PROJECT NARRATIVE & DRAINAGE REPORT TO ACCOMPANY COMPREHENSIVE PERMIT APPLICATION

Multi-Family Development
1486 Main Street Waltham, MA

Prepared: January 20, 2022
Revised: May 25, 2022

Site Locus

CLIENT:
Limited Dividend Affiliate of
WP East Acquisitions, LLC
91 Hartwell Avenue
Lexington, MA 02421

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

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A&M PROJECT NO.:
1670-14

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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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1.1 INTRODUCTION

The applicant, a Limited Dividend Affiliate of WP East Acquisitions LLC, is submitting a comprehensive permit application in accordance with Massachusetts General Law chapter 40B, Sections 20-23 for construction of a multi-family residential development located at 1486 Main Street in the City of Waltham, Massachusetts consisting of a total of 179 residential units on approximately 2.15 acres as shown on the Site Development Drawings. The proposed project will include the construction of a four/five (4/5) story residential building with two (2) story parking garage located underneath. The parking garage will have two (2) separate entrances, one off Main Street servicing the lower level and the other off an existing access road servicing the second floor. The clubhouse/amenity area will be located within the lower level of the building and an exterior courtyard with a pool will be located in the central core of the building. Construction will also include an access road, 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 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 in total, whereas a redevelopment project is required to meet only to the extent practicable.

1.2 SITE CATEGORIZATION FOR STORMWATER REGULATIONS

The proposed project is considered a mix of redevelopment and new development under the MassDEP Stormwater Management Standards. A majority of the site was previously developed in 2005 for a garage and parking areas for vehicles. These areas will be considered redevelopment and are required to meet the Stormwater Management Standards to the maximum extent practicable and provide an improvement over existing conditions.

The proposed development will improve the stormwater quality, because the project will minimize exterior parking areas which are subject to pollutants. The proposed building will encompass a majority of the property, therefore clean roof runoff from the building will be collected and piped into a subsurface infiltration system located underneath the parking garage. Stormwater associated with the front parking area will be directed to a water quality structure and into a subsurface infiltration system located within the parking area. Stormwater associated with the easterly access road will continue to drain either into the proposed raingarden, an existing leaching catch basin or onto Main Street. The subsurface infiltration system will consist of Retain-it concrete chambers. The larger subsurface infiltration system located underneath the parking garage will utilize the existing outlet control structures along the westerly property line. The smaller subsurface infiltration system located within the parking lot will be designed for 100% containment and will infiltrate the stormwater. The entire drainage system has been designed to meet or be less than pre-development conditions.

SECTION 2.0
EXISTING CONDITIONS

2.1 SITE LOCATION AND ACCESS

The subject property (the "Property") is located at 1486 Main Street in the City of Waltham which is located in eastern Massachusetts in Middlesex County. Waltham is located approximately 11 miles northwesterly of downtown Boston and approximately 3 miles northwest of Boston's Brighton neighborhood. The property is located in the southwesterly corner of Waltham, near the Town line of Weston and westerly of Interstate Route 95. The Property has legal frontage on the south side of Main Street (Route 117). Main Street run east/west and merges with Route 20 to the east beyond Route 95. Refer to Figure 1, which shows the entire Property, outlined in red.

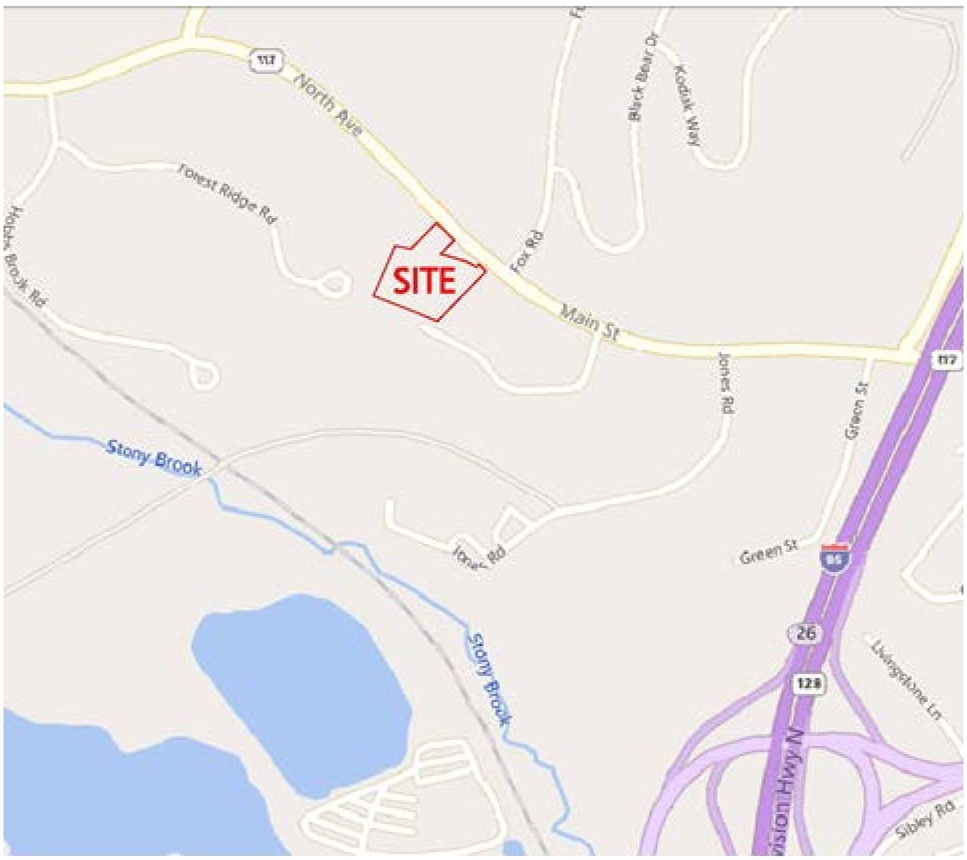


Figure 1 – Locus Map (Bing Map)

Directly in front of the site the paved road is approximately 33 feet wide with a lane in each direction. Just beyond the existing entrance, the southerly lane splits into two lanes, with one dedicated to left turns into the existing residential development on the northerly side of Main Street.

The City of Waltham Assessor's office identifies the property as Parcel ID: R056 002 0005 with a known address of 1486 Main Street and is approximately 2.15 acres in size. The current ownership is titled to TSA Properties, LLC recorded in Middlesex County deed book 56729 page 296. The Property is situated in the Commercial (C) Zoning District with Residence A2 (RA2) and Residence C (RC) Zoning Districts located on the northerly side of Main Street with an Industrial (I) Zoning District located further southerly.

2.2 EXISTING SITE CONDITIONS

The Property is approximately 2.15 acres in size with the majority currently developed, refer to Figure 2 below, which shows the entire property, outlined in red. The property is being used as an automotive maintenance/service garage, storage of vehicles and parts. The 1-story garage is approximately 9,075 sf in footprint area, having an exterior consisting of metal siding/roof and was built in 2005. The parking area and access roads are currently paved and totals approximately 56,202 sf of impervious surfaces. The total lot coverage of impervious surface is approximately 65,277 sf or 69.7%.

Figure 2 - Locus Map (MassGIS Aerial)

The site is located on the Concord USGS Quadrangle map. The site topography is fairly to moderately sloped, adjacent to the existing garage, but elevated around the perimeter with various retaining walls. The topography ranges from a low elevation of 149± at the northerly corner at Main Street as well as the southwesterly corner to a high elevation of 176± at the southerly corner along the top of the retaining walls. Please refer to the site plans for site specific elevations and details.

2.3 WATERSHED

The property falls within the Charles River Watershed with a drainage area of approximately 308 square miles. The Charles River Watershed is comprised of thirty-five (35) communities with Waltham being located in the northerly portion. There are over 80 brooks and streams, 33 lakes and ponds and several major aquifers that feed the Charles River. The Charles River is approximately 80 miles long, meanders through 23 communities and eventually discharges to the sea.

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:

- 251B Haven silt loam, 3 to 8% slopes;
- 420B Canton fine sandy loam, 3 to 8% slopes;
- 424D Canton fine sandy loam, 15 to 25% slopes, extremely bouldery;
- 656 Udorthents-Urban land complex.

Figure 3 – Soil's Map

Haven and Canton soils are associated with the Hydrologic Soil Group (HSG) designation of A & B. Both soils are well drained with a depth to the water table greater than 80 inches. Udorthents are lands that have been altered/developed.

Test pits and borings have been performed on-site by Haley Aldrich and Vertex in June 2021. Test pits and borings were done for various portions of the project which include foundation and footing design. Soils consist of fill and very dense silty sand with gravels. The water table ranges in depth from 6.2 to 13.7 feet below existing grade. A copy of the soil mapping from the NRCS website and the preliminary geotechnical report are included in the Appendix D.

2.5 FEMA FLOODPLAIN

The Flood Insurance Rate Map (FIRM) (Map Number 25017C0394E) for the City of Waltham dated June 4, 2010 indicates the entire property lies within a FEMA Zone X, refer to Figure 7 below. The FEMA Zone X which is defined as "areas determined to be outside the 0.2% annual chance floodplain".

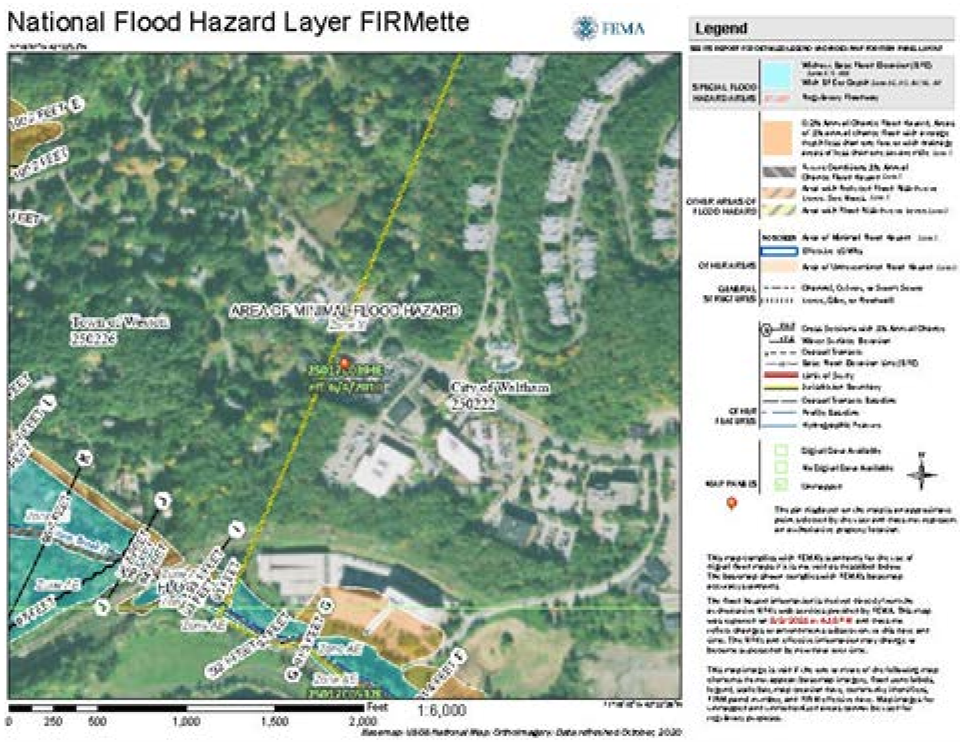


Figure 4 – FEMA FIRMette (Map 25017C0394E)

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 MassDEP OLIVER website, the property is located within an Outstanding Resource Water (ORW) to a public water supply watershed to Stony Brook Reservoir in the Charles Watershed Basin, located in a Surface Water Protection Area Zone C to Stony Brook Reservoir, and located in an Interim Wellhead Protection Area (IWPA) Kendall Green Tub. Wells (Weston Water Department PWS ID 3333000-01G)(Radius=2640-ft).

There are no wetland resource areas, no riverfront areas and no priority and protected habitat for rare and endangered species on the Property.

2.7 EXISTING STORMWATER PATTERNS

In order to compare the difference between pre- and post-development peak flows and run-off volumes, A&M is relying on the Stormwater Analysis submitted during the permitting of the existing facility as prepared by Brassard Design & Engineering, Inc. dated April 26, 2005 to establish the pre-development conditions prior to development. A&M will also be utilizing the 2005 post-development conditions to establish the baseline. The design points for existing watersheds were established as the outer limits of the property to ensure proper analysis from pre- and post-development conditions.

Stormwater drains from the east-south to the west-north portion of the site. A majority of the stormwater from the existing development is currently being collected in a series of catch basins and piped into a sub-surface infiltration system located adjacent to the garage. Based on record files, the sub-surface infiltration system consist of 36" perforated pipe and has been designed with an outlet control structure which discharges treated stormwater to the southwesterly corner of the site. Stormwater from the main access road is collected by a catch basin and discharges into a drywell. A portion of the stormwater from the secondary access drive is collected by a leaching catch basin and the remaining portion flows into Main Street.

See Appendix E for a copy of the Stormwater Analysis and the rear of this report for a copy of the Existing Watershed Plan (EWS-1).

2.8 EXISTING SITE UTILITIES

The existing garage is currently being serviced by serval utilities which include municipal water and sewer, underground electrical/communication services and gas service. There are two (2) water mains, an eight (8) inch and a twelve (12) inch main, located on the southerly side of Main Street within the travelled way. According to record plans, there are two water lines servicing the garage/facility, one for fire protection and the other for domestic use.

The closest sewer manhole is currently located at the intersection of the secondary drive and Main Street. Due to the location and grade changes, the existing garage discharges into the municipal system via a two (2) inch force main, approximately 350-ft away. The floor drains in the garage are connected to a gas trap and connected to the pump chamber. Sanitary waste is also connected to the pump chamber located on the northerly side of the building.

Utility poles and overhead wires are located on the southerly side of Main Street. Eversource Electric is the electrical service provider for the City of Waltham. Verizon, Comcast, RCN and AT&T supply the City with communication lines that can be either through overhead cables or underground conduits. A gas main is located on the northerly side of Main Street within the travelled way. National Grid Gas is the gas provider for the City of Waltham.

The secondary drive on the easterly side of the property also has several utilities located within the right of way which include municipal water and sewer, overhead utilities and gas service. Based on record plans, these utilities are servicing the existing development at 1474 Main Street, the Keane Fire and Safety Building.

SECTION 3.0
PROPOSED CONDITIONS

3.1 PROPOSED OVERVIEW

The applicant, a Limited Dividend Affiliate of WP East Acquisitions LLC, is submitting a comprehensive permit application in accordance with Massachusetts General Law Chapter 40B, Sections 20-23 for construction of a multi-family residential development located at 1486 Main Street in the City of Waltham, Massachusetts consisting of a total of 179 residential units on approximately 2.15 acres as shown on the Site Development Drawings. The proposed project will include the construction of a four/five (4/5) story residential building with two (2) story parking garage located underneath. The parking garage will have two (2) separate entrances, one off Main Street servicing the lower level and the other off an existing access road servicing the second floor. The clubhouse/amenity area will be located within the lower level of the building and an exterior courtyard with a pool will be located in the central core of the building. Construction will also include an access road, parking areas, amenities and all supporting site features and infrastructure required to support the proposed development.

Figure 5 – Aerial Map with Proposed Overlay

Parking spaces are dispersed throughout the 2-story parking garage and some exterior spaces are provided adjacent to the clubhouse entrance. 264 total parking spaces are provided comprised of 10 exterior spaces and 254 spaces within the parking garage, or 1.47 spaces per unit. Standard parking spaces are designed at 9′ by 18′. 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 or amenities. Drive aisles shall be provided at a minimum width of 24 feet to accommodate two way traffic patterns. 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). A trash and recycling room will be provided on the second floor of the parking garage. Direction signage will be included for internal navigation of the site.

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 appropriate best management practices, including a raingarden, a water quality structure, and two (2) subsurface infiltration systems. The subsurface infiltration systems will consist of ReTain-It concrete chambers with varying heights. The system has been designed with infiltration and an outlet control structures. 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.

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 five (5) 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 are less than the existing conditions analysis. The breakdown is as follows:

- Watershed P-1 is associated with the proposed building/courtyard and is 56,366 sf in size. Watershed P-1 will consist of grass/landscape area with good groundcover and impervious surfaces (building, pool, patio/sidewalk). Since the central courtyard is located directly above the second floor of the parking garage, A&M has assumed a conservative approach and calculated the entire footprint as impervious. Stormwater will be collected via roof drains and directed into Subsurface Infiltration System No. 1. Subsurface Infiltration System No. 1 will be equipped with an outlet control structure, directing treated runoff into the existing drywell located at the southwesterly corner of the property as originally designed in 2005;

- Watershed P-2 is located on the northerly portion of the site, associated with the exterior parking area and landscape areas adjacent to the building and is 13,123 sf in size. Watershed P-2 consists of grass/landscape area with good groundcover and impervious surfaces (parking, sidewalks). Stormwater will be directed to a deep sump hooded catch basins (water quality structure) and into Subsurface Infiltration System No. 2. Subsurface Infiltration System No. 2 has been designed to infiltrate all storm events up to and including the 100-year event;
- Watershed P-3 is located on the easterly side, associated with the access drive and is 8,294 sf in size. Watershed P-3 consists of grass/landscape area with good groundcover and impervious surfaces (driveway, sidewalks). Stormwater will continue to drain by overland flow to either the existing leaching catch basin or into Main Street as it currently exists;
- Watershed P-4A is associated with the southerly and westerly edges of the property and is 11,107 sf in size. Watershed P-4 consists of grass/landscape area with good groundcover and impervious surfaces (sidewalk). Stormwater will continue to drain by overland flow to the westerly property line;
- Watershed P-4B is associated with the newly created fire turnaround in the southwesterly corner of the property and is 7,008 sf in size. Watershed P-4B consists of grass/landscape area with good groundcover and impervious surfaces (turnaround). Stormwater will drain into the proposed raingarden located within the center of the turnaround. The raingarden will have an overflow drain which will be connected to the existing overflow structure in the southeast corner of the site;
- Watershed P-5 is associated with the northerly edge of the property and is 170 sf in size. Watershed P-5 consists of grass/landscape area with good groundcover. Stormwater will continue to drain by overland flow to Main Street;

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

Design Point #1 – Westerly Property Line

Table 3.2.A – Design Point 1 Existing vs Proposed peak rate of runoff to Westerly Property Line

Design Storm	2005 Existing (cfs)	2005 Proposed (cfs)	2022 Proposed (cfs)
2-year	1.2	1.1	0.08
10-year	3.0	2.6	1.06
25-year	4.7	3.6	1.84
100-year	8.0	7.9	2.68

Note: 2005 Existing and 2005 Proposed values are taken from the Stormwater Analysis submitted during the permitting of the existing facility as prepared by Brassard Design & Engineering, Inc. dated April 26, 2005 and reviewed and approved by the City of Waltham. The 2022 proposed peak rate of runoff are less than existing conditions and the 2005 design.

Design Point #2 – Main Street

Table 3.2.B – Design Point 2 Existing vs Proposed peak rate of runoff to Main Street

Design Storm	2005 Existing (cfs)	2005 Proposed (cfs)	2022 Proposed (cfs)
2-year	0.9	0.6	0.50
10-year	1.7	1.2	0.83
25-year	2.3	1.7	1.10
100-year	3.5	2.7	1.64

Note: 2005 Existing and 2005 Proposed values are taken from the Stormwater Analysis submitted during the permitting of the existing facility as prepared by Brassard Design & Engineering, Inc. dated April 26, 2005 and reviewed and approved by the City of Waltham. The 2022 proposed peak rate of runoff are less than existing conditions and the 2005 design.

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 the Northeast Regional Climate Center Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada (Cornell Atlas). The extreme precipitation estimates for Waltham are shown in the following table:

Table 3.3.1 – Rainfall (Cornell Atlas)

	2-year	10-year	25-year	100-year
	3.16 inches	4.77 inches	6.03 inches	8.61 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 were performed for a 25-year storm event. The closed drainage system has also been analyzed for the 100-year event. The following standards were 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, as designed, is capable of handling 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 (potential scour conditions).

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. Due to the nature of the site and access, the construction entrance location may require modification throughout the project as building construction commences. 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, 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 serviced by municipal sewer. An existing sewer manhole is located at the intersection of Main Street and the secondary access drive. This sewer manhole is identified as manhole number 3420 on the City of Waltham's GIS system. The manhole is the upgradient (first) manhole in Main Street, receiving flow from 1474, 1481 and 1486 Main Street. The manhole is approximately 8.3-ft deep, with three (3) inlets pipes and one (1) outlet pipe. The inlet pipes are a two (2) inch force main from 1486 Main Street, a four (4) inch gravity line from 1474 Main Street and an eight (8) inch from 1481 Main Street. The outlet pipe is an eight (8) inch diameter, which flows in a southeasterly direction. The proposed project proposes a new oil/gas separator for the floor drains from the parking garage and a separate line for sanitary waste from the clubhouse/amenity space located on the lower level. The discharge line and sizing of the oil/gas separator shall be coordinated with the plumbing engineers as the project progresses. The sewage flows will be combined in a new lift pump station and pumped into the proposed sewer manhole being constructed over the existing four (4) inch main within the secondary access way. Since the residential units are located on the upper levels, the sewage from the residential units will be via gravity to the new sewer manhole in the access drive. The existing four (4) inch main will be replaced with an eight (8) inch main from the new manhole to the existing manhole in Main Street.

The proposed residential development is anticipated to have 103 one-bedroom units, 96 two-bedroom units, and 24 three-bedroom units; totaling 283 bedrooms. The proposed sewer flows are estimated to be 31,369 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	283 bedrooms	31,130 gpd	31,130 gpd
Office (Clubhouse)	75 gpd/1000 sf min of 200 gpd	3,183 sf	238.7 gpd	239 gpd
Total Flow				**31,369 gpd**

The applicant will seek approval of the municipal sewer connection as shown on the permit application drawings as part of the Comprehensive Permit process through the Zoning Board of Appeals in conformance with the statutes.

Water
The project site is located in an area that is serviced by municipal water system, provided by the Massachusetts Water Resource Authority (MWRA). There are two (2) water mains, an eight (8) inch and a twelve (12) inch main, located on the southerly side of Main Street within the travel way. On May 13, 2021 A&M conducted a hydrant flow test to determine the static and residual pressure for the eight (8) inch main in Main Street. Refer to the Appendix for the hydrant flow test results.

A new eight (8) inch main is being proposed within the secondary access drive as well as the installation of three (3) new hydrants. The new main will provide separate service connections to the building for domestic and fire protection. The proposed project water consumption is calculated at 34,506 gpd based on average sewage flow noted above plus 10%.

Other Utilities
The proposed development will connect to the existing utility poles with a new riser pole and underground conduits will be installed along the westerly side of the property. Transformers and underground conduit locations are shown on the proposed site plan, but the final location will be coordinated with Eversource Electric and determined by the various utility providers.
A new gas main will be provided off the existing gas main within Main Street and the access drive. The new main will be installed around the perimeter of the building to various location of gas meter banks located along the face of the building. Final locations will be coordinated with the Architect, MEP, and National Grid Gas.

3.7 TRANSPORTATION

Vannesse Associates, Inc. is the traffic engineer of record for the project and has prepared as a Traffic and Impact Assessment Study (TIAS) in accordance with standard engineering practice. The TIAS report is included as Appendix B.

3.8 ARCHITECTURAL

The Architectural Team is the architect of record for the project and has prepared an Architectural Design Narrative as included in Appendix C.

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 –

- Water Quality Structures/Hydrodynamic separators
- Subsurface Infiltration Systems (ReTain-It Concrete Chambers)
- Raingarden
- 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 mix of redevelopment and new development 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 proposed stormwater management system will consists of a raingarden, a water quality structure and two (2) subsurface infiltration systems. The project will utilize the existing outlet control structure as designed and approved in 2005. All discharges from impervious surfaces (parking and drive aisles) will be treated prior to discharging. Where applicable, clean runoff from building roofs will be routed directly to the infiltration 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 E 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 post-development condition. Subsurface infiltration chambers will be designed to meet this requirement. All Infiltration Systems were designed using the "Static" 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 for purposes of recharge.

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	56,366 sf	629 sf-	55,737 sf	-	-
Pavement/sidewalk	20,388 sf	611-sf	19,777 sf-	-	-
Total New Impervious Area	76,754 sf	1,240 sf	75,514 sf	-	-

The project is considered a mix of redevelopment and new development. Under existing conditions, there is approximately 65,145 sf of existing impervious surfaces (pavement/roof). Under proposed conditions, the project will have a total of 76,754 sf of impervious surface area, therefore a net increase of 11,609 sf. Per the Massachusetts Stormwater Handbook, the project is only required to recharge the increase in impervious surface above existing conditions. The required recharge volume is given by the following equation:

R_v = F x IA (Equation 1 Stormwater Handbook Volume 3)

where R_v = Required Recharge Volume, ft^3
F = Target Depth factor
IA = Impervious drainage area
R_v = F x IA
= (0.60 inches)(1 foot/12 inches)(1,240 sf) + (0.35 inches)(1 foot/12 inches)(75,514 sf)
=2,264 cubic feet

The infiltration BMP has been sized using the "Static" Method. The volume within the subsurface infiltration systems is approximately 30,587 cubic feet which exceeds the required volume of 2,264 cubic feet.

MA MS4 General Permit requires the project to retain and infiltrate the volume of one (1) inch over the post-developed new impervious surface, and 0.8 inches for redevelopment, therefore the required V= (1")(1'/12")(11,609 sf) + (0.8")(1'/12")(65,145 sf) = 5,310 cf.

The volume within the subsurface infiltration systems is approximately 38,203 cubic feet which exceeds the required volume of 5,310 cubic feet.

The basin drawdown time is defined as:

$Time_{drawdown}$ = R_v / (K)(bottom area)
where R_v = Required Recharge Volume, ft3
K = Saturated Hydraulic Conductivity (from MassDEP 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	26,327 cf	1.02 in/hr	8,048 sf	38.5 hrs
Sub-surface Sys 2	5,649 cf	1.02 in/hr	1,700 sf	39.1 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, water quality structure and several subsurface infiltration systems consisting of ReTain-It concrete chambers.

The water quality volume for the site development will be captured and treated using a proprietary separator. All systems 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 – Clean Roof Runoff				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Subsurface Infiltration	80%	1.00	0.80	0.20
			Total TSS Removal	**80.0%**

TSS Removal Calculation Worksheet – Raingarden				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Raingarden with 1-ft wide shoulder & 4-ft wide grass strip	90%	1.00	0.90	0.10
			Total TSS Removal	**90.0%**

TSS Removal Calculation Worksheet – Sub-Surface Infiltration System 2 Prior to Infiltration				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Proprietary Separator	50%*	1.00	0.50	0.50
			Total TSS Removal prior to infiltration	**50.0%* (44% Required)****

*Proprietary TSS removal rates have been capped at 50% though manufacturer studies report more effectiveness.
**A 44% TTS Pre-treatment removal rate is required prior to infiltration.

TSS Removal Calculation Worksheet – Sub-Surface Infiltration System 2				
A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load	Amount Removed (B*C)	Remaining Load (C-D)
Subsurface Infiltration with pre-treatment	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 development 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 hydrodynamic separators 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.*

According to the MassDEP OLIVER website, the property is located within an Outstanding Resource Water (ORW) to a public water supply watershed to Stony Brook Reservoir in the Charles Watershed Basin, located in a Surface Water Protection Area Zone C to Stony Brook Reservoir, and located in an Interim Wellhead Protection Area (IWPA) Kendall Green Tub. Wells (Weston Water Department PWS ID 3333000-01G)(Radius=2640-ft).

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 hydrodynamic separators 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.

The project is considered a mix of redevelopment and new development. Under existing conditions, there is approximately 65,145 sf of existing impervious surfaces (pavement/roof). Under proposed conditions, the project will have a total of 76,754 sf of impervious surface area, therefore a net increase of 11,609 sf. Per the Massachusetts Stormwater Handbook, the project is only required to recharge the increase in impervious surface above existing conditions.

The proposed development will improve the stormwater quality, because the project will minimize exterior parking areas which are subject to pollutants. The proposed building will encompass a majority of the property, therefore clean roof runoff from the building will be collected and piped into a subsurface infiltration system located underneath the parking garage. Stormwater associated with the front parking lot will be directed to a water quality structure and into a subsurface infiltration system located within the parking area. Stormwater associated with the easterly access road will continue to drain either into an existing leaching catch basin, onto Main Street or to the proposed raingarden. The subsurface infiltration system will consist of Retain-it concrete chambers. The larger subsurface infiltration system located underneath the parking garage will utilize the existing outlet control structures along the westerly property line. The smaller subsurface infiltration system located within the parking lot will be designed for 100% containment and will infiltrate the stormwater. The entire drainage system has been designed to meet or be less than pre-development conditions.

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 G 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 and prior to the issuance of a Certificate of Compliance.

See the next page for the MassDEP Stormwater Checklist.

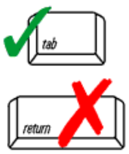
MassDEP Stormwater Checklist

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.

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

Philip L Cordeiro
c=US, o=Allen and Major Associates Inc.,
ou=A01410C00000175798BB4FD00002012
, cn=Philip L Cordeiro
2022.06.14 17:51:54 -04'00'

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): ______________________

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.

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

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☐ An Illicit Discharge Compliance Statement is attached;

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

SECTION 5.0
WAIVERS

5.1 WAIVERS

Application for a Comprehensive Permit through the Zoning Board of Appeals Article V of the Zoning Board of Appeals Rules and Regulations requires an Applicant to comply with all local requirements and regulations including local codes, ordinances, Bylaws or regulations unless an exemption or variance is requested and listed in the application or modification to the application. This will include, but not limited to:

- City of Waltham's Code;
- Rules & Regulations of the Zoning Board of Appeals; and
- Land Rules and Regulations of the Board of Survey and Planning;

The Applicant's requested waivers are based on the Plans entitled "1486 Main Street Waltham, MA" dated January 14, 2022 revised through May 26, 2022 prepared by Allen & Major Associates, Inc. and the design team ("Site Development Plans"). The applicant requests waivers from all local bylaws necessary to permit the project as shown on the Site Development Plans including the following:

Chapter 25 – STORMWATER

- Article I, Stormwater Management §25-3, Applicability
    - Required: Requires a Stormwater Management Permit for land disturbance over one an acre from the Stormwater Enforcement Agent.
    - Proposed: A waiver is being requested not to obtain an individual Stormwater Management Permit from the Stormwater Enforcement Agent. The applicant request the permit be reviewed and issued through the ZBA during the Comprehensive Permit process.
- Article I, Stormwater Management §25-7, Performance Guarantee
    - Required: The Stormwater Enforcement Agent shall require from the developer a surety or cash bond or other means of security acceptable to the City Treasurer, prior to the issuance of any building permit.
    - Proposed: A waiver is being requested not to post a surety, cash bond or other security acceptable to the City Treasurer.

Chapter Z – ZONING CODE

- Article III, Establishment of Districts, §3.4, Table of Use
    - Allowed: Multi-family is not an allowed use in the Commercial Zoning District.
    - Proposed: A waiver is being requested to allow Multi-family apartments as shown on the Site Development Plans in the Commercial Zoning District.
- Article III, Establishment of Districts, §3.5, Special Permits

  - Required: §3.537 For special permits increasing the intensity of use, requires the provision of 15% open space with an increase directly proportional to Floor to Area Ratio.
  - Proposed: 32.0% open space is proposed.
- Article III, Establishment of Districts, §3.5, Special Permits
  - Required: §3.539 Traffic Safety and Infrastructure Maintenance Fund, for special permits for increasing intensity of use, a contribution of $1 per square foot of gross floor area for that part of Floor to Area Ratio in excess of what is allowed by right.
  - Proposed: No contribution to the Traffic Safety and Infrastructure Maintenance Fund is being proposed.
- Article VI, Dimensional Requirements, §4.1 General Provisions, §4.11, Table of Dimensional Regulations
  - Allowed: Minimum Building Setback Side – 37.9 feet (1/2 building height)
  - Proposed: 9.26 feet to amenity space, 13.4 feet to foundation and 12.4 feet to overhang.
- Article VI, Dimensional Requirements, §4.1 General Provisions, §4.11, Table of Dimensional Regulations
  - Allowed: Minimum Building Setback Rear – 37.9 feet (1/2 building height)
  - Proposed: 15.5 feet to foundation and 14.1 feet to overhang.
- Article VI, Dimensional Requirements, §4.1 General Provisions, §4.11, Table of Dimensional Regulations
  - Allowed: 0.40 FAR by right, 2.0 FAR by Special Permit
  - Proposed: 203,238 s.f./93,645 s.f. = 2.17 FAR.
- Article V, Parking Requirements, §5.2 Off-street parking requirement, §5.21, Table of Off-Street Parking Requirements
  - Required: Multi-family dwelling, 2 spaces per dwelling units (179 x 2 = 358 spaces)
  - Proposed: 264 spaces / 179 units = 1.47 spaces per dwelling unit.
- Article V, Parking Requirements, §5.4 Design of parking areas for more than five cars
  - Required: §5.42, No paved area, excluding entrances and exits, shall extend within five (5) feet of any lot or street line, nor into any front yard.
  - Proposed: The proposed parking area will be located in the front yard.
- Article V, Parking Requirements, §5.4 Design of parking areas for more than five cars
  - Required: §5.43, Trees with a minimum size of 3 1/2 inches in diameter (measured six inches from ground level) shall be provided at the rate of one for every 10 cars. (264 spaces/10 would require 26.4 trees).

  - Proposed: The project is proposing a parking garage, appropriate landscape will be provided.
- Article VI, Special Provisions Relating to Signs, §6.6 Regulations Governing Particular Types of Signs
  - Required: §6.63(b), No ground sign shall be located within 12 feet of an adjacent business establishment activity or property, and further, ground signs shall be set back at least six feet from the street line.
  - Proposed: A monument sign is being proposed at the main entrance, in the vicinity of the existing sign and approximately two (2) feet off the right-of-way line.
- Article IX, Affordable Housing, §9.1 Affordable housing provisions
  - Required: Provisions of either a specific number of dwelling units at certain reduced prices, a fee in lieu of affordable dwelling units, or the purchase or construction of off-site dwelling units.
  - Proposed: The proposed project will create 48 rental units affordable to households earning 80% of Area Median Income, comprising 25% of the units in the overall development.

Land Rules and Regulations of the Board of Survey and Planning
The application does not constitute a subdivision of land, therefore, the Applicant requests a waiver from the entirety of the Land Rules and Regulations with specificity to the sections outlined below as may be applicable to site design elements:

- Section 4 Design Standards
- Section 5 Required Improvements
  - J(2)(a) Catch basins shall be placed before intersections;
  - J(2)(j) Storm drains shall be designed to have 2.5 feet minimum cover over the pipe.

The Applicant reserves the right to amend or modify the list of requested waivers as the project moves through review with the Zoning Board of Appeals and may request such waivers from any additional local bylaws or regulations in order to build the Project as shown on the Site Development Plans.

APPENDIX A

SUPPORT DOCUMENTS TO COMPREHENSIVE PERMIT APPLICATION

APPLICATION FOR HEARING

PROJECT ELIGIBILITY LETTER

EVIDENCE OF SITE CONTROL

PROJECT TEAM

CERTIFIED ABUTTER'S LIST

APPENDIX B TRAFFIC IMPACT ASSESSMENT

APPENDIX C
ARCHITECTURAL

APPENDIX D
GEOTECHNICAL REPORT

www.haleyaldrich.com

PRELIMINARY GEOTECHNICAL INVESTIGATION
1486 MAIN STREET
WALTHAM, MASSACHUSETTS

by
Haley & Aldrich, Inc.
Boston, Massachusetts

for
WP East Acquisitions, LLC
Lexington, Massachusetts

DRAFT

File No. 0200959
June 2021

HALEY & ALDRICH, INC.
465 Medford St.
Suite 2200
Boston, MA 02129
617.886.7400

23 June 2021
File No. 0200959-000

WP East Acquisitions, LLC
c/o Wood Partners
91 Hartwell Avenue
Lexington, MA 02421

Attention: Michael Tulipani

Subject: Preliminary Geotechnical Investigation
1486 Main Street
Waltham, Massachusetts

Ladies and Gentlemen:

This report summarizes the results of a preliminary geotechnical investigation of a proposed development site located at 1486 Main Street in Waltham, Massachusetts. The investigation was conducted in accordance with our 9 October 2020 proposal, 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

WP East Acquisitions, LLC is considering acquisition of the property located at 1486 Main Street in Waltham, Massachusetts for development of a new 6-story building consisting of four-levels of wood frame residential over two-levels of steel podium parking, as wells as bituminous paved parking areas, utilities, and other infrastructure. Our understanding of the proposed development configuration is based on the concept Layout and Materials Plan prepared by Allen & Major Associates, Inc. dated 15 December 2020. The general location of the site is shown on Figure 1, Project Locus.

The approximately 2.2-acre site is currently occupied by an approximately 9,000 SF garage and auto storage facility and bituminous paved parking areas. Site grades are relatively level across the majority of the project site, generally ranging from approximately El. 153 (towards Main Street) to about El. 157[1] along the south side of the site. The exception is along the eastern limits of the site where there is a two-tier concrete block retaining wall; the first wall supports an approximately 7-ft raise-in-grade (up to

[1] Elevations are in feet and reference the North American Vertical Datum of 1988 (NAVD88)

about El. 164) and the second tier (set back approximately 15 to 25 from the first tier) supports an additional approximately 4-to-12-foot raise-in-grade to match grades with the abutting access road (up to approximately El. 165 to El. 175). The eastern access road is located within the property limits but is part of a City Right of Way Easement.

PROPOSED CONSTRUCTION

The proposed building will be a six-story building the lowest two levels consisting of steel podium construction for parking and then four levels of wood frame residential construction above. The building footprint is approximately 62,000 SF footprint area, configured as shown on Figure 2 – Site and Subsurface Exploration Location Plan. The lowest parking level will roughly match existing grades coming off Main Street at El. 152 and slope up to El. 157. The parking will ramp up to the second level at El. 168, matching site grades along the eastern access road. The new building is planned to be built up to the limits of the access road such that the podium parking is "benched into" the existing perimeter grades, with separate garage entrances off Main Street (to Level 1) and off the access road (to Level 2). The proposed development will also consist of new site utilities and improvements, including stormwater infiltration systems positioned outside the building footprint along Main Street and below the lowest level parking slab.

Subsurface Exploration Program

SUBSURFACE SOIL CONDITIONS

Our understanding of the subsurface soil and groundwater conditions is based on six test borings (designated HA-01 through HA-06) conducted by Haley & Aldrich between 3 and 7 June 2021, and seven test boring explorations conducted by Vertex (designated VTX-101 to VTX-107) between 2 and 4 June 2021. The designations and approximate locations of test borings are shown on Figure 2 and a summary of the Haley & Aldrich test boring information is provided in Table I. Copies of logs describing conditions encountered in the test borings are provided in Appendix A. Vertex test borings were conducted using auger methods to gather samples for environmental testing and observe area groundwater levels. The boring locations are shown on Figure 2 and the logs are included in Appendix A for information only. The summary of subsurface conditions and geotechnical design recommendations were based on the conditions observed in the referenced Haley & Aldrich borings only. The table below lists the subsurface units encountered at the test borings conducted at the site, in order of increasing depth below ground surface:

Subsurface Unit	Top of Stratum (NAVD88)	Range in Thickness (ft)
Fill	El. 153 to El. 175 (Ground Surface)	0 to 14
Glacial Deposits	El. 159 to El. 143	2 to 5
Bedrock	El. 155 to El. 138	N/A

A generalized description of the soil units is provided below.

- *Fill* was encountered at three of the six Haley & Aldrich boring locations and typically consisted of a medium dense to very dense silty SAND with gravel or poorly graded SAND ranging in thickness from about 6 to 14 ft below existing site grades, where encountered. At one location at the eastern end of the site (HA-05), an approximately 2-ft thick layer of blast rock was noted within the Fill layer. The Fill generally appears to consist of re-worked natural material and is of greatest thickness near the existing site building. Within the center of the site (boring locations HA-03, HA-04, and HA-06), no Fill material was encountered, with the natural, undisturbed Glacial Till deposits identified directly below the 4 to 5-in. thick bituminous parking surface.
- *Glacial Deposits* were encountered at all boring locations, either beneath the Fill (where present) or directly below the bituminous parking surface, at elevations ranging from approximately El. 159 to El. 143. The Glacial Deposits were generally described as very dense silty SAND with Gravel. Where penetrated, the Glacial Deposits were found to range in thickness from about 2 to 5 ft.

- *Bedrock* was encountered beneath the Glacial Deposits at all Haley & Aldrich boring locations, with the exception of boring HA-02. When encountered and cored, the bedrock was observed to consist of very hard to slightly weathered QUARTZITE at depths of approximately 1.4 to 19.5 ft below existing site grades, corresponding to approximately El. 155 to El. 138. The bedrock surface appears to be highest towards the middle portion of the site and drops towards the eastern and western ends of the site.

GEOTECHNICAL LABORATORY TESTING

Four (4) soil samples were collected from the Haley & Aldrich test borings and submitted to our geotechnical laboratory for soil gradation testing. Three of the samples were collected from the Fill and one sample was collected from the Glacial Deposits. The results of the soil gradation test data are included in Appendix B.

GROUNDWATER

Six (6) groundwater observation wells were installed across the site by Vertex. At the completion of the test boring program, water was measured within the observation wells at depths ranging from about 6.2 to 13.7 ft below existing site grades, corresponding to approximately El. 146 to El. 143. Water levels should be expected to vary with location, season, recent precipitation, snowmelt, nearby construction activities, and other factors.

Preliminary Geotechnical Recommendations

The following preliminary geotechnical recommendations are based on the conceptual design of the project and the subsurface conditions encountered in the Haley & Aldrich test borings. These preliminary geotechnical recommendations are in accordance with the 9th Edition of the Massachusetts

State Building Code. The following recommendations are provided to aid with initial planning and preliminary cost estimating and are not intended for project final design.

FOUNDATION DESIGN

Based on the subsurface conditions encountered in the Haley & Aldrich test borings, the proposed structure can be founded on shallow spread footings bearing at conventional foundation depths on either the Glacial Deposits, Bedrock, or on compacted structural fill or lean concrete placed above the natural Glacial Deposits (following the removal of the existing Fill within the zone of influence of the footings). *Note – given the density of the existing Fill material, further investigations may confirm that some portion of the Fill material may be suitable for foundation bearing and forgo the need for its over-excavation/replacement. Additional evaluation will be required during final design.*

For initial planning purposes, we recommend the following:

- We recommend that footings be designed to bear in the Glacial Deposits or on Bedrock using a maximum net allowable bearing pressure of 8.0 kips per square foot (ksf). Unsuitable Fill materials, where present beneath design footing bearing levels, would have to be removed within the zone of influence beneath new foundations.
- The thickness of Fill was noted to be from 6 to 14 ft, with the greatest thickness concentrated in areas near the existing site building. Assuming the building finished floor is located at approximately El. 153, over-excavation of unsuitable soils below normal footing bearing elevations will typically range from none to about ten (10) ft at footing locations. 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 or lean concrete[2] with a minimum 1,500 psi compressive strength. Refer to Figure 3 for conceptual over-excavation details. Bearing capacity recommendations should be re-visited during final design once the site grades and building configuration have been established because higher bearing allowable capacities may be possible if footings are to bear directly on bedrock.
- At the recommended allowable bearing pressures, we estimate that settlement of individual footings under static loading conditions, constructed as recommended herein, will not exceed about 1 in., with differential settlements between individual footings, or within a 30-ft distance along a continuous strip footing, not exceeding about ½ in. Actual footing settlements will depend on final building loadings, proper footing subgrade preparation, and placement of structural backfills (if/where required).
- Locate bottoms of footings at least 48 in. below lowest adjacent ground surface exposed to freezing, and a minimum 18 in. below the top of the adjacent ground floor slab at heated interior locations.

[2] Due to their limited thickness and density/composition, excavation/replacement of the unsuitable soils is expected to be the more cost-effective approach to enable footing foundations compared with ground improvement techniques such as aggregate piers.

- Tops of footings should be positioned a minimum of 4 in. beneath the underside of the overlying floor slab.

Based on the conditions encountered in the recent explorations, the existing fill on the western edge of the building appears to consist of re-worked natural glacial materials that are medium to very dense in nature. The existing fil materials may be suitable for support of the new foundations in their current condition and may not require over-excavation and replacement. Further explorations including test pits and test borings will be required during final design to confirm if the existing materials are suitable in their current state.

LOWEST LEVEL SLAB

The lowest level slabs can be designed as conventional soil support slab-on-grade. We recommend that slabs bear on a minimum of eight (8) inches of Structural Fill or ¾ in. crushed stone separated from underlying/adjacent soils using a geotextile filter fabric (6 oz per sy minimum, needle-punched, non-woven).

The existing Fill is relatively dense, predominantly granular, and is considered suitable to leave in place below slabs-on-grade (including slab haunches supporting load bearing walls) following proof compaction with several passes of a large vibratory roller and provided the risk of some slab cracking and/or settlement is tolerable. We anticipate this risk would be low based on the quality of the Fill observed in the test borings. Existing Fill that is observed to be organic in composition (if encountered) should be removed below slabs.

SEISMIC DESIGN CONSIDERATIONS

Based on the preliminary test borings, the Seismic Site Class is considered to be C. The soils at the site are not considered to be susceptible to liquefaction under the Building Code design level earthquake.

LATERAL EARTH PRESSURES

Building foundation walls retaining earth (such as along the eastern perimeter where the garage wall will retain up to approximately 20 ft of soil) should be designed to resist permanent static, seismic and surcharge loadings indicated below. The pressures do not include hydrostatic loads, as such walls will be above anticipated groundwater levels.

- Static: Use an equivalent fluid unit weight of soil equal to 60 pcf.
- Seismic: Calculate in accordance with the Building Code (Article 1610.2) using a total soil unit weight (γt) of 125 pcf.
- Surcharge: Calculate on the basis of a uniform lateral pressure equal to 0.33 times the vertical surface load (psf), acting on the backside of the wall over the full height of the wall.

GROUNDWATER AND PERMANENT FOUNDATION DRAINAGE

The observed groundwater (measured at depths ranging from approximately 6 to 14 ft bgs) level is well below the planned lowest level slab elevation and is not anticipated to be encountered within the planned excavations for the new building; accordingly, underslab drainage is not required for the proposed building. However, where the lowest level slab is finished 2 ft or greater below adjacent exterior finished grade elevations, we recommend the installation of permanent perimeter foundation drains, consisting of the following:

- Waterstops, caulking, or other seals provided at all foundation wall and wall/footing construction joints where the exterior grading immediately adjacent to the building is higher than the interior floor slab of the building;
- A perimeter foundation drainage system consisting of a continuous loop of 4-in. diameter perforated PVC or slotted corrugated polyethylene pipes placed adjacent to the perimeter footings, laid flat or with a slight pitch (if possible) downward toward the ejection/discharge point(s). The pipe should be surrounded by a minimum thickness of 6 in. of ¾-in. crushed stone, which in turn is surrounded by 6-oz. per sq. yd. non-woven geotextile;
- Where perimeter foundation drainage is provided, below-grade walls should be waterproofed and geocomposite drainage board should be placed against the wall, up to 12 in. below ground surface, and hydraulically connected to the perimeter drainage pipe;
- Inverts of perimeter drainage pipes should be positioned above the bearing elevation of adjacent footings and at least 12 inches below the adjacent finished floor elevations;
- All points in the perimeter drainage should have redundant flow paths to the ejection/discharge point(s);
- Discharge from the drainage systems should be directed to at least one reliable gravity outlet. If gravity discharge is not possible, effluent should be directed to a sump system having redundant pumps and emergency backup power.
- The drainage system piping should be provided with cleanouts.

A moisture vapor retarded membrane is recommended directly beneath the ground floor slabs in occupied and finished spaces, or those with moisture sensitive spaces or floor coverings.

RADON MITIGATION SYSTEM

According to the EPA, the project is located in an area of Massachusetts which has an elevated risk of radon concentrations above recommended action levels (i.e., potential for concentrations above 4 pCi/L). The elevated risk is due to the relatively shallow granitic bedrock beneath the building footprint. Accordingly, a radon mitigation system is a recommended beneath ground floor lobby/amenity areas, as well as elevators and stairwells servicing residential floor levels. A radon mitigation system typically consists of an 8-inch-thick layer of ¾ in. crushed stone below a 15 mill Class A vapor barrier under the lowest building slab. Within the ¾ in. crushed stone layer is a network of perforate PVC pipes that are vented to the exterior of the building, typically through the roof. The building design should include routing power to the roof area in the event the system needs to be activated with mechanical fans.

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. *We recommend that additional investigations be considered in areas of deep manhole structures or other utility corridors to evaluate the presence of shallow bedrock. Where possible, we recommend that consideration be given to relocating these structures away from areas where significant bedrock removal may be required.*
- Stormwater recharge into the naturally deposited Glacial Till soils or Bedrock will be difficult given their low permeabilities. Refer to soil gradation test data included in Appendix B. Test pits and infiltration testing is recommended in planned recharge areas to evaluate permeability assumptions and assist the project's Civil Engineer with stormwater storage/recharge design.

EARTHWORK

Existing site grades within the limits of proposed building generally range from approximately El. 153 to El. 157, which site grades at the eastern site limits (behind the concrete block retaining walls) up to about El. 175. The anticipated bottom of excavation for the footings is generally at about El. 153 while isolated excavations for elevator pits, stormwater recharge system(s) and other utilities could extend to even greater elevations. Accordingly, we anticipate *typical* cuts of about 3 to 4 at footing locations, with some deeper areas of over-excavation where fill thickness extends below design footing elevation. Along the eastern/southeastern site limits, an approximately 7 to 20 ft cut is anticipated as the proposed building benches into the existing site grades. A support of excavation system will be required to facilitate excavations to these depths while mitigating off-property impacts.

Excavations to construct the buildings will extend through the existing Fill and into the Glacial Deposits or Bedrock. Excavated materials will include pavement, soil, existing utilities, cobbles, boulders, bedrock, and possibly miscellaneous debris. Based on prior experience in the Waltham area, we recommend an allowance for screening (remove oversize cobbles and boulders) of site soils to be reused or transported off-site for disposal.

The Fill and Glacial Deposits appear to consist primarily of fine sandy or gravelly material 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. They will also be susceptible to disturbance from construction traffic. Placement of 3-4 inches 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.

Based on available subsurface data and an anticipated bottom of footing at approximately EL. 153, we anticipate that up to approximately 2 ft of rock removal may be required beneath portions of the building footprint. Excavation of *soils* for foundation construction can likely be conducted using normal mechanized earth-moving equipment. Excavation of *rock* for foundation construction will be difficult. Prior to final design and construction, we recommend that test pits be conducted in areas of high bedrock to assess the bedrock quality to determine if the rock can be removed using hoe ram/excavation methods or if blasting or other means will be required. For initial project planning and pricing we recommend that you carry an allowance for bedrock removal and assume 50 % of the footprint will require bedrock removal of 2 feet.

DEWATERING

Building excavations are anticipated to be above normal groundwater levels; accordingly, temporary dewatering to allow for construction in the dry is not anticipated to be required with the exception of that necessary for controlling precipitation that falls on excavations and surface water runoff that collects in excavations. Localized dewatering may be required for locally deeper excavations or on an intermittent basis during periods of moderate to heavy precipitation or snow melt.

TEMPORARY SUPPORT OF EXCAVATION

Temporary earth support consisting of soldier piles and timber lagging is anticipated along the east/southeast perimeter as cuts of up to approximately 7 to 20-ft may be required to construct the lowest parking level. Given the density and composition of the Fill/Glacial soils, and the likely need to embed the soldier piles into the underlying Bedrock, we do *not* anticipate vibratory methods will be feasible for installing the piles. Instead, we recommend that solider piles be installed using drilled methods.

When site cuts (in favorable soil conditions) are less than about 15-ft, temporary excavation system systems can often be cantilevered, assuming that up to about 2 to 4 inches of movement at the top of the system is permissible. Permissible magnitude of excavation support movement will need to consider off-site impacts to adjacent utilities/infrastructure, as well as potential encroachment into alignment of the perimeter foundation wall (particularly if blindside forming/waterproofing is planned based upon Contractor means and methods). For planning purposes, we recommend that solider piles and timber lagging be assumed internally braced using a continuous waler and steel rakers when planned excavation depths are greater than about 15-ft. These conditions will need to be evaluated further during subsequent stages of design.

ADDITIONAL EXPLORATIONS AND TESTING

Based on the observations during this due diligence phase, we recommend that additional explorations consisting of test pits and test borings be conducted to further investigate subsurface conditions and help advance the following evaluations:

- Feasibility of foundation bearing on/within the existing Fill material.
- Final evaluation/design of east perimeter excavation support system.
- Subsurface conditions (and more specifically depth to bedrock and quality of bedrock) within areas of planned building foundations, utility corridors, and deep utility structures.
- Permeability testing and/or textural classification of soils within the plan limits of proposed stormwater recharge system(s).

The types, numbers, and locations of additional explorations will depend on the final development and utility layout, stormwater infiltration locations, and proposed grading.

CONCLUDING COMMENTS

This report provides preliminary information and comments on geotechnical aspects of development of the subject site based on available information. The comments provided herein are not suitable for final design of any structure. Additional subsurface explorations and engineering evaluations will be needed to better define subsurface conditions and for final design and construction of the subject buildings.

Thank you for the opportunity to assist WP East Acquisitions, LLC on this matter. We trust the information provided herein is helpful to your current planning, and we look forward to assisting you with future phases of the project. Please do not hesitate to contact us if you wish to discuss the contents of this report.

Sincerely yours,
HALEY & ALDRICH, INC.

