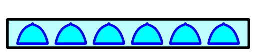
72 Chambers x 45.9 cf = 3,307.7 cf Chamber Storage

9,351.0 cf Field - 3,307.7 cf Chambers = 6,043.3 cf Stone x 40.0% Voids = 2,417.3 cf Stone Storage

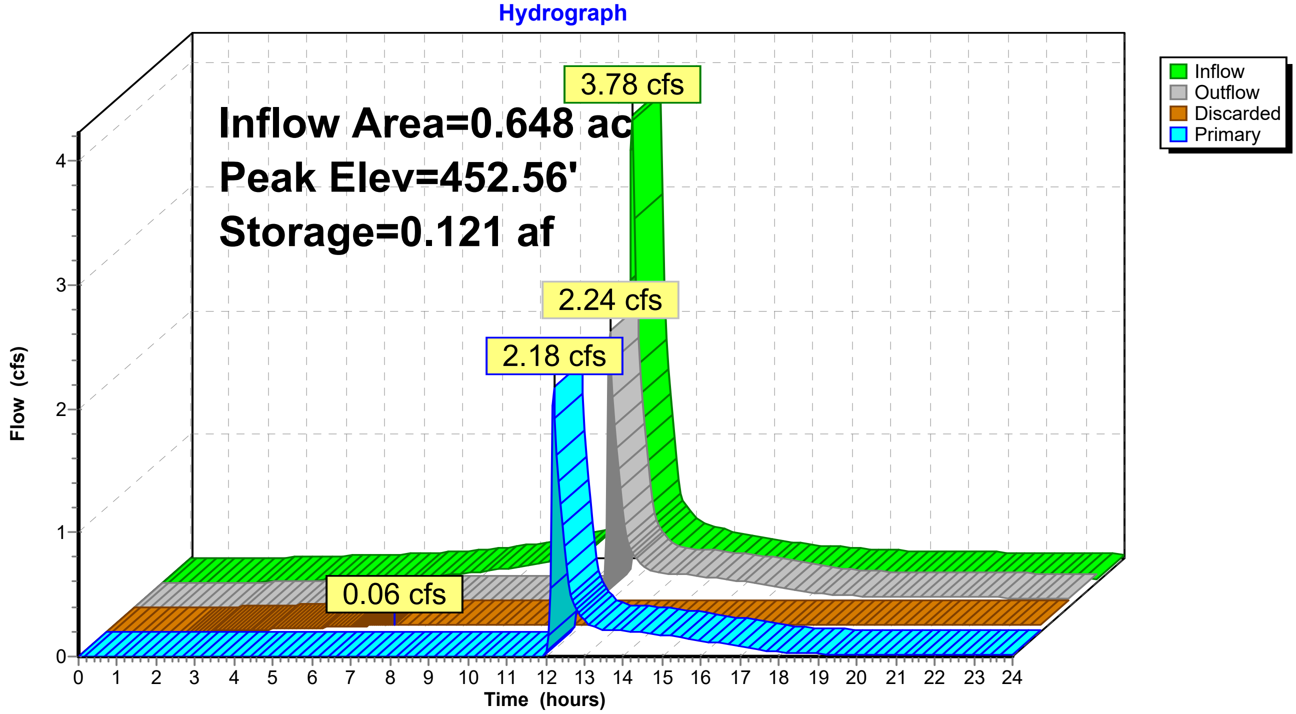
Chamber Storage + Stone Storage = 5,725.0 cf = 0.131 af
Overall Storage Efficiency = 61.2%
Overall System Size = 89.06' x 30.00' x 3.50'

72 Chambers
346.3 cy Field
223.8 cy Stone





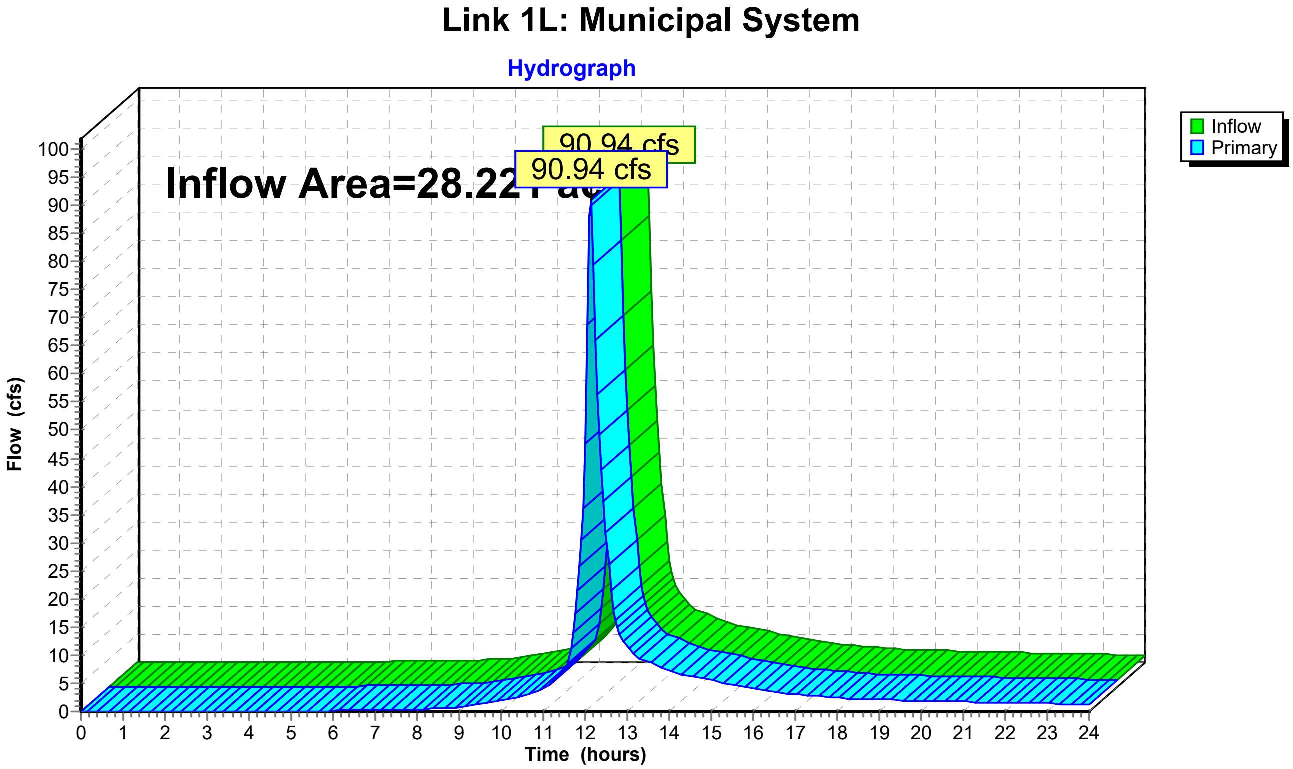
Pond 2P: SubSurface Sys 2



Summary for Link 1L: Municipal System

Inflow Area = 28.221 ac, 41.10% Impervious, Inflow Depth > 3.33" for 25-Year event
Inflow = 90.94 cfs @ 12.13 hrs, Volume= 7.829 af
Primary = 90.94 cfs @ 12.13 hrs, Volume= 7.829 af, Atten= 0%, Lag= 0.0 min

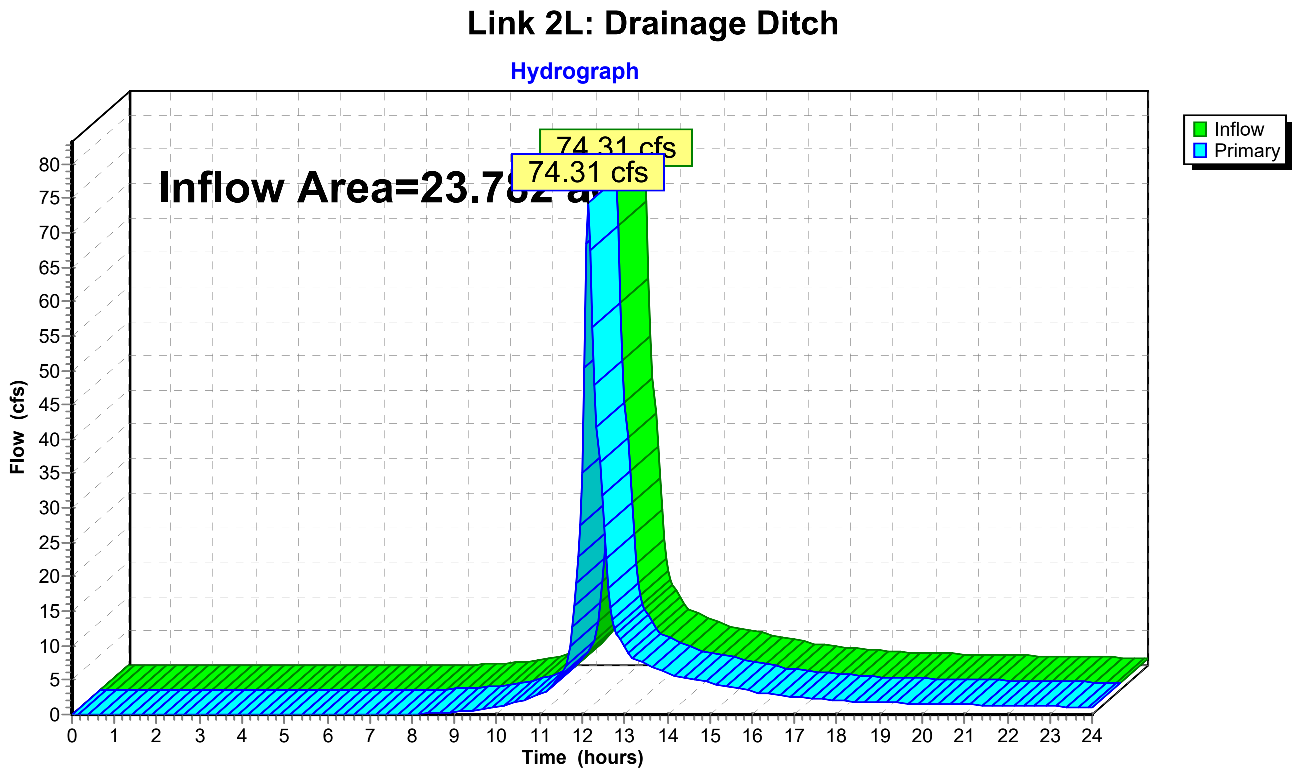
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Link 2L: Drainage Ditch

Inflow Area = 23.782 ac, 37.70% Impervious, Inflow Depth > 3.14" for 25-Year event
Inflow = 74.31 cfs @ 12.15 hrs, Volume= 6.226 af
Primary = 74.31 cfs @ 12.15 hrs, Volume= 6.226 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment E-4: Off-site W'ly Runoff Area=703,961 sf 43.81% Impervious Runoff Depth>4.39"
Tc=10.0 min CN=70 Runoff=71.92 cfs 5.910 af

Subcatchment E-5: Jefferson Parking Lot Runoff Area=28,241 sf 88.75% Impervious Runoff Depth>7.32"
Tc=6.0 min CN=95 Runoff=4.86 cfs 0.395 af

Subcatchment E-6: Off-site E'ly Runoff Area=265,943 sf 20.28% Impervious Runoff Depth>5.43"
Tc=10.0 min CN=79 Runoff=33.18 cfs 2.760 af

Subcatchment P-1: Nly Area Runoff Area=37,808 sf 8.29% Impervious Runoff Depth>3.27"
Flow Length=130' Tc=7.7 min CN=60 Runoff=3.05 cfs 0.236 af

Subcatchment P-2: Ely Area to Trail Runoff Area=6,239 sf 3.38% Impervious Runoff Depth>4.85"
Tc=6.0 min UI Adjusted CN=74 Runoff=0.80 cfs 0.058 af

Subcatchment P-3: Access Rd Runoff Area=31,850 sf 55.85% Impervious Runoff Depth>5.78"
Tc=6.0 min CN=82 Runoff=4.74 cfs 0.352 af

Subcatchment P-4: Garage Runoff Area=34,671 sf 100.00% Impervious Runoff Depth>7.68"
Tc=6.0 min CN=98 Runoff=6.04 cfs 0.509 af

Subcatchment P-5: W'ly Parking Lot Runoff Area=6,610 sf 86.17% Impervious Runoff Depth>6.72"
Tc=6.0 min CN=90 Runoff=1.09 cfs 0.085 af

Subcatchment P-6: Res Building Runoff Area=74,887 sf 60.00% Impervious Runoff Depth>7.08"
Tc=6.0 min CN=93 Runoff=12.72 cfs 1.014 af

Subcatchment P-7: Courtyard B Runoff Area=8,175 sf 26.90% Impervious Runoff Depth>1.89"
Tc=6.0 min UI Adjusted CN=47 Runoff=0.36 cfs 0.030 af

Subcatchment P-8: Courtyard A Runoff Area=14,260 sf 34.49% Impervious Runoff Depth>3.16"
Tc=6.0 min CN=59 Runoff=1.17 cfs 0.086 af

Subcatchment P-9: Front Landscape Runoff Area=16,653 sf 25.90% Impervious Runoff Depth>2.62"
Tc=6.0 min CN=54 Runoff=1.10 cfs 0.083 af

Pond 1P: SubSurface Sys 1 Peak Elev=447.62' Storage=0.047 af Inflow=1.09 cfs 0.085 af
Discarded=0.00 cfs 0.007 af Primary=0.19 cfs 0.044 af Outflow=0.20 cfs 0.052 af

Pond 2P: SubSurface Sys 2 Peak Elev=452.77' Storage=0.126 af Inflow=4.86 cfs 0.395 af
Discarded=0.06 cfs 0.104 af Primary=4.80 cfs 0.213 af Outflow=4.86 cfs 0.317 af

Link 1L: Municipal System Inflow=135.30 cfs 11.296 af
Primary=135.30 cfs 11.296 af

Link 2L: Drainage Ditch Inflow=112.32 cfs 9.119 af
Primary=112.32 cfs 9.119 af

Total Runoff Area = 28.221 ac Runoff Volume = 11.519 af Average Runoff Depth = 4.90"
58.90% Pervious = 16.621 ac 41.10% Impervious = 11.600 ac

Summary for Subcatchment E-4: Off-site W'ly

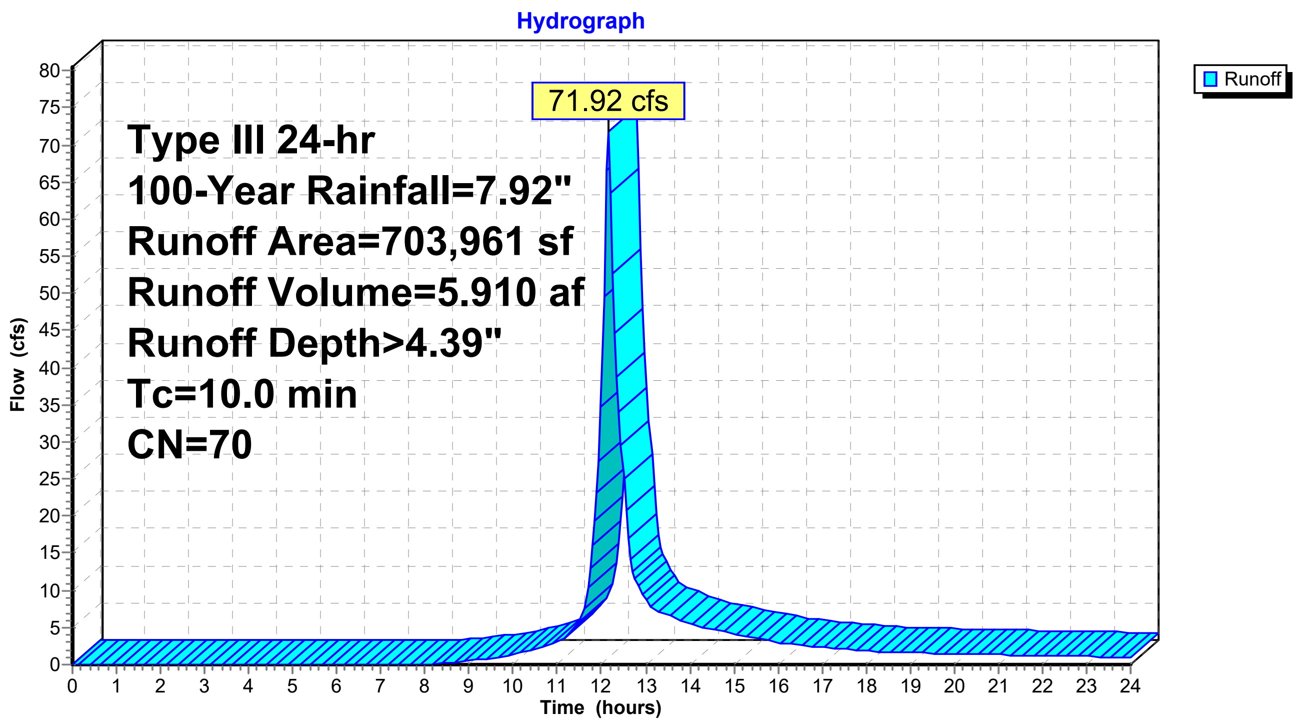
Runoff = 71.92 cfs @ 12.14 hrs, Volume= 5.910 af, Depth> 4.39"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
47,490	89	Urban commercial, 85% imp, HSG A
39,577	94	Urban commercial, 85% imp, HSG C
441,312	61	1/4 acre lots, 38% imp, HSG A
175,582	83	1/4 acre lots, 38% imp, HSG C
703,961	70	Weighted Average
395,534		56.19% Pervious Area
308,427		43.81% Impervious Area

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

Subcatchment E-4: Off-site W'ly



Summary for Subcatchment E-5: Jefferson Parking Lot

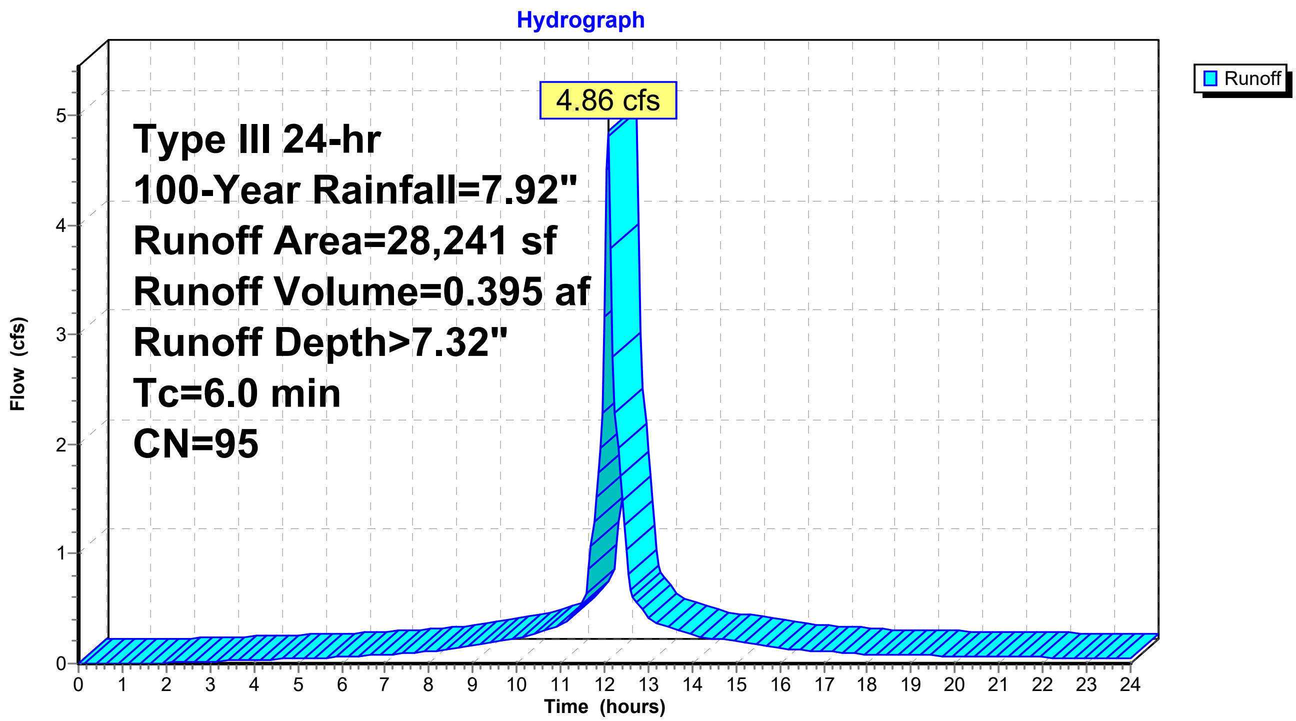
Runoff = 4.86 cfs @ 12.09 hrs, Volume= 0.395 af, Depth> 7.32"
Routed to Pond 2P : SubSurface Sys 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
25,063	98	Paved parking, HSG C
3,178	74	>75% Grass cover, Good, HSG C
28,241	95	Weighted Average
3,178		11.25% Pervious Area
25,063		88.75% Impervious Area

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

Subcatchment E-5: Jefferson Parking Lot



Summary for Subcatchment E-6: Off-site E'ly

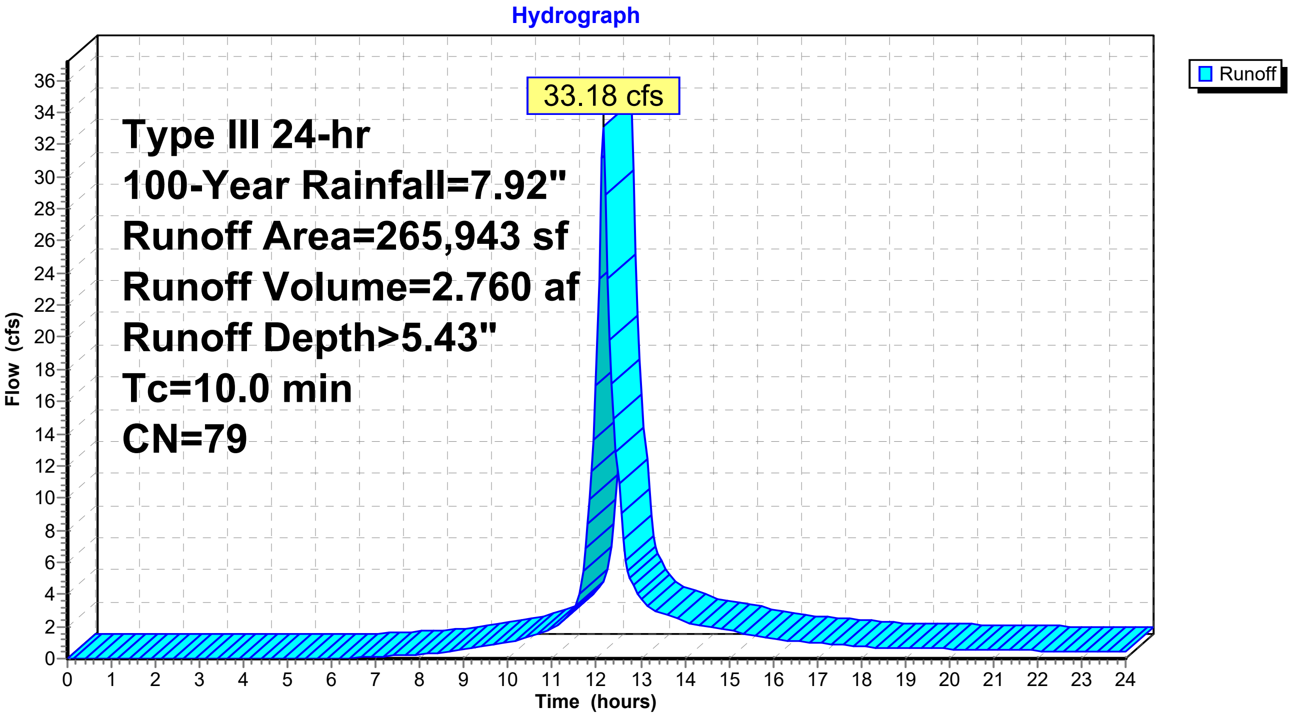
Runoff = 33.18 cfs @ 12.14 hrs, Volume= 2.760 af, Depth> 5.43"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
124,000	74	>75% Grass cover, Good, HSG C
141,943	83	1/4 acre lots, 38% imp, HSG C
265,943	79	Weighted Average
212,005		79.72% Pervious Area
53,938		20.28% Impervious Area

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

Subcatchment E-6: Off-site E'ly



Summary for Subcatchment P-1: Nly Area

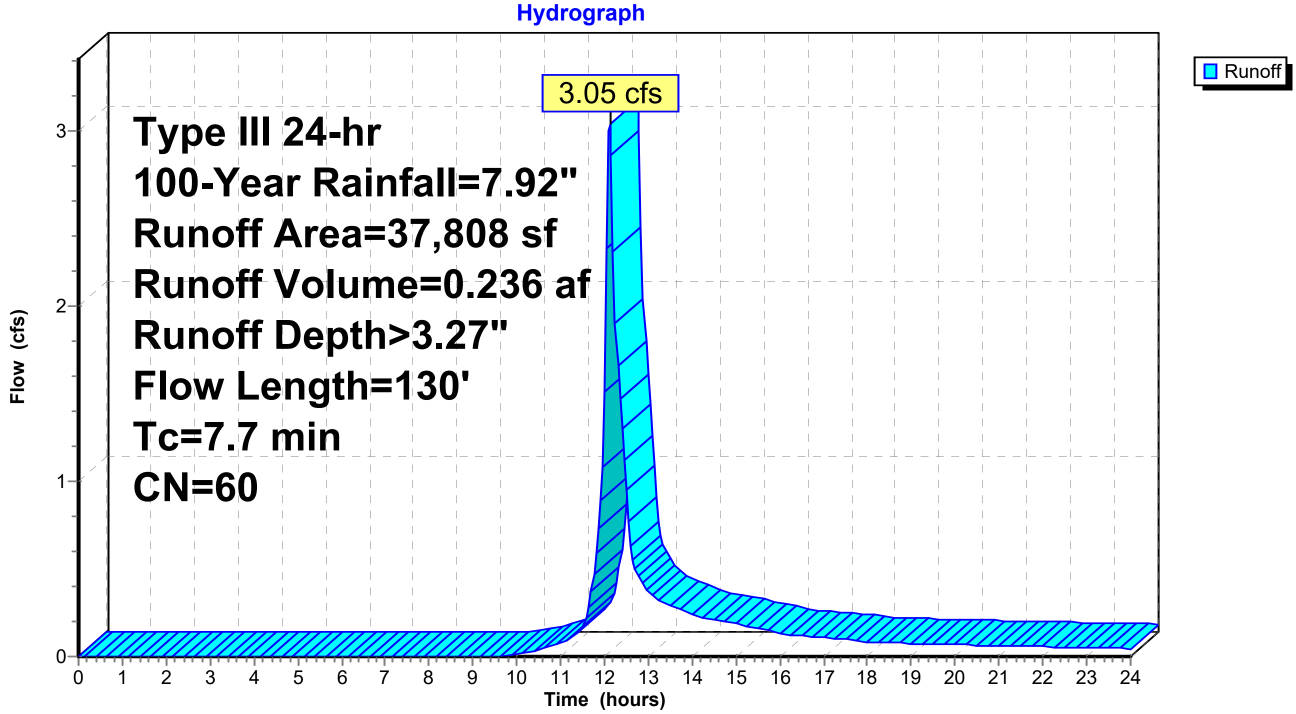
Runoff = 3.05 cfs @ 12.12 hrs, Volume= 0.236 af, Depth> 3.27"
Routed to Link 2L : Drainage Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
18,483	39	>75% Grass cover, Good, HSG A
4,093	74	>75% Grass cover, Good, HSG C
1,011	98	Paved parking, HSG A
2,124	98	Paved parking, HSG C
8,477	70	Woods, Good, HSG C
2,192	98	Water Surface, 0% imp, HSG A
1,428	98	Water Surface, 0% imp, HSG C
37,808	60	Weighted Average
34,673		91.71% Pervious Area
3,135		8.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.1053	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.30"
1.5	80	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.7	130	Total			

Subcatchment P-1: Nly Area



Summary for Subcatchment P-2: Ely Area to Trail

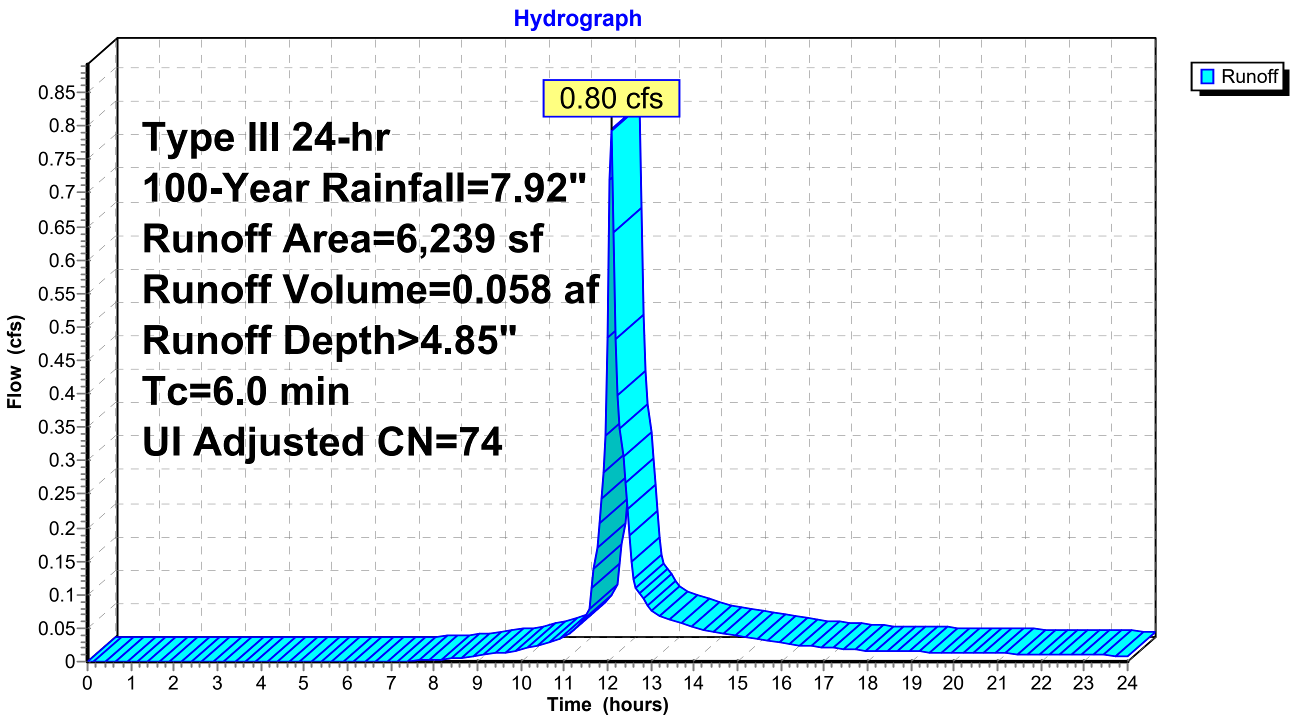
Runoff = 0.80 cfs @ 12.09 hrs, Volume= 0.058 af, Depth> 4.85"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Adj	Description
6,028	74		>75% Grass cover, Good, HSG C
14	98		Paved parking, HSG C
197	98		Unconnected roofs, HSG C
6,239	75	74	Weighted Average, UI Adjusted
6,028			96.62% Pervious Area
211			3.38% Impervious Area
197			93.36% Unconnected

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

Subcatchment P-2: Ely Area to Trail



Summary for Subcatchment P-3: Access Rd

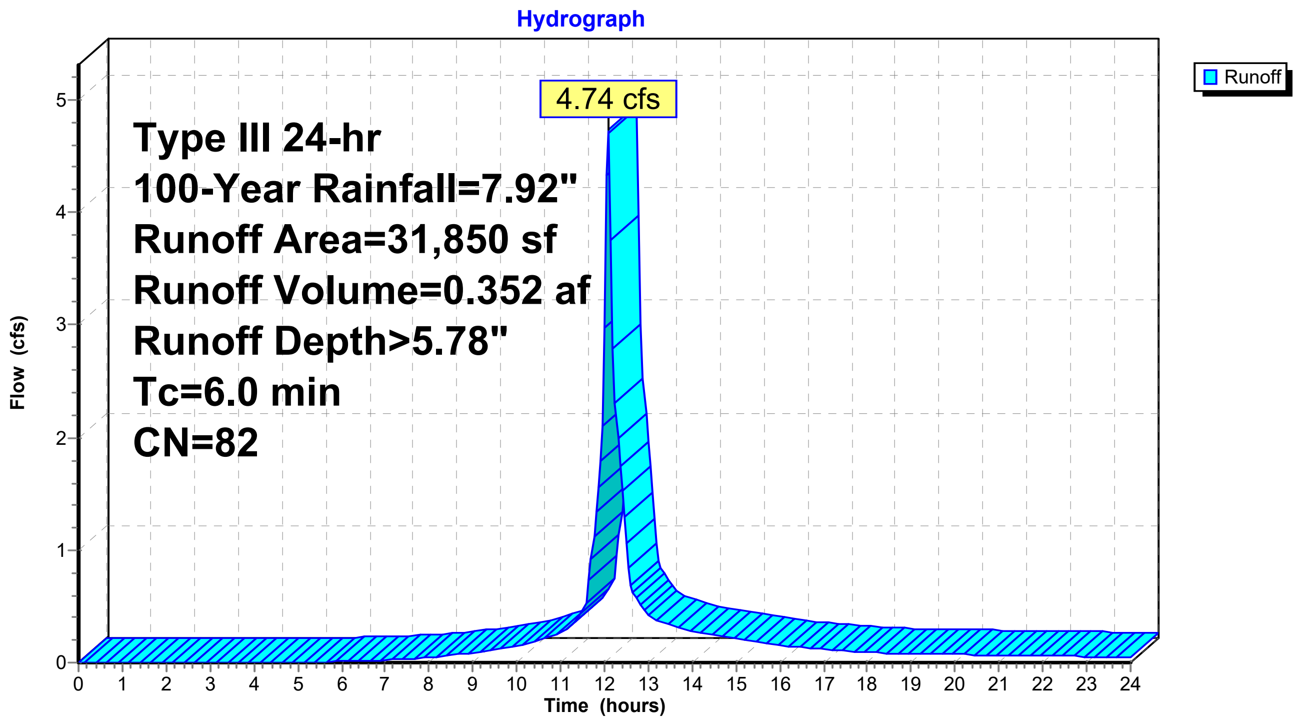
Runoff = 4.74 cfs @ 12.09 hrs, Volume= 0.352 af, Depth> 5.78"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
4,580	39	>75% Grass cover, Good, HSG A
9,481	74	>75% Grass cover, Good, HSG C
197	98	Roofs, HSG C
5,663	98	Paved parking, HSG A
11,929	98	Paved parking, HSG C
31,850	82	Weighted Average
14,061		44.15% Pervious Area
17,789		55.85% Impervious Area

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

Subcatchment P-3: Access Rd



Summary for Subcatchment P-4: Garage

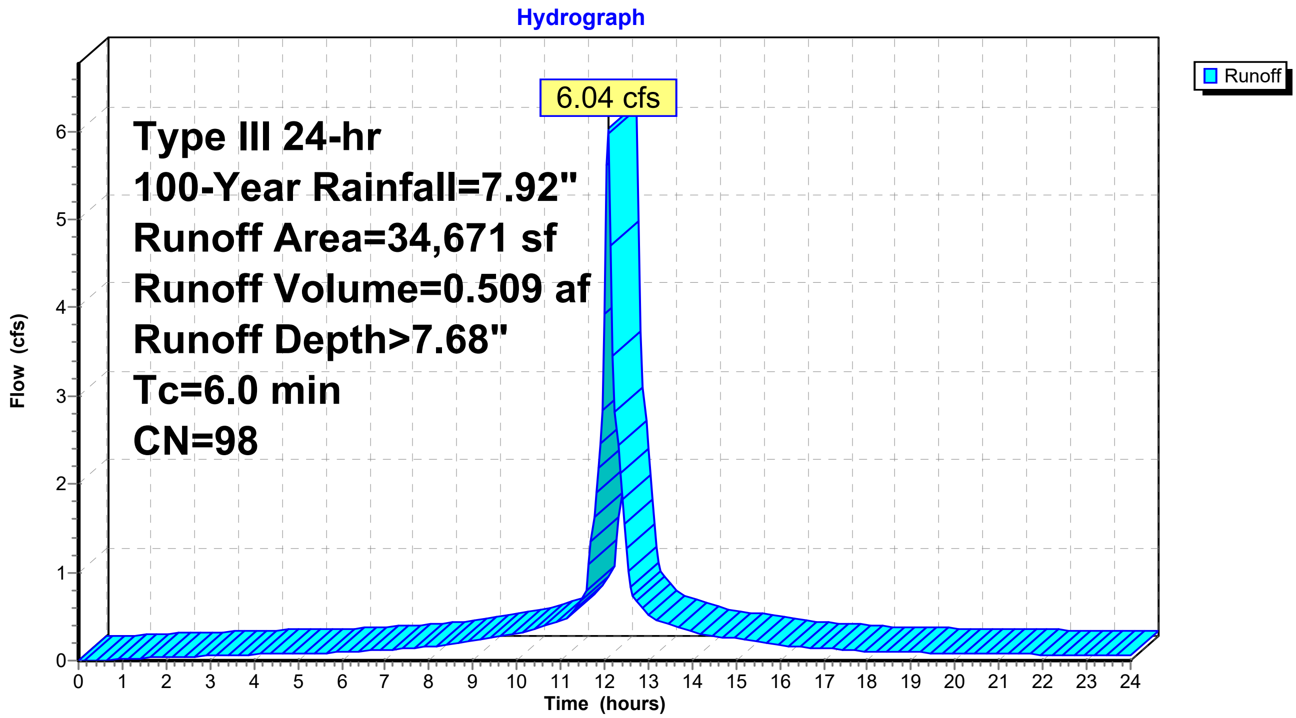
Runoff = 6.04 cfs @ 12.09 hrs, Volume= 0.509 af, Depth> 7.68"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
32,961	98	Roofs, HSG A
1,710	98	Roofs, HSG C
34,671	98	Weighted Average
34,671		100.00% Impervious Area

