ATTACHMENT H

ACORN ENGINEERING, INC.

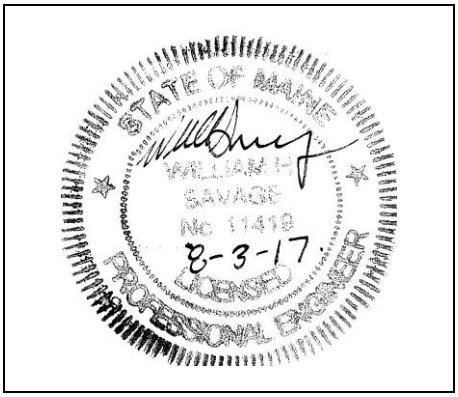
FINAL STORMWATER MANAGEMENT REPORT

Prepared For:

BD Sheridan LLC
Vazza Real Estate Group
1266 Furnace Brook Parkway Suite 300
Quincy, Massachusetts 02169

Prepared By:

Acorn Engineering, Inc.
158 Danforth Street
Portland, Maine 04102



March 2017
Revised July 2017

INTRODUCTION

Acorn Engineering, Inc. has been retained by BD Sheridan LLC to provide civil engineering services for the proposed urban infill project at 155 Sheridan Street. The proposed project is to develop an existing single family, 1.5-story residence into a high-density, 19-unit apartment building.

A stormwater analysis was prepared to demonstrate that the project will meet the following requirements of the City of Portland (the City):

- City of Portland Land Use Ordinance Chapter 14, Article V. Site Plan Section 14-523. Required Approvals and Applicability (F) Level III Site Plan Review.
- City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards and Maine DEP Chapter 500 Stormwater Management.

The proposed project will include the redevelopment of existing, impervious area including a rooftop, and concrete steps and walkways. The project will result in a net increase of impervious area above 1,000 sf, and, as such, is required to include stormwater management features for stormwater quality & quantity control. The stormwater analysis is documented with supporting calculations and reports attached to this narrative.

The current course of action is to provide primary water quality treatment to the stormwater via filtration utilizing a subsurface chamber sand filter, or underdrain subsurface sand filter (USSF) designed per Chapter 7.3 of Volume III of the Maine Stormwater Management BMP manual. The implemented BMP system is to provide water quality treatment for no less than 95% of the new impervious area and 80% of the developed area. For this stormwater analysis, water quality and quantity benefits as a result from the proposed green roof have not been taken into consideration during the modeling of rain events. The green roof will cover approximately 36% of the building.

EXISTING CONDITIONS

The proposed project site is located on Sheridan Street between Cumberland Ave and Walnut Street within the East End neighborhood on Munjoy Hill. A boundary plan has been prepared by Titcomb Associates of Falmouth, Maine dated March 4, 2016 and revised January 30, 2017.

Abutting Uses:

➢	North	R-6 Zone	Multi-Family Residential
➢	West	R-6 Zone	Multi-Family Residential
➢	South	B-2b Zone	Community Business
➢	East	R-6 Zone	Multi-Family Residential

Fort Sumner Park directly abuts the property to the east.

Most of the site is pervious with dense overgrowth and limited mature tree growth. The average grade is relatively steep. The existing dwelling is sided by a concrete walk and stairway with the steps continuing into the property. There are also two retaining walls further into the site, potentially continuing into the northernmost abutting property.

The project team is not aware of the presence of any existing significant natural features located on the site. Given the urban setting, and existing free-draining soils, a field inventory of significant natural features was not undertaken. The project is not located within a watershed classified as an Urban Impaired Stream.

PROPOSED DEVELOPMENT

The proposed project is a 19-unit redevelopment of an existing single-family lot. Covered, garage parking will be provided on-site on the first floor of the building, below the residential units. Select residential units on the second and third floors will have access to outdoor patios which will drain to the filter BMP. Due to the existing steep conditions, portions of the site will have greater slopes that will require structural retaining walls and riprap support. The reminder of the property will be landscaped.

Most of the added impervious surface will be generated by the new roof surface from the building footprint. The new runoff will be collected and piped from the rooftop to a subsurface, detention system below the patios outside the third-floor apartments. The runoff generated from the patios and third level lawns is to be redirected into the system as well via field inlet drains. The roof is to be composed of a series of green roof trays.

The development will be served by the Portland Water District, underground power/cable/communications, natural gas, and the municipal sewer system. The project anticipates incorporating Maine DEP approved stormwater Best Management Practices to meet the General and Flooding Standards.

GENERAL STANDARDS - WATER QUALITY

The Underdrained Subsurface Sand Filtration system (USSF) is sized to meet or exceed to the requirements set forth within the MDEP Volume III BMPs Technical Design Manual, Chapter 7.3. Filter BMP systems have shown to be effective at filtering out and removing a wide range of pollutants from stormwater runoff.