Lee S. Vanzler, P.E. (MA)
Senior Project Manager

Michael J. Weaver, P.E. (MA)
Senior Associate

Attachments:

Table I	Summary of Haley & Aldrich Test Boring Data
Figure 1	Project Locus
Figure 2	Site and Subsurface Exploration Location Plan
Figure 3	Conceptual Over-Excavation Details
Appendix A	Logs of Recent Test Borings
Appendix B	Soil Gradation Testing

TABLES

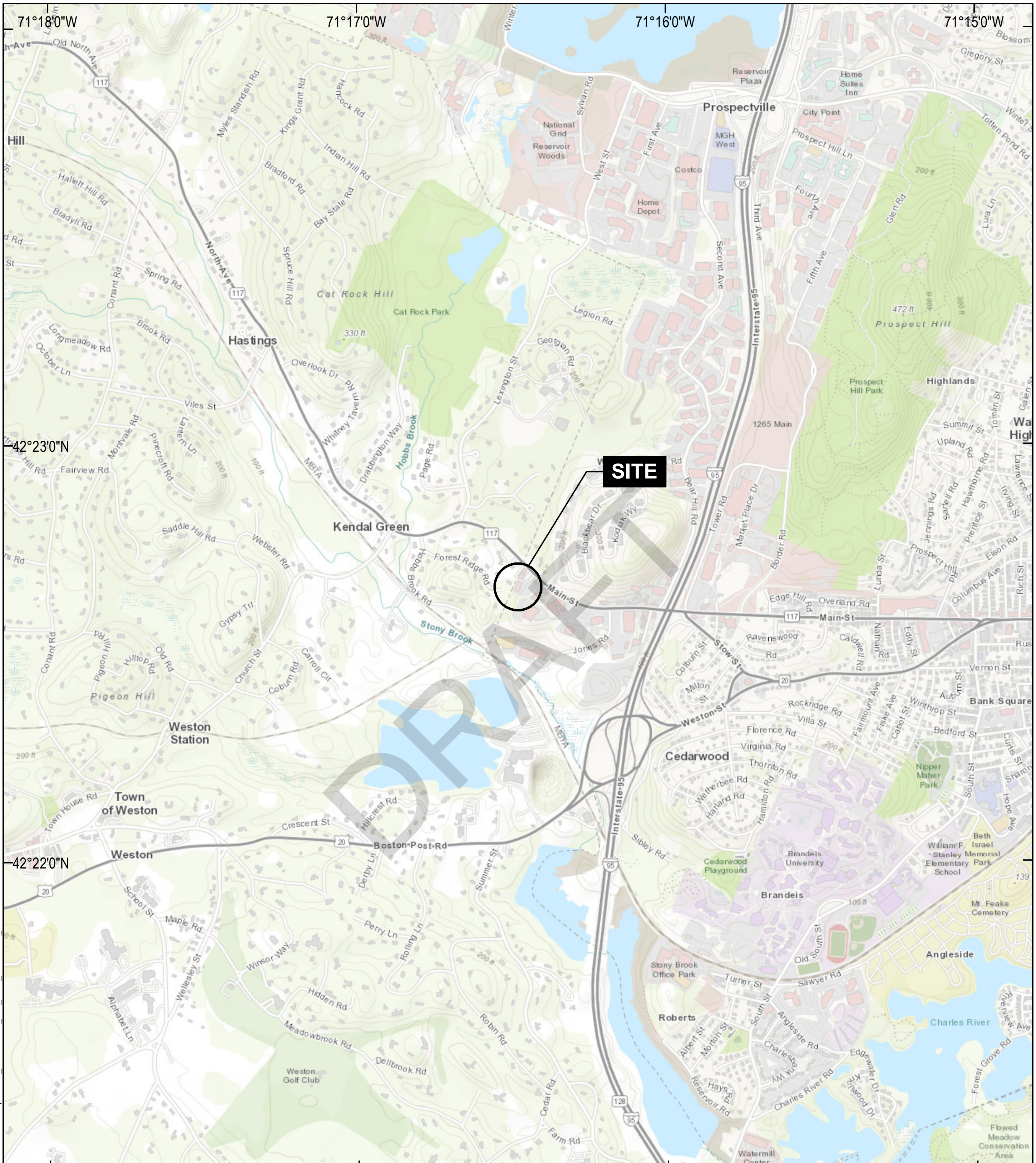
TABLE I - SUMMARY OF HALEY & ALDRICH EXPLORATION DATA
1486 MAIN STREET
WALTHAM, MASSACHUSETTS
FILE NO.: 0200959-001

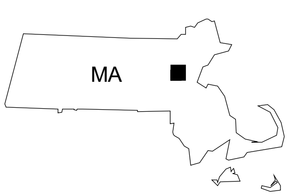
Test Boring ID	Ground Surface Elevation, ft (NAVD88)	Total Exploration Depth (ft)	Fill		Glacial Till		Bedrock
			Top Elevation (ft)	Thickness (ft)	Top Elevation (ft)	Thickness (ft)	Top Elevation (ft)
HA-01	157.0	19.5	157.0	14.0	143.0	5.5	137.5
HA-02	156.0	16.0	156.0	8.0	148.0	BNE	--
HA-03	156.7	11.0	156.7	0.4	156.3	1.2	155.1
HA-04	156.7	5.5	156.7	0.4	156.3	1.3	155.0
HA-05	164.7	19.0	164.7	6.0	158.7	6.0	152.7
HA-06	156.7	6.5	156.7	0.4	156.3	1.0	155.3

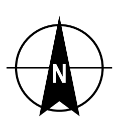
NOTES:

1. Elevations are in feet and reference the North Amercian Vertical Datum of 1988 (NAVD88). Surface elevations are estimated based on interpolation of surface grades provided on Existing Conditions Plan.
2. "-" = Not Encountered
3. BNE = Bottom of Soil Layer Not Encountered

FIGURES







MAP SOURCE: ESRI
SITE COORDINATES: 42°22'40"N, 71°16'29"W

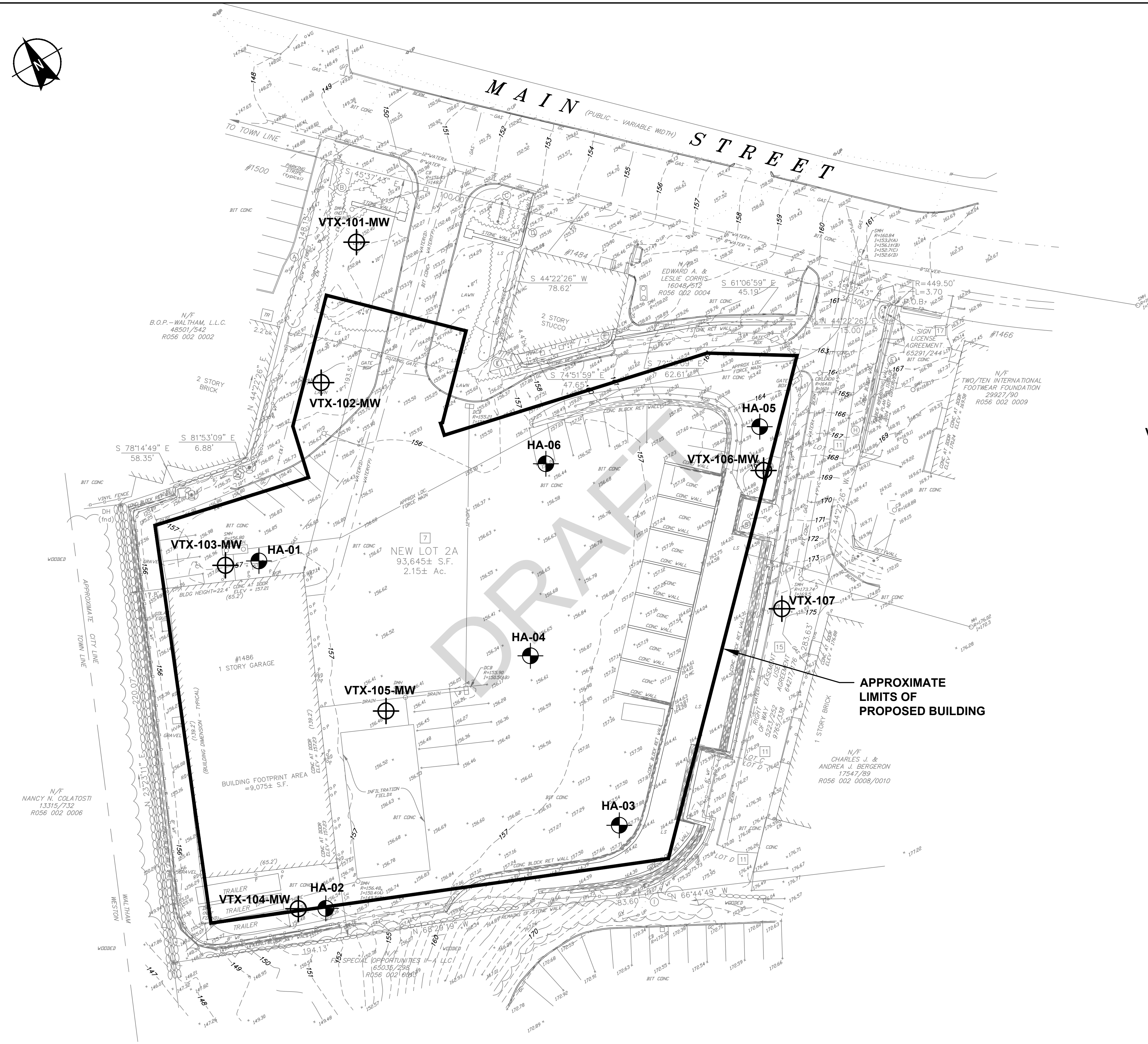
HALEY ALDRICH

1486 MAIN STREET
WALTHAM, MASSACHUSETTS

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
JUNE 2021

FIGURE 1



LEGEND

HA-01 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING EXPLORATION CONDUCTED BY NEW ENGLAND BORING GEOTECH AND OBSERVED BY HALEY & ALDRICH, INC. BETWEEN 3 AND 7 JUNE 2021

VTX-101-MW — TEST BORING EXPLORATION CONDUCTED BY NEW ENGLAND BORING GEOTECH AND OBSERVED BY VERTEX BETWEEN 2 AND 4 JUNE 2021

(OW) — INDICATES OBSERVATION WELL INSTALLED IN COMPLETED BOREHOLE

NOTES

1. PLAN TAKEN FROM "ALTA/NSPS LAND TITLE SURVEY"PREPARED BY PRECISION LAND SURVEYING, INC. AND DATED 11 NOVEMBER 2020.
2. ELEVATIONS SHOWN ARE IN FEET AND REFERENCE THE NORTH AMERICAN VERTICAL DATUM IN 1988 (NAVD88).
3. PROPOSED LIMITS OF BUILDING TAKEN FROM DRAWING TITLED "LAYOUT & MATERIALS PLAN, C-101" PREPARED BY ALLEN & MAJOR ASSOCIATES, INC. AND DATED 15 DECEMBER 2020.

0 50 100
SCALE IN FEET

HALEY ALDRICH

1486 MAIN STREET
WALTHAM, MASSACHUSETTS

SITE AND SUBSURFACE EXPLORATION LOCATION PLAN

SCALE: AS SHOWN
JUNE 2021

FIGURE 2

Saved by: DTE
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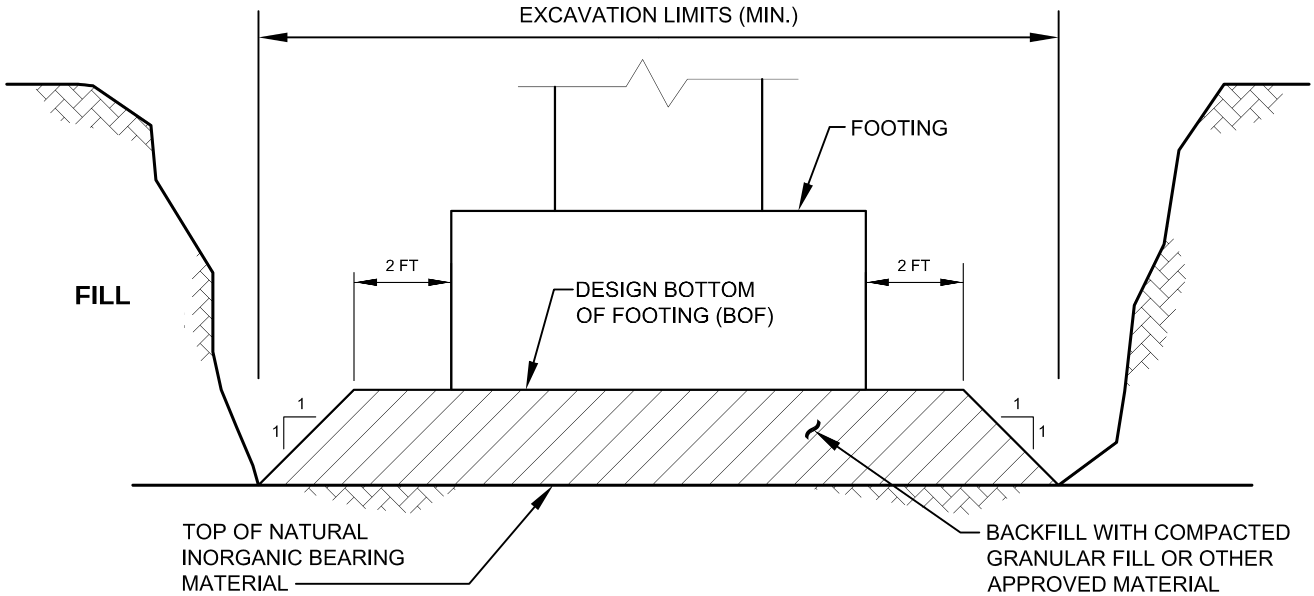
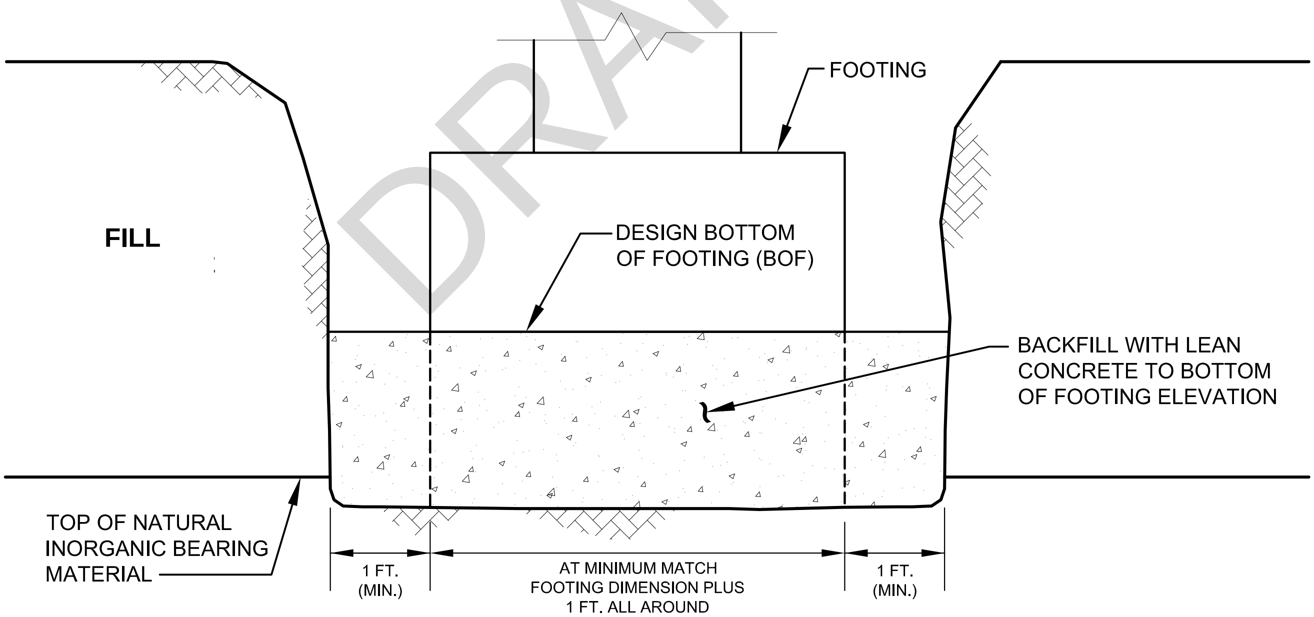


FOOTING BEARING ON GRANULAR FILL

NOT TO SCALE



FOOTING BEARING ON LEAN CONCRETE

NOT TO SCALE

HALEY ALDRICH
1486 MAIN STREET
WALTHAM, MASSACHUSETTS

CONCEPTUAL
OVER - EXCAVATION DETAILS

SCALE: AS SHOWN
JUNE 2021

FIGURE 3

MCELENEY, TERRI Printed: September 3, 2015Layout: A077
Drawing: J:\GRAPHICS\35060\35060-403-A077.DWG

APPENDIX A

Logs of Recent Test Borings

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-01

Project	1486 MAIN ST, WALTHAM, MA	File No.	0200959-000
Client	WP EAST ACQUISTIONS, LLC	Sheet No.	1 of
Contractor	NEW ENGLAND BORING CONTRACTORS	Start	June 3, 2021
		Finish	June 3, 2021
		Driller	K. Smith
		H&A Rep.	D. Palleiko
		Elevation	157.0 (est.)
		Datum	NAVD88
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S		Rig Make & Model: GEFCO Strata Star
Inside Diameter (in.)	4	1.4		Bit Type: Roller Bit; Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: Driven
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	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					156.6 / 0.4	-ASPHALT ROADWAY-										
	14 12 18	S1 7	0.5 2.0	SP-SM		Medium dense light-brown poorly-graded SAND with silt and gravel (SP-SM), no odor		15		5	70	10				
	11 11 10 20	S2 8	2.0 4.0	SP-SM		Medium dense light-brown poorly-graded SAND with silt (SP-SM), no odor, moist Note: sample collected for soil gradation testing.		29	7	17	30	17				
5	37 22 16 18	S3 7	4.0 6.0	SM		Dense brown silty SAND with gravel (SM), blocky, no odor, moist to wet - TILL FILL -	5	15	5	5	40	30				
	16 16 17 7	S4 5	6.0 8.0	SM		Dense brown silty SAND with gravel (SM), blocky, wet	10	10	5	15	35	25				
	5 5 12 21	S5 4	8.0 10.0	GM		Medium dense gray-brown silty GRAVEL with sand (GM), no odor, wet, limited recovery	60	5		10	10	15				
10	10 14 4 6	S6 3	10.0 12.0	GM		Medium dense gray-brown silty GRAVEL with sand (GM), no odor, wet, limited recovery	60	5		10	10	15				
	8 13 18 40	S7 5	12.0 14.0	GM		Dense gray-brown silty GRAVEL with sand (GM), no odor, wet, limited recovery	60	5		10	10	15				
15	33 51 53 100/4"	S8 14	14.0 15.8	SM	143.0 / 14.0	Very dense gray-brown silty SAND with gravel (SM), bonded, no odor, moist to wet - GLACIAL TILL -	10	10	20	15	25	20				
	110	S9 5	19.0 19.5	SM	137.5 / 19.5	Very dense gray-brown silty SAND with gravel (SM), Bonded, no odor, moist to wet. - GLACIAL TILL - BOTTOM OF EXPLORATION 19.5 FT refusal on probable bedrock	10	10	20	15	25	20				

DRAFT

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
					4.0-5.0

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) 19.5
Rock Cored (ft) -
Samples S9

Boring No. HA-01

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. HA-02

Project	1486 MAIN ST, WALTHAM, MA
Client	WP EAST ACQUISTIONS, LLC
Contractor	NEW ENGLAND BORING CONTRACTORS

File No.	0200959-000
Sheet No.	1 of
Start	June 3, 2021
Finish	June 3, 2021
Driller	K. Smith
H&A Rep.	D. Palleiko
Elevation	156.0 (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: GEFCO Strata Star
Bit Type: Roller Bit
Drill Mud: None
Casing: Driven
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					155.6 0.4	-ASPHALT ROADWAY-										
	16 20 45	S1 9	0.5 2.0	SM		Very dense brown to light-brown silty SAND with gravel (SM), no odor, moist	10	15	10	20	30	15				
	79 77 26 35	S2 16	2.0 4.0	SM		Very dense brown with gray silty SAND with gravel (SM), moist, trace concrete Note: sample collected for soil gradation testing.		31	11	17	19	22				
5	8 10 20 14	S2 6	4.0 6.0	SM		Medium dense light-brown silty SAND with gravel (SM), blocky, moist to wet - TILL FILL -		33	9	15	21	22				
	8 7 9 16	S4 2	6.0 8.0	SM		Note: sample collected for soil gradation testing. Medium dense light-brown silty SAND with gravel (SM), blocky, no odor, wet	15	15		10	45	15				
	46 48 72 72	S5 12	8.0 10.0	SM	148.0 8.0	Very dense gray-brown silty SAND with gravel (SM), bonded, moist	5	15	5	5	50	20				
10	61 100/4"	S6	10.0 10.8	SM		Very dense gray to gray-brown silty SAND with gravel (SM), cemented, moist - GLACIAL TILL - Rough drilling	5	10		10	60	15				
15	37 79 43 54	S7 12	14.0 16.0	SM		Very dense gray to gray-brown silty SAND with gravel (SM), cemented, moist	5	10		10	60	15				
					140.0 16.0	BOTTOM OF EXPLORATION 16.0 FT										

DRAFT

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
					4.0-5.0

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)	16.0
Rock Cored (ft)	-
Samples	S7

Boring No. HA-02

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. HA-03

Project 1486 MAIN ST, WALTHAM, MA
Client WP EAST ACQUISTIONS, LLC
Contractor NEW ENGLAND BORING CONTRACTORS

File No. 0200959-000
Sheet No. 1 of 2
Start June 7, 2021
Finish June 7, 2021
Driller K. Smith
H&A Rep. D. Palleiko
Elevation 156.7 (est.)
Datum NAVD88
Location See Plan

	Casing	Sampler	Barrel
Type	HW	S	NX
Inside Diameter (in.)	4	1.4	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: GEFCO Strata Star
Bit Type: Roller Bit
Drill Mud: None
Casing: Driven
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					156.3 0.4	-ASPHALT ROADWAY-										
	10 61 100/1"	S1 8	0.5 1.6	SM		Very dense gray-brown to brown silty SAND with gravel (SM), bonded, no odor, moist	5	15	15	10	30	25				
					155.1 1.6	- GLACIAL TILL - TOP OF BEDROCK 1.6 FT										
						Advanced rollerbit to 3.0 start C1 SEE CORE BORING REPORT FOR ROCK DETAILS										
5																

DRAFT

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

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) 1.6
Rock Cored (ft) 3.4
Samples S1, C1

Boring No. HA-03

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.

CORE BORING REPORT

HALEY ALDRICH

Boring No. **HA-03**
File No. 0200959-000
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	5 5 5	C1	2.0 5.0	32.0 8.0	89 22	fresh		Very hard, fresh to slightly weathered, gray, aphanitic to medium grained, QUARTZITE. Primary joint set, low angle, close to moderate, smooth, discolored, bed parallel. Secondary joint set, high angle. close, manganese, discolored weathering, iron staining on joint set with halo.
							151.7	-BEDROCK-
5	5						5.0	BOTTOM OF EXPLORATION 5.0 FT
10								
15								
20								
25								
30								
35								

DRAFT

H+A_CORE+WELL-09 PLOG-HA-LIB09-BOS STANDARD ONLY.GLB HA-TB+CORE+WELL-09 W FENCE.GDT \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\0200959\GINT\0200959-000-TB.GPJ Jun 25, 21

HALEY ALDRICH — TEST BORING REPORT

Boring No. HA-04

Project	1486 MAIN ST, WALTHAM, MA	File No.	0200959-000
Client	WP EAST ACQUISTIONS, LLC	Sheet No.	1 of 2
Contractor	NEW ENGLAND BORING CONTRACTORS	Start	June 3, 2021
		Finish	June 4, 2021
		Driller	K. Smith
		H&A Rep.	D. Palleiko
		Elevation	156.7 (est.)
		Datum	NAVD88
		Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NX
Inside Diameter (in.)	4	1.4	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: GEFCO Strata Star
Bit Type: Roller Bit
Drill Mud: None
Casing: Driven
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					156.3 0.4	-ASPHALT ROADWAY-										
	25 54 100/2"	S1	0.5 1.7	SM		Very dense gray-brown to brown silty SAND with gravel (SM), bonded, no odor, moist		40	12	17	12	19				
					155.0 1.7	- GLACIAL TILL - Note: sample collected for soil gradation testing. TOP OF BEDROCK 1.7 FT										
						Advanced rollerbit to 4.0 start C1										
						SEE CORE BORING REPORT FOR ROCK DETAILS										
5																

DRAFT

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

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) 1.7
Rock Cored (ft) 3.8
Samples S1, C1

Boring No. HA-04

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.

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
5		C1	4.0 5.5	17.0 10.0	94 56	fresh	151.2 5.5	Very hard, fresh to slightly weathered, gray, aphanitic to medium grained, QUARTZITE. Primary joint set,low angle, close to moderate, smooth, discolored weathering, bed parallel. Secondary joint set, high angle, close, manganese infilling, discolored weathering, iron staining on joint set with halo. -BEDROCK- BOTTOM OF EXPLORATION 5.5 FT
10								
15								
20								
25								
30								
35								

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-05

Project	1486 MAIN ST, WALTHAM, MA
Client	WP EAST ACQUISTIONS, LLC
Contractor	NEW ENGLAND BORING CONTRACTORS

File No.	0200959-000
Sheet No.	1 of
Start	June 3, 2021
Finish	June 4, 2021
Driller	K. Smith
H&A Rep.	D. Palleiko
Elevation	164.7 (est.)
Datum	NAVD88
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NX
Inside Diameter (in.)	4	1.4	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: GEFCO Strata Star
Bit Type: Roller Bit
Drill Mud: None
Casing: Driven
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					164.3 0.4	-ASPHALT ROADWAY-										
	48 20 28	S1 9	0.5 2.0	SM		Dense gray-brown to light-brown silty SAND with gravel (SM), no odor, moist	5	15	5	10	40	25				
	31 41 32 46	S2 11	2.0 4.0	SM		Very dense light-brown silty SAND with gravel (SM), no odor, moist	5	15	5	15	35	25				
						- TILL FILL -										
5	30 54 38 49	S3 10	4.0 6.0	GW		Very dense tan to yellow-brown well-graded GRAVEL with sand (GW), no odor, wet, blast rock fill	35	40	10	10	5					
	66 75 70 39	S4 15	6.0 8.0	SM	158.7 6.0	Very dense light-brown silty SAND with gravel (SM), bonded, no odor, moist	5	15	5	10	40	25				
	79 54 123 51	S5 9	8.0 10.0	SM		Very dense gray-brown with brown silty SAND with gravel (SM), bonded, no odor, moist to wet	5	15	10	20	30	20				
						- GLACIAL TILL -										
10	51 42 40 56	S6 9	10.0 12.0	SM		Very dense brown to gray-brown silty SAND with gravel (SM), bonded, no odor, moist	5	15	10	20	30	20				
					152.7 12.0	TOP OF BEDROCK 12.0 FT										
15	20 16 10 7	S7 14	14.0 16.0	SC		Medium dense yellow-brown to yellow clayey SAND with gravel (SC), exhibits relict bedrock structure, no odor, moist	5	25	5	15	30	20				
						- WEATHERED BEDROCK -										
						Hard, Top of sound bedrock at 18.5 ft										
		NA 0	19.0 19.0		145.7 19.0	BOTTOM OF EXPLORATION 19.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
					9.0

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)	18.5
Rock Cored (ft)	0.5
Samples	S8

Boring No. HA-05

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. HA-06

Project	1486 MAIN ST, WALTHAM, MA	File No.	0200959-000
Client	WP EAST ACQUISTIONS, LLC	Sheet No.	1 of 2
Contractor	NEW ENGLAND BORING CONTRACTORS	Start	June 7, 2021
		Finish	June 7, 2021
		Driller	K. Smith
		H&A Rep.	D. Palleiko
		Elevation	156.7 (est.)
		Datum	NAVD88
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S	NX	Rig Make & Model: GEFCO Strata Star
Inside Diameter (in.)	4	1.4	2.0	Bit Type: Roller Bit Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: Driven
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	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	Toughness	Plasticity	Strength
0					156.3 0.4	-ASPHALT ROADWAY-										
	20 140/5"	S1 9	0.5 1.4	SM	155.3 1.4	Very dense gray-brown to gray silty SAND with gravel (SM), bonded, no odor, moist - TILL FILL - TOP OF BEDROCK 1.4 FT	5	15	15	10	30	25				
						Advanced rollerbit to 3.0 start C1 SEE CORE BORING REPORT FOR ROCK DETAILS										
5																

DRAFT

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

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) 1.4
- Rock Cored (ft) 7.1
- Samples S1, C1

Boring No. HA-06

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.

H&A-TEST BORING-09 REV PLOG-HA-LIB09-BOS STANDARD ONLY.GLB GREAT PYRAMID H&A.GPJ \\HALEYALDRICH.COM\SHARE\CF\PROJECTS\0200959\GINT\0200959-000-TB.GPJ Jun 25, 21

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HA-06**
File No. 0200959-000

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weath-ering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
5		C1	3.5 8.5	42.0 7.0	70 12	fresh		Very hard, fresh to slightly weathered, gray, aphanitic to medium grained, QUARTZITE. Primary joint set, low angle, close, moderate, smooth, discolored weathering, bed parallel. Secondary joint, high angle, close, manganese, discolored weathering, iron staining on joint set with halo. -BEDROCK-
							148.2 8.5	BOTTOM OF EXPLORATION 8.5 FT
10								
15								
20								
25								
30								
35								

SOIL BORING/MONITORING WELL CONSTRUCTION LOGS

VTX-101-MW

Project: Wood Partners | City: Waltham | State: MA

VERTEX®

BORING INFORMATION		WELL CONSTRUCTION DETAILS		LOCATION	
Start/Completion Date:	06/02/2021 / 06/02/2021	Well Depth (ft):	15.0	Datum:	
Personnel:	Jacob Golden	Welll Diameter (in):		Lat:	
Drilling Co.:	Crawford	Screen Start/End (ft):	7.0 - 15.0	Long:	
Method:	Hollow-Stem Auger	Slot Size (in):	0.010	GS Elev (ft):	
Boring Depth (ft):	15.0	Completion Type:	Crawford	TOC (ft):	
		Casing Diameter (in):			

NOTES DRAFT

Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.
PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Moisture	PID (parts per million by volume)
	60	vac truck					Fine to Medium Sand	0"-60" Light Brown FINE TO MEDIUM SAND, Trace Gravel, Trace Cobbles, No Odor.	Damp	1.7
5	24	12	4	1	1	1		0"-8" Light Brown FINE TO MEDIUM SAND, Trace Gravel, No Odor.	Moist	1.3
							Sand and Silt	8"-12" Light Brown SILT, Some Brown Fine Sand, Trace Light Brown Gravel, No Odor.	Moist to Wet	1.3
	24	11	7	3	5	5	Fine to Medium Sand	0"-1" Light Brown FINE TO MEDIUM SAND, Trace Gravel, No Odor.	Wet	0.8
							Sand and Silt	1"-5" Reddish Brown SILT, AND FINE SAND, Trace Gravel, No Odor.	Wet	1.5
							Fine Sand	5"-11" Light Brown FINE SAND, Some Silt, Trace Gravel, No Odor.	Wet	1.0
	24	12	11	19	33	41	Fine to Medium Sand	0"-4" Light Brown FINE TO MEDIUM SAND, Little Brown Silt, Trace Gravel, No Odor.	Wet	1.0
10							Sand and Silt	4"-12" Light Brown SILT, AND FINE SAND, Some Gravel, No Odor.	Wet	1.6
	24	14	35	35	37	42	Gravel	0"-1" Light Brown GRAVEL, No Odor.	Wet	
							Sand and Silt	1"-8" Light Brown FINE SAND, Brown SILT, AND Light Brown GRAVEL, No Odor.	Wet	1.3
								8"-14" Light Brown SILT, AND FINE SAND, Some Gravel, No Odor.	Wet	1.4
	24	10	24	17	16	17		0"-10" Light Brown SILT, AND MEDIUM TO COARSE SAND, Some Gravel, Brick, No Odor.	Wet	3.9
15										
20										

DRAFT

06/22/2021

SOIL BORING

Project: Wood Partners City: Waltham State: MA **VTX-102**

BORING INFORMATION

Start/Completion Date: 06/02/2021 / 06/04/2021

Personnel: Jacob Golden

Drilling Co.: Crawford

Method: Hollow-Stem Auger

Refusal:

REFUSAL AT 8.5 ft.

Boring Depth (ft): 8.5

LOCATION

Datum:

Lat:

Long:

GS Elev (ft):

NOTES DRAFT

PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.
Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Moisture	PID (parts per million by volume)
0–5	60	vac truck					Fine to Medium Sand	0"-60" Light Brown FINE TO MEDIUM SAND, Trace Gravel, Trace Cobbles, No Odor.	Damp	1.8
5	1	0	50				No Recovery	"-" NO RECOVERY.		
	23	0						"-" NO RECOVERY.		
	8	2	63	50			Sand and Silt	0"-2" Brown FINE SAND, AND SILT, Some Gravel, No Odor.	Wet	1.0
	10	0					No Recovery	"-" NO RECOVERY.		
10										
15										
20										

06/22/2021

SOIL BORING/MONITORING WELL CONSTRUCTION LOGS

VTX-102A-MW

Project: Wood Partners City: Waltham State: MA

VERTEX®

BORING INFORMATION

Start/Completion Date: 06/04/2021 / 06/04/2021

Personnel: Jacob Golden

Drilling Co.: Crawford

Method: Hollow-Stem Auger

Boring Depth (ft): 11.0

WELL CONSTRUCTION DETAILS

Well Depth (ft): 11.0

Welll Diameter (in):

Screen Start/End (ft): 6.0 - 11.0

Slot Size (in): 0.010

Completion Type: Crawford

Casing Diameter (in):

LOCATION

Datum:

Lat:

Long:

GS Elev (ft):

TOC (ft):

NOTES DRAFT

Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.
PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Well Construction	Moisture	PID (parts per million by volume)
	24	24					Fine to Medium Sand	0"-6" Brown FINE TO MEDIUM SAND, Some Silt, Organics, No Odor.		Dry	0.6
								6"-18" Light Brown FINE TO MEDIUM SAND, Some Gravel, Trace Cobbles, No Odor.		Dry	0.6
							Sand and Gravel	"-" Light Brown FINE TO MEDIUM SAND, AND GRAVEL, No Odor.		Dry	0.6
	12	0					No Recovery	0"-" NO RECOVERY, No Odor.			
	24	6	34	21	14	13	Fine to Medium Sand	0"-6" Brown FINE TO MEDIUM SAND, Some Silt, Some Gravel, No Odor.		Dry	0.3
5	24	18	14	21	37	43	Sand and Silt	0"-7" Brown FINE SAND, AND SILT, Some Gravel, No Odor.		Dry	0.3
							Fine to Medium Sand	7"-12" Light Brown FINE TO MEDIUM SAND, Some Gravel, No Odor.		Dry	0.4
								12"-13" Grayish Brown FINE TO MEDIUM SAND, Some Gravel, No Odor.		Dry	0.4
	18	4	36	17	16	50		13"-18" Light Brown FINE TO MEDIUM SAND, Some Gravel, Trace Silt, No Odor.		Dry	0.4
								0"-4" Light Brown FINE TO MEDIUM SAND, Some Gravel, No Odor.		Damp	0.6
	6	0					No Recovery	0"-" NO RECOVERY.			
	24	18	12	13	11	17	Sand and Silt	0"-6" Brown FINE SAND, AND SILT, Some Gravel, No Odor.		Wet	0.8
10							Fine to Medium Sand	6"-8" Reddish Brown FINE TO MEDIUM SAND, Some Gravel, Little Gravel, No Odor.		Moist	0.7
	2	50					Sand and Silt	0"-2" Brown FINE SAND, AND SILT, Some Gravel, No Odor.		Wet	1.1
15											
20											

SOIL BORING/MONITORING WELL CONSTRUCTION LOGS

Project: Wood Partners City: Waltham State: MA

VTX-103-MW

BORING INFORMATION		WELL CONSTRUCTION DETAILS		VERTEX LOCATION	
Start/Completion Date:	06/02/2021 / 06/02/2021	Well Depth (ft):	19.0	Datum:	
Personnel:	Jacob Golden	Welll Diameter (in):		Lat:	
Drilling Co.:	Crawford	Screen Start/End (ft):	9.0 - 19.0	Long:	
Method:	Hollow-Stem Auger	Slot Size (in):	0.010	GS Elev (ft):	
Boring Depth (ft):	19.0	Completion Type:	Crawford	TOC (ft):	
		Casing Diameter (in):			

NOTES DRAFT

Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.
PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Well Construction	Moisture	PID (parts per million by volume)
0	60	vac truck					Asphalt	0"-4" Black ASPHALT (PAVED).		Dry	
							Fine to Medium Sand	4"-60" Light Brown FINE TO MEDIUM SAND, Trace Gravel, No Odor.		Dry	1.4
5	24	5	4	3	9	11		0"-4" Light Brown FINE TO MEDIUM SAND, Trace Gravel, No Odor.		Dry	1.5
							Soil Not Observed	4"-5" Red PREVIOUSLY REPORTED, Brick, No Odor.		Dry	
	24	6	9	7	14	7	Fine to Medium Sand	0"-6" Light Brown FINE TO MEDIUM SAND, Trace Gravel, Trace Silt, Brick, No Odor.		Dry to Damp	1.5
	24	7	4	4	4	9		0"-7" Brown FINE TO MEDIUM SAND, Trace Silt, Trace Gravel, Brick, No Odor.		Damp	3.3
10	24	14	24	46	47	34		0"-2" Brown FINE TO MEDIUM SAND, Little Gravel, Trace Silt, No Odor.		Damp	3.5
							Gravel	2"-3" Brown GRAVEL, No Odor.		Damp	
							Fine to Medium Sand	3"-14" Brown FINE TO MEDIUM SAND, Some Gravel, Trace Silt, No Odor.		Damp	3.2
	18	12	21	27	43			0"-12" Brown FINE TO MEDIUM SAND, Little Gravel, Trace Silt, No Odor.		Moist	0.7
15	7	1	7	40	43		Sand and Silt	0"-1" Brown FINE SAND, SILT, AND GRAVEL, No Odor.		Wet	1.0
	36	0					Soil Not Observed	0"-" NO RECOVERY.			
	2	2	50				Sand and Silt	0"-2" Brown FINE SAND, SILT, AND GRAVEL, No Odor.		Wet	1.7
20	10	0					Soil Not Observed	0"-" NO RECOVERY.			

06/22/2021

SOIL BORING

Project: Wood Partners City: Waltham State: MA

VTX-104

BORING INFORMATION	LOCATION
Start/Completion Date: 06/03/2021 / 06/03/2021	Datum:
Personnel: Jacob Golden	Lat:
Drilling Co.: Crawford	Long:
Method: Hollow-Stem Auger	GS Elev (ft):
Refusal: REFUSAL AT 11.5 ft.	
Boring Depth (ft): 11.5	

VERTEX®

NOTES DRAFT

PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.
Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Moisture	PID (parts per million by volume)
0	60	vac truck					Asphalt	0"-4" Black ASPHALT (PAVED).	Dry	
							Fine to Medium Sand	4"-60" Light Brown FINE TO MEDIUM SAND, AND COBBLES, Some Gravel, No Odor.	Dry	0.6
5	24	6	14	19	12	4		0"-6" Brown FINE TO MEDIUM SAND, Some Gravel, No Odor.	Dry	0.3
	24	19	4	9	7	5		0"-14" Light Brown FINE TO MEDIUM SAND, Some Gravel, No Odor.	Dry	0.3
							Sand and Gravel	14"-19" Brown FINE TO MEDIUM SAND, AND GRAVEL, No Odor.	Dry	0.6
	24	5	12	17	12	9		0"-5" Brown FINE TO MEDIUM SAND, AND GRAVEL, No Odor.	Dry	0.3
10										
	6	1	12				Gravel	0"-1" Brown GRAVEL.		
15										
20										

SOIL BORING/MONITORING WELL CONSTRUCTION LOGS

Project: Wood Partners City: Waltham State: MA

VTX-105-MW

VERTEX®

BORING INFORMATION		WELL CONSTRUCTION DETAILS		LOCATION	
Start/Completion Date:	06/04/2021 / 06/04/2021	Well Depth (ft):	10.0	Datum:	
Personnel:	Jacob Golden	Welll Diameter (in):		Lat:	
Drilling Co.:	Crawford	Screen Start/End (ft):	5.0 - 10.0	Long:	
Method:	Hollow-Stem Auger	Slot Size (in):	0.010	GS Elev (ft):	
Boring Depth (ft):	10.0	Completion Type:	Crawford	TOC (ft):	
		Casing Diameter (in):			

NOTES DRAFT

Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.
PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Moisture	PID (parts per million by volume)
	36	vac truck					Asphalt	0"-4" Black ASPHALT (PAVED).	Dry	
							Fine to Medium Sand	4"-36" Light Brown FINE TO MEDIUM SAND, GRAVEL, AND COBBLES, No odor.	Dry	0.3
	24	5	8	11	21	7		0"-5" Light Brown FINE TO MEDIUM SAND, AND GRAVEL, No odor.	Dry	0.3
5	24	8	9	6	7	17		0"-8" Grayish Brown FINE TO MEDIUM SAND, Some Gravel, No odor.	Dry	0.8
	24	6	7	13	14	17		0"-3" Brown FINE TO MEDIUM SAND, Some Gravel, No odor.	Dry	1.0
								3"-6" Brown FINE TO MEDIUM SAND, Some Gravel, Trace Silt, No odor.	Moist	0.8
	6	2	23				Sand and Silt	0"-2" Brown FINE SAND, SILT, AND GRAVEL, No odor.	Moist to Wet	0.7
10	6	0					No Recovery	0"-" NO RECOVERY, No odor.		
15										
20										

Well Construction

DRAFT

06/22/2021

SOIL BORING

Project: Wood Partners | City: Waltham | State: MA

VTX-106

VERTEX®

BORING INFORMATION	
Start/Completion Date:	06/04/2021 / 06/04/2021
Personnel:	Jacob Golden
Drilling Co.:	Crawford
Method:	Hollow-Stem Auger
Refusal:	REFUSAL AT 5 ft.
Boring Depth (ft):	5.0

LOCATION	
Datum:	
Lat:	
Long:	
GS Elev (ft):	

NOTES DRAFT

PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.
Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata	Soil Description	Moisture	PID (parts per million by volume)
	36	vac truck					Asphalt	0"-4" Black ASPHALT (PAVED).	Dry	
							Fine to Medium Sand	4"-36" Brown FINE TO MEDIUM SAND, Some Gravel, Little Cobbles, No Odor.	Dry	0.5
	24	3	15	12	17	21	Sand and Gravel	0"-3" Light Brown FINE TO MEDIUM SAND, AND GRAVEL, No Odor.	Dry	0.6
5										
10										
15										
20										

DRAFT

06/22/2021

SOIL BORING

Project: Wood Partners City: Waltham State: MA

VTX-107

BORING INFORMATION		LOCATION	
Start/Completion Date:	06/03/2021 / 06/03/2021	Datum:	
Personnel:	Jacob Golden	Lat:	
Drilling Co.:	Crawford	Long:	
Method:	Hollow-Stem Auger	GS Elev (ft):	
Refusal:			
END OF BORING AT 8 REFUSAL NOT ENCOUNTERED.			
Boring Depth (ft):	8.0		

VERTEX®

NOTES DRAFT

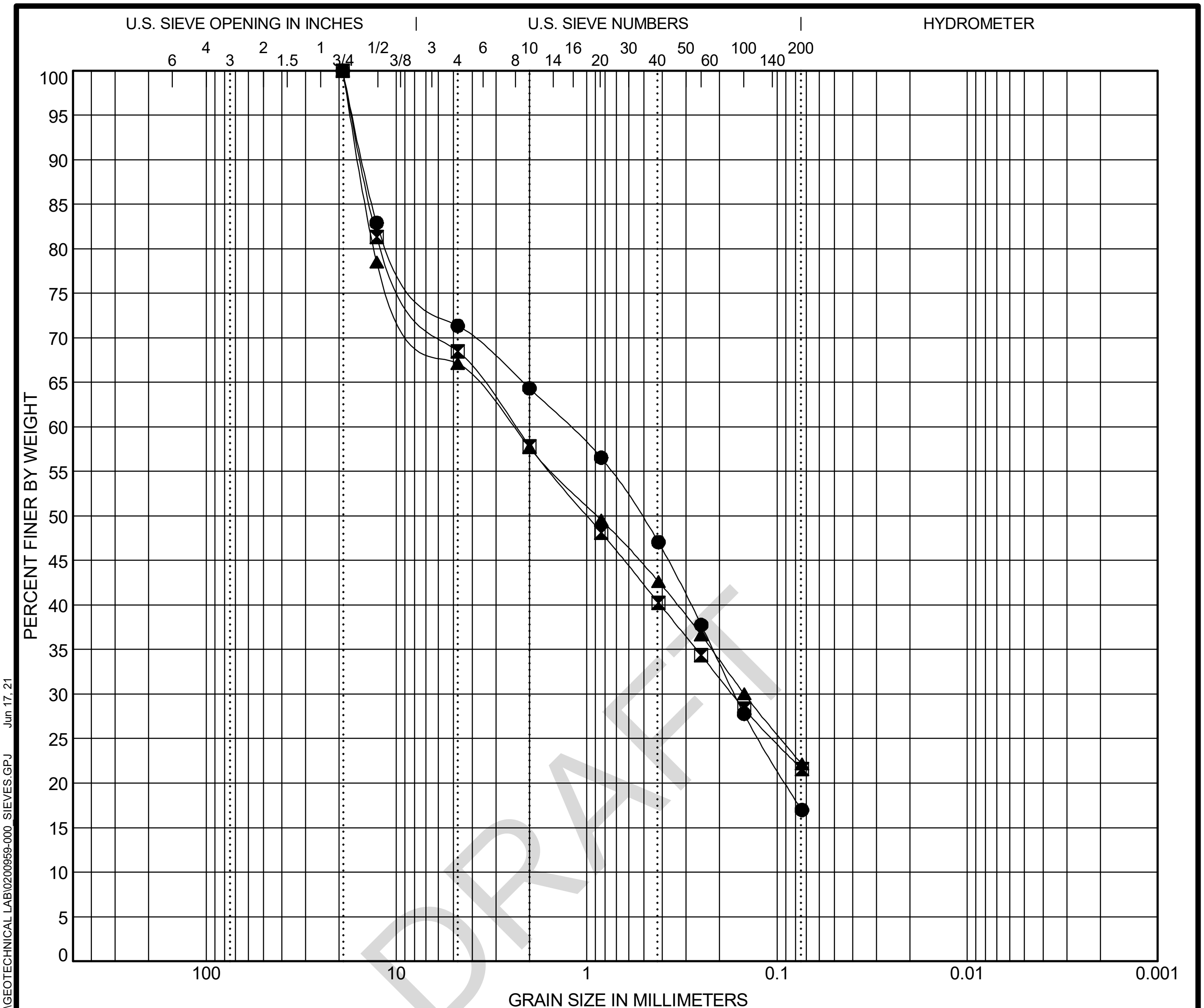
PID screening as follows: Ion Science Tiger PID; 10.6 eV; RF of 1; a DL of 0.1 ppmV; calibration 100 ppmV isobutylene.
Soil were visually classified in general accordance with the Modified Burmister Soil Classification System.

Depth (ft)	Penetration (in)	Recovered (in)	Blow Count (6 in) (1,2,3,4)				Strata		Soil Description	Moisture	PID (parts per million by volume)
	60	vac truck						Fine to Medium Sand	0"-60" Light Brown FINE TO MEDIUM SAND, Some Cobbles, Little Gravel, Asphalt, No odor.	Dry	0.5
5	12	12							0"-12" Brown FINE TO MEDIUM SAND, Some Gravel, Asphalt, No odor.	Dry	0.4
	12	12							0"-12" Brown FINE TO MEDIUM SAND, Some Gravel, No odor.	Dry	0.6
	12	12							0"-12" Brown FINE TO MEDIUM SAND, Trace Gravel, No odor.	Dry	0.3
10											
15											
20											

06/22/2021

APPENDIX B

Soil Gradation Testing



	COBBLES	% GRAVEL		% SAND			% FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	% SILT	% CLAY
●		**0.0**	**28.6**	**7.0**	**17.3**	**30.1**	**17.0**	
⧗		**0.0**	**31.5**	**10.7**	**17.6**	**18.7**	**21.6**	
▲		**0.0**	**32.9**	**9.4**	**15.0**	**20.5**	**22.1**	

	Expl. No.	Sample No.	Depth (ft.)	LL	PL	PI	Water Content (%)	Cc	Cu
●	**HA-01**	**S2**	**2-4**				**12.2**		
⧗	**HA-02**	**S2**	**2-4**				**12.8**		
▲	**HA-02**	**S3**	**4-6**				**11.7**		

	Sample Description
●	
⧗	
▲	

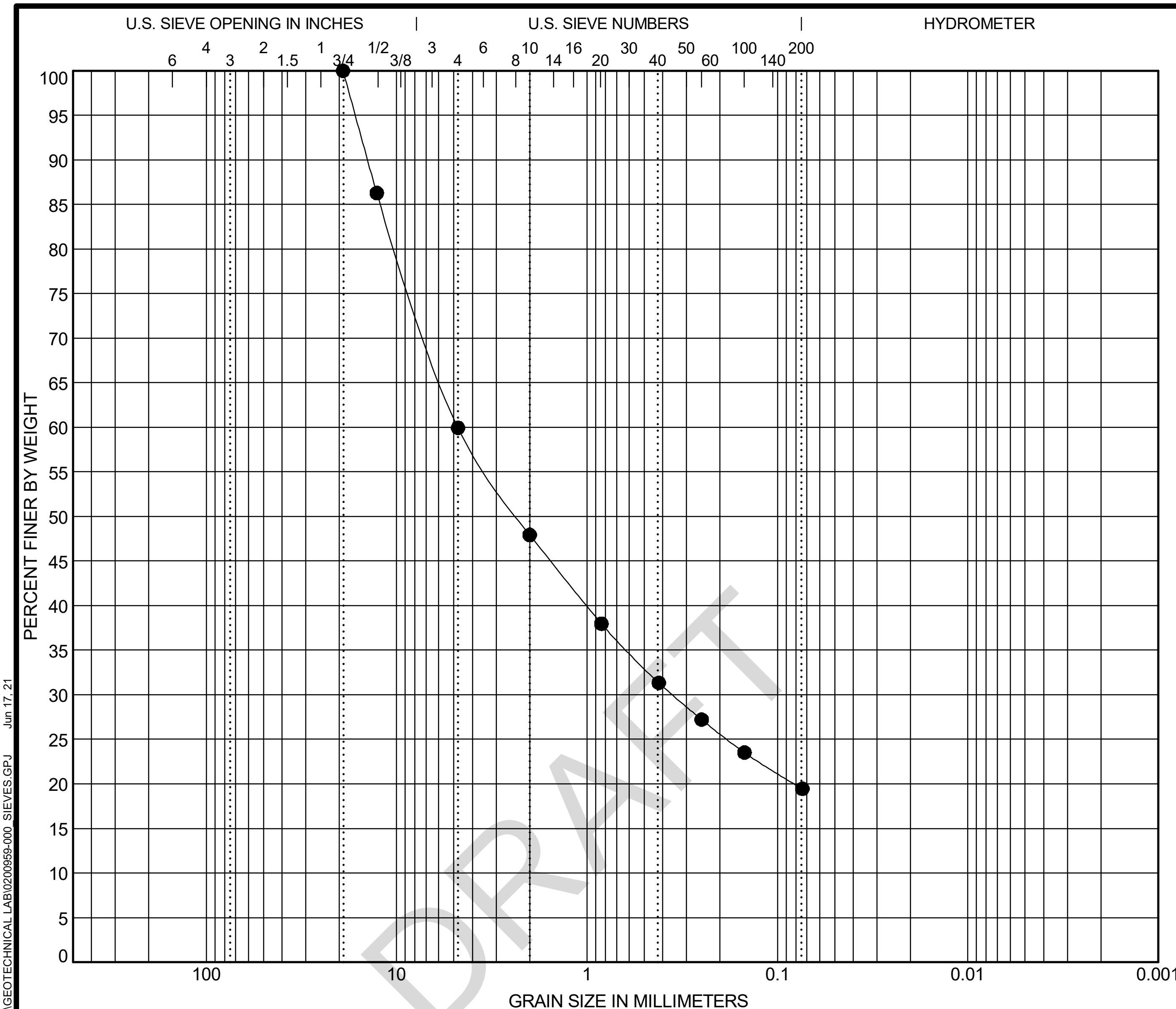
Remarks:

HALEY ALDRICH
Rocky Hill, Connecticut

1486 Main Street
Waltham, MA

GRAIN SIZE DISTRIBUTION

Date: 6/15/2021 File No.: 0200959-000



	COBBLES	% GRAVEL		% SAND			% FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	% SILT	% CLAY
●		**0.0**	**40.0**	**12.0**	**16.6**	**11.9**	**19.4**	

	Expl. No.	Sample No.	Depth (ft.)	LL	PL	PI	Water Content (%)	Cc	Cu
●	**HA-04**	**S1**	**0.5-1.7**				**9.3**		

	Sample Description
●	

Remarks:

HALEY ALDRICH

Rocky Hill, Connecticut

1486 Main Street
Waltham, MA

GRAIN SIZE DISTRIBUTION

Date: 6/15/2021 File No.: 0200959-000

APPENDIX E
HydroCAD

2005 STORMWATER ANALYSIS

BRASSARD DESIGN + ENGINEERING

Storm Water Analysis

Supplemental Documents Accompanying Municipal Review Application

Subject Site: 1490 Main Street
Waltham, Massachusetts

Date: April 26, 2005

Brassard Design & Engineering, Inc. - 91 Prescott Street - Worcester, MA 01605
tel. 508-755-1166 fax 508-755-1945 email: contact@brassarddesign.com

CONTENTS

Brassard Design & Engineering, Inc. · 91 Prescott Street · Worcester, MA 01605

tel. 508-755-1166 fax 508-755-1945 email: contact@brassarddesign.com

SITE DESCRIPTION

The 2.2 acre(+/-) project site is located at 1490 Main Street in Waltham, MA and has been generally cleared and used for storage of landscape materials and as a construction staging area. An existing building originally occupied the immediate frontage area on Main Street.

This building area and other open space areas drained overland toward the street; other portions of the site generally drain to the southwestern edge of the property and into a wooded area. Topographic relief across the original site was fairly uniform with a drainage divide running from southeast to northwest across the site as shown on Figure 1.

Based on an on-site soil test as well as visual inspection of exposed natural soil material, the surficial soils would be classified as medium to coarse loamy sand. This well-drained soil would fall under hydrologic soil group B for the purposes of runoff analysis. Brassard Design & Engineering, Inc. witnessed a test pit excavation on April 11, 2005 on the southwest corner of the project site. A test pit was excavated to a depth of 12 feet. The upper 5 feet of material was compacted fill from other parts of the site and was consistent with natural parent material in the remainder of the excavation, which as noted above consists of well graded medium to coarse sandy loam with approximately 40-50% gravel & cobbles. Some 1 – 2-foot diameter boulders were also observed. No groundwater or soil mottling was observed in any part of the excavation. No percolation test was conducted as the naturally occurring parent material was present at a depth that was unsafe for hand excavation.

PROJECT DESCRIPTION / STORM WATER MANAGEMENT

The proposed development includes the construction of a pre-fabricated building and material storage areas, and a paved access drive and maneuvering area. Runoff from the main paved area will be collected in deep-sump hooded catch basins. Runoff collected in the basins and by the roof drain (gutters & downspouts) will be directed into a subsurface storm water detention system for peak flow mitigation. Flow from the subsurface system will be controlled by the outlet structure as detailed on sheet L-03 of the project drawing set.

Reduced flow from the outlet structure will be routed into a small drywell located near the project limits in the southwest corner of the site. The purpose of the drywell is to allow excess water to surcharge and overflow from the drywell grate, promoting sheet discharge from the site in lieu of a typical point source discharge.

Runoff from the entrance drive will be collected in a catch basin that will direct flow to another drywell. Note that because the post-development runoff generated by the area tributary to Main Street is less than that generated under existing conditions, the drywell performance has not been calculated.

Calculation Methodology & Procedure

Calculations were performed to determine pipe sizes and to estimate peak runoff rates using HydroCAD™; a computer aided design program that combines SCS runoff methodology (TR-20) with standard hydraulic calculations. A model of the site's hydrology and hydraulics was developed for pre- and post-development conditions to assess the effects of the proposed development on the project site and surrounding areas.

Conventions used:

- Rainfall depths for all design storms were obtained from the "Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada", prepared by the Northeast Regional Climate Research Center, Cornell University, Ithaca, NY; publication No. RR 93-5, September 1993. The rainfall depths listed below were used in the calculations:

Return Period (1-day accum.)	inches	adjusted for 24-hour duration
2-year	2.80	3.16in
10-year	4.20	4.75in
25-year	5.40	6.10in
100-year	7.50	8.48in

- Permeability testing was not conducted as part of the geotechnical investigation, but the soils present indicate that the parent material in the vicinity of the infiltration systems is relatively well-drained. An overall unit exfiltration rate of 0.0007cfs/sec-sf was used in the calculations.
- A minimum time of concentration of 6 minutes was used in the pre and post-development subcatchment descriptions for simplification purposes.

(all figures represent flow in cubic feet per second)

Peak Runoff Summary Table - Runoff toward Main Street

Condition \ Storm Event	2 year storm	10 year storm	25 year storm	100 year storm
Pre-Devel (Subcatch.-1)	0.9	1.7	2.3	3.5
Post-Devel (Subcatch -100)	0.6	1.2	1.7	2.7

(all figures represent flow in cubic feet per second)

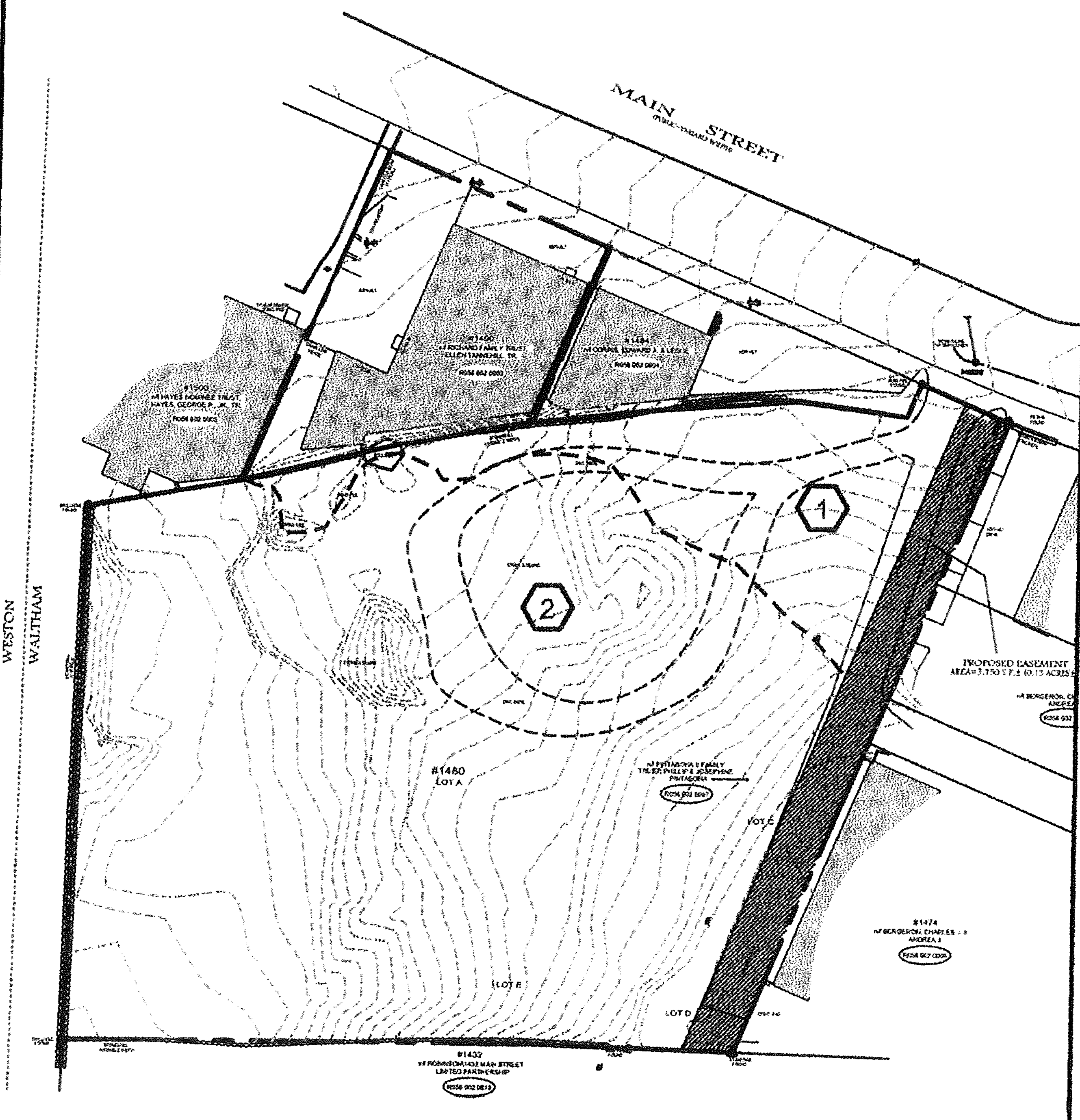
Peak Runoff Summary Table - Runoff toward South West

Condition \ Storm Event	2 year storm	10 year storm	25 year storm	100 year storm
Pre-Devel (Subcatch.-2)	1.2	3.0	4.7	8.0
Post-Devel (Reach-200)	1.1	2.6	3.6	7.9

Based on the results of the calculations, the storm water management system should provide adequate peak flow mitigation for the proposed development.