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

Subcatchment P-4: Garage



Summary for Subcatchment P-5: W'ly Parking Lot

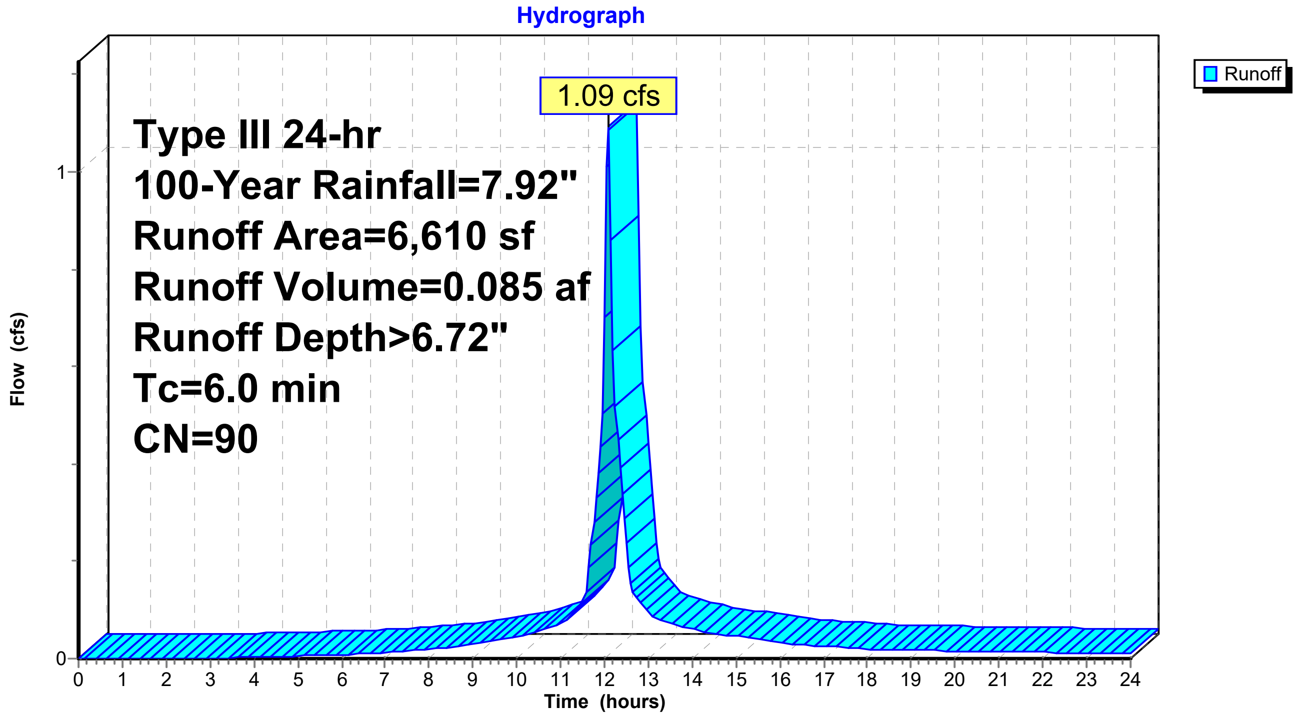
Runoff = 1.09 cfs @ 12.09 hrs, Volume= 0.085 af, Depth> 6.72"
Routed to Pond 1P : SubSurface Sys 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
914	39	>75% Grass cover, Good, HSG A
5,696	98	Paved parking, HSG A
6,610	90	Weighted Average
914		13.83% Pervious Area
5,696		86.17% Impervious Area

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

Subcatchment P-5: W'ly Parking Lot



Summary for Subcatchment P-6: Res Building

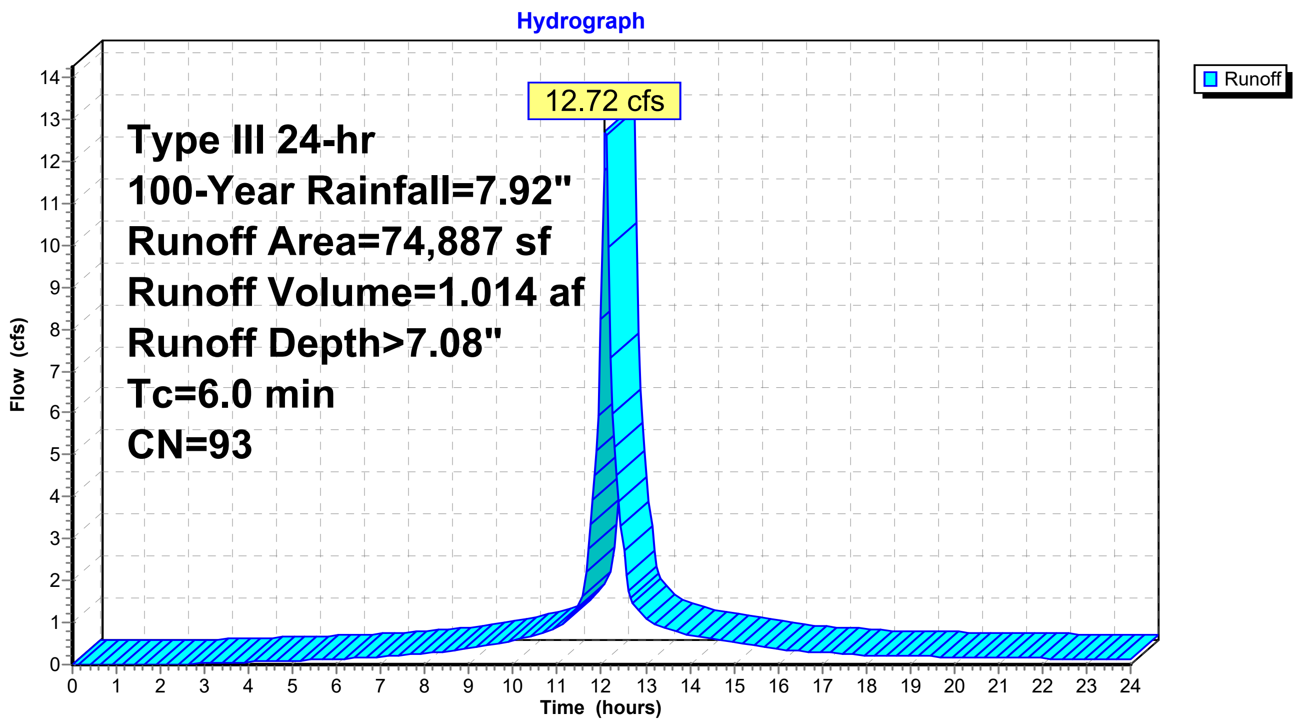
Runoff = 12.72 cfs @ 12.09 hrs, Volume= 1.014 af, Depth> 7.08"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

	Area (sf)	CN	Description
	40,967	98	Roofs, HSG A
	3,965	98	Roofs, HSG C
*	27,312	86	GreenRoof, HSG A (40% Roof Area)
*	2,643	86	GreenRoof, HSG C (40% Roof Area)
	74,887	93	Weighted Average
	29,955		40.00% Pervious Area
	44,932		60.00% Impervious Area

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

Subcatchment P-6: Res Building



Summary for Subcatchment P-7: Courtyard B

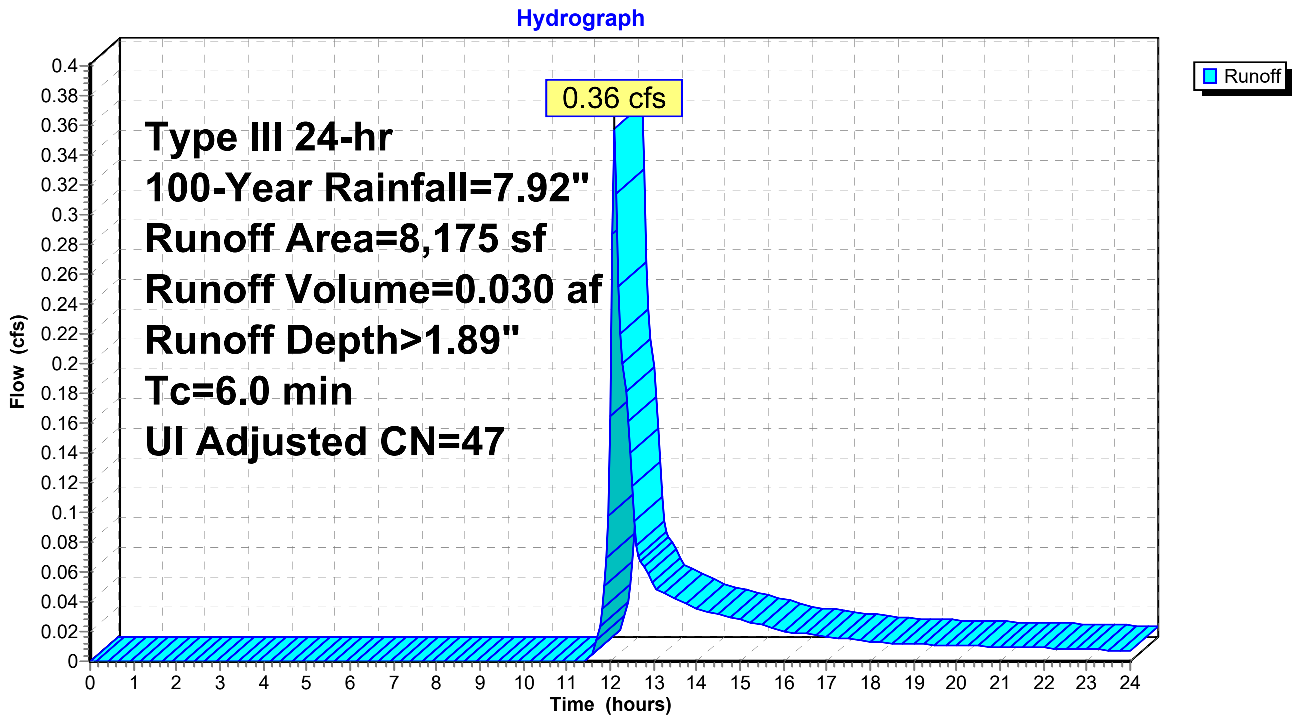
Runoff = 0.36 cfs @ 12.11 hrs, Volume= 0.030 af, Depth> 1.89"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Adj	Description
2,199	98		Unconnected pavement, HSG A
5,976	39		>75% Grass cover, Good, HSG A
8,175	55	47	Weighted Average, UI Adjusted
5,976			73.10% Pervious Area
2,199			26.90% Impervious Area
2,199			100.00% Unconnected

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

Subcatchment P-7: Courtyard B



Summary for Subcatchment P-8: Courtyard A

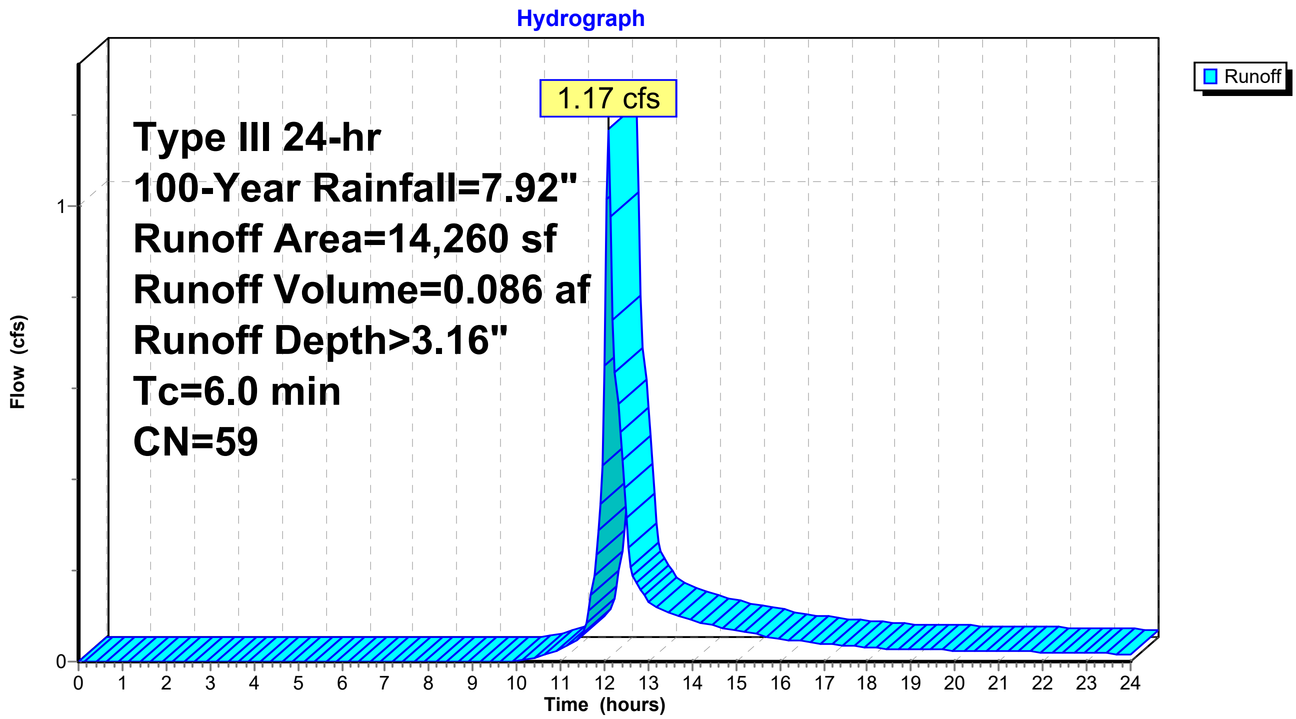
Runoff = 1.17 cfs @ 12.10 hrs, Volume= 0.086 af, Depth> 3.16"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
4,918	98	Unconnected pavement, HSG A
9,342	39	>75% Grass cover, Good, HSG A
14,260	59	Weighted Average
9,342		65.51% Pervious Area
4,918		34.49% Impervious Area
4,918		100.00% Unconnected

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

Subcatchment P-8: Courtyard A



Summary for Subcatchment P-9: Front Landscape

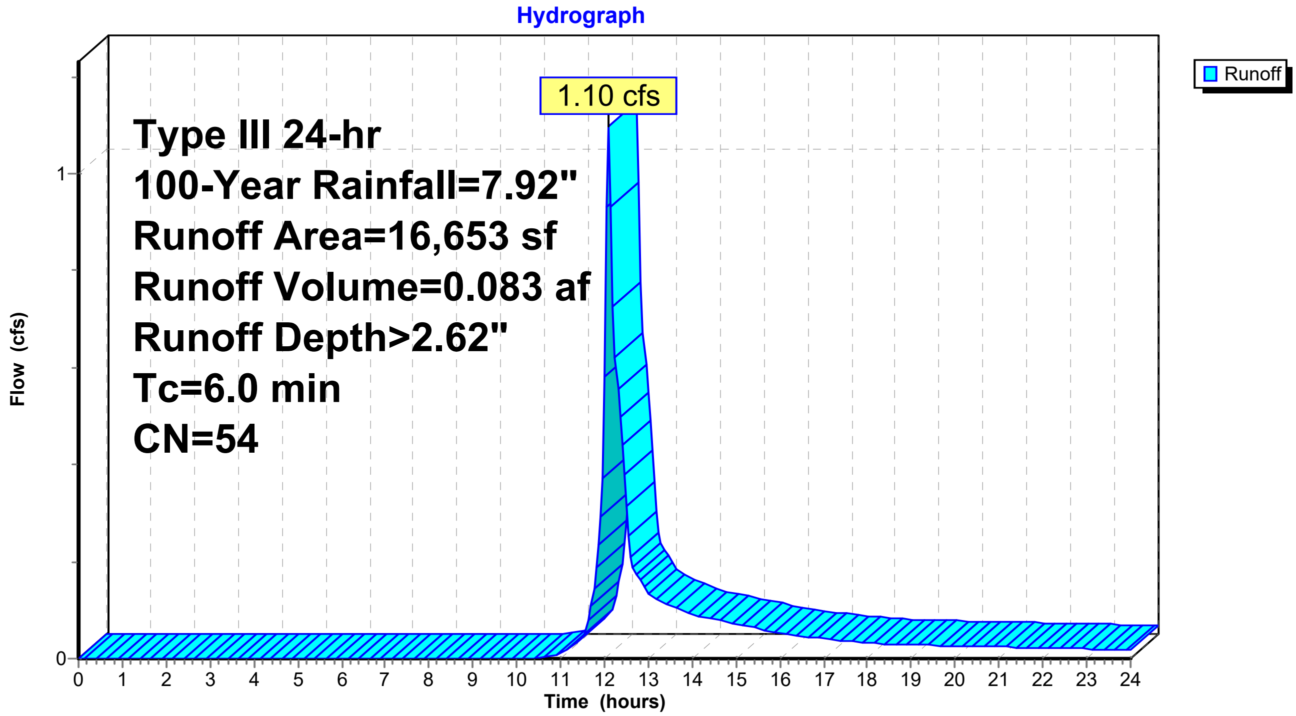
Runoff = 1.10 cfs @ 12.10 hrs, Volume= 0.083 af, Depth> 2.62"
Routed to Link 1L : Municipal System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=7.92"

Area (sf)	CN	Description
12,340	39	>75% Grass cover, Good, HSG A
4,313	98	Paved parking, HSG A
16,653	54	Weighted Average
12,340		74.10% Pervious Area
4,313		25.90% Impervious Area

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

Subcatchment P-9: Front Landscape



Summary for Pond 1P: SubSurface Sys 1

Inflow Area = 0.152 ac, 86.17% Impervious, Inflow Depth > 6.72" for 100-Year event
Inflow = 1.09 cfs @ 12.09 hrs, Volume= 0.085 af
Outflow = 0.20 cfs @ 12.54 hrs, Volume= 0.052 af, Atten= 82%, Lag= 27.2 min
Discarded = 0.00 cfs @ 5.70 hrs, Volume= 0.007 af
Primary = 0.19 cfs @ 12.54 hrs, Volume= 0.044 af
Routed to Link 1L : Municipal System

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 447.62' @ 12.54 hrs Surf.Area= 0.027 ac Storage= 0.047 af

Plug-Flow detention time= 233.8 min calculated for 0.052 af (61% of inflow)
Center-of-Mass det. time= 131.2 min (906.9 - 775.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	445.00'	0.025 af	**15.75'W x 74.82'L x 3.50'H Field A** 0.095 af Overall - 0.032 af Embedded = 0.063 af x 40.0% Voids
#2A	445.50'	0.032 af	**ADS_StormTech SC-740 +Cap** x 30 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 30 Chambers in 3 Rows
		0.057 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	445.00'	**0.170 in/hr Exfiltration over Surface area**
#2	Primary	445.00'	**12.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 445.00' / 444.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	446.50'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	447.00'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	447.75'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.00 cfs @ 5.70 hrs HW=445.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.19 cfs @ 12.54 hrs HW=447.62' (Free Discharge)
└─**2=Culvert** (Passes 0.19 cfs of 5.45 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.03 cfs @ 5.00 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.17 cfs @ 3.39 fps)
  └─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: SubSurface Sys 1 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

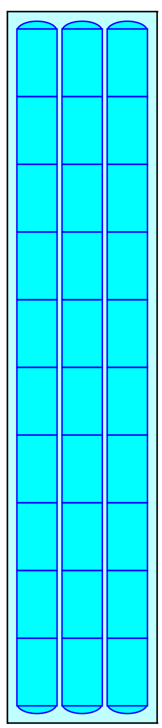
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
3 Rows x 51.0" Wide + 6.0" Spacing x 2 + 12.0" Side Stone x 2 = 15.75' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

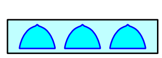
30 Chambers x 45.9 cf = 1,378.2 cf Chamber Storage

4,124.3 cf Field - 1,378.2 cf Chambers = 2,746.1 cf Stone x 40.0% Voids = 1,098.4 cf Stone Storage

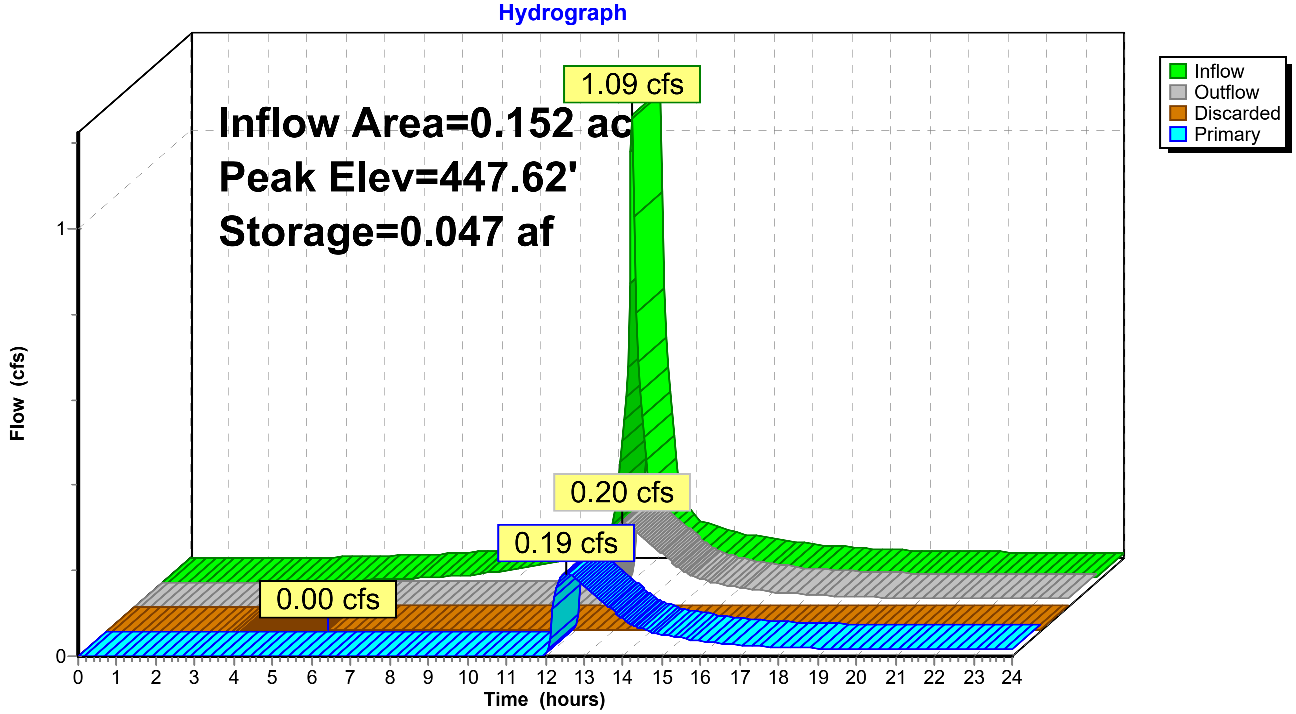
Chamber Storage + Stone Storage = 2,476.6 cf = 0.057 af
Overall Storage Efficiency = 60.1%
Overall System Size = 74.82' x 15.75' x 3.50'

30 Chambers
152.8 cy Field
101.7 cy Stone





Pond 1P: SubSurface Sys 1



Summary for Pond 2P: SubSurface Sys 2

Inflow Area = 0.648 ac, 88.75% Impervious, Inflow Depth > 7.32" for 100-Year event
Inflow = 4.86 cfs @ 12.09 hrs, Volume= 0.395 af
Outflow = 4.86 cfs @ 12.12 hrs, Volume= 0.317 af, Atten= 0%, Lag= 1.9 min
Discarded = 0.06 cfs @ 6.40 hrs, Volume= 0.104 af
Primary = 4.80 cfs @ 12.12 hrs, Volume= 0.213 af
Routed to Link 2L : Drainage Ditch

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 452.77' @ 12.12 hrs Surf.Area= 0.061 ac Storage= 0.126 af

Plug-Flow detention time= 146.1 min calculated for 0.317 af (80% of inflow)
Center-of-Mass det. time= 71.6 min (828.5 - 756.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	449.50'	0.055 af	**30.00'W x 89.06'L x 3.50'H Field A** 0.215 af Overall - 0.076 af Embedded = 0.139 af x 40.0% Voids
#2A	450.00'	0.076 af	**ADS_StormTech SC-740 +Cap** x 72 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 72 Chambers in 6 Rows
		0.131 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	449.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	449.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 449.50' / 449.00' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#3	Device 2	451.00'	**1.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	451.50'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Device 2	452.25'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.06 cfs @ 6.40 hrs HW=449.54' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=4.44 cfs @ 12.12 hrs HW=452.74' (Free Discharge)
└─**2=Culvert** (Passes 4.44 cfs of 9.56 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.03 cfs @ 6.28 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.25 cfs @ 5.09 fps)
  └─**5=Broad-Crested Rectangular Weir** (Weir Controls 4.15 cfs @ 2.10 fps)

Pond 2P: SubSurface Sys 2 - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 +Cap (ADS StormTech® SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

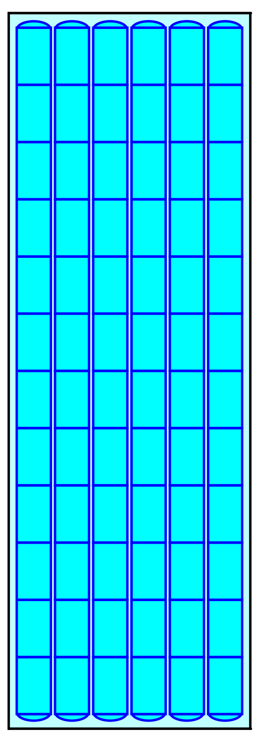
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +12.0" End Stone x 2 = 89.06' Base Length
6 Rows x 51.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 30.00' Base Width
6.0" Stone Base + 30.0" Chamber Height + 6.0" Stone Cover = 3.50' Field Height

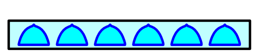
72 Chambers x 45.9 cf = 3,307.7 cf Chamber Storage

9,351.0 cf Field - 3,307.7 cf Chambers = 6,043.3 cf Stone x 40.0% Voids = 2,417.3 cf Stone Storage

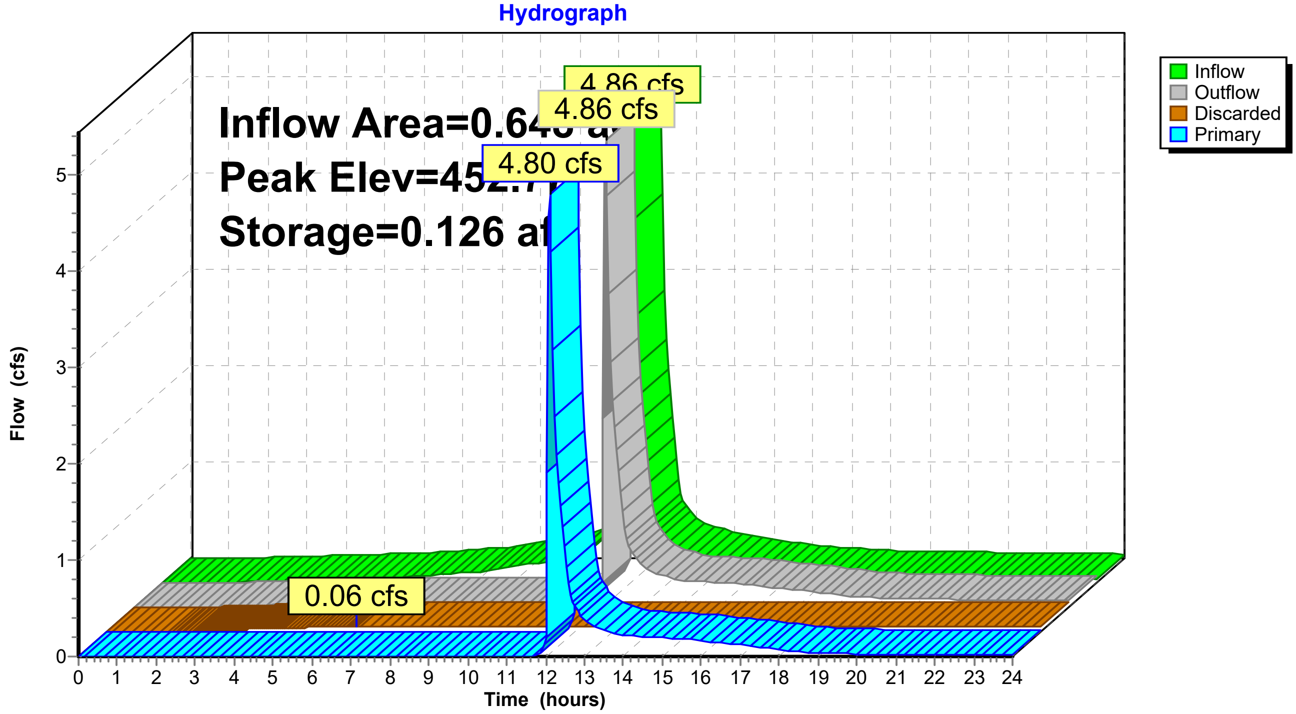
Chamber Storage + Stone Storage = 5,725.0 cf = 0.131 af
Overall Storage Efficiency = 61.2%
Overall System Size = 89.06' x 30.00' x 3.50'

72 Chambers
346.3 cy Field
223.8 cy Stone





Pond 2P: SubSurface Sys 2

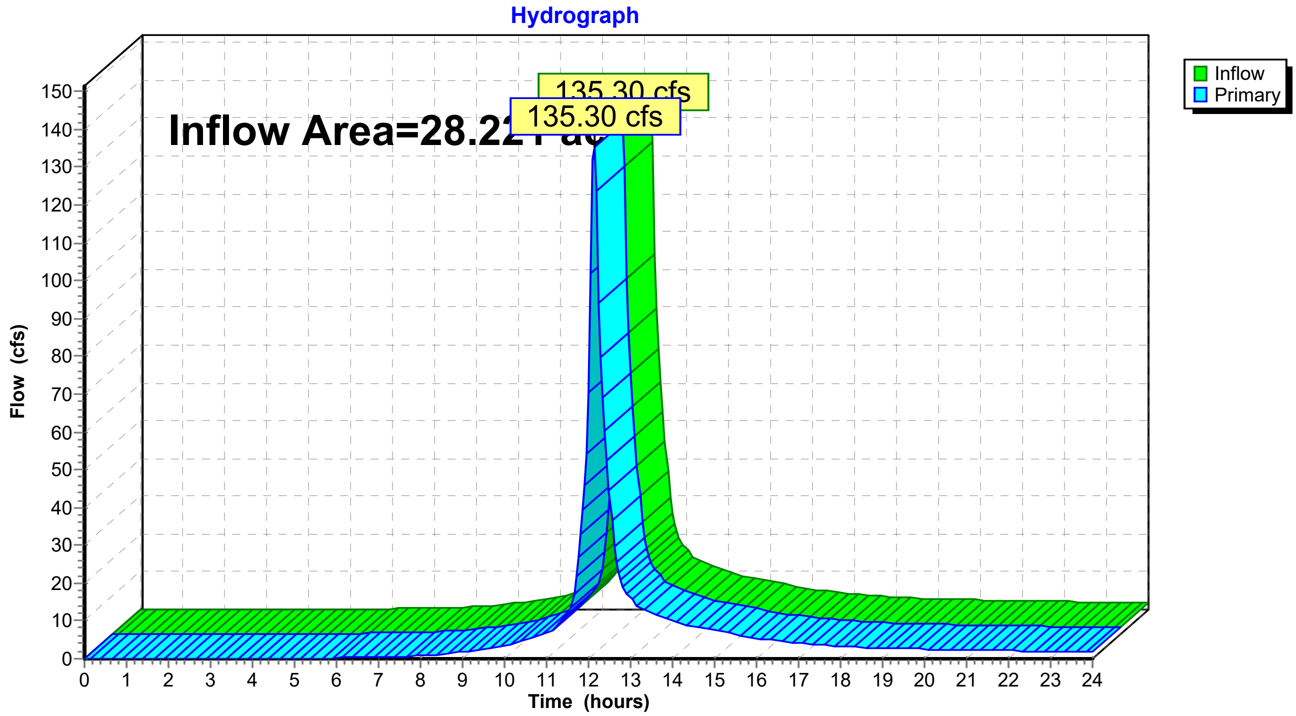


Summary for Link 1L: Municipal System

Inflow Area = 28.221 ac, 41.10% Impervious, Inflow Depth > 4.80" for 100-Year event
Inflow = 135.30 cfs @ 12.13 hrs, Volume= 11.296 af
Primary = 135.30 cfs @ 12.13 hrs, Volume= 11.296 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

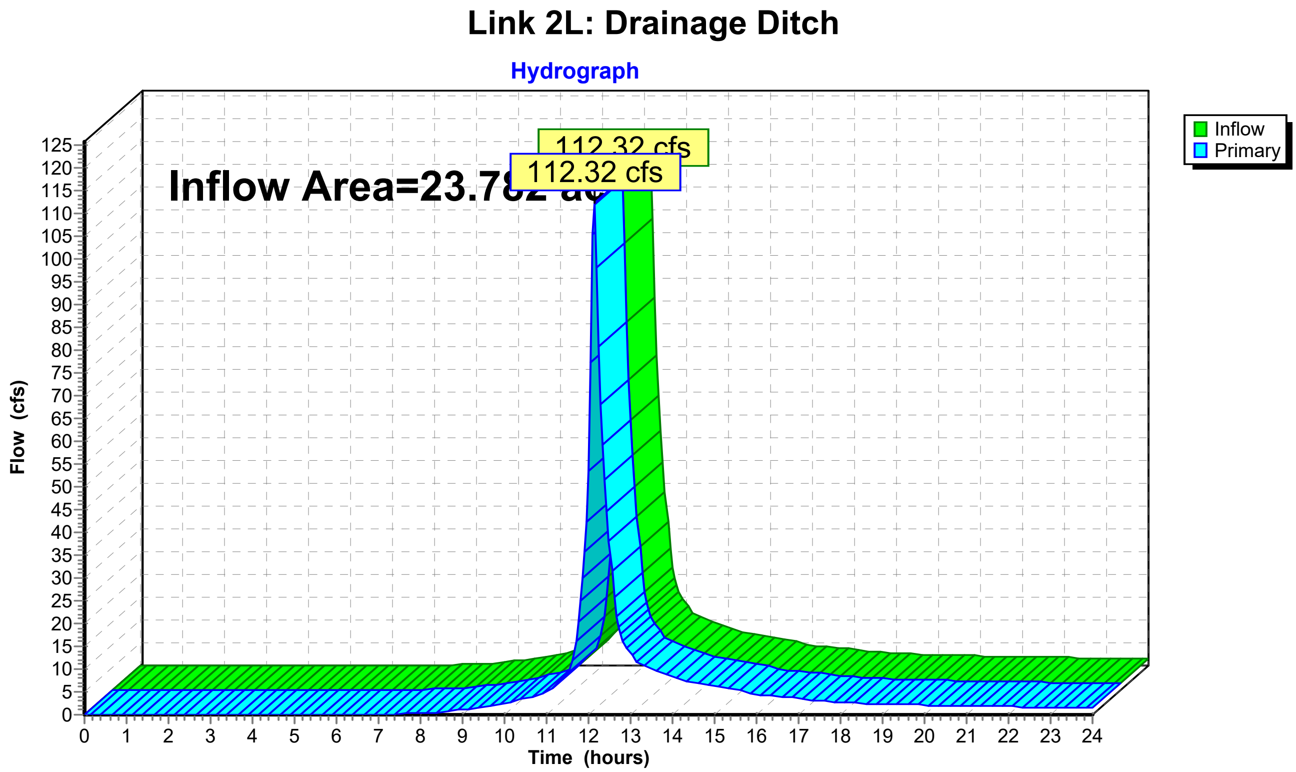
Link 1L: Municipal System



Summary for Link 2L: Drainage Ditch

Inflow Area = 23.782 ac, 37.70% Impervious, Inflow Depth > 4.60" for 100-Year event
Inflow = 112.32 cfs @ 12.14 hrs, Volume= 9.119 af
Primary = 112.32 cfs @ 12.14 hrs, Volume= 9.119 af, Atten= 0%, Lag= 0.0 min
Routed to Link 1L : Municipal System

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



APPENDIX B
SUPPORTING INFORMATION

ILLICIT DISCHARGE STATEMENT

Project: Mixed-Use Development
ALTA Marlborough
Lincoln & Mechanic Street
Marlborough, MA

Date: April 1, 2022

The stormwater management system proposed shall not be connected to the wastewater management system and shall not be contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease per Massachusetts DEP stormwater standard 10.