Treatment Area

Runoff generated from the new building roof and the third level patio and lawn areas is to be redirected and conveyed into the USSF system set below the third-floor patios. The runoff is to be treated in a series of two StormTech Isolator Rows. These structures are to be outfitted with at least one access point provided by either the outlet control structure or the drainage manhole and additional access via an inspection port per Isolator Row for the removal of any accumulated sediment or debris. The runoff will enter the sand filter structure and be detained for a minimum of 24 hours and a maximum of 48 hours. The underdrains below the sand filter will then outlet into a control structure. This structure will serve to attenuate

flows into the existing municipal separated stormwater system within Sheridan Street and prevent flooding.

The treatment of the impervious surface by the BMPs are as follows:

Table 1 - Impervious Treatment Area Table					
	Existing Impervious Area (SF)	Proposed Total Impervious Area (SF)	Net change in Impervious Area (SF)	Proposed Impervious Area with Treatment (SF)	% Overall New Imp. Area Treated
Subsurface Sand Filter	1,287	12,287	11,000	10,466	95%

As shown above, the project anticipates meeting the required treatment for new impervious surfaces assuming the entire roof is impervious and accounting for the green roof. Note that the existing impervious area as recorded does not include the area of existing riprap slope.

Furthermore, the MDEP defines developed area as "Disturbed area" excluding area that within one calendar year of being disturbed is returned to a condition with the same drainage pattern that existed prior to the disturbance and is revegetated, provided the area is not mowed more than once per year. The proposed developed areas as generated by the project will span from the rear retaining walls to the front property line. The disturbed soils behind the retaining walls, to the rear property line are to be regraded to reflect the existing drainage pattern.

Based upon this definition, Table 2 summarizes the proposed disturbance and treatment areas.

Table 2: Developed Area Treatment			
	Proposed Total Developed Area (SF)	Proposed Developed Area with Treatment (SF)	% Overall Developed Area Treated
Subsurface Sand Filter	15,670	12,960	83%

As shown in Table 2, the project anticipates exceeding the required treatment for the total developed area through the utilization of the USSF BMP. Note that this developed area includes the building footprint.

Filter Area Size

Per the requirements for an underdrained subsurface sand filter as defined in Volume III BMPs Technical Design Manual, Chapter 7.3, the surface area of the filter shall be no less than the sum of 5% of the tributary impervious area and 2% of the tributary landscaped area.

The filter area is calculated by the following formula:

$$Filter\ Area\ (sf) = (Imperivous\ Area \times 0.05) + (Landscaped\ Area \times 0.02)$$

Table 3 – Total Filter Surface Area, displays the proposed sand filter sizing requirements, actual size, and the percentage of required area.

Table 3 –Total Filter Surface Area				
	Tributary Landscaped Area (SF)	Tributary Impervious Area (SF)	Filter Area Required (SF)	Filter Area Provided (SF)
Subsurface Sand Filter	2,559	10,466	575	601

The outflow from the sand filter structure is then tributary to the outlet control structure before entering the municipal stormwater system. As shown, the size of the soil filter area will meet and exceed the surface area requirements.

Isolator Row Sizing

The isolator row was sized by referencing a letter from Mark Bergeron, Director of the MDEP Bureau of Land Resources, to StormTech dated July 29, 2016. Mr. Bergeron recommends determining the minimum number of stormwater chambers per isolator row by dividing the one-year peak flow rate by the specific flow rate of the chamber. However, no flow rate was designated for StormTech's MC-4500 chamber system. Assuming that the MC-4500 model has at least a flow rate of 0.3 cfs per isolator chamber as defined for the MC-3500 model, the proposed three-chamber system would have a treatment flow rate of at least 0.9 cfs to accommodate for a one-year peak flow rate of 0.47 cfs as defined by the HydroCAD model.

Water Quality Volume

In accordance with the Volume III: BMPs Technical Design Manual, a water quality volume of 1.0-inch times the tributary impervious area plus 0.4-inch times the tributary landscaped developed area is required to be treated by the Underdrained Subsurface Sand Filter. The water quality volume is calculated by the following formula:

$$Treatment\ Volume\ (cf) = \frac{\left((Impervious\ Area \times 1.0") + (\text{Disturbed Area} \times 0.4")\right)}{(12"/1')}$$

Within the USSF system, the water quality volume is defined by the depth and surface area of the sand layer. For this project, the total water quality volume is the sum of the two Isolator Row sand filter layers. The system treatment volume was calculated using StormTech's storage volume for the MC-4500 chamber and end cap as provided in the MC-4500 Design Manual and the available stone storage surrounding the system assuming a 40% porosity.

The StormTech values are as follows:

MC-4500 Chamber 109.9 cf/unit

MC-4500 End Cap 35.7 cf/unit

The Water Quality Volume (WQV) is then calculated using the following:

$$WQV = [Total\ USSF\ System\ Vol] + [(Stone\ Vol - Total\ USSF\ System\ Vol) * 0.4]$$

A summary of the proposed water quality volume is as follows:

Table 4 – Water Quality Volume Table, displays the tributary landscaped area, tributary impervious area, treatment volume required, and treatment volume provided.