Brassard Design & Engineering, Inc. - 91 Prescott Street - Worcester, MA 01605
tel. 508-755-1166 fax 508-755-1945 email: contact@brassarddesign.com

List of Figures



BRASSARD DESIGN ENGINEERING

81 Prescott Street
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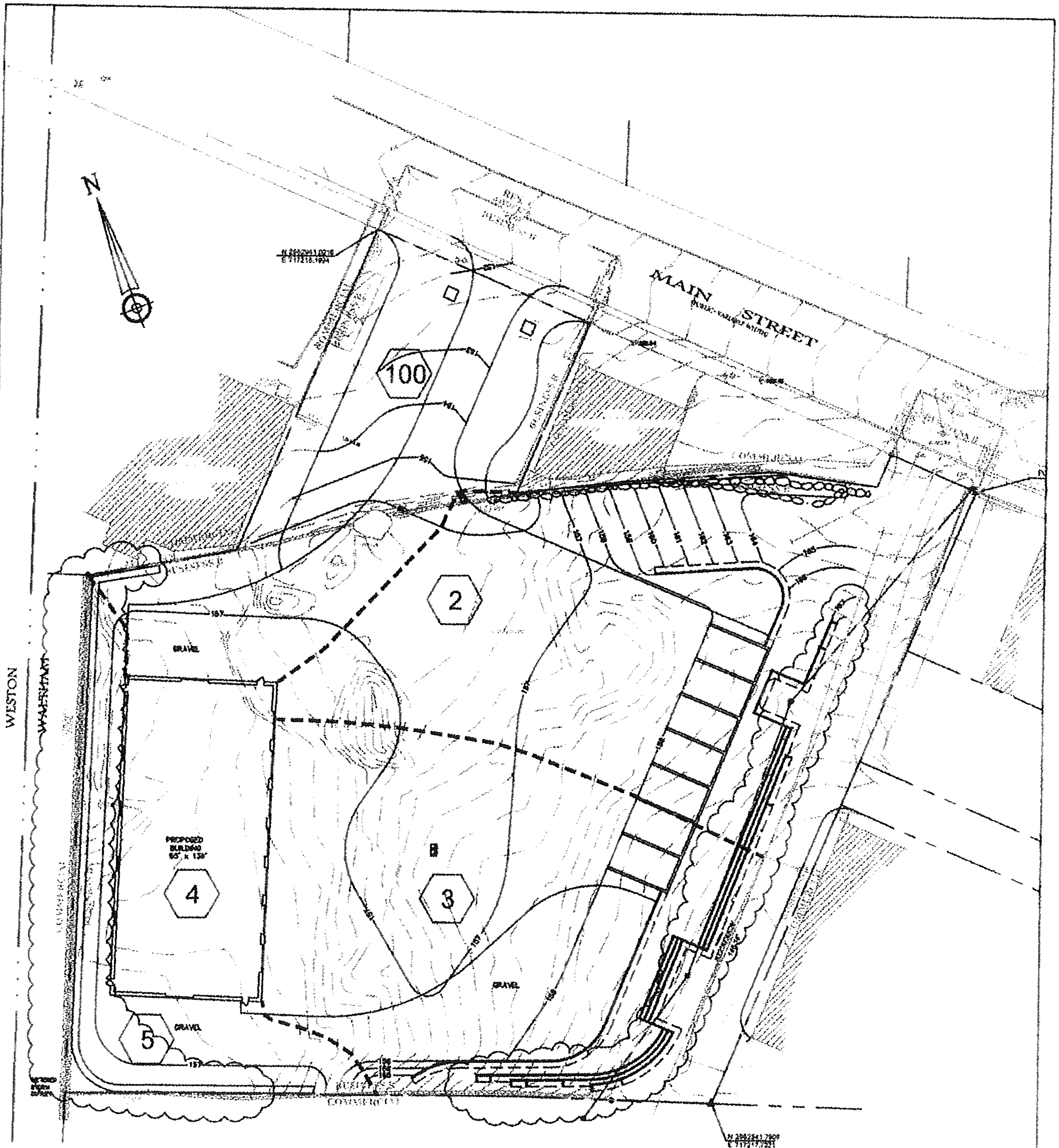
contact@brassarddesign.com

Existing Subcatchments

1490 Main Street
Waltham, MA

1" = 60'
4/26/05

1



BRASSARD
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11 Prescott Street
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Proposed Subcatchments

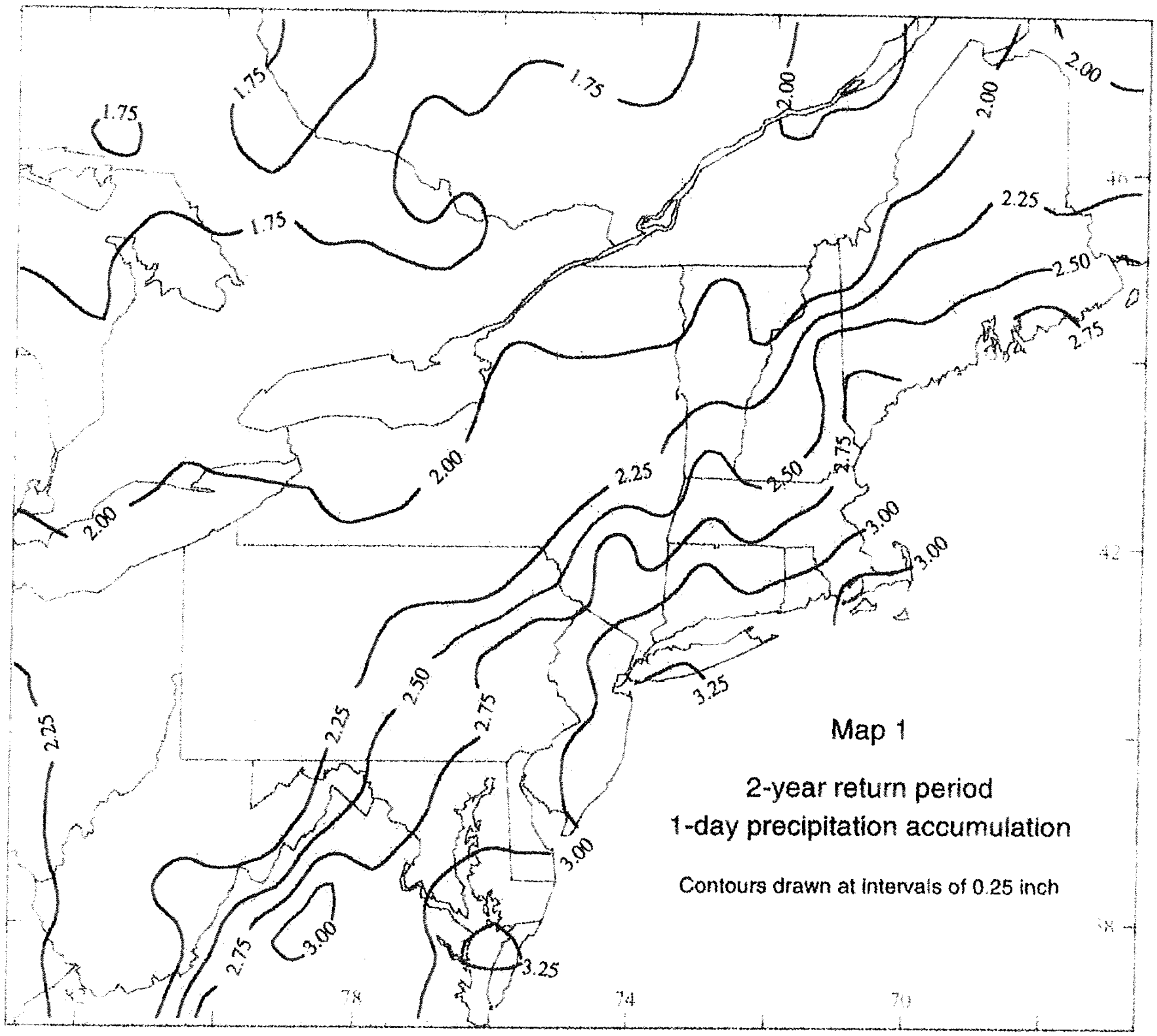
1490 Main Street

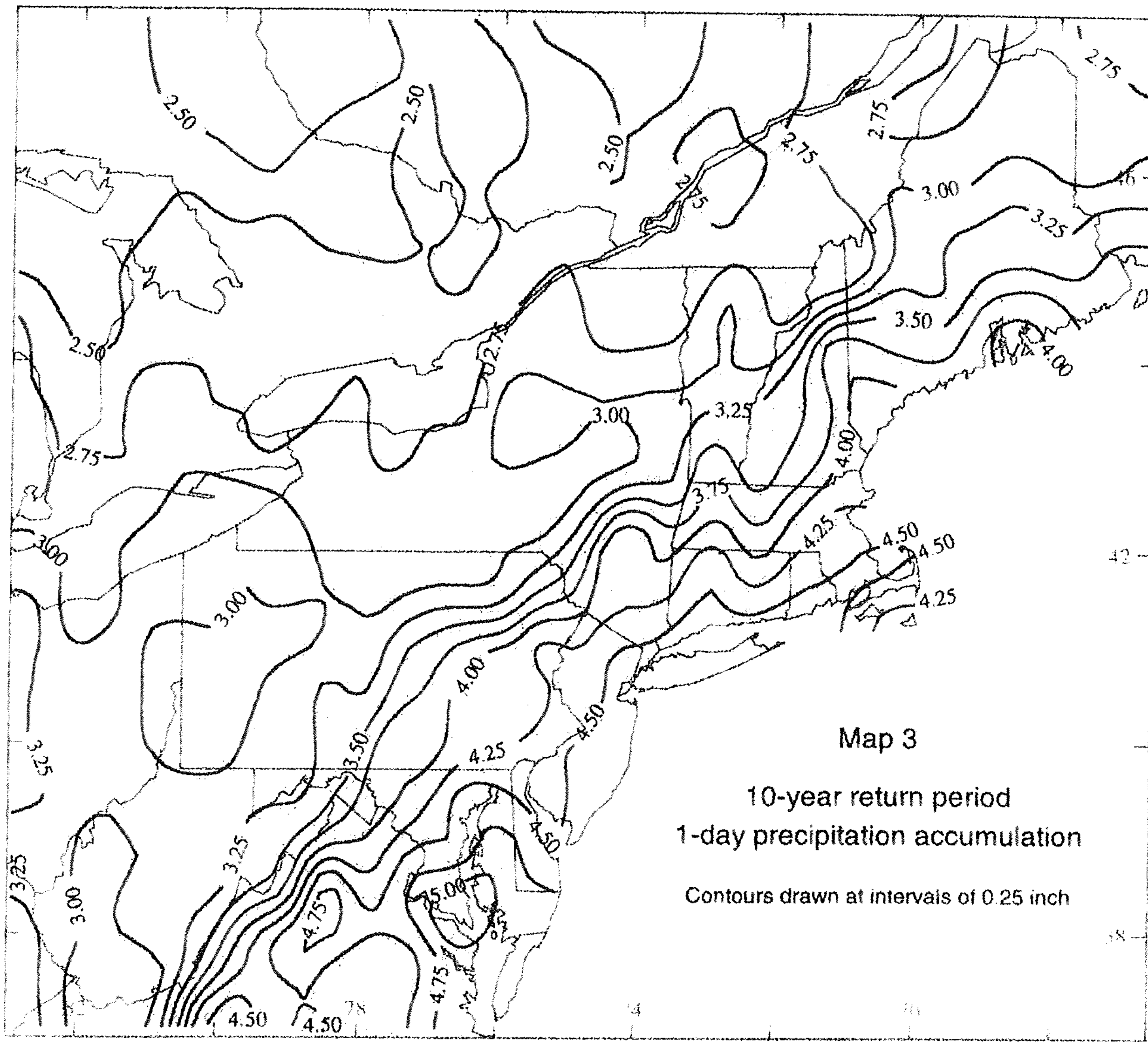
Waltham, MA

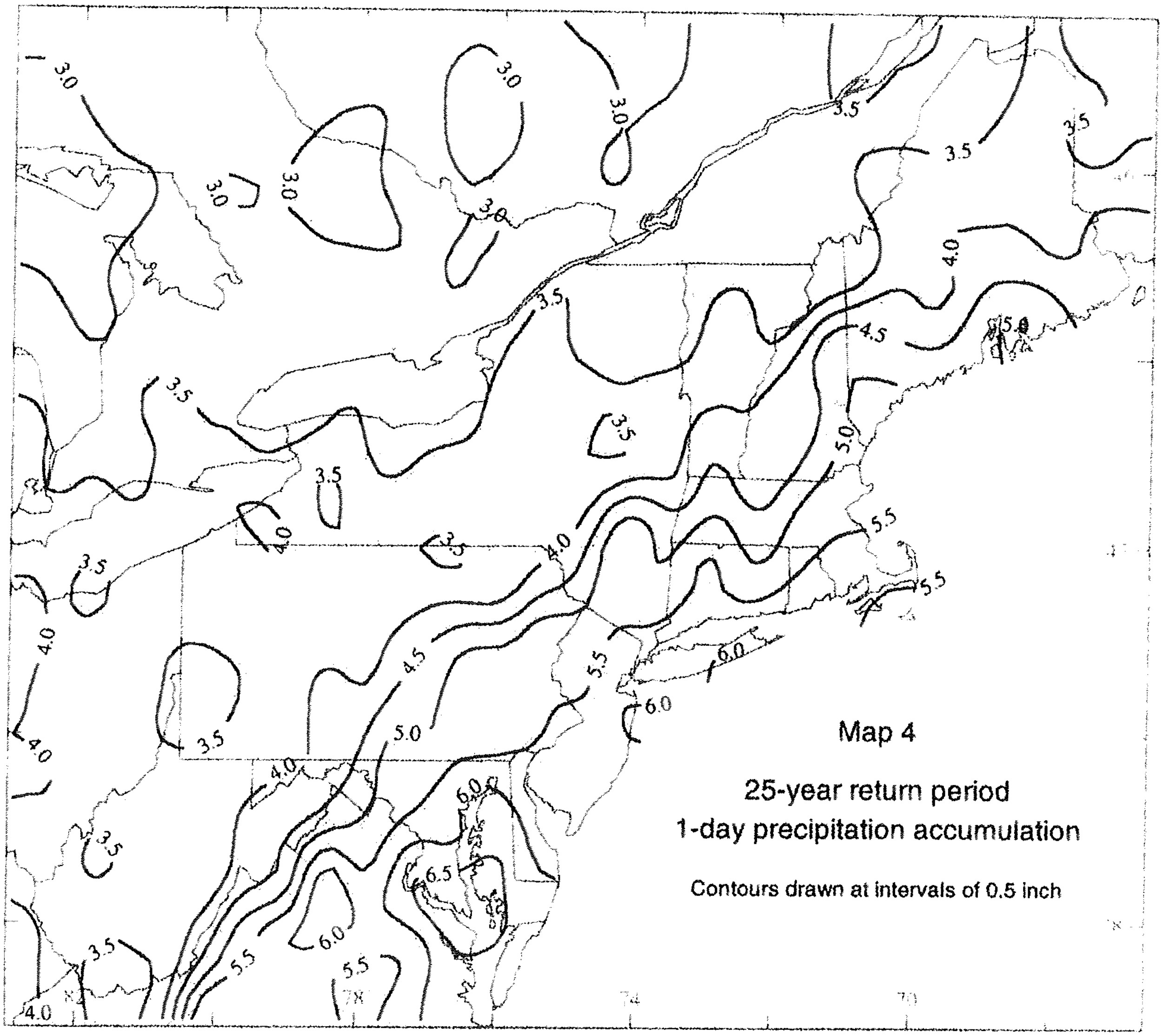
1" = 60'

4/26/05

2


Map 1
2-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.25 inch
1.75
2.00
2.25
2.50
2.75
3.00
3.25
78
74
70
42

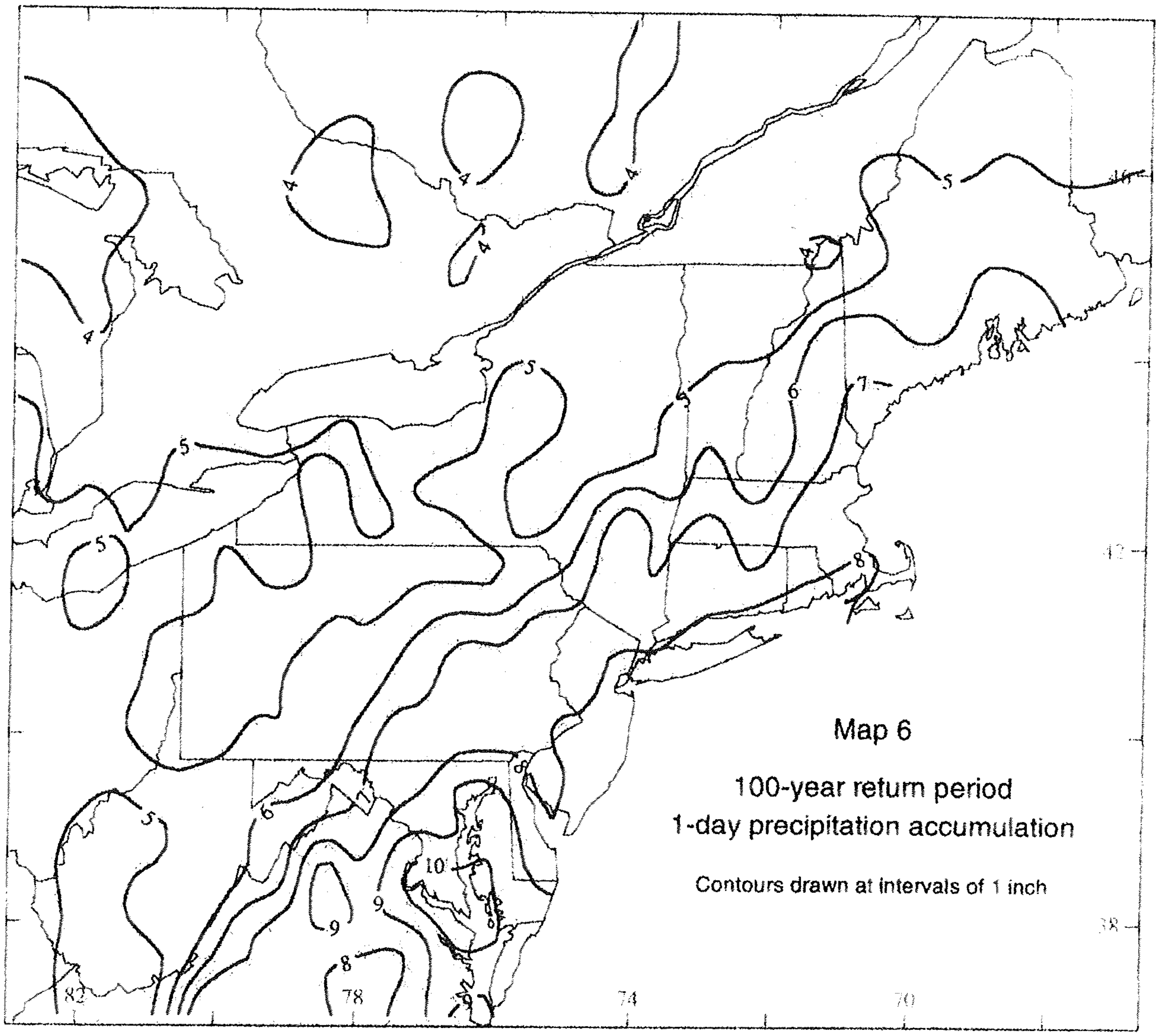

Map 3
10-year return period
1-day precipitation accumulation
Contours drawn at intervals of 0.25 inch



Map 4

25-year return period
1-day precipitation accumulation

Contours drawn at intervals of 0.5 inch


Map 6
100-year return period
1-day precipitation accumulation
Contours drawn at intervals of 1 inch
4
5
6
7
8
9
10
82
78
74
70
42
38

Technical Appendix

Graduated Pipe Volume Storage Calculations

Pre-Development Calculation Data:

Post-Development Calculation Data:

Brassard Design & Engineering, Inc. · 91 Prescott Street · Worcester, MA 01605
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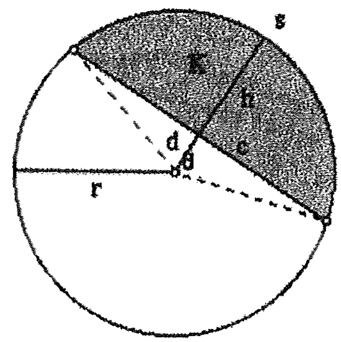
1490 Main Street
Waltham, MA
date: 04/26/05
Graduated Pipe Cross-sectional Area

Brassard Design + Engineering, Inc.
91 Prescott Street
Worcester, MA 01605

K = Graduated Area

$d = r - h$
$\Theta = 2 \arccos(d/r)$
$c = 2r \sin(\Theta/2)$
$s = r\,\Theta$
$K = r^2[\Theta - \sin\Theta]/2$



pipe diameter = 36 in
pipe diameter = 3 ft
pipe radius = 1.5 ft

refer to diagram

h (ft)	d (ft)	Θ (rad)	c (ft)	s (ft)	K (sf)
0.00	1.50	0.00	0.00	0.00	0.00
0.25	1.25	1.17	1.66	1.76	0.28
0.50	1.00	1.68	2.24	2.52	0.77
0.75	0.75	2.09	2.60	3.14	1.38
1.00	0.50	2.46	2.83	3.69	2.06
1.25	0.25	2.81	2.96	4.21	2.79
1.50	0.00	3.14	3.00	4.71	3.53
1.75	-0.25	3.48	2.96	5.21	4.28
2.00	-0.50	3.82	2.83	5.73	5.01
2.25	-0.75	4.19	2.60	6.28	5.69
2.50	-1.00	4.60	2.24	6.90	6.29
2.75	-1.25	5.11	1.66	7.67	6.79
3.00	-1.50	6.28	0.00	9.42	7.07

1490 Main Street
Waltham, MA
date: 04/26/05

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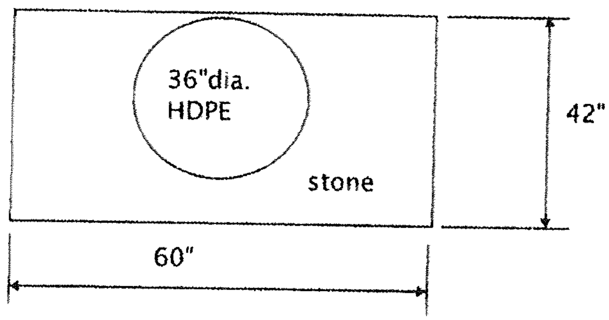
Worcester, MA 01605

Segmented Pipe Trench Unit Volume (per unit length of each pipe section)
(Subsurface Detention)

Pipe trench diagram:



Overall Unit Volume Data:

pipe size:	36 in
section width:	60 in
section height:	42 in
stone void ratio:	0.40
unit pipe volume:	7.07 cf/lf
unit stone volume:	10.43 cf/lf
unit stone void volur	4.17 cf/lf
total unit volume:	11.24 cf/lf

H = height from bottom of stone base (ft)
V_p = graduated unit volume of pipe (cf/lf)
V_s = graduated unit volume of stone (cf/lf)
V_{sv} = graduated unit volume of stone voids (cf/lf)
V_t = total graduated unit volume (cf/lf)

H	V_p	V_s	V_{sv}	V_t
0.00	0.00	0.00	0.00	0.00
0.25	0.00	1.25	0.50	0.50
0.50	0.00	2.50	1.00	1.00
0.75	0.28	3.47	1.39	1.67
1.00	0.77	4.23	1.69	2.46
1.25	1.38	4.87	1.95	3.33
1.50	2.06	5.44	2.17	4.24
1.75	2.79	5.96	2.38	5.17
2.00	3.53	6.47	2.59	6.12
2.25	4.28	6.97	2.79	7.07
2.50	5.01	7.49	3.00	8.00
2.75	5.69	8.06	3.23	8.91
3.00	6.29	8.71	3.48	9.78
3.25	6.79	9.46	3.79	10.57
3.50	7.07	10.43	4.17	11.24

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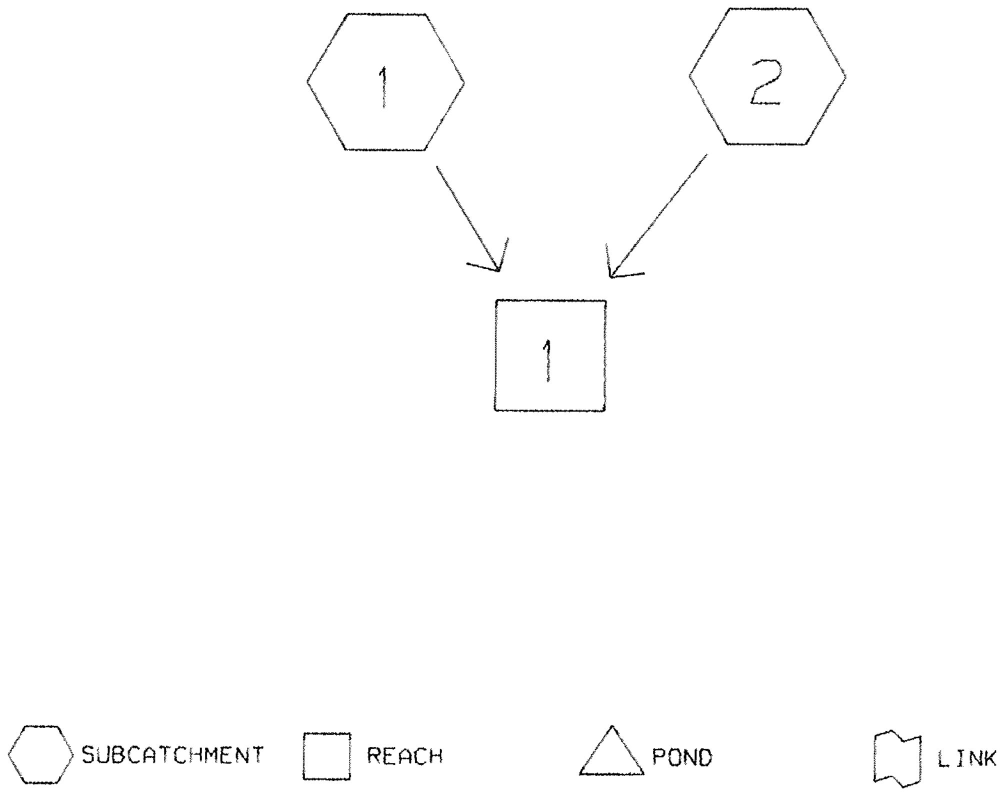
Subsurface Detention System - Graduated Volume (Entire Field)

Number of Rows	7
Length of Rows	70
Total Length of Pipe	490
Field Length	70
Field Width	35
Stone Base Elevation	148.5

Height	Volume
148.45	0
148.70	245
148.95	490
149.20	818
149.70	1631
149.95	2076
150.20	2535
150.45	2999
150.70	3464
150.95	3922
151.20	4367
151.45	4790
151.70	5180
151.95	5508

WATERSHED ROUTING ===



SUBCATCHMENT 1 **AREA TRIBUTARY TO MAIN STREET**

PEAK= .93 CFS @ 12.06 HRS, VOLUME= .06 AF

ACRES	CN	
.23	98	IMPERVIOUS
.20	69	OPEN AREA, FAIR CND., HSG B
.04	85	GRAVEL AREA, FAIR CND., HSG B
.47	85	

SCS TR-20 METHOD
TYPE III 24-HOUR
RAINFALL= 3.16 IN
SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 2 **AREA TRIBUTARY TO WEST - OFF SITE)**

PEAK= 1.15 CFS @ 12.08 HRS, VOLUME= .09 AF

ACRES	CN	
1.31	69	OPEN AREA, FAIR CND., HSG B
.11	85	GRAVEL AREA, FAIR CND., HSG B
1.42	70	

SCS TR-20 METHOD
TYPE III 24-HOUR
RAINFALL= 3.16 IN
SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1

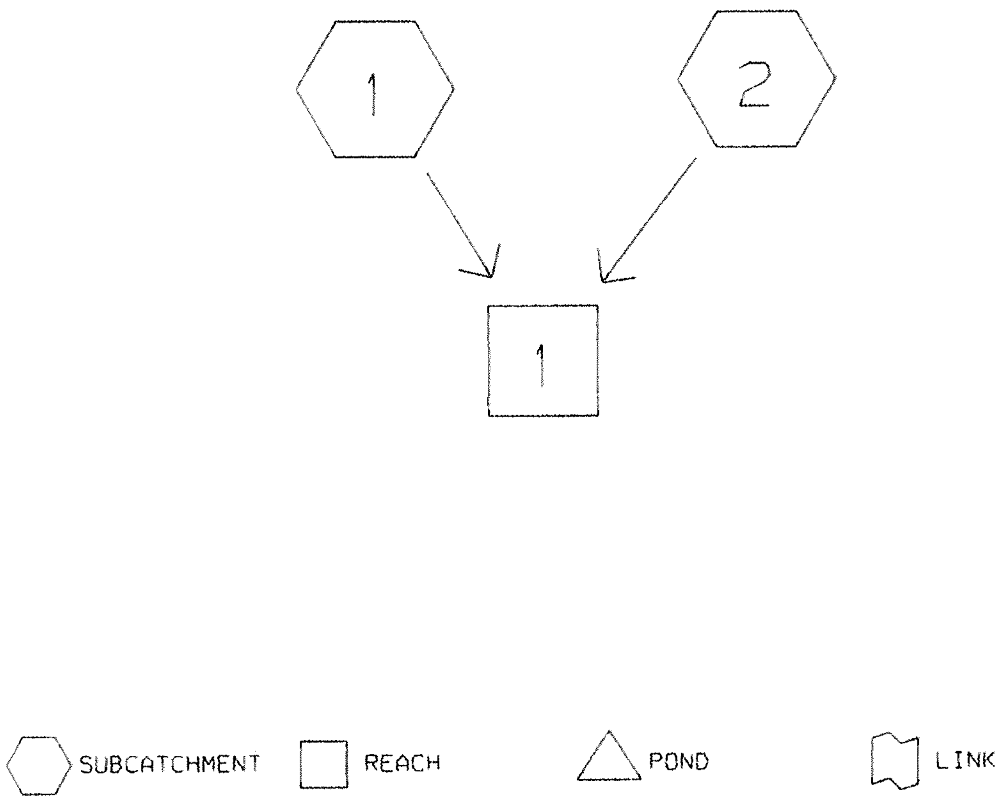
Not described

Qin = 2.10 CFS @ 12.07 HRS, VOLUME= .15 AF
Qout= 2.10 CFS @ 12.07 HRS, VOLUME= .15 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

WATERSHED ROUTING ==



SUBCATCHMENT 1 **AREA TRIBUTARY TO MAIN STREET**

PEAK= 1.69 CFS @ 12.06 HRS, VOLUME= .11 AF

ACRES	CN		
.23	98	IMPERVIOUS	SCS TR-20 METHOD
.20	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 4.75 IN
.47	85		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 2 **AREA TRIBUTARY TO WEST - OFF SITE)**

PEAK= 2.96 CFS @ 12.07 HRS, VOLUME= .20 AF

ACRES	CN		
1.31	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.11	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
1.42	70		RAINFALL= 4.75 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1

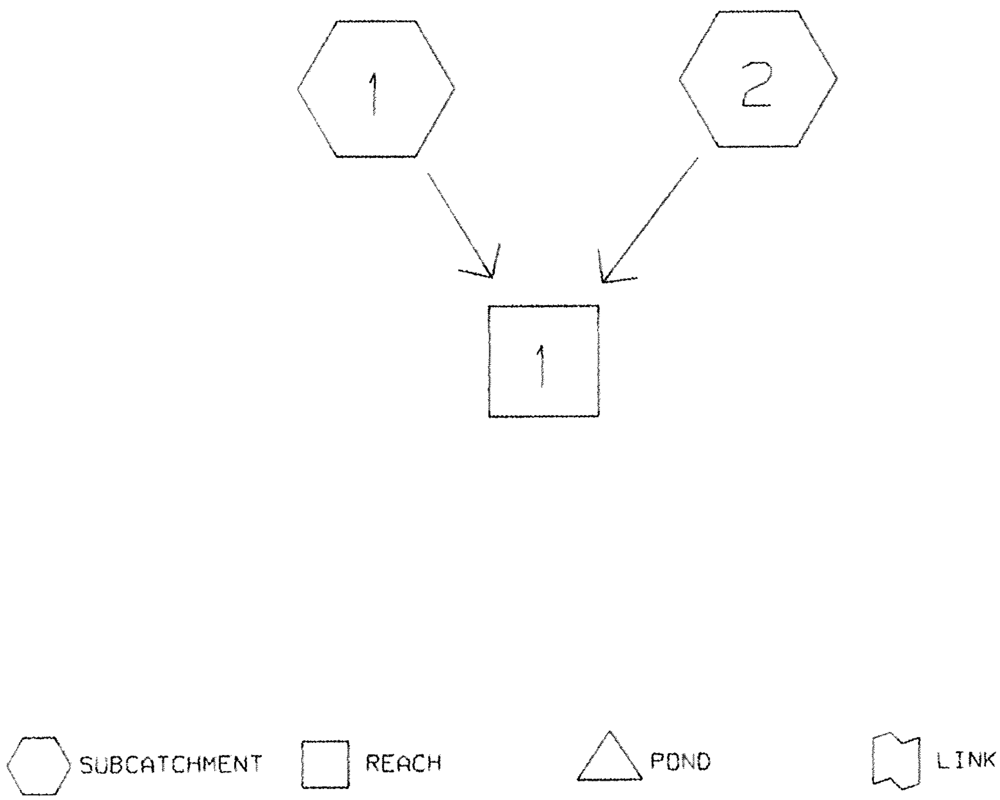
Not described

Qin = 4.64 CFS @ 12.07 HRS, VOLUME= .31 AF
Qout= 4.64 CFS @ 12.07 HRS, VOLUME= .31 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

WATERSHED ROUTING ==



SUBCATCHMENT 1 AREA TRIBUTARY TO MAIN STREET

PEAK= 2.34 CFS @ 12.06 HRS, VOLUME= .15 AF

ACRES	CN		
.23	98	IMPERVIOUS	SCS TR-20 METHOD
.20	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 6.10 IN
.47	85		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 2 AREA TRIBUTARY TO WEST - OFF SITE)

PEAK= 4.70 CFS @ 12.07 HRS, VOLUME= .31 AF

ACRES	CN		
			SCS TR-20 METHOD
1.31	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.11	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 6.10 IN
1.42	70		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1

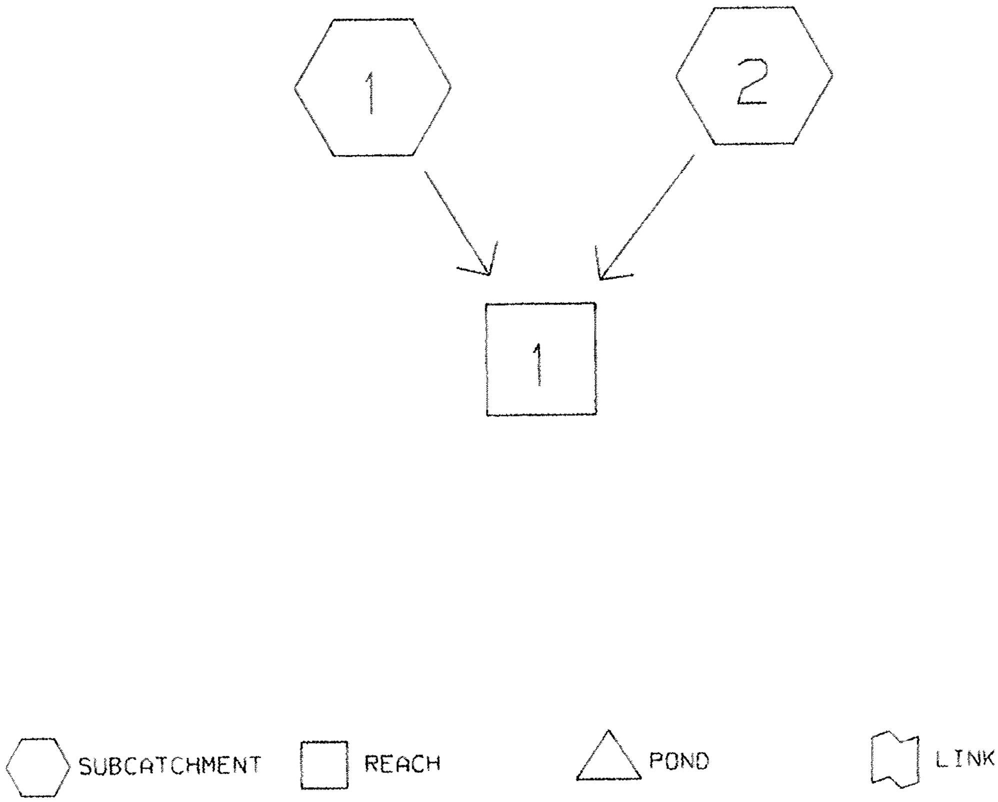
Not described

Qin = 7.03 CFS @ 12.06 HRS, VOLUME= .47 AF
Qout= 7.03 CFS @ 12.06 HRS, VOLUME= .47 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

WATERSHED ROUTING ==



SUBCATCHMENT 1 **AREA TRIBUTARY TO MAIN STREET**

PEAK= 3.48 CFS @ 12.06 HRS, VOLUME= .23 AF

ACRES	CN		
.23	98	IMPERVIOUS	SCS TR-20 METHOD
.20	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 8.48 IN
.47	85		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 2 **AREA TRIBUTARY TO WEST - OFF SITE)**

PEAK= 7.99 CFS @ 12.06 HRS, VOLUME= .53 AF

ACRES	CN		
1.31	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.11	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
1.42	70		RAINFALL= 8.48 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1

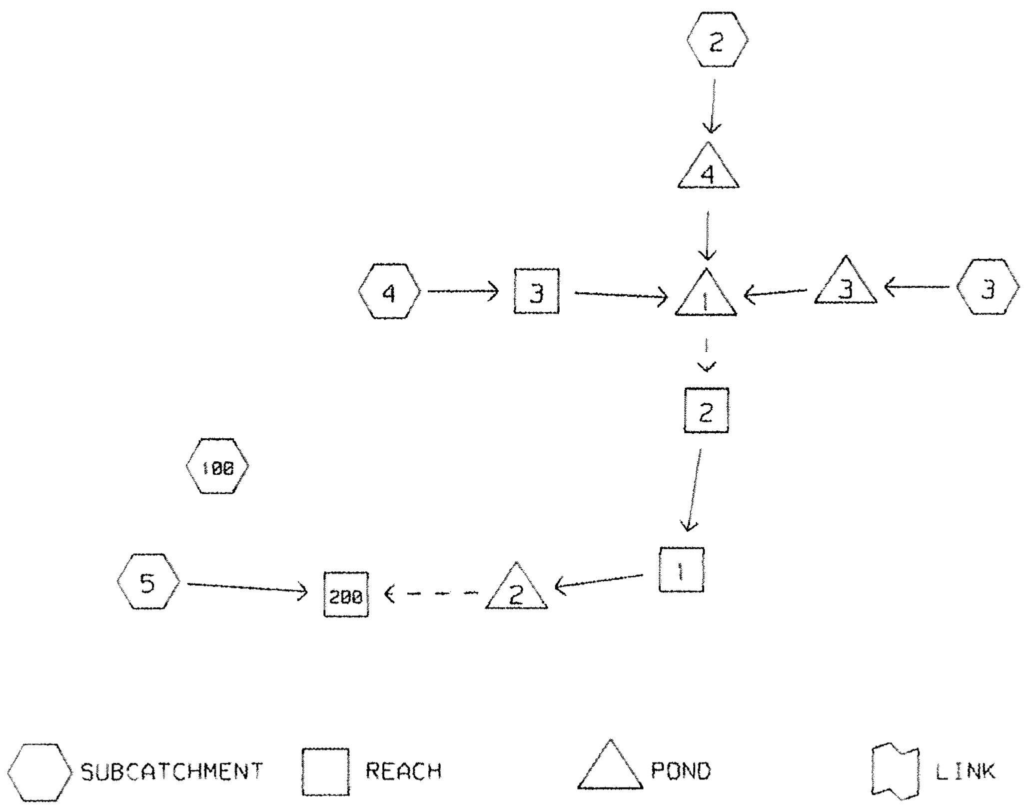
Not described

Qin = 11.46 CFS @ 12.06 HRS, VOLUME= .76 AF
Qout= 11.46 CFS @ 12.06 HRS, VOLUME= .76 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

WATERSHED ROUTING ==



SUBCATCHMENT 2 AREA TRIBUTARY TO CB-1

PEAK= 1.04 CFS @ 12.06 HRS, VOLUME= .07 AF

ACRES	CN		
.30	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.18	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.48	87		RAINFALL= 3.16 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 3 AREA TRIBUTARY TO CB-2

PEAK= 1.59 CFS @ 12.06 HRS, VOLUME= .10 AF

ACRES	CN		
.41	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.08	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.14	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 3.16 IN
.63	91		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 4 BUILDING ROOF RUNOFF

PEAK= .60 CFS @ 12.06 HRS, VOLUME= .04 AF

ACRES	CN		
.20	98	IMPERVIOUS AREA	SCS TR-20 METHOD
			TYPE III 24-HOUR
			RAINFALL= 3.16 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 5 AREA TRIBUTARY TO WEST - OFF SITE

PEAK= .18 CFS @ 12.07 HRS, VOLUME= .01 AF

ACRES	CN		
.13	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.05	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.18	73		RAINFALL= 3.16 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 100 **AREA TRIBUTARY TO MAIN STREET**

PEAK= .59 CFS @ 12.07 HRS, VOLUME= .04 AF

ACRES	CN	
.12	98	IMPERVIOUS AREA
.24	69	OPEN AREA, FAIR CND., HSG B
.04	85	GRAVEL AREA, FAIR CND., HSG B
.40	79	

SCS TR-20 METHOD
TYPE III 24-HOUR
RAINFALL= 3.16 IN
SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1 **DMH-3 TO DRYWELL**

Qin = .68 CFS @ 12.29 HRS, VOLUME= .04 AF
Qout= .68 CFS @ 12.30 HRS, VOLUME= .04 AF, ATTEN= 0%, LAG= .1 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.76
.30	.20	1.69
.70	.59	7.23
.80	.67	8.44
.90	.74	9.20
.94	.77	9.28
.97	.78	9.20
1.00	.79	8.63

12" PIPE

n= .012
LENGTH= 16 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .19 FT
PEAK VELOCITY= 6.6 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 2 **DMH-2 TO DMH-3**

Qin = .68 CFS @ 12.28 HRS, VOLUME= .04 AF
Qout= .68 CFS @ 12.29 HRS, VOLUME= .04 AF, ATTEN= 0%, LAG= .7 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.74
.30	.20	1.66
.70	.59	7.08
.80	.67	8.27
.90	.74	9.01
.94	.77	9.10
.97	.78	9.01
1.00	.79	8.46

12" PIPE

n= .012
LENGTH= 68 FT
SLOPE= .048 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .19 FT
PEAK VELOCITY= 6.5 FPS
TRAVEL TIME = .2 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 3 **BUILDING ROOF DRAIN TO DMH-1**

Qin = .60 CFS @ 12.06 HRS, VOLUME= .04 AF
Qout= .60 CFS @ 12.06 HRS, VOLUME= .04 AF, ATTEN= 1%, LAG= .2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.07	.02	.06
.13	.05	.26
.20	.09	.57
.47	.26	2.45
.53	.30	2.86
.60	.33	3.12
.63	.34	3.15
.65	.35	3.12
.67	.35	2.93

8" PIPE

n= .012
LENGTH= 50 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .20 FT
PEAK VELOCITY= 6.6 FPS
TRAVEL TIME = .1 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 200

Not described

Qin = 1.14 CFS @ 12.25 HRS, VOLUME= .04 AF
Qout= 1.14 CFS @ 12.25 HRS, VOLUME= .04 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

POND 1 **INFILTRATION FIELD**

```
Qin =  3.22 CFS @ 12.06 HRS,  VOLUME=   .21 AF
Qout=  1.36 CFS @ 12.28 HRS,  VOLUME=   .21 AF,  ATTEN= 58%,  LAG=  13.2 MIN
Qpri=   .68 CFS @ 12.16 HRS,  VOLUME=   .18 AF
Qsec=   .68 CFS @ 12.28 HRS,  VOLUME=   .04 AF
```

ELEVATION (FT)	CUM.STOR (CF)
148.5	0
148.7	245
149.0	490
149.2	818
149.7	1631
150.0	2076
150.2	2535
150.5	2999
150.7	3464
151.0	3922
151.2	4367
151.5	4790
151.7	5180
152.0	5508

STOR-IND METHOD
PEAK STORAGE = 1798 CF
PEAK ELEVATION= 149.8 FT
FLOOD ELEVATION= 152.0 FT
START ELEVATION= 148.5 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 10.7 MIN (.21 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	148.5'	**EXFILTRATION** Q= .68 CFS at and above 148.6'
2	S	149.0'	**4" CULVERT X 2** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
3	S	149.8'	**8" CULVERT** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
4	S	151.2'	**2' SHARP-CRESTED RECTANGULAR WEIR** Q=C L H^1.5 C=3.27+.4 H/2.3 L=Length-2(.1 H)

```
Primary Discharge
└──1=Exfiltration

Secondary Discharge
├──2=Culvert
├──3=Culvert
└──4=Sharp-Crested Rectangular Weir
```

POND 2 **DRYWELL**

```
Qin =   .68 CFS @ 12.30 HRS,  VOLUME=   .04 AF
Qout=  1.06 CFS @ 12.25 HRS,  VOLUME=   .04 AF,  ATTEN= 0%,  LAG=  0.0 MIN
Qpri=   .02 CFS @ 12.25 HRS,  VOLUME=   .01 AF
Qsec=  1.04 CFS @ 12.25 HRS,  VOLUME=   .03 AF
```

ELEVATION (FT)	CUM.STOR (CF)
142.8	0
143.8	31
144.8	80
145.8	128
146.8	177
147.8	225
148.8	273
149.8	322
150.0	322

STOR-IND METHOD
PEAK STORAGE = 322 CF
PEAK ELEVATION= 149.9 FT
FLOOD ELEVATION= 150.0 FT
START ELEVATION= 142.8 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 37.3 MIN (.04 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	142.8'	**EXFILTRATION** Q= .02 CFS at and above 142.9'
2	S	149.8'	**24" HORIZONTAL ORIFICE/GRATE** Q=.6 Area SQR(2gH) (Limited to weir flow @ low head)

Primary Discharge
└─1=Exfiltration

Secondary Discharge
└─2=Orifice/Grate

POND 3 **CB-2 TO DMH-1**

```
Qin =  1.59 CFS @ 12.06 HRS,  VOLUME=   .10 AF
Qout=  1.59 CFS @ 12.06 HRS,  VOLUME=   .10 AF,  ATTEN= 0%,  LAG=   .1 MIN
```

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
156.0	20	84	84
157.0	6484	3252	3336

STOR-IND METHOD
PEAK STORAGE = 13 CF
PEAK ELEVATION= 152.4 FT
FLOOD ELEVATION= 157.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .4 MIN (.1 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=15' S=.05'/' Ke=.5 Cc=.9 Cd=.6

POND 4 **CB1-DMH-1**

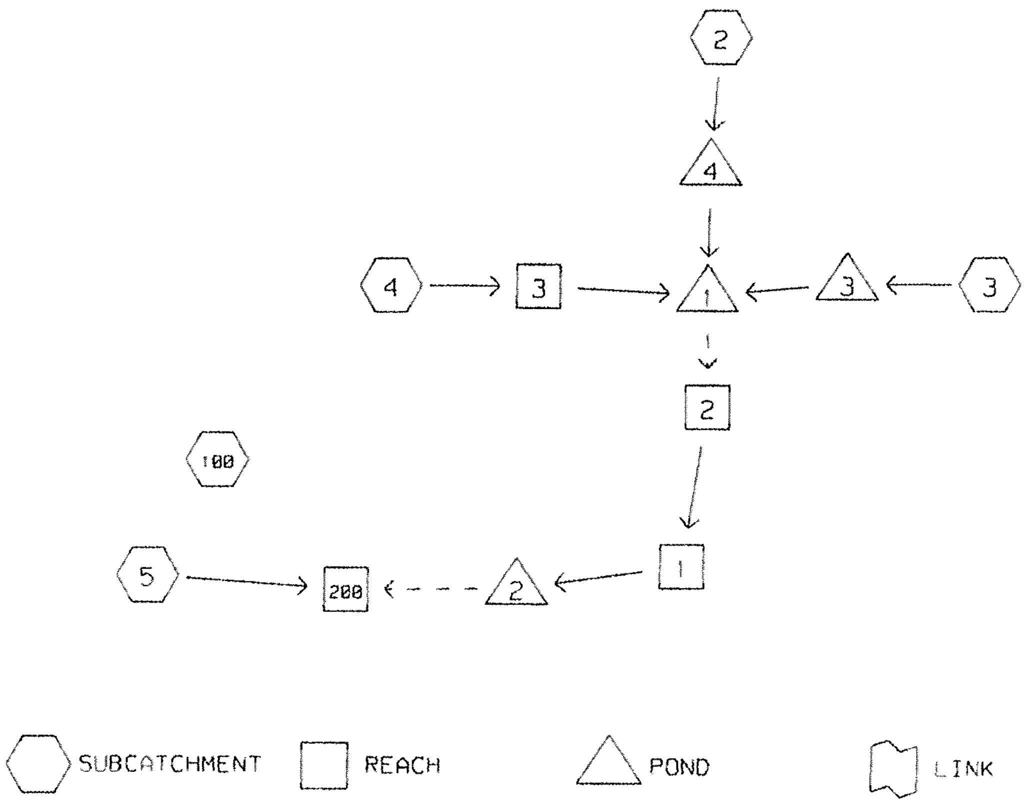
Qin = 1.04 CFS @ 12.06 HRS, VOLUME= .07 AF
Qout= 1.04 CFS @ 12.07 HRS, VOLUME= .07 AF, ATTEN= 0%, LAG= .1 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
155.2	20	69	69
156.0	602	248	317

STOR-IND METHOD
PEAK STORAGE = 11 CF
PEAK ELEVATION= 152.3 FT
FLOOD ELEVATION= 156.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .5 MIN (.07 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=150' S=.005'/' Ke=.5 Cc=.9 Cd=.6

WATERSHED ROUTING



SUBCATCHMENT 2 **AREA TRIBUTARY TO CB-1**

PEAK= 1.82 CFS @ 12.06 HRS, VOLUME= .12 AF

ACRES	CN		
.30	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.18	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.48	87		RAINFALL= 4.75 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 3 **AREA TRIBUTARY TO CB-2**

PEAK= 2.61 CFS @ 12.06 HRS, VOLUME= .17 AF

ACRES	CN		
.41	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.08	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.14	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 4.75 IN
.63	91		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 4 **BUILDING ROOF RUNOFF**

PEAK= .91 CFS @ 12.06 HRS, VOLUME= .06 AF

ACRES	CN		
.20	98	IMPERVIOUS AREA	SCS TR-20 METHOD
			TYPE III 24-HOUR
			RAINFALL= 4.75 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 5 **AREA TRIBUTARY TO WEST - OFF SITE**

PEAK= .43 CFS @ 12.07 HRS, VOLUME= .03 AF

ACRES	CN		
.13	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.05	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.18	73		RAINFALL= 4.75 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 100 AREA TRIBUTARY TO MAIN STREET

PEAK= 1.19 CFS @ 12.06 HRS, VOLUME= .08 AF

ACRES	CN		
.12	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.24	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 4.75 IN
.40	79		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1 **DMH-3 TO DRYWELL**

Qin = 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF
Qout= 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.76
.30	.20	1.69
.70	.59	7.23
.80	.67	8.44
.90	.74	9.20
.94	.77	9.28
.97	.78	9.20
1.00	.79	8.63

12" PIPE
n= .012
LENGTH= 16 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .32 FT
PEAK VELOCITY= 9.1 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 2 **DMH-2 TO DMH-3**

Qin = 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF
Qout= 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF, ATTEN= 0%, LAG= .1 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.74
.30	.20	1.66
.70	.59	7.08
.80	.67	8.27
.90	.74	9.01
.94	.77	9.10
.97	.78	9.01
1.00	.79	8.46

12" PIPE
n= .012
LENGTH= 68 FT
SLOPE= .048 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .33 FT
PEAK VELOCITY= 9.0 FPS
TRAVEL TIME = .1 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 3 **BUILDING ROOF DRAIN TO DMH-1**

Qin = .91 CFS @ 12.06 HRS, VOLUME= .06 AF
Qout= .91 CFS @ 12.06 HRS, VOLUME= .06 AF, ATTEN= 1%, LAG= .2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.07	.02	.06
.13	.05	.26
.20	.09	.57
.47	.26	2.45
.53	.30	2.86
.60	.33	3.12
.63	.34	3.15
.65	.35	3.12
.67	.35	2.93

8" PIPE
n= .012
LENGTH= 50 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .25 FT
PEAK VELOCITY= 7.6 FPS
TRAVEL TIME = .1 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 200

Not described

Qin = 2.62 CFS @ 12.20 HRS, VOLUME= .12 AF
Qout= 2.62 CFS @ 12.20 HRS, VOLUME= .12 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

POND 1 **INFILTRATION FIELD**

Qin = 5.33 CFS @ 12.06 HRS, VOLUME= .35 AF
Qout= 2.69 CFS @ 12.22 HRS, VOLUME= .35 AF, ATTEN= 49%, LAG= 9.3 MIN
Qpri= .68 CFS @ 12.00 HRS, VOLUME= .24 AF
Qsec= 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF

ELEVATION (FT)	CUM.STOR (CF)
148.5	0
148.7	245
149.0	490
149.2	818
149.7	1631
150.0	2076
150.2	2535
150.5	2999
150.7	3464
151.0	3922
151.2	4367
151.5	4790
151.7	5180
152.0	5508

STOR-IND METHOD
PEAK STORAGE = 3151 CF
PEAK ELEVATION= 150.6 FT
FLOOD ELEVATION= 152.0 FT
START ELEVATION= 148.5 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 12.7 MIN (.35 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	148.5'	**EXFILTRATION** Q= .68 CFS at and above 148.6'
2	S	149.0'	**4" CULVERT X 2** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
3	S	149.8'	**8" CULVERT** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
4	S	151.2'	**2' SHARP-CRESTED RECTANGULAR WEIR** Q=C L H^1.5 C=3.27+.4 H/2.3 L=Length-2(.1 H)

Primary Discharge
└—1=Exfiltration

Secondary Discharge
├—2=Culvert
├—3=Culvert
└—4=Sharp-Crested Rectangular Weir

POND 2 **DRYWELL**

Qin = 2.01 CFS @ 12.22 HRS, VOLUME= .11 AF
Qout= 2.39 CFS @ 12.20 HRS, VOLUME= .11 AF, ATTEN= 0%, LAG= 0.0 MIN
Qpri= .02 CFS @ 12.10 HRS, VOLUME= .01 AF
Qsec= 2.37 CFS @ 12.20 HRS, VOLUME= .10 AF

ELEVATION (FT)	CUM.STOR (CF)
142.8	0
143.8	31
144.8	80
145.8	128
146.8	177
147.8	225
148.8	273
149.8	322
150.0	322

STOR-IND METHOD
PEAK STORAGE = 322 CF
PEAK ELEVATION= 150.0 FT
FLOOD ELEVATION= 150.0 FT
START ELEVATION= 142.8 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 15.3 MIN (.11 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	142.8'	**EXFILTRATION** Q= .02 CFS at and above 142.9'
2	S	149.8'	**24" HORIZONTAL ORIFICE/GRATE** Q=.6 Area SQR(2gH) (Limited to weir flow @ low head)