Engineer:
Allen & Major Associates, Inc.
10 Main Street
Lakeville, MA 02347

________________________ ________________________

Print Name Signature

Owner:
ALTA Marlborough, LLC
91 Hartwell Avenue
Lexington, MA 02421

________________________ ________________________

Print Name Signature

SOIL INFORMATION

United States Department of Agriculture

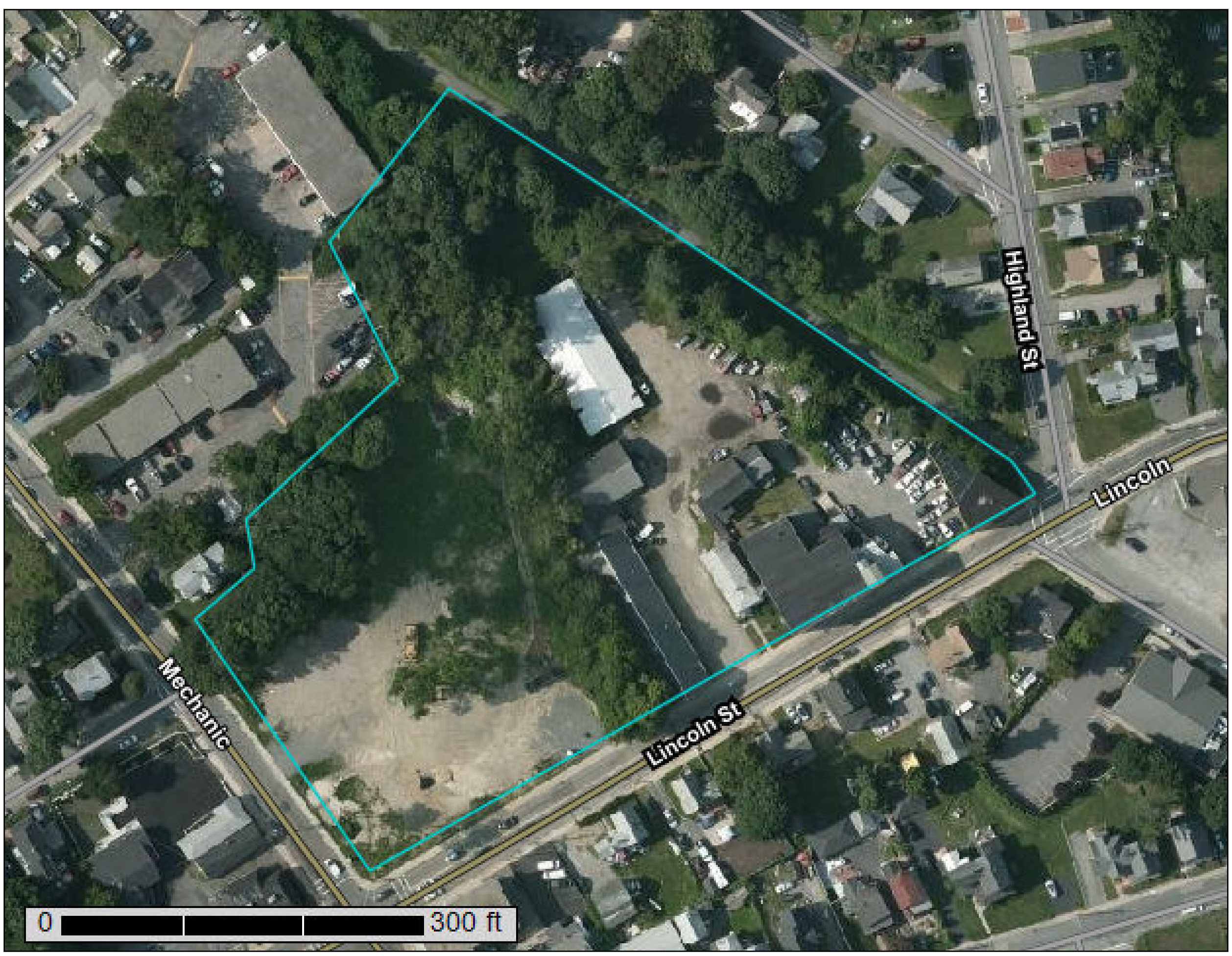
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Middlesex County, Massachusetts



December 8, 2021

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

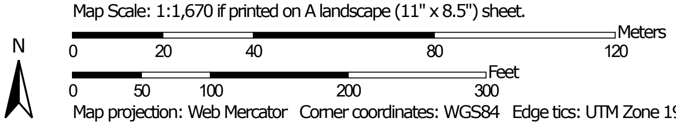
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map (Lincoln Street Marlborough)

Map Scale: 1:1,670 if printed on A landscape (11" x 8.5") sheet.



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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 21, Sep 2, 2021

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

Date(s) aerial images were photographed: Jul 28, 2019—Aug 15, 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.

Map Unit Legend (Lincoln Street Marlborough)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
622C	Paxton-Urban land complex, 3 to 15 percent slopes	0.2	3.2%
629C	Canton-Charlton-Urban land complex, 3 to 15 percent slopes	3.7	72.1%
654	Udorthents, loamy	1.3	24.7%
Totals for Area of Interest		**5.1**	**100.0%**

Map Unit Descriptions (Lincoln Street Marlborough)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Middlesex County, Massachusetts

622C—Paxton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w67k
Elevation: 0 to 930 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Paxton and similar soils: 45 percent
Urban land: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton

Setting

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

Typical profile

Ap - 0 to 8 inches: fine sandy loam
Bw1 - 8 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: fine sandy loam
Cd - 26 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Description of Urban Land

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Woodbridge

Percent of map unit: 9 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Charlton

Percent of map unit: 6 percent
Landform: Hills
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Udorthents

Percent of map unit: 4 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ridgebury

Percent of map unit: 1 percent
Landform: Drumlins, depressions, ground moraines, hills, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: Yes

629C—Canton-Charlton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 9959
Elevation: 0 to 1,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Canton and similar soils: 40 percent
Charlton and similar soils: 30 percent
Urban land: 25 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canton

Setting

Landform: Hills
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Base slope, side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable sandy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 8 inches: fine sandy loam
H2 - 8 to 21 inches: fine sandy loam
H3 - 21 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 18 to 30 inches to strongly contrasting textural stratification
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A

Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Landform: Ground moraines, drumlins
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over friable loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 22 inches: sandy loam
H3 - 22 to 65 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Scituate

Percent of map unit: 2 percent
Landform: Hillslopes, depressions
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Montauk

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, summit
Landform position (three-dimensional): Nose slope, head slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 1 percent
Hydric soil rating: No

654—Udorthents, loamy

Map Unit Setting

National map unit symbol: vr1l
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Udorthents, Loamy

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Minor Components

Udorthents, sandy

Percent of map unit: 10 percent
Hydric soil rating: No

Urban land

Percent of map unit: 5 percent
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear

Udorthents, wet substratum

Percent of map unit: 5 percent
Hydric soil rating: Yes

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www.haleyaldrich.com

FINAL PRELIMINARY GEOTECHNICAL REPORT
PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
283 TO 325 LINCOLN STREET
MARLBOROUGH, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
WP East Acquisitions, LLC
Lexington, Massachusetts

File No. 0204525-000
February 2022

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4 February 2022
File No. 0204525-000

WP East Acquisitions, LLC
c/o Wood Partners
91 Hartwell Avenue
Lexington, Massachusetts 02421

Attention: David Moore

Subject: Final Preliminary Geotechnical Report
Proposed Multi-Family Residential Development
283 to 325 Lincoln Street
Marlborough, Massachusetts

Ladies and Gentlemen:

This letter report summarizes the results of a preliminary geotechnical investigation performed by Haley & Aldrich, Inc. (Haley & Aldrich) and provides preliminary geotechnical design recommendations and associated construction considerations for a proposed multi-family residential development project located at 283 to 325 Lincoln Street in Marlborough, Massachusetts. The work summarized in this report was performed in accordance with our proposal dated 2 December 2021 and your subsequent authorization.

The information presented in this report is intended for initial project planning and preliminary cost estimating purposes only. Final design recommendations and associated construction requirements will be developed during the final design phase of the project upon completion of final design explorations.

Introduction

SITE CONDITIONS

The project site is located at 283 to 325 Lincoln Street in Marlborough, Massachusetts as generally shown on the attached Figure 1 Project Locus. The site is comprised of 11 smaller parcels that are being combined to create one larger 4.71-acre parcel. The project development also includes work to create a new parking area for the City of Marlborough that they own at 56 Jefferson Street adjacent to the existing rail trail.

The Lincoln Street parcels are currently occupied by six, 1- to 3-story industrial/commercial buildings, a residential building, and open landscape areas. Based on information obtained from the project environmental consultant (Vertex Engineering), the current landscape area along Lincoln Street and Mechanic Street was used as a former filling station. There is also an existing municipal drainage easement crossing in a general north-south direction that roughly bisects the property. The approximate location of the easement is illustrated on Figure 2. The property at 56 Jefferson Street is currently a dirt parking area.

Existing site grades range from approximately Elevation (El.) 451 in the northwest corner of the site along Mechanic Street to El. 439 in the southeast corner of the site along Lincoln Street.

PROPOSED DEVELOPMENT

Based on our review of the Concept Drawings, dated 26 January 2022 (herein "Concept Drawings") provided by Wood Partners, we understand that the proposed development will consist of the construction of a 4- to 5-story, interconnected building with approximately 249 residential units and occupying a footprint area of approximately 63,000 square feet (sq. ft). The lowest level floor is planned at approximately El. 440, except for the west half of the west wing along Mechanic Street which will step up to approximately El. 451.66 roughly matching existing grades. Copies of the Concept Drawings are provided in Appendix A. Based on the grades shown on the Concept Drawings some areas of the site will require 2 to 5 feet (ft) of filling (mostly on eastern half of the site and within the parking garage).

The wings of the building will provide two amenity courtyards (Courtyard A with a footprint of approximately 8,200 sq. ft, and Courtyard B with a footprint of approximately 15,500 sq. ft). Courtyard A will be located at the west end of the building and surrounded on four sides by the building. Courtyard B will be located at the east end of the building and surrounded on three sides by the building with the open side facing Lincoln Street to the south. An approximately 5-ft deep pool is planned in Courtyard B.

The proposed development also includes the construction of a 4-story precast concrete parking garage along the north side of the building and the west side of the building's east wing. The parking garage will occupy a footprint of approximately 34,500 sq. ft with a lowest floor at approximately El. 440 roughly matching existing site grades and the lowest finished floor of the adjacent building. A small public bathroom building is also planned to be constructed at the northeast corner of the site adjacent to the existing rail trail.

Additional information regarding the proposed development layout is illustrated on the Concept Drawings provided in Appendix A. The approximate limits of the proposed building and garage relative to existing site features are depicted on the attached Figure 2.

New site utilities including stormwater infiltration are also planned.

Subsurface Exploration Program

SUBSURFACE EXPLORATIONS

Haley & Aldrich conducted a subsurface exploration program consisting of six soil borings (designated HA21-1 through HA21-6) drilled at the proposed project site. The borings were drilled and sampled to depths ranging from 14 to 19 ft below existing ground surface (bgs). Two groundwater observation wells were installed in completed boreholes HA21-1(OW) and HA21-6(OW). The test borings were performed by Northern Drill Service between 17 and 20 December 2021 and were observed in the field by a Haley & Aldrich geologist.

Additionally, four test pits designated TP-1 through TP-4 were advanced at the site by the project Civil Engineer Allen & Major for the purposes of gathering information to support design of stormwater infiltration systems. Test pit TP-1 was conducted at the 56 Jefferson Street parcel and test pits TP-2 through TP-4 were conducted on the Lincoln Street parcel.

Additionally, Vertex Engineering conducted subsurface explorations at the site to gather soil and groundwater samples for environmental evaluations. The locations of the explorations (as reported by Vertex Engineering) as shown on the attached Figure 2.

The approximate locations of the explorations relative to existing site conditions and proposed construction are shown on Figure 2. Logs of test borings are provided in Appendix B. Logs of the test pits provided by Allen & Major are provided in Appendix C.

Subsurface Conditions

SOIL AND BEDROCK CONDITIONS

Subsurface conditions encountered at the test boring locations consisted of the following stratigraphic units starting at existing ground surface:

Fill was encountered to depths ranging from 2 to 8 ft bgs in five of the six borings. Fill was not encountered at HA21-3. The Fill generally consisted of loose to dense silty SAND, silty SAND with gravel, or poorly graded SAND with silt. A layer of organic topsoil was encountered in HA21-4 below the fill at a depth of 4 ft bgs. At location HA21-2, the fill was noted to be 8 ft thick and contain a high percentage of brick, and a 6-inch (in.) thick concrete slab was encountered between the fill and underlying natural glacial soils. This slab could possibly be the bottom of a former tank area associated with the previous filling station that was subsequently filled with debris. The Fill present at HA21-6 was noted to contain a high percentage of ash and organics.

Glacial Deposits consisting of Glaciofluvial Deposits and Glacial Till were encountered at the existing ground surface at HA21-3 or below the Fill at the remaining five test borings. The thickness of the Glacial Deposits ranged from approximately 4.5 ft at HA21-2 to 15 ft at HA21-3. The Glacial Deposits generally consisted of medium dense to dense silty SAND or silty SAND with gravel. However, at HA21-3, the upper 8 ft of the Glacial Deposits was loose to very loose. It is noted that HA21-3 is close to the area of a drainage easement and existing drainage pipe such that it may be possible that installation of the pipe, loss of ground into the pipe, or leakage from the pipe may have disturbed these soils resulting in the low SPT N-values measured in the boring. We anticipate this loose soil condition at HA21-3 to be limited to the existing drain line alignment, and recommend this area be further investigated and delineated during final design.

Bedrock was encountered below the Glacial Deposits at each boring location based on refusal to the drilling equipment. The depth to the top of the rock ranged from 11 to 15 ft bgs. The upper approximate 1 to 4 ft of the bedrock was observed to be weathered.

A summary of the top of subsurface unit elevations is provided for each of the recent H&A borings on Figure 1.

GROUNDWATER

Groundwater observation wells were installed in borings HA21-1(OW) and HA21-6 (OW). Water levels were measured on 20 December 2021 at 3 ft bgs in HA21-6(OW) and 8 ft bgs in HA21-1(OW), corresponding to approximately El. 439.5 to El. 442, respectively. Groundwater measurements were also made by Vertex Engineering (Vertex) that showed groundwater levels in the same range as observed in the Haley & Aldrich observation wells. The recent groundwater level data from Vertex is summarized on Figure 2 and provided in Appendix D.

Site groundwater levels will fluctuate with season, precipitation, leakage into and out of utilities, among other factors, and as a result will vary from conditions encountered on the dates indicated in this report.

Preliminary Geotechnical Recommendations

This section provides preliminary geotechnical recommendations to aid with initial project planning and preliminary cost estimating. These recommendations are not intended for project final design. These recommendations are based on the Concept Drawings and the subsurface conditions encountered in the test borings and are in accordance with the 9th Edition of the Massachusetts State Building Code.

BUILDING AND PARKING GARAGE FOUNDATIONS

Based on the subsurface conditions encountered in the test borings, the proposed buildings (residential building and parking garage) can be founded on conventional shallow spread footings bearing at conventional foundation depths on the medium dense to dense Glacial Deposits or on compacted structural fill placed above the natural Glacial Deposits (following the removal of the existing Fill within the zone of influence of the footings).

For initial planning, we recommend that footings be sized for a maximum allowable bearing pressure of five kips per square foot (ksf). Settlements of footings sized for this bearing pressure would be on the order of up to 1 in. total and ½ in. differential (over a distance of approximately 30 ft).

The thickness of Fill below existing site grades was noted to range from 2 to 8 ft. In the un-excavated area of the residential building, 3 to 7 ft of over-excavation of unsuitable soils below normal footing bearing elevations will be required. Over the remainder of the residential building and parking garage, up to 2 ft of over-excavation of unsuitable soils below normal footing bearing elevations is anticipated, except along the drainage easement where the top 8 ft of the natural Glacial Deposits in HA21-3 was noted to be loose or very loose in nature and will therefore also require removal and replacement. For preliminary planning, we recommend it be assumed that these loose natural soils within 5 ft either side of the drainpipe will require removal and replacement with structural fill to approximately El. 434 (i.e., 6 ft below proposed finished floor grade).

Further explorations will be needed during final design to refine the area of loose soils. If the drainpipe remains under the new structures, footings will need to step down in the vicinity of the pipe such that they bear below the invert elevation of the pipe, and a grade beam may be needed for the wall footing above the pipe to span this area. Additionally, if the pipe is left in place the project should consider exposing the pipe to assess its current condition and possible backfill around the pipe using flowable fill to reduce the risk of erosion of soils below the building into the pipe in the future.

Where over-excavation is required, the existing Fill should be removed within the zone of influence of the new footings and replaced with compacted structural fill. The zone of influence is defined as the zone beneath imaginary lines extending two ft laterally outward from the lower edges of footings and down a 1H:1V splay to the top of the natural Glacial Deposits.

Excavations to remove and replace unsuitable fill soils within the zone of influence as described above will extend below the groundwater table in some areas and locally lowering of the groundwater table by 2 to 3 ft to enable this work to be conducted in-the-dry.

LOWEST LEVEL SLABS

The lowest level slabs of the residential building and parking garage can be designed as conventional soil support slab-on-grades. We recommend that slabs bear on a minimum of 8 in. of imported Structural Fill in the un-excavated building area and 12 of ¾ in. washed crushed stone over the remainder of the footprint of the residential building and parking garage. The crushed stone should be separated from underlying/adjacent soils using a geotextile filter fabric (6 ounces [oz] per square yard minimum, needle-punched, non-woven).

The existing Fill is variable in nature and in-place density. There are pockets of Fill near HA21-2 that consist mostly of debris (may be the grave of a former tank from filling station) and Organics were noted in the Fill at HA21-4 and HA21-6. As discussed, in the section above, loose soils were also encountered in the vicinity of HA21-3. If the existing Fill soils are left in place below slab areas (including areas which slab haunches to support walls) without improvement it will be difficult to estimate future possible slab settlements.

For initial planning, we recommend that in areas where fill will be left in-place below finished floor slab elevations that the areas be over-cut to provide a minimum of a minimum of 3 ft of compacted fill below the finished floor level (the thickness of the compacted fill would be less where natural soils are encountered within 3 ft below the finished floor level). Additional over-cutting may be required where subgrades exhibit signs of instability during proof-compaction. Where Organics are present in the Fill (shaded area on Figure 1), these areas should be excavated deeper to remove the Organics. Following proof compaction, the granular portions of the existing Fill could be replaced and compacted in lifts. The above noted approach assumes that the risk of some slab cracking and/or settlement is tolerable.

If some risk of slab cracking and/or settlement is not tolerable, the Fill should be excavated and replaced in its entirety, or the Fill could be improved using ground improvement as described above for building foundation support.

SEISMIC DESIGN CONSIDERATIONS

Based on the preliminary test borings, the Seismic Site Class is considered to be a C. The soils at the site are not considered to be susceptible to liquefaction under the Building Code design level earthquake.

GROUNDWATER AND PERMANENT FOUNDATION DRAINAGE

Groundwater elevations varied across the site between approximately El. 442.5 and El. 434.1 and should be anticipated in excavations conducted for foundations and utility construction. Groundwater observations at exploration locations are shown on the attached Figure 2.

Finished floors are planned at El. 440 for most of the residential building and parking garage footprints, which puts them slightly below or within a foot of the observed groundwater table. As such, we recommend that the portions of the residential building and parking garage with a lowest level slab finished at El. 440 have underslab drainage systems consisting of a network of 4 in. diameter perforated PVC pipes placed within a 12-in. thick layer of crushed stone placed below the slab. Piping should generally be located along the inside perimeter of the structures and then spaced every 25 ft across the footprints. Piping will need to be coordinated with radon mitigation system piping.

Additionally, underslab drainage should be provided below the pool planned in the courtyard.

Foundation walls and retaining walls should be drained to eliminate design hydrostatic forces and dampproofed full-height. If a radon mitigation system is not installed (see next section), we recommend from a geotechnical perspective that a moisture vapor retarder be installed directly beneath the ground floor slabs in occupied and finished spaces, or those with moisture sensitive spaces or floor coverings.

RADON MITIGATION SYSTEM

The project is located in an area of Massachusetts which according to the EPA, has an elevated risk of radon concentrations above recommended action levels (i.e., potential for concentrations above 4 picocuries per liter [pCi/L]). The elevated risk is due to the relatively shallow granitic bedrock beneath the building footprints. Accordingly, a radon mitigation system is a recommended beneath ground floor lobby/amenity areas, residential areas, as well as elevators and stairwells servicing residential floor levels.

A radon mitigation system typically consists of an 8 to 12-in.-thick layer of 3/4 in. crushed stone below a minimum 15- measure of thickness (mil) vapor barrier under the lowest building slab. Within the 3/4 in.

crushed stone layer is a network of perforated PVC pipes that are vented to the exterior of the building, typically through the roof. The building design should include providing power to the roof area in the event the system needs to be activated with mechanical fans.

Radon mitigation is not considered necessary below parking garage slabs or other non-occupied areas.

The crushed stone layer installed for the radon mitigation system can be coordinated with the under-slab drainage system as described above.

UTILITIES AND OTHER SITE IMPROVEMENTS

We recommend that the following considerations be incorporated into the preliminary design:

- Utilities below soil-supported slabs-on-grade within the building footprint may be earth-supported and installed using conventional methods.
- Site utilities can be supported in the natural Glacial Deposits or Fill soils. Oversized materials, if present at the subgrade level, should be removed to preclude a “hard spot” along the utility bottom that could damage or break the utility.
- Foundations for light pole bases, guard rails, small signs, and similar lightweight ancillary structures can be designed and installed using conventional methods.

Site grades are planned to generally be approximately El. 440 around the structures which will result in the need for some low-height (in the range of 3-7 ft) retaining walls in the northwest corner of the site and potentially along Lincoln Street. Retaining walls may consist of gravity block walls or mechanically stabilized (grid reinforced) earth walls depending on the retained height and required surcharge loads. Positioning of grid reinforced walls relative to property lines and other site constraints should consider lengths of grid reinforcement and excavation requirements for installation of grid reinforcement. For initially planning, it should be assumed that grid reinforcement lengths may be on the order of one times the wall height (for walls with level backslope grades), and that excavation limits would extend to 1.5 times the wall height from the back of the grid reinforcement (where existing grades are flat). Subsurface drains should be assumed in the courtyard areas given the shallow depth to groundwater. These drains should be assumed to consist of 4-in. diameter perforated PVC pipe installed in crushed stone filled trenches (18-in. width) lined with filter fabric. Inverts of these pipes would be approximately 2 ft below finished site grades with 6 in. minimum of crushed stone beneath the piping. Assume pipe network would line the courtyard perimeters with intermediate runs, if/ where necessary. These drains would be routed to the site storm drain system along with the underslab drains.

The existing Fill and near surface Glacial Deposits were noted to generally be sandy in nature. We anticipate that stormwater infiltration will be possible but understand that the civil engineer is evaluating the feasibility of these systems.

EARTHWORK AND DEWATERING

Based on anticipated grading for the proposed construction and subsurface conditions encountered in the test borings, conventional earthwork procedures and equipment can be used. Depending on the approach taken for structure foundations and slab areas, excavations may extend below normal groundwater levels, in those cases temporary dewatering to allow for construction in-the-dry would be required. Dewatering using well points, or a system of deeper sumps may be needed to lower the water table sufficiently to allow for construction in the dry. Dewatering should also be anticipated for locally deeper excavations or on an intermittent basis during periods of moderate to heavy precipitation or snow melt.

The existing Fill appears to be variable in nature and suitable for use as Common Fill to raise grades around the site or potentially below slab-on-grade areas. The near surface natural Glacial Deposits that appear consist primarily of fine sand materials and appear suitable for re-use as common fill and potentially as compacted structural fill. It will be important to protect these soils during earthwork activities to the extent practical as excessive moisture may render these soils difficult to not possible to reuse as compacted fill. The Fill in several locations was also noted to contain significant amounts of debris which will need to be segregated from the Fill prior to re-use. They will also be susceptible to disturbance from construction traffic.

During the preliminary investigation, explorations were not conducted within the limits of the parking garage. We anticipate that the conditions will be similar to other areas of the site that were explored, but there may be a thicker layer of topsoil at the surface as they are vegetated. As a result, these areas may require a raise in grade with suitable on-site common fill or imported compacted structural fill following the removal of these existing organic soils to achieve the desired finished grades.

The footing subgrades within the natural Glacial Deposits will consist of fine sand and will be susceptible to disturbance from storm water and traffic. As such, placement of 3-4 in. of crushed stone on prepared foundations subgrades (with geotextile filter fabric separation) is recommended to protect the subgrades from disturbance during placement of re-bar and forms.

ADDITIONAL EXPLORATIONS AND TESTING

Based on the observations during this preliminary phase, we recommend that additional explorations consisting of test borings and test pits be conducted at the site to further investigate the subsurface conditions, limits of debris areas, and gather bulk samples for geotechnical testing to evaluate the re-use potential of the existing Fill and natural Glacial Deposits. The types, numbers, and locations will depend on the final development layout, stormwater infiltration locations, and proposed grading.

CLOSING

We appreciate the opportunity to provide these preliminary geotechnical engineering services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely yours,
HALEY & ALDRICH, INC.

Michael J. Weaver, P.E. (MA)
Senior Associate

John T. Difini, P.E. (MA)
Principal

Attachments:

Figure 1	Project Locus
Figure 2	Site and Subsurface Exploration Location Plan
Appendix A	Concept Plans dated 26 January 2022
Appendix B	Logs of Test Borings and Observation Well Installation Reports
Appendix C	Logs of Test Pits Prepared by Allen & Major
Appendix D	Groundwater Measurements by Vertex

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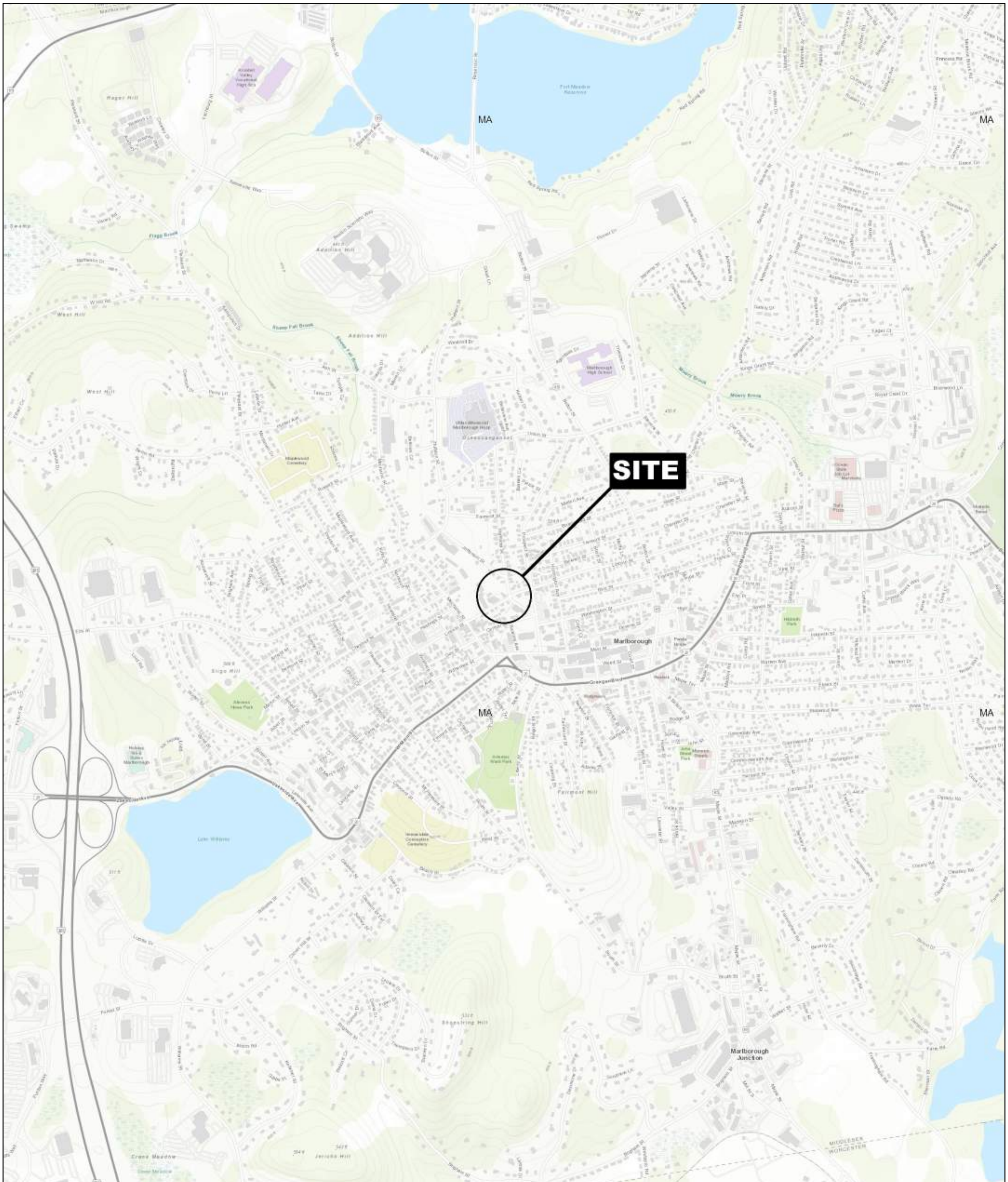
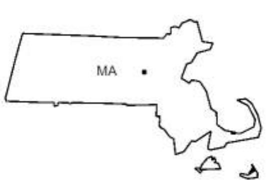
FIGURES



SITE COORDINATES: 42°20'55"N, 71°33'12"W



MAP SOURCE: USGS

HALEY ALDRICH

LINCOLN STREET RE-DEVELOPMENT
283 TO 325 LINCOLN STREET
MARLBOROUGH, MASSACHUSETTS

PROJECT LOCUS

APPROXIMATE SCALE: 1 INCH = 2,000 FEET
FEBRUARY 2022

FIGURE 1

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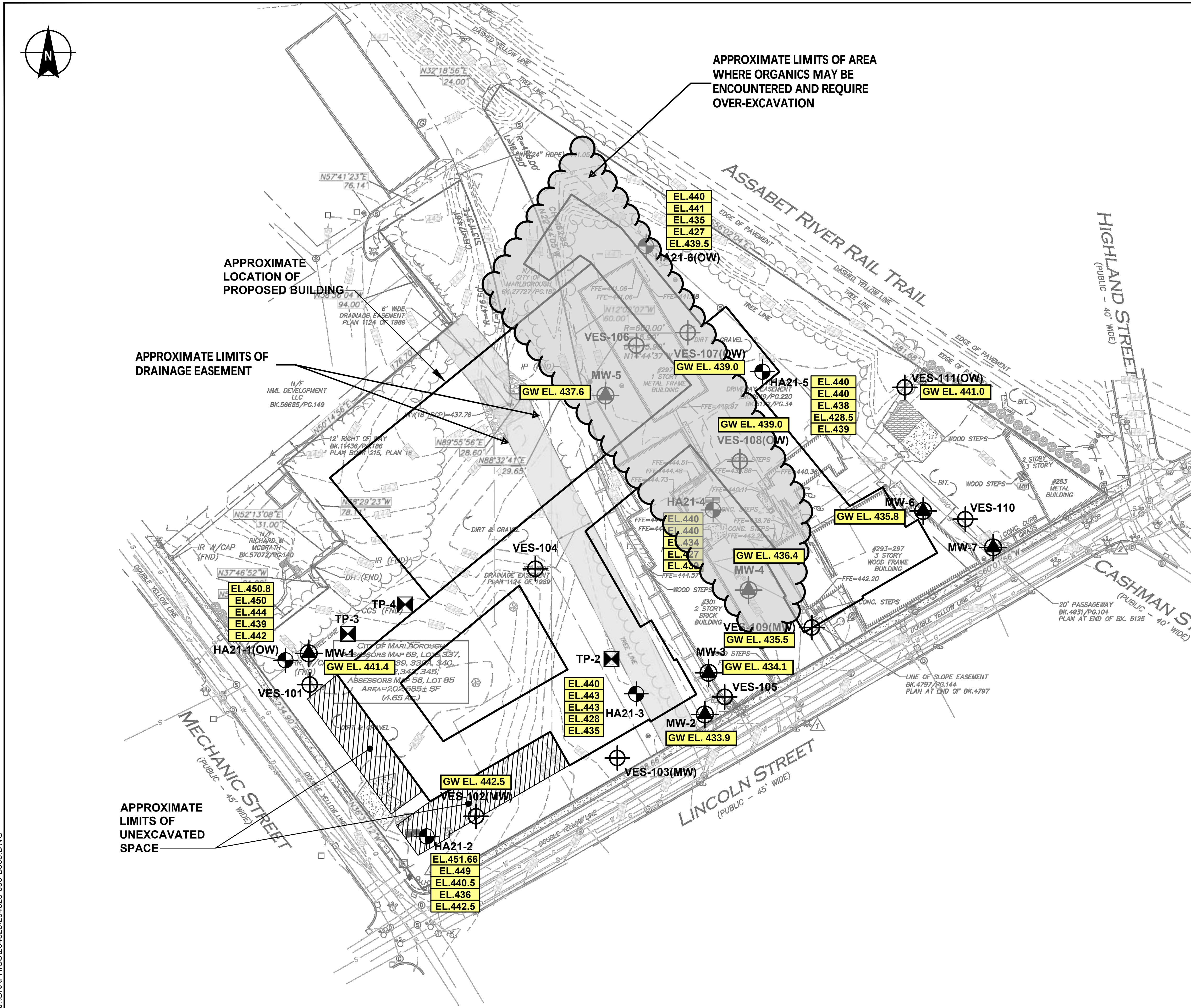

LEGEND

HA-1	DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING ADVANCED BY NORTHERN DRILL SERVICE BETWEEN 17 AND 20 DECEMBER 2021. EXPLORATIONS WERE OBSERVED IN THE FIELD BY HALEY & ALDRICH GEOLOGIST.
TP-1	DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY M.J. CATALDO ON 17 DECEMBER 2021. EXPLORATIONS WERE MONITORED IN THE FIELD BY A REPRESENTATIVE FROM ALLEN & MAJOR ASSOCIATES.
VES-101	DESIGNATION AND APPROXIMATE LOCATION OF NEW EXPLORATION BY VERTEX ENGINEERING (SEE APPENDIX D)
MW-1	DESIGNATION AND APPROXIMATE LOCATION OF EXISTING MONITORING WELL BY OTHERS (SEE APPENDIX D)
(OW)	INDICATES A GROUNDWATER OBSERVATION WELL WAS INSTALLED IN THE COMPLETED BORING
EL.440	PROPOSED ELEVATION
EL.450	EXISTING GROUND SURFACE ELEVATION
EL.444	TOP OF NATURAL SOIL ELEVATION
EL.439	TOP OF ROCK ELEVATION
EL.442	APPROXIMATE GROUNDWATER ELEVATION

NOTES

1. BASE PLAN TAKEN FROM A DRAWING TITLED "EXISTING CONDITIONS, V-101", PREPARED BY ALLEN & MAJOR ASSOCIATES, INC., DATED 18 JANUARY 2022.
2. EXPLORATION LOCATIONS ARE CONSIDERED APPROXIMATE AND WERE DETERMINED IN THE FIELD BY TAPING TO EXISTING SITE FEATURES.
3. LIMITS OF PROPOSED BUILDINGS WERE TAKEN FROM DRAWINGS ENTITLED, "CONCEPT PLAN," DATED 3 JUNE 2021 AND OBTAINED FORM WOOD PARTNERS VIA EMAIL ON 5 JANUARY 2022
4. TEST PIT TP-1 WAS ADVANCED AT AN OFF-SITE LOCATION, 56 JEFFERSON STREET, MARLBOROUGH, MA, AND OBSERVED BY ALLEN & MAJOR AND ASSOCIATES. SEE REPORT TEXT FOR DETAILS.
5. LOCATIONS AND DESIGNATIONS OF WELLS AND EXPLORATIONS BY OTHERS FROM VERTEX ENGINEERING PLAN, "FIGURE 3 - PROPOSED BORING PLAN," DATED 14 JANUARY 2022.