Primary Discharge
└─1=Exfiltration

Secondary Discharge
└─2=Orifice/Grate

POND 3 **CB-2 TO DMH-1**

Qin = 2.61 CFS @ 12.06 HRS, VOLUME= .17 AF
Qout= 2.60 CFS @ 12.06 HRS, VOLUME= .17 AF, ATTEN= 0%, LAG= .1 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
156.0	20	84	84
157.0	6484	3252	3336

STOR-IND METHOD
PEAK STORAGE = 19 CF
PEAK ELEVATION= 152.7 FT
FLOOD ELEVATION= 157.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .3 MIN (.17 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=15' S=.05'/' Ke=.5 Cc=.9 Cd=.6

POND 4 **CB1-DMH-1**

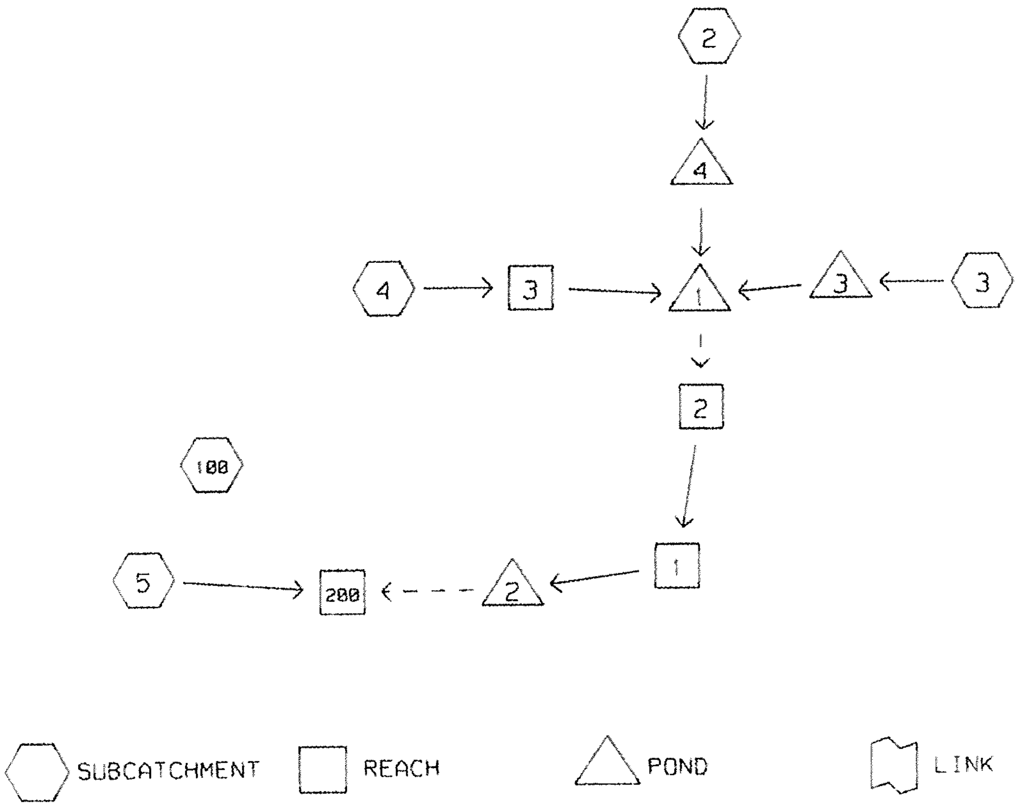
Qin = 1.82 CFS @ 12.06 HRS, VOLUME= .12 AF
Qout= 1.81 CFS @ 12.06 HRS, VOLUME= .12 AF, ATTEN= 0%, LAG= .1 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
155.2	20	69	69
156.0	602	248	317

STOR-IND METHOD
PEAK STORAGE = 16 CF
PEAK ELEVATION= 152.5 FT
FLOOD ELEVATION= 156.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .4 MIN (.12 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=150' S=.005'/' Ke=.5 Cc=.9 Cd=.6

WATERSHED ROUTING ==



SUBCATCHMENT 2 **AREA TRIBUTARY TO CB-1**

PEAK= 2.48 CFS @ 12.06 HRS, VOLUME= .16 AF

ACRES	CN		
.30	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.18	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.48	87		RAINFALL= 6.10 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 3 **AREA TRIBUTARY TO CB-2**

PEAK= 3.47 CFS @ 12.06 HRS, VOLUME= .23 AF

ACRES	CN		
.41	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.08	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.14	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 6.10 IN
.63	91		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 4 **BUILDING ROOF RUNOFF**

PEAK= 1.18 CFS @ 12.06 HRS, VOLUME= .08 AF

ACRES	CN		
.20	98	IMPERVIOUS AREA	SCS TR-20 METHOD
			TYPE III 24-HOUR
			RAINFALL= 6.10 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 5 **AREA TRIBUTARY TO WEST - OFF SITE**

PEAK= .66 CFS @ 12.07 HRS, VOLUME= .04 AF

ACRES	CN		
.13	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.05	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.18	73		RAINFALL= 6.10 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 100 AREA TRIBUTARY TO MAIN STREET

PEAK= 1.73 CFS @ 12.06 HRS, VOLUME= .11 AF

ACRES	CN		
.12	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.24	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 6.10 IN
.40	79		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1 **DMH-3 TO DRYWELL**

Qin = 2.90 CFS @ 12.22 HRS, VOLUME= .17 AF
Qout= 2.90 CFS @ 12.22 HRS, VOLUME= .17 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)		
			12" PIPE	STOR-IND+TRANS METHOD
0.00	0.00	0.00		PEAK DEPTH= .39 FT
.10	.04	.18	n= .012	PEAK VELOCITY= 10.2 FPS
.20	.11	.76	LENGTH= 16 FT	TRAVEL TIME = 0.0 MIN
.30	.20	1.69	SLOPE= .05 FT/FT	SPAN= 10-20 HRS, dt=.05 HRS
.70	.59	7.23		
.80	.67	8.44		
.90	.74	9.20		
.94	.77	9.28		
.97	.78	9.20		
1.00	.79	8.63		

REACH 2 **DMH-2 TO DMH-3**

Qin = 2.90 CFS @ 12.22 HRS, VOLUME= .17 AF
Qout= 2.90 CFS @ 12.22 HRS, VOLUME= .17 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)		
			12" PIPE	STOR-IND+TRANS METHOD
0.00	0.00	0.00		PEAK DEPTH= .39 FT
.10	.04	.18	n= .012	PEAK VELOCITY= 10.1 FPS
.20	.11	.74	LENGTH= 68 FT	TRAVEL TIME = .1 MIN
.30	.20	1.66	SLOPE= .048 FT/FT	SPAN= 10-20 HRS, dt=.05 HRS
.70	.59	7.08		
.80	.67	8.27		
.90	.74	9.01		
.94	.77	9.10		
.97	.78	9.01		
1.00	.79	8.46		

REACH 3 **BUILDING ROOF DRAIN TO DMH-1**

Qin = 1.18 CFS @ 12.06 HRS, VOLUME= .08 AF
Qout= 1.17 CFS @ 12.06 HRS, VOLUME= .08 AF, ATTEN= 1%, LAG= .2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)		
			8" PIPE	STOR-IND+TRANS METHOD
0.00	0.00	0.00		PEAK DEPTH= .28 FT
.07	.02	.06	n= .012	PEAK VELOCITY= 8.2 FPS
.13	.05	.26	LENGTH= 50 FT	TRAVEL TIME = .1 MIN
.20	.09	.57	SLOPE= .05 FT/FT	SPAN= 10-20 HRS, dt=.05 HRS
.47	.26	2.45		
.53	.30	2.86		
.60	.33	3.12		
.63	.34	3.15		
.65	.35	3.12		
.67	.35	2.93		

REACH 200

Not described

Qin = 3.55 CFS @ 12.15 HRS, VOLUME= .21 AF
Qout= 3.55 CFS @ 12.15 HRS, VOLUME= .21 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

\- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

POND 1 **INFILTRATION FIELD**

Qin = 7.10 CFS @ 12.06 HRS, VOLUME= .47 AF
Qout= 3.58 CFS @ 12.22 HRS, VOLUME= .47 AF, ATTEN= 50%, LAG= 9.2 MIN
Qpri= .68 CFS @ 12.00 HRS, VOLUME= .29 AF
Qsec= 2.90 CFS @ 12.22 HRS, VOLUME= .17 AF

ELEVATION (FT)	CUM.STOR (CF)
148.5	0
148.7	245
149.0	490
149.2	818
149.7	1631
150.0	2076
150.2	2535
150.5	2999
150.7	3464
151.0	3922
151.2	4367
151.5	4790
151.7	5180
152.0	5508

STOR-IND METHOD
PEAK STORAGE = 4285 CF
PEAK ELEVATION= 151.2 FT
FLOOD ELEVATION= 152.0 FT
START ELEVATION= 148.5 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 13.5 MIN (.47 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	148.5'	**EXFILTRATION** Q= .68 CFS at and above 148.6'
2	S	149.0'	**4" CULVERT X 2** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
3	S	149.8'	**8" CULVERT** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
4	S	151.2'	**2' SHARP-CRESTED RECTANGULAR WEIR** Q=C L H^1.5 C=3.27+.4 H/2.3 L=Length-2(.1 H)

Primary Discharge
└──1=Exfiltration

Secondary Discharge
├──2=Culvert
├──3=Culvert
└──4=Sharp-Crested Rectangular Weir

POND 2 **DRYWELL**

```
Qin =  2.90 CFS @ 12.22 HRS,  VOLUME=   .17 AF
Qout=  3.18 CFS @ 12.25 HRS,  VOLUME=   .17 AF,  ATTEN=  0%,  LAG=   2.0 MIN
Qpri=   .02 CFS @ 12.05 HRS,  VOLUME=   .01 AF
Qsec=  3.16 CFS @ 12.25 HRS,  VOLUME=   .16 AF
```

ELEVATION (FT)	CUM.STOR (CF)
142.8	0
143.8	31
144.8	80
145.8	128
146.8	177
147.8	225
148.8	273
149.8	322
150.0	322

STOR-IND METHOD
PEAK STORAGE = 322 CF
PEAK ELEVATION= 150.1 FT
FLOOD ELEVATION= 150.0 FT
START ELEVATION= 142.8 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 9 MIN (.17 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	142.8'	**EXFILTRATION** Q= .02 CFS at and above 142.9'
2	S	149.8'	**24" HORIZONTAL ORIFICE/GRATE** Q=.6 Area SQR(2gH) (Limited to weir flow @ low head)

Primary Discharge
└─1=Exfiltration

Secondary Discharge
└─2=Orifice/Grate

POND 3 **CB-2 TO DMH-1**

```
Qin =  3.47 CFS @ 12.06 HRS,  VOLUME=   .23 AF
Qout=  3.45 CFS @ 12.06 HRS,  VOLUME=   .23 AF,  ATTEN=  1%,  LAG=    .2 MIN
```

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
156.0	20	84	84
157.0	6484	3252	3336

STOR-IND METHOD
PEAK STORAGE = 26 CF
PEAK ELEVATION= 153.0 FT
FLOOD ELEVATION= 157.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .3 MIN (.23 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=15' S=.05'/' Ke=.5 Cc=.9 Cd=.6

POND 4 **CB1-DMH-1**

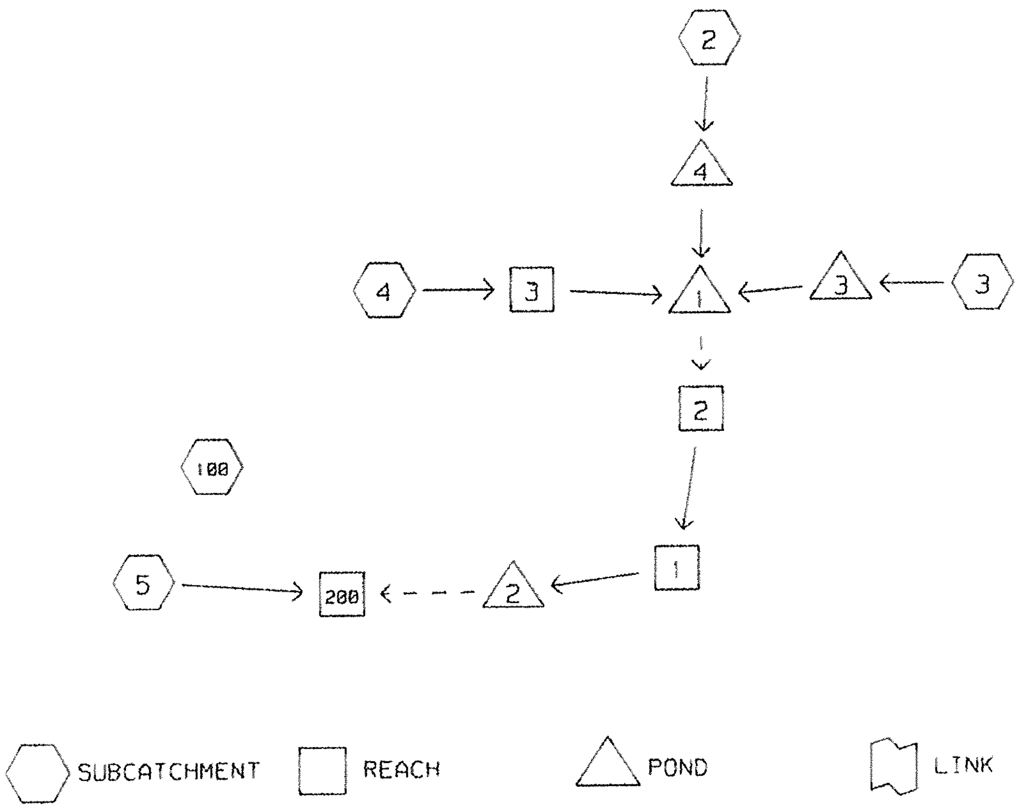
Qin = 2.48 CFS @ 12.06 HRS, VOLUME= .16 AF
Qout= 2.47 CFS @ 12.06 HRS, VOLUME= .16 AF, ATTEN= 0%, LAG= .1 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
155.2	20	69	69
156.0	602	248	317

STOR-IND METHOD
PEAK STORAGE = 20 CF
PEAK ELEVATION= 152.7 FT
FLOOD ELEVATION= 156.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .3 MIN (.16 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=150' S=.005'/' Ke=.5 Cc=.9 Cd=.6

WATERSHED ROUTING ==



SUBCATCHMENT 2 **AREA TRIBUTARY TO CB-1**

PEAK= 3.64 CFS @ 12.06 HRS, VOLUME= .24 AF

ACRES	CN		
.30	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.18	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.48	87		RAINFALL= 8.48 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 3 **AREA TRIBUTARY TO CB-2**

PEAK= 4.97 CFS @ 12.06 HRS, VOLUME= .33 AF

ACRES	CN		
.41	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.08	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.14	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 8.48 IN
.63	91		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 4 **BUILDING ROOF RUNOFF**

PEAK= 1.64 CFS @ 12.06 HRS, VOLUME= .11 AF

ACRES	CN		
.20	98	IMPERVIOUS AREA	SCS TR-20 METHOD
			TYPE III 24-HOUR
			RAINFALL= 8.48 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 5 **AREA TRIBUTARY TO WEST - OFF SITE**

PEAK= 1.08 CFS @ 12.06 HRS, VOLUME= .07 AF

ACRES	CN		
.13	69	OPEN AREA, FAIR CND., HSG B	SCS TR-20 METHOD
.05	85	GRAVEL AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.18	73		RAINFALL= 8.48 IN
			SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

SUBCATCHMENT 100 AREA TRIBUTARY TO MAIN STREET

PEAK= 2.70 CFS @ 12.06 HRS, VOLUME= .18 AF

ACRES	CN		
.12	98	IMPERVIOUS AREA	SCS TR-20 METHOD
.24	69	OPEN AREA, FAIR CND., HSG B	TYPE III 24-HOUR
.04	85	GRAVEL AREA, FAIR CND., HSG B	RAINFALL= 8.48 IN
.40	79		SPAN= 10-20 HRS, dt=.05 HRS

Method	Comment	Tc (min)
DIRECT ENTRY	**MINIMUM Tc**	6.0

REACH 1 **DMH-3 TO DRYWELL**

Qin = 7.38 CFS @ 12.14 HRS, VOLUME= .31 AF
Qout= 7.38 CFS @ 12.15 HRS, VOLUME= .31 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.76
.30	.20	1.69
.70	.59	7.23
.80	.67	8.44
.90	.74	9.20
.94	.77	9.28
.97	.78	9.20
1.00	.79	8.63

12" PIPE

n= .012
LENGTH= 16 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .71 FT
PEAK VELOCITY= 12.3 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 2 **DMH-2 TO DMH-3**

Qin = 7.37 CFS @ 12.14 HRS, VOLUME= .31 AF
Qout= 7.38 CFS @ 12.14 HRS, VOLUME= .31 AF, ATTEN= 0%, LAG= .2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.10	.04	.18
.20	.11	.74
.30	.20	1.66
.70	.59	7.08
.80	.67	8.27
.90	.74	9.01
.94	.77	9.10
.97	.78	9.01
1.00	.79	8.46

12" PIPE

n= .012
LENGTH= 68 FT
SLOPE= .048 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .73 FT
PEAK VELOCITY= 12.1 FPS
TRAVEL TIME = .1 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 3 **BUILDING ROOF DRAIN TO DMH-1**

Qin = 1.64 CFS @ 12.06 HRS, VOLUME= .11 AF
Qout= 1.63 CFS @ 12.06 HRS, VOLUME= .11 AF, ATTEN= 1%, LAG= .2 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)
0.00	0.00	0.00
.07	.02	.06
.13	.05	.26
.20	.09	.57
.47	.26	2.45
.53	.30	2.86
.60	.33	3.12
.63	.34	3.15
.65	.35	3.12
.67	.35	2.93

8" PIPE

n= .012
LENGTH= 50 FT
SLOPE= .05 FT/FT

STOR-IND+TRANS METHOD
PEAK DEPTH= .35 FT
PEAK VELOCITY= 8.8 FPS
TRAVEL TIME = .1 MIN
SPAN= 10-20 HRS, dt=.05 HRS

REACH 200

Not described

Qin = 7.85 CFS @ 12.13 HRS, VOLUME= .37 AF
Qout= 7.85 CFS @ 12.13 HRS, VOLUME= .37 AF, ATTEN= 0%, LAG= 0.0 MIN

DEPTH (FT)	END AREA (SQ-FT)	DISCH (CFS)

- METHOD
PEAK DEPTH= 0.00 FT
PEAK VELOCITY= 0.0 FPS
TRAVEL TIME = 0.0 MIN
SPAN= 10-20 HRS, dt=.05 HRS

POND 1 INFILTRATION FIELD

Qin = 10.13 CFS @ 12.06 HRS, VOLUME= .68 AF
Qout= 8.05 CFS @ 12.14 HRS, VOLUME= .67 AF, ATTEN= 21%, LAG= 4.6 MIN
Qpri= .68 CFS @ 11.80 HRS, VOLUME= .36 AF
Qsec= 7.37 CFS @ 12.14 HRS, VOLUME= .31 AF

ELEVATION (FT)	CUM.STOR (CF)
148.5	0
148.7	245
149.0	490
149.2	818
149.7	1631
150.0	2076
150.2	2535
150.5	2999
150.7	3464
151.0	3922
151.2	4367
151.5	4790
151.7	5180
152.0	5508

STOR-IND METHOD
PEAK STORAGE = 5400 CF
PEAK ELEVATION= 151.9 FT
FLOOD ELEVATION= 152.0 FT
START ELEVATION= 148.5 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 13.4 MIN (.67 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	148.5'	**EXFILTRATION** Q= .68 CFS at and above 148.6'
2	S	149.0'	**4" CULVERT X 2** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
3	S	149.8'	**8" CULVERT** n=.012 L=1' S=.05'/' Ke=.5 Cc=.9 Cd=.6
4	S	151.2'	**2' SHARP-CRESTED RECTANGULAR WEIR** Q=C L H^1.5 C=3.27+.4 H/2.3 L=Length-2(.1 H)

Primary Discharge
└─1=Exfiltration

Secondary Discharge
├─2=Culvert
├─3=Culvert
└─4=Sharp-Crested Rectangular Weir

POND 2 **DRYWELL**

Qin = 7.38 CFS @ 12.15 HRS, VOLUME= .31 AF
Qout= 7.06 CFS @ 12.14 HRS, VOLUME= .31 AF, ATTEN= 4%, LAG= 0.0 MIN
Qpri= .02 CFS @ 12.10 HRS, VOLUME= .01 AF
Qsec= 7.04 CFS @ 12.14 HRS, VOLUME= .30 AF

ELEVATION (FT)	CUM.STOR (CF)
142.8	0
143.8	31
144.8	80
145.8	128
146.8	177
147.8	225
148.8	273
149.8	322
150.0	322

STOR-IND METHOD
PEAK STORAGE = 323 CF
PEAK ELEVATION= 150.4 FT
FLOOD ELEVATION= 150.0 FT
START ELEVATION= 142.8 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= 5.4 MIN (.31 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	142.8'	**EXFILTRATION** Q= .02 CFS at and above 142.9'
2	S	149.8'	**24" HORIZONTAL ORIFICE/GRATE** Q=.6 Area SQR(2gH) (Limited to weir flow @ low head)

Primary Discharge
└─1=Exfiltration

Secondary Discharge
└─2=Orifice/Grate

POND 3 **CB-2 TO DMH-1**

Qin = 4.97 CFS @ 12.06 HRS, VOLUME= .33 AF
Qout= 4.94 CFS @ 12.06 HRS, VOLUME= .33 AF, ATTEN= 1%, LAG= .3 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
156.0	20	84	84
157.0	6484	3252	3336

STOR-IND METHOD
PEAK STORAGE = 43 CF
PEAK ELEVATION= 153.9 FT
FLOOD ELEVATION= 157.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .2 MIN (.33 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=15' S=.05'/' Ke=.5 Cc=.9 Cd=.6

POND 4 **CB1-DMH-1**

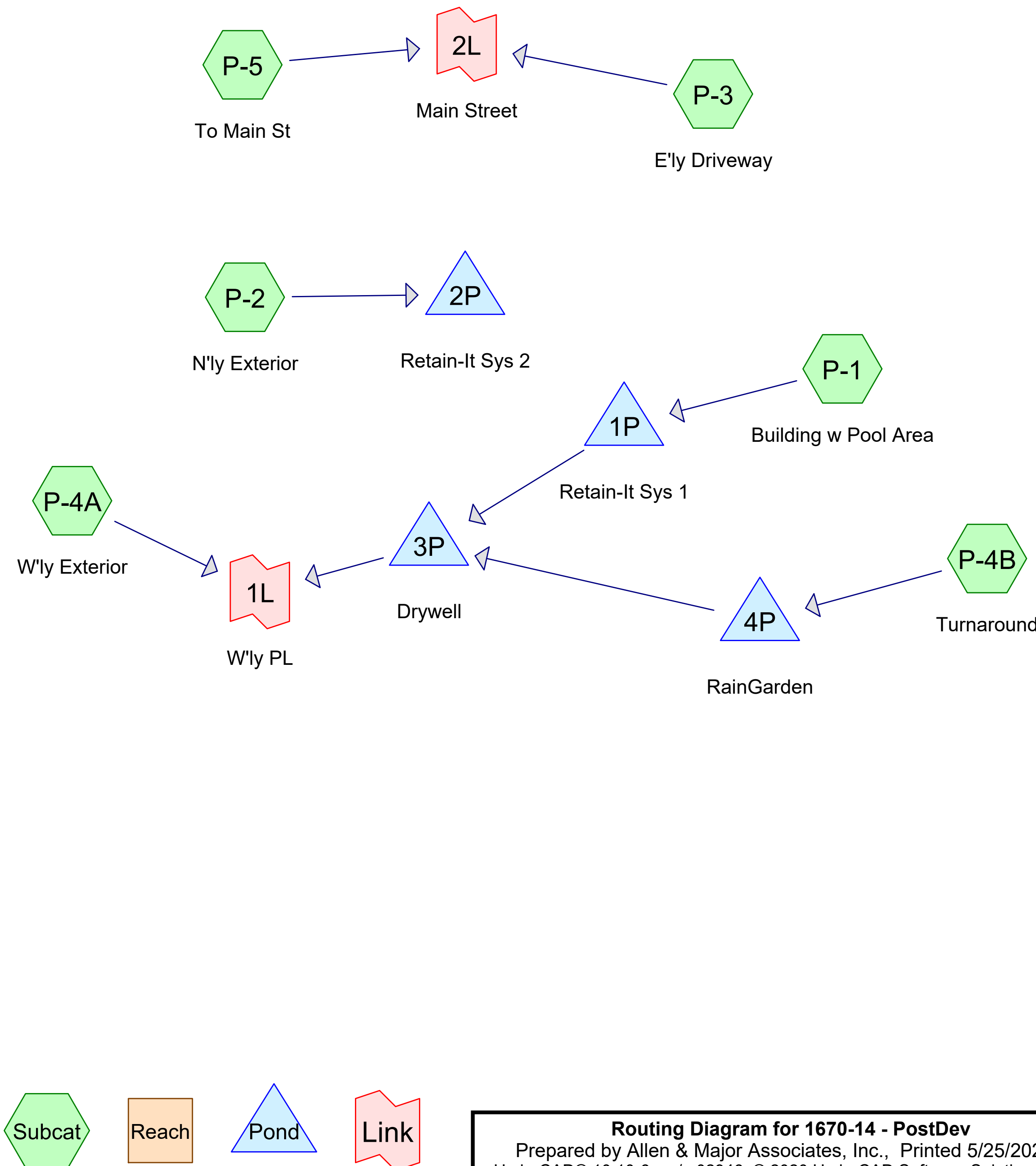
Qin = 3.64 CFS @ 12.06 HRS, VOLUME= .24 AF
Qout= 3.56 CFS @ 12.07 HRS, VOLUME= .24 AF, ATTEN= 2%, LAG= .6 MIN

ELEVATION (FT)	AREA (SF)	INC.STOR (CF)	CUM.STOR (CF)
151.7	20	0	0
155.2	20	69	69
156.0	602	248	317

STOR-IND METHOD
PEAK STORAGE = 38 CF
PEAK ELEVATION= 153.6 FT
FLOOD ELEVATION= 156.0 FT
START ELEVATION= 151.7 FT
SPAN= 10-20 HRS, dt=.05 HRS
Tdet= .3 MIN (.24 AF)

#	ROUTE	INVERT	OUTLET DEVICES
1	P	151.7'	**12" CULVERT** n=.012 L=150' S=.005'/' Ke=.5 Cc=.9 Cd=.6

POST-DEVELOPMENT



Routing Diagram for 1670-14 - PostDev
Prepared by Allen & Major Associates, Inc., Printed 5/25/2022
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Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr	Type III 24-hr		Default	24.00	1	3.16	2
2	10-yr	Type III 24-hr		Default	24.00	1	4.77	2
3	25-yr	Type III 24-hr		Default	24.00	1	6.03	2
4	100-yr	Type III 24-hr		Default	24.00	1	8.61	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.030	39	>75% Grass cover, Good, HSG A (P-4A)
0.385	61	>75% Grass cover, Good, HSG B (P-2, P-3, P-4A, P-4B, P-5)
0.430	98	Paved parking, HSG B (P-2, P-3, P-4B)
0.014	98	Roofs, HSG A (P-1)
1.280	98	Roofs, HSG B (P-1)
0.014	98	Unconnected pavement, HSG A (P-4A)
0.024	98	Unconnected pavement, HSG B (P-4A)
0.049	55	Woods, Good, HSG B (P-4A)
2.226	**90**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.059	HSG A	P-1, P-4A
2.167	HSG B	P-1, P-2, P-3, P-4A, P-4B, P-5
0.000	HSG C	
0.000	HSG D	
0.000	Other	
2.226		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.030	0.385	0.000	0.000	0.000	0.415	>75% Grass cover, Good	P-2, P-3, P-4A, P-4B, P-5
0.000	0.430	0.000	0.000	0.000	0.430	Paved parking	P-2, P-3, P-4B
0.014	1.280	0.000	0.000	0.000	1.294	Roofs	P-1
0.014	0.024	0.000	0.000	0.000	0.038	Unconnected pavement	P-4A
0.000	0.049	0.000	0.000	0.000	0.049	Woods, Good	P-4A
0.059	**2.167**	**0.000**	**0.000**	**0.000**	**2.226**	**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	152.80	152.00	16.0	0.0500	0.012	0.0	12.0	0.0
2	4P	169.00	168.00	25.0	0.0400	0.012	0.0	12.0	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 P-1: Building w Pool Area Runoff Area=56,366 sf 100.00% Impervious Runoff Depth>2.93"
Tc=6.0 min CN=98 Runoff=3.88 cfs 0.315 af

Subcatchment P-2: N'ly Exterior Runoff Area=13,123 sf 49.13% Impervious Runoff Depth>1.31"
Tc=6.0 min CN=79 Runoff=0.45 cfs 0.033 af

Subcatchment P-3: E'ly Driveway Runoff Area=8,294 sf 84.99% Impervious Runoff Depth>2.31"
Tc=6.0 min CN=92 Runoff=0.49 cfs 0.037 af

Subcatchment P-4A: W'ly Exterior Runoff Area=11,107 sf 15.03% Impervious Runoff Depth>0.39"
Tc=0.0 min UI Adjusted CN=60 Runoff=0.08 cfs 0.008 af

Subcatchment P-4B: Turnaround Runoff Area=7,008 sf 74.53% Impervious Runoff Depth>2.05"
Tc=0.0 min CN=89 Runoff=0.44 cfs 0.027 af

Subcatchment P-5: To Main St Runoff Area=1,078 sf 0.00% Impervious Runoff Depth>0.43"
Tc=6.0 min CN=61 Runoff=0.01 cfs 0.001 af

Pond 1P: Retain-It Sys 1 Peak Elev=150.11' Storage=6,640 cf Inflow=3.88 cfs 0.315 af
Discarded=0.18 cfs 0.249 af Primary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.249 af

Pond 2P: Retain-It Sys 2 Peak Elev=143.85' Storage=575 cf Inflow=0.45 cfs 0.033 af
Outflow=0.04 cfs 0.033 af

Pond 3P: Drywell Peak Elev=149.80' Storage=318 cf Inflow=0.63 cfs 0.013 af
Discarded=0.02 cfs 0.012 af Primary=0.05 cfs 0.001 af Outflow=0.07 cfs 0.013 af

Pond 4P: RainGarden Peak Elev=174.29' Storage=226 cf Inflow=0.44 cfs 0.027 af
Discarded=0.01 cfs 0.012 af Primary=0.63 cfs 0.013 af Outflow=0.64 cfs 0.024 af

Link 1L: W'ly PL Inflow=0.08 cfs 0.009 af
Primary=0.08 cfs 0.009 af

Link 2L: Main Street Inflow=0.50 cfs 0.038 af
Primary=0.50 cfs 0.038 af

Total Runoff Area = 2.226 ac Runoff Volume = 0.422 af Average Runoff Depth = 2.27"
20.85% Pervious = 0.464 ac 79.15% Impervious = 1.762 ac

Summary for Subcatchment P-1: Building w Pool Area

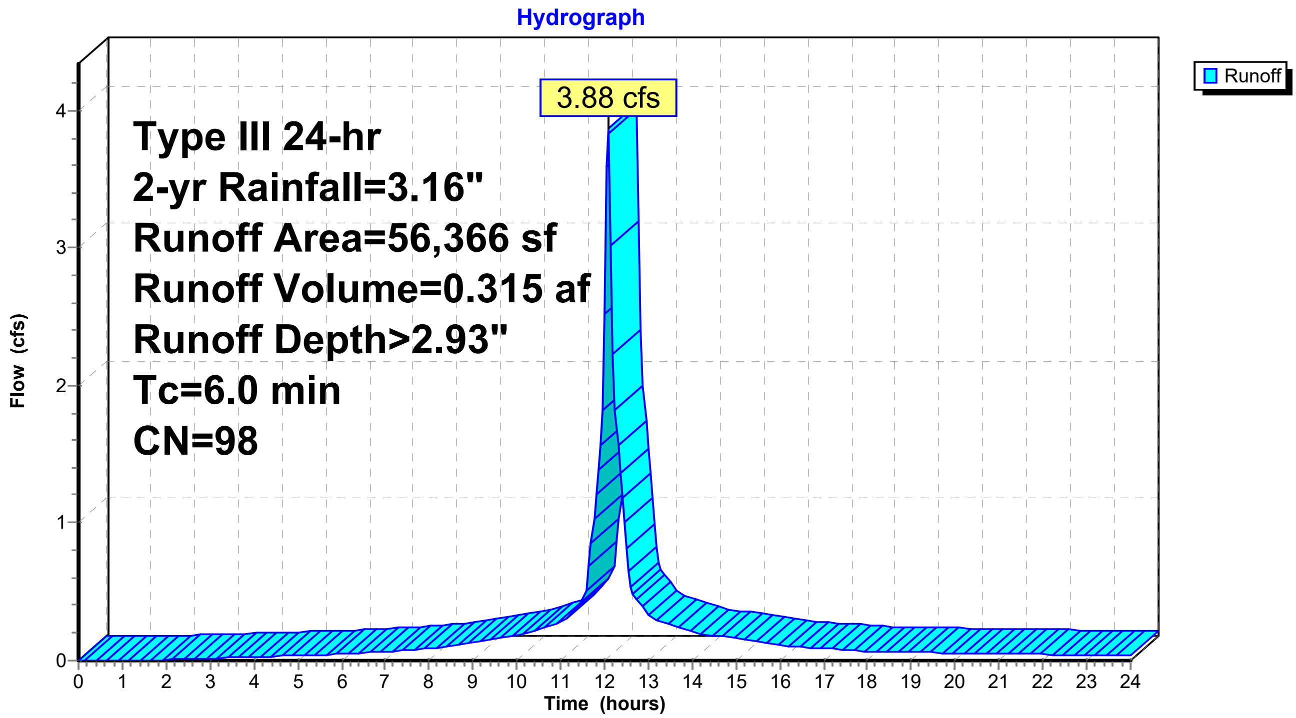
Runoff = 3.88 cfs @ 12.09 hrs, Volume= 0.315 af, Depth> 2.93"
Routed to Pond 1P : Retain-It Sys 1

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-yr Rainfall=3.16"

Area (sf)	CN	Description
629	98	Roofs, HSG A
55,737	98	Roofs, HSG B
56,366	98	Weighted Average
56,366		100.00% Impervious Area

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

Subcatchment P-1: Building w Pool Area



Summary for Subcatchment P-2: N'ly Exterior

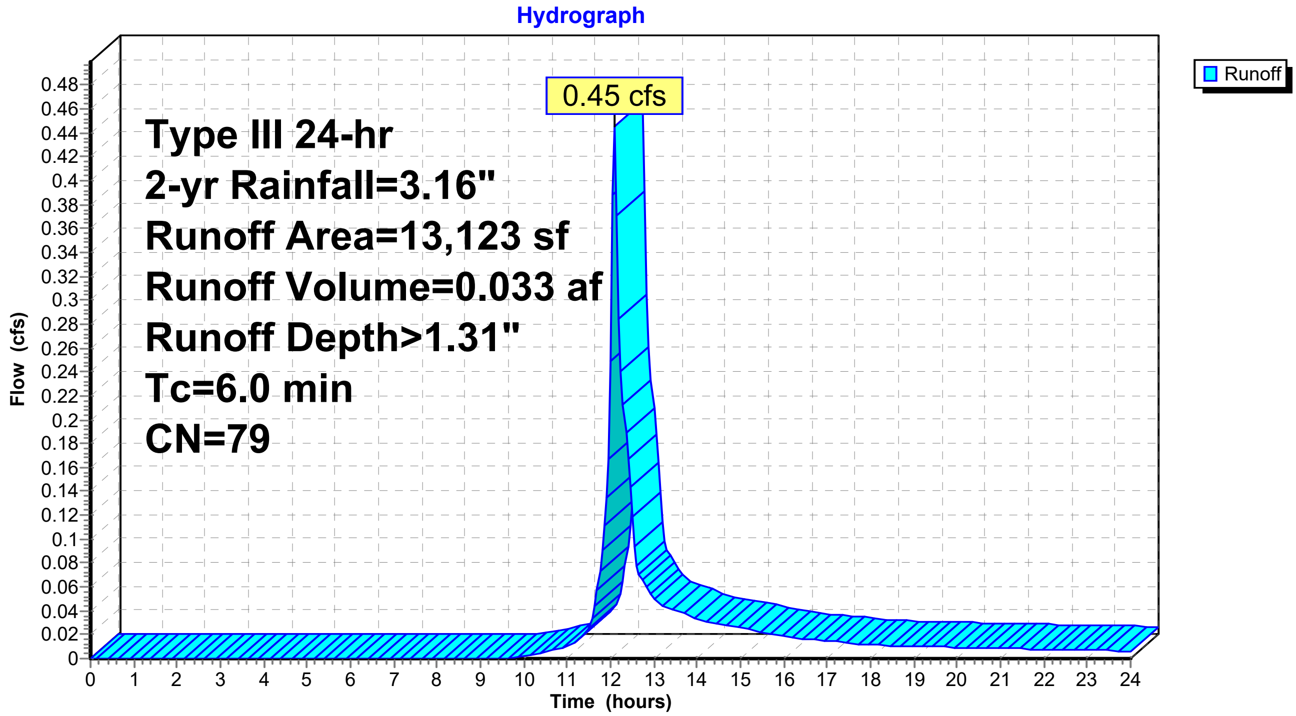
Runoff = 0.45 cfs @ 12.10 hrs, Volume= 0.033 af, Depth> 1.31"
Routed to Pond 2P : Retain-It Sys 2

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-yr Rainfall=3.16"

Area (sf)	CN	Description
6,676	61	>75% Grass cover, Good, HSG B
6,447	98	Paved parking, HSG B
13,123	79	Weighted Average
6,676		50.87% Pervious Area
6,447		49.13% Impervious Area

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

Subcatchment P-2: N'ly Exterior



Summary for Subcatchment P-3: E'ly Driveway

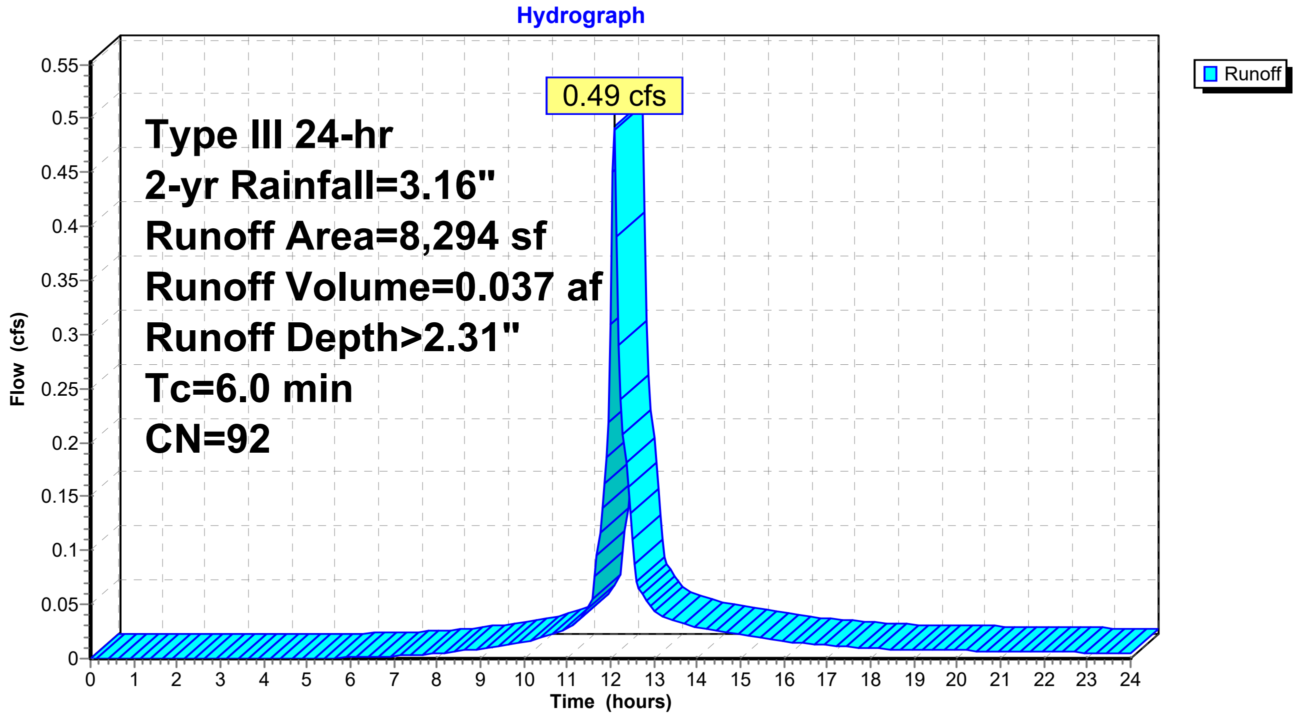
Runoff = 0.49 cfs @ 12.09 hrs, Volume= 0.037 af, Depth> 2.31"
Routed to Link 2L : Main Street

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-yr Rainfall=3.16"

Area (sf)	CN	Description
1,245	61	>75% Grass cover, Good, HSG B
7,049	98	Paved parking, HSG B
8,294	92	Weighted Average
1,245		15.01% Pervious Area
7,049		84.99% Impervious Area

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

Subcatchment P-3: E'ly Driveway



Summary for Subcatchment P-4A: W'ly Exterior

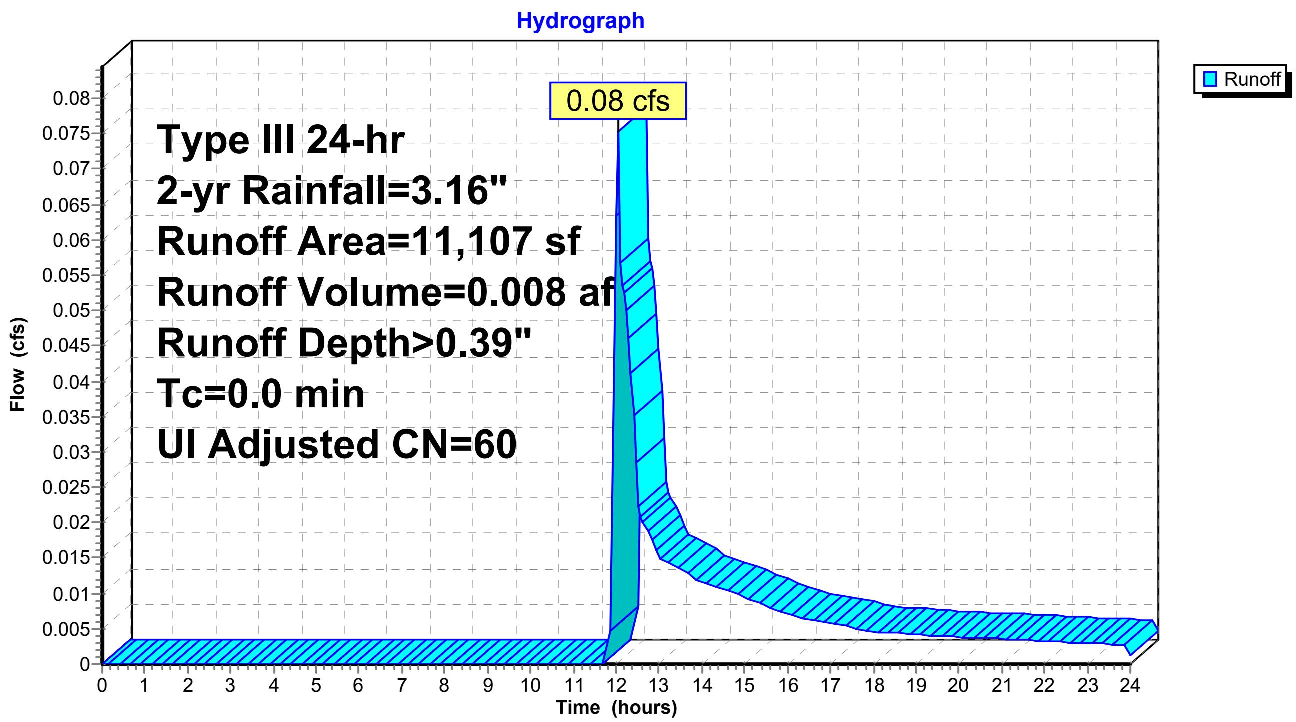
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.08 cfs @ 12.04 hrs, Volume= 0.008 af, Depth> 0.39"
Routed to Link 1L : W'ly PL

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-yr Rainfall=3.16"

Area (sf)	CN	Adj	Description
2,135	55		Woods, Good, HSG B
1,328	39		>75% Grass cover, Good, HSG A
5,975	61		>75% Grass cover, Good, HSG B
611	98		Unconnected pavement, HSG A
1,058	98		Unconnected pavement, HSG B
11,107	63	60	Weighted Average, UI Adjusted
9,438			84.97% Pervious Area
1,669			15.03% Impervious Area
1,669			100.00% Unconnected

Subcatchment P-4A: W'ly Exterior



Summary for Subcatchment P-4B: Turnaround

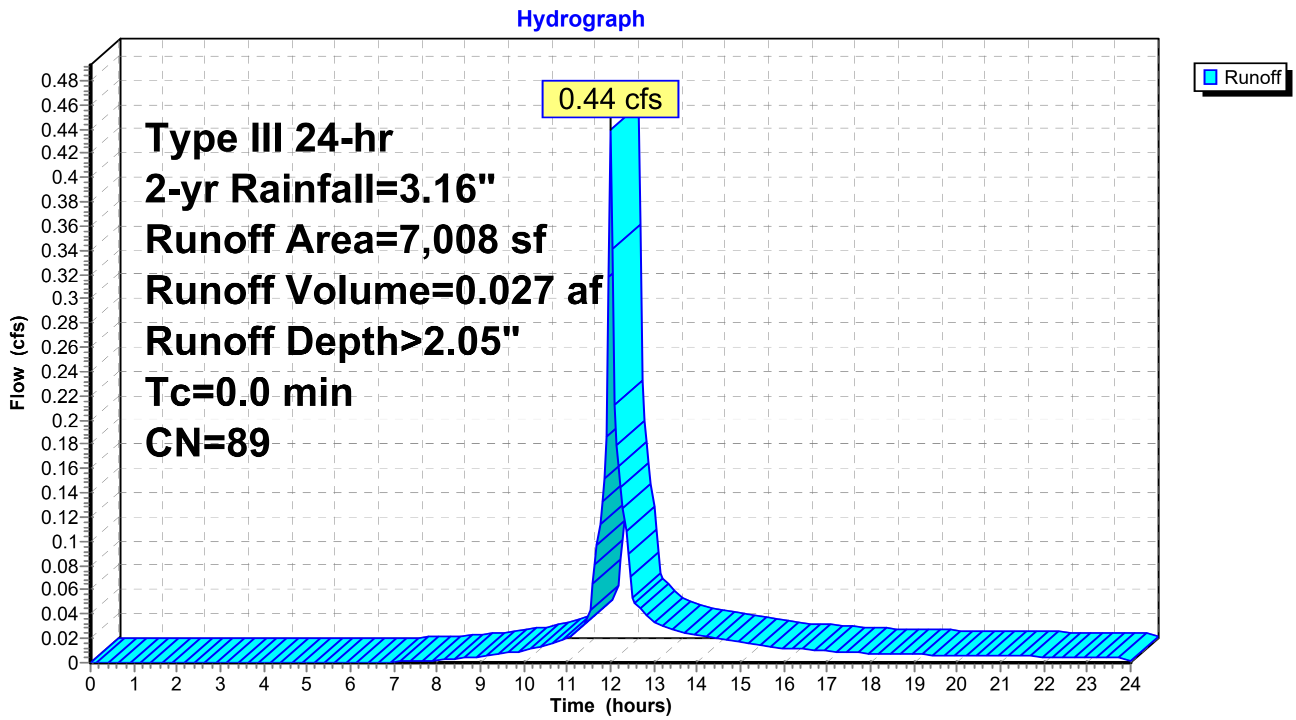
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.44 cfs @ 12.00 hrs, Volume= 0.027 af, Depth> 2.05"
Routed to Pond 4P : RainGarden

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-yr Rainfall=3.16"

Area (sf)	CN	Description
1,785	61	>75% Grass cover, Good, HSG B
5,223	98	Paved parking, HSG B
7,008	89	Weighted Average
1,785		25.47% Pervious Area
5,223		74.53% Impervious Area

Subcatchment P-4B: Turnaround



Summary for Subcatchment P-5: To Main St

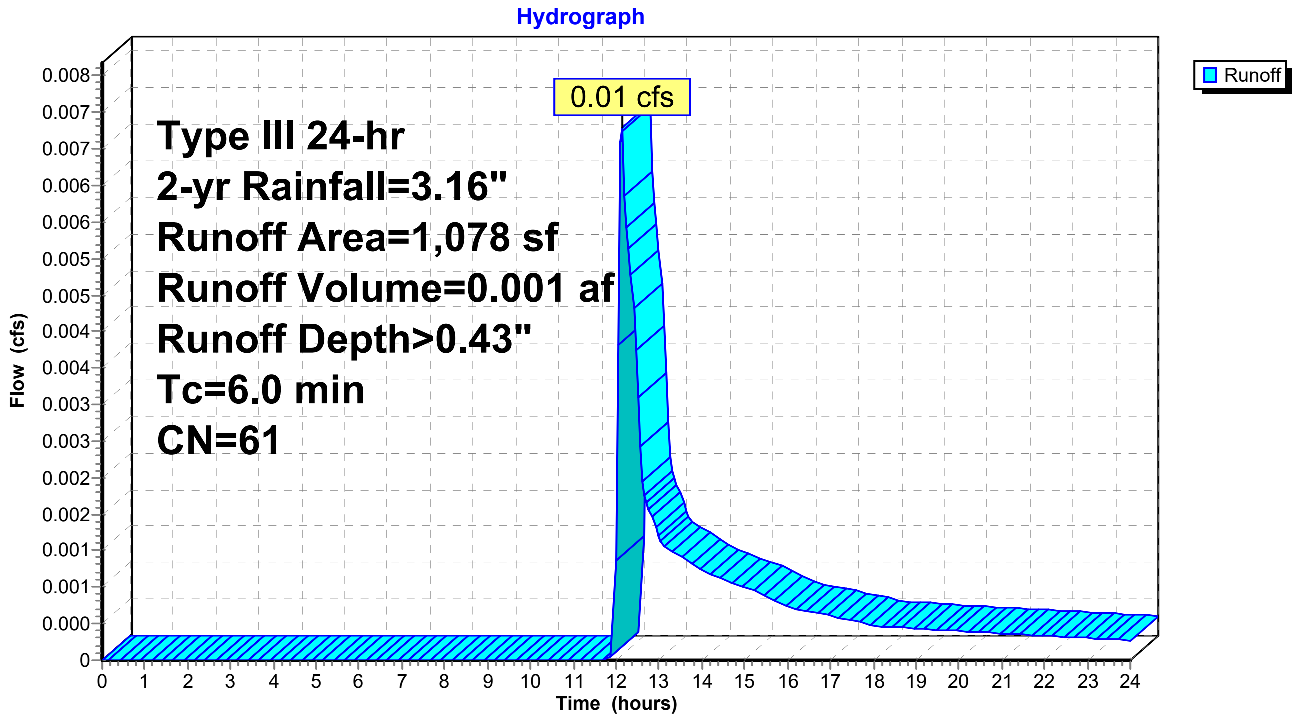
Runoff = 0.01 cfs @ 12.13 hrs, Volume= 0.001 af, Depth> 0.43"
Routed to Link 2L : Main Street

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-yr Rainfall=3.16"

Area (sf)	CN	Description
1,078	61	>75% Grass cover, Good, HSG B
1,078		100.00% Pervious Area

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

Subcatchment P-5: To Main St



Summary for Pond 1P: Retain-It Sys 1

Inflow Area = 1.294 ac,100.00% Impervious, Inflow Depth > 2.93" for 2-yr event
Inflow = 3.88 cfs @ 12.09 hrs, Volume= 0.315 af
Outflow = 0.18 cfs @ 10.30 hrs, Volume= 0.249 af, Atten= 95%, Lag= 0.0 min
Discarded = 0.18 cfs @ 10.30 hrs, Volume= 0.249 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 150.11' @ 14.50 hrs Surf.Area= 7,700 sf Storage= 6,640 cf

Plug-Flow detention time= 256.0 min calculated for 0.248 af (79% of inflow)
Center-of-Mass det. time= 178.3 min (934.5 - 756.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	148.50'	6,607 cf	**10.00'W x 770.00'L x 6.67'H Field A** 51,333 cf Overall - 34,816 cf Embedded = 16,517 cf x 40.0% Voids
#2A	149.50'	25,947 cf	**retain_it retain_it 5.0'** x 96 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 1 Rows adjusted for 2,015.7 cf perimeter wall
		32,554 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	148.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.80'	**12.0" Round Culvert** L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.80' / 152.00' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	153.50'	**7.0' 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=0.18 cfs @ 10.30 hrs HW=148.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=148.50' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Retain-It Sys 1 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 5.0' (retain-it®)
Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf
Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf
1 Rows adjusted for 2,015.7 cf perimeter wall

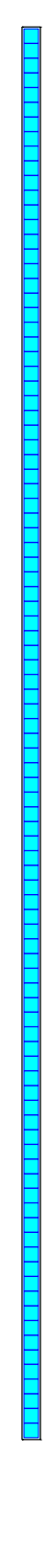
96 Chambers/Row x 8.00' Long = 768.00' Row Length +12.0" End Stone x 2 = 770.00' Base Length
1 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 10.00' Base Width
12.0" Stone Base + 68.0" Chamber Height = 6.67' Field Height

10.4 cf Sidewall x 96 x 2 + 10.4 cf Endwall x 1 x 2 = 2,015.7 cf Perimeter Wall
96 Chambers x 291.3 cf - 2,015.7 cf Perimeter wall = 25,947.2 cf Chamber Storage
96 Chambers x 362.7 cf = 34,816.0 cf Displacement

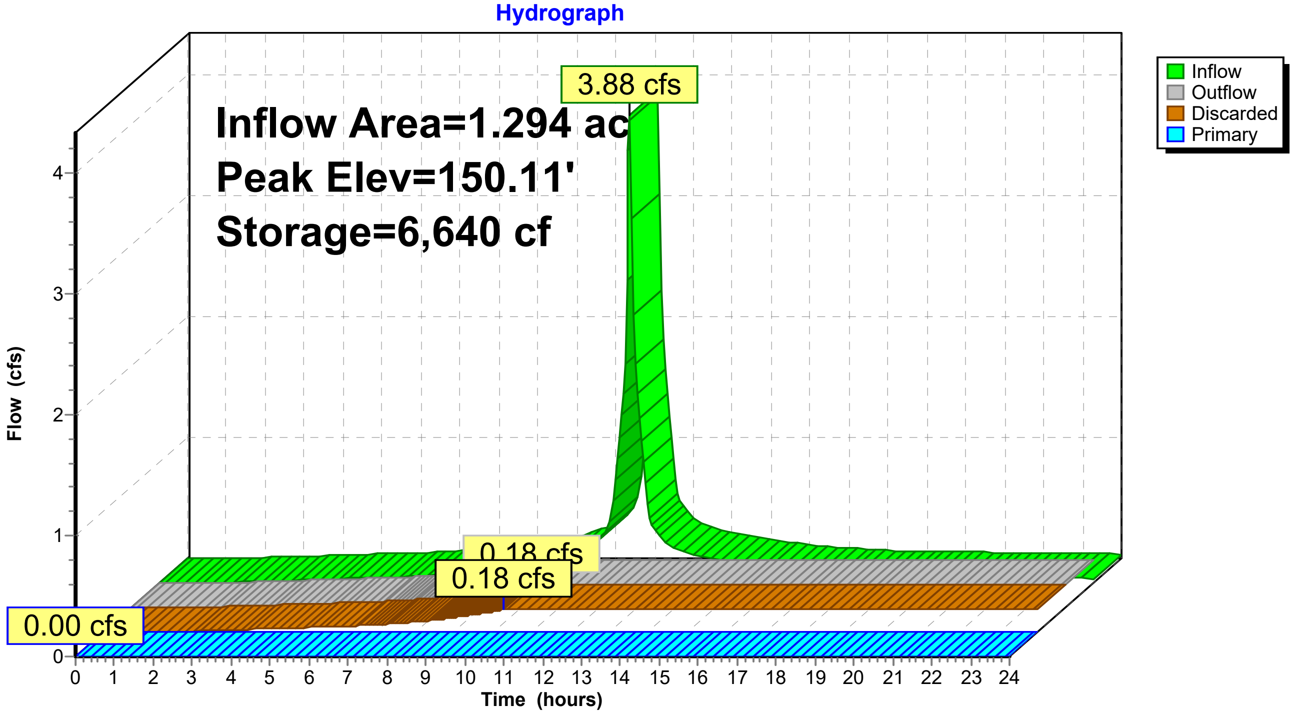
51,333.3 cf Field - 34,816.0 cf Chambers = 16,517.3 cf Stone x 40.0% Voids = 6,606.9 cf Stone Storage

Chamber Storage + Stone Storage = 32,554.2 cf = 0.747 af
Overall Storage Efficiency = 63.4%
Overall System Size = 770.00' x 10.00' x 6.67'

96 Chambers
1,901.2 cy Field
611.8 cy Stone



Pond 1P: Retain-It Sys 1



Summary for Pond 2P: Retain-It Sys 2

Inflow Area = 0.301 ac, 49.13% Impervious, Inflow Depth > 1.31" for 2-yr event
Inflow = 0.45 cfs @ 12.10 hrs, Volume= 0.033 af
Outflow = 0.04 cfs @ 11.80 hrs, Volume= 0.033 af, Atten= 91%, Lag= 0.0 min
Discarded = 0.04 cfs @ 11.80 hrs, Volume= 0.033 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 143.85' @ 13.51 hrs Surf.Area= 1,700 sf Storage= 575 cf

Plug-Flow detention time= 137.8 min calculated for 0.033 af (99% of inflow)
Center-of-Mass det. time= 135.2 min (981.2 - 846.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	143.00'	953 cf	**50.00'W x 34.00'L x 5.17'H Field A**
			8,783 cf Overall - 6,400 cf Embedded = 2,383 cf x 40.0% Voids
#2A	144.00'	4,696 cf	**retain_it retain_it 3.5'** x 24 Inside #1
			Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
			Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
			6 Rows adjusted for 122.8 cf perimeter wall
		5,649 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	143.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 11.80 hrs HW=143.06' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Pond 2P: Retain-It Sys 2 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 3.5' (retain-it®)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
6 Rows adjusted for 122.8 cf perimeter wall

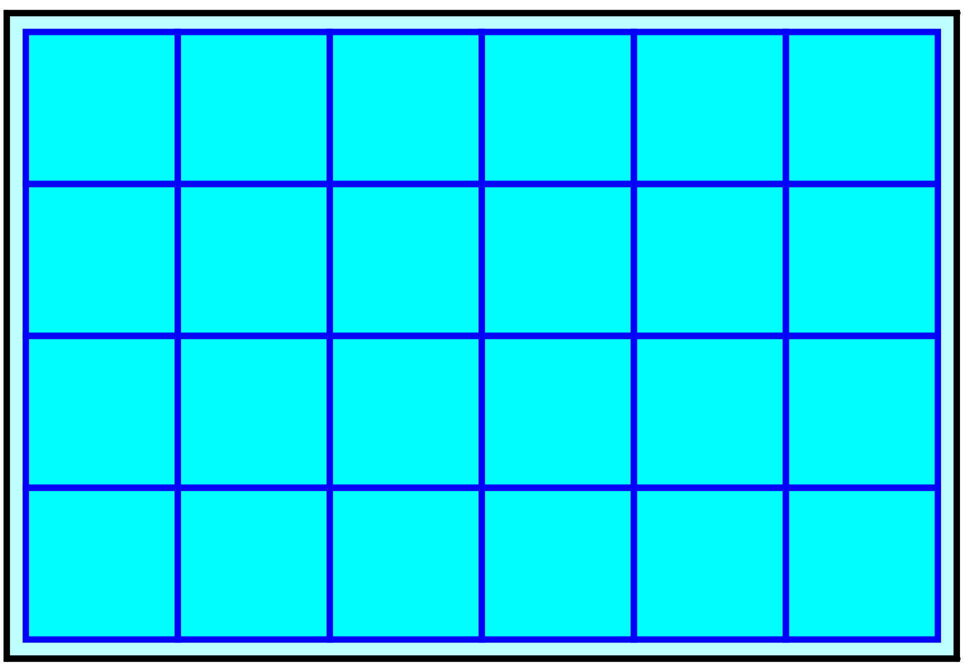
4 Chambers/Row x 8.00' Long = 32.00' Row Length +12.0" End Stone x 2 = 34.00' Base Length
6 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 50.00' Base Width
12.0" Stone Base + 50.0" Chamber Height = 5.17' Field Height

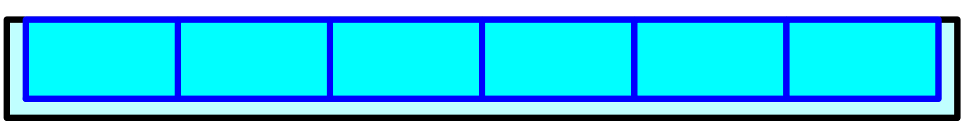
6.1 cf Sidewall x 4 x 2 + 6.1 cf Endwall x 6 x 2 = 122.8 cf Perimeter Wall
24 Chambers x 200.8 cf - 122.8 cf Perimeter wall = 4,695.9 cf Chamber Storage
24 Chambers x 266.7 cf = 6,400.0 cf Displacement

8,783.3 cf Field - 6,400.0 cf Chambers = 2,383.3 cf Stone x 40.0% Voids = 953.3 cf Stone Storage

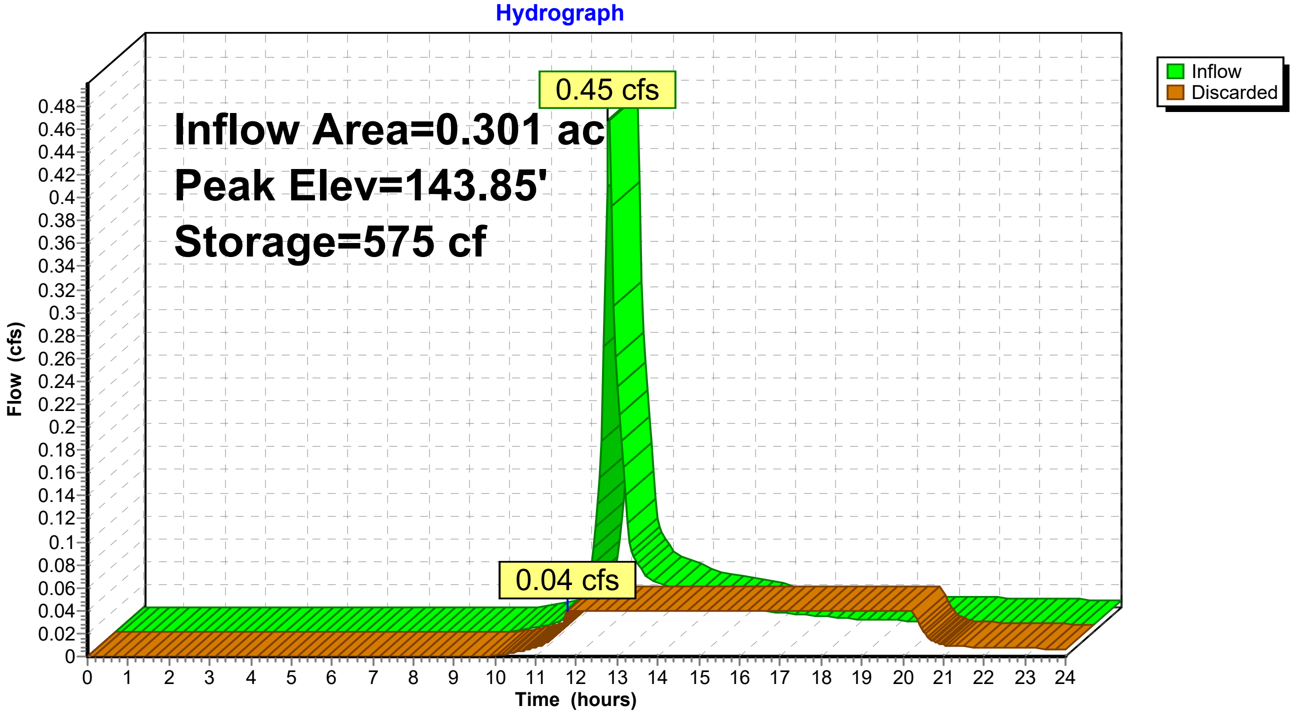
Chamber Storage + Stone Storage = 5,649.3 cf = 0.130 af
Overall Storage Efficiency = 64.3%
Overall System Size = 34.00' x 50.00' x 5.17'

24 Chambers
325.3 cy Field
88.3 cy Stone





Pond 2P: Retain-It Sys 2



Summary for Pond 3P: Drywell

Inflow Area = 1.455 ac, 97.18% Impervious, Inflow Depth = 0.10" for 2-yr event
Inflow = 0.63 cfs @ 12.00 hrs, Volume= 0.013 af
Outflow = 0.07 cfs @ 12.55 hrs, Volume= 0.013 af, Atten= 89%, Lag= 32.8 min
Discarded = 0.02 cfs @ 11.95 hrs, Volume= 0.012 af
Primary = 0.05 cfs @ 12.55 hrs, Volume= 0.001 af
Routed to Link 1L : W'ly PL

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 149.80' @ 12.55 hrs Storage= 318 cf

Plug-Flow detention time= 163.7 min calculated for 0.012 af (100% of inflow)
Center-of-Mass det. time= 163.6 min (923.6 - 760.0)

Volume	Invert	Avail.Storage	Storage Description
#1	142.80'	323 cf	**Custom Stage Data** Listed below

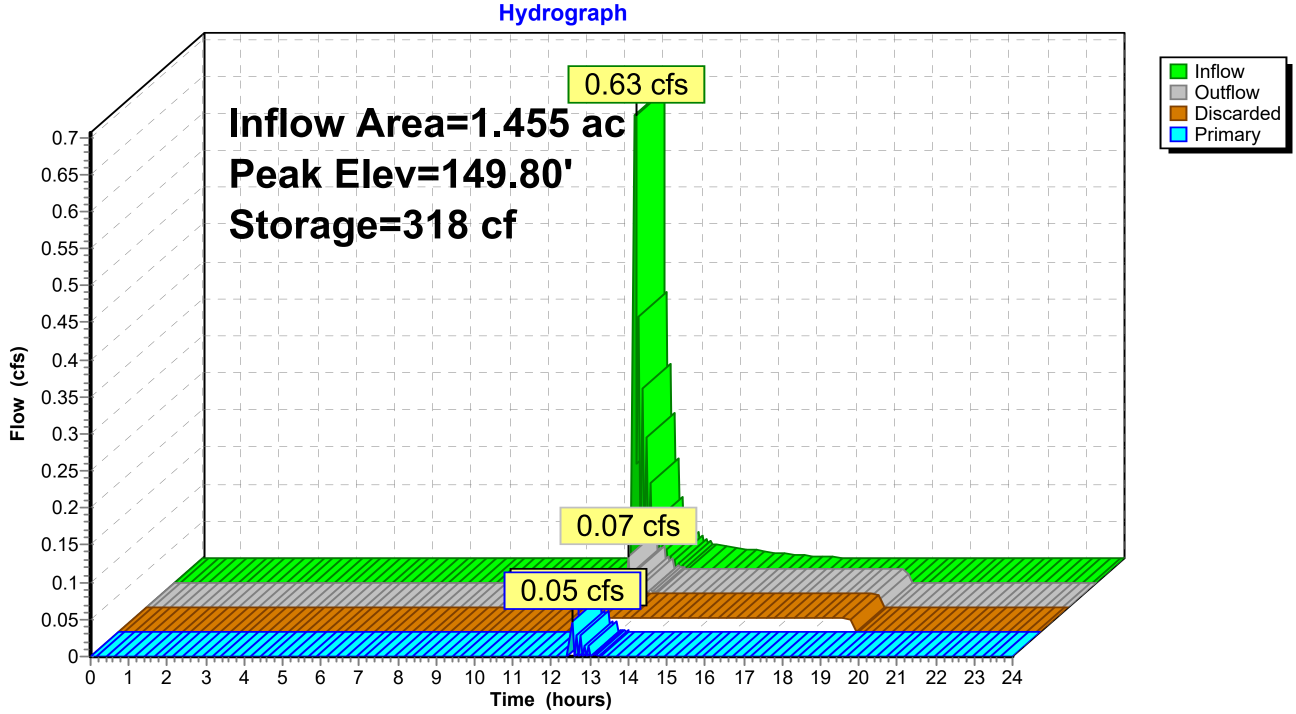
Elevation (feet)	Cum.Store (cubic-feet)
142.80	0
143.80	31
144.80	80
145.80	128
146.80	177
147.80	225
148.80	273
149.90	322
150.00	323

Device	Routing	Invert	Outlet Devices
#1	Discarded	142.80'	**0.02 cfs Exfiltration at all elevations**
#2	Primary	149.80'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 11.95 hrs HW=142.96' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.01 cfs @ 12.55 hrs HW=149.80' (Free Discharge)
└─**2=Orifice/Grate** (Weir Controls 0.01 cfs @ 0.16 fps)

Pond 3P: Drywell



Summary for Pond 4P: RainGarden

[88] Warning: Qout>Qin may require smaller dt or Finer Routing
[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=11)

Inflow Area = 0.161 ac, 74.53% Impervious, Inflow Depth > 2.05" for 2-yr event
Inflow = 0.44 cfs @ 12.00 hrs, Volume= 0.027 af
Outflow = 0.64 cfs @ 12.00 hrs, Volume= 0.024 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.01 cfs @ 12.00 hrs, Volume= 0.012 af
Primary = 0.63 cfs @ 12.00 hrs, Volume= 0.013 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 174.29' @ 12.00 hrs Surf.Area= 395 sf Storage= 226 cf

Plug-Flow detention time= 115.2 min calculated for 0.024 af (89% of inflow)
Center-of-Mass det. time= 61.5 min (867.5 - 806.0)

Volume	Invert	Avail.Storage	Storage Description
#1	172.00'	904 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

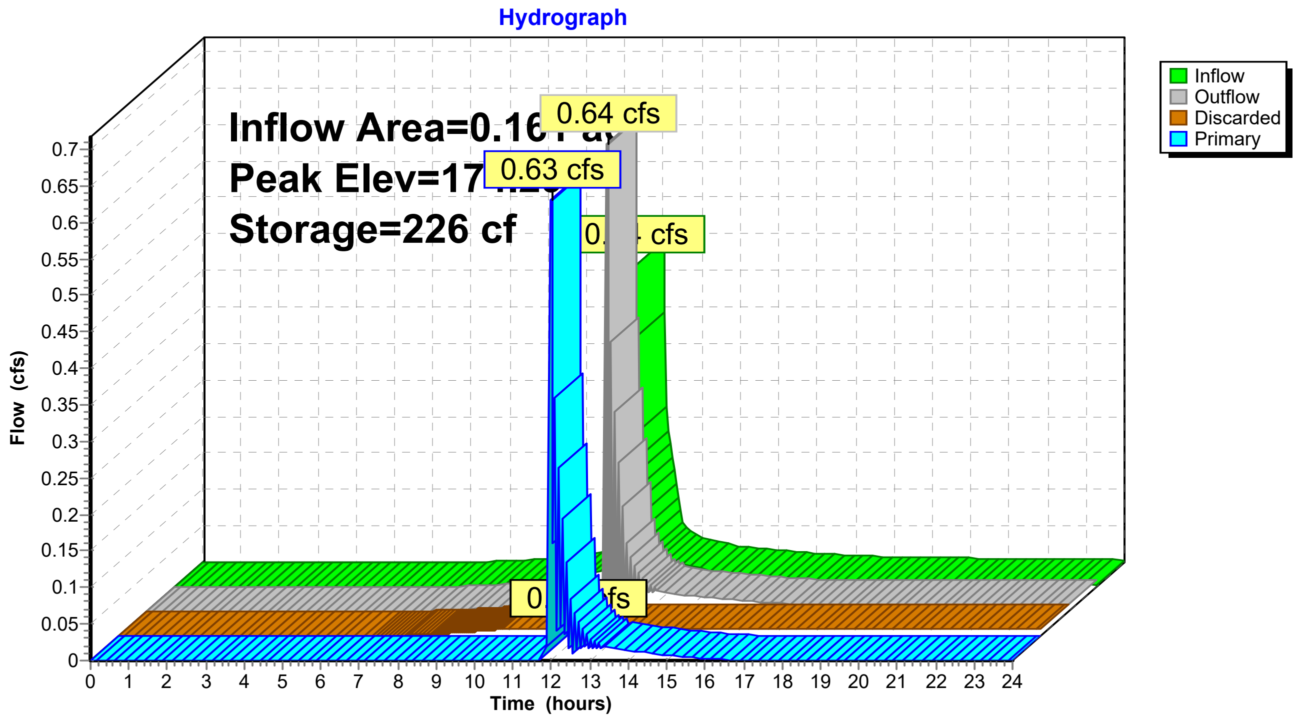
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
172.00	394	0.0	0	0
174.50	395	25.0	247	247
175.50	919	100.0	657	904

Device	Routing	Invert	Outlet Devices
#1	Discarded	172.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	169.00'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 169.00' / 168.00' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	174.25'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.00 hrs HW=174.29' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.56 cfs @ 12.00 hrs HW=174.29' (Free Discharge)
└─**2=Culvert** (Passes 0.56 cfs of 8.27 cfs potential flow)
  └─**3=Orifice/Grate** (Weir Controls 0.56 cfs @ 0.63 fps)

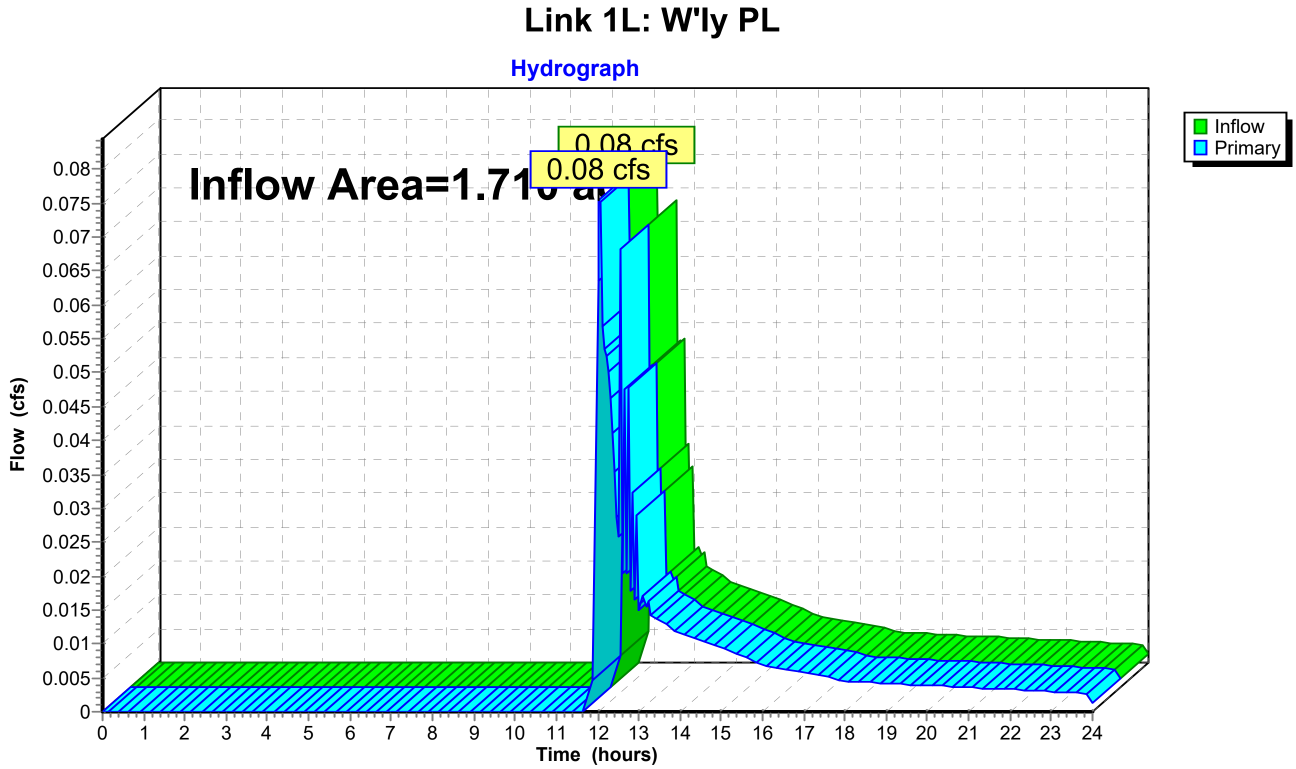
Pond 4P: RainGarden



Summary for Link 1L: W'ly PL

Inflow Area =	1.710 ac, 84.93% Impervious, Inflow Depth > 0.06"		for 2-yr event
Inflow =	0.08 cfs @ 12.04 hrs, Volume=	0.009 af	
Primary =	0.08 cfs @ 12.04 hrs, Volume=	0.009 af, Atten= 0%, Lag= 0.0 min	

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

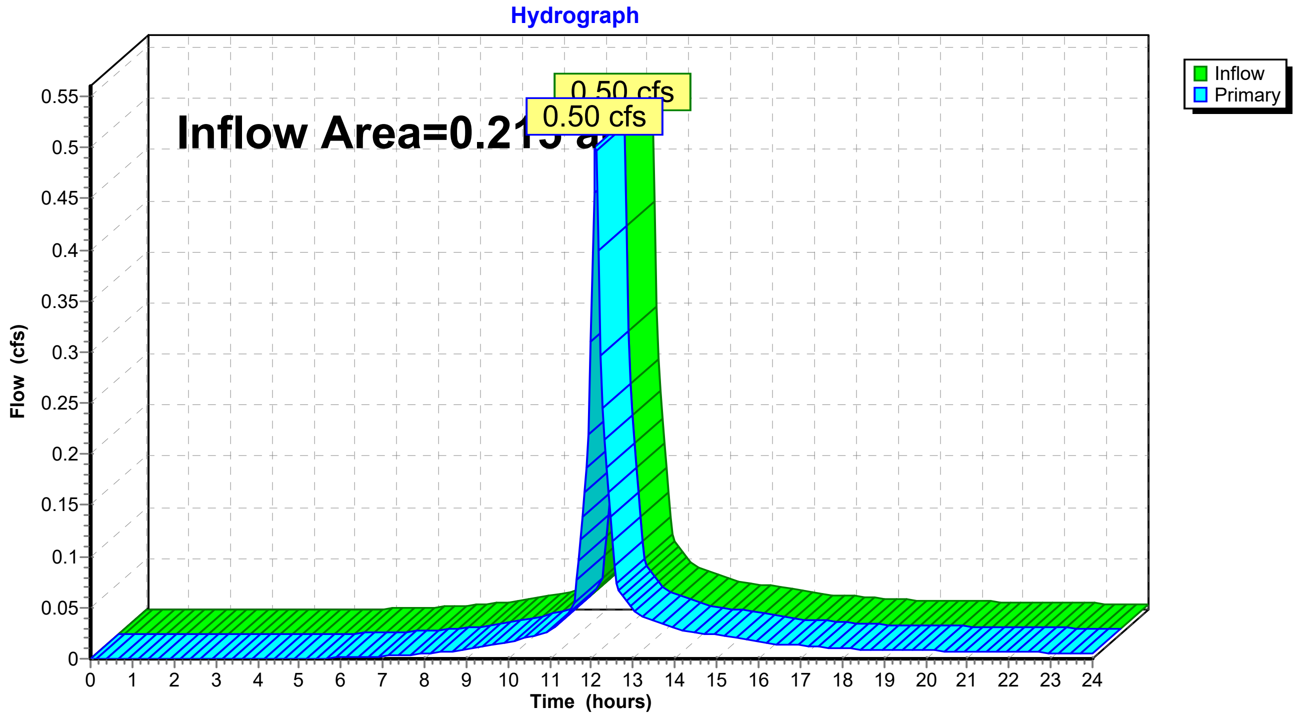


Summary for Link 2L: Main Street

Inflow Area = 0.215 ac, 75.21% Impervious, Inflow Depth > 2.09" for 2-yr event
Inflow = 0.50 cfs @ 12.09 hrs, Volume= 0.038 af
Primary = 0.50 cfs @ 12.09 hrs, Volume= 0.038 af, Atten= 0%, Lag= 0.0 min

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

Link 2L: Main Street



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 P-1: Building w Pool Area Runoff Area=56,366 sf 100.00% Impervious Runoff Depth>4.53"
Tc=6.0 min CN=98 Runoff=5.89 cfs 0.489 af

Subcatchment P-2: N'ly Exterior Runoff Area=13,123 sf 49.13% Impervious Runoff Depth>2.60"
Tc=6.0 min CN=79 Runoff=0.90 cfs 0.065 af

Subcatchment P-3: E'ly Driveway Runoff Area=8,294 sf 84.99% Impervious Runoff Depth>3.86"
Tc=6.0 min CN=92 Runoff=0.80 cfs 0.061 af

Subcatchment P-4A: W'ly Exterior Runoff Area=11,107 sf 15.03% Impervious Runoff Depth>1.17"
Tc=0.0 min UI Adjusted CN=60 Runoff=0.35 cfs 0.025 af

Subcatchment P-4B: Turnaround Runoff Area=7,008 sf 74.53% Impervious Runoff Depth>3.55"
Tc=0.0 min CN=89 Runoff=0.75 cfs 0.048 af

Subcatchment P-5: To Main St Runoff Area=1,078 sf 0.00% Impervious Runoff Depth>1.23"
Tc=6.0 min CN=61 Runoff=0.03 cfs 0.003 af

Pond 1P: Retain-It Sys 1 Peak Elev=151.05' Storage=12,061 cf Inflow=5.89 cfs 0.489 af
Discarded=0.18 cfs 0.273 af Primary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.273 af

Pond 2P: Retain-It Sys 2 Peak Elev=144.60' Storage=1,526 cf Inflow=0.90 cfs 0.065 af
Outflow=0.04 cfs 0.045 af

Pond 3P: Drywell Peak Elev=149.83' Storage=319 cf Inflow=0.71 cfs 0.030 af
Discarded=0.02 cfs 0.015 af Primary=0.68 cfs 0.015 af Outflow=0.70 cfs 0.030 af

Pond 4P: RainGarden Peak Elev=174.29' Storage=226 cf Inflow=0.75 cfs 0.048 af
Discarded=0.01 cfs 0.013 af Primary=0.71 cfs 0.030 af Outflow=0.72 cfs 0.043 af

Link 1L: W'ly PL Inflow=1.06 cfs 0.040 af
Primary=1.06 cfs 0.040 af

Link 2L: Main Street Inflow=0.83 cfs 0.064 af
Primary=0.83 cfs 0.064 af

Total Runoff Area = 2.226 ac Runoff Volume = 0.690 af Average Runoff Depth = 3.72"
20.85% Pervious = 0.464 ac 79.15% Impervious = 1.762 ac

Summary for Subcatchment P-1: Building w Pool Area

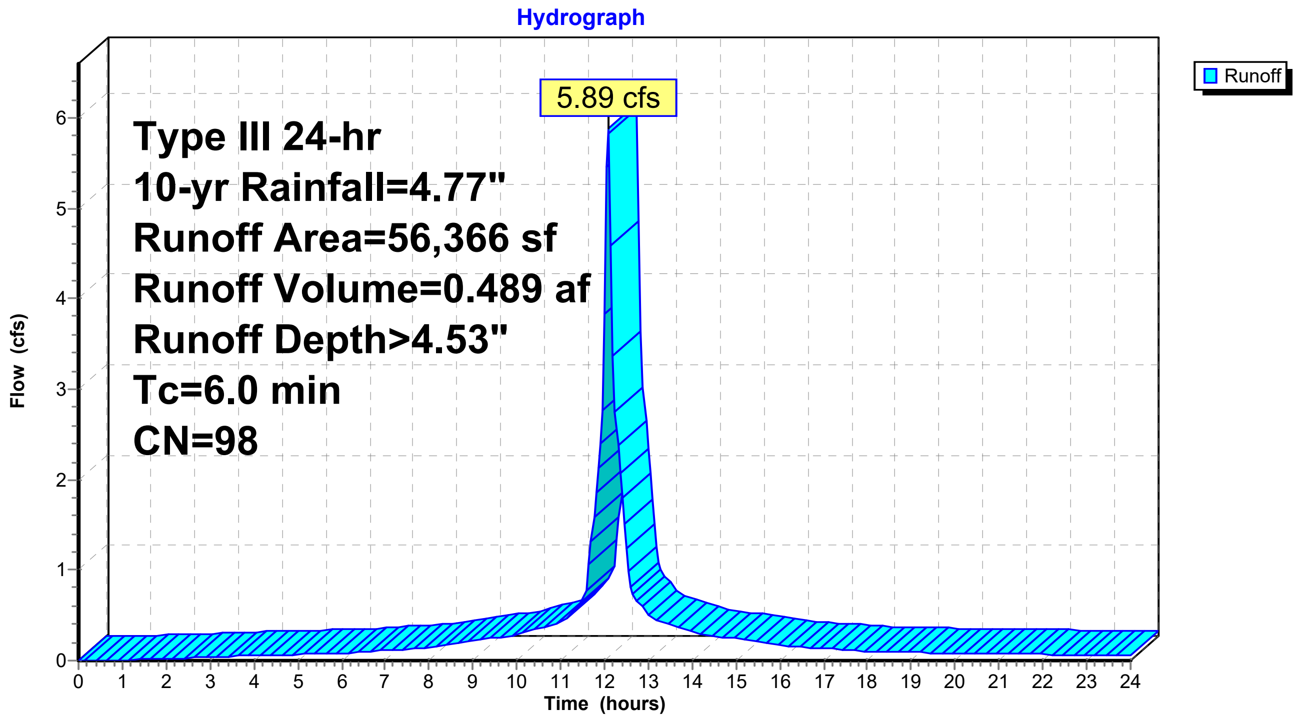
Runoff = 5.89 cfs @ 12.09 hrs, Volume= 0.489 af, Depth> 4.53"
Routed to Pond 1P : Retain-It Sys 1

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-yr Rainfall=4.77"

Area (sf)	CN	Description
629	98	Roofs, HSG A
55,737	98	Roofs, HSG B
56,366	98	Weighted Average
56,366		100.00% Impervious Area

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

Subcatchment P-1: Building w Pool Area



Summary for Subcatchment P-2: N'ly Exterior

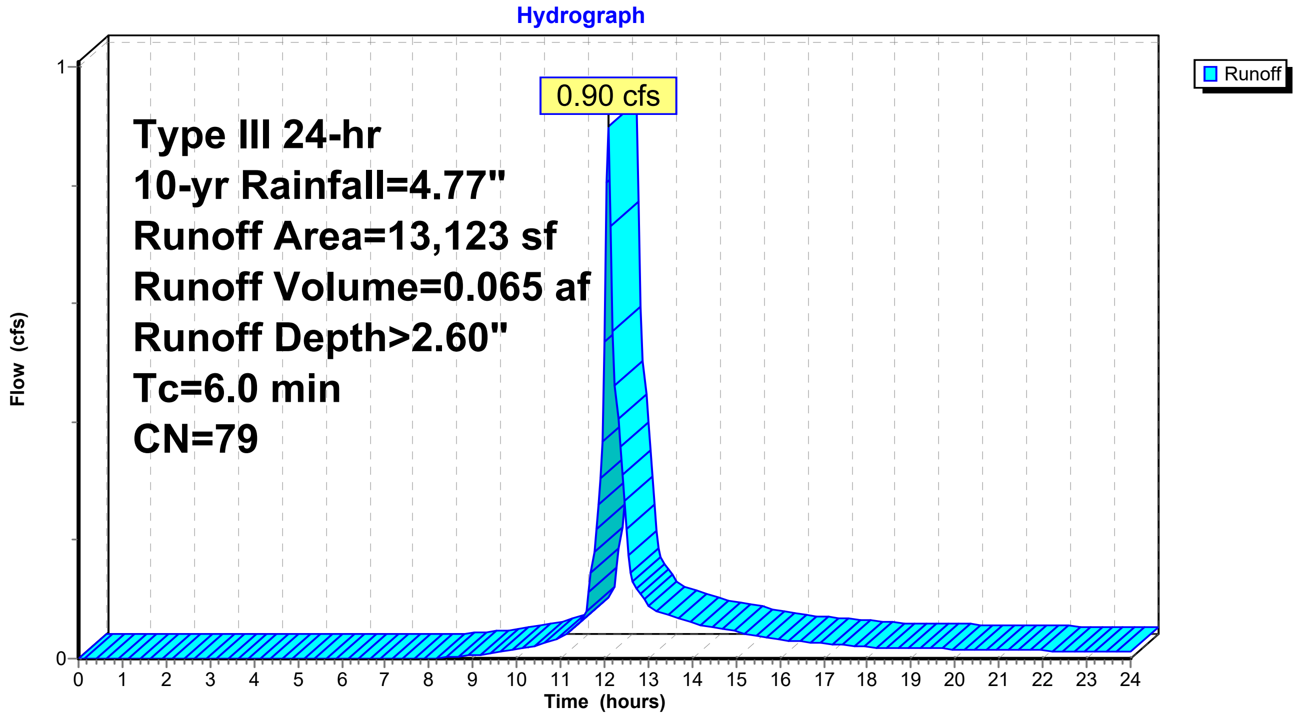
Runoff = 0.90 cfs @ 12.09 hrs, Volume= 0.065 af, Depth> 2.60"
Routed to Pond 2P : Retain-It Sys 2

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-yr Rainfall=4.77"

Area (sf)	CN	Description
6,676	61	>75% Grass cover, Good, HSG B
6,447	98	Paved parking, HSG B
13,123	79	Weighted Average
6,676		50.87% Pervious Area
6,447		49.13% Impervious Area

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

Subcatchment P-2: N'ly Exterior



Summary for Subcatchment P-3: E'ly Driveway

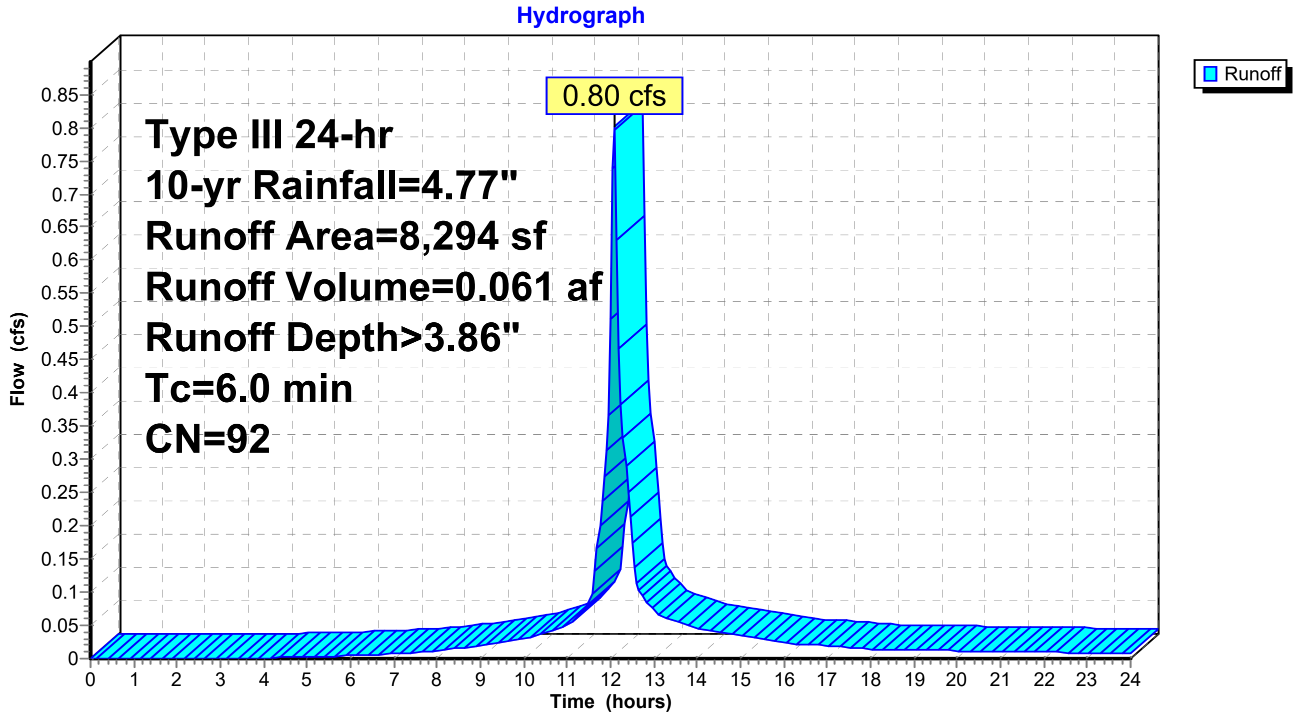
Runoff = 0.80 cfs @ 12.09 hrs, Volume= 0.061 af, Depth> 3.86"
Routed to Link 2L : Main Street

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-yr Rainfall=4.77"

Area (sf)	CN	Description
1,245	61	>75% Grass cover, Good, HSG B
7,049	98	Paved parking, HSG B
8,294	92	Weighted Average
1,245		15.01% Pervious Area
7,049		84.99% Impervious Area

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

Subcatchment P-3: E'ly Driveway



Summary for Subcatchment P-4A: W'ly Exterior

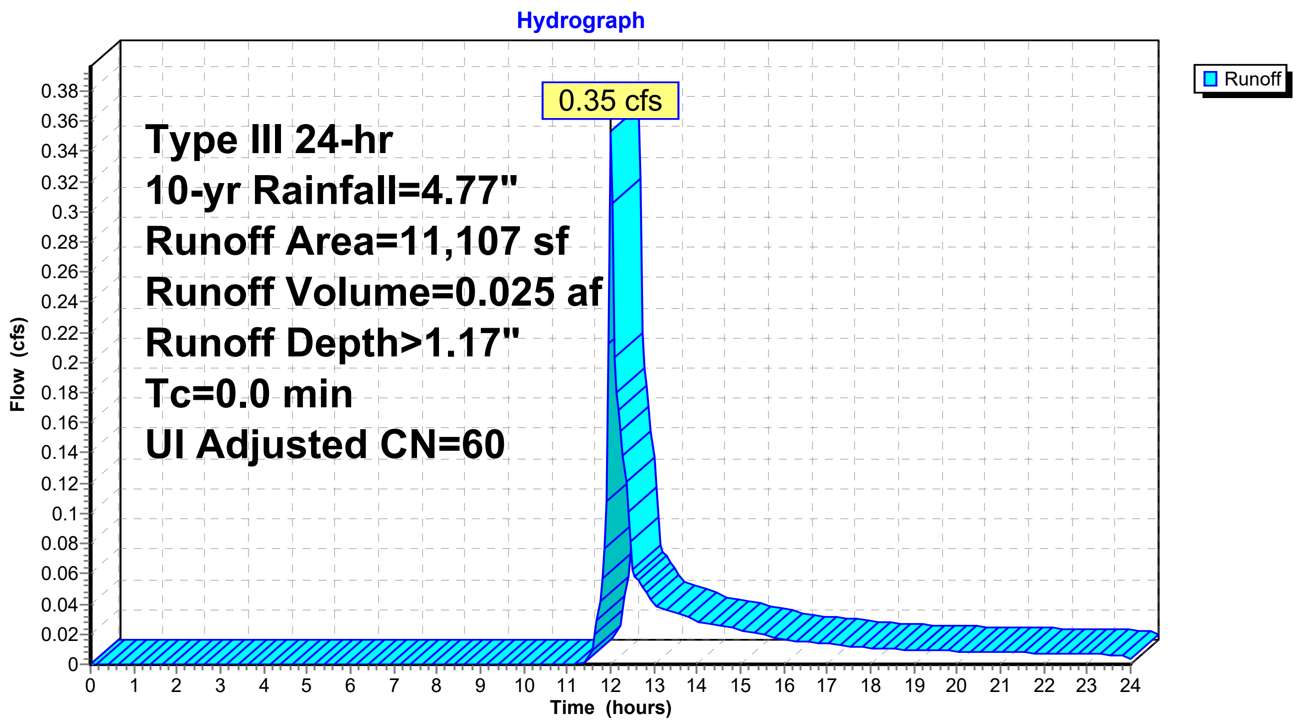
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.35 cfs @ 12.01 hrs, Volume= 0.025 af, Depth> 1.17"
Routed to Link 1L : W'ly PL

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-yr Rainfall=4.77"

Area (sf)	CN	Adj	Description
2,135	55		Woods, Good, HSG B
1,328	39		>75% Grass cover, Good, HSG A
5,975	61		>75% Grass cover, Good, HSG B
611	98		Unconnected pavement, HSG A
1,058	98		Unconnected pavement, HSG B
11,107	63	60	Weighted Average, UI Adjusted
9,438			84.97% Pervious Area
1,669			15.03% Impervious Area
1,669			100.00% Unconnected

Subcatchment P-4A: W'ly Exterior



Summary for Subcatchment P-4B: Turnaround

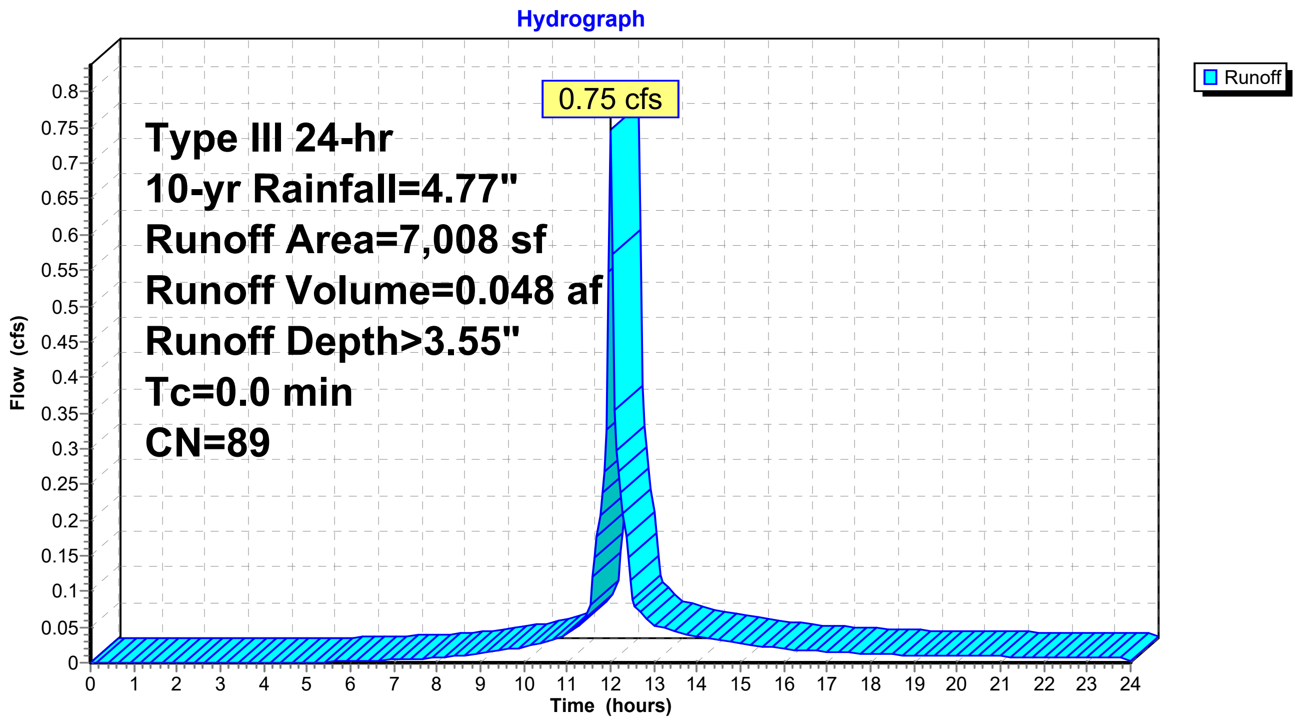
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.75 cfs @ 12.00 hrs, Volume= 0.048 af, Depth> 3.55"
Routed to Pond 4P : RainGarden

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-yr Rainfall=4.77"

Area (sf)	CN	Description
1,785	61	>75% Grass cover, Good, HSG B
5,223	98	Paved parking, HSG B
7,008	89	Weighted Average
1,785		25.47% Pervious Area
5,223		74.53% Impervious Area

Subcatchment P-4B: Turnaround



Summary for Subcatchment P-5: To Main St

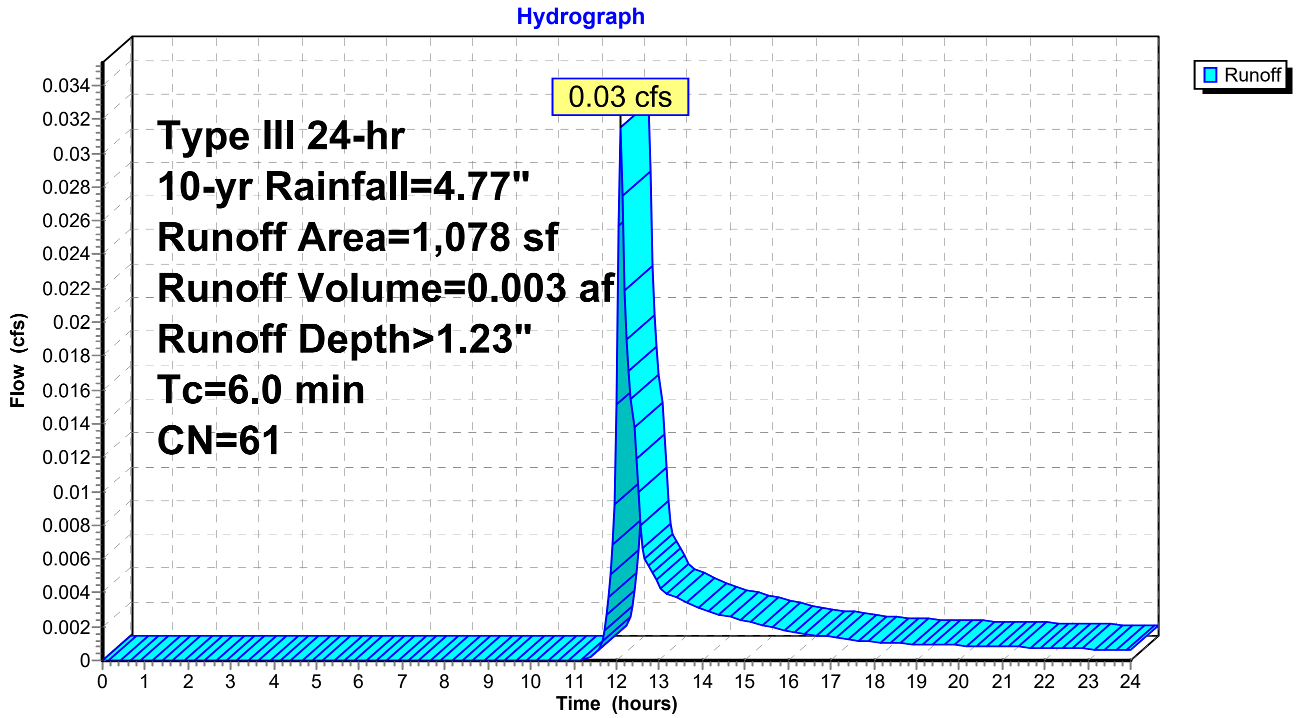
Runoff = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af, Depth> 1.23"
Routed to Link 2L : Main Street

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-yr Rainfall=4.77"

Area (sf)	CN	Description
1,078	61	>75% Grass cover, Good, HSG B
1,078		100.00% Pervious Area

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

Subcatchment P-5: To Main St



Summary for Pond 1P: Retain-It Sys 1

Inflow Area = 1.294 ac,100.00% Impervious, Inflow Depth > 4.53" for 10-yr event
Inflow = 5.89 cfs @ 12.09 hrs, Volume= 0.489 af
Outflow = 0.18 cfs @ 8.90 hrs, Volume= 0.273 af, Atten= 97%, Lag= 0.0 min
Discarded = 0.18 cfs @ 8.90 hrs, Volume= 0.273 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 151.05' @ 15.81 hrs Surf.Area= 7,700 sf Storage= 12,061 cf

Plug-Flow detention time= 256.0 min calculated for 0.273 af (56% of inflow)
Center-of-Mass det. time= 138.7 min (887.0 - 748.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	148.50'	6,607 cf	**10.00'W x 770.00'L x 6.67'H Field A** 51,333 cf Overall - 34,816 cf Embedded = 16,517 cf x 40.0% Voids
#2A	149.50'	25,947 cf	**retain_it retain_it 5.0'** x 96 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 1 Rows adjusted for 2,015.7 cf perimeter wall
		32,554 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	148.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.80'	**12.0" Round Culvert** L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.80' / 152.00' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	153.50'	**7.0' 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=0.18 cfs @ 8.90 hrs HW=148.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=148.50' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Retain-It Sys 1 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 5.0' (retain-it®)
Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf
Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf
1 Rows adjusted for 2,015.7 cf perimeter wall

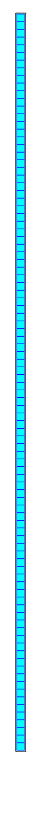
96 Chambers/Row x 8.00' Long = 768.00' Row Length +12.0" End Stone x 2 = 770.00' Base Length
1 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 10.00' Base Width
12.0" Stone Base + 68.0" Chamber Height = 6.67' Field Height

10.4 cf Sidewall x 96 x 2 + 10.4 cf Endwall x 1 x 2 = 2,015.7 cf Perimeter Wall
96 Chambers x 291.3 cf - 2,015.7 cf Perimeter wall = 25,947.2 cf Chamber Storage
96 Chambers x 362.7 cf = 34,816.0 cf Displacement

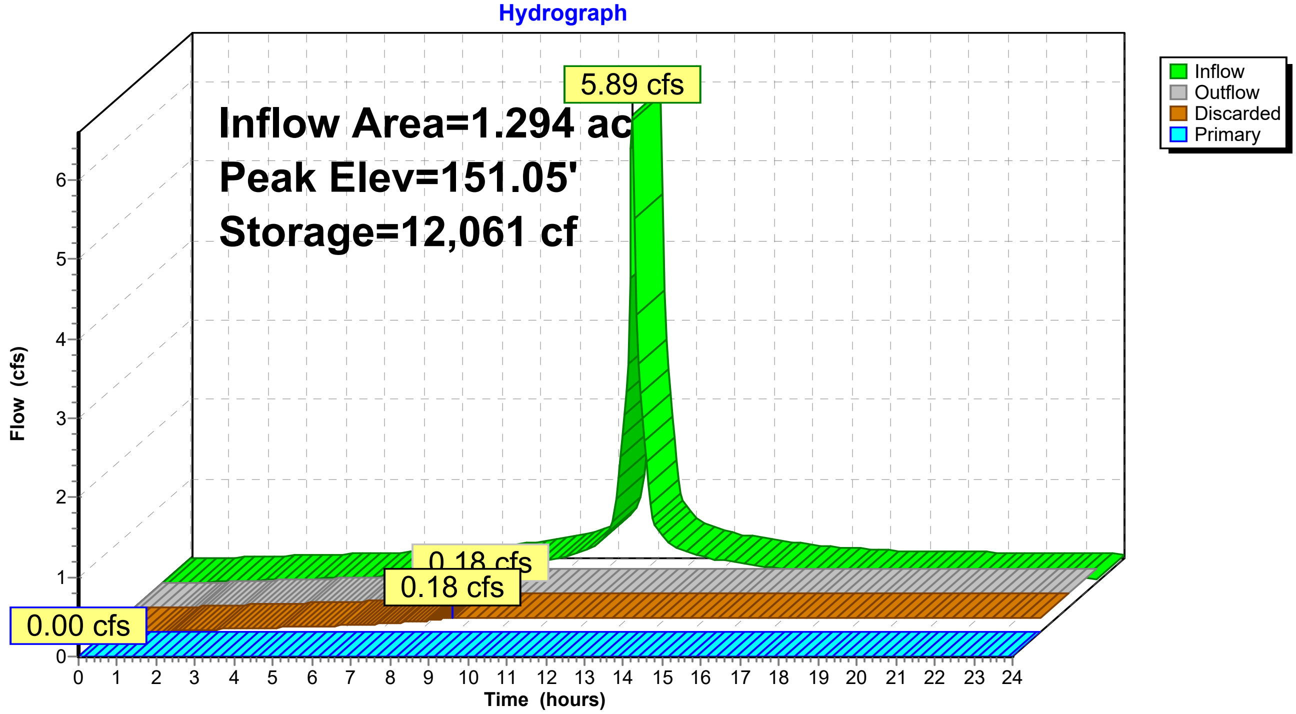
51,333.3 cf Field - 34,816.0 cf Chambers = 16,517.3 cf Stone x 40.0% Voids = 6,606.9 cf Stone Storage

Chamber Storage + Stone Storage = 32,554.2 cf = 0.747 af
Overall Storage Efficiency = 63.4%
Overall System Size = 770.00' x 10.00' x 6.67'

96 Chambers
1,901.2 cy Field
611.8 cy Stone



Pond 1P: Retain-It Sys 1



Summary for Pond 2P: Retain-It Sys 2

Inflow Area = 0.301 ac, 49.13% Impervious, Inflow Depth > 2.60" for 10-yr event
Inflow = 0.90 cfs @ 12.09 hrs, Volume= 0.065 af
Outflow = 0.04 cfs @ 11.35 hrs, Volume= 0.045 af, Atten= 96%, Lag= 0.0 min
Discarded = 0.04 cfs @ 11.35 hrs, Volume= 0.045 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 144.60' @ 15.41 hrs Surf.Area= 1,700 sf Storage= 1,526 cf

Plug-Flow detention time= 298.7 min calculated for 0.045 af (69% of inflow)
Center-of-Mass det. time= 202.7 min (1,028.7 - 826.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	143.00'	953 cf	**50.00'W x 34.00'L x 5.17'H Field A** 8,783 cf Overall - 6,400 cf Embedded = 2,383 cf x 40.0% Voids
#2A	144.00'	4,696 cf	**retain_it retain_it 3.5'** x 24 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 6 Rows adjusted for 122.8 cf perimeter wall
		5,649 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	143.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 11.35 hrs HW=143.06' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Pond 2P: Retain-It Sys 2 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 3.5' (retain-it®)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
6 Rows adjusted for 122.8 cf perimeter wall

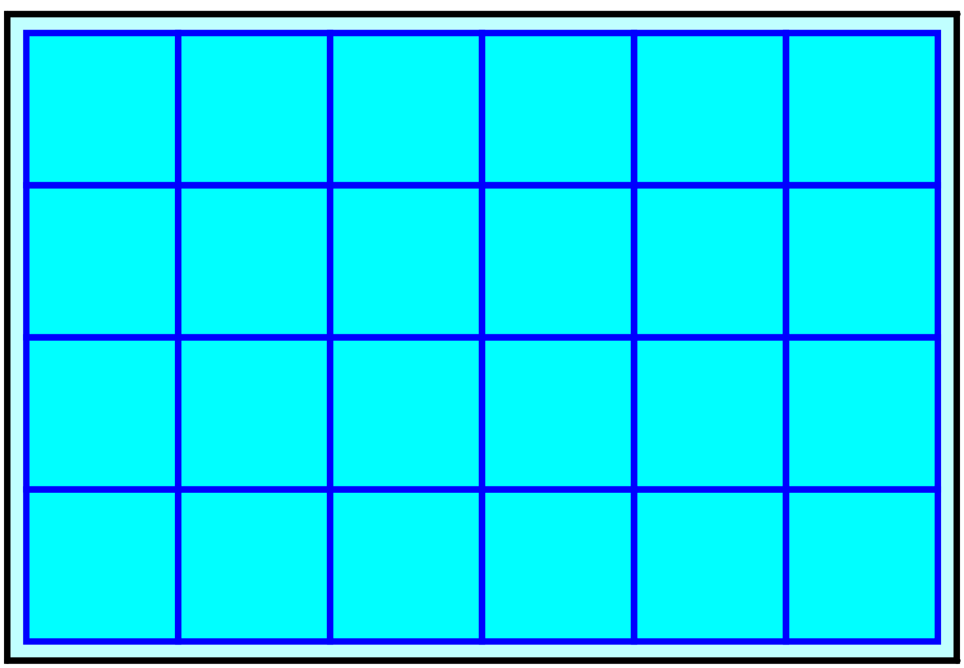
4 Chambers/Row x 8.00' Long = 32.00' Row Length +12.0" End Stone x 2 = 34.00' Base Length
6 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 50.00' Base Width
12.0" Stone Base + 50.0" Chamber Height = 5.17' Field Height

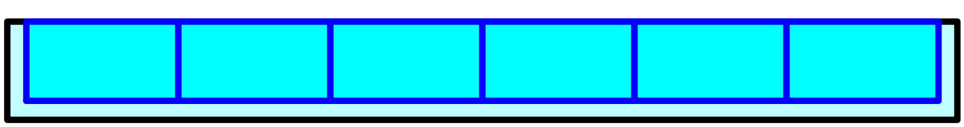
6.1 cf Sidewall x 4 x 2 + 6.1 cf Endwall x 6 x 2 = 122.8 cf Perimeter Wall
24 Chambers x 200.8 cf - 122.8 cf Perimeter wall = 4,695.9 cf Chamber Storage
24 Chambers x 266.7 cf = 6,400.0 cf Displacement

8,783.3 cf Field - 6,400.0 cf Chambers = 2,383.3 cf Stone x 40.0% Voids = 953.3 cf Stone Storage