0 80 160
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

LINCOLN STREET RE-DEVELOPMENT
283 TO 325 LINCOLN STREET
MARLBOROUGH, MASSACHUSETTS

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
FEBRUARY 2022

FIGURE 2

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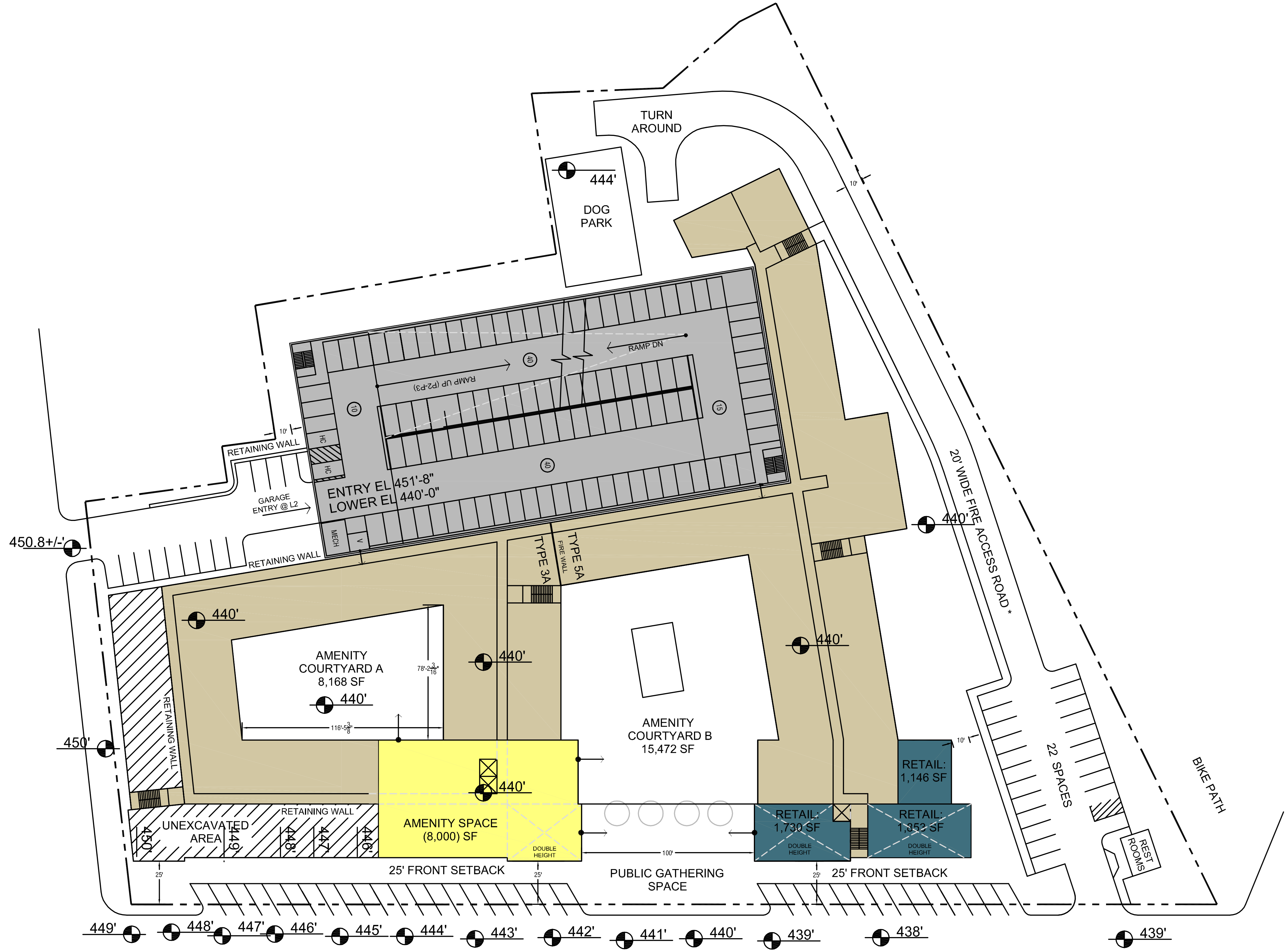
APPENDIX A

CONCEPT PLANS DATED 26 JANUARY 2022

LINCOLN ST
Marlborough, MA.

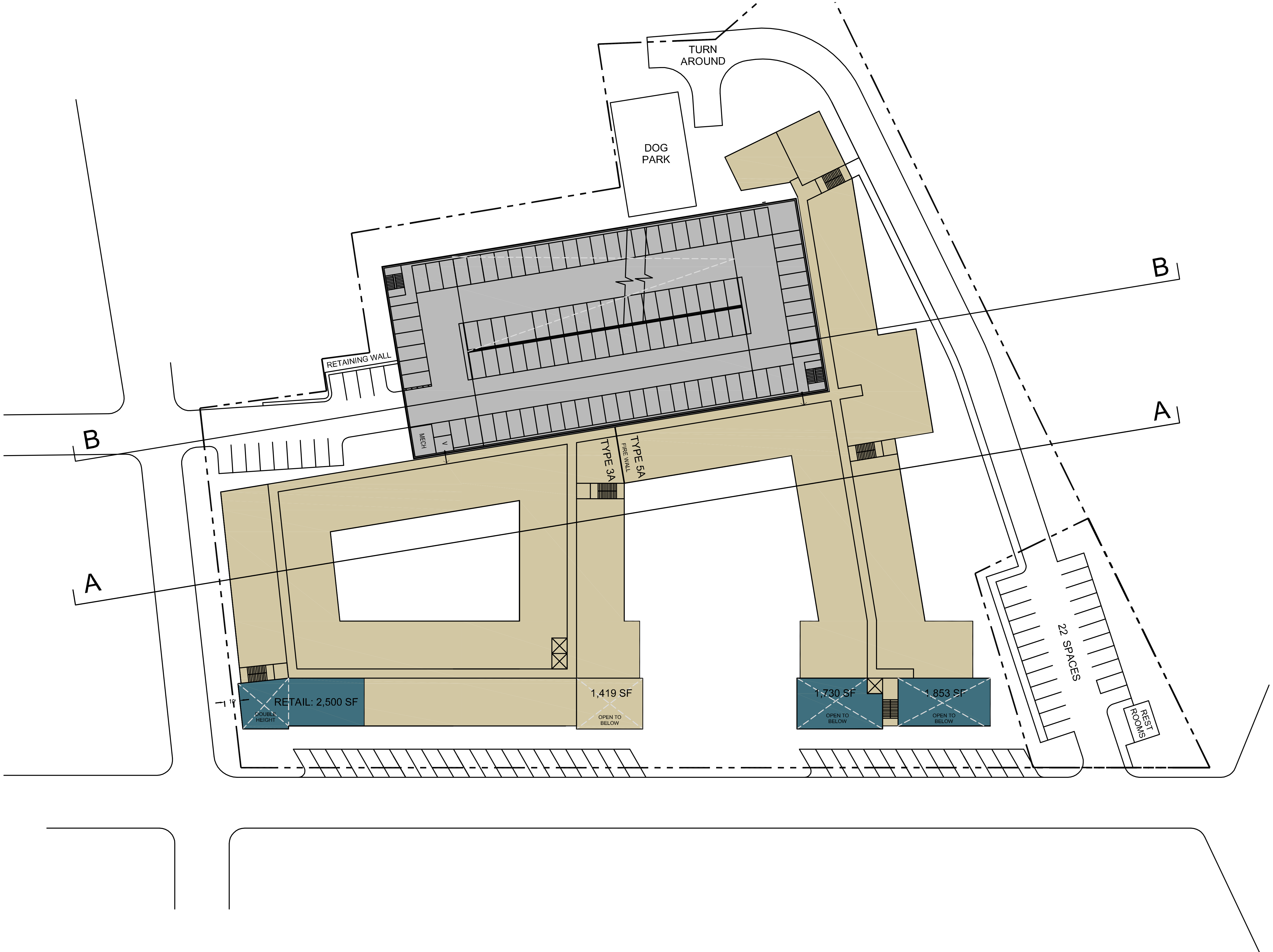


CONCEPT PLAN
1.26.21

WOOD PARTNERS

LEVEL 1

LINCOLN ST
Marlborough, MA.

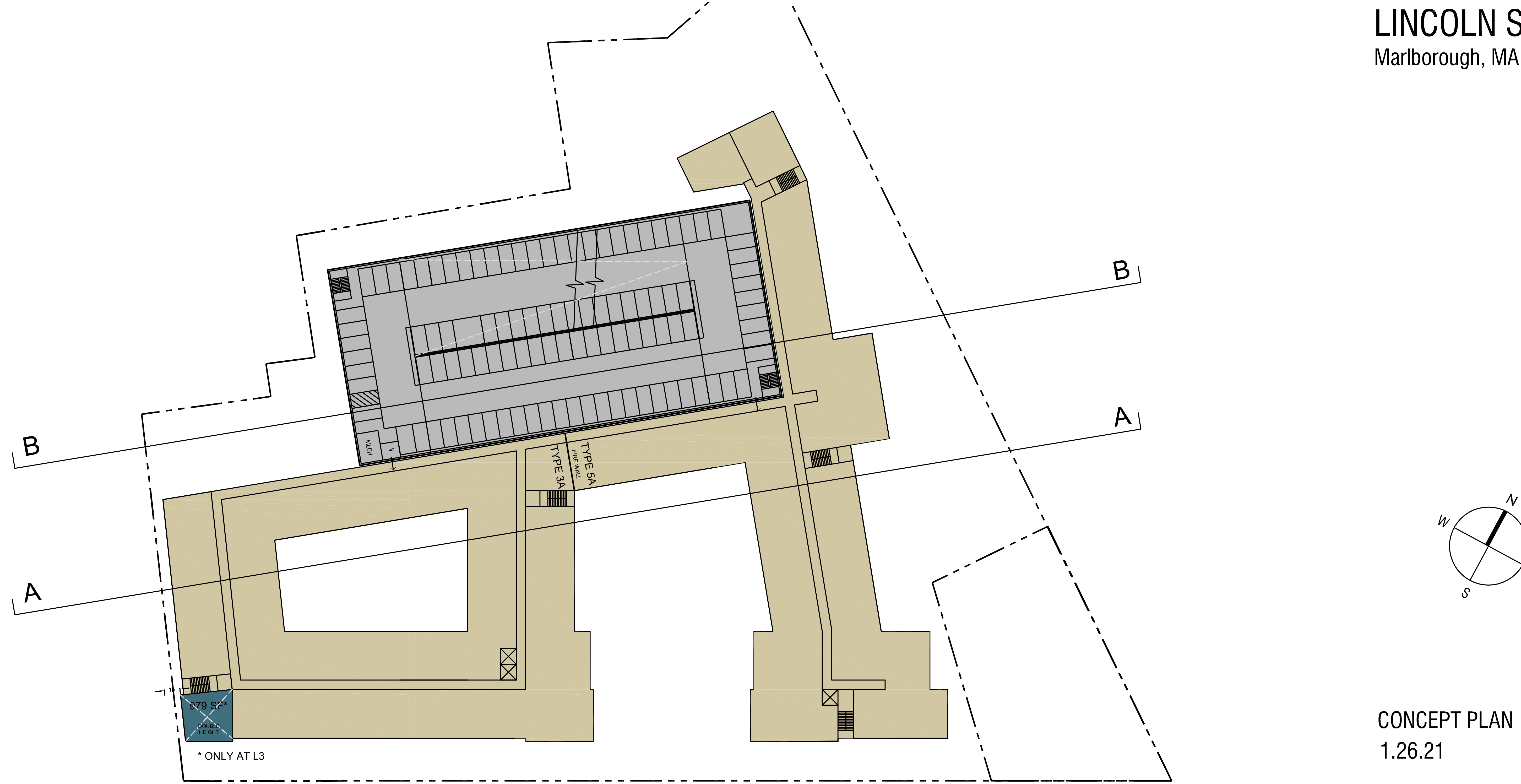


CONCEPT PLAN
1.26.21

WOOD PARTNERS

LEVEL 2

LINCOLN ST
Marlborough, MA.

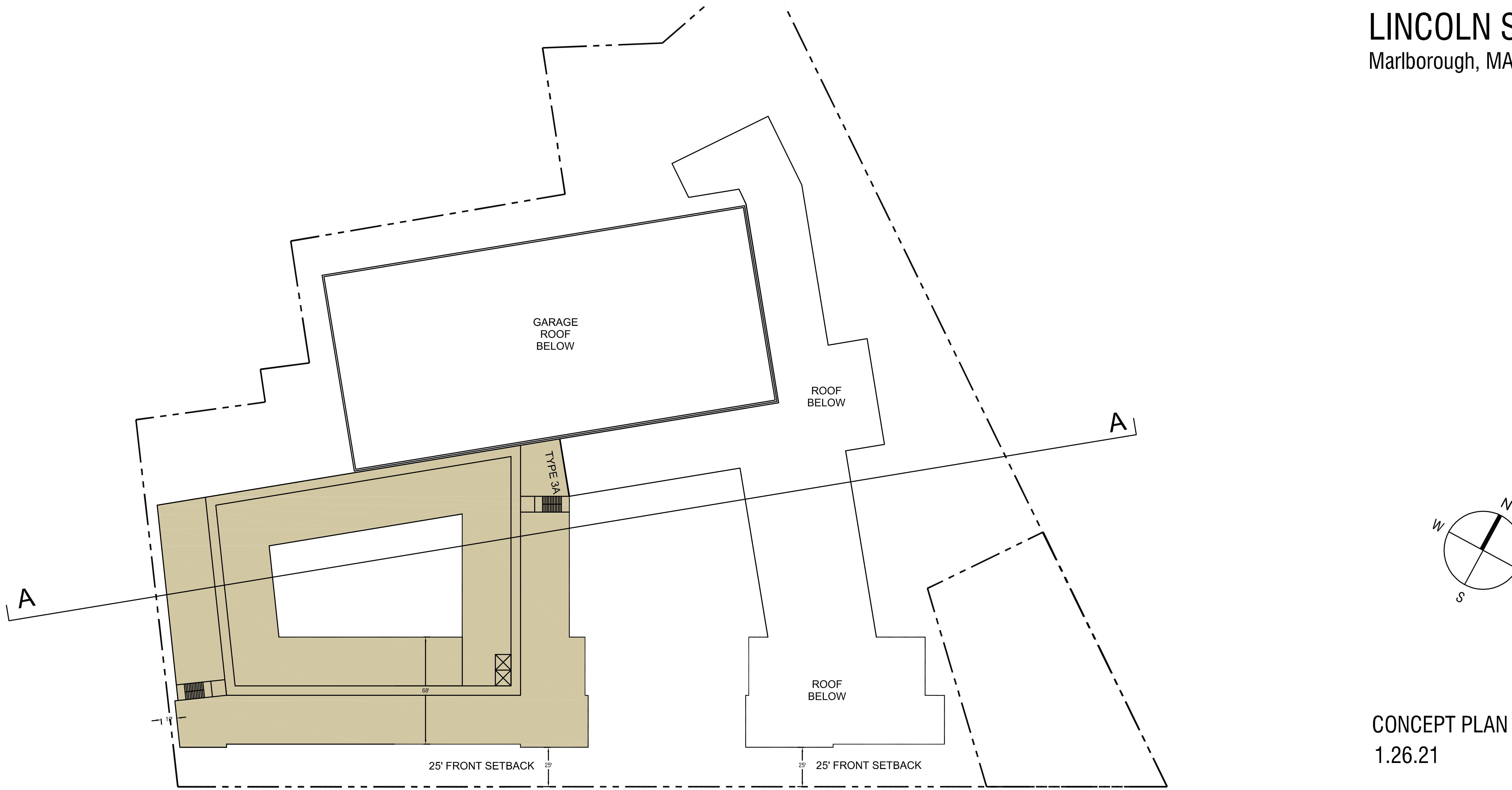


CONCEPT PLAN
1.26.21

WOOD PARTNERS

LEVEL 3-4

LINCOLN ST
Marlborough, MA.

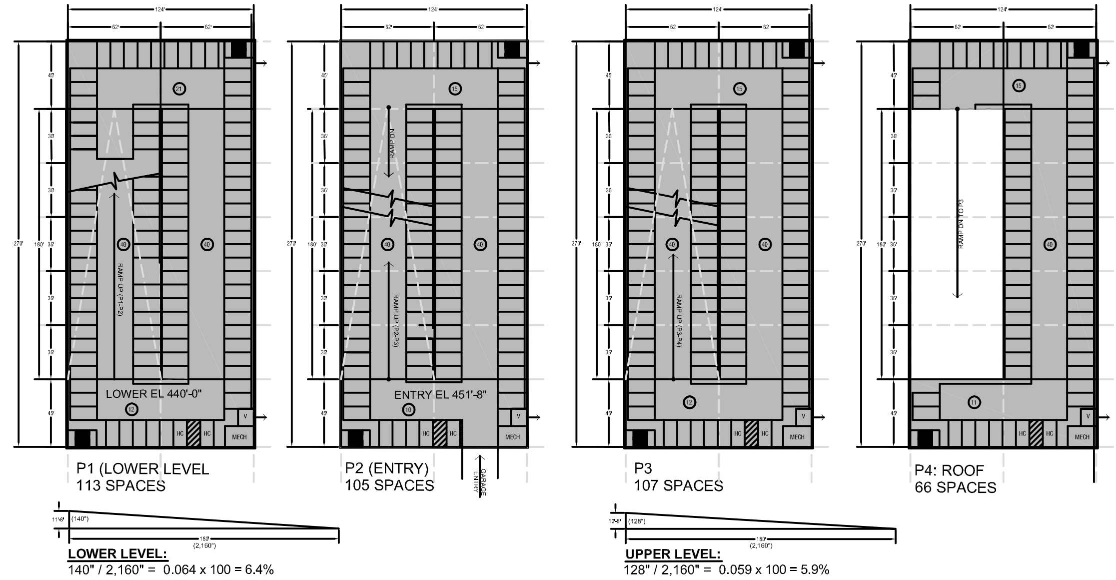


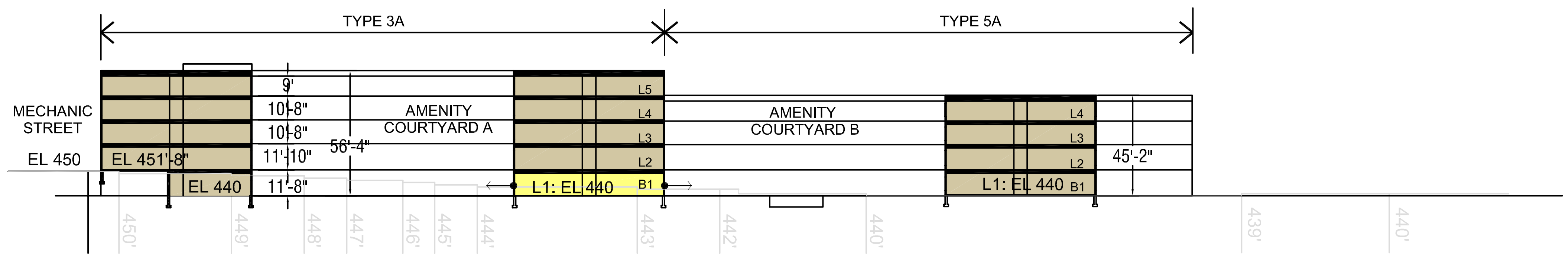
CONCEPT PLAN
1.26.21

WOOD PARTNERS

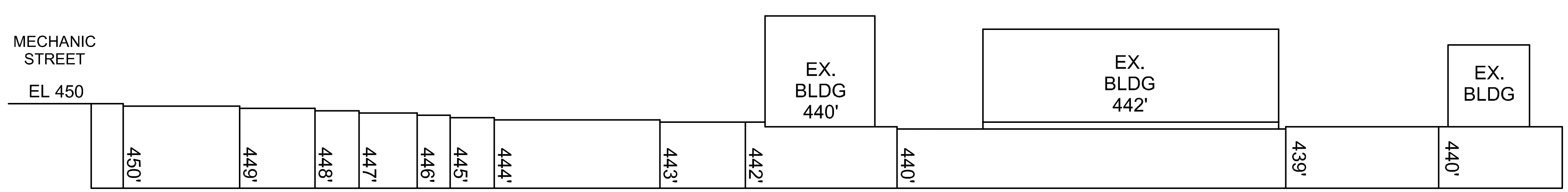
LEVEL 5

LINCOLN ST
Marlborough, MA.

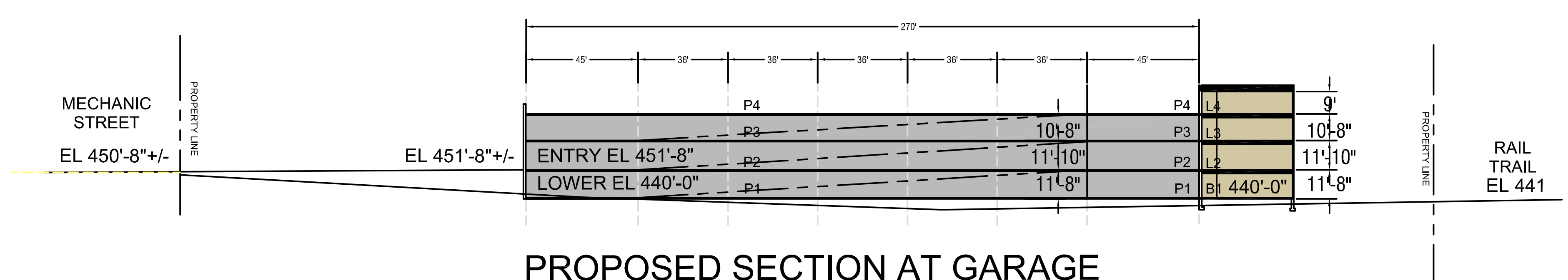




PROPOSED SECTION AT LINCOLN STREET



EXISTING SECTION AT LINCOLN STREET



PROPOSED SECTION AT GARAGE

CONCEPT PLAN
1.26.21

WOOD
PARTNERS

LINCOLN ST
Marlborough, MA.

GSF - Residential	Type 3A	Type 5A	Retail	Garage GSF	Spaces	Open to Below Type 3A	Open to Below Type 5A	Amenity	UNITS Type 3A	UNITS Type 5A
L5	36,801	0	0	0	0			0	33	0
L4	36,801	31,636	0	22,921	66			0	33	29
L3	35,822	31,636	0	34,272	107	979		0	32	29
L2	32,882	28,053	2,500	34,272	105	1,419	3,583	0	27	29
L1	20,761	26,879	4,757	34,272	113			8,000	15	22
Totals	**163,067**	**118,204**	**7,257**	**125,737**	**391**	**2,398**	**3,583**	**8,000**	**140**	**109**

Total Res. GSF	281,271	
Efficiency:	80.42%	
NRSF:	226,200	
Lot Size	4.71	AC (including corner lot)

Parking Grade (Retail)	48
Parking Garage (Res.)	391
Total Spaces	439
Ratio/unit (Res.)	1.57
Ratio/bed (Res.)	1.09

Retail SF	7,257
Req. Pkg	29
Prov. Pkg	48

Corner Lot	14,695	GSF (+/-)
Restroom Building	394	GSF (+/-)
Parking Spaces	21	Spaces

Unit Types									Beds
Studio		EA	527	NRSF/UNIT	0	0%	0%		0
Jr 1 Bedroom/1 BA		EA	600	NRSF/UNIT	0	0%			0
1 Bedroom/1 BA	127	EA	750	NRSF/UNIT	95,250	51%			127
1 Bed+Den/1 BA	25	EA	850	NRSF/UNIT	21,250	10%	61%		25
2 Bedroom/2 BA	85	EA	1,100	NRSF/UNIT	93,500	34%	34%		170
3 Bedroom/2 BA	12	EA	1,350	NRSF/UNIT	16,200	5%	5%		36
	249	**EA**	**908**	**TOTAL NRSF**	**226,200**	**100%**	**100%**		**358**

CONCEPT PLAN
1.26.21

WOOD PARTNERS

INSTALLATION

OF

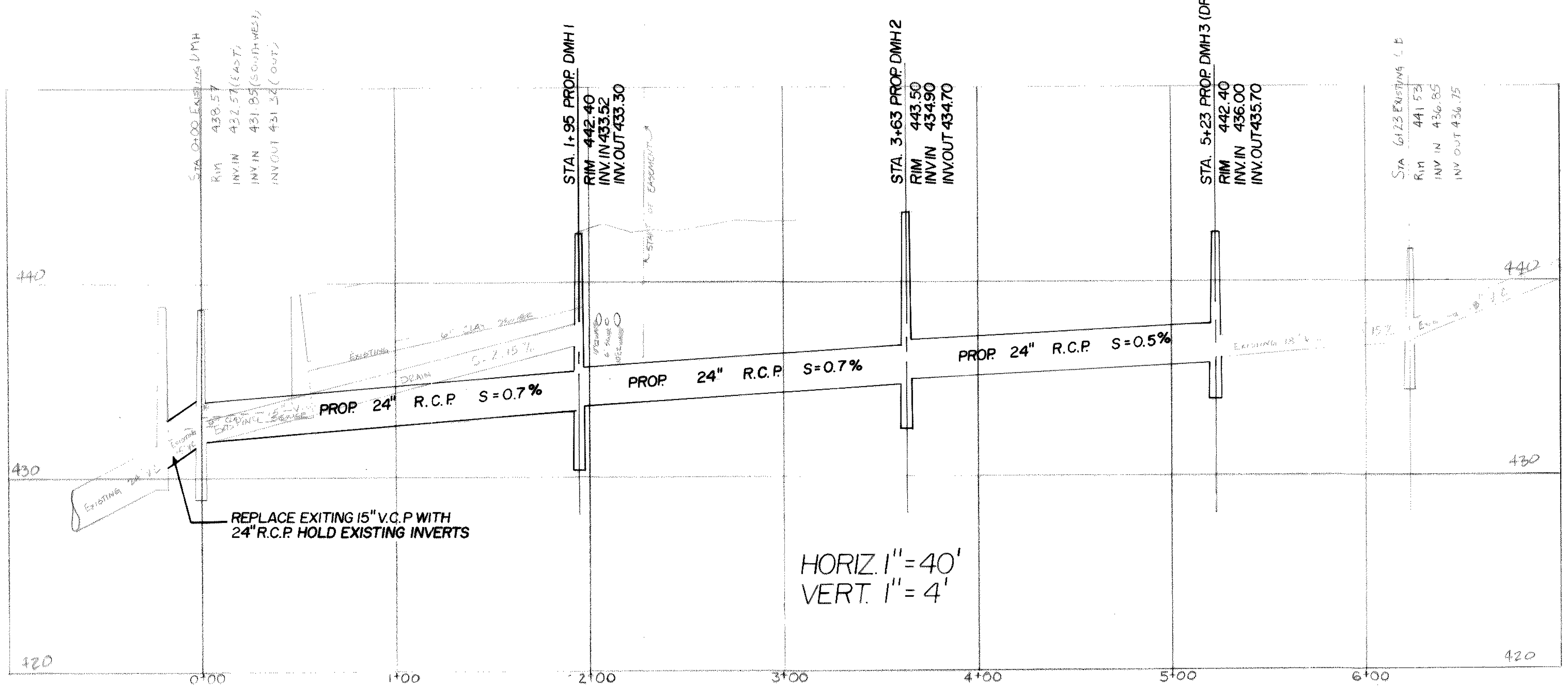
DRAINAGE

MARLBOROUGH, MASSACHUSETTS

ENGINEERING DIVISION
DEPT. OF PUBLIC WORKS

PAUL A. SHARON, COMM. OF D.P.W.
RONALD M. LaFRENIERE, CITY ENGINEER

L-282



LEGEND

PROP. 24" R.C.P.
PROP. DMH
EXISTING D.M.H.
EXISTING C.B.
EXISTING DRAIN LINES
HAYBALES
EXISTING HYDRANT
EXISTING U.P.
EXISTING WATERLINE
EXISTING SEWER LINE
EXISTING W.G.
EXISTING SMH
EXISTING GAS LINE
EXISTING FENCE

NOTES:

1. REMOVE AND DISPOSE OF EXISTING 15" V.C. PIPE BETWEEN STA. 0+00 THRU STA. 1+95.

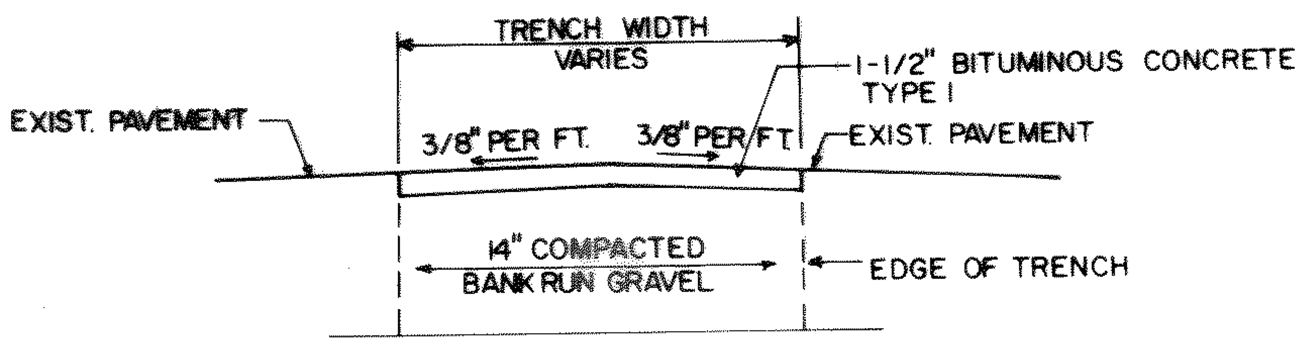
PLAN OF PROPOSED DRAINAGE & APPURTENANCES
LINCOLN STREET
MARLBOROUGH, MASSACHUSETTS

SCALE: AS SHOWN
DATE: JUNE, 1988
REV. FEB. 1989

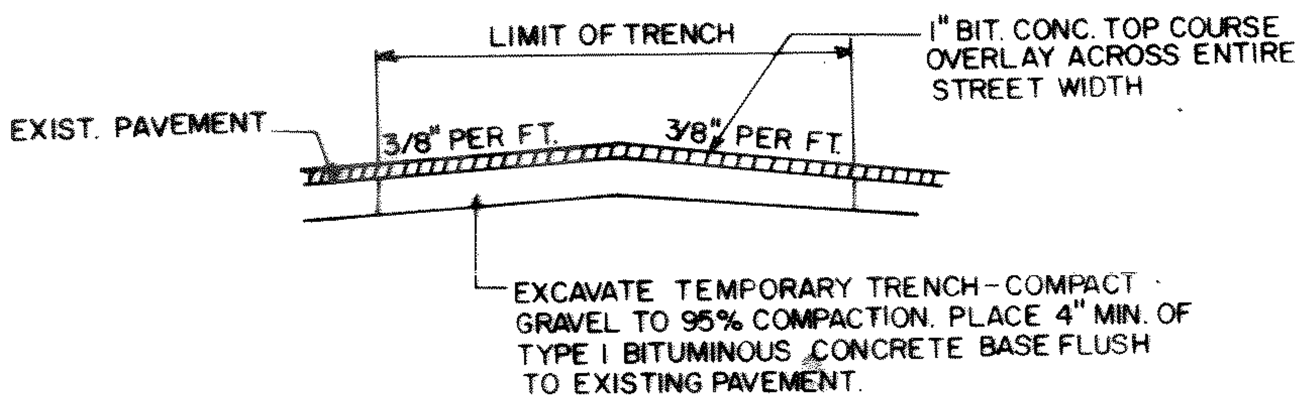
RONALD M. LAFRENIERE P.E., CITY ENGINEER

523

L-282



TEMPORARY TRENCH PATCH
NOT TO SCALE

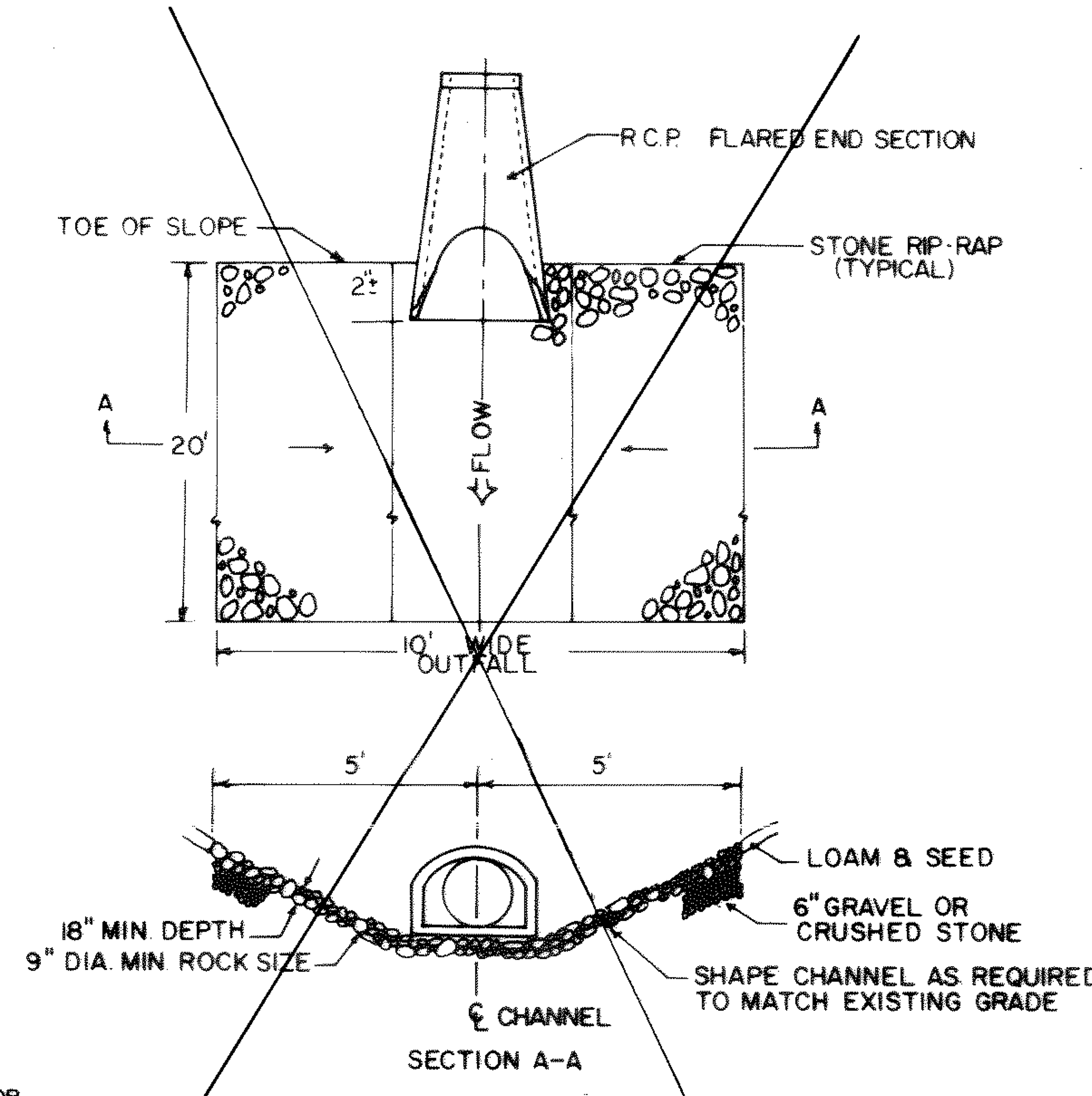


PERMANENT PAVING
NOT TO SCALE

STONE FOR PIPE ENDS

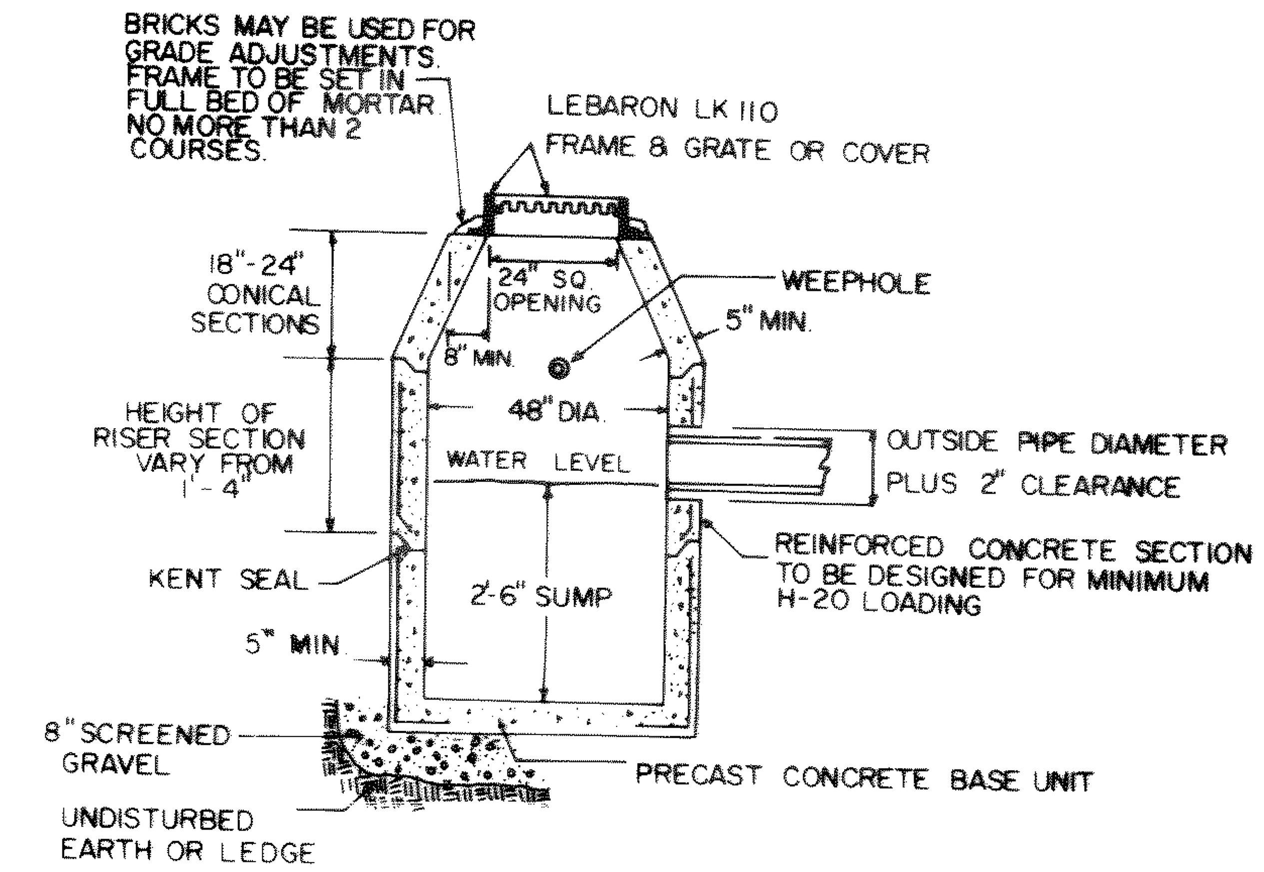
STONE FOR PIPE ENDS SHALL BE SOUND, DURABLE ROCK WHICH IS ANGULAR IN SHAPE. ROUNDED STONES, BOULDERS, SANDSTONE OR SIMILAR STONE OR RELATIVELY THIN SLABS WILL NOT BE ACCEPTABLE. EACH STONE SHALL WEIGH NOT LESS THAN 50 POUNDS NOR MORE THAN 125 POUNDS AND AT LEAST 75% OF THE VOLUME SHALL CONSIST OF STONE WEIGHING NOT LESS THAN 75 POUNDS EACH. THE REMAINDER OF THE STONE SHALL BE PLACED WITH THE LARGER STONES SO THAT WHEN GRADED THE ENTIRE MASS WILL BE COMPACTED.