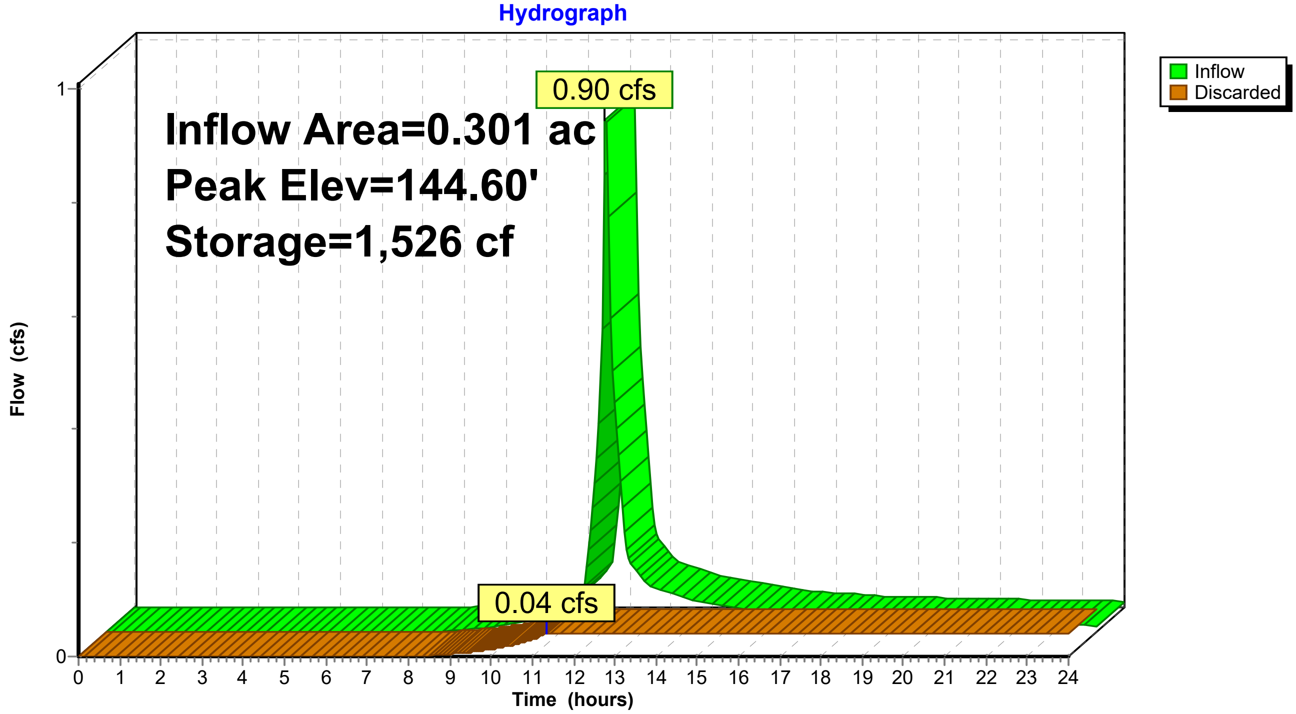
Chamber Storage + Stone Storage = 5,649.3 cf = 0.130 af
Overall Storage Efficiency = 64.3%
Overall System Size = 34.00' x 50.00' x 5.17'

24 Chambers
325.3 cy Field
88.3 cy Stone





Pond 2P: Retain-It Sys 2



Summary for Pond 3P: Drywell

[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=19)

Inflow Area = 1.455 ac, 97.18% Impervious, Inflow Depth = 0.25" for 10-yr event
Inflow = 0.71 cfs @ 12.00 hrs, Volume= 0.030 af
Outflow = 0.70 cfs @ 12.03 hrs, Volume= 0.030 af, Atten= 2%, Lag= 1.3 min
Discarded = 0.02 cfs @ 11.65 hrs, Volume= 0.015 af
Primary = 0.68 cfs @ 12.03 hrs, Volume= 0.015 af
Routed to Link 1L : W'ly PL

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 149.83' @ 12.05 hrs Storage= 319 cf

Plug-Flow detention time= 95.9 min calculated for 0.030 af (100% of inflow)
Center-of-Mass det. time= 95.9 min (858.6 - 762.7)

Volume	Invert	Avail.Storage	Storage Description
#1	142.80'	323 cf	**Custom Stage Data** Listed below

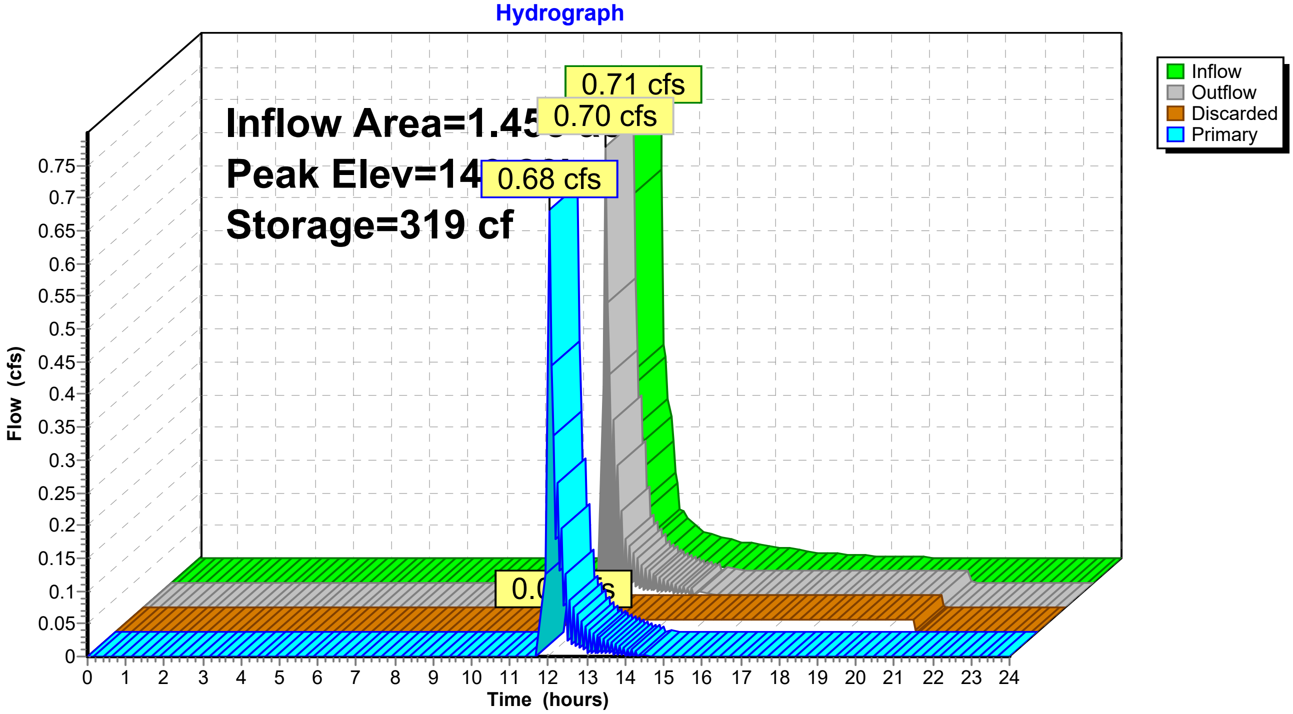
Elevation (feet)	Cum.Store (cubic-feet)
142.80	0
143.80	31
144.80	80
145.80	128
146.80	177
147.80	225
148.80	273
149.90	322
150.00	323

Device	Routing	Invert	Outlet Devices
#1	Discarded	142.80'	**0.02 cfs Exfiltration at all elevations**
#2	Primary	149.80'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 11.65 hrs HW=143.34' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.50 cfs @ 12.03 hrs HW=149.83' (Free Discharge)
└─**2=Orifice/Grate** (Weir Controls 0.50 cfs @ 0.60 fps)

Pond 3P: Drywell



Summary for Pond 4P: RainGarden

[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=1)

Inflow Area = 0.161 ac, 74.53% Impervious, Inflow Depth > 3.55" for 10-yr event
Inflow = 0.75 cfs @ 12.00 hrs, Volume= 0.048 af
Outflow = 0.72 cfs @ 12.00 hrs, Volume= 0.043 af, Atten= 3%, Lag= 0.1 min
Discarded = 0.01 cfs @ 12.00 hrs, Volume= 0.013 af
Primary = 0.71 cfs @ 12.00 hrs, Volume= 0.030 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 174.29' @ 12.00 hrs Surf.Area= 395 sf Storage= 226 cf

Plug-Flow detention time= 70.6 min calculated for 0.043 af (90% of inflow)
Center-of-Mass det. time= 23.8 min (814.3 - 790.5)

Volume	Invert	Avail.Storage	Storage Description
#1	172.00'	904 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

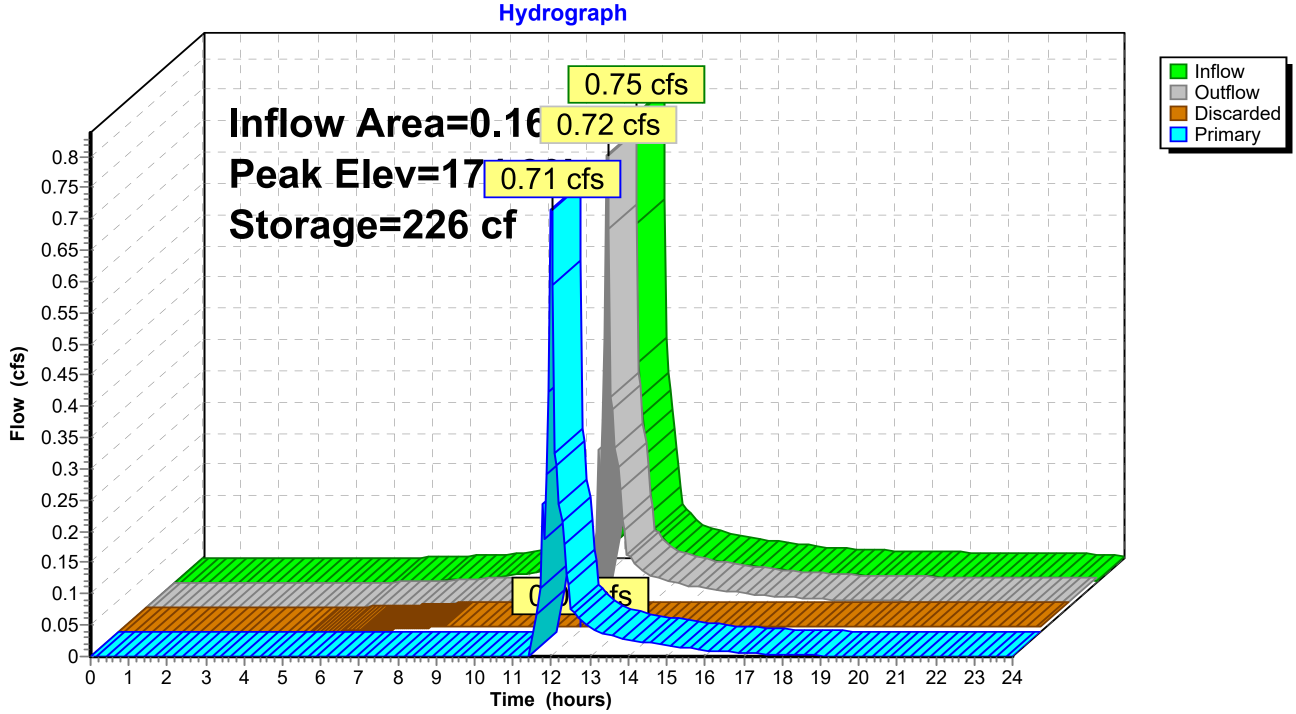
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
172.00	394	0.0	0	0
174.50	395	25.0	247	247
175.50	919	100.0	657	904

Device	Routing	Invert	Outlet Devices
#1	Discarded	172.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	169.00'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 169.00' / 168.00' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	174.25'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.00 hrs HW=174.29' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.66 cfs @ 12.00 hrs HW=174.29' (Free Discharge)
└─**2=Culvert** (Passes 0.66 cfs of 8.28 cfs potential flow)
  └─**3=Orifice/Grate** (Weir Controls 0.66 cfs @ 0.67 fps)

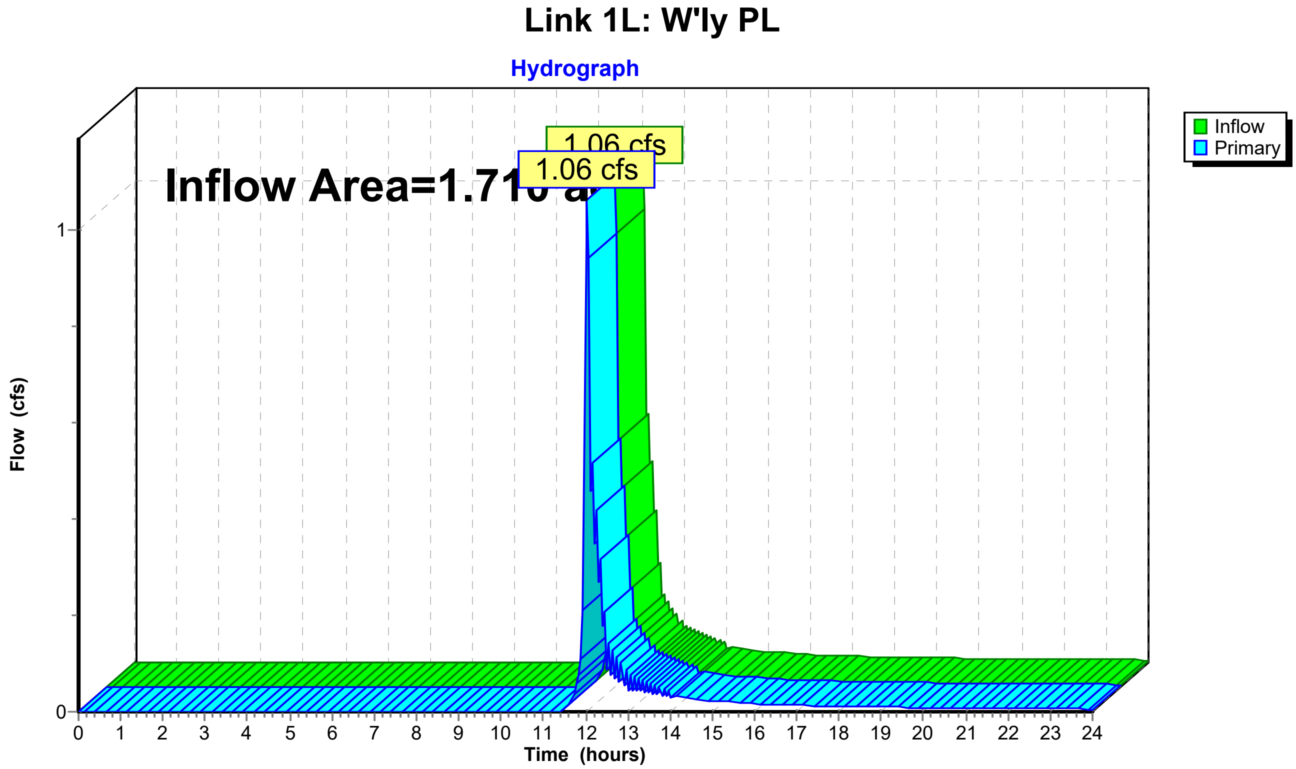
Pond 4P: RainGarden



Summary for Link 1L: W'ly PL

Inflow Area = 1.710 ac, 84.93% Impervious, Inflow Depth > 0.28" for 10-yr event
Inflow = 1.06 cfs @ 12.02 hrs, Volume= 0.040 af
Primary = 1.06 cfs @ 12.02 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

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

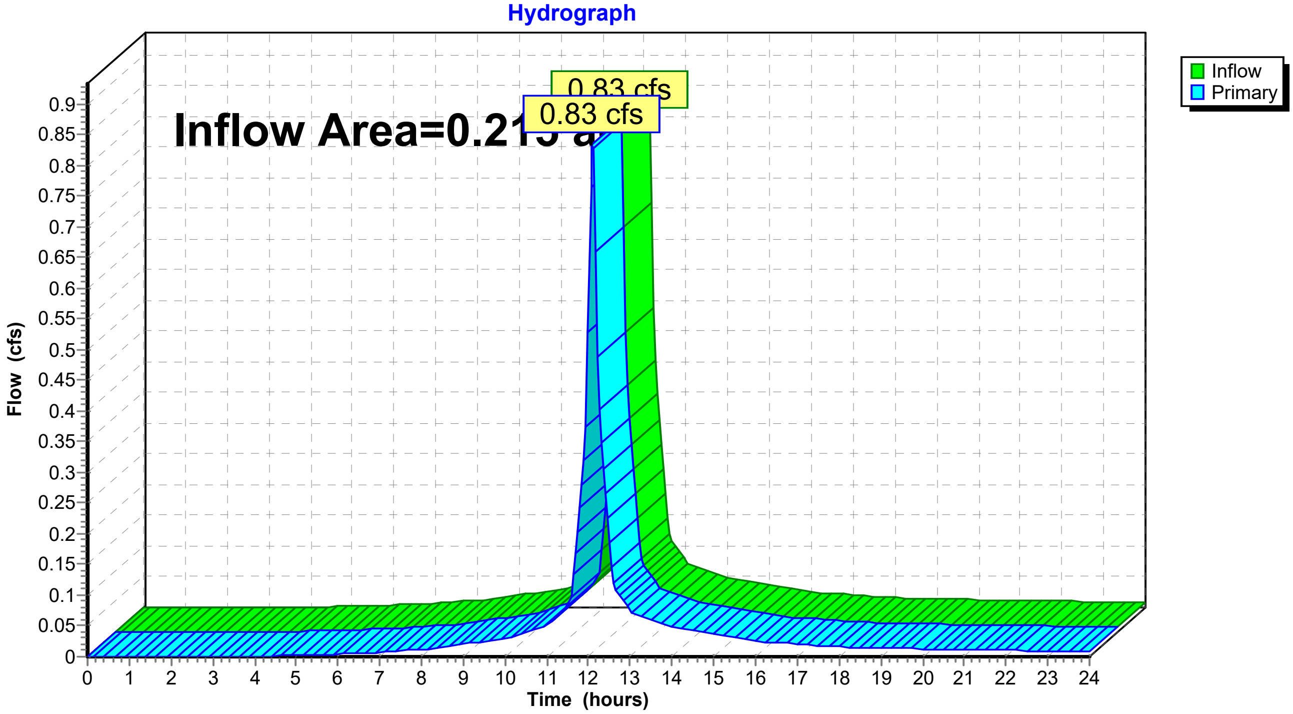


Summary for Link 2L: Main Street

Inflow Area = 0.215 ac, 75.21% Impervious, Inflow Depth > 3.56" for 10-yr event
Inflow = 0.83 cfs @ 12.09 hrs, Volume= 0.064 af
Primary = 0.83 cfs @ 12.09 hrs, Volume= 0.064 af, Atten= 0%, Lag= 0.0 min

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

Link 2L: Main Street



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 P-1: Building w Pool Area Runoff Area=56,366 sf 100.00% Impervious Runoff Depth>5.79"
Tc=6.0 min CN=98 Runoff=7.47 cfs 0.624 af

Subcatchment P-2: N'ly Exterior Runoff Area=13,123 sf 49.13% Impervious Runoff Depth>3.70"
Tc=6.0 min CN=79 Runoff=1.28 cfs 0.093 af

Subcatchment P-3: E'ly Driveway Runoff Area=8,294 sf 84.99% Impervious Runoff Depth>5.10"
Tc=6.0 min CN=92 Runoff=1.04 cfs 0.081 af

Subcatchment P-4A: W'ly Exterior Runoff Area=11,107 sf 15.03% Impervious Runoff Depth>1.94"
Tc=0.0 min UI Adjusted CN=60 Runoff=0.63 cfs 0.041 af

Subcatchment P-4B: Turnaround Runoff Area=7,008 sf 74.53% Impervious Runoff Depth>4.76"
Tc=0.0 min CN=89 Runoff=0.99 cfs 0.064 af

Subcatchment P-5: To Main St Runoff Area=1,078 sf 0.00% Impervious Runoff Depth>2.02"
Tc=6.0 min CN=61 Runoff=0.06 cfs 0.004 af

Pond 1P: Retain-It Sys 1 Peak Elev=151.84' Storage=16,662 cf Inflow=7.47 cfs 0.624 af
Discarded=0.18 cfs 0.288 af Primary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.288 af

Pond 2P: Retain-It Sys 2 Peak Elev=145.25' Storage=2,437 cf Inflow=1.28 cfs 0.093 af
Outflow=0.04 cfs 0.048 af

Pond 3P: Drywell Peak Elev=149.87' Storage=321 cf Inflow=0.98 cfs 0.045 af
Discarded=0.02 cfs 0.018 af Primary=1.21 cfs 0.027 af Outflow=1.23 cfs 0.045 af

Pond 4P: RainGarden Peak Elev=174.30' Storage=227 cf Inflow=0.99 cfs 0.064 af
Discarded=0.01 cfs 0.014 af Primary=0.98 cfs 0.045 af Outflow=0.99 cfs 0.059 af

Link 1L: W'ly PL Inflow=1.84 cfs 0.068 af
Primary=1.84 cfs 0.068 af

Link 2L: Main Street Inflow=1.10 cfs 0.085 af
Primary=1.10 cfs 0.085 af

Total Runoff Area = 2.226 ac Runoff Volume = 0.907 af Average Runoff Depth = 4.89"
20.85% Pervious = 0.464 ac 79.15% Impervious = 1.762 ac

Summary for Subcatchment P-1: Building w Pool Area

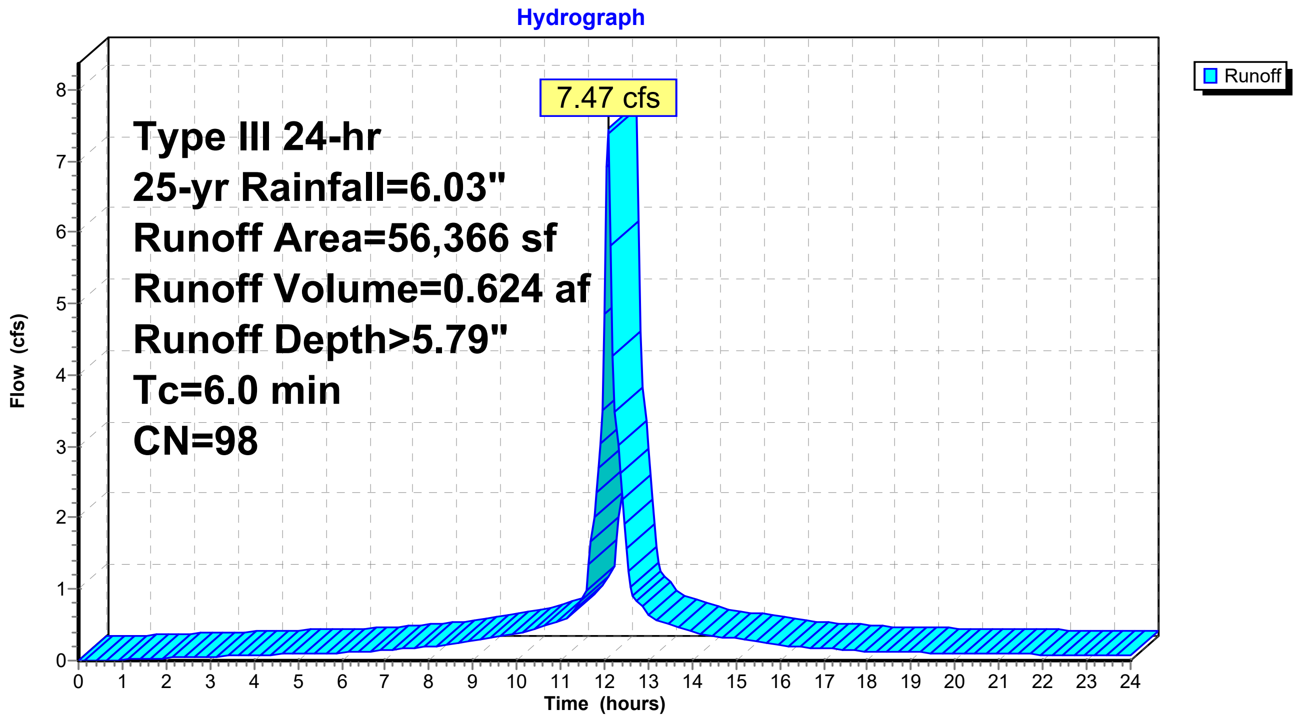
Runoff = 7.47 cfs @ 12.09 hrs, Volume= 0.624 af, Depth> 5.79"
Routed to Pond 1P : Retain-It Sys 1

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-yr Rainfall=6.03"

Area (sf)	CN	Description
629	98	Roofs, HSG A
55,737	98	Roofs, HSG B
56,366	98	Weighted Average
56,366		100.00% Impervious Area

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

Subcatchment P-1: Building w Pool Area



Summary for Subcatchment P-2: N'ly Exterior

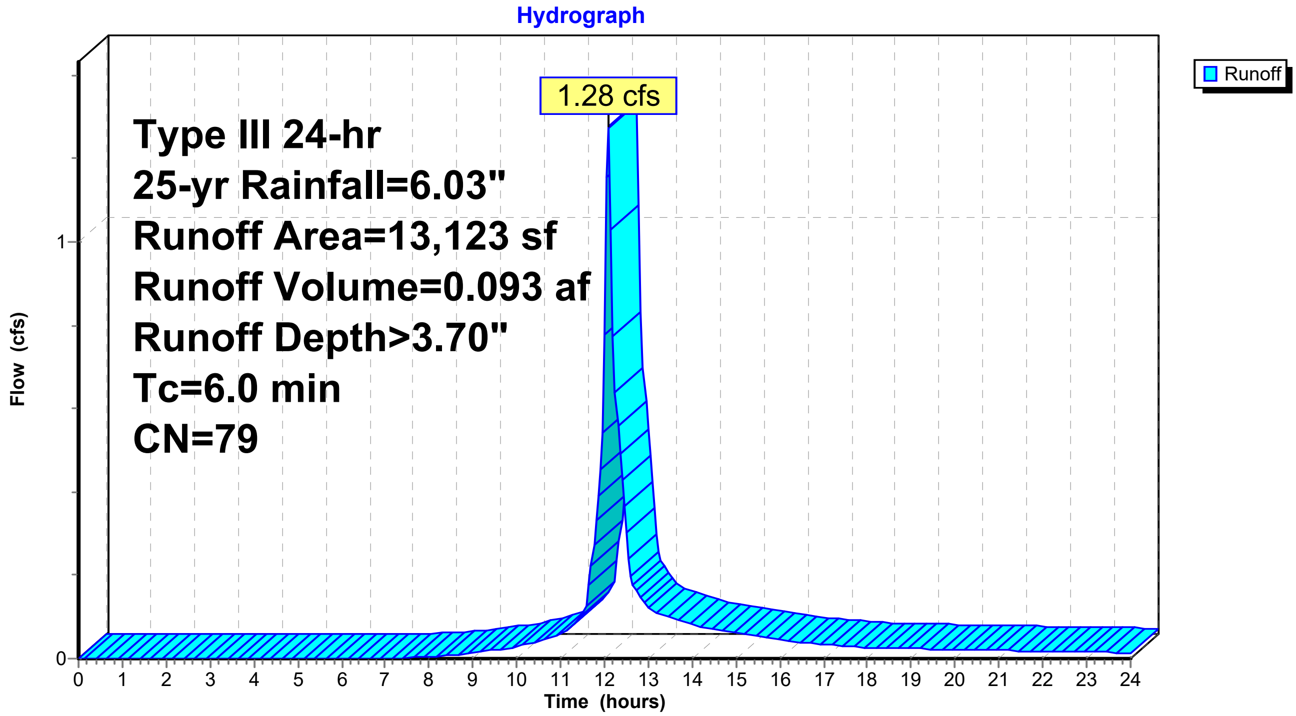
Runoff = 1.28 cfs @ 12.09 hrs, Volume= 0.093 af, Depth> 3.70"
Routed to Pond 2P : Retain-It Sys 2

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-yr Rainfall=6.03"

Area (sf)	CN	Description
6,676	61	>75% Grass cover, Good, HSG B
6,447	98	Paved parking, HSG B
13,123	79	Weighted Average
6,676		50.87% Pervious Area
6,447		49.13% Impervious Area

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

Subcatchment P-2: N'ly Exterior



Summary for Subcatchment P-3: E'ly Driveway

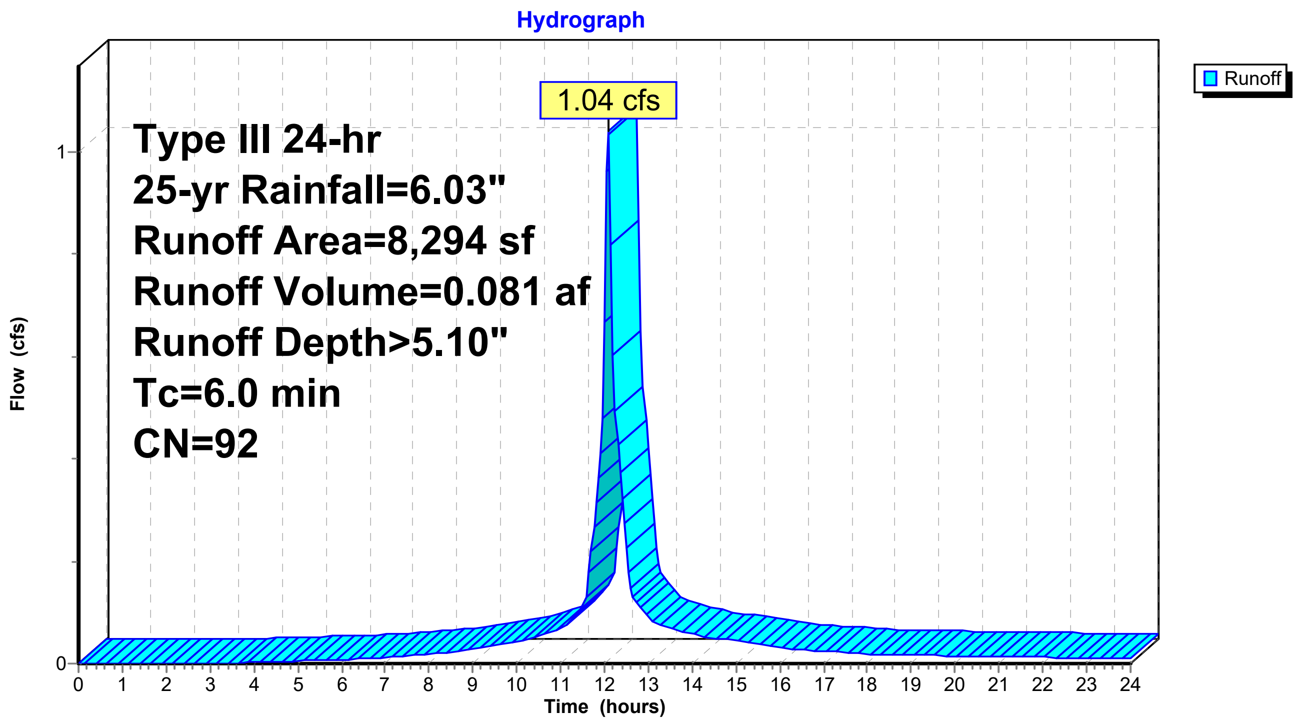
Runoff = 1.04 cfs @ 12.09 hrs, Volume= 0.081 af, Depth> 5.10"
Routed to Link 2L : Main Street

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-yr Rainfall=6.03"

Area (sf)	CN	Description
1,245	61	>75% Grass cover, Good, HSG B
7,049	98	Paved parking, HSG B
8,294	92	Weighted Average
1,245		15.01% Pervious Area
7,049		84.99% Impervious Area

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

Subcatchment P-3: E'ly Driveway



Summary for Subcatchment P-4A: W'ly Exterior

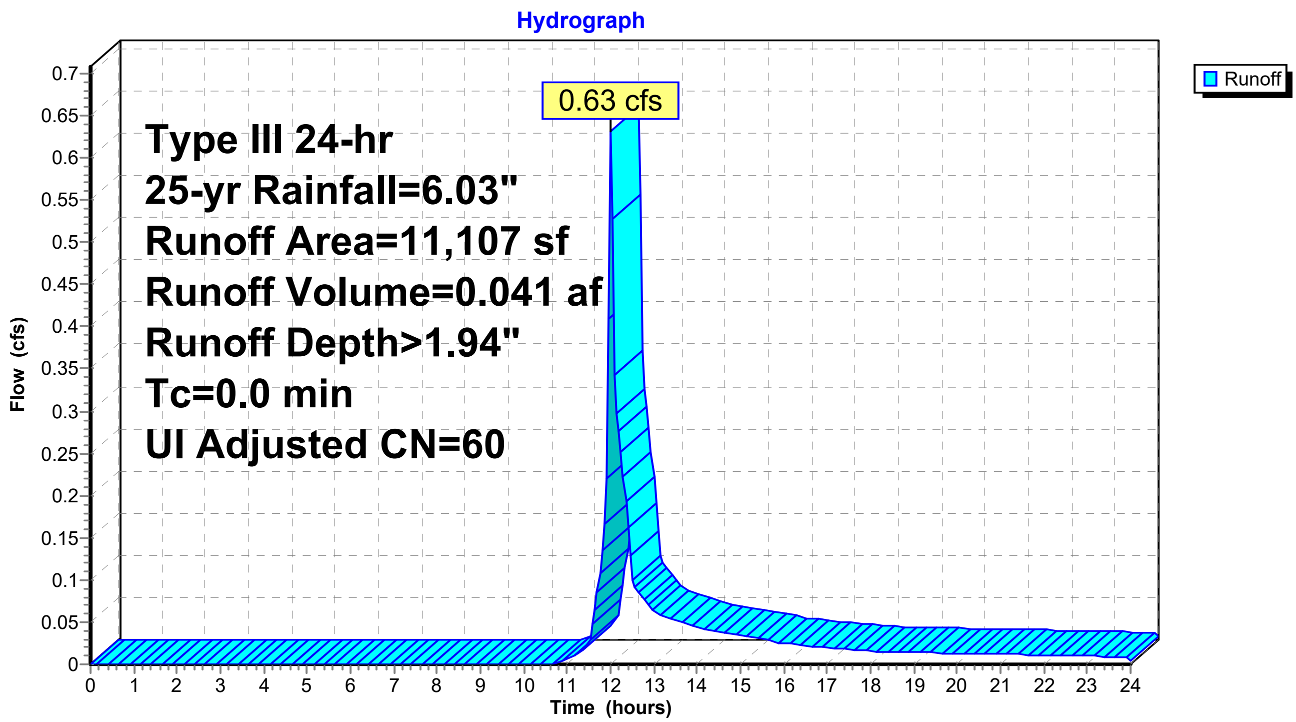
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.63 cfs @ 12.01 hrs, Volume= 0.041 af, Depth> 1.94"
Routed to Link 1L : W'ly PL

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-yr Rainfall=6.03"

Area (sf)	CN	Adj	Description
2,135	55		Woods, Good, HSG B
1,328	39		>75% Grass cover, Good, HSG A
5,975	61		>75% Grass cover, Good, HSG B
611	98		Unconnected pavement, HSG A
1,058	98		Unconnected pavement, HSG B
11,107	63	60	Weighted Average, UI Adjusted
9,438			84.97% Pervious Area
1,669			15.03% Impervious Area
1,669			100.00% Unconnected

Subcatchment P-4A: W'ly Exterior



Summary for Subcatchment P-4B: Turnaround

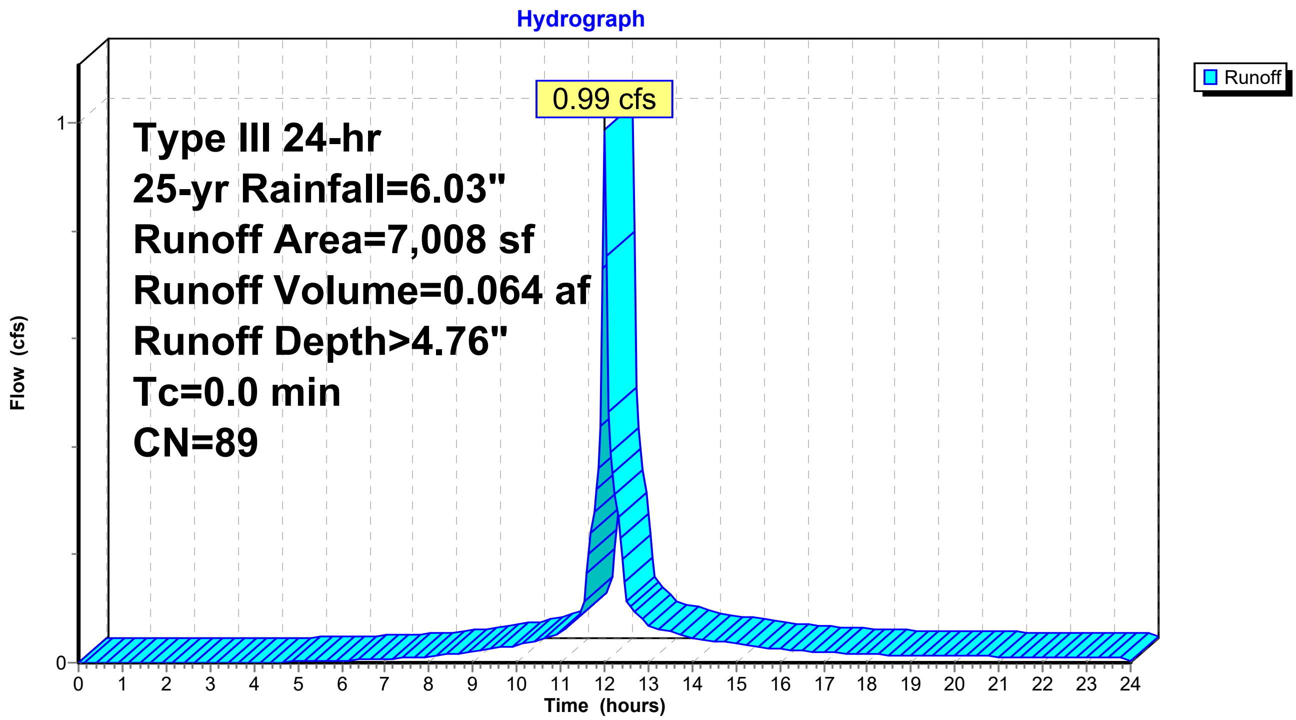
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.99 cfs @ 12.00 hrs, Volume= 0.064 af, Depth> 4.76"
Routed to Pond 4P : RainGarden

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-yr Rainfall=6.03"

Area (sf)	CN	Description
1,785	61	>75% Grass cover, Good, HSG B
5,223	98	Paved parking, HSG B
7,008	89	Weighted Average
1,785		25.47% Pervious Area
5,223		74.53% Impervious Area

Subcatchment P-4B: Turnaround



Summary for Subcatchment P-5: To Main St

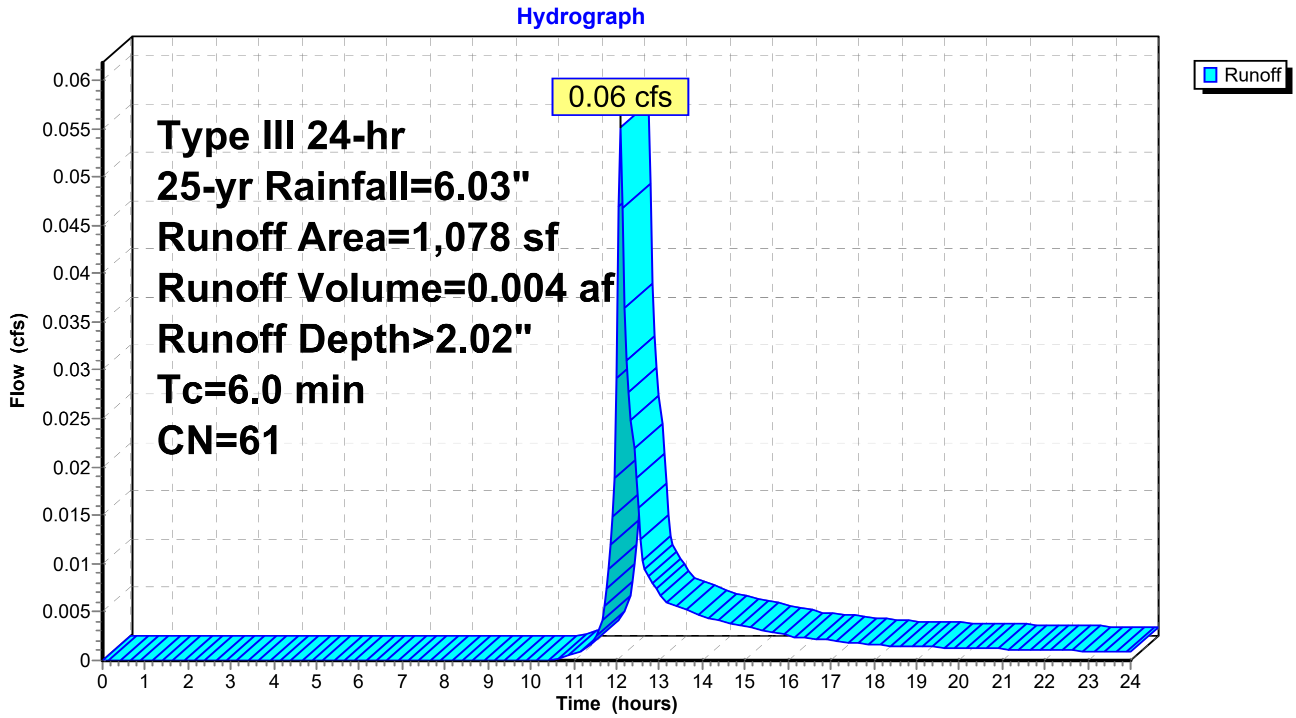
Runoff = 0.06 cfs @ 12.10 hrs, Volume= 0.004 af, Depth> 2.02"
Routed to Link 2L : Main Street

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-yr Rainfall=6.03"

Area (sf)	CN	Description
1,078	61	>75% Grass cover, Good, HSG B
1,078		100.00% Pervious Area

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

Subcatchment P-5: To Main St



Summary for Pond 1P: Retain-It Sys 1

Inflow Area = 1.294 ac,100.00% Impervious, Inflow Depth > 5.79" for 25-yr event
Inflow = 7.47 cfs @ 12.09 hrs, Volume= 0.624 af
Outflow = 0.18 cfs @ 8.15 hrs, Volume= 0.288 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.18 cfs @ 8.15 hrs, Volume= 0.288 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 151.84' @ 16.66 hrs Surf.Area= 7,700 sf Storage= 16,662 cf

Plug-Flow detention time= 253.7 min calculated for 0.287 af (46% of inflow)
Center-of-Mass det. time= 114.1 min (858.8 - 744.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	148.50'	6,607 cf	**10.00'W x 770.00'L x 6.67'H Field A** 51,333 cf Overall - 34,816 cf Embedded = 16,517 cf x 40.0% Voids
#2A	149.50'	25,947 cf	**retain_it retain_it 5.0'** x 96 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 1 Rows adjusted for 2,015.7 cf perimeter wall
		32,554 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	148.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.80'	**12.0" Round Culvert** L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.80' / 152.00' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	153.50'	**7.0' 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=0.18 cfs @ 8.15 hrs HW=148.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=148.50' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)
  └─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Retain-It Sys 1 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 5.0' (retain-it®)
Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf
Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf
1 Rows adjusted for 2,015.7 cf perimeter wall

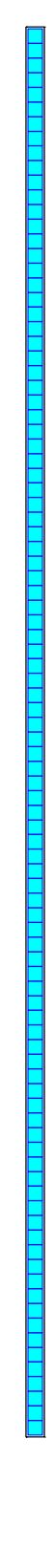
96 Chambers/Row x 8.00' Long = 768.00' Row Length +12.0" End Stone x 2 = 770.00' Base Length
1 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 10.00' Base Width
12.0" Stone Base + 68.0" Chamber Height = 6.67' Field Height

10.4 cf Sidewall x 96 x 2 + 10.4 cf Endwall x 1 x 2 = 2,015.7 cf Perimeter Wall
96 Chambers x 291.3 cf - 2,015.7 cf Perimeter wall = 25,947.2 cf Chamber Storage
96 Chambers x 362.7 cf = 34,816.0 cf Displacement

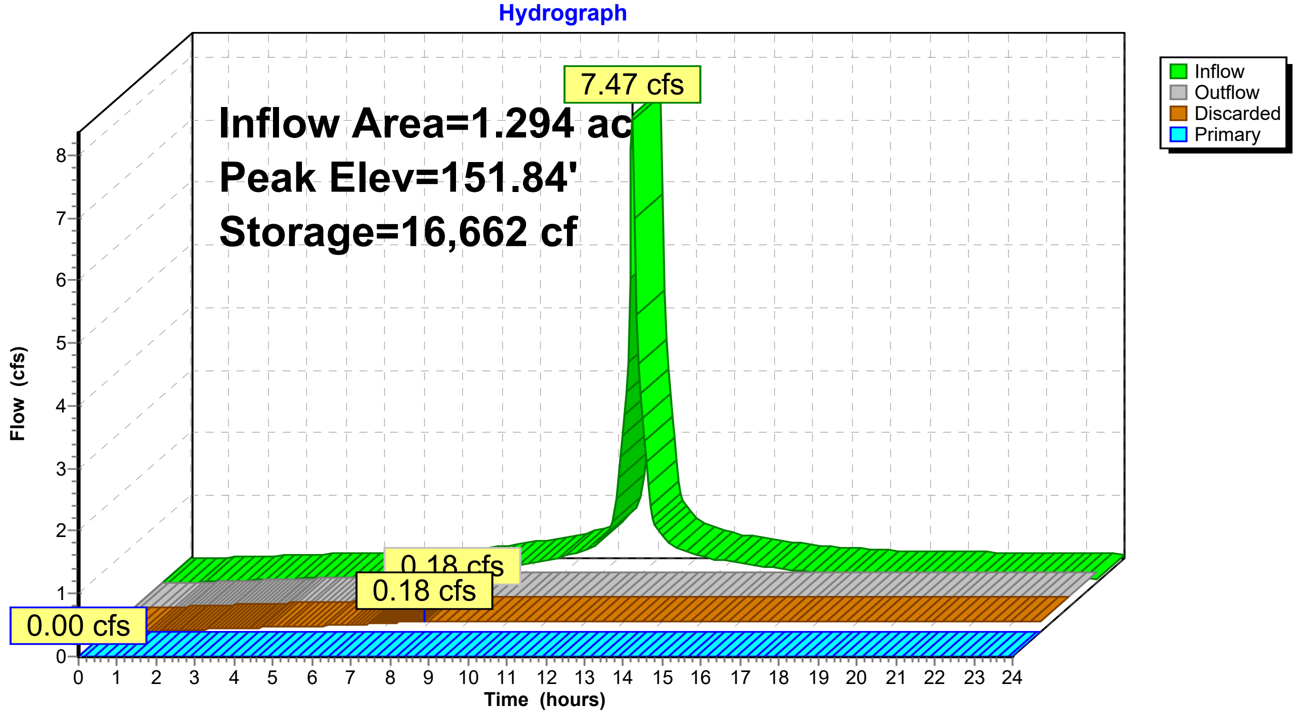
51,333.3 cf Field - 34,816.0 cf Chambers = 16,517.3 cf Stone x 40.0% Voids = 6,606.9 cf Stone Storage

Chamber Storage + Stone Storage = 32,554.2 cf = 0.747 af
Overall Storage Efficiency = 63.4%
Overall System Size = 770.00' x 10.00' x 6.67'

96 Chambers
1,901.2 cy Field
611.8 cy Stone



Pond 1P: Retain-It Sys 1



Summary for Pond 2P: Retain-It Sys 2

Inflow Area = 0.301 ac, 49.13% Impervious, Inflow Depth > 3.70" for 25-yr event
Inflow = 1.28 cfs @ 12.09 hrs, Volume= 0.093 af
Outflow = 0.04 cfs @ 10.70 hrs, Volume= 0.048 af, Atten= 97%, Lag= 0.0 min
Discarded = 0.04 cfs @ 10.70 hrs, Volume= 0.048 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 145.25' @ 16.28 hrs Surf.Area= 1,700 sf Storage= 2,437 cf

Plug-Flow detention time= 299.4 min calculated for 0.048 af (52% of inflow)
Center-of-Mass det. time= 188.2 min (1,004.1 - 815.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	143.00'	953 cf	**50.00'W x 34.00'L x 5.17'H Field A** 8,783 cf Overall - 6,400 cf Embedded = 2,383 cf x 40.0% Voids
#2A	144.00'	4,696 cf	**retain_it retain_it 3.5'** x 24 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 6 Rows adjusted for 122.8 cf perimeter wall
		5,649 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	143.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 10.70 hrs HW=143.05' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Pond 2P: Retain-It Sys 2 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 3.5' (retain-it®)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
6 Rows adjusted for 122.8 cf perimeter wall

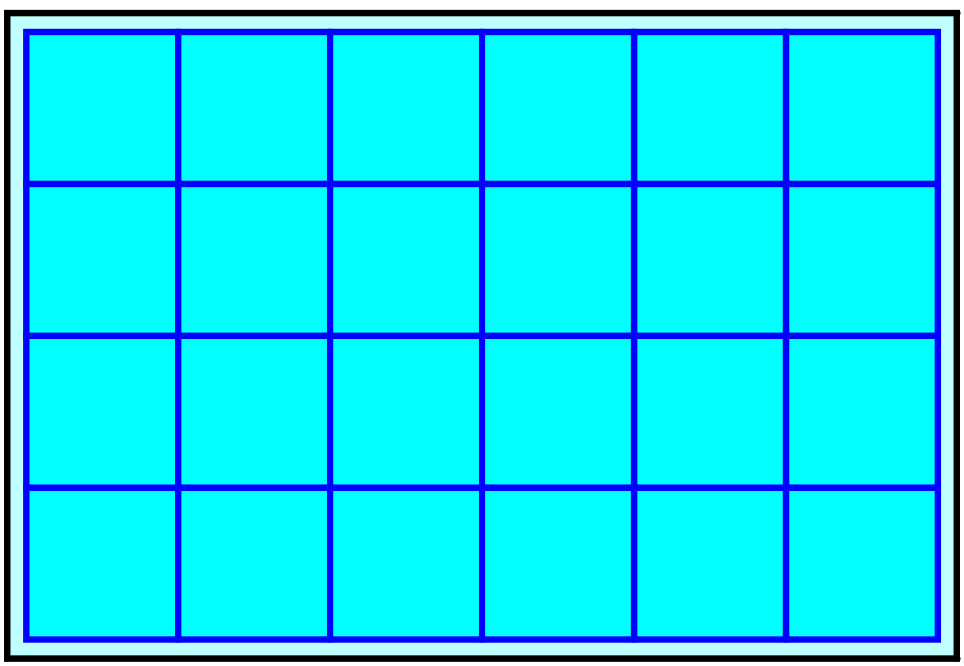
4 Chambers/Row x 8.00' Long = 32.00' Row Length +12.0" End Stone x 2 = 34.00' Base Length
6 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 50.00' Base Width
12.0" Stone Base + 50.0" Chamber Height = 5.17' Field Height

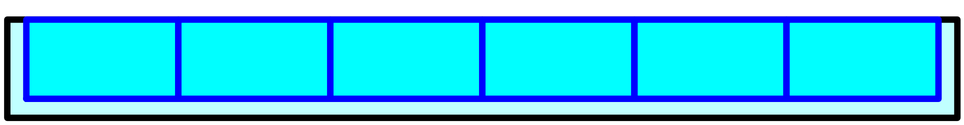
6.1 cf Sidewall x 4 x 2 + 6.1 cf Endwall x 6 x 2 = 122.8 cf Perimeter Wall
24 Chambers x 200.8 cf - 122.8 cf Perimeter wall = 4,695.9 cf Chamber Storage
24 Chambers x 266.7 cf = 6,400.0 cf Displacement

8,783.3 cf Field - 6,400.0 cf Chambers = 2,383.3 cf Stone x 40.0% Voids = 953.3 cf Stone Storage

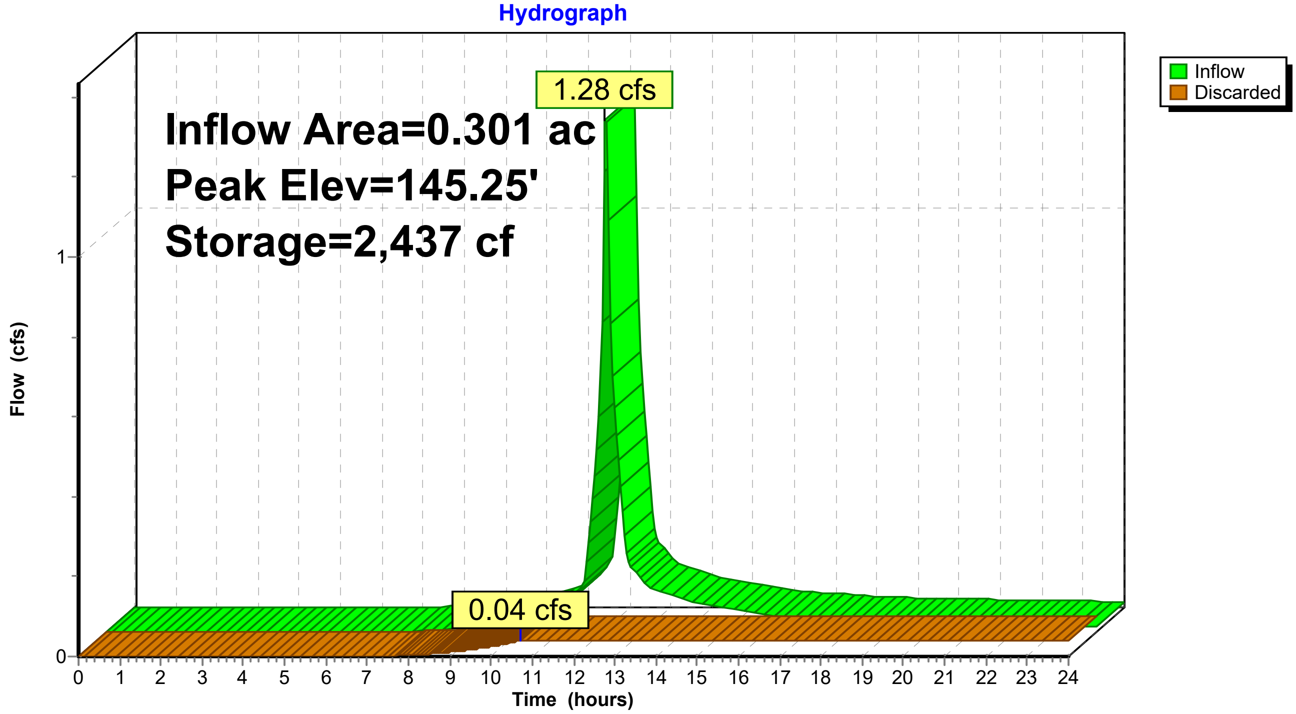
Chamber Storage + Stone Storage = 5,649.3 cf = 0.130 af
Overall Storage Efficiency = 64.3%
Overall System Size = 34.00' x 50.00' x 5.17'

24 Chambers
325.3 cy Field
88.3 cy Stone





Pond 2P: Retain-It Sys 2



Summary for Pond 3P: Drywell

[88] Warning: Qout>Qin may require smaller dt or Finer Routing
[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=31)

Inflow Area = 1.455 ac, 97.18% Impervious, Inflow Depth = 0.37" for 25-yr event
Inflow = 0.98 cfs @ 12.00 hrs, Volume= 0.045 af
Outflow = 1.23 cfs @ 12.00 hrs, Volume= 0.045 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.10 hrs, Volume= 0.018 af
Primary = 1.21 cfs @ 12.00 hrs, Volume= 0.027 af
Routed to Link 1L : W'ly PL

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 149.87' @ 12.00 hrs Storage= 321 cf

Plug-Flow detention time= 75.8 min calculated for 0.045 af (100% of inflow)
Center-of-Mass det. time= 75.7 min (843.0 - 767.3)

Volume	Invert	Avail.Storage	Storage Description
#1	142.80'	323 cf	**Custom Stage Data** Listed below