THE STONE SHALL BE UNDERLAYED BY A FILTER BLANKET COMPOSED OF CLEAN COARSE GRAVEL WITH NO STONES OVER 3" AND LESS THAN 10% PASSING A # 200 SIEVE. THE FILTER BLANKET NEED NOT BE COMPACTED BUT SHALL BE GRADED TO A UNIFORM SURFACE. THE MINIMUM THICKNESS SHALL BE 6".

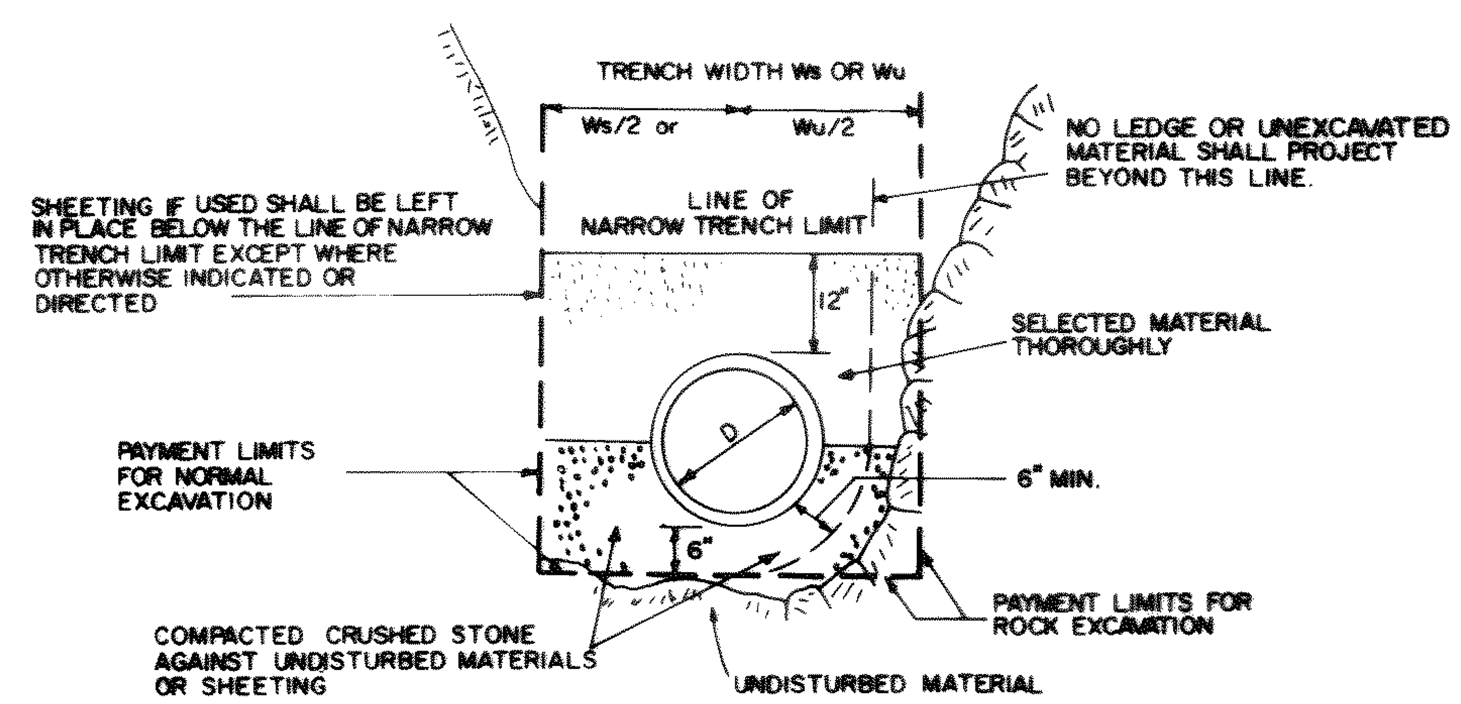


EROSION PROTECTION AT OUTLET
NOT TO SCALE

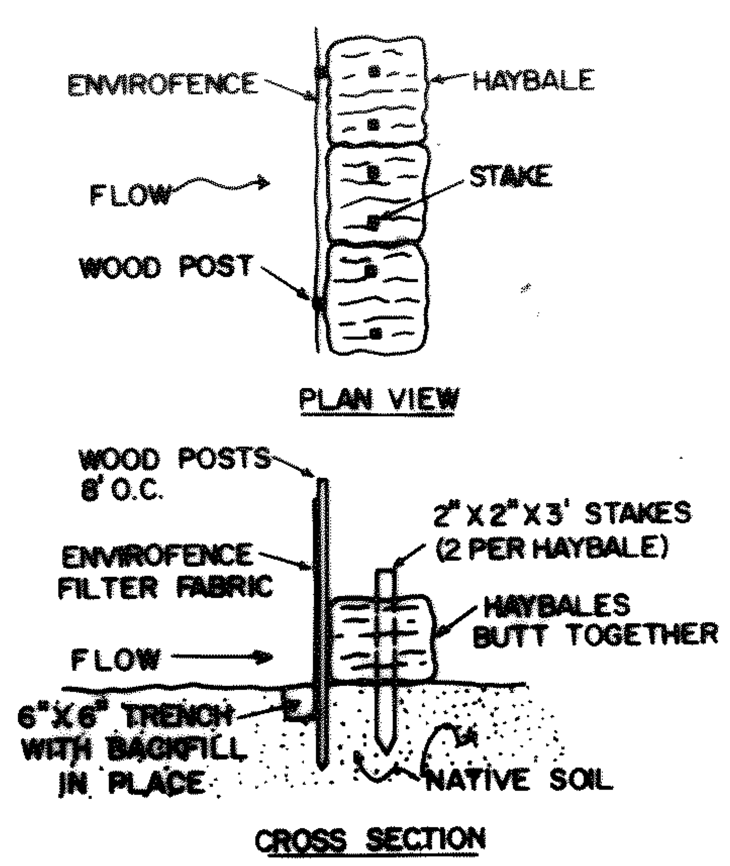
N/A



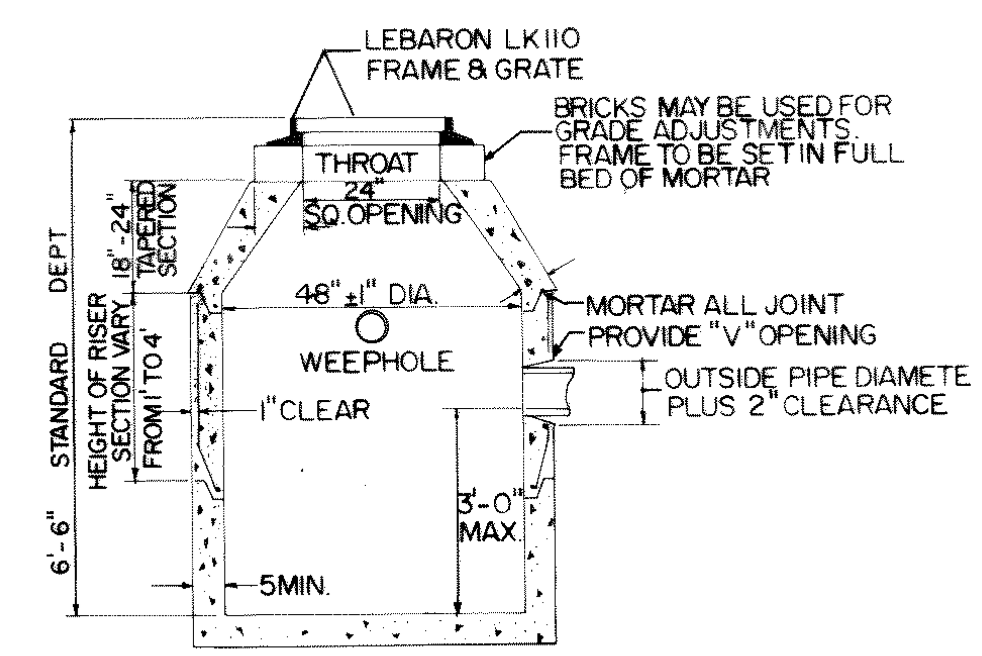
PRECAST CONCRETE CATCH BASIN
NOT TO SCALE



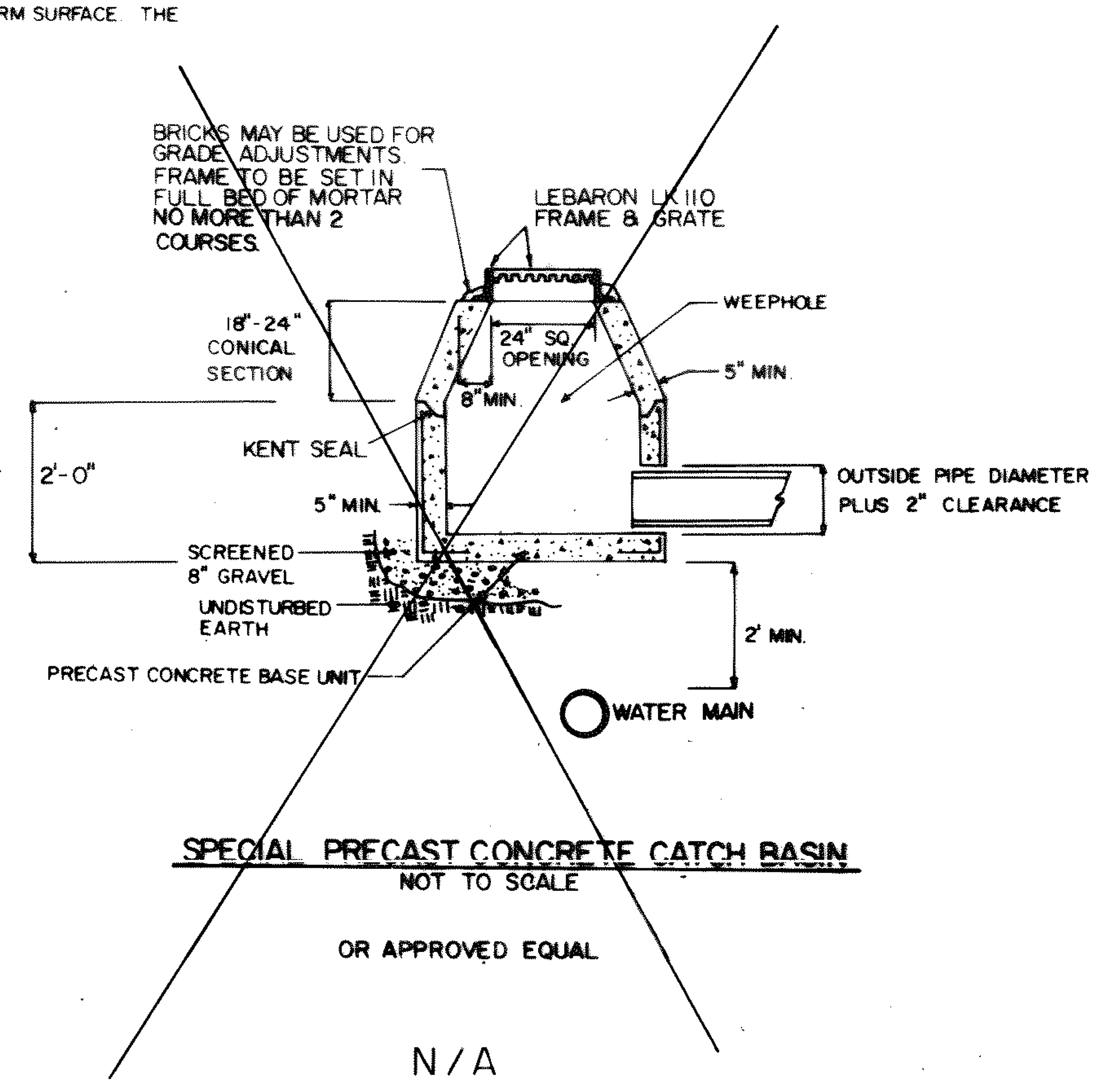
DRAINAGE TRENCH SECTION
NOT TO SCALE



EROSION CONTROL BARRIER
NOT TO SCALE



SPECIAL PRECAST CONCRETE DROP INLET
NOT TO SCALE



SPECIAL PRECAST CONCRETE CATCH BASIN
NOT TO SCALE

OR APPROVED EQUAL

N/A

PLAN
OF
TYPICAL DRAINAGE DETAILS
FOR THE CITY
of
MARLBOROUGH, MASSACHUSETTS

MARLBOROUGH, MASSACHUSETTS
SCALE : AS NOTED

COMMONWEALTH OF MASSACHUSETTS RONALD MATTHEW LaFRENIERE No. 29405 REGISTERED PROFESSIONAL ENGINEER

CITY ENGINEER

L-282

APPENDIX B

LOGS OF TEST BORINGS AND OBSERVATION WELL INSTALLATION REPORTS

TEST BORING REPORT

Boring No. HA21-1(OW)

Project	283-325 LINCOLN ST, MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.

File No.	0204525-000
Sheet No.	1 of 1
Start	16 December 2021
Finish	16 December 2021
Driller	T. Tucker
H&A Rep.	D. Palleiko
Elevation	450.0 (est.)
Datum	NAVD88
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	
Inside Diameter (in.)	4	1.4	
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile DRILL B53
Bit Type: Roller Bit
Drill Mud: None
Casing: Drive and wash
Hoist/Hammer: Winch / Automatic hammer
PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	7 5 4 3	S1 14	0.0 2.0	SM			Loose gray-brown to dark brown silty SAND with gravel (SM), no structure, no odor, moist, trace concrete -FILL-	5	10		15	50	20				
	1 3 5 6	S2 9	2.0 4.0														
5	11 29 10 3	S3	4.0 6.0	SM		444.0 6.0	Dense gray silty SAND with gravel (SM), no structure, no odor, moist to wet	15	15	5	10	35	20				
	10 10 9 12	S4 15	6.0 8.0	SM			Medium dense brown to light-brown silty SAND (SM), bonded, no odor, weathered till -GLACIAL TILL-	5	5	5	15	45	25				
10	9 11 14 100	S5 14	9.0 11.0	SM		439.0 11.0	Medium dense brown to light-brown silty SAND (SM), bonded, no odor, weathered till	5	5	5	15	45	25				
15	18 82 100/5"	S6 16	14.0 15.4	SM			Very dense red-brown and gray silty SAND with gravel (SM), exhibits relict rock structure, no odor -WEATHERED BEDROCK-	15	20	10	15	20	20				
	100/3"	S7 2	19.0 19.3	GW		430.7 19.3	Very dense gray well-graded GRAVEL with sand (GW), exhibits relict rock structure, no odor BOTTOM OF EXPLORATION 19.3 FT Note: Installed observation well in completed boring. Note: Equipment refusal.	15	55	5	10	10	5				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/21	07:42	100.0		14.8	8.9

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 19.3
Rock Cored (ft) 0
Samples S7

Boring No. HA21-1(OW)

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

† **Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. HA21-1(OW)

Project	283-325 LINCOLN ST
Location	MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.
Driller	T. Tucker
Initial Water Level (depth bgs)	~8.0 ft

Well Diagram

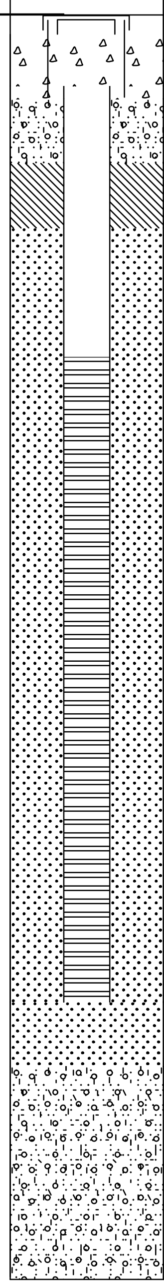
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	0204525-000
Date Installed	16 Dec 2021
H&A Rep.	D. Palleiko
Location	See Plan
Ground El.	450.0 (est.)
Datum	NAVD88

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
FILL	6.0
GLACIAL TILL	11.0
WEATHERED BEDROCK	19.3

WELL DETAILS



DEPTH (ft.)	ELEVATION (ft.)
0.0	450.0
0.8	449.2
1.0	449.0
2.0	448.0
3.0	447.0
5.0	445.0
15.0	435.0
16.0	434.0
19.3	430.7

WELL CONSTRUCTION DETAILS

Type of protective cover	Compression cap
Depth of Roadway Box below ground surface	0.0 ft
Depth of top of riser below ground surface	0.8 ft
Type of protective casing	Roadway Box
Length	0.8 ft
Inside diameter	4.0 in.
Depth of bottom of Roadway Box	0.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	5.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite	2.0	1.0
	-	-
	-	-

Diameter of borehole	4.5 in.
Depth to top of well screen	5.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	#1 Filter Sand
Depth to bottom of well screen	15.0 ft
Bottom of silt trap	15.0 ft
Depth of bottom of well	19.3 ft
Depth of bottom of borehole	19.3 ft

COMMENTS:

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA21-2

Project	283-325 LINCOLN ST, MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.

File No.	0204525-000
Sheet No.	1 of 1
Start	16 December 2021
Finish	16 December 2021
Driller	T. Tucker
H&A Rep.	D. Palleiko
Elevation	449.0 (est.)
Datum	NAVD88
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	
Inside Diameter (in.)	4	1.4	
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures
- Rig Make & Model: Mobile DRILL B53
- Bit Type: Roller Bit
- Drill Mud: None
- Casing: Drive and wash
- Hoist/Hammer: Winch / Automatic hammer
- PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	5 5 4 3	S1 11	0.0 2.0	SM		Loose gray-brown to brown silty SAND with gravel (SM), no structure, no odor, moist -FILL-	5	15	5	10	35	30				
	6 5 2 4	S2 4	2.0 4.0	SM		Loose brown with red silty SAND with gravel (SM), 40% brick	35	5	10	15	20	15				
5	5 8 2 1	S3 1	4.0 6.0	GP		Loose red poorly-graded GRAVEL (GP), no structure, no odor, moist, 65% brick		100								
	3 36 4 18	S4 7	6.0 8.0	SP-SM	443.0 6.0	Dense brown to gray poorly-graded SAND with silt and gravel (SP-SM), no structure, no odor, moist, weathered concrete -URBAN FILL-	20	20	15	20	15	10				
					441.0 8.0	-CONCRETE-										
10	17 16 11 10	S5 6	9.0 11.0	SM	440.5 8.5	Medium dense yellow-brown to orange silty SAND with gravel (SM), bonded, no odor, wet, clayey sand -GLACIAL TILL- Note: Casing refusal at 13.0 ft on weathered bedrock. TOP OF WEATHERED BEDROCK	10	10	15	15	30	20				
	100/2"	S6 2	14.0 14.2	GW	436.0 13.0 434.8 14.2	Very dense gray with red-brown well-graded GRAVEL with sand (GW), exhibits relict rock structure, no odor, wet -WEATHERED BEDROCK- BOTTOM OF EXPLORATION 14.2 FT Note: Equipment refusal.	35	20	15	10	15	5				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/16/21	13:22	0.3	13.0	13.6	2.3

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 14.2
- Rock Cored (ft) 0
- Samples S6

Boring No. HA21-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA21-3

Project	283-325 LINCOLN ST, MARLBOROUGH, MA	File No.	0204525-000
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE	Sheet No.	1 of 1
Contractor	NORTHERN DRILL SERVICE, INC.	Start	16 December 2021
		Finish	17 December 2021
		Driller	T. Tucker
		H&A Rep.	D. Palleiko
		Elevation	443.0 (est.)
		Datum	NAVD88
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S		Rig Make & Model: Mobile DRILL B53
Inside Diameter (in.)	4	1.4		Bit Type: Roller Bit Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: Drive and wash Hoist/Hammer: Winch / Automatic hammer
Hammer Fall (in.)	24	30	-	PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	8 11 11 12	S1 18	0.0 2.0	SM		Medium dense light-brown with dark brown (SM), no structure, no odor, moist		5	5	5	45	40				
				SM		Loose dark brown to brown silty SAND (SM), no structure, no odor, wet to wet		5		10	45	40				
						-GLACIOFLUVIAL DEPOSITS-										
5	1 0. 0 0	S3 3	4.0 6.0	SM		Very loose gray-brown silty SAND (SM), no structure, no odor, wet to wet		5		10	45	40				
	1 0 0 0	NR 0	6.0 8.0													
10	6 4 4	S4 12	9.0 10.5	SM	434.0 9.0	Loose olive-gray with brown silty SAND (SM), moist, bonding increases with depth	5	5		10	40	40				
						-GLACIAL TILL-										
15	11 15 43 36	S5 16	14.0 16.0	SM		Medium dense silty SAND (SM), bonded, no odor, moist		5	5		45	45				
				SM	428.0 15.0	Very dense silty SAND with gravel (SM), exhibits relict rock structure, no odor, moist	20	10		15	30	25				
				SM		Very dense silty SAND with gravel (SM), exhibits relict rock structure, no odor, moist	20	10		15	30	25				
						-WEATHERED BEDROCK-										
	100/2"	S6 2	19.0 19.2		423.8 19.2	BOTTOM OF EXPLORATION 19.2 FT										
						Note: Equipment refusal.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/17/21	07:16	16.0	9.0	7.7	3.2
12/17/21	08:37	0.2	16.0	19.2	4.3

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	19.2
Rock Cored (ft)	0
Samples	S7

Boring No. HA21-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA21-4

Project	283-325 LINCOLN ST, MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.

File No.	0204525-000
Sheet No.	1 of 1
Start	17 December 2021
Finish	17 December 2021
Driller	T. Tucker
H&A Rep.	D. Palleiko
Elevation	440.0 (est.)
Datum	NAVD88
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	
Inside Diameter (in.)	4	1.4	
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures
- Rig Make & Model: Mobile DRILL B53
- Bit Type: Roller Bit
- Drill Mud: None
- Casing: Drive and wash
- Hoist/Hammer: Winch / Automatic hammer
- PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	6 7 7 2	S1 19	0.0 2.0	SM		Medium dense olive-brown to gray-brown silty SAND with gravel (SM) -FILL-	10	10	5	15	40	20				
	4 4 5 2	S2 11	2.0 4.0	SM		Loose black to gray silty SAND (SM), no structure, no odor, wet, trace ash	5	5		15	45	30				
5	2 4 3 5	S3 3	4.0 6.0	SM	436.0 4.0	Loose black silty SAND (SM), no structure, no odor, wet, 10% organics, fine gravel -TOPSOIL-		10	10	15	40	25				
	9 8 5 3	S4 11	6.0 8.0	SM	434.0 6.0	Medium dense gray silty SAND (SM), no odor, wet -GLACIAL TILL-	5	5		10	50	30				
10	11 15 32 26	S5 14	9.0 11.0	SM		Dense brown to light-brown silty SAND (SM), bonded		10	15	10	35	30				
						Note: Drill action change observed at 13.0 ft - hardens up, indicating stratum change.										
	100/3"	S6 3	14.0 14.3	SM	427.0 13.0 / 425.7 14.3	Very dense black and gray silty SAND with gravel (SM), exhibits relict rock structure, no odor, wet -WEATHERED BEDROCK-	10	10	30	15	20	15				

BOTTOM OF EXPLORATION 14.3 FT

Note: Equipment refusal.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/17/21	11:11	0.2	9.0	14.1	2.6

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 14.3
- Rock Cored (ft) 0
- Samples S6

Boring No. HA21-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA21-5

Project	283-325 LINCOLN ST, MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.

File No.	0204525-000
Sheet No.	1 of 1
Start	17 December 2021
Finish	17 December 2021
Driller	T. Tucker
H&A Rep.	D. Palleiko
Elevation	440.0 (est.)
Datum	NAVD88
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	
Inside Diameter (in.)	4	1.4	
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile DRILL B53
Bit Type: Roller Bit
Drill Mud: None
Casing: Drive and wash
Hoist/Hammer: Winch / Automatic hammer
PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	19 10 6 3	S1 15	0.0 2.0	SM		Medium dense brown to black silty SAND with gravel (SM), no structure, no odor, moist, 5% brick and ash in particles and specks -FILL-		15	5	15	35	30				
	3 5 6 100/1"	S2 9	2.0 3.6	SM	438.0 2.0	Medium dense black silty SAND (SM), no structure, no odor, moist to wet, 10% organics -GLACIOFLUVIAL DEPOSITS-		10	5	5	40	40				
5					436.4 3.6	Note: Boulder from 3.6 to 6.0 ft. -WEATHERED BOULDER-										
	18 18 13 12	S3 10	6.0 8.0	SM	434.0 6.0	Dense brown to light-brown silty SAND (SM), no structure, no odor, wet -GLACIOFLUVIAL DEPOSITS-				5	75	20				
10	6 9 9 69	S4 14	9.0 11.0	SM	431.0 9.0	Medium dense brown silty SAND with gravel (SM), bonded, no odor, wet -GLACIAL TILL- Note: NW Casing spun to 11.5 ft then slows. TOP OF WEATHERED BEDROCK AT 11.5 FT	10	10	5	15	30	30				
					428.5 11.5											
	100/1"	S5 1	14.0 14.1	SM	425.9 14.1	Very dense black and gray silty SAND (SM), no structure, no odor, wet, refusal in bedrock -WEATHERED BEDROCK- BOTTOM OF EXPLORATION 14.1 FT Note: Equipment refusal.				15	35	50				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/17/21	14:04	0.2	11.5	14.1	1.5

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	14.1
Rock Cored (ft)	0
Samples	S5

Boring No. HA21-5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA21-6(OW)

Project	283-325 LINCOLN ST, MARLBOROUGH, MA	File No.	0204525-000
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE	Sheet No.	1 of 1
Contractor	NORTHERN DRILL SERVICE, INC.	Start	20 December 2021
		Finish	20 December 2021
		Driller	T. Tucker
		H&A Rep.	D. Palleiko
		Elevation	441.0 (est.)
		Datum	NAVD88
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S		Rig Make & Model: Mobile DRILL B53
Inside Diameter (in.)	4	1.4		Bit Type: Roller Bit; Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: Drive and wash
Hammer Fall (in.)	24	30	-	Hoist/Hammer: Winch / Automatic hammer; PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	19 11 6 4	S1 14	0.0 2.0	SM			Medium dense light-brown to black silty SAND (SM), no structure, no odor, moist, 30% ash, coal increasing with depth -FILL-		10	10	15	40	25				
	3 8 6 5	S2 9	2.0 4.0	SM			Medium dense black to dark brown silty SAND (SM), no structure, no odor, moist to wet, 10% ash		5	5	20	40	30				
5	2 5 5 8	S3 9	4.0 6.0	SM		435.0 6.0	Loose black to dark brown silty SAND (SM), no structure, no odor, wet, 20% organics				10	45	45				
	6 11 9 6	S4 14	6.0 8.0	SM			Medium dense dark brown to gray-brown silty SAND (SM), no structure, no odor, wet -GLACIOFLUVIAL DEPOSITS-				5	50	45				
						432.0 9.0	Note: Drill action indicates stratum change 9.0 ft.										
10	9 24 10 16	S5 14	9.0 11.0	SM			Dense yellow-brown silty SAND with gravel (SM), bonded, no odor -GLACIAL TILL-	10	15	10	15	30	20				
15	36 47 100/4"	S6	14.0 15.3	SM		427.0 14.0	Very dense olive-brown with red-brown silty SAND with gravel (SM), exhibits relict rock structure, no odor, moist -WEATHERED BEDROCK-	5	15	10	15	25	30				
						425.0 16.0	Drill action hardens up at 16.0 ft. -BEDROCK-										
		NA 0	17.0 17.0			424.0 17.0	BOTTOM OF EXPLORATION 17.0 FT Note: Installed observation well in completed boring. Note: Equipment refusal.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/21	07:27	0.4	0.0	4.0	1.5
12/20/21	10:30	0.2	12.0	17.0	1.7

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 17.0
Rock Cored (ft) 0
Samples S7

Boring No. HA21-6(OW)

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. HA21-6(OW)

Project	283-325 LINCOLN ST
Location	MARLBOROUGH, MA
Client	WP EAST ACQUISITIONS, LLC / DAVID MOORE
Contractor	NORTHERN DRILL SERVICE, INC.
Driller	T. Tucker
Initial Water Level (depth bgs)	~3.0 ft

Well Diagram

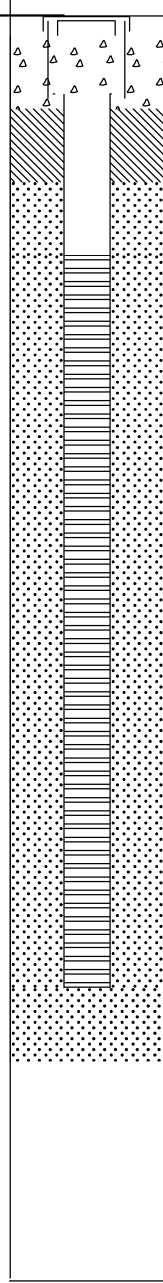
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	0204525-000
Date Installed	20 Dec 2021
H&A Rep.	D. Palleiko
Location	See Plan
Ground El.	441.0 (est.)
Datum	NAVD88

SOIL/ROCK

CONDITIONS	DEPTH (ft.)
FILL	6.0
GLACIOFLUVIAL DEPOSITS	9.0
GLACIAL TILL	14.0
WEATHERED BEDROCK	16.0
BEDROCK	17.0

WELL DETAILS



DEPTH (ft.)	ELEVATION (ft.)
0.0	441.0
0.8	440.2
1.0	440.0
2.0	439.0
3.0	438.0
13.0	428.0
14.0	427.0
17.0	424.0

WELL CONSTRUCTION DETAILS

Type of protective cover	Compression cap
Depth of Roadway Box below ground surface	0.0 ft
Depth of top of riser below ground surface	0.8 ft
Type of protective casing	Roadway Box
Length	0.8 ft
Inside diameter	4.0 in.
Depth of bottom of Roadway Box	0.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	3.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite	1.0	1.0
	-	-
	-	-

Diameter of borehole	4.5 in.
Depth to top of well screen	3.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	#1 Filter Sand
Depth to bottom of well screen	13.0 ft
Bottom of silt trap	13.0 ft
Depth of bottom of well	17.0 ft
Depth of bottom of borehole	17.0 ft

COMMENTS:

APPENDIX C

LOGS OF TEST PITS PREPARED BY ALLEN & MAJOR

TEST PIT LOGS PROVIDED BY ALLEN & MAJOR

PGM 1670-20 12/16/21

WOOD PARTNERS
LINCOLN ST
MARLBOROUGH, MA

EXCAVATOR: JUSTIN MILLER – MJ CATALDO, INC.
HALEY ALDRICH – DAVID PALLEIKO
PAUL MATOS – A&M

TEST PIT 1

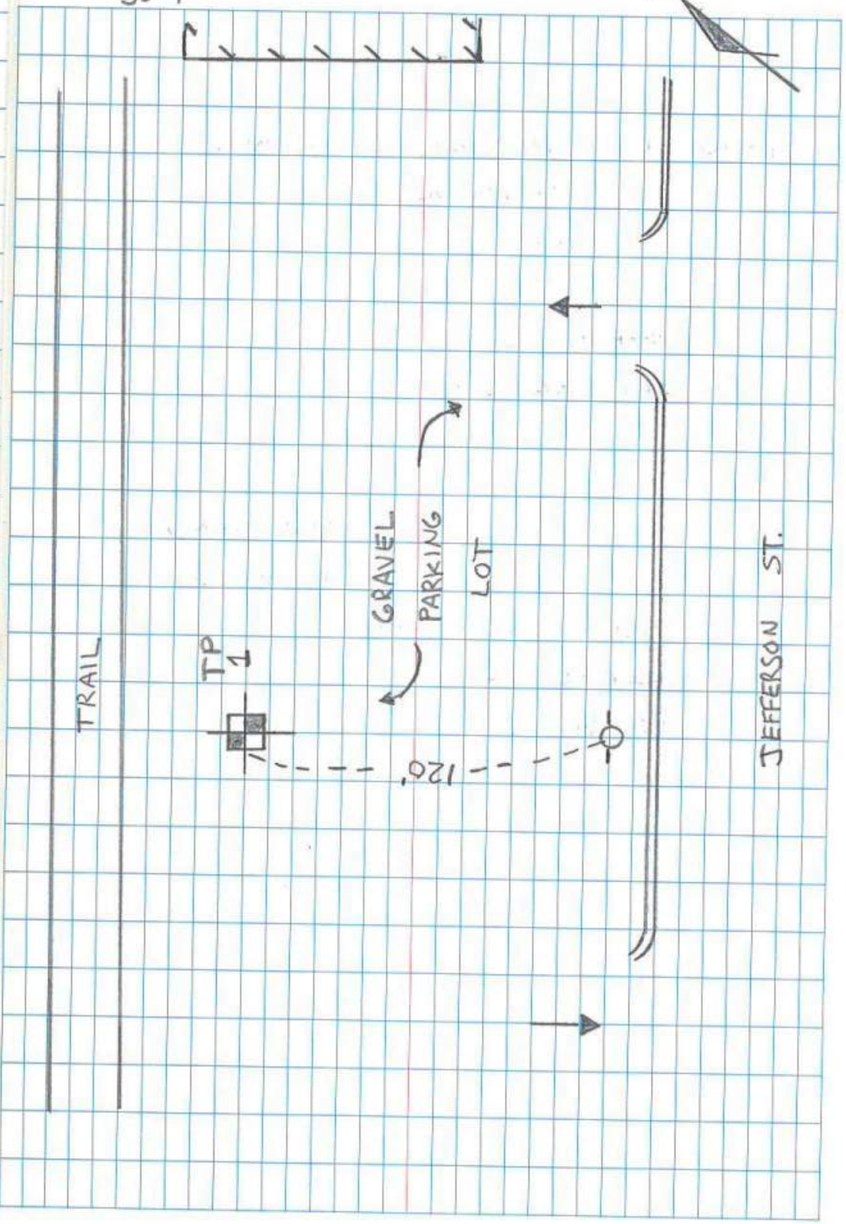
0-10	FILL 3/4" CRUSH STONE / GRAVEL
10-126	FILL GRAVELLY FINE-MED LOAMY SAND 15% GRAVEL 10% COBBLES 5% BOULDERS

MISC. Debris (WOOD, BRICK, CURB STOP)

WET. MATERIAL @ 100"
WEEPING @ 112"
STANDING @ 120"

OVERCAST
56° F

13



1670-20 CONT.

TP 2

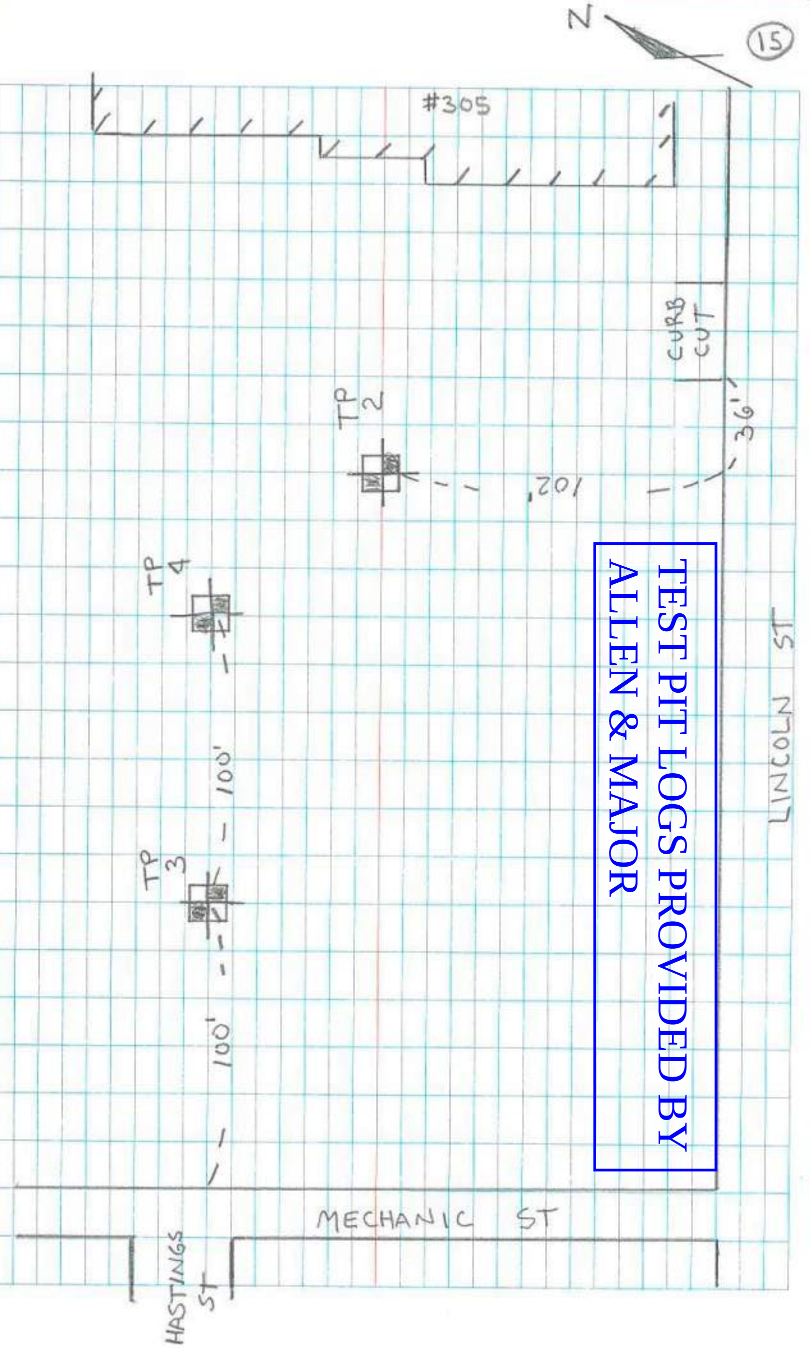
0-24	FILL GRAVEL / RECYCLE ASPHALT
24-90	FILL BOULDERY LOAMY SAND
	40% BOULDERS
	10% COBBLES
	MISC. DEBRIS (BRICK)
	WEEPING @ 36"
	STANDING @ 72"

TP 3

0-110	FILL GRAVELLY LOAMY SAND
	BRICKS, BOULDERS, WOOD
110-120	FINE SILTY LOAM
	WEEPING @ 108"
	STANDING @ 115"

TP 4

0-12	LOAM, ROOTS
12-30	FINE SANDY LOAM
30-84	FINE SANDY LOAM 5% STONES
84-108	FINE SILT CLAY LOAM (BLACK ORGANIC)
108-120	FINE SILT CLAY LOAM
	WEEPING @ 90"
	STANDING @ 100"



TEST PIT LOGS PROVIDED BY ALLEN & MAJOR

APPENDIX D

GROUNDWATER MEASUREMENTS BY VERTEX

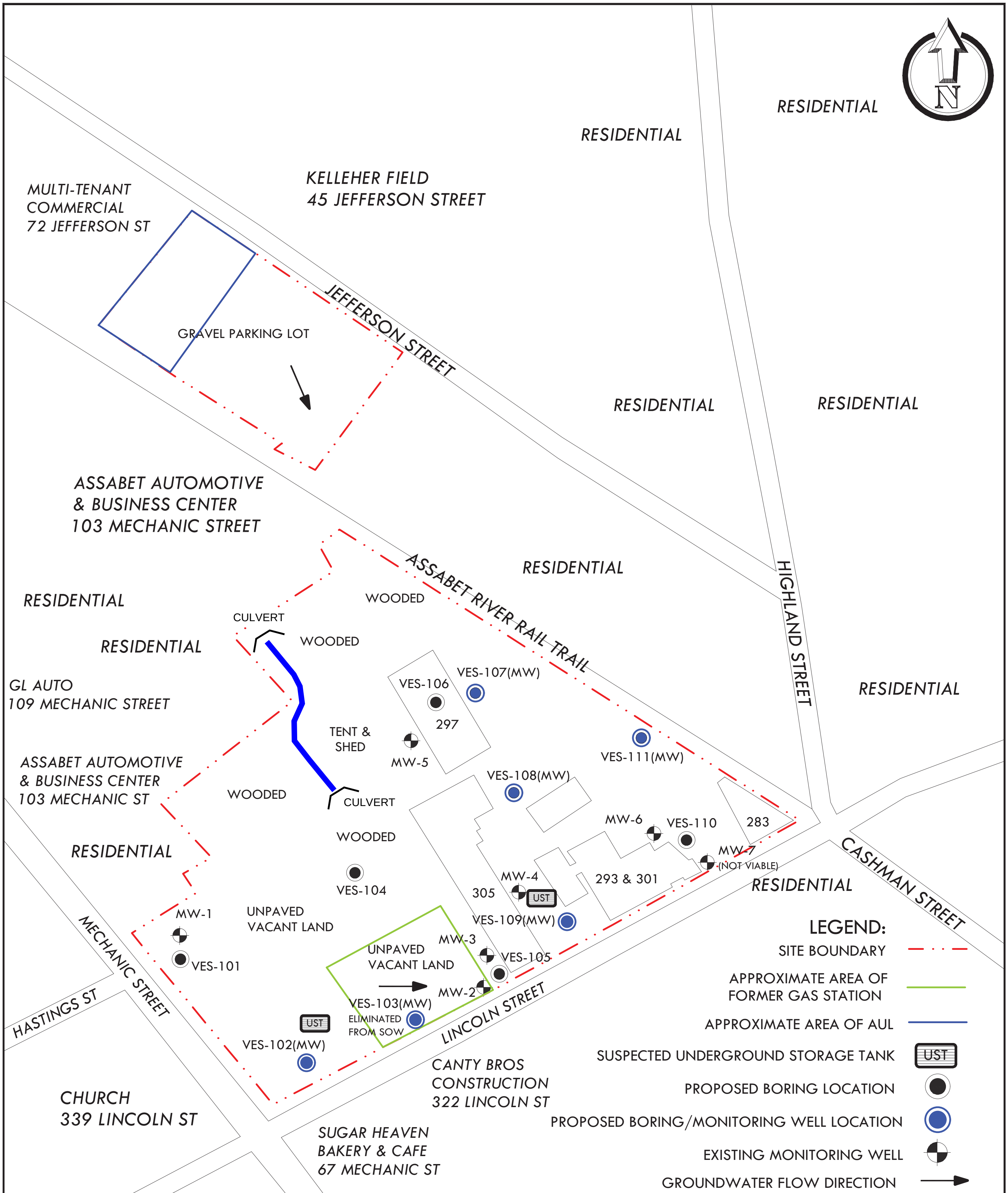


FIGURE 3 - PROPOSED BORING PLAN

283-325 LINCOLN STREET
56 FEDERAL STREET
MARLBOROUGH, MASSACHUSETTS

NOT TO SCALE		FIGURE
Date:	01/14/2022	3
Drawn:	ERC	
Checked:	LL	
Job No.:	75611	

VERTEXENG.COM
VERTEX
400 LIBBEY PARKWAY
WEYMOUTH, MA 02189
(T): 781.952.6000

Table 1
Monitoring Well Gauging Data
283-325 Lincoln Street
Marlborough, MA
Vertex Project No. 75611

APPROXIMATE GROUND SURFACE ELEVATION ESTIMATED AT EXPLORATION LOCATION	Well ID	Depth to GW (ft)	Depth to Bottom of Well (ft)	APPROXIMATE GROUND WATER ELEVATION ESTIMATED AT EXPLORATION LOCATION
El. 449	VES-102 (MW)	6.55	13.06	El. 442.5
El. 440	VES-107 (MW)	1.03	5.58	El. 439.0
El. 440	VES-108 (MW)	0.78	9.93	El. 439.0
El. 440	VES-109 (MW)	4.48	--	El. 435.5
El. 442	VES-111 (MW)	0.73	9.26	El. 441.0
El. 450	MW-1	8.58	14.60	El. 441.4
El. 442	MW-2	8.13	18.37	El. 433.9
El. 442	MW-3	7.93	18.00	El. 434.1
El. 440	MW-4	3.64	9.58	El. 436.4
El. 441	MW-5	3.44	12.45	El. 437.6
El. 439	MW-6	3.25	10.53	El. 435.8
	MW-7	Not Viable	~1.0	

Notes:
*Depths measured from top of PVC.
*Gauging conducted on 1/10/2022, except for VES-102 (MW) which was gauged on 1/14/2022.

ESTIMATED GROUND SURFACE AND GROUNDWATER ELEVATIONS ADDED BY HALEY & ALDRICH.

APPENDIX C
OPERATION & MAINTENANCE PLAN

OPERATION & MAINTENANCE PLAN

Mixed-Use Development
Lincoln St. & Mechanic St. Marlborough, MA

Prepared: April 1, 2022

Site Locus

CLIENT:
ALTA Marlborough, LLC
91 Hartwell Avenue
Lexington, MA 02421

PREPARED BY:
Allen & Major Associates, Inc.
10 Main Street
Lakeville, Massachusetts 02347

allenmajor.com

OPERATION & MAINTENANCE PLAN

Mixed-Use Development
Lincoln St. & Mechanic St.
Marlborough, MA

PROPONENT:
ALTA Marlborough, LLC
91 Hartwell Avenue
Lexington, MA 02421

PREPARED BY:
Allen & Major Associates, Inc.
10 Main Street
Lakeville, Massachusetts 02347

ISSUED:
April 1, 2022

REVISED:
-

A&M PROJECT NO.:
1670-20

TABLE OF CONTENTS

SECTION 1.0
OPERATIONS & MAINTENANCE PLAN

1.1 INTRODUCTION

In accordance with the standards set forth by the Stormwater Management Policy issued by the Massachusetts Department of Environmental Protection (MassDEP), Allen & Major Associates, Inc. has prepared the following Operations & Maintenance (O&M) Plan for the proposed stormwater management system for the Mixed-Use Development located at the intersection of Lincoln and Mechanic Streets in Marlborough, MA.

This plan focuses on post construction maintenance of the on-site drainage system. Operation and Maintenance (O&M) practices discussed below are recommendations made by the Design Engineer based on available reference material on Best Management Practices (BMP's) and experience. The property owner is responsible for implementation of the plan, and is encouraged to revise / supplement this plan accordingly based on actual site conditions.

The plan is broken down into two major sections. The first section describes the long-term pollution prevention measures (Long Term Pollution Prevention Plan). The second section is a post-construction operation and maintenance plan designed to address the long-term maintenance needs of the stormwater management system (Long Term Maintenance Plan).

1.2 NOTIFICATION PROCEDURES FOR CHANGE OF RESPONSIBILITY FOR O&M

The Stormwater Management System (SMS) for this project is owned by ALTA Marlborough, LLC (owner). The owner shall be legally responsible for the long-term operation and maintenance of this SMS as outlined in this Operation and Maintenance Plan.

The owner shall submit an annual summary report and the completed Operation & Maintenance Schedule & Checklist to the Engineering Department (via email or print copy), highlighting inspection and maintenance activities including performances of BMPs. Should ownership of the SMS change, the owner will continue to be responsible until the succeeding owner shall notify the Engineering Department that the succeeding owner has assumed such responsibility.

1.3 CONTACT INFORMATION

Stormwater Management System Owner:	ALTA Marlborough, LLC 91 Hartwell Avenue Lexington, MA 02421 Phone: TBD

Emergency Contact Information:

ALTA Marlborough, LLC (Owner/Operator)	Phone: TBD
Marlborough Department of Public Works	Phone: 508-624-6910 x33300
Marlborough Fire Department (non-emergency line)	Phone: 508-624-6986
MassDEP Emergency Response	Phone: (888) 304-1133
Clean Harbors Inc (24-Hour Line)	Phone: (800) 645-8265

1.4 CONSTRUCTION PERIOD

1. Call Digsafe: 1-888-344-7233
2. Schedule a meeting with the various City Departments, Design Engineer and Owner at least three (3) days prior to start of construction.
3. Install Erosion Control measures (construction entrance, wattles, straw bales, silt fence, silt sac, etc.) as shown on the Plans prepared by A&M. If required, by any special conditions, the Town shall review the installation of erosion control measures prior to the start of any site demolition work. Install Construction fencing if determined to be necessary at the commencement of construction.
4. All erosion and sedimentation controls shall be in accordance with MassDEP's Erosion and Sedimentation Control guidelines revised through May 2003 and the USDA SCS Erosion and Sedimentation Control in site development dated September 1983.
5. Site access shall be achieved only from the designated construction entrances.
6. Cut and clear trees in construction areas only (within the limit of work; see plans).
7. Stockpiles of materials subject to erosion shall be stabilized with erosion control matting or temporary seeding whenever practicable, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased.
8. Install silt sacks and straw bales around each drain inlet prior to any demolition and or construction activities.

9. All erosion control measures shall be inspected weekly and after every rainfall event. Records of these inspections shall be kept on-site for review.
10. All erosion control measures shall be maintained, repaired, or replaced as required or at the direction of the owner's engineer or the Town's representative.
11. Sediment accumulation up-gradient of the straw bales, silt fence, and stone check dams greater than 6" in depth shall be removed and disposed of in accordance with all applicable regulations.
12. If it appears that sediment is exiting the site, silt sacks shall be installed in all catch basins adjacent to the site. Sediment accumulation on all adjacent catch basin inlets shall be removed and the silt sack replaced if torn or damaged.
13. Install stone check dam on-site during construction as needed. Refer to the erosion control details. Temporary sediment basins combined with stone check damns shall be installed on-site during construction to control and collect runoff from upland areas of this site during demolition and construction activities.
14. The contractor shall comply with the Sedimentation and Erosion Control Notes as shown on the Site Development Plans and Specifications.
15. The stabilized construction entrances shall be inspected weekly and records of inspections kept. The entrances shall be maintained by adding additional clean, angular, durable stone to remove the soil from the construction vehicle's tires when exiting the site. If soil is still leaving the site via the construction vehicle tires, adjacent roadways shall be kept clean by street sweeping.
16. Dust pollution shall be controlled using on-site water trucks and/or an approved soil stabilization product.
17. During demolition and construction activities, Status Reports on compliance with this O&M Document shall be submitted weekly. The report shall document any deficiencies and corrective actions taken by the applicant.
18. No overuse, over-compaction, or storage of materials shall occur within any areas defined as stormwater infiltration to prevent the incidental compaction of soils. The areas are to be constructed as soon as possible and protected from construction traffic. NO CONSTRUCTION WATERS are to be emptied into an infiltration system. An allowance may be accommodated for a temporary excavation of soils within the infiltration basin for collection and handling of construction water, but the entirety of the debris is to be removed in order to achieve the grades as shown on the construction drawings.

19. The entire drainage system, including but not limited to catch basin, manholes, piping, water quality structures and infiltration system should be cleaned prior to turnover to the Owner.

1.5 LONG-TERM POLLUTION PREVENTION PLAN

Standard #4 from the MassDEP Stormwater Management Handbook requires that a Long-Term Pollution Prevention Plan (LTPPP) be prepared and incorporated as part of the Operation and Maintenance Plan of the Stormwater Management System. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges, and to describe the implementation of practices to reduce the pollutants in stormwater discharges. The following items describe the source control and proper procedures of the LTPPP.

- **Housekeeping**
  The existing development has been designed to maintain a high level of water quality treatment for all stormwater discharge to the wetland areas. An Operation and Maintenance (O&M) plan has been prepared and is included in this section of the report. The owner (or its designee) is responsible for adherence to the O&M plan in a strict and complete manner.

- **Storing of Materials & Water Products**
  The trash and waste program for the site includes exterior dumpsters. There is a trash contractor used to pick up the waste material in the dumpsters. The stormwater drainage system has water quality inlets designed to capture trash and debris.

- **Vehicle Washing**
  Outdoor vehicle washing has the potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash the grime off the vehicle enters the stormwater drainage system. The existing development does not include any designated vehicle washing areas, nor is it expected that any vehicle washing will take place on-site.

- **Spill Prevention & Response**
  Sources of potential spill hazards include vehicle fluids, liquid fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within the buildings and would not enter the stormwater drainage system. However, there are spill hazards from vehicle fluids or liquid fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:

1. Spill hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers' recommended spill cleanup protocol.
2. Vehicle fluids and liquid fuel spill shall be remediated according to the local and state regulations governing fuel spills.
3. The owner shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust pans, mops, rags, gloves, absorptive material, sand, sawdust, plastic and metal trash containers.
4. All spills shall be cleaned up immediately after discovery.
5. Spills of toxic or hazardous material shall be reported, regardless of size, to the Massachusetts Department of Environmental Protection at (888) 304-1333.
6. Should a spill occur, the pollution prevention plan will be adjusted to include measures to prevent another spill of a similar nature. A description of the spill, along with the causes and cleanup measures will be included in the updated pollution prevention plan.

- **Maintenance of Lawns, Gardens, and Other Landscaped Areas**
  It should be recognized that this is a general guideline towards achieving high quality and well-groomed landscaped areas. The grounds staff/landscape contractor must recognize the shortcomings of a general maintenance plan such as this, and modify and/or augment it based on weekly, monthly, and yearly observations. In order to assure the highest quality conditions, the staff must also recognize and appreciate the need to be aware of the constantly changing conditions of the landscaping and be able to respond to them on a proactive basis. No trees shall be planted over the drain lines or recharge area, and that only shallow rooted plants and shrubs will be allowed.

  - **Fertilizer**

    Maintenance practices should be aimed at reducing environmental, mechanical and pest stresses to promote healthy and vigorous growth. When necessary, pest outbreaks should be treated with the most sensitive control measure available. Synthetic chemical controls should be used only as a last resort to organic and biological control methods. Fertilizer, synthetic chemical controls and pest management applications (when necessary) shall be performed only by licensed applicators in accordance with the manufacturer's label instructions when environmental conditions are conducive to controlled product application.

Only slow-release organic fertilizers should be used in the planting and mulch areas to limit the amount of nutrients that could enter downstream resource areas. Fertilization of the planting and mulch areas will be performed within manufacturers labeling instructions and shall not exceed an NPK ration of 1:1:1 (i.e. Triple 10 fertilizer mix), considered a low nitrogen mixture. Fertilizers approved for the use under this O&M Plan are as follows:

Type: LESCO® 28-0-12 (Lawn Fertilizer)
MERIT® 0.2 Plus Turf Fertilizer
MOMENTUM™ Force Weed & Feed

- **Suggested Aeration Program**

  In-season aeration of lawn areas is good cultural practice, and is recommended whenever feasible. It should be accomplished with a solid thin tine aeration method to reduce disruption to the use of the area. The depth of solid tine aeration is similar to core type, but should be performed when the soil is somewhat drier for a greater overall effect.

  Depending on the intensity of use, it can be expected that all landscaped lawn areas will need aeration to reduce compaction at least once per year. The first operation should occur in late May following the spring season. Methods of reducing compaction will vary based on the nature of the compaction. Compaction on newly established landscaped areas is generally limited to the top 2-3" and can be alleviated using hollow core or thin tine aeration methods.

  The spring aeration should consist of two passes at opposite directions with 1/4" hollow core tines penetrating 3-5" into the soil profile. Aeration should occur when the soil is moist but not saturated. The soil cores should be shattered in place and dragged or swept back into the turf to control thatch. If desired the cores may also be removed and the area top-dressed with sand or sandy loam. If the area drains on average too slowly, the topdressing should contain a higher percentage of sand. If it is draining on average too quickly, the top dressing should contain a higher percentage of soil and organic matter.

- **Landscape Maintenance Program Practices**:

  - **Lawn**

    1. Mow a minimum of once a week in spring, to a height of 2” to 2 1/2” high. Mowing should be frequent enough so that no more than 1/3 of grass blade is removed at each mowing. The top growth supports the roots; the shorter the grass is cute, the less the roots will grow. Short cutting also dries out the soil and encourages weeds to germinate.

2. Mow approximately once every two weeks from July 1st to August 15th depending on lawn growth.
3. Mow on a ten-day cycle in fall, when growth is stimulated by cooler nights and increased moisture.
4. Do not remove grass clippings after mowing.
5. Keep mower blades sharp to prevent ragged cuts on grass leaves, which cause a brownish appearance and increase the chance for disease to enter a leaf.

- **Shrubs**
  1. Mulch not more than 3" depth with shredded pine or fir bark.
  2. Hand prune annually, immediately after blooming, to remove 1/3 of the above-ground biomass (older stems). Stem removals are to occur within 6" of the ground to open up shrub and maintain two-year wood (the blooming wood).
  3. Hand-prune evergreen shrubs only as needed to remove dead and damaged wood and to maintain the naturalistic form of the shrub. Never mechanically shear evergreen shrubs.
- **Trees**
  1. Provide aftercare of new tree plantings for the first three years.
  2. Do not fertilize trees, it artificially stimulates them (unless tree health warrants).
  3. Water once a week for the first year; twice a month for the second; once a month for the third year.
  4. Prune trees on a four-year cycle.
- **Invasive Species**
  1. Inform the Conservation Commission Agent prior to the removal of invasive species proposed either through hand work or through chemical removal.

- **Storage and Use of Herbicides and Pesticides**
  Integrated Pest Management is the combination of all methods (of pest control) which may prevent, reduce, suppress, eliminate, or repel an insect population. The main requirements necessary to support any pest population are food, shelter and water, and any upset of the balance of these will assist in controlling a pest population. Scientific pest management is the knowledgeable use of all pest

control methods (sanitation, mechanical, chemical) to benefit mankind's health, welfare, comfort, property and food. A Pest Management Professional (PMP) should be retained who is licensed with the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, Department of Agricultural Resources.

The site manager will be provided with approved bulletin before entering into or renewing an agreement to apply pesticides for the control of indoor household or structural pests, refer to 333 CMR 13.08.

Before beginning each application, the applicator must post a Department approved notice on all of the entrances to the treated room or area. The applicator must leave such notices posted after the application. The notice will be posted at conspicuous point(s) of access to the area treated. The location and number of signs will be determined by the configuration of the area to be treated based on the applicator's best judgment. It is intended to give sufficient notice so that no one comes into an area being treated unaware that the applicator is working and pesticides are being applied. However, if the contracting entity does not want the signs posted, he/she may sign a Department approved waiver indicating this.

The applicator or employer will provide to any person upon their request the following information on previously conducted applications:

1. Name and phone number of pest control company;
2. Date and time of the application;
3. Name and license number of the applicator;
4. Target pests; and
5. Name and EPA Registration Number of pesticide products applied.

- **Pet Waste Management**
  The owner's landscape crew (or designee) shall remove any obvious pet waste that has been left behind by pet owners within the development. The pet waste shall be disposed of in accordance with local and state regulations.

- **Management of Deicing Chemicals and Snow**
  Snow will be stockpiled on site until the accumulated snow becomes a hazard to the daily operations of the site. It will be the responsibility of the snow removal contractor to properly dispose of transported snow according to MassDEP, Bureau of Resource Protection – Snow Disposal Guideline #BRPG01-01, governing the proper disposal of snow. It will be the responsibility of the snow removal contractor to follow these guidelines and all applicable laws and regulations

  The owner's maintenance staff (or its designee) will be responsible for the clearing of the sidewalk and building entrances. The owner may be required to use a deicing agent such as potassium chloride to maintain a safe walking surface. If used, the de-icing agent for the walkways and building entrances will be kept within the storage rooms located within the building. If used, de-icing agents will not be stored outside. The owner's maintenance staff will limit the application of sand.

1.6 LONG-TERM MAINTENANCE PLAN – FACILITIES DESCRIPTION

A maintenance log will be kept (i.e. report) summarizing inspections, maintenance, and any corrective actions taken. The log will include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the clean-out of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. The log will be made accessible to department staff and a copy provided to the department upon request.

The following is a description of the Stormwater Management System for the project site.

- **Stormwater Collection System – On-Site**: The stormwater collection system is comprised of deep sump hooded catch basins, water quality structures, Stormtech Isolator Row, a sub-surface infiltration system consisting of Stormtech Chambers, drainage basin, a closed gravity pipe network, outlet control structures and a green roof.
  The stormwater runoff from the building rooftops are collected using roof drains. The stormwater is conveyed to the discharge locations using internal building plumbing and external roof leaders.

1.7 INSPECTION AND MAINTENANCE FREQUENCY AND CORRECTIVE MEASURES

In accordance with MA DEP Stormwater Handbook: Volume 2, Chapter 2; the following areas, facilities, and measures will be inspected and the identified deficiencies will be corrected. Clean-out must include the removal and legal disposal of any accumulated sediments, trash, and debris. In any and all cases, operations, inspections, and maintenance activities shall utilize best practical measures to avoid and minimize impacts to wetland resource areas outside the footprint of the SMS.

Attached is an Operation and Maintenance Plan (OM-1) illustrating the location of the following SMS components that will require continuing inspection as outlined in the document:

- *Street Sweeping*
- *Deep Sump and Hooded Catch Basin*
- *Water Quality Structures*
- *Green Roof*
- *Stormtech Isolator Row*

- *Sub-Surface Infiltration Systems (Stormtech SC-740 Chambers)*
- *Pipe Ends*
- *Basin*
- *Snow Storage (as outlined on plan)*

1.8 STRUCTURAL PRETREATMENT BMPS

Regular maintenance of these BMPs is especially critical because they typically receive the highest concentration of suspended solids during the first flush of a storm event.

Deep Sump Catch Basins:

Deep sump catch basins, also known as oil and grease or hooded catch basins, are underground retention systems designed to remove trash, debris, and coarse sediment from stormwater runoff, and serve as temporary spill containment devices for floatables such as oils and greases.

Regular maintenance is essential. Deep sump catch basins remain effective by removing pollutants only if they are cleaned out frequently. One study found that once 50% of the sump volume is filled, the catch basin is not able to retain additional sediments.

Inspect or clean deep sump catch basins at least four times per year and at the end of the foliage and snow-removal seasons. Sediments must also be removed four times per year or whenever the depths of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Always consider the safety of the staff cleaning deep sump catch basins. Cleaning a deep sump catch basin within a road with active traffic or even within a parking lot is dangerous, and a police detail may be necessary to safeguard workers.

Although catch basin debris often contains concentrations of oil and hazardous materials, such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin cleanings may be taken to a landfill or other facility permitted by MassDEP to accept solid waste, without any prior approval by MassDEP. However, some landfills require catch basin cleanings to be tested before they are accepted.

With prior MassDEP approval, catch basin cleanings may be used as grading and shaping materials at landfills undergoing closure (see Revised Guidelines for Determining Closure Activities at Inactive Unlined Landfill Sites) or as daily cover at active landfills. MassDEP also encourages the beneficial reuse of catch basin cleanings whenever possible. A Beneficial Reuse Determination is required for such use.

MassDEP regulations prohibit landfills from accepting materials that contain free-draining liquids. One way to remove liquids is to use a hydraulic lift truck during cleaning operations so that the material can be decanted at the site. After loading material from several catch basins into a truck, elevate the truck so that any free-draining liquid can flow back into the structure. If there is no free water in the truck, the material may be deemed to be sufficiently dry. Otherwise catch basin cleanings must undergo a Paint Filter Liquids Test. Go to www.Mass.gov/dep/recycle/laws/cafacts.doc for information on all of the MassDEP requirements pertaining to the disposal of catch basin cleanings

Water Quality Structure:

Regular maintenance is essential. Inspect or clean water quality structure at least twice per year (e.g. spring & fall) and snow-removal seasons. Sediments must also be removed whenever the depths of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. Please refer to the Stormceptor STC Operation and Maintenance Guide attached hereafter.

Vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Always consider the safety of the staff cleaning the structure. Cleaning structures within a road with active traffic or even within a parking lot is dangerous, and a police detail may be necessary to safeguard workers.

Although debris often contains concentrations of oil and hazardous materials, such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

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Sediment Forebay:

A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids.

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Check for signs of rilling and gullying and repair as needed.

1.9 TREATMENT BMPS

Stormtech Isolator Row:

Stormtech's Isolator Row is an isolated row of chambers wrapped in geotextile fabric which filters the stormwater, trapping pollutants in the row before entering the adjacent chambers. The Isolator Row inspection/maintenance should be done in accordance with the manufacturer's guidelines and documentation. A copy is attached hereafter.

1.10 INFILTRATION BMPS

Subsurface Structures:

Subsurface structures are underground systems that capture runoff, and gradually infiltrate it into the groundwater through rock and gravel.

Because subsurface structures are installed underground, they are extremely difficult to maintain. Inspect inlets at least twice a year. Remove any debris that might clog the system. Include mosquito controls in the Operation and Maintenance Plan.

Inspect outlet from subsurface structures to adjacent resource area for signs of scour and sediment accumulation at least twice annually. Remove sediment accumulation and add rip rap as necessary to prevent scour.

1.11 OTHER BMPS AND ACCESSORIES:

Green Roof

Green roofs are permanent rooftop planting system containing live plants in a lightweight engineered soil medium designed to retain precipitation where the water is taken up by plants and transpired into the air. Green roofs help reduce the volume and rate of runoff from more frequent storms.

The vegetation in green roofs requires support during establishment and yearly maintenance thereafter. Weeding and mulching may be needed during the establishment period and periodically thereafter throughout the life of the roof. Regularly remove any woody plants that become established on the roof. If necessary, apply a slow-release fertilizer once a year to ensure continued vigorous growth of the vegetation.

Outlet Control Structures:

Outlets of BMPs are devices that control the flow of stormwater out of the BMP to the conveyance system.

Inspect outlet structures twice per year. Remove any accumulated sediment and debris that could prevent flow at the outlet structure.

Culverts:

Inspect culverts 2 times per year (preferably in Spring and Fall) to ensure that the culverts are working in their intended fashion and that they are free of debris. Remove any obstructions to flow; remove accumulated sediments and debris at the inlet, at the outlet, and within the conduit and repair any erosion damage at the culvert's inlet and outlet.

Rip Rap and Level Spreaders:

Inspect twice per year for erosion, debris accumulation, and unwanted vegetation. Erosion areas shall be stabilized and sediment, debris, and woody vegetation will be removed.

Vegetated Areas:

Inspect slopes and embankments early in the growing season to identify active or potential erosion problems. Replant bare areas or areas with sparse growth. Where rill erosion is evident, armor the area with an appropriate lining or divert the erosive flows to on-site areas able to withstand the concentrated flows.

Roadway and Parking Surfaces:

Clear accumulations of winter sand in parking lots and along roadways at least once a year, preferably in the spring. Accumulations on pavement may be removed by pavement sweeping. Accumulations of sand along road shoulders may be removed by grading excess sand to the pavement edge and removing it manually or by a front-end loader.

Mosquito Control Plan:

MA Stormwater Handbook; Volume 2, Chapter 5 (Attached)

Both above ground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance, and treatment with larvicides can minimize this potential.

1.12 SUPPLEMENTAL INFORMATION

PROPOSED OPERATIONS AND MAINTENANCE LOG FORM

Based on site specific stormwater management system asset list. At a minimum, fields should be provided for:

- Date of inspection
- Name of inspector
- Condition of each BMP, including components such as:
    - Pretreatment devices
    - Vegetation
    - Other safety devices
    - Control structures
    - Embankments, slopes, and safety benches
    - Inlet and outlet channels and structures
    - Underground drainage

  - Sediment and debris accumulation in storage and forebay areas (including catch basins)
  - Any nonstructural practices
  - Any other item that could affect the proper function of the stormwater management system
- Description of the need for maintenance
- Description of maintenance performed

APPENDIX A
SUPPLEMENT INFORMATION

SNOW DISPOSAL GUIDANCE

MassDEP
Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs
Department of Environmental Protection
One Winter Street Boston, MA 02108 • 617-292-5500

Massachusetts Department of Environmental Protection
Bureau of Water Resources
Snow Disposal Guidance

Effective Date: December 23, 2019

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

Supersedes: Bureau of Resource Protection (BRP) Snow Disposal Guideline No. BRPG97-1 issued December 12, 1997 and BRPG01-01 issued March 8, 2001; Bureau of Water Resources (BWR) snow disposal guidance issued December 21, 2015 and December 12, 2018.

Approved by: Kathleen Baskin, Assistant Commissioner, Bureau of Water Resources

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 all federal agencies, state agencies, state authorities, municipal 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 MassDEP is 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 that occurs on the land has the potential to impact the Commonwealth's 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 federal agencies, state agencies, state authorities, 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 away from water resources and drinking water wells. At these locations, the snow meltwater can filter into the soil, leaving behind sand and debris which can be removed in the spring. The following conditions should be followed:

- Within water supply Zone A and Zone II, avoid storage or disposal of snow and ice containing deicing chemicals that has been collected from streets located outside these zones. Municipalities may have a water supply protection land use control that prohibits the disposal of snow and ice containing deicing chemicals from outside the Zone A and Zone II, subject to the Massachusetts Drinking Water Regulations at 310 CMR 22.20C and 310 CMR 22.21(2).
- Avoid storage or disposal of snow or ice in Interim Wellhead Protection Areas (IWPA) of public water supply wells, and within 75 feet of a private well, where road salt may contaminate water supplies.
- Avoid dumping 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 systems including detention basins, swales or ditches. Snow combined with sand and debris may block a stormwater 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:

- 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.
- Identify sites that could potentially be used for snow disposal, such as municipal open space (e.g., parking lots or parks).
- Select sites located in upland locations that are not likely to impact sensitive environmental resources first.
- 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 in identifying possible locations to potentially dispose of snow. MassDEP encourages municipalities to use this tool to identify possible snow disposal options. 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/.