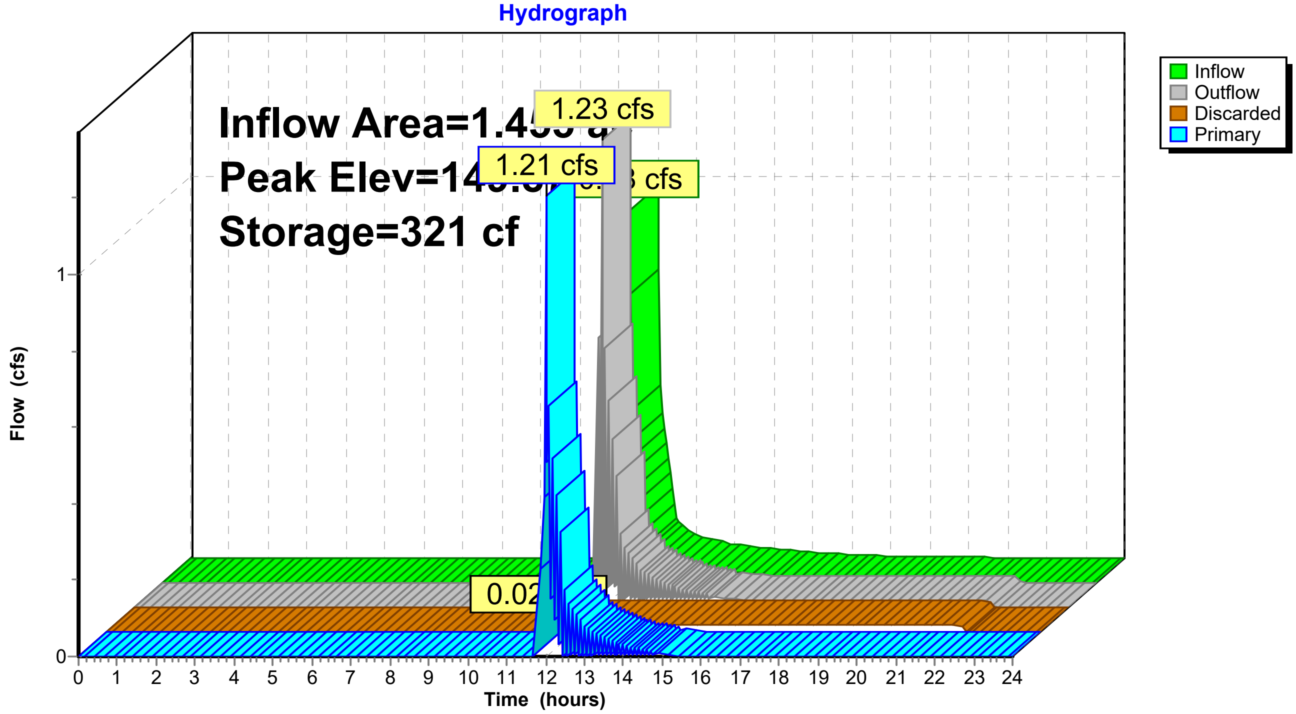
Elevation (feet)	Cum.Store (cubic-feet)
142.80	0
143.80	31
144.80	80
145.80	128
146.80	177
147.80	225
148.80	273
149.90	322
150.00	323

Device	Routing	Invert	Outlet Devices
#1	Discarded	142.80'	**0.02 cfs Exfiltration at all elevations**
#2	Primary	149.80'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 11.10 hrs HW=142.88' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.27 cfs @ 12.00 hrs HW=149.87' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.27 cfs @ 1.27 fps)

Pond 3P: Drywell



Summary for Pond 4P: RainGarden

Inflow Area = 0.161 ac, 74.53% Impervious, Inflow Depth > 4.76" for 25-yr event
Inflow = 0.99 cfs @ 12.00 hrs, Volume= 0.064 af
Outflow = 0.99 cfs @ 12.00 hrs, Volume= 0.059 af, Atten= 0%, Lag= 0.1 min
Discarded = 0.01 cfs @ 12.00 hrs, Volume= 0.014 af
Primary = 0.98 cfs @ 12.00 hrs, Volume= 0.045 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 174.30' @ 12.00 hrs Surf.Area= 395 sf Storage= 227 cf

Plug-Flow detention time= 56.8 min calculated for 0.059 af (92% of inflow)
Center-of-Mass det. time= 16.7 min (799.2 - 782.4)

Volume	Invert	Avail.Storage	Storage Description
#1	172.00'	904 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

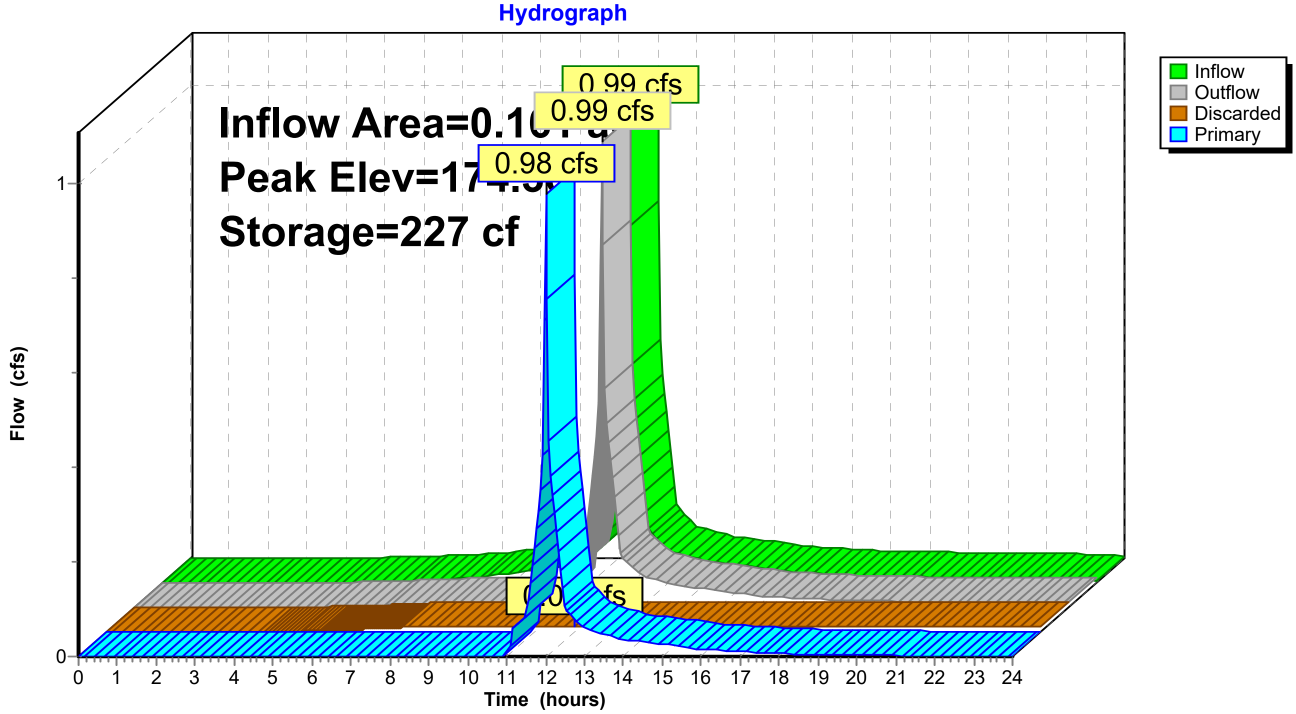
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
172.00	394	0.0	0	0
174.50	395	25.0	247	247
175.50	919	100.0	657	904

Device	Routing	Invert	Outlet Devices
#1	Discarded	172.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	169.00'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 169.00' / 168.00' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	174.25'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.00 hrs HW=174.30' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.94 cfs @ 12.00 hrs HW=174.30' (Free Discharge)
└─**2=Culvert** (Passes 0.94 cfs of 8.29 cfs potential flow)
  └─**3=Orifice/Grate** (Weir Controls 0.94 cfs @ 0.75 fps)

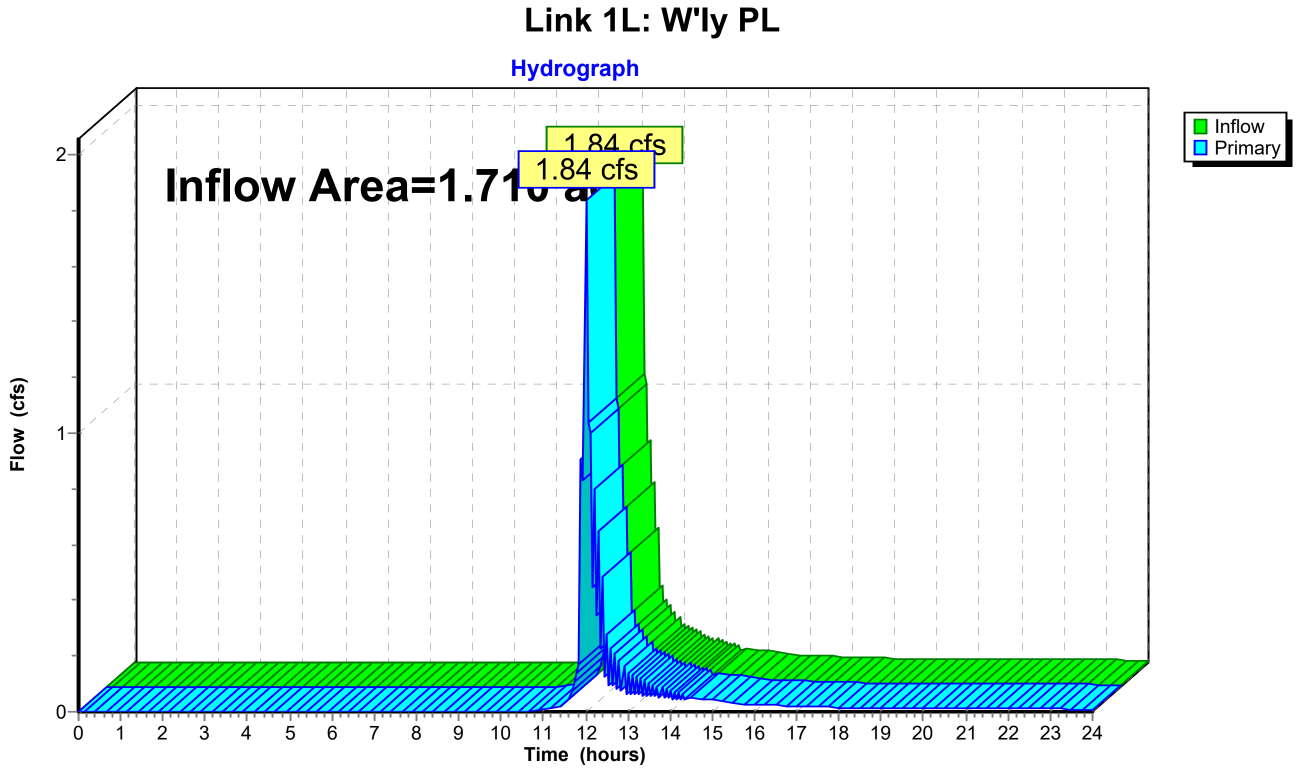
Pond 4P: RainGarden



Summary for Link 1L: W'ly PL

Inflow Area = 1.710 ac, 84.93% Impervious, Inflow Depth > 0.48" for 25-yr event
Inflow = 1.84 cfs @ 12.00 hrs, Volume= 0.068 af
Primary = 1.84 cfs @ 12.00 hrs, Volume= 0.068 af, Atten= 0%, Lag= 0.0 min

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

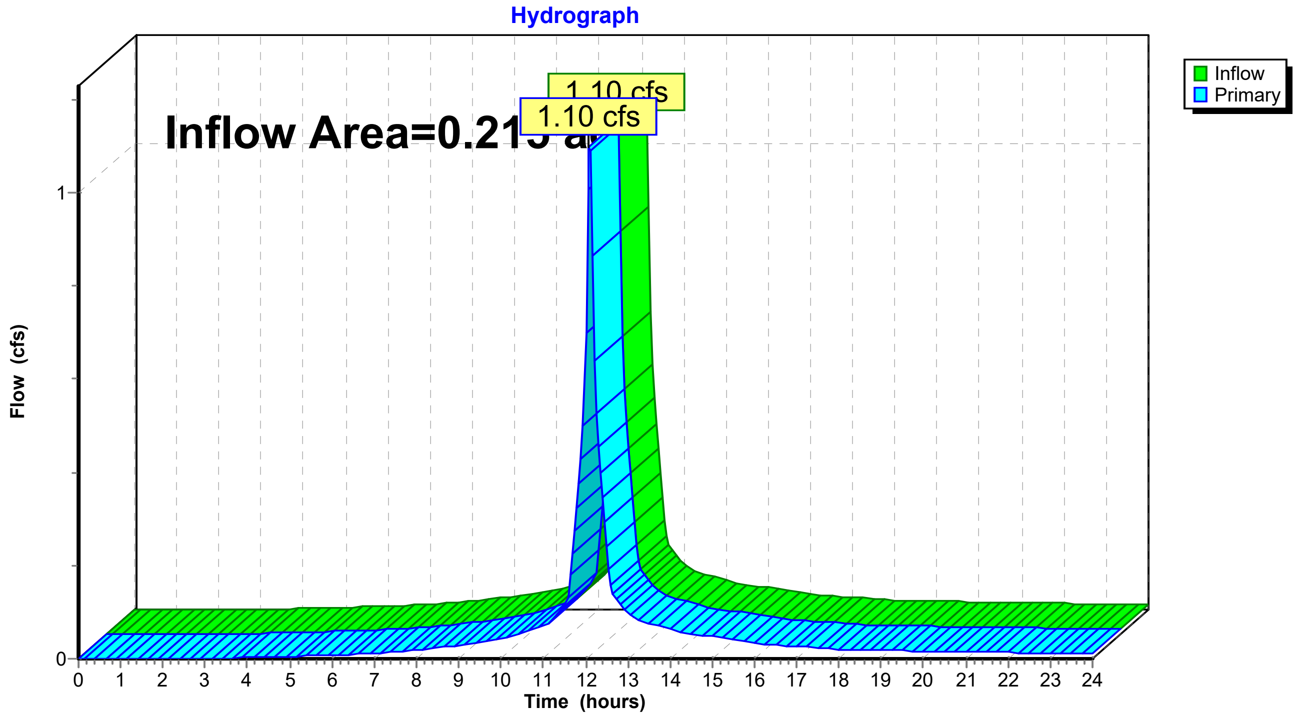


Summary for Link 2L: Main Street

Inflow Area = 0.215 ac, 75.21% Impervious, Inflow Depth > 4.74" for 25-yr event
Inflow = 1.10 cfs @ 12.09 hrs, Volume= 0.085 af
Primary = 1.10 cfs @ 12.09 hrs, Volume= 0.085 af, Atten= 0%, Lag= 0.0 min

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

Link 2L: Main Street



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 P-1: Building w Pool Area Runoff Area=56,366 sf 100.00% Impervious Runoff Depth>8.36"
Tc=6.0 min CN=98 Runoff=10.68 cfs 0.902 af

Subcatchment P-2: N'ly Exterior Runoff Area=13,123 sf 49.13% Impervious Runoff Depth>6.07"
Tc=6.0 min CN=79 Runoff=2.07 cfs 0.152 af

Subcatchment P-3: E'ly Driveway Runoff Area=8,294 sf 84.99% Impervious Runoff Depth>7.64"
Tc=6.0 min CN=92 Runoff=1.53 cfs 0.121 af

Subcatchment P-4A: W'ly Exterior Runoff Area=11,107 sf 15.03% Impervious Runoff Depth>3.80"
Tc=0.0 min UI Adjusted CN=60 Runoff=1.29 cfs 0.081 af

Subcatchment P-4B: Turnaround Runoff Area=7,008 sf 74.53% Impervious Runoff Depth>7.29"
Tc=0.0 min CN=89 Runoff=1.47 cfs 0.098 af

Subcatchment P-5: To Main St Runoff Area=1,078 sf 0.00% Impervious Runoff Depth>3.91"
Tc=6.0 min CN=61 Runoff=0.11 cfs 0.008 af

Pond 1P: Retain-It Sys 1 Peak Elev=153.52' Storage=26,417 cf Inflow=10.68 cfs 0.902 af
Discarded=0.18 cfs 0.311 af Primary=0.08 cfs 0.009 af Outflow=0.26 cfs 0.320 af

Pond 2P: Retain-It Sys 2 Peak Elev=146.77' Storage=4,577 cf Inflow=2.07 cfs 0.152 af
Outflow=0.04 cfs 0.053 af

Pond 3P: Drywell Peak Elev=149.89' Storage=321 cf Inflow=1.45 cfs 0.087 af
Discarded=0.02 cfs 0.023 af Primary=1.38 cfs 0.062 af Outflow=1.40 cfs 0.086 af

Pond 4P: RainGarden Peak Elev=174.34' Storage=231 cf Inflow=1.47 cfs 0.098 af
Discarded=0.01 cfs 0.015 af Primary=1.45 cfs 0.078 af Outflow=1.46 cfs 0.093 af

Link 1L: W'ly PL Inflow=2.68 cfs 0.143 af
Primary=2.68 cfs 0.143 af

Link 2L: Main Street Inflow=1.64 cfs 0.129 af
Primary=1.64 cfs 0.129 af

Total Runoff Area = 2.226 ac Runoff Volume = 1.362 af Average Runoff Depth = 7.34"
20.85% Pervious = 0.464 ac 79.15% Impervious = 1.762 ac

Summary for Subcatchment P-1: Building w Pool Area

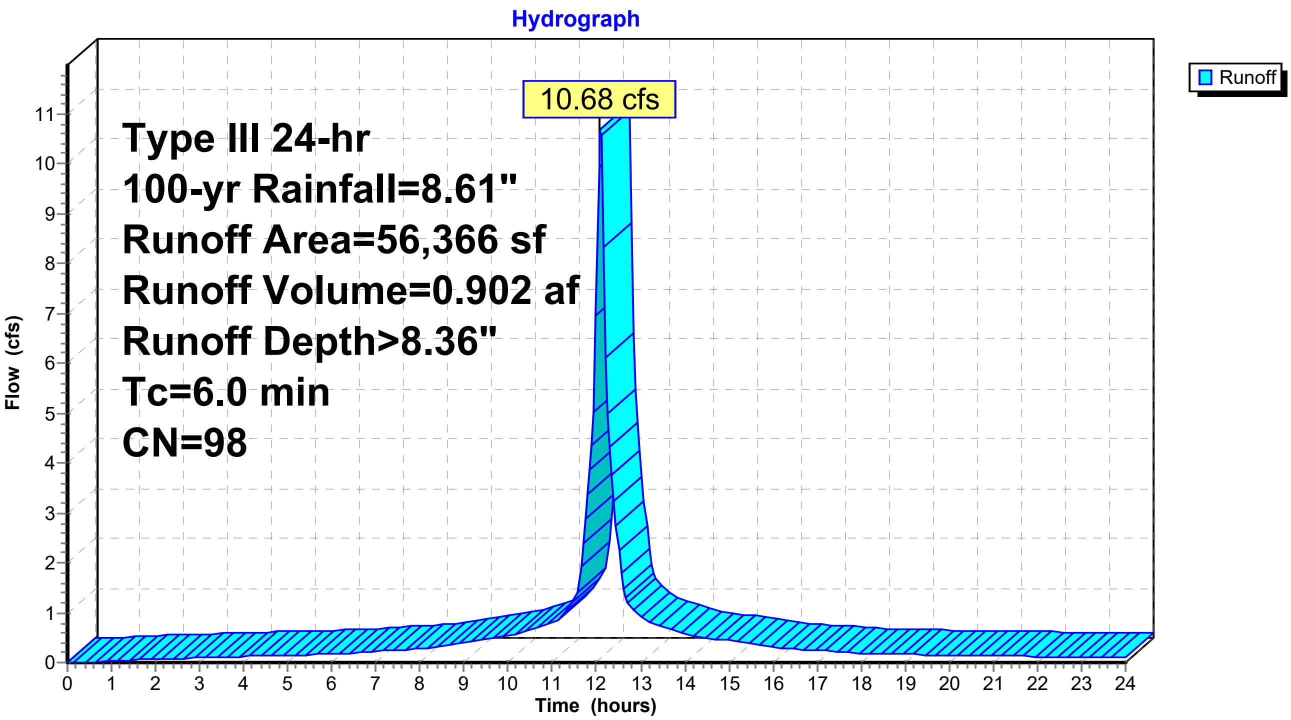
Runoff = 10.68 cfs @ 12.09 hrs, Volume= 0.902 af, Depth> 8.36"
Routed to Pond 1P : Retain-It Sys 1

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-yr Rainfall=8.61"

Area (sf)	CN	Description
629	98	Roofs, HSG A
55,737	98	Roofs, HSG B
56,366	98	Weighted Average
56,366		100.00% Impervious Area

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

Subcatchment P-1: Building w Pool Area



Summary for Subcatchment P-2: N'ly Exterior

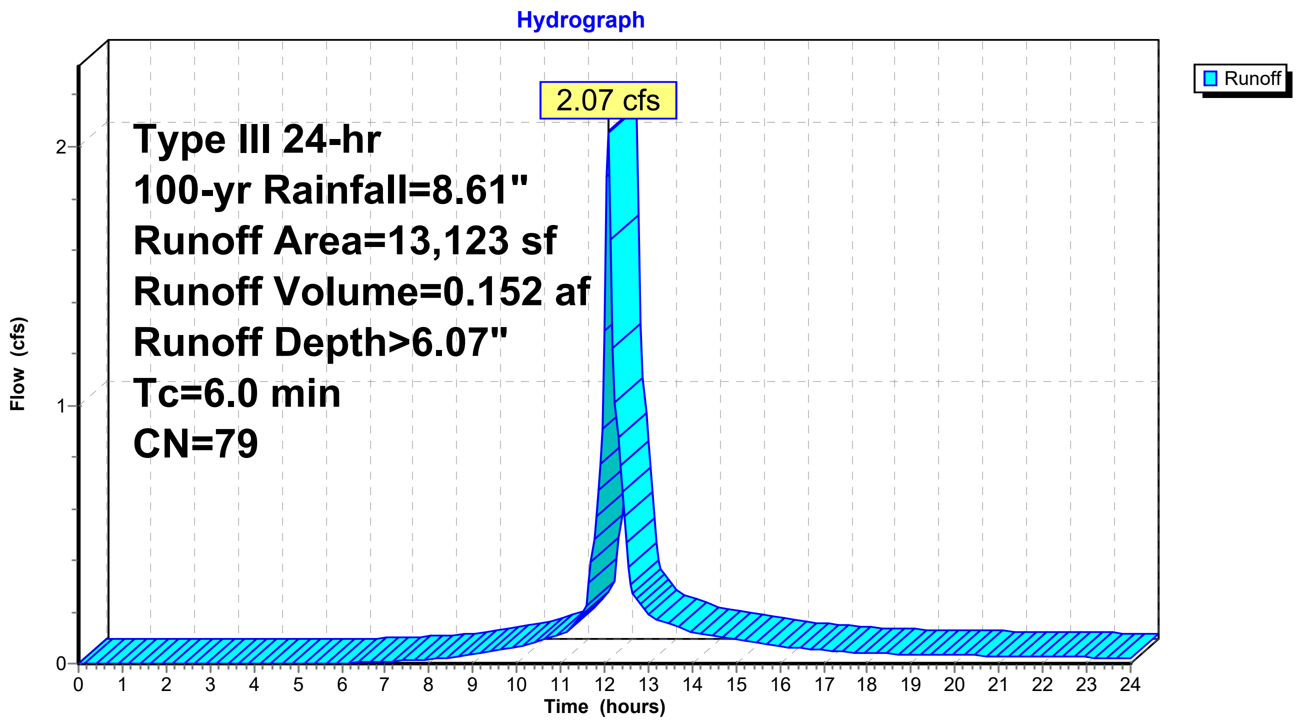
Runoff = 2.07 cfs @ 12.09 hrs, Volume= 0.152 af, Depth> 6.07"
Routed to Pond 2P : Retain-It Sys 2

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-yr Rainfall=8.61"

Area (sf)	CN	Description
6,676	61	>75% Grass cover, Good, HSG B
6,447	98	Paved parking, HSG B
13,123	79	Weighted Average
6,676		50.87% Pervious Area
6,447		49.13% Impervious Area

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

Subcatchment P-2: N'ly Exterior



Summary for Subcatchment P-3: E'ly Driveway

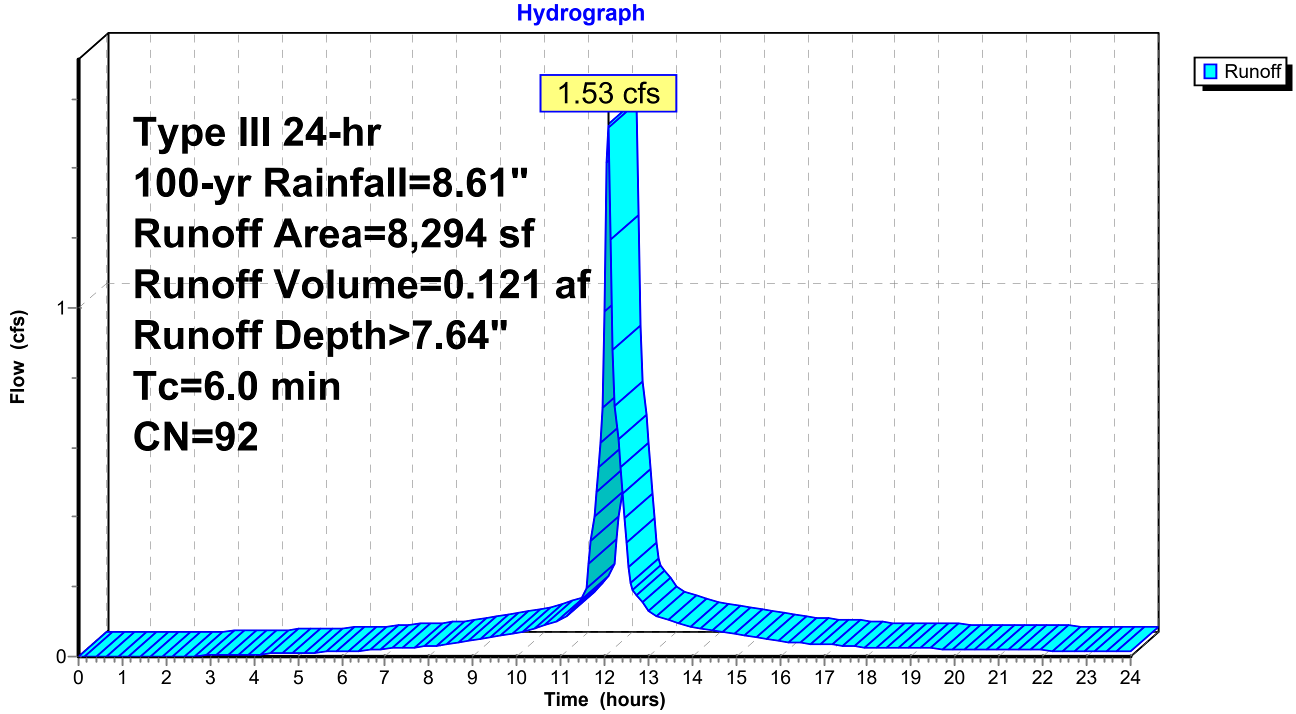
Runoff = 1.53 cfs @ 12.09 hrs, Volume= 0.121 af, Depth> 7.64"
Routed to Link 2L : Main Street

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-yr Rainfall=8.61"

Area (sf)	CN	Description
1,245	61	>75% Grass cover, Good, HSG B
7,049	98	Paved parking, HSG B
8,294	92	Weighted Average
1,245		15.01% Pervious Area
7,049		84.99% Impervious Area

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

Subcatchment P-3: E'ly Driveway



Summary for Subcatchment P-4A: W'ly Exterior

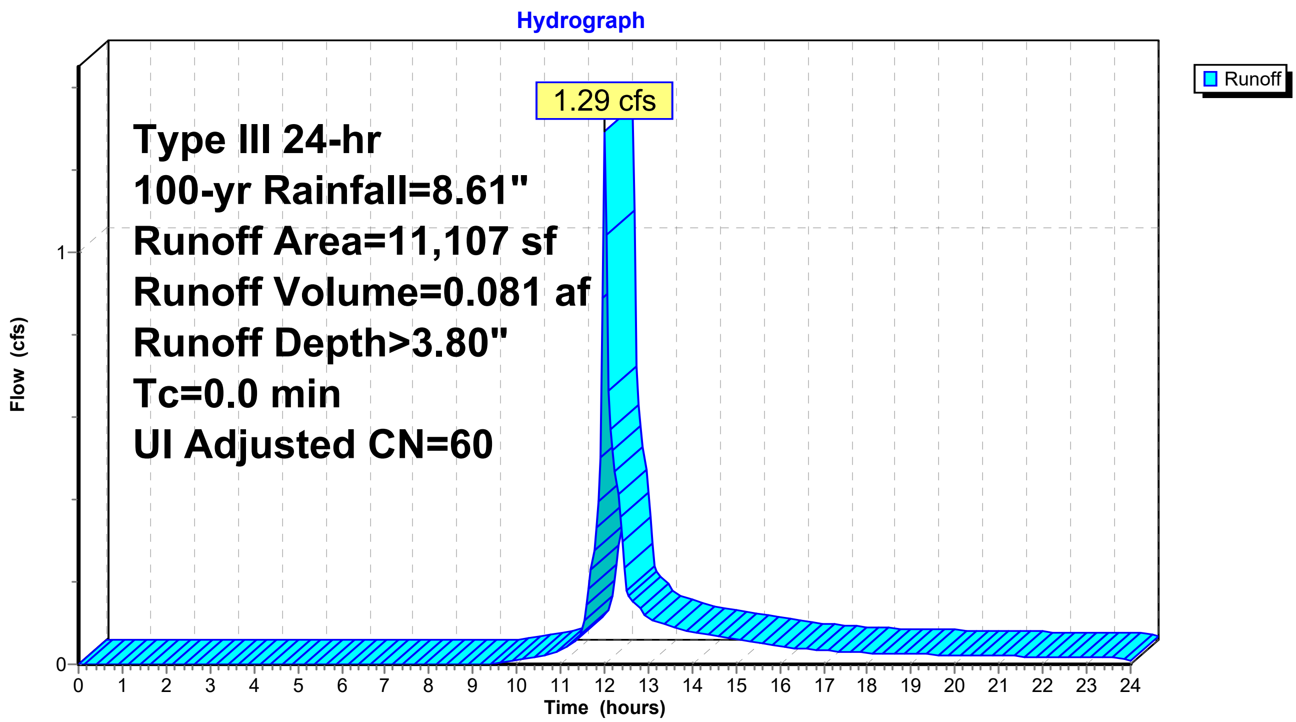
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 1.29 cfs @ 12.01 hrs, Volume= 0.081 af, Depth> 3.80"
Routed to Link 1L : W'ly PL

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-yr Rainfall=8.61"

Area (sf)	CN	Adj	Description
2,135	55		Woods, Good, HSG B
1,328	39		>75% Grass cover, Good, HSG A
5,975	61		>75% Grass cover, Good, HSG B
611	98		Unconnected pavement, HSG A
1,058	98		Unconnected pavement, HSG B
11,107	63	60	Weighted Average, UI Adjusted
9,438			84.97% Pervious Area
1,669			15.03% Impervious Area
1,669			100.00% Unconnected

Subcatchment P-4A: W'ly Exterior



Summary for Subcatchment P-4B: Turnaround

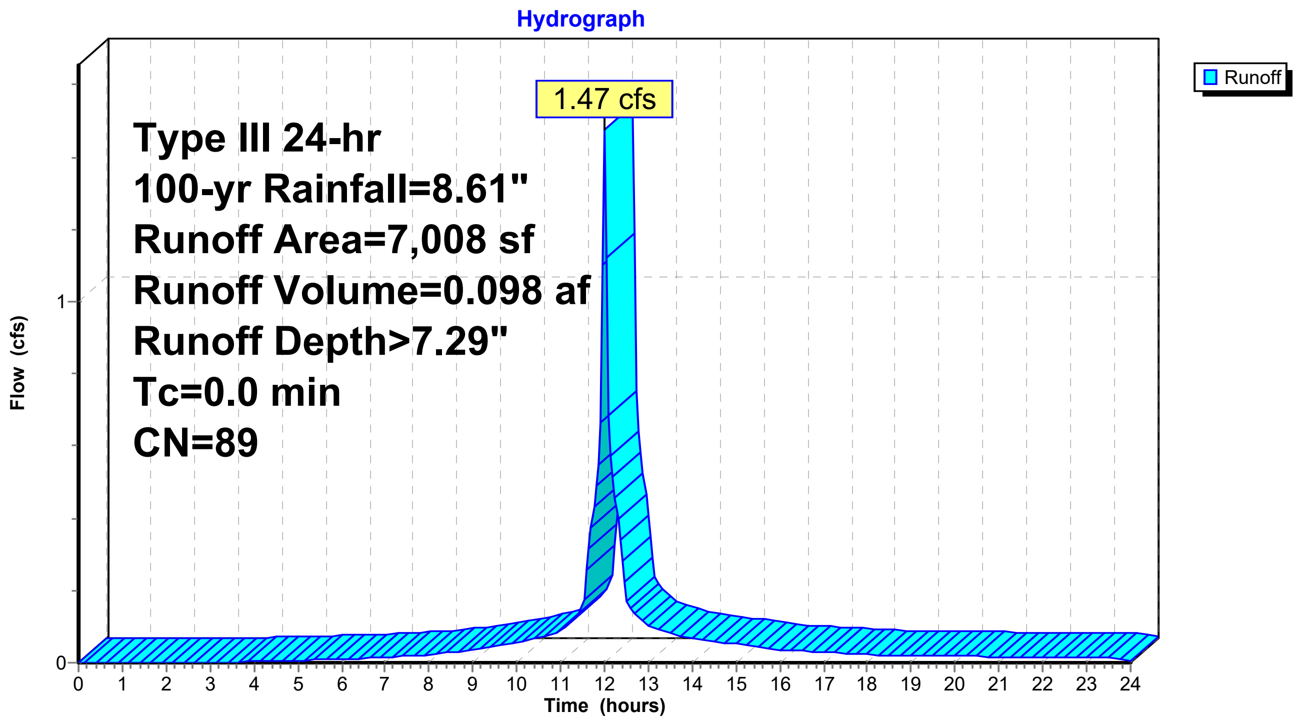
[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 1.47 cfs @ 12.00 hrs, Volume= 0.098 af, Depth> 7.29"
Routed to Pond 4P : RainGarden

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-yr Rainfall=8.61"

Area (sf)	CN	Description
1,785	61	>75% Grass cover, Good, HSG B
5,223	98	Paved parking, HSG B
7,008	89	Weighted Average
1,785		25.47% Pervious Area
5,223		74.53% Impervious Area

Subcatchment P-4B: Turnaround



Summary for Subcatchment P-5: To Main St

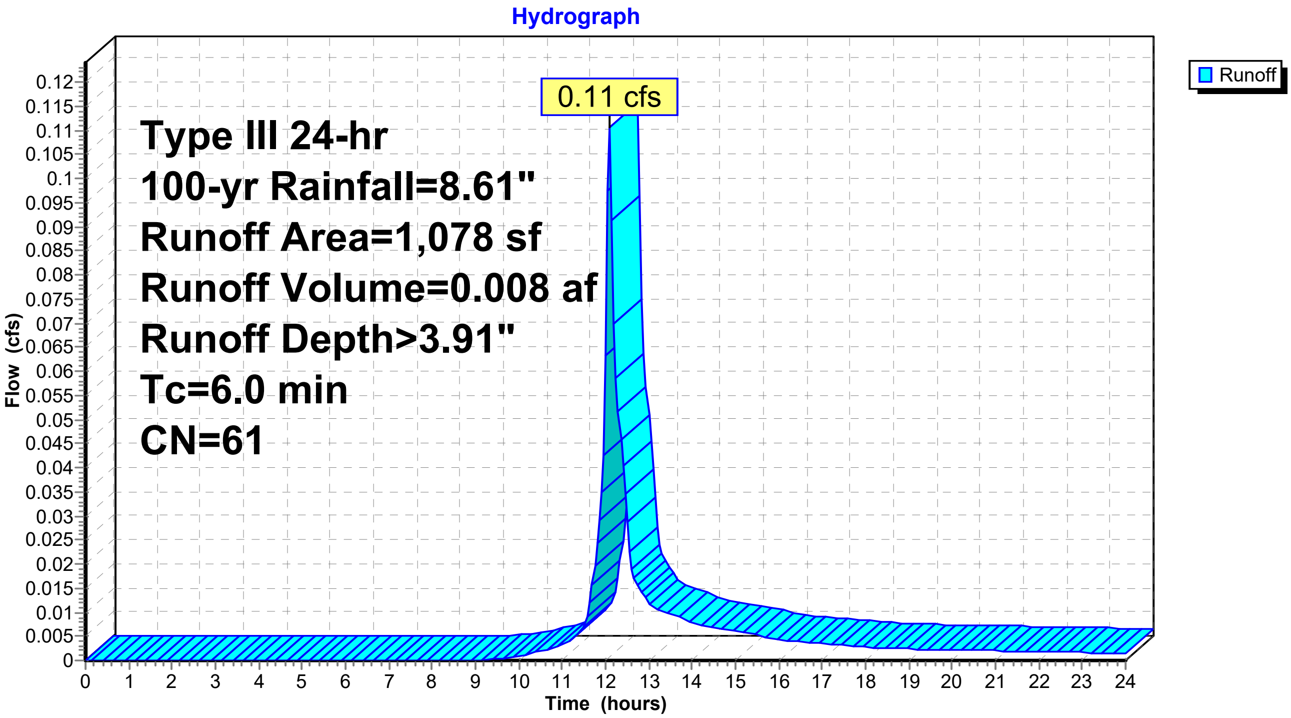
Runoff = 0.11 cfs @ 12.10 hrs, Volume= 0.008 af, Depth> 3.91"
Routed to Link 2L : Main Street

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-yr Rainfall=8.61"

Area (sf)	CN	Description
1,078	61	>75% Grass cover, Good, HSG B
1,078		100.00% Pervious Area

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

Subcatchment P-5: To Main St



Summary for Pond 1P: Retain-It Sys 1

Inflow Area = 1.294 ac,100.00% Impervious, Inflow Depth > 8.36" for 100-yr event
Inflow = 10.68 cfs @ 12.09 hrs, Volume= 0.902 af
Outflow = 0.26 cfs @ 16.66 hrs, Volume= 0.320 af, Atten= 98%, Lag= 274.7 min
Discarded = 0.18 cfs @ 6.65 hrs, Volume= 0.311 af
Primary = 0.08 cfs @ 16.66 hrs, Volume= 0.009 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 153.52' @ 16.66 hrs Surf.Area= 7,700 sf Storage= 26,417 cf

Plug-Flow detention time= 262.9 min calculated for 0.320 af (36% of inflow)
Center-of-Mass det. time= 81.8 min (821.7 - 739.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	148.50'	6,607 cf	**10.00'W x 770.00'L x 6.67'H Field A** 51,333 cf Overall - 34,816 cf Embedded = 16,517 cf x 40.0% Voids
#2A	149.50'	25,947 cf	**retain_it retain_it 5.0'** x 96 Inside #1 Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf 1 Rows adjusted for 2,015.7 cf perimeter wall
		32,554 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	148.50'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	152.80'	**12.0" Round Culvert** L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 152.80' / 152.00' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	153.50'	**7.0' 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=0.18 cfs @ 6.65 hrs HW=148.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=0.04 cfs @ 16.66 hrs HW=153.52' (Free Discharge)
└─**2=Culvert** (Passes 0.04 cfs of 1.73 cfs potential flow)
  └─**3=Broad-Crested Rectangular Weir** (Weir Controls 0.04 cfs @ 0.35 fps)

Pond 1P: Retain-It Sys 1 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 5.0' (retain-it®)
Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf
Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf
1 Rows adjusted for 2,015.7 cf perimeter wall

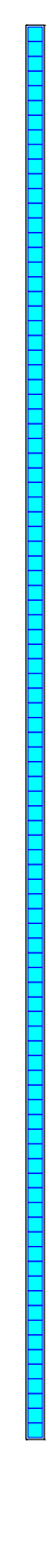
96 Chambers/Row x 8.00' Long = 768.00' Row Length +12.0" End Stone x 2 = 770.00' Base Length
1 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 10.00' Base Width
12.0" Stone Base + 68.0" Chamber Height = 6.67' Field Height

10.4 cf Sidewall x 96 x 2 + 10.4 cf Endwall x 1 x 2 = 2,015.7 cf Perimeter Wall
96 Chambers x 291.3 cf - 2,015.7 cf Perimeter wall = 25,947.2 cf Chamber Storage
96 Chambers x 362.7 cf = 34,816.0 cf Displacement

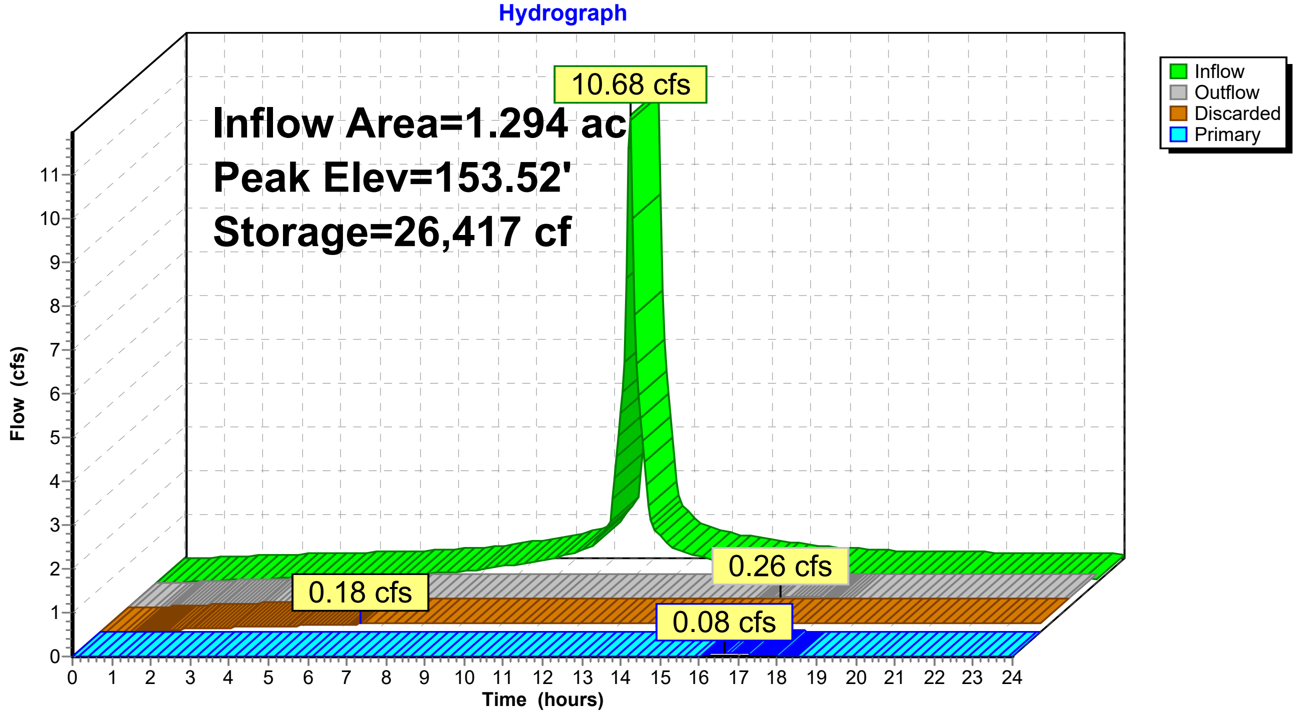
51,333.3 cf Field - 34,816.0 cf Chambers = 16,517.3 cf Stone x 40.0% Voids = 6,606.9 cf Stone Storage

Chamber Storage + Stone Storage = 32,554.2 cf = 0.747 af
Overall Storage Efficiency = 63.4%
Overall System Size = 770.00' x 10.00' x 6.67'

96 Chambers
1,901.2 cy Field
611.8 cy Stone



Pond 1P: Retain-It Sys 1



Summary for Pond 2P: Retain-It Sys 2

Inflow Area = 0.301 ac, 49.13% Impervious, Inflow Depth > 6.07" for 100-yr event
Inflow = 2.07 cfs @ 12.09 hrs, Volume= 0.152 af
Outflow = 0.04 cfs @ 9.45 hrs, Volume= 0.053 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.04 cfs @ 9.45 hrs, Volume= 0.053 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 146.77' @ 18.00 hrs Surf.Area= 1,700 sf Storage= 4,577 cf

Plug-Flow detention time= 290.4 min calculated for 0.053 af (34% of inflow)
Center-of-Mass det. time= 161.4 min (963.4 - 801.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	143.00'	953 cf	**50.00'W x 34.00'L x 5.17'H Field A**
			8,783 cf Overall - 6,400 cf Embedded = 2,383 cf x 40.0% Voids
#2A	144.00'	4,696 cf	**retain_it retain_it 3.5'** x 24 Inside #1
			Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
			Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
			6 Rows adjusted for 122.8 cf perimeter wall
		5,649 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	143.00'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.04 cfs @ 9.45 hrs HW=143.05' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Pond 2P: Retain-It Sys 2 - Chamber Wizard Field A

Chamber Model = retain_it retain_it 3.5' (retain-it®)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
6 Rows adjusted for 122.8 cf perimeter wall

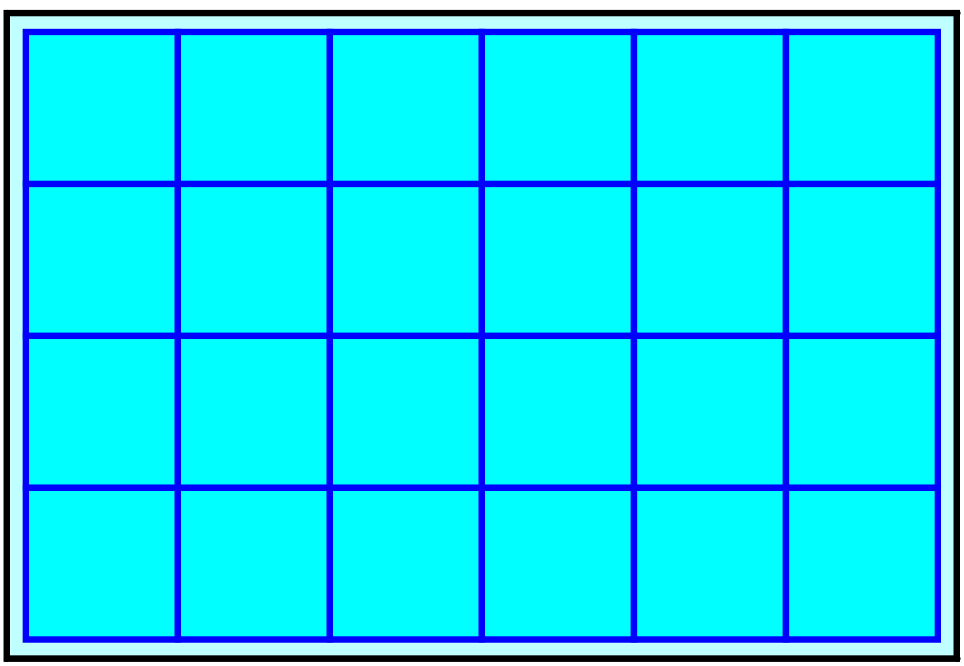
4 Chambers/Row x 8.00' Long = 32.00' Row Length +12.0" End Stone x 2 = 34.00' Base Length
6 Rows x 96.0" Wide + 12.0" Side Stone x 2 = 50.00' Base Width
12.0" Stone Base + 50.0" Chamber Height = 5.17' Field Height

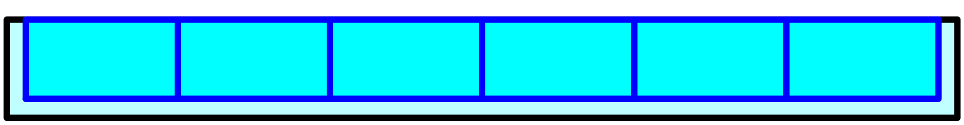
6.1 cf Sidewall x 4 x 2 + 6.1 cf Endwall x 6 x 2 = 122.8 cf Perimeter Wall
24 Chambers x 200.8 cf - 122.8 cf Perimeter wall = 4,695.9 cf Chamber Storage
24 Chambers x 266.7 cf = 6,400.0 cf Displacement

8,783.3 cf Field - 6,400.0 cf Chambers = 2,383.3 cf Stone x 40.0% Voids = 953.3 cf Stone Storage

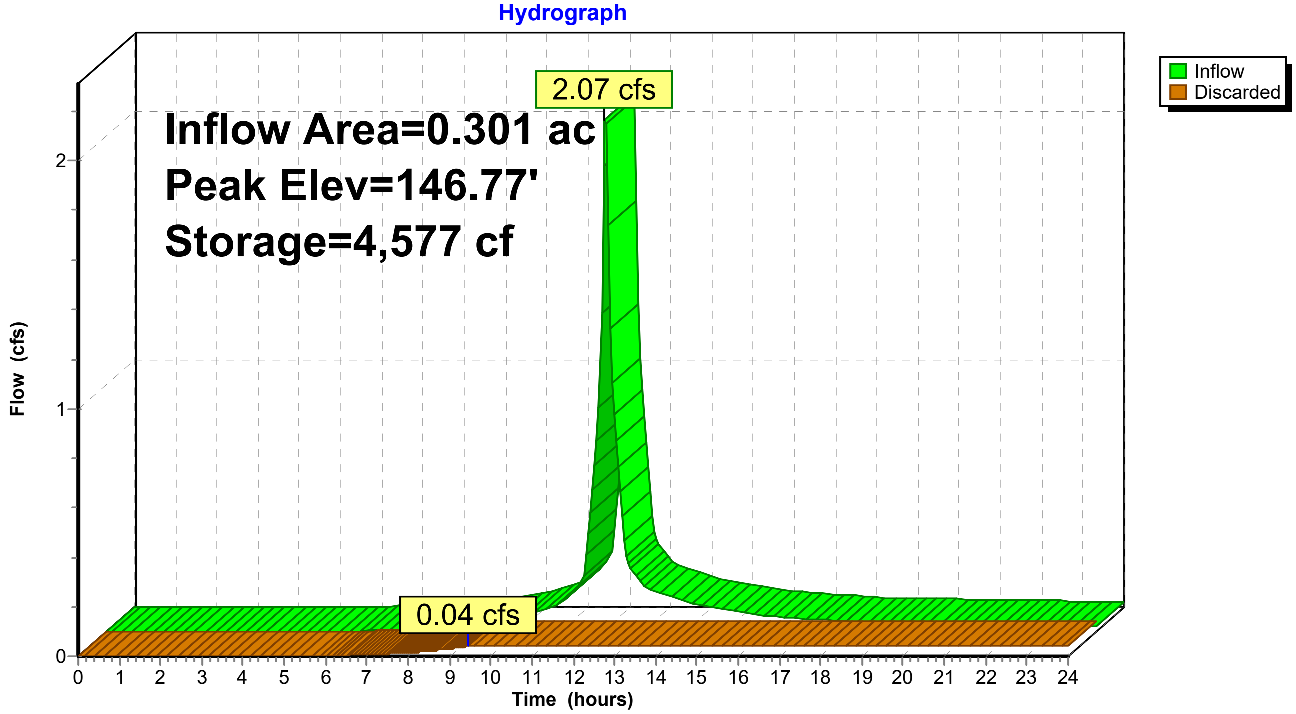
Chamber Storage + Stone Storage = 5,649.3 cf = 0.130 af
Overall Storage Efficiency = 64.3%
Overall System Size = 34.00' x 50.00' x 5.17'

24 Chambers
325.3 cy Field
88.3 cy Stone





Pond 2P: Retain-It Sys 2



Summary for Pond 3P: Drywell

[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=7)

Inflow Area = 1.455 ac, 97.18% Impervious, Inflow Depth > 0.72" for 100-yr event
Inflow = 1.45 cfs @ 12.00 hrs, Volume= 0.087 af
Outflow = 1.40 cfs @ 12.01 hrs, Volume= 0.086 af, Atten= 3%, Lag= 0.1 min
Discarded = 0.02 cfs @ 9.90 hrs, Volume= 0.023 af
Primary = 1.38 cfs @ 12.01 hrs, Volume= 0.062 af
Routed to Link 1L : W'ly PL

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 149.89' @ 12.01 hrs Storage= 321 cf

Plug-Flow detention time= 54.5 min calculated for 0.086 af (99% of inflow)
Center-of-Mass det. time= 47.8 min (845.8 - 798.0)

Volume	Invert	Avail.Storage	Storage Description
#1	142.80'	323 cf	**Custom Stage Data** Listed below

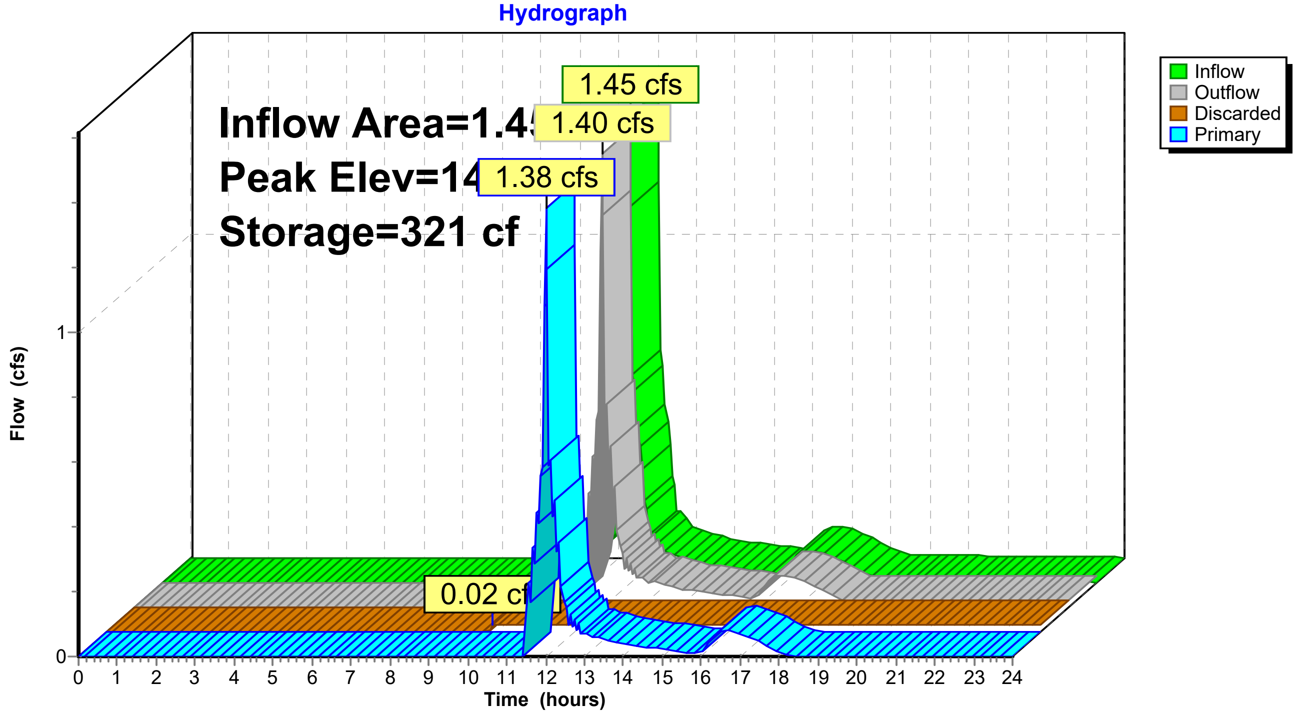
Elevation (feet)	Cum.Store (cubic-feet)
142.80	0
143.80	31
144.80	80
145.80	128
146.80	177
147.80	225
148.80	273
149.90	322
150.00	323

Device	Routing	Invert	Outlet Devices
#1	Discarded	142.80'	**0.02 cfs Exfiltration at all elevations**
#2	Primary	149.80'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 9.90 hrs HW=142.94' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.40 cfs @ 12.01 hrs HW=149.89' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 1.40 cfs @ 1.40 fps)

Pond 3P: Drywell



Summary for Pond 4P: RainGarden

[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=5)

Inflow Area = 0.161 ac, 74.53% Impervious, Inflow Depth > 7.29" for 100-yr event
Inflow = 1.47 cfs @ 12.00 hrs, Volume= 0.098 af
Outflow = 1.46 cfs @ 12.00 hrs, Volume= 0.093 af, Atten= 1%, Lag= 0.2 min
Discarded = 0.01 cfs @ 12.00 hrs, Volume= 0.015 af
Primary = 1.45 cfs @ 12.00 hrs, Volume= 0.078 af
Routed to Pond 3P : Drywell

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 174.34' @ 12.00 hrs Surf.Area= 395 sf Storage= 231 cf

Plug-Flow detention time= 43.3 min calculated for 0.093 af (95% of inflow)
Center-of-Mass det. time= 13.9 min (785.2 - 771.3)

Volume	Invert	Avail.Storage	Storage Description
#1	172.00'	904 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