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.
- Wherever possible maintain a 50-foot vegetated buffer between the disposal site and adjacent waterbodies to filter pollutants from the meltwater.
- Clear debris from the site prior to using the site for snow disposal.
- Clear debris from the site and properly dispose of it 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:

- 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 stormwater 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 an entity exhausts all available upland snow disposal sites. The location and mapping of snow disposal sites will help facilitate each entity's routine snow management efforts.
- Emergency Certifications – If an entity demonstrates that there is no remaining capacity at upland snow disposal locations, local conservation commissions may issue an Emergency Certification under the Massachusetts Wetlands Protection regulations to authorize snow disposal in buffer zones to wetlands, certain open water areas, and certain wetland resource areas (i.e. within flood plains). 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. See 310 CMR 10.06(1)-(4). Use the following guidelines in these emergency situations:
    - Dispose of snow in open water with adequate flow and mixing to prevent ice dams from forming.
    - 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.
    - Do not dispose of snow where trucks may cause shoreline damage or erosion.
    - Consult with the municipal Conservation Commission to ensure that snow disposal in open water complies with local ordinances and bylaws.

- Severe Weather 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 federal agencies, state agencies, state authorities, municipalities, and businesses 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 enable MassDEP and the Massachusetts Emergency Management Agency (MEMA) 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. In these situations, a buffer of at least 50 feet, preferably vegetated, should still be maintained between the site and the waterbody. 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 federal agency, state agency, state authority, municipality or business seeking to dispose of snow in a waterbody should take the following steps***:

- Call the emergency contact phone number [(888) 304-1133)] and notify the MEMA of the municipality's intent.
- MEMA will ask for some information about where the requested disposal will take place.
- MEMA will confirm that the disposal is consistent with MassDEP's Severe Weather 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 [(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, 978-694-3246
Southeast Regional Office, Lakeville, 508-946-2714
Central Regional Office, Worcester, 508-792-7650
Western Regional Office, Springfield, 413-755-2114

MOSQUITO CONTROL

Chapter 5
Miscellaneous Stormwater Topics

Mosquito Control in Stormwater Management Practices

Both aboveground and underground stormwater BMPs have the potential to serve as mosquito breeding areas. Good design, proper operation and maintenance and treatment with larvicides can minimize this potential.

EPA recommends that stormwater treatment practices dewater within 3 days (72 hours) to reduce the number of mosquitoes that mature to adults, since the aquatic stage of many mosquito species is 7 to 10 days. Massachusetts has had a 72-hour dewatering rule in its Stormwater Management Standards since 1996. The 2008 technical specifications for BMPs set forth in Volume 2, Chapter 2 of the Massachusetts Stormwater Handbook also concur with this practice by requiring that all stormwater practices designed to drain do so within 72 hours.

Some stormwater practices are designed to include permanent wet pools. These practices – if maintained properly – can limit mosquito breeding by providing habitat for mosquito predators. Additional measures that can be taken to reduce mosquito populations include increasing water circulation, attracting mosquito predators by adding suitable habitat, and applying larvicides.

The Massachusetts State Reclamation and Mosquito Control Board (SRMCB), through the Massachusetts Mosquito Control Districts, can undertake further mosquito control actions specifically for the purpose of mosquito control pursuant to Massachusetts General Law Chapter 252. The Mosquito Control Board, http://www.mass.gov/agr/mosquito/, describes mosquito control methods and is in the process of developing guidance documents that describe Best Management Practices for mosquito control projects.

The SRMCB and Mosquito Control Districts are not responsible for operating and maintaining stormwater BMPs to reduce mosquito populations. The owners of property that construct the stormwater BMPs or municipalities that "accept" them through local subdivision approval are responsible for their maintenance.[1] The SRMCB is composed of officials from MassDEP, Department of Agricultural Resources, and Department of Conservation and Recreation. The nine (9) Mosquito Control Districts overseen by the SRMCB are located throughout Massachusetts, covering 176 municipalities.

<u>Construction Period Best Management Practices for Mosquito Control</u>

To minimize mosquito breeding during construction, it is essential that the following actions be taken to minimize the creation of standing pools by taking the following actions:

- ***Minimize Land Disturbance:*** Minimizing land disturbance reduces the likelihood of mosquito breeding by reducing silt in runoff that will cause construction period controls to clog and retain standing pools of water for more than 72 hours.
- ***Catch Basin inlets:*** Inspect and refresh filter fabric, hay bales, filter socks or stone dams on a regular basis to ensure that any stormwater ponded at the inlet drains within 8 hours after precipitation stops. Shorter periods may be necessary to avoid hydroplaning in roads

[1] MassDEP and MassHighway understand that the numerous stormwater BMPs along state highways pose a unique challenge. To address this challenge, the 2004 MassHighway Stormwater Handbook will provide additional information on appropriate operation and maintenance practices for mosquito control when the Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards..

caused by water ponded at the catch basin inlet. Treat catch basin sumps with larvicides such as *Bacillus sphaericus* (*Bs*) using a licensed pesticide applicator.

- ***Check Dams:*** If temporary check dams are used during the construction period to lag peak rate of runoff or pond runoff for exfiltration, inspect and repair the check dams on a regular basis to ensure that any stormwater ponded behind the check dam drains within 72 hours.
- ***Design construction period sediment traps*** to dewater within 72 hours after precipitation. Because these traps are subject to high silt loads and tend to clog, treat them with the larvicide *Bs* after it rains from June through October, until the first frost occurs.
- ***Construction period open conveyances:*** When temporary manmade ditches are used for channelizing construction period runoff, inspect them on a regular basis to remove any accumulated sediment to restore flow capacity to the temporary ditch.
- ***Revegetating Disturbed Surfaces:*** Revegetating disturbed surfaces reduces sediment in runoff that will cause construction period controls to clog and retain standing pools of water for greater than 72 hours.
- ***Sediment fences/hay bale barriers:*** When inspections find standing pools of water beyond the 24-hour period after a storm, take action to restore barrier to its normal function.

<u>Post-Construction Stormwater Treatment Practices</u>

- Mosquito control begins with the environmentally sensitive site design. Environmentally sensitive site design that minimizes impervious surfaces reduces the amount of stormwater runoff. Disconnecting runoff using the LID Site Design credits outlined in the Massachusetts Stormwater Handbook reduces the amount of stormwater that must be conveyed to a treatment practice. Utilizing green roofs minimizes runoff from smaller storms. Storage media must be designed to dewater within 72 hours after precipitation.
- Mosquito control continues with the selection of structural stormwater BMPs that are unlikely to become breeding grounds for mosquitoes, such as:
    - ***Bioretention Areas/Rain Gardens/Sand Filter:*** These practices tend not to result in mosquito breeding. If any level spreaders, weirs or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.
    - ***Infiltration Trenches:*** This practice tends not to result in mosquito breeding. If any level spreaders, weirs, or sediment forebays are used as part of the design, inspect them and correct them as necessary to prevent standing pools of water for more than 72 hours.
- Another mosquito control strategy is to select BMPs that can become habitats for mosquito predators, such as:
    - ***Constructed Stormwater Wetlands:*** Habitat features can be incorporated in constructed stormwater wetlands to attract dragonflies, amphibians, turtles, birds, bats, and other natural predators of mosquitoes.
    - ***Wet Basins:*** Wet basins can be designed to incorporate fish habitat features, such as deep pools. Introduce fish in consultation with Massachusetts Division of Fisheries and Wildlife. Vegetation within wet basins designed as fish habitat must be properly managed to ensure that vegetation does not overtake the habitat. Proper design to ensure that no low circulation or "dead" zones are created may reduce the potential for mosquito breeding. Introducing bubblers may increase water circulation in the wet basin.

Effective mosquito controls require proponents to design structural BMPs to prevent ponding and facilitate maintenance and, if necessary, the application of larvicides. Examples of such design practices include the following:

- ***Basins:*** Provide perimeter access around wet basins, extended dry detention basins and dry detention basins for both larviciding and routine maintenance. Control vegetation to ensure that access pathways stay open.
- ***BMPs without a permanent pool of water:*** All structural BMPs that do not rely on a permanent pool of water must drain and completely dewater within 72 hours after precipitation. This includes dry detention basins, extended dry detention basins, infiltration basins, and dry water quality swales. Use underdrains at extended dry detention basins to drain the small pools that form due to accumulation of silts. Wallace indicates that extended dry extended detention basins may breed more mosquitoes than wet basins. It is, therefore, imperative to design outlets from extended dry detention basins to completely dewater within the 72-hour period.
- ***Energy Dissipators and Flow Spreaders:*** Currier and Moeller, 2000 indicate that shallow recesses in energy dissipators and flow spreaders trap water where mosquitoes breed. Set the riprap in grout to reduce the shallow recesses and minimize mosquito breeding.
- ***Outlet control structures:*** Debris trapped in small orifices or on trash racks of outlet control structures such as multiple stage outlet risers may clog the orifices or the trash rack, causing a standing pool of water. Optimize the orifice size or trash rack mesh size to provide required peak rate attenuation/water quality detention/retention time while minimizing clogging.
- ***Rain Barrels and Cisterns:*** Seal lids to reduce the likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over inlets. The cistern system should be designed to ensure that all collected water is drained into it within 72 hours.
- ***Subsurface Structures, Deep Sump Catch Basins, Oil Grit Separators, and Leaching Catch Basins:*** Seal all manhole covers to reduce likelihood of mosquitoes laying eggs in standing water. Install mosquito netting over the outlet (CALTRANS 2004).

The Operation and Maintenance Plan should provide for mosquito prevention and control.

- ***Check dams:*** Inspect permanent check dams on the schedule set forth in the O&M Plan. Inspect check dams 72 hours after storms for standing water ponding behind the dam. Take corrective action if standing water is found.
- ***Cisterns:*** Apply *Bs* larvicide in the cistern if any evidence of mosquitoes is found. The Operation and Maintenance Plan shall specify how often larvicides should be applied to waters in the cistern.
- ***Water quality swales:*** Remove and properly dispose of any accumulated sediment as scheduled in the Operation and Maintenance Plan.
- ***Larvicide Treatment:*** The Operation and Maintenance Plan must include measures to minimize mosquito breeding, including larviciding.
- The party identified in the Operation and Maintenance Plan as responsible for maintenance shall see that larvicides are applied as necessary to the following stormwater treatment practices: catch basins, oil/grit separators, wet basins, wet water quality swales, dry extended detention basins, infiltration basins, and constructed stormwater wetlands. The Operation and Maintenance Plan must ensure that all larvicides are applied by a licensed pesticide applicator and in compliance with all pesticide label requirements.
- The Operation and Maintenance Plan should identify the appropriate larvicide and the time and method of application. For example, *Bacillus sphaericus (Bs*), the preferred

larvicide for stormwater BMPs, should be hand-broadcast.[2] Alternatively, Altosid, a Methopren product, may be used. Because some practices are designed to dewater between storms, such as dry extended detention and infiltration basins, the Operation and Maintenance Plan should provide that larviciding must be conducted during or immediately after wet weather, when the detention or infiltration basin has a standing pool of water, unless a product is used that can withstand extended dry periods.

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[2] *Bacillus thuringienis israelensis* or *Bti* is usually applied by helicopter to wetlands and floodplains

Roads and Stormwater BMPs

In general, the stormwater BMPs used for land development projects can also be used for new roadways and roadway improvement projects. However, for improvement of existing roads, there are often constraints that limit the choice of BMP. These constraints derive from the linear configuration of the road, the limited area within the existing right-of-way, the structural and safety requirements attendant to good roadway design, and the long-term maintainability of the roadway drainage systems. The MassHighway Handbook provides strategies for dealing with the constraints associated with providing stormwater BMPs for roadway redevelopment projects.

Roadway design can minimize impacts caused by stormwater. Reducing roadway width reduces the total and peak volume of runoff. Designing a road with country drainage (no road shoulders or curbs) disconnects roadway runoff. Disconnection of roadway runoff is eligible for the Low Impact Site Design Credit provided the drainage is disconnected in accordance with specifications outlined in Volume 3.

Like other parties, municipalities that work within wetlands jurisdictional areas and adjacent buffer zones must design and implement structural stormwater best management practices in accordance with the Stormwater Management Standards and the Stormwater Management Handbook. In addition, in municipalities and areas where state agencies operate stormwater systems, the DPWs (or other town or state agencies) must meet the “good housekeeping“ requirement of the municipality’s or agency's MS4 permit.

MassHighway has taken stormwater management one step further by working with MassDEP to develop the MassHighway Storm Water Handbook for Highways and Bridges. The purpose of the MassHighway Handbook is to provide guidance for persons involved in the design, permitting, review and implementation of state highway projects, especially those involving existing roadways where physical constraints often limit the stormwater management options available. These constraints, like those common to redevelopment sites, may make it difficult to comply precisely with the requirements of the Stormwater Management Standards and the Massachusetts Stormwater Handbook.[3] In response to these constraints, MassDEP and MHD developed specific design, permitting, review and implementation practices that meet the unique challenges of providing environmental protection for existing state roads. The information in the MassHighway Handbook may also aid in the planning and design of projects to build new highways and to add lanes to existing highways, since they may face similar difficulties in meeting the requirements of the Stormwater Management Standards.

Although it is very useful, the MassHighway Handbook does not allow MassHighway projects to proceed without individual review and approval by the issuing authority when subject to the Wetlands Protection Act Regulations, 310 CMR 10.00, or the 401 Water Quality Certification Regulations, 314 CMR 9.00. For example, MassHighway must provide a Conservation Commission with a project-specific Operation and Maintenance Plan in accordance with Standard 9 that documents how the project’s post-construction BMPs will be operated and maintained.[4]

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[3] The 2004 MassHighway Handbook outlines standardized methods for dealing with these constraints as they apply to highway redevelopment projects. MassDEP and MassHighway intend to work together to provide guidance for add a lane projects when the 2004 Handbook is revised to reflect the 2008 changes to the Stormwater Management Standards.

[4] The general permit for municipal separate storm sewer systems (the MS4 Permit) requires MassHighway to develop and implement procedures for the proper operation and maintenance of stormwater BMPs. To

Some municipalities have asked if the MassHighway Handbook governs municipal road projects. The answer is no.[5] The MassHighway Handbook was developed in response to the unique problems and challenges arising out of the management of the state highway system. Like other project proponents, cities and towns planning road or other projects in areas subject to jurisdiction under the Wetlands Protection Act must design and implement LID, non-structural and structural best management practices in accordance with the Stormwater Management Standards and the Massachusetts Stormwater Handbook.

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avoid duplication of effort, MassHighway may be able rely on the same procedures to fulfill the operation and maintenance requirements of Standard 9 and the MS 4 Permit.

[5] Although the MassHighway Handbook does not govern municipal road projects, cities and towns may find some of the information presented in the Handbook useful.

OPERATION & MAINTENANCE SUMMARY TABLE

OPERATION AND MAINTENANCE PLAN SCHEDULE **Date:**

Project: Mixed-Use Development
Project Address: Off Lincoln Street Marlborough, MA

Responsible for O&M Plan: ALTA Marlborough, LLC
Address: 91 Hartwell Avenue Lexington, MA 02421
Phone:

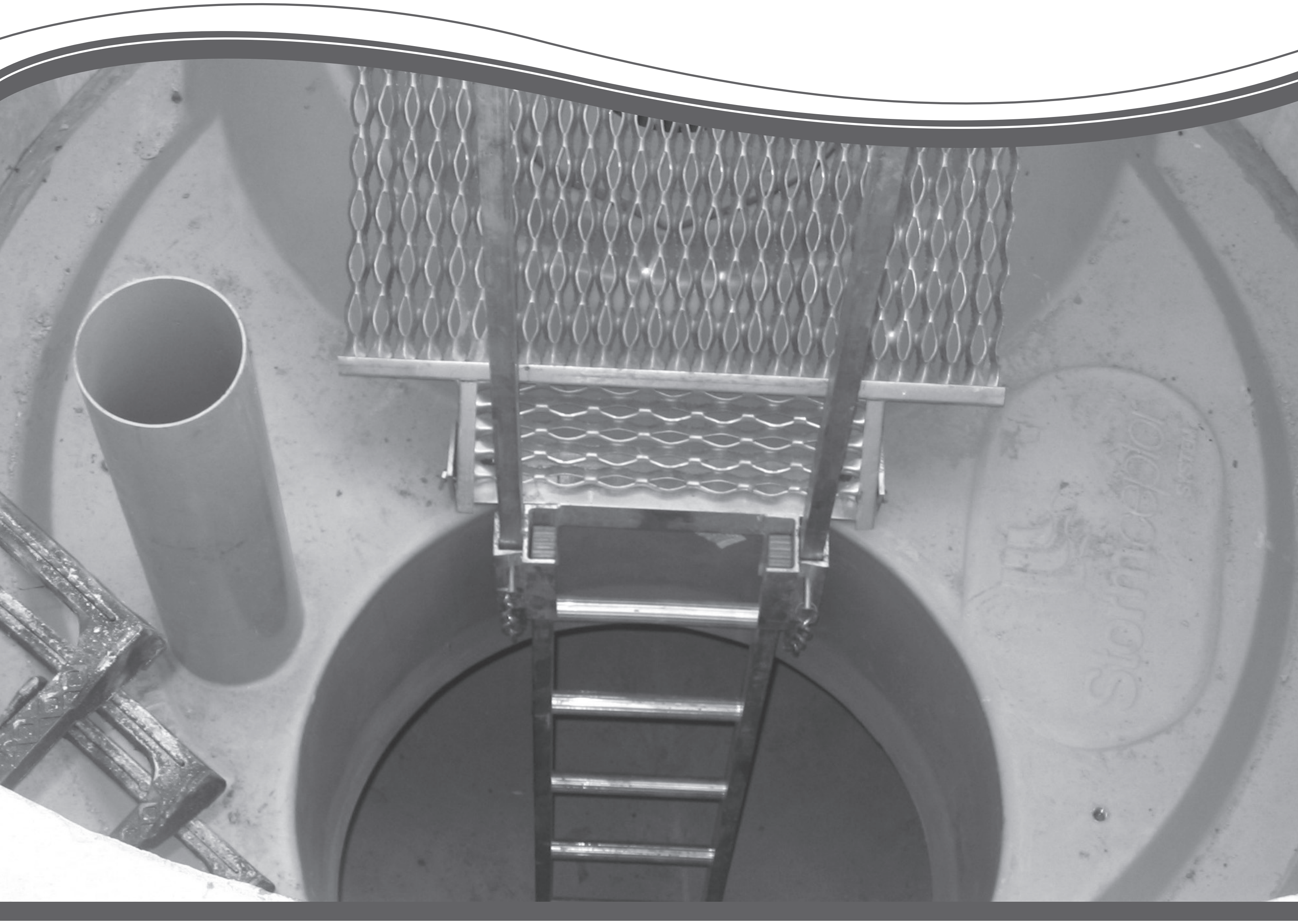
All information within table is derived from Massachussetts Stormwater Handbook: Volume 2, Chapter 2

BMP CATEGORY	BMP OR MAINTENANCE ACTIVITY	SCHEDULE/ FREQUENCY	NOTES	ESTIMATED ANNUAL MAINTENANCE COST	INSPECTION PERFORMED	
					DATE:	BY:
STRUCTURAL PRETREATMENT BMPs	DEEP SUMP HOODED CATCH BASIN	Twice per year.	Inspect and clean catch basin units whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.	$500		
	PROPRIETARY SEPARATORS	In accordance with manufacturers requirements, but no less than twice a year following installation and once a year thereafter.	Remove sediment and other trapped pollutants at frequency or level specified by manufacturer.	$2,000		
TREATMENT BMPs	PROPRIETARY STORMTECH ISOLATOR ROW	Twice per year minimum; follow manufacturer's schedule	Inspect for standing water, sediment, trash and debris and clogging. Inspect to determine if system drains in 72 hours once a year during wet season after a large storm.	$1,000		
INFILTRATION BMPs	SUBSURFACE STRUCTURES	Inspect structure inlets at least twice a year. Remove debris that may clog the system as needed.	Because subsurface structures are installed underground, they are extremely difficult to maintain. Remove any debris that might clog the system.	$1,000		
BMP ACCESSORIES	GREEN ROOF	The vegetation in green roofs requires support during establishment and yearly maintenance thereafter.	Weeding and mulching may be needed during the establishment period and periodically thereafter throughout the life of the roof. Regularly remove any woody plants that become established on the roof. If necessary, apply a slow-release fertilizer once a year to ensure continued vigorous growth of the vegetation.	$2,500		
	LEVEL SPREADERS	Inspect regularly, especially after large rainfall events.	Inspect level spreaders regularly, especially after large rainfall events. Note and repair any erosion or low spots in the spreader.	$500		

	OUTLET STRUCTURES	Periodic cleaning of Outlet Control Structures as needed.	Clear trash and debris as necessary.	$500		
OTHER MAINTENANCE ACTIVITY	**MISQUITO CONTROL**	Inspect BMPs as needed to ensure the system's drainage time is less than the maximum 72 hour period.	Massachusetts stormwater handbook requires all stormwater practices that are designed to drain do so within 72 hours to reduce the number of mosquitos that mature to adults since the aquatic stage of a mosquito is 7-10 days.	$500		
	SNOW STORAGE	Clear and remove snow to approved storage locations as necessary to ensure systems are working properly and are protected from meltwater pollutants.	Carefully select snow disposal sites before winter. Avoid dumping removed snow over catch basins, or in detention ponds, sediment forebays, rivers, wetlands, and flood plains. It is also prohibited to dump snow in the bioretention basins or gravel swales.	$1,000		
	STREET SWEEPING	Clear accumulations of winter sand in parking lots and along roadways at least once a year, preferably in the spring.	Sweep, power broom or vacuum paved areas. Submit information that confirms that all street sweepings have been completed in accordance with state and local requirements	$1,000		

STORMCEPTOR OPERATION & MAINTENANCE

Stormceptor® STC
Operation and Maintenance Guide



Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

Inlet and outlet invert elevation differences are as follows:

Inlet and Outlet Pipe Invert Elevations Differences			
Inlet Pipe Configuration	STC 450i	STC 900 to STC 7200	STC 11000 to STC 16000
Single inlet pipe	3 in. (75 mm)	1 in. (25 mm)	3 in. (75 mm)
Multiple inlet pipes	3 in. (75 mm)	3 in. (75 mm)	Only one inlet pipe.

Maximum inlet and outlet pipe diameters:

Inlet/Outlet Configuration	Inlet Unit STC 450i	In-Line Unit STC 900 to STC 7200	Series* STC 11000 to STC 16000
Straight Through	24 inch (600 mm)	42 inch (1050 mm)	60 inch (1500 mm)
Bend (90 degrees)	18 inch (450 mm)	33 inch (825 mm)	33 inch (825 mm)

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

Stormceptor® STC

OPERATION AND MAINTENANCE GUIDE
Table of Content

1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

2. Stormceptor Design Overview

2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18” (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

3. Key Operation Features

3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

v_{SC} = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

A_S = surface area, ft^2 (m^2)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

4. Stormceptor Product Line

4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

Table 1. Stormceptor Models

Stormceptor Model	Total Storage Volume U.S. Gal (L)	Hydrocarbon Storage Capacity U.S. Gal (L)	Maximum Sediment Capacity ft³ (L)
STC 450i	470 (1,780)	86 (330)	46 (1,302)
STC 900	952 (3,600)	251 (950)	89 (2,520)
STC 1200	1,234 (4,670)	251 (950)	127 (3,596)
STC 1800	1,833 (6,940)	251 (950)	207 (5,861)
STC 2400	2,462 (9,320)	840 (3,180)	205 (5,805)
STC 3600	3,715 (1,406)	840 (3,180)	373 (10,562)
STC 4800	5,059 (1,950)	909 (3,440)	543 (15,376)
STC 6000	6,136 (23,230)	909 (3,440)	687 (19,453)
STC 7200	7,420 (28,090)	1,059 (4,010)	839 (23,757)
STC 11000	11,194 (42,370)	2,797 (10, 590)	1,086 (30,752)
STC 13000	13,348 (50,530)	2,797 (10, 590)	1,374 (38,907)
STC 16000	15,918 (60,260)	3,055 (11, 560)	1,677 (47,487)

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

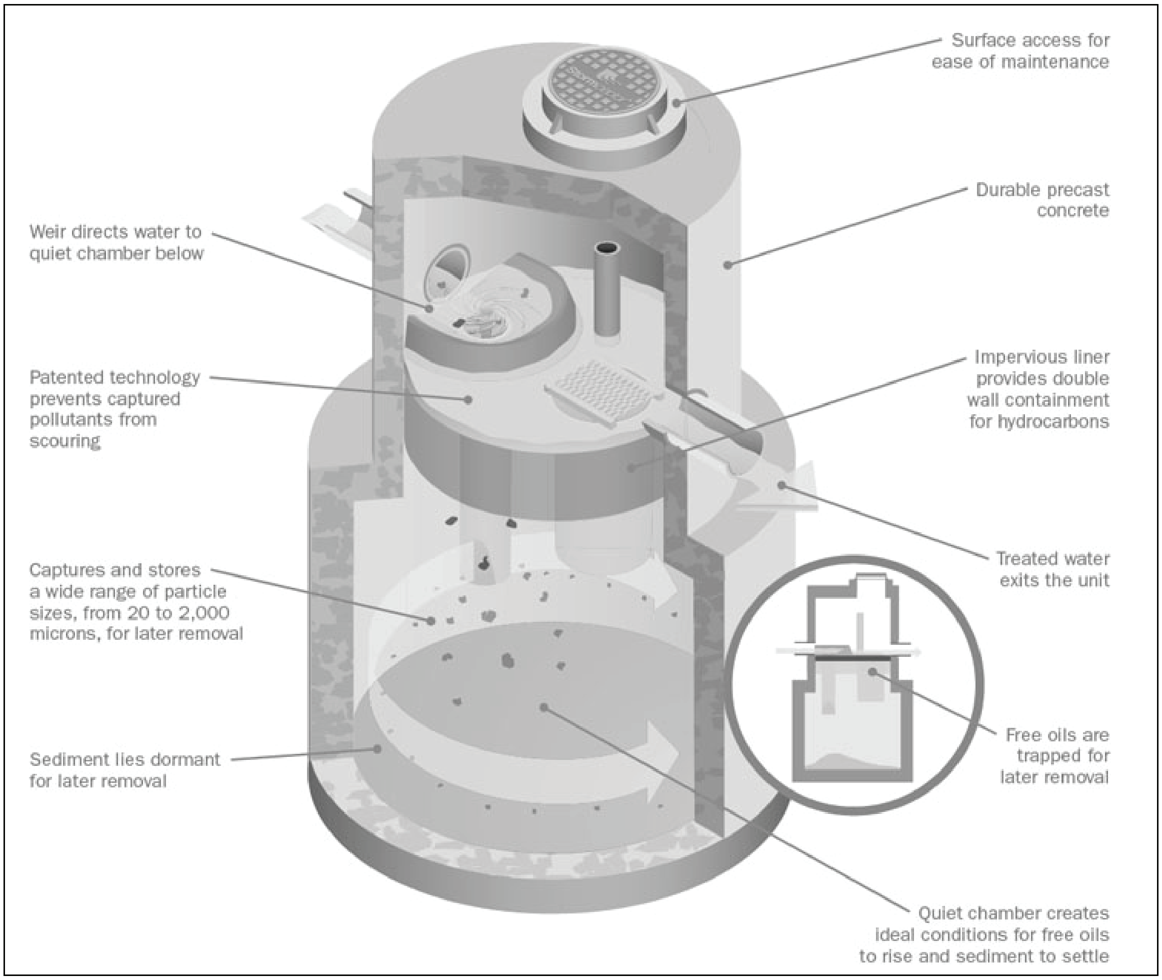


Figure 1. Inline Stormceptor

Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

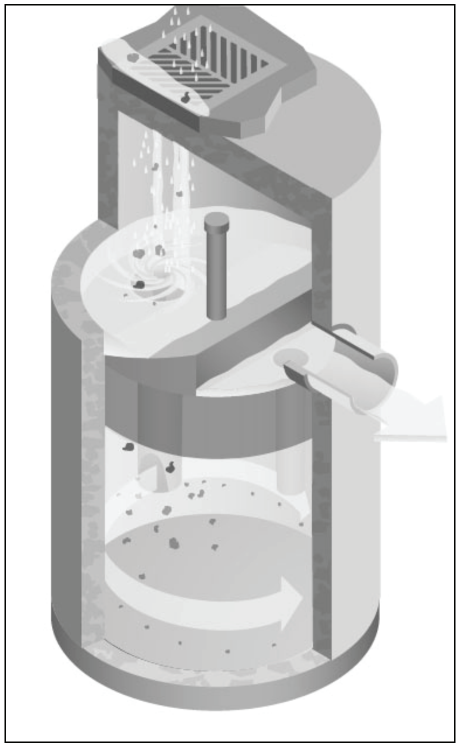


Figure 2. Inlet Stormceptor

4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

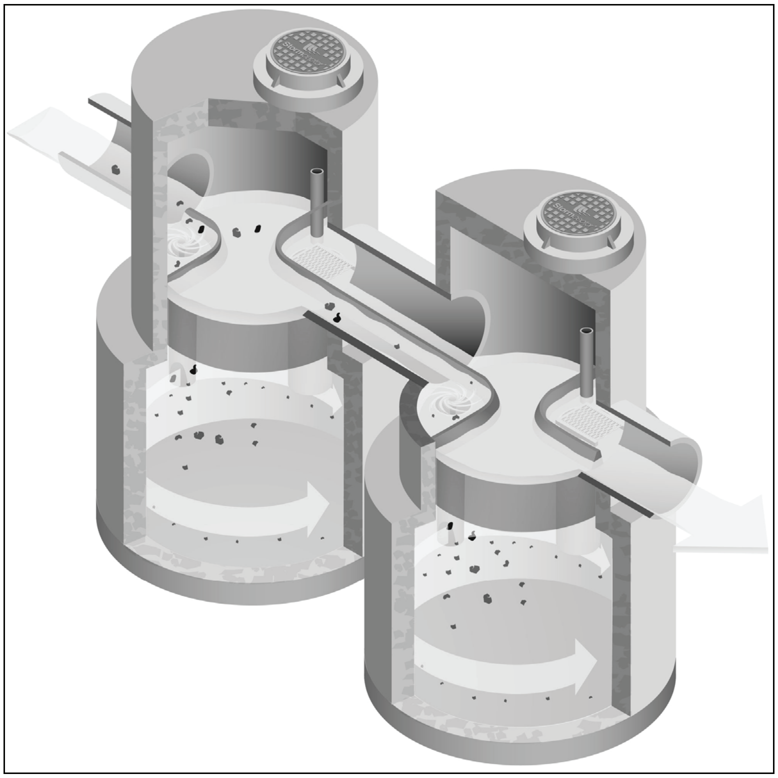


Figure 3. Series System

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

Table 2. Fine Distribution

Particle Size	Distribution	Specific Gravity
20	20%	1.3
60	20%	1.8
150	20%	2.2
400	20%	2.65
2000	20%	2.65

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
   - » The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
   - » The distribution of TSS with the hydrology is properly and accurately considered in the sizing
   - » Particle size distribution is properly considered in the sizing
   - » The sizing can be optimized for TSS removal
   - » The cost benefit of alternate TSS removal criteria can be easily assessed
   - » The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

‘Spill Capture’ describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit’s available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

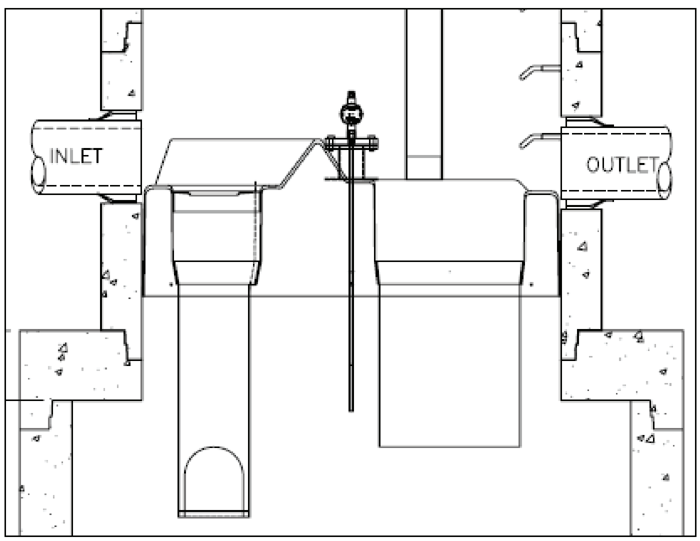


Figure 4. Oil level alarm

6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

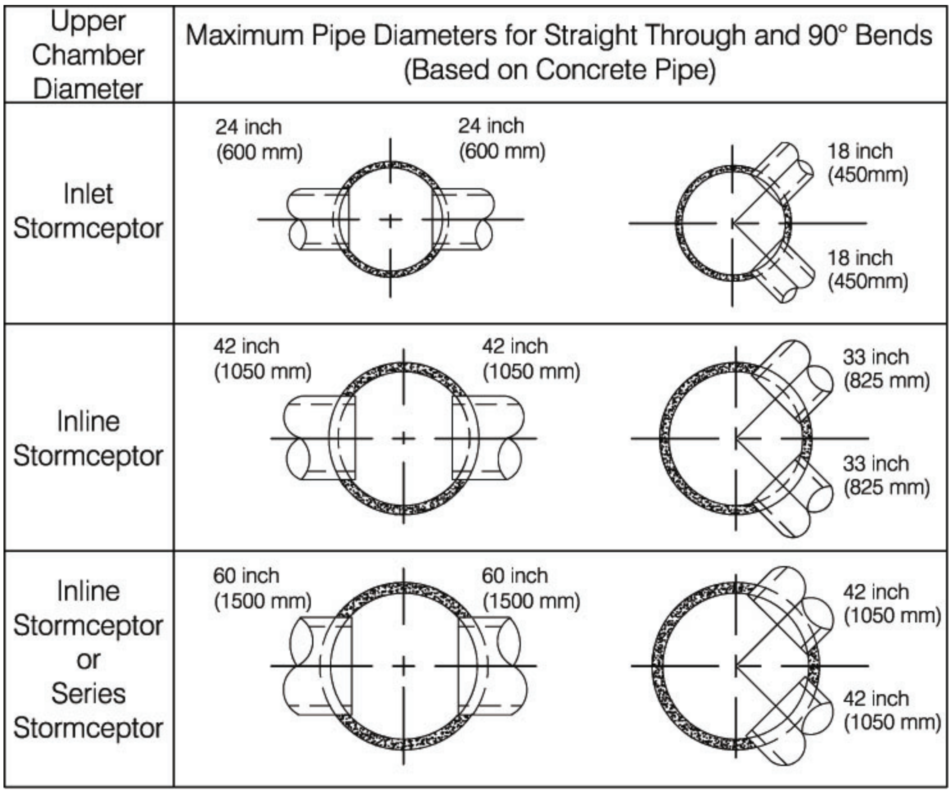


Figure 5. Maximum pipe diameters for straight through and bend applications

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

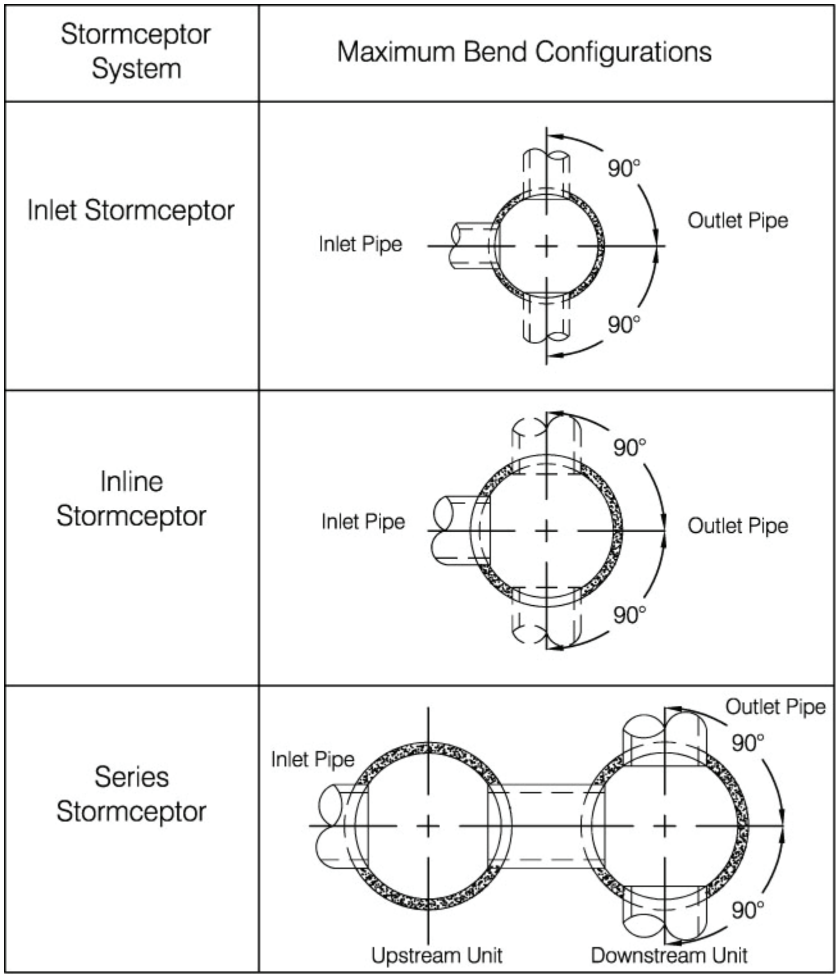


Figure 6. Maximum bend angles

7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts

Number of Inlet Pipes	Inlet System	In-Line System	Series System
1	3 inches (75 mm)	1 inch (25 mm)	3 inches (75 mm)
>1	3 inches (75 mm)	3 inches (75 mm)	Not Applicable

7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

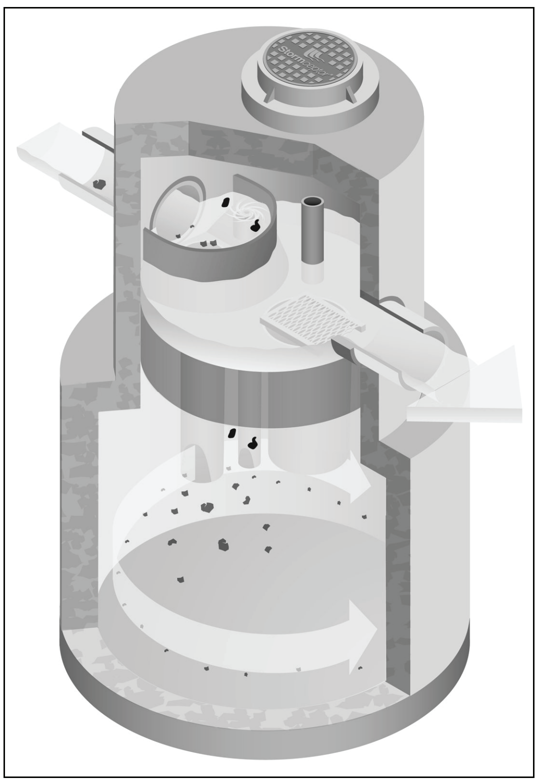


Figure 7. Submerged Stormceptor

8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between "approved alternatives". The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system's performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product's performance claims.

8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system's design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

12. Maintenance

12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

Table 4. Sediment Depths Indicating Required Servicing*

Particle Size	Specific Gravity
Model	Sediment Depth inches (mm)
450i	8 (200)
900	8 (200)
1200	10 (250)
1800	15 (381)
2400	12 (300)
3600	17 (430)
4800	15 (380)
6000	18 (460)
7200	15 (381)
11000	17 (380)
13000	20 (500)
16000	17 (380)
* based on 15% of the Stormceptor unit's total storage	

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.

SUPPORT

Drawings and specifications are available at www.ContechES.com.

Site-specific design support is available from our engineers.

CONTECH ENGINEERED SOLUTIONS
800-925-5240
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STORMTECH ISOLATOR ROW OPERATION & MAINTENANCE

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Detention • Retention • Water Quality
An ADS® company

Isolator® Row O&M Manual

*THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS™*

ADS®

THE ISOLATOR® ROW

INTRODUCTION
An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

THE ISOLATOR ROW
The Isolator Row is a row of StormTech chambers, either SC-160LP, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC- 310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the SC-160LP, DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

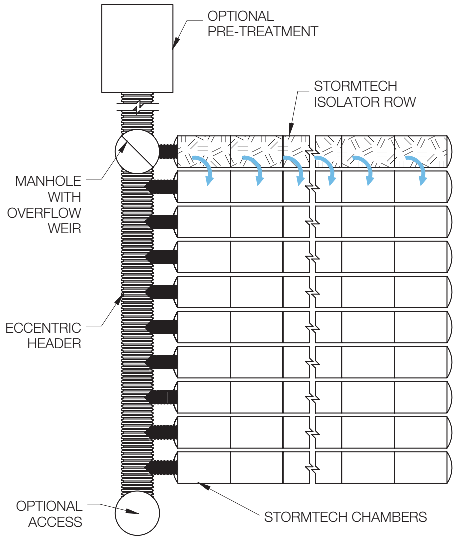
The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

StormTech Isolator Row with Overflow Spillway (not to scale)



ISOLATOR ROW INSPECTION/MAINTENANCE

INSPECTION

The frequency of inspection and maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

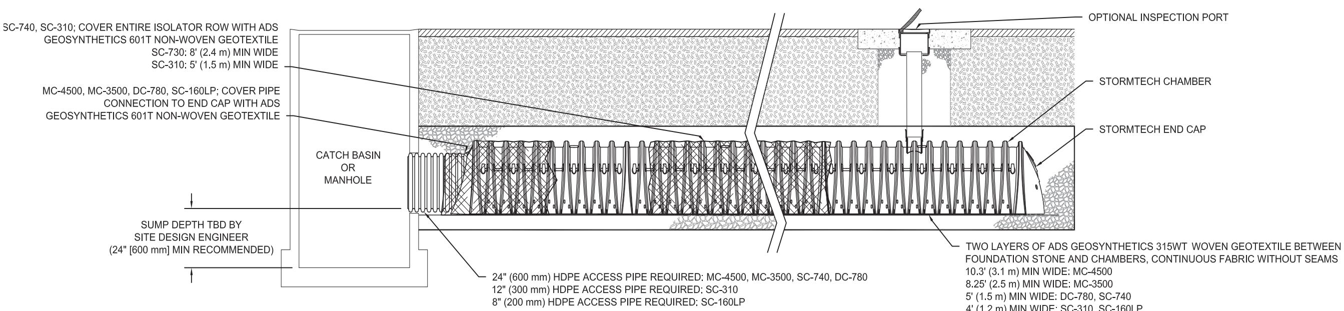
MAINTENANCE

The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for SC-160LP, DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.



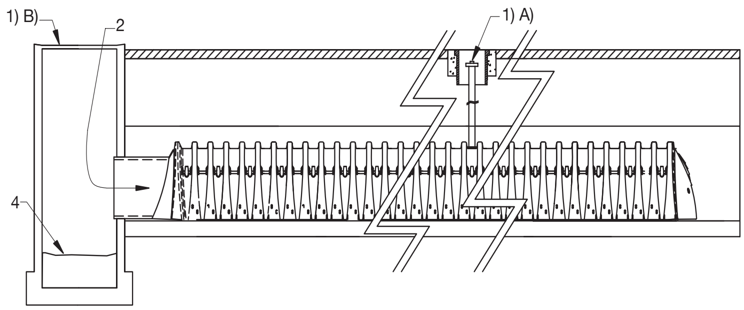
ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

STEP 1
Inspect Isolator Row for sediment.
- A) Inspection ports (if present)
  - i. Remove lid from floor box frame
  - ii. Remove cap from inspection riser
  - iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
  - iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.
- B) All Isolator Rows
  - i. Remove cover from manhole at upstream end of Isolator Row
  - ii. Using a flashlight, inspect down Isolator Row through outlet pipe
    1. Mirrors on poles or cameras may be used to avoid a confined space entry
    2. Follow OSHA regulations for confined space entry if entering manhole
  - iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

STEP 2
Clean out Isolator Row using the JetVac process.
- A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
- B) Apply multiple passes of JetVac until backflush water is clean
- C) Vacuum manhole sump as required

STEP 3
Replace all caps, lids and covers, record observations and actions.

STEP 4
Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

Date	Stadia Rod Readings: Fixed point to chamber bottom (1)	Stadia Rod Readings: Fixed point to top of sediment (2)	Sediment Depth (1)–(2)	Observations/Actions	Inspector
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

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1-800-821-6710 www.ads-pipe.com

StormTech Maintenance Log

Project Name:
Location:

StormTech®
www.stormtech.com

	Stadia Rod Readings				
Date	**Fixed point to chamber bottom (1)**	**Fixed point to top of sediment (2)**	**Sediment Depth (1) - (2)**	**Observations / Actions**	**Inspector**

GREEN ROOF SAMPLE MAINTENANCE

LiveRoof Operation Manual

The LiveRoof Operation Manual is simple and takes you through each year season-by-season. It is based upon sound horticulture and lean processes, and is designed to protect owner investment with minimal time and costs.

DOCUMENTATION

Always record each maintenance event. By keeping records (in spreadsheet format), you will learn the particular nuances of caring for your LiveRoof®. A printable log sheet is included on the last page of this guide.

Name of Person	Date	Activity	Observations
		If soil test, which lab, what test, and what were the results?	
		If fertilizer, record type and amount applied per 1000 sf	
		Time needed for bi-weekly weed walk and drain inspection.	
		If irrigation, duration and weather conditions?	

The following recommendations are generally tailored to LiveRoof® systems planted with low-growing, drought tolerant succulents. Deep & Maxx systems planted with traditional landscape perennials & ornamental grasses typically have different maintenance requirements and increased irrigation needs.

Maintenance training by LiveRoof representative is required for registration of the LiveRoof® module warranty. Consult your LiveRoof® Grower to confirm maintenance recommendations / watering regimen recommended for your specific application and plant mix(es).

Sign Up!
For monthly Seasonal Care Instructions, & notifications of updates to this guide:
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Biweekly Weed Walks

Twice monthly, during any time that the roof is not frozen, conduct an inspection of your green roof system. This will only take a few minutes. In fact, it's like a walk through a meadow, and it's easy. Simply pull any and all weeds, before they have a chance to flower and set seed. You might only fill up your hand with tiny weeds, this is the goal, to catch them when they are small and to prevent the development of a "seed bank" within your green roof. And, it is what keeps your total maintenance time to a minimum.

During inspections, BE SAFE. Use protective equipment, including harnesses if needed, and make sure that the roof is free of frost or other slipping hazards.

PULL WEEDS

Doing this is efficient, and the reason for the two week interval is that by pulling weeds when they are tiny, you keep them from maturing and creating seed.

By weeding every two weeks, you weed smart, not hard, and minimize the time needed for weeding. In fact, you can maintain an acre sized LiveRoof in just 30 minutes every two weeks, using this method. That's a total of only 8 hours per year in areas of temperate climate!

On the other hand, if you neglect your bi-weekly weed walk, weeds can become plentiful and time consuming to remove.

It is especially important that no woody plant ever be allowed to establish in a green roof system. Woody plants have extensive root systems that can damage roofing membranes.

INSPECT FOR POTENTIAL ISSUES

Other things to check for when taking your Weed Walk:

DISPLACED SOIL: Nesting birds can displace soil. Any displaced soil should immediately be replaced.

DRAIN INSPECTION: Roof drains should be inspected every two weeks and any debris, pebbles, or leaves should be removed to keep drains flowing freely. After inspecting drains, replace lids and ensure secured against wind uplift with pins. Failure to secure lids can result in damage or injury.

PLANT HEALTH: Most plant issues are a result of watering issues. Check the soil with your finger. If it is overly dry, decrease the interval between waterings and/or check irrigation system to ensure it is running properly. If it is too wet, cut back on irrigation.

PEST CONTROL: Occasionally pest insects such as aphids may show up and bother the plant material, and while not commonplace, fungal problems like mildew occasionally affect green roof plants. Most pest problems are the result of an imbalance in the relationship of the pest organism and its natural biological controls (beneficial insects like ladybugs and lacewings). Many pests and fungal infirmities (like blight or mildew) are usually triggered by unusual weather events that cause the pest to multiply faster than it's biological control. In time, the biological control usually catches up and most pest and disease issues tend to be temporary in nature.

On the other hand, if you detect persistent pest problems, LiveRoof suggests the use of organic and natural biological control agents instead of conventional pesticides. Conventional pesticides may runoff into sensitive areas and might also damage roofing membranes. Consult a professional prior to applying any biocontrol or pest or disease fighting agent.

Dog waste (urine and excrement) are toxic to and will kill succulent green roof plants. Therefore, unless you have a green roof that is specifically developed for dog traffic, keep dogs off the roof.

If your green roof has been specifically developed for dog traffic, then it is likely vegetated with either a turf grass or a lily-turf, such as Liriope spicata. Such roofs require a minimum of 6 inches of soil (the LiveRoof deep system), and should be cared for so as to preserve the plant material. Excrement should be picked up and the plants should be watered regularly, not just for hydration, but to flush the urine from the soil.

Water Management

In northern North America, irrigation may not be needed to keep your green roof alive during some summers, provided it is populated with Sedums and a contains a minimum of 4 ¼" soil (LiveRoof Standard modules).

- For the LiveRoof® Lite system, expect to irrigate more frequently, typically weekly during hot, dry weather.
- Likewise, the Deep (6") and Maxx (8") systems, when populated with native or conventional (non-succulent) perennials, often require very frequent irrigation.

When in doubt, consult your LiveRoof® Grower for watering recommendations for your specific plant mix(es) and site conditions.

In warmer climates, regular irrigation is required. Regardless of climate, LiveRoof® recommends a permanent irrigation system, as practical and efficient for the scale of the installation, as an "as needed" management tool during the hottest, driest months of the year.

At any soil depth, prolonged hot dry weather without supplemental irrigation will result in plant thinning or death.

HOT DRY WEATHER is generally defined as periods of 75 degree weather, with less than 1 inch of rainfall per month. This "ballpark" time period will tend to be less if the temperatures are hotter, or on sloping roofs and roofs exposed to persistent winds or reflected sunlight. Such conditions can dry out the soil and cause the plants to go dormant, or in extreme cases, to dry up and die.

During prolonged hot dry weather or when plants become drought stressed, irrigation should be applied, temporarily, to re-wet the soil to the point of saturation. This will keep plants from going dormant, keep them plump and healthy so they can cover the soil effectively, and optimize their appearance. It also enhances the evaporative cooling effect of the green roof.

There are no absolutes when it comes to drought stress and irrigation. Check the plants for wilting, especially in the afternoon. If the plants are wilting, it is time to irrigate.

WATERING SEASON

Generally, the green roof system will be deactivated during traditional "winter" months, where snow or rainfall and cold weather persist. In warmer climates, irrigation may be required year round. During periods of unusually warm, dry winter weather, the green roof may need to be irrigated.

Areas beneath building overhangs will not receive direct rainfall, thus require regular irrigation regardless of plant type and soil depth.

HOW MUCH WATER?

Drenching the soil periodically, just to the point of runoff, is better than more frequent, light irrigation events. Light irrigation can encourage shallow rooting and create a build-up of salts in the soil. The duration of the irrigation run and the volume of water to apply will depend upon the soil depth, and available water pressure and volume at the rooftop.

In areas of shade, less irrigation will be required.
DO NOT OVER WATER as this can cause widespread plant losses.

Thoroughly irrigating, as indicated above, will pay off significantly.

Not only will the plants be healthier and fuller, bringing reduced maintenance costs, but the actual cost of irrigation is minimal compared to the energy savings derived from enhancing the evaporative cooling of the green roof.

Spring Maintenance

Spring Maintenance begins 3-4 weeks before the spring "growth flush," which varies with locale. It is the time when plants "wake up" and grow very fast. This typically coincides with spring rain and "spring flowers" such as Forsythia, Daffodils, and Wisteria. In Tennessee, for example, it occurs around mid March, while in Minnesota it begins around mid April. In climates without cold winters, this could be February.

Resume biweekly "weed walks" and inspections. Weeds are opportunists, and many weeds actually grow during winter. Therefore, you will probably have a few weeds waiting for you in spring. Once your roof is thawed out it is time to walk your roof and pull any and all weeds, no matter how small—every two weeks.

EARLY TO MID MARCH (ADJUST EARLIER OR LATER FOR LOCAL CLIMATE)

PERFORM ANNUAL SOIL TEST

LiveRoof soils are formulated for sustainable nutrient content, but rainstorms and snowmelt can leach nutrients and deplete fertility. Soil testing is best conducted during late winter which leaves time to apply fertilizer, before the spring growth flush, the time when plants most require adequate nutrition.

To test soil, gather a two cup sample by digging soil out in small quantities (using a large spoon) from at least 15-20 separate places throughout the roof. Place these small samples ("sub-samples") in a labeled, sealed, plastic bag, or test kit from your testing lab. LiveRoof, LLC strongly recommends the following lab and test procedures.

Pennsylvania State University, University Park, PA
Saturated paste, pH, salts, nutrients plus percent solids & organic matter, appx. $55

EARLY APRIL (ADJUST EARLIER OR LATER FOR LOCAL CLIMATE)

APPLY FERTILIZER (if needed)

Upon receipt of your soil test results from the lab, interpret the information and determine the need, if any, for fertilization. Pay attention to the various nutrient levels; such as Nitrogen (N or NO_3-N), Potassium (K), Phosphorus (P). For each of these, the soil report will indicate if there is a Low (L), Moderate (M), or High (H) amount of that nutrient in the soil. The most important of these, in terms of plant vigor, is Nitrogen. If your soil contains less than a Moderate (M) amount of nitrogen, the plants will thin out and create areas of exposed soil. Therefore, if the Nitrogen level is Low, it is advisable to apply supplemental fertilizer.

- When applying fertilizer to green roofs, it is important to be sensitive of runoff potential. Ask yourself, where is the runoff water going, and what might it affect (e.g., fish, frogs, etc.)? In all cases, it is imperative to use a "Slow Release" fertilizer rather than a conventional fertilizer to minimize nutrient runoff. Slow release fertilizers are coated with a waxy or sulphur covering that allows the fertilizer to release into the soil over time, rather than all at once. Such fertilizers are more readily absorbed by the plants, and therefore are less likely to contaminate runoff water.
- Always choose a high quality slow release granular fertilizer—available at your local garden center. Good brands are Osmocote® and Nutricote®, but there are others. High quality fertilizers are designated "Coated Slow Release Fertilizer", and the label will typically indicate something to the effect of "provides 4 to 6 months of continuous feeding". Some high quality "turf-grade" fertilizers may work well on the green roof, but they too must indicate "slow release", and must contain NO Herbicides or other Pesticides. The best of these, in our opinion, is Lesco 14-14-14 sulfur coated, available from John Deere Landscapes. If fertilizers containing phosphorus are banned from local use, we recommend Lesco 21-0-21.
- Fertilization is best conducted during the spring, with a single annual application. Spring is the correct time because the plants are actively growing and not under drought stress.

- All fertilizers will be labeled with three numbers, which indicate the % by weight of Nitrogen (N), Phosphorus (P), and Potassium (K), in the fertilizer. Common formulations are 21-0-21, 18-6-12 or 14-14-14, but there are many others. In some communities, Phosphorus-containing fertilizers are prohibited due to the potential for creating algae growth in waterways. If in doubt, check with your local cooperative extension agency (https://nifa.usda.gov/land-grant-colleges-and-universities-partner-website-directory).
- A Rotary Spreader (push type or belly-crank type) can be used to ensure that fertilizer is applied evenly.

In all cases, fertilizer should be applied in accord with manufacturer's recommendations, and evaluated by the applicator for runoff potential in accord with site specifics.
The greater the runoff potential, the lower the application rate should be.
Applicator assumes all risks associated with fertilizer application.

pH

The acidity or alkalinity of the soil is determined by its pH. Plants have a preferred pH range for optimal utilization of nutrients, and in the case of most green roof plants, this range is 6.5 to 7.0. Below 6.0 is too acid, and above 7.5 is too alkaline. If your soil pH is below 6.5, consult your soil testing lab for recommendations to increase alkalinity. Typically, this means adding lime. And, if the soil is above 7.5, it can be made more acid with elemental sulphur or an application of acidifying fertilizer, such as Lesco 14-14-14 sulfur coated fertilizer. Since LiveRoof soils are formulated to buffer against pH changes, the need to adjust pH is relatively uncommon.

MOWING

Mowing is recommended to tidy up the roof after winter. Persistent dried seed heads can detract from the aesthetic qualities of the green roof. And, in some cases they are so thick as to shade the foliage. If this occurs, you may choose to mow the green roof and the time to do this is early April (adjust accordingly to precede spring growth flush). In especially humid climates (such as US Southeast), a spring trimming helps to prevent fungal issues that may result from excessive humidity buildup beneath the plant canopy. Do not mow plants in summer.

If you choose to mow your green roof, set the mower blade just above the foliage. The idea is to mow the dried seed heads, but avoid cutting the foliage. Do not bag the clippings, instead blow them into the vegetated portion of the roof so that they can decompose and nourish the soil. You can also do this with a string trimmer.

Deep and Maxx Systems: The Deep and Maxx systems are often populated with perennials and grasses. In addition to the maintenance outlined above, any non evergreen perennials should be trimmed down at this time of year to tidy them up. Vegetable plants should be removed and the soil raked smooth and any weeds removed before replanting.

APRIL TO MAY

Continue biweekly "weed walks" and inspections, and activate irrigation system and/or adjust watering schedule as needed for changing weather.

Summertime Maintenance

JUNE TO SEPTEMBER (ADJUST EARLIER OR LATER FOR LOCAL CLIMATE)

Continue biweekly "weed walks" and inspections, and activate or adjust watering schedule as needed for changing weather. During the hottest, most humid months of the year, be sure to water as needed to maintain healthy plants.

Fall Maintenance

OCTOBER TO NOVEMBER (ADJUST EARLIER OR LATER FOR LOCAL CLIMATE)

Continue biweekly "weed walks" and inspections, and activate or adjust watering schedule as needed for changing weather.

Many weeds germinate and grow during fall. Weeding up until snow fall in cold winter climates can save a lot of work the following year. Stay off the roof if there is frost or ice. Many weeds are capable of reproducing during winter, even under the snow, so you will want to have the roof "weed-free" going into winter.

Use care to avoid walking on the plants in the presence of ice, frost or other slipping hazards.

In addition

- In climates with cold winters, DO NOT fertilize during fall. It may stimulate tender growth and compromise the cold hardiness of the plant material. In warm winter climates, without freezes, fall fertilizer may be desirable.
- Rake up any fallen and matted tree leaves. These can smother the green roof plants.
- Be sure the drains are free-flowing and not impaired by fallen leaves. Impaired drainage can damage the roof and damage or kill the plants.
- If the green roof is cantilevered with no heat under it, install heat tape or heat cable in the drains to keep the drains from freezing shut during winter.

Deep and Maxx Systems: The Deep and Maxx systems will likely contain vegetable, perennial, and grass species. During fall, these plants may be trimmed and tidied up for winter. Vegetable plants may be removed altogether; however, we recommend leaving the vegetable plants over the winter to prevent wind erosion. In spring, they may be removed and replanted.

Winter Maintenance

DECEMBER TO FEBRUARY (ADJUST EARLIER OR LATER FOR LOCAL CLIMATE)

In Northern Temperate Regions: Across the northern temperate region of North America, the plants will be dormant and the soil will usually be frozen during the winter season. This is the time to stay off the roof as it may be slippery and dangerous. While the roof is frozen, the only winter maintenance required may be snow removal from rooftop walkways--if roof ingress and egress is required.

- Should you have to shovel pathways on your roof during winter, AVOID USING SALT AND OTHER DEICING CHEMICALS. They will kill the plants and damage the pavers. Instead, use sand or cat litter as an anti-slip agents.
- In some cases, electronic heat tape or cable snow-melt systems may be appropriate, but must be installed in a manner that does not heat up the soil in modules adjacent to walkways. Take care and seek approval from the membrane manufacturer to confirm that such systems will not compromise or damage the membrane.
- Avoid piling all the snow in one place. Instead disperse it evenly over the green roof plantings. Excess snow can potentially damage the plant material by insulating the plants and keeping them too warm, thereby triggering fungal diseases.

In Warm Climate Regions: In areas of warm climate, the plants will likely be dormant or semi-dormant during winter, but the weeds will not be. Therefore, you must continue biweekly "weed walks" and inspections, and activate or adjust watering schedule as needed for changing weather.

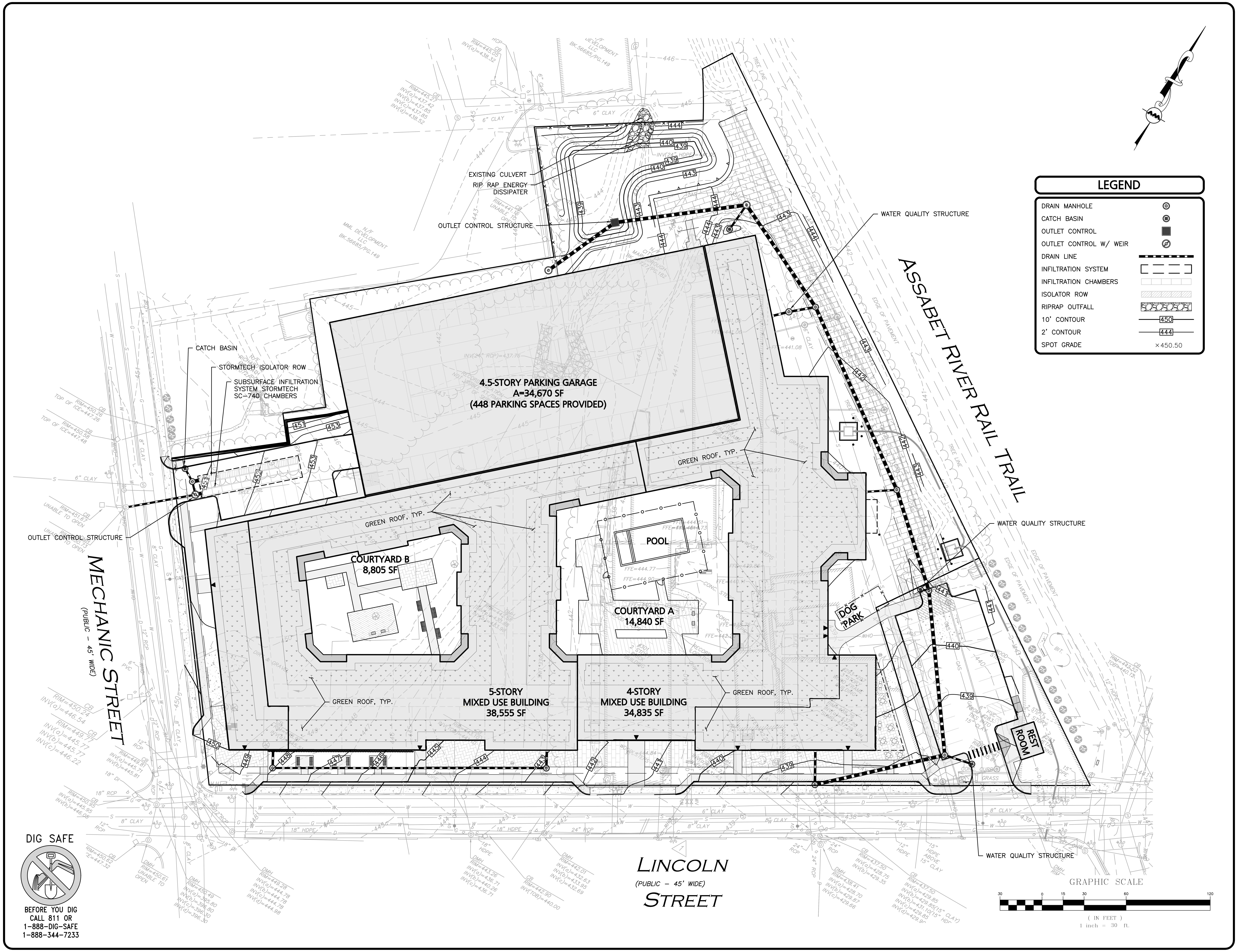
LiveRoof Operation & Maintenance Log

Project Name	Date Installed	LiveRoof System Type(s)	Plant Mix Notes	Recommended Typical Irrigation Regimen
		☐ LITE (2 ½”) ☐ STANDARD (4¼”) ☐ DEEP (6”) ☐ MAXX (8”)		

Name of Person	Date	Duration	Weather Conditions	Activity	Observations

APPENDIX B SITE PLANS

SITE PLAN



ISSUED FOR SPECIAL PERMIT
APRIL 1, 2022

COMMONWEALTH OF MASSACHUSETTS
PAUL G. MATOS
CIVIL
NO. 52850
REGISTERED PROFESSIONAL ENGINEER

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PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

REV	DATE	DESCRIPTION

APPLICANT\OWNER:

ALTA MARLBOROUGH, LLC
91 HARTWELL AVENUE, 3RD FLOOR
LEXINGTON, MA 02421

PROJECT:

ALTA MARLBOROUGH
283-325 LINCOLN STREET
MARLBOROUGH, MA

PROJECT NO.	1670-20	DATE:	04-01-2022
SCALE:	1" = 30'	DWG. NAME:	C1670-20
DESIGNED BY:	PGM	CHECKED BY:	PLC

PREPARED BY:

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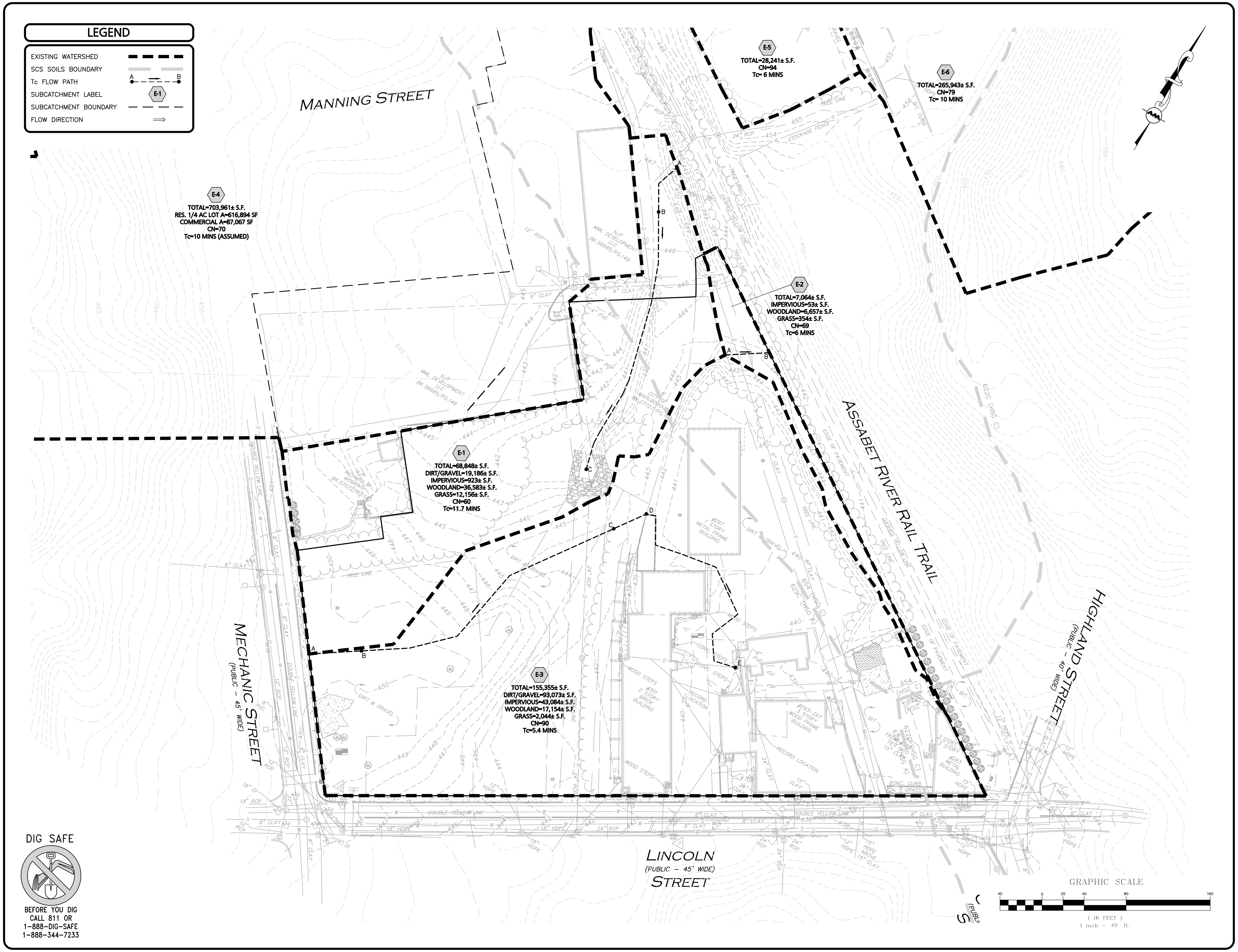
DRAWING TITLE:	SHEET No.
OPERATION & MAINTENANCE PLAN	O&M 1

APPENDIX D
WATERSHED PLANS

EXISTING WATERSHED PLAN EWS-1



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PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

REV	DATE	DESCRIPTION

APPLICANT\OWNER:

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91 HARTWELL AVENUE, 3RD FLOOR
LEXINGTON, MA 02421

PROJECT:

ALTA MARLBOROUGH
283-325 LINCOLN STREET
MARLBOROUGH, MA

PROJECT NO.	1670-20	DATE:	04-01-2022
SCALE:	1" = 40'	DWG. NAME:	C1670-20
DESIGNED BY:	PGM/JS	CHECKED BY:	PLC

PREPARED BY:

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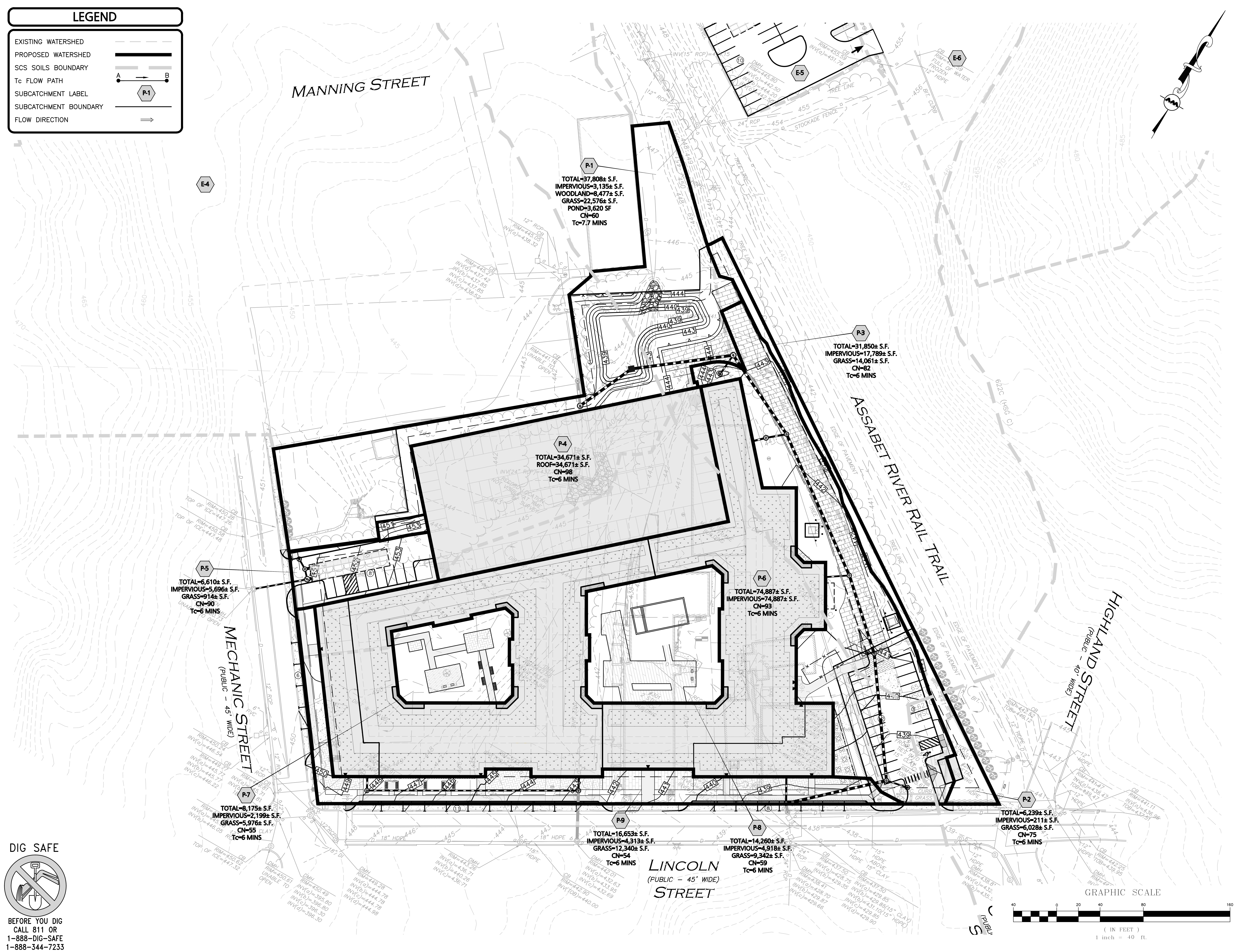
DRAWING TITLE: EXISTING WATERSHED PLAN

SHEET No. EWS-1

PROPOSED WATERSHED PLAN – PWS-1



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PROFESSIONAL ENGINEER FOR
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APPLICANT\OWNER:
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PROJECT:
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DRAWING TITLE: PROPOSED WATERSHED PLAN

SHEET No. PWS-1