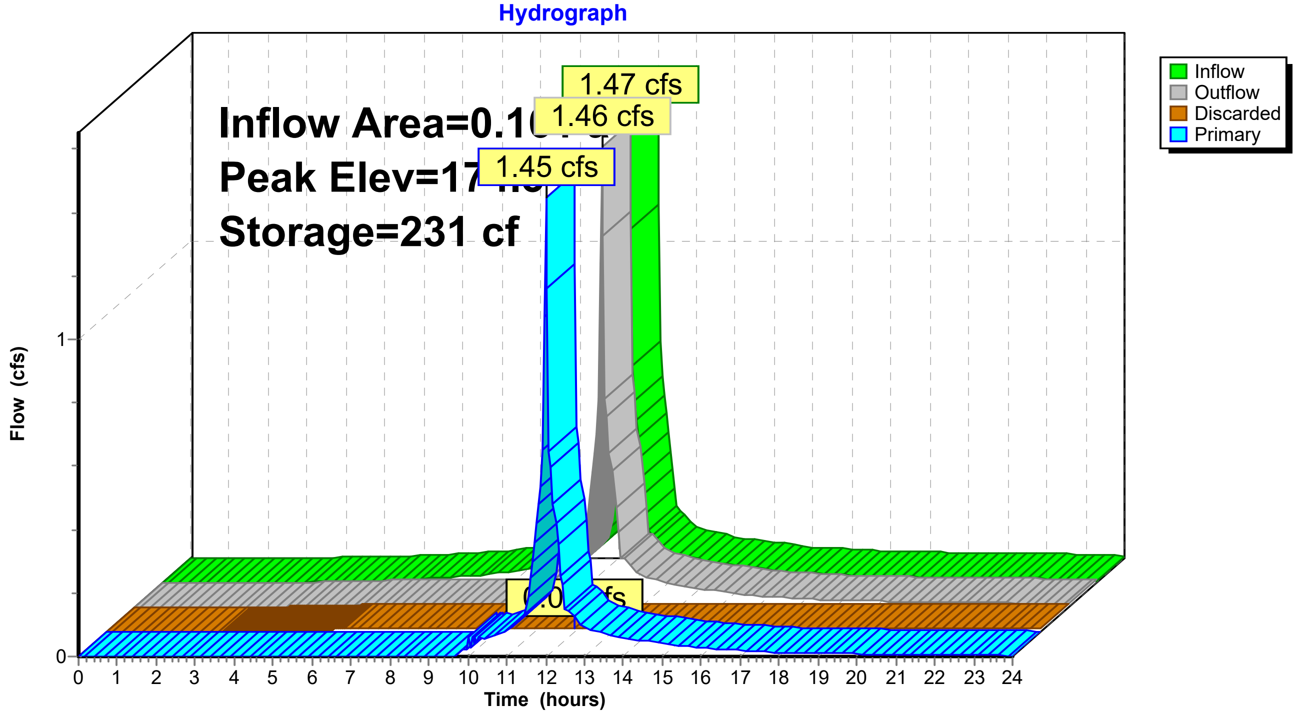
Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
172.00	394	0.0	0	0
174.50	395	25.0	247	247
175.50	919	100.0	657	904

Device	Routing	Invert	Outlet Devices
#1	Discarded	172.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	169.00'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 169.00' / 168.00' S= 0.0400 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf
#3	Device 2	174.25'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.00 hrs HW=174.34' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.43 cfs @ 12.00 hrs HW=174.34' (Free Discharge)
└─**2=Culvert** (Passes 1.43 cfs of 8.32 cfs potential flow)
  └─**3=Orifice/Grate** (Orifice Controls 1.43 cfs @ 1.43 fps)

Pond 4P: RainGarden

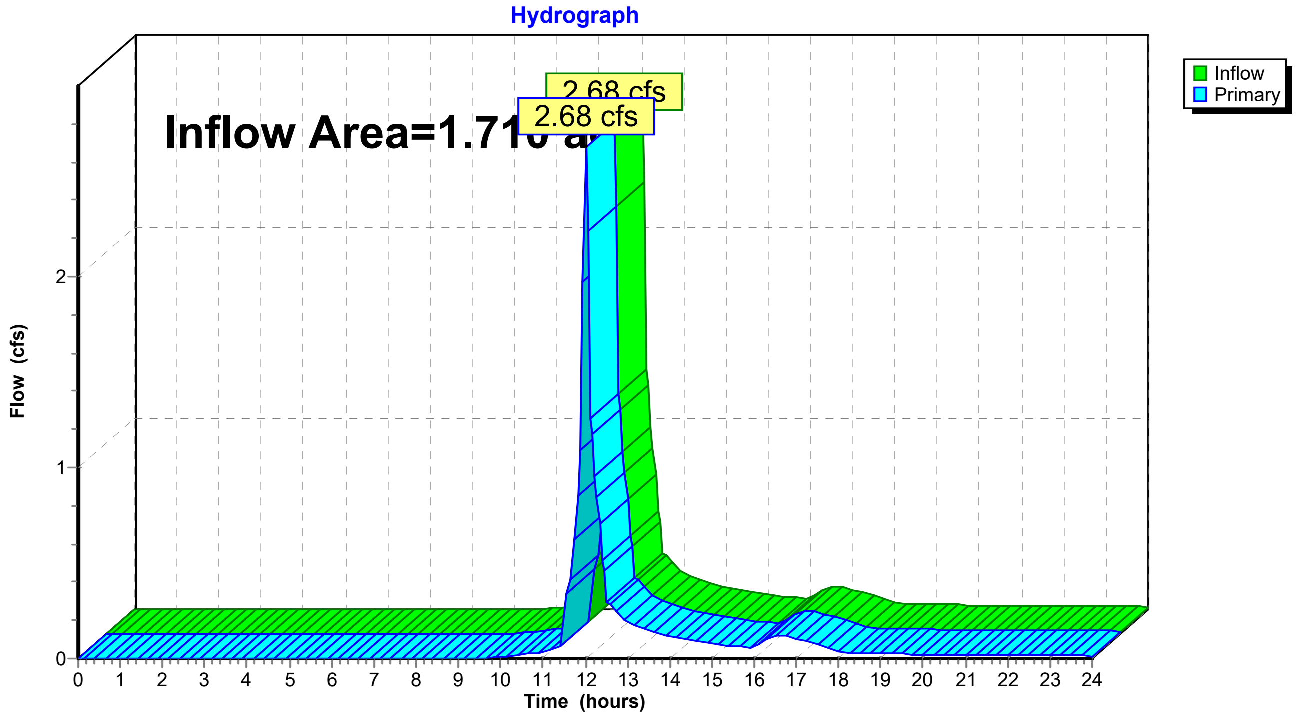


Summary for Link 1L: W'ly PL

Inflow Area = 1.710 ac, 84.93% Impervious, Inflow Depth > 1.00" for 100-yr event
Inflow = 2.68 cfs @ 12.01 hrs, Volume= 0.143 af
Primary = 2.68 cfs @ 12.01 hrs, Volume= 0.143 af, Atten= 0%, Lag= 0.0 min

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

Link 1L: W'ly PL

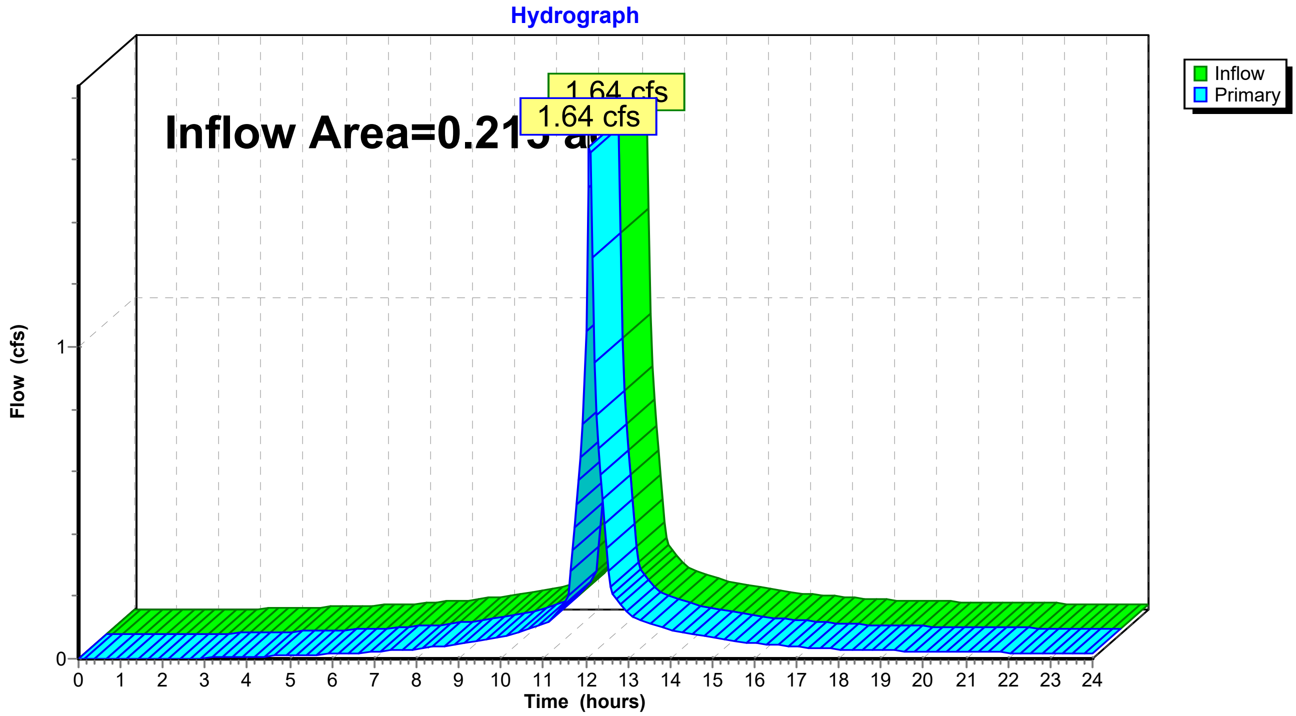


Summary for Link 2L: Main Street

Inflow Area = 0.215 ac, 75.21% Impervious, Inflow Depth > 7.21" for 100-yr event
Inflow = 1.64 cfs @ 12.09 hrs, Volume= 0.129 af
Primary = 1.64 cfs @ 12.09 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min

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

Link 2L: Main Street



APPENDIX F

SUPPORTING INFORMATION

ILLICIT DISCHARGE STATEMENT

Project: Multi-Family Residential Development
1486 Main Street
Waltham, MA

Date: May 25, 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

Philip Cordeiro
Print Name

Philip L Cordeiro
c=US, o=Allen and Major Associates Inc.,
ou=A01410C00000175798BB4FD00002012
, cn=Philip L Cordeiro
2022.06.14 17:53:28 -04'00'
Signature

Owner:
Limited Dividend Affiliate of
WP East Acquisitions, LLC
91 Hartwell Avenue
Lexington, MA 02421

Print Name

Signature

RAINFALL DATA

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	71.275 degrees West
Latitude	42.378 degrees North
Elevation	0 feet
Date/Time	Thu, 23 Dec 2021 13:51:22 -0500

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.54	0.70	0.88	1.11	**1yr**	0.76	1.05	1.28	1.63	2.07	2.64	2.85	**1yr**	2.34	2.74	3.23	3.91	4.57	**1yr**
2yr	0.35	0.54	0.67	0.88	1.11	1.39	**2yr**	0.96	1.28	1.61	2.02	2.53	3.16	3.50	**2yr**	2.80	3.36	3.86	4.60	5.24	**2yr**
5yr	0.42	0.65	0.81	1.09	1.39	1.77	**5yr**	1.20	1.60	2.05	2.57	3.21	3.99	4.45	**5yr**	3.53	4.28	4.90	5.84	6.54	**5yr**
10yr	0.47	0.74	0.93	1.27	1.65	2.11	**10yr**	1.42	1.90	2.46	3.09	3.85	4.77	5.34	**10yr**	4.22	5.14	5.88	6.99	7.73	**10yr**
25yr	0.56	0.89	1.14	1.56	2.07	2.68	**25yr**	1.79	2.38	3.12	3.92	4.88	6.03	6.81	**25yr**	5.33	6.55	7.48	8.89	9.66	**25yr**
50yr	0.63	1.02	1.31	1.83	2.47	3.22	**50yr**	2.13	2.83	3.77	4.73	5.87	7.20	8.19	**50yr**	6.37	7.87	8.98	10.66	11.44	**50yr**
100yr	0.72	1.17	1.52	2.15	2.94	3.86	**100yr**	2.54	3.36	4.53	5.69	7.04	8.61	9.85	**100yr**	7.62	9.47	10.79	12.79	13.55	**100yr**
200yr	0.84	1.37	1.77	2.54	3.50	4.62	**200yr**	3.02	3.99	5.42	6.82	8.43	10.30	11.85	**200yr**	9.12	11.39	12.96	15.35	16.05	**200yr**
500yr	1.02	1.68	2.18	3.17	4.43	5.87	**500yr**	3.82	5.02	6.91	8.69	10.73	13.06	15.14	**500yr**	11.56	14.56	16.53	19.55	20.09	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.36	0.45	0.60	0.74	0.83	**1yr**	0.64	0.81	1.10	1.45	1.77	2.26	2.50	**1yr**	2.00	2.40	2.76	3.53	4.04	**1yr**
2yr	0.33	0.51	0.63	0.85	1.05	1.26	**2yr**	0.91	1.23	1.44	1.90	2.44	3.09	3.41	**2yr**	2.73	3.28	3.70	4.49	5.11	**2yr**
5yr	0.39	0.60	0.74	1.02	1.29	1.49	**5yr**	1.12	1.46	1.72	2.24	2.87	3.71	4.12	**5yr**	3.28	3.96	4.52	5.42	6.09	**5yr**
10yr	0.43	0.67	0.82	1.15	1.49	1.70	**10yr**	1.29	1.66	1.90	2.52	3.23	4.24	4.72	**10yr**	3.76	4.54	5.12	6.26	6.93	**10yr**
25yr	0.50	0.76	0.95	1.35	1.78	2.00	**25yr**	1.53	1.96	2.23	2.96	3.78	5.05	5.62	**25yr**	4.47	5.41	5.99	7.54	8.20	**25yr**
50yr	0.55	0.84	1.05	1.51	2.03	2.28	**50yr**	1.75	2.23	2.50	3.35	4.26	5.74	6.42	**50yr**	5.08	6.17	6.67	8.68	9.33	**50yr**
100yr	0.61	0.93	1.16	1.68	2.30	2.59	**100yr**	1.98	2.53	2.81	3.44	4.80	6.54	7.28	**100yr**	5.78	7.00	7.40	9.98	10.61	**100yr**
200yr	0.68	1.03	1.30	1.89	2.63	2.94	**200yr**	2.27	2.87	3.17	3.80	5.42	7.41	8.25	**200yr**	6.56	7.93	8.13	11.48	12.04	**200yr**
500yr	0.79	1.18	1.52	2.20	3.14	3.48	**500yr**	2.71	3.40	3.70	4.35	6.39	8.71	9.67	**500yr**	7.71	9.30	9.03	13.79	14.24	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.32	0.49	0.59	0.80	0.98	1.16	**1yr**	0.85	1.13	1.35	1.79	2.26	2.83	3.07	**1yr**	2.50	2.95	3.45	4.19	4.89	**1yr**
2yr	0.37	0.57	0.70	0.94	1.16	1.36	**2yr**	1.00	1.33	1.57	2.08	2.67	3.25	3.61	**2yr**	2.88	3.48	4.04	4.73	5.40	**2yr**
5yr	0.45	0.70	0.86	1.19	1.51	1.80	**5yr**	1.30	1.76	2.04	2.64	3.35	4.31	4.83	**5yr**	3.81	4.64	5.31	6.28	6.99	**5yr**
10yr	0.54	0.84	1.04	1.45	1.87	2.22	**10yr**	1.61	2.17	2.57	3.19	4.02	5.36	6.06	**10yr**	4.74	5.83	6.63	7.81	8.57	**10yr**
25yr	0.70	1.07	1.33	1.90	2.50	2.94	**25yr**	2.16	2.87	3.43	4.11	5.11	7.16	8.22	**25yr**	6.33	7.90	8.95	10.43	11.24	**25yr**
50yr	0.85	1.29	1.61	2.31	3.11	3.64	**50yr**	2.68	3.56	4.26	4.99	6.14	8.94	10.35	**50yr**	7.91	9.95	11.23	13.01	13.79	**50yr**
100yr	1.03	1.56	1.96	2.83	3.88	4.50	**100yr**	3.34	4.40	5.30	6.60	7.37	11.20	13.07	**100yr**	9.91	12.57	14.20	16.23	16.93	**100yr**
200yr	1.25	1.89	2.39	3.46	4.83	5.57	**200yr**	4.17	5.44	6.60	8.12	8.84	14.06	16.55	**200yr**	12.44	15.92	18.01	20.28	20.79	**200yr**
500yr	1.63	2.42	3.12	4.53	6.45	7.35	**500yr**	5.56	7.18	8.83	10.69	11.25	19.03	22.66	**500yr**	16.84	21.78	24.76	27.23	27.32	**500yr**

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

November 20, 2020

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.

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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

Map Scale: 1:1,030 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 20, Jun 9, 2020

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

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
251B	Haven silt loam, 3 to 8 percent slopes	0.1	4.1%
420B	Canton fine sandy loam, 3 to 8 percent slopes	0.1	2.8%
424D	Canton fine sandy loam, 15 to 25 percent slopes, extremely bouldery	0.0	0.1%
656	Udorthents-Urban land complex	2.2	93.0%
Totals for Area of Interest		**2.4**	**100.0%**

Map Unit Descriptions

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

251B—Haven silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 990d
Elevation: 30 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Haven

Setting

Landform: Plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over loose sandy glaciofluvial deposits

Typical profile

H1 - 0 to 2 inches: silt loam
H2 - 2 to 20 inches: silt loam
H3 - 20 to 32 inches: very fine sandy loam
H4 - 32 to 65 inches: stratified coarse sand to sand to fine sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 18 to 36 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 capacity: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY023CT - Well Drained Outwash
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 9 percent
Landform: Plains, terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Scio

Percent of map unit: 5 percent
Landform: Terraces, depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Unnamed

Percent of map unit: 1 percent

420B—Canton fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2w81b
Elevation: 0 to 1,180 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Canton

Setting

Landform: Ridges, moraines, hills
Landform position (two-dimensional): Backslope, summit, shoulder
Landform position (three-dimensional): Side slope, crest, nose slope
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 7 inches: fine sandy loam
Bw1 - 7 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: gravelly fine sandy loam
2C - 26 to 65 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Scituate

Percent of map unit: 10 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Footslope, backslope, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Montauk

Percent of map unit: 5 percent
Landform: Drumlins, hills, ground moraines, moraines
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Charlton

Percent of map unit: 4 percent
Landform: Hills, ground moraines, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Swansea

Percent of map unit: 1 percent

Landform: Kettles, swamps, bogs, depressions, marshes
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

424D—Canton fine sandy loam, 15 to 25 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: vqs3
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Canton

Setting

Landform: Hills
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 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: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 9.0 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 capacity: Very low (about 2.9 inches)

Interpretive groups

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

Minor Components

Charlton

Percent of map unit: 10 percent
Landform: Ground moraines, drumlins
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent
Landform: Eskers, ridges, terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

656—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 995k
Elevation: 0 to 3,000 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

Udorthents 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 Udorthents

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

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

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

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Plains, terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Paxton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

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WATER QUALITY SIZING (CONTECH)

Project:	**1486 Main St**
Location:	**Waltham, MA**
Prepared For:	**Allen & Major / Paul Maros**

CONTECH ENGINEERED SOLUTIONS

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

Q = (qu) (A) (WQV)

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
PCB 1	0.10	0.0001563	6.0	0.100	1.00	774.00	0.12

Brief Stormceptor Sizing Report - PCB 1

Project Information & Location			
Project Name	1486 Main St	**Project Number**	698607
City	Waltham	**State/ Province**	Massachusetts
Country	United States of America	**Date**	1/11/2022
Designer Information		**EOR Information (optional)**	
Name	Jim Lyons	**Name**	Paul Matos
Company	Contech Engineered Solutions	**Company**	Allen & Major Assoc
Phone #	413-246-5151	**Phone #**	413-246-5151
Email	jimlyons413@gmail.com	**Email**	pmatos@allenmajor.com

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	PCB 1
Target TSS Removal (%)	80
TSS Removal (%) Provided	96
Recommended Stormceptor Model	STC 450i

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

Stormceptor Sizing Summary	
Stormceptor Model	**% TSS Removal Provided**
STC 450i	96
STC 900	98
STC 1200	98
STC 1800	98
STC 2400	99
STC 3600	99
STC 4800	99
STC 6000	99
STC 7200	99
STC 11000	100
STC 13000	100
STC 16000	100

Stormceptor®

CONTECH ENGINEERED SOLUTIONS

Sizing Details

Drainage Area	
Total Area (acres)	0.26
Imperviousness %	38.0

Rainfall	
Station Name	BLUE HILL
State/Province	Massachusetts
Station ID #	0736
Years of Records	58
Latitude	42°12'44"N
Longitude	71°6'53"W

Water Quality Objective	
TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (Gal)	
Peak Conveyed Flow Rate (CFS)	1.69
Water Quality Flow Rate (CFS)	0.12

Up Stream Storage	
Storage (ac-ft)	Discharge (cfs)
0.000	0.000

Up Stream Flow Diversion	
Max. Flow to Stormceptor (cfs)	

Particle Size Distribution (PSD)
The selected PSD defines TSS removal

OK-110

Particle Diameter (microns)	Distribution %	Specific Gravity
1.0	0.0	2.65
53.0	3.0	2.65
75.0	15.0	2.65
88.0	25.0	2.65
106.0	41.0	2.65
125.0	15.0	2.65
150.0	1.0	2.65
212.0	0.0	2.65

Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX

Stormceptor®

Stormwater Treatment Made Simple!

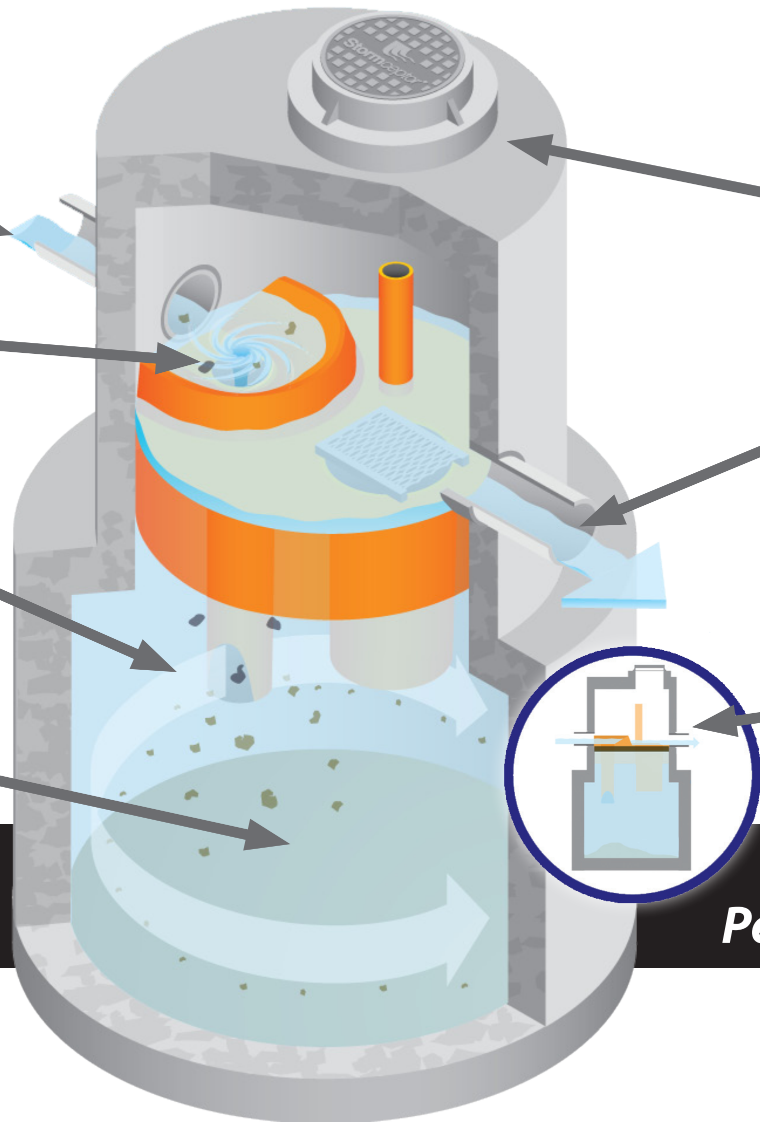
TSS & Oil Removal ■ *Scour Prevention* ■ *Small Footprint*

Dirty water enters the unit

Inlet Vortex draws pollutants into the lower chamber

Optimized for hydraulic efficiency, pollutant capture and retention

Large pollutant storage volume reduces maintenance frequency



Easy to inspect and maintain

Clean water enters the environment

Spill protection limits liability

Design Flexibility

Proven Performance

Environmentally Engineered Stormwater Solutions...
that exceed your client's needs!

A calm treatment environment

CONTECH® ENGINEERED SOLUTIONS

Stormceptor® STC

Stormceptor® is an underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention. With thousands of systems operating worldwide, Stormceptor delivers protection every day in every storm.

With patented technology, optimal treatment occurs by allowing free oil to rise and sediment to settle. The Stormceptor design prohibits scour and release of previously captured pollutants, ensuring superior treatment and protection during even the most extreme storm events.

Stormceptor is very easy to design and provides flexibility under varying site constraints such as tight right-of-ways, zero lot lines and retrofit projects. Design flexibility allows for a cost-effective approach to stormwater treatment. Stormceptor has proven performance backed by the longest record of lab and field verification in the industry.

Tested Performance

- Fine particle capture
- Prevents scour or release
- 95%+ Oil removal

Massachusetts – Water Quality (Q) Flow Rate

Stormceptor STC Model	Inside Diameter (ft)	Typical Depth Below Inlet Pipe Invert [1] (in)	Water Quality Flow Rate Q [2] (cfs)	Peak Conveyance Flow Rate [3] (cfs)	Hydrocarbon Capacity [4] (Gallons)	Maximum Sediment Capacity [4] (ft^3)
STC 450i	4	68	0.40	5.5	86	46
STC 900	6	63	0.89	22	251	89
STC 2400	8	104	1.58	22	840	205
STC 4800	10	140	2.47	22	909	543
STC 7200	12	148	3.56	22	1,059	839
STC 11000	2 x 10	142	4.94	48	2,792	1,086
STC 16000	2 x 12	148	7.12	48	3,055	1,677

[1] Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity can vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special designs or site conditions. Contact your local representative for assistance.
[2] Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.
[3] Peak Conveyance Flow Rate is based upon ideal velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.
[4] Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.

APPENDIX G

OPERATION & MAINTENANCE PLAN

OPERATION & MAINTENANCE PLAN

Multi-Family Development
1486 Main Street Waltham, MA

Prepared: January 14, 2022
Revised: May 26, 2022

Site Locus

CLIENT:
Limited Dividend Affiliate of
WP East Acquisitions, LLC
91 Hartwell Avenue
Lexington, MA 02421

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

allenmajor.com

OPERATION & MAINTENANCE PLAN

Multi-Family Development
1486 Main Street Waltham, MA

PROPONENT:
Limited Dividend Affiliate of
WP East Acquisitions, LLC
91 Hartwell Avenue
Lexington, MA 02421

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

ISSUED:
January 14, 2022

REVISED:
May 26, 2022

A&M PROJECT NO.:
1670-14

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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 Multi-Family Development located at 1486 Main Street in Waltham, 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 a Limited Dividend Affiliate of WP East Acquisitions, 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 Conservation Commission (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 Commission that the succeeding owner has assumed such responsibility.

1.3 CONTACT INFORMATION

Stormwater Management System Owner:	Limited Dividend Affiliate of WP East Acquisitions, LLC 91 Hartwell Avenue Lexington, MA 02421 Phone: TBD

Emergency Contact Information:

Limited Dividend Affiliate of WP East Acquisitions, LLC (Owner/Operator)	Phone: TBD
Waltham Engineering Department	Phone: 781-314-3835
Waltham Fire Department (non-emergency line)	Phone: 781-314-3710
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 City 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 City'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 de-icing 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, a sub-surface infiltration system consisting of ReTain-It concrete chambers, a closed gravity pipe network an outlet control structure.
  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. The building rooftop runoff discharges to one of the sub-surface infiltration systems.

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*
- *Water Quality Structures*
- *Raingarden*

- *Sub-Surface Infiltration Systems (ReTain-It Concrete Chambers)*
- *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.

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.

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.

1.9 TREATMENT BMPS

Rain Gardens:

Rain gardens are shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation. Rain gardens use soils, plants and microbes to treat stormwater before it is infiltrated and/or discharged.

Rain gardens require careful attention while plants are being established and seasonal landscaping maintenance thereafter. Inspect pretreatment devices and cells regularly for sediment build-up, structural damage and standing water. Inspect soil and repair eroded areas monthly. Re-mulch void areas as needed. Remove litter and debris monthly. Treat diseased vegetation as needed. Remove and replace dead vegetation twice per year (spring & fall). Remove invasive species as needed to prevent these species from spreading into the area. Replace mulch every two (2) years, in the early spring.

Upon failure, contact the design engineer. At a minimum the area should be excavated, scarify bottom and sides, replace filter fabric and soil, replant and mulch.

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:

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

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Kathleen A. Theoharides
Secretary

Martin Suuberg
Commissioner

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.

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:**

ALLEN & MAJOR ASSOCIATES, INC.

Project: Multi-Family Development
Project Address: 1486 Main Street Waltham, MA

Responsible for O&M Plan: WP East Acquisitions, LLC
Address: 91 Hartwell Avenue Lexington, MA 02421
Phone:

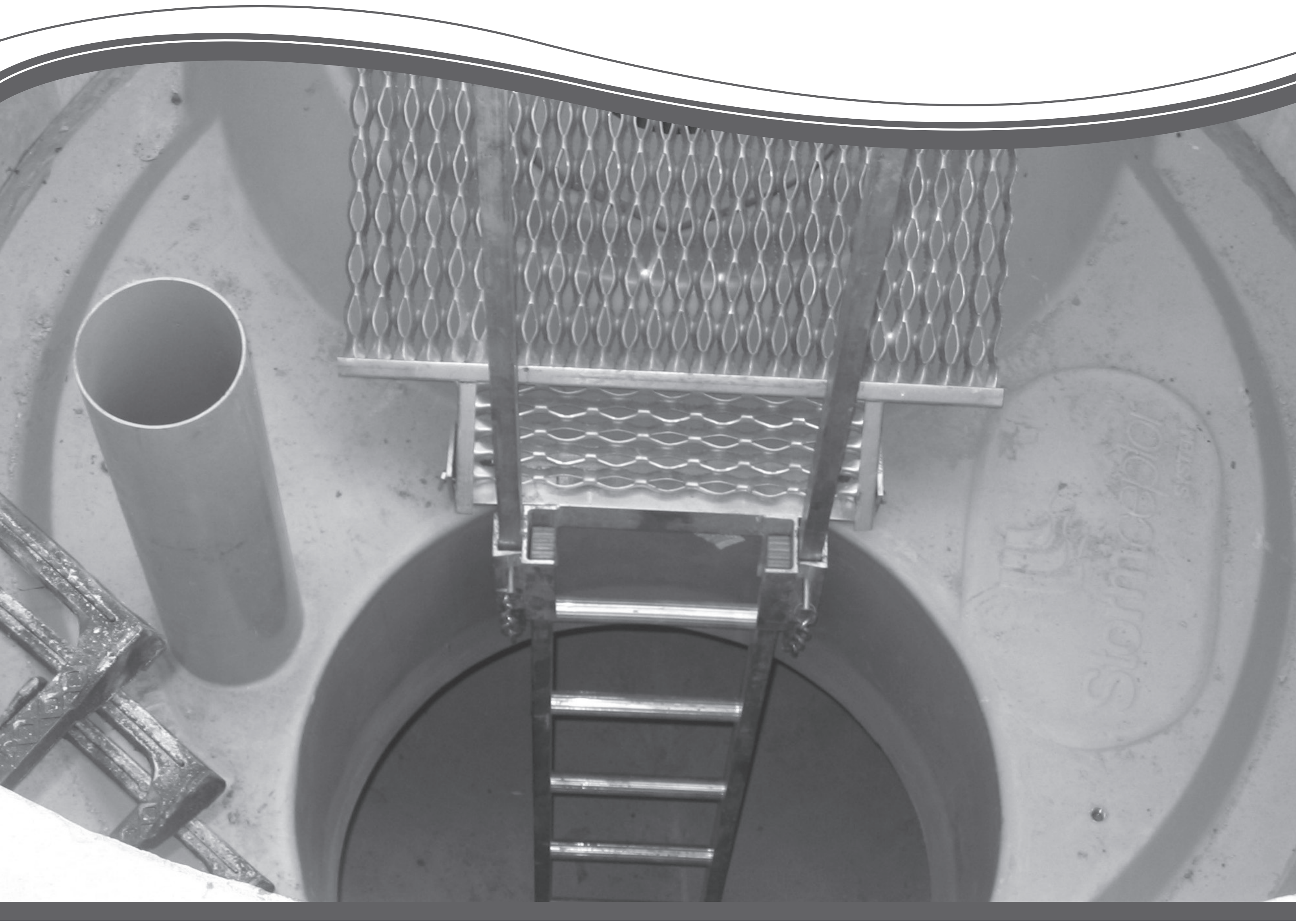
All information within table is derived from Massachussetts Stormwater Handbook: Volume 2, Chapter 2

BMP CATEGORY	BMP OR MAINTENANCE ACTIVITY	SCHEDULE/ FREQUENCY	NOTES	ESTIMATED ANNUAL MAINTENANCE COST	INSPECTION PERFORMED	
					DATE:	BY:
STRUCTURAL PRETREATMENT BMPs	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.	$1,000		
TREATMENT BMPs	BIORETENTION AREA & RAIN GARDEN	Remove trash monthly. Remove and replace dead vegetation, prune and mulch annually.	Inspect & remove trash, Mulch, Remove dead vegetation, Replace dead vegetation, Prune, Replace entire media & all vegetation.	$2,000		
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.	$2,500		
BMP ACCESSORIES	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		

BMP CATEGORY	BMP OR MAINTENANCE ACTIVITY	SCHEDULE/ FREQUENCY	NOTES	ESTIMATED ANNUAL MAINTENANCE COST	INSPECTION PERFORMED	
					DATE:	BY:
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.	$300		
	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.	$500		
	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	$500		

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 ft^3 (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.

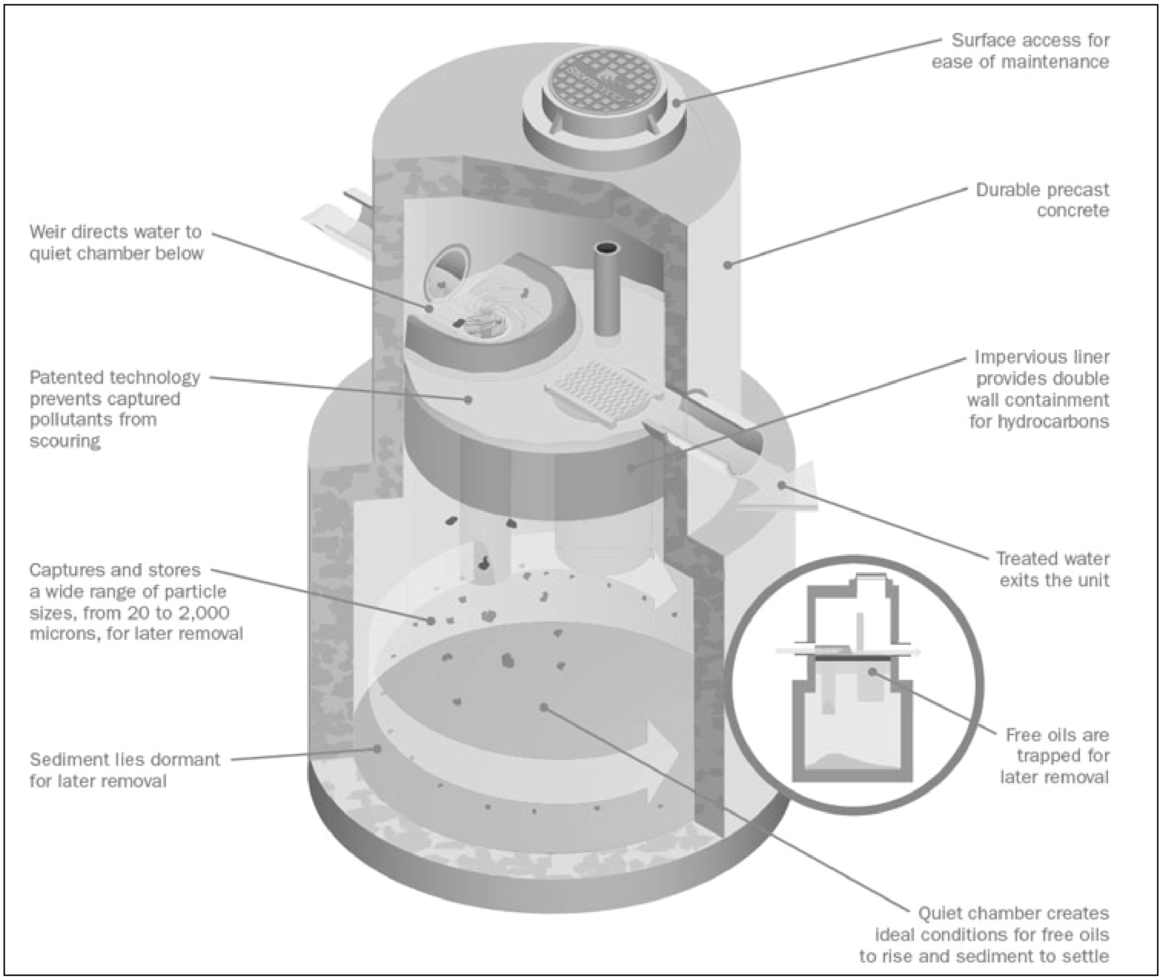


Figure 1. Inline Stormceptor

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.

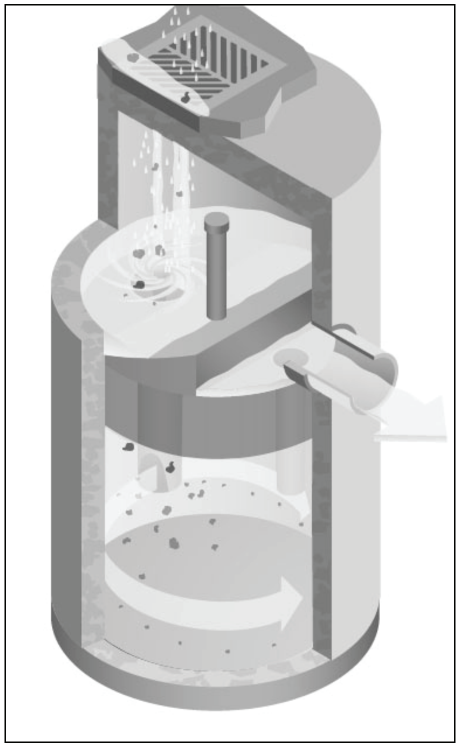


Figure 2. Inlet Stormceptor

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.

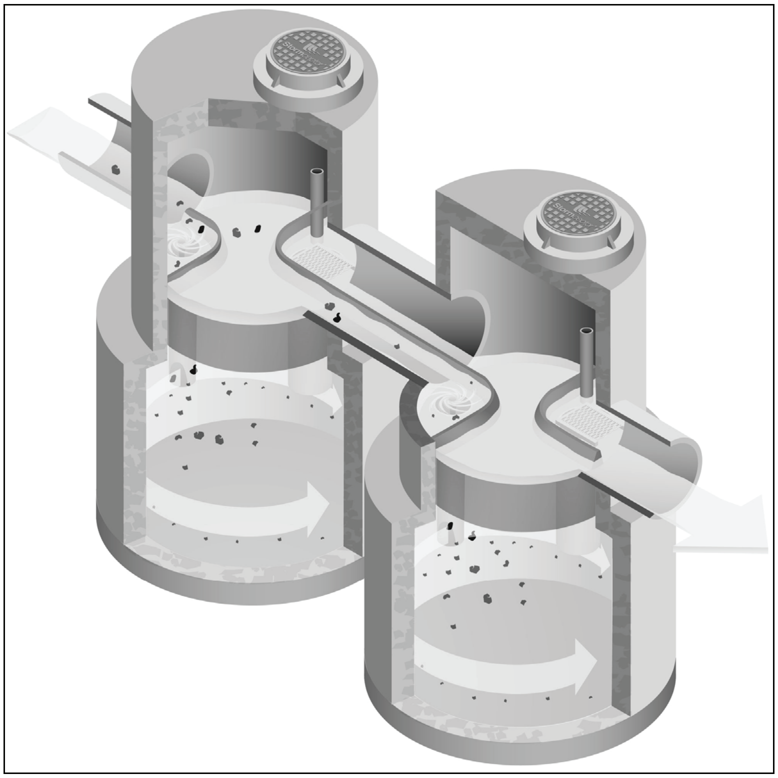


Figure 3. Series System

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.

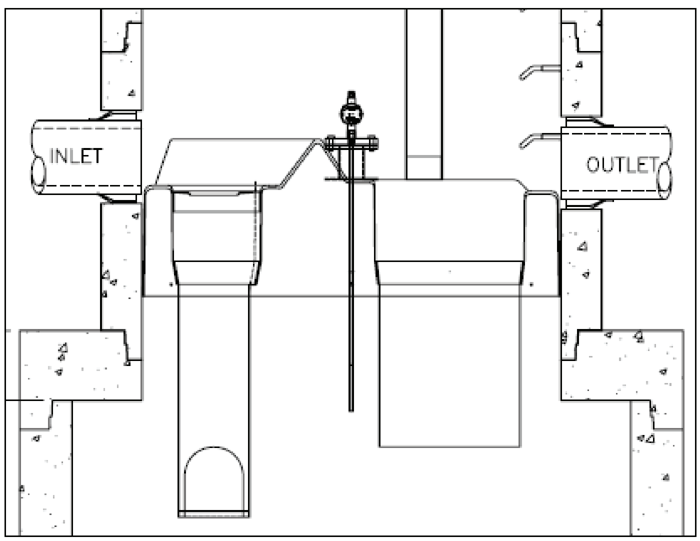


Figure 4. Oil level alarm

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

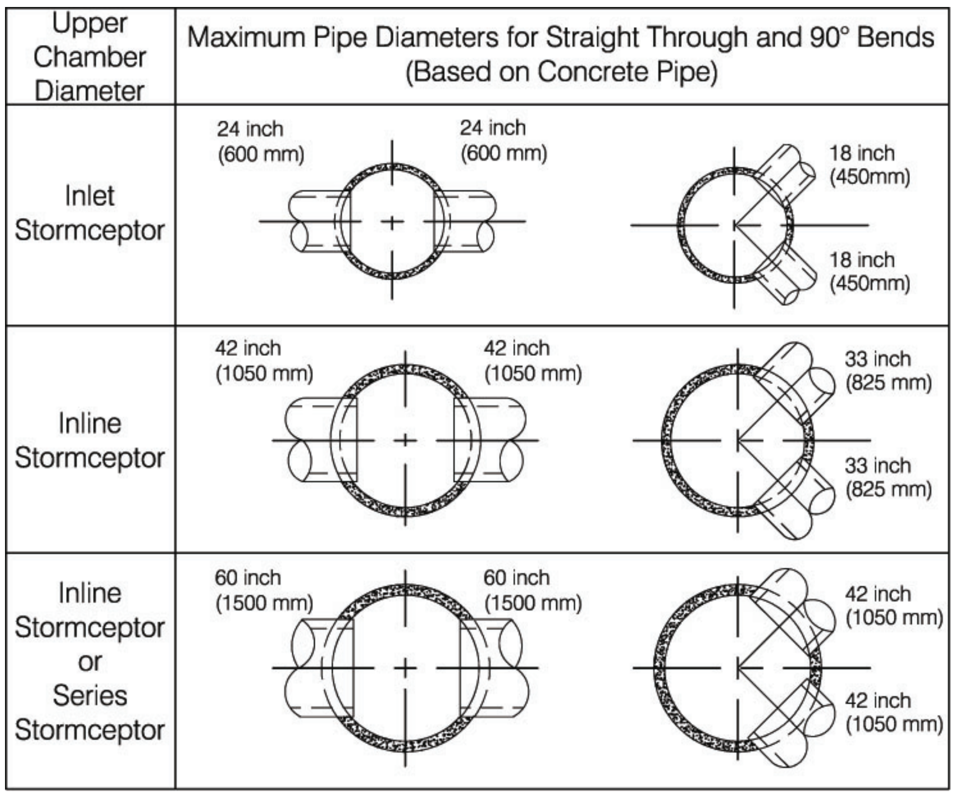


Figure 5. Maximum pipe diameters for straight through and bend applications

*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.

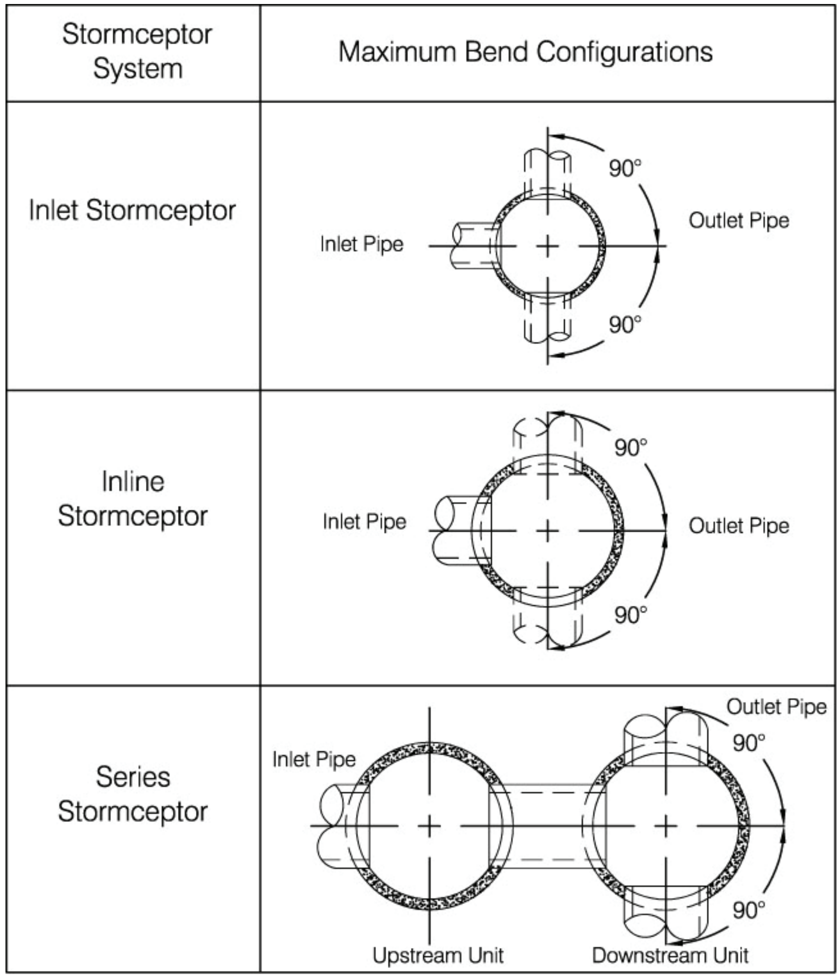


Figure 6. Maximum bend angles

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

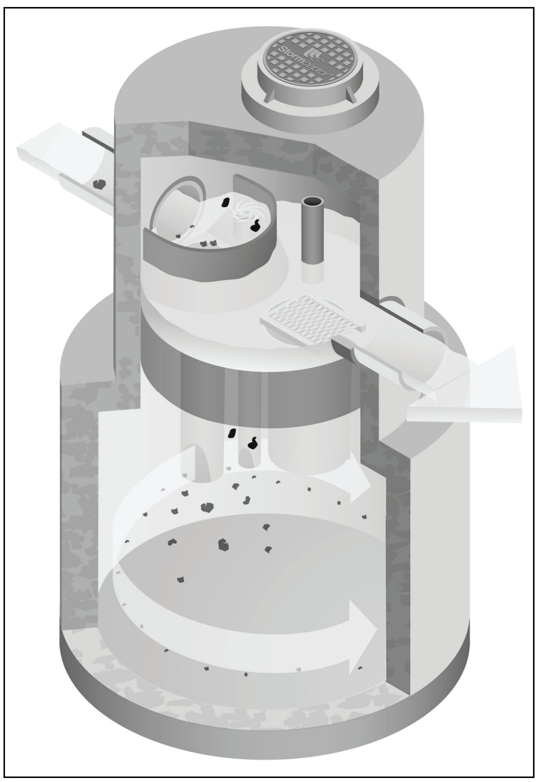


Figure 7. Submerged Stormceptor

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

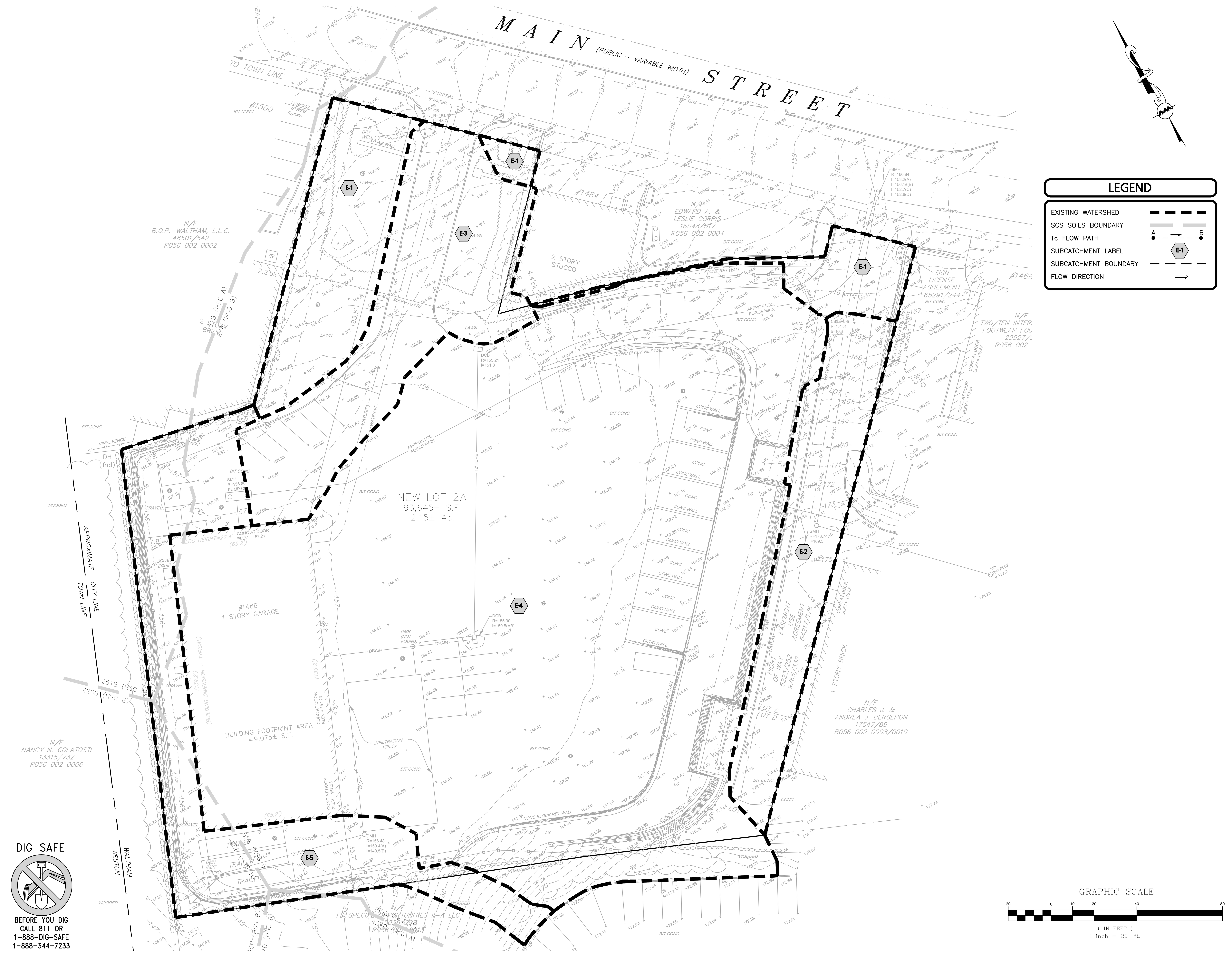
800-925-5240
www.ContechES.com

APPENDIX B SITE PLANS

SITE PLAN

APPENDIX H
WATERSHED PLANS

EXISTING WATERSHED PLAN EWS-1



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JANUARY 20, 2022 REV. 05-26-22

COMMONWEALTH OF MASSACHUSETTS
PHILIP L. CORDEIRO
CIVIL
NO. 47083
REGISTERED PROFESSIONAL ENGINEER

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PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

REV	DATE	DESCRIPTION
01	05-26-22	FIRE ACCESS & SITE LAYOUT

APPLICANT\OWNER:
WP EAST ACQUISITIONS, LLC
91 HARTWELL AVENUE, 3RD FLOOR
LEXINGTON, MA 02421

PROJECT:
1486 MAIN STREET
WALTHAM, MA

PROJECT NO.	1670-14	DATE:	01-20-2022
SCALE:	1" = 20'	DWG. NAME:	C1670-14_
DESIGNED BY:	PGM	CHECKED BY:	PLC

PREPARED BY:
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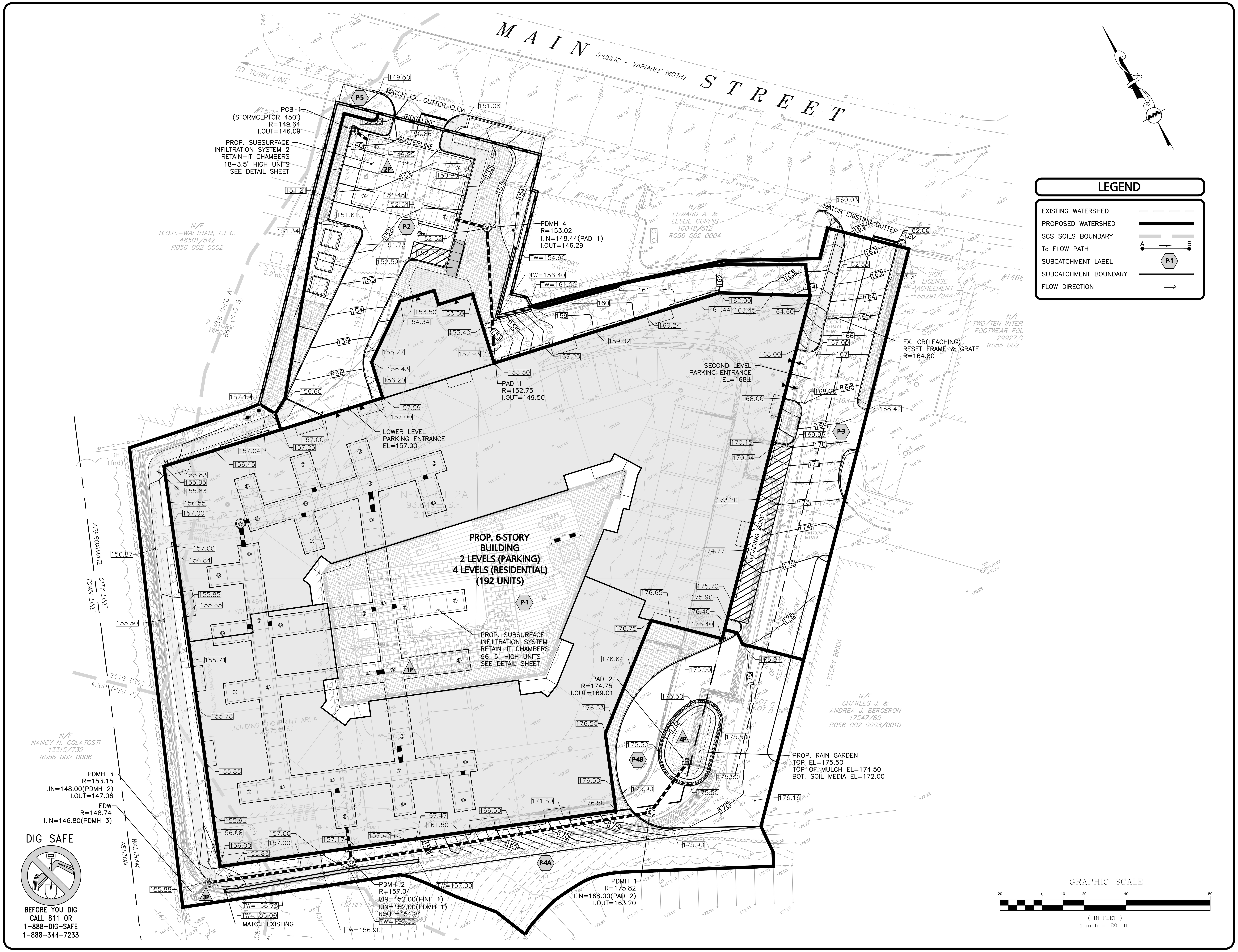
WOBURN, MA ◆ LAKEVILLE, MA ◆ MANCHESTER, NH

DRAWING TITLE: EXISTING WATERSHED PLAN

SHEET No. EWS-1

PROPOSED WATERSHED PLAN – PWS-1



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COMMONWEALTH OF MASSACHUSETTS PHILIP L CORDEIRO CIVIL NO. 47083 REGISTERED PROFESSIONAL ENGINEER

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PROPOSED WATERSHED PLAN	PWS-1