Table 4 - Water Quality Volume Table

	Tributary Landscaped Area (SF)	Tributary Impervious Area (SF)	Treatment Volume Required (CF)	Treatment Volume Provided
Subsurface Sand Filter	2,559	10,466	**957**	**2,091**

As shown, the size of the combined water quality volume will meet and exceed the treatment volume requirements. Values from the HydroCAD calculations are attached to this report.

HydroCAD Adjustments

Given that the water quality volumetric infiltration rates through the soil filter vary, a water quality outlet is modeled to provide the required minimum 24-hour release time. This is completed by adjusting the rainfall amount in HydroCAD until the inflow volume is equal to or greater than the calculated treatment volume. The storm events are modeled as type III, 24-hour storm events in HydroCAD.

A vertical orifice is modeled in HydroCAD at the outlet structures of the USSF BMP. The orifice diameter is sized to detain the stormwater for an approximate period of 24 hours. The orifice is intended to be a PVC cap placed on the outfall pipe (no glue) with the orifice drilled into the cap eccentrically and is to be fitted at the end of the outfall pipe on the outlet control structure baffle to be inspected or replaced if necessary. The PVC cap can be inspected, removed or replaced if necessary. The orifice for the water quantity volume is then set above the peak elevation determined for the water quality volume.

Also, once the water quality volume is known, an artificial rainfall is created within HydroCAD, to mimic a storm event which equals the water quality volume (2.35"). Based on the artificial rainfall event, the depth of the water quality volume within the chamber system at peak elevation will not exceed 18 inches, as defined by Chapter 7.3.

Additional Quality Provided by the Green Roof

The above calculations do not consider the additional water quality treatment provided by the modular green roof trays covering 36% of the building rooftop. Per the Stormwater BMP Manual, Chapter 7.6 on Vegetated Roofs, rooftop vegetation can contribute to the General Standards requirement for Water Quality via filtration and water quality volume within the filter layer of the trays.

FLOODING STANDARD – WATER QUANTITY

The proposed project was modeled using HydroCAD to verify that the post-development conditions do not exceed the pre-development conditions. The model applied a 24-hour SCS Type III storm distribution for the 2, 10, and 25-year storm events with the corresponding rainfall amounts 3.1", 4.6", and 5.8" respectively. Rainfall amounts are from Appendix H of the Chapter 500 for Cumberland SE.

Both the pre- and post-development conditions were developed to model all runoff to enter the Sheridan Street municipal stormwater system. This assumption is based on the existing grades sloping downward from the property.

Due to the numerous variables and inherent inaccuracies with the modeling program used to calculate stormwater runoff, it is custom at Acorn Engineering, Inc. to round to the nearest whole number or to the nearest tenth for urban infill projects. Due to the relatively small size of the project footprint, the stormwater runoff shall be rounded to the nearest tenth of a cubic foot per second (cfs).

Time of Concentration (T_c)

For the pre-development condition, the Tc was represented using a fifty-foot sheet flow component, assuming light, wooded underbrush followed by shallow concentrated flow through forest with heavy litter. The modelled flow path assumed the greatest time was associated with the longest physical distance travelled from the most remote point of the subcatchment.

Given the urban environment and the short flow paths in the post condition, a Tc of 5 minutes was used for the post-development subcatchments.

Curve Number

It was assumed that the existing, steep sloping condition of the site would be best represented by the following CN condition:

- Woods/Grass Combo – Good

Furthermore, Cumberland County describes the existing soil condition as a hydrologic soil group A, but the site no longer contains primarily native soils (Hinckley Gravelly Sandy Loam). This is based upon the urban fill and silts/clays that were discovered on site. Therefore, the soil is closer to a B or C soil. It was modeled as group B in this report. Refer to

Appendix A, page 103 from the USDA Urban Hydrology for Small Watersheds TR-55 from HydroCAD.net as well as Summit Geoengineering's Geotechnical Report for more information.

The existing stairways, building, and concrete structures were assumed to be classified as impervious. A more conservative CN value was designated to the existing riprap wall to more accurately represent the limited permeability of the compacted surface.

The post-development conditions for the proposed building roof was modelled assuming both a completely impervious section represented by the wooden decks and hardtop surface and a semi-pervious section formed by the modular green roof system; the green roof covers about 36% of the total rooftop area. Based on past research as published in the December 2015 edition of the Journal of Hydrologic Engineering, "Curve Number and Runoff Coefficients for Extensive Living Roofs", extensive green roof systems can be modeled using a CN of 84.

It was also assumed that all newly proposed landscaped areas would be in good condition. The following curve numbers implemented in the post-development condition are as follows:

- > 75% Grass cover – Good

The remaining retaining walls, patios, and internal walkways were all classified as completely impervious.

Pre-development Calculations

The pre-development condition was modeled as one subcatchment to determine the net impact of the development.

- Subcatchment 1 –Rear property line to Sheridan Street

A Pre-Development Watershed Map developed for this project can be viewed in Attachment A, and a copy of the HydroCAD calculations is included within Attachment D of this report.

Peak flow rates for the storm events are as follows:

Table 5 – Pre-Development Peak Stormwater Flows

Drainage Area	2 – Year Storm Event (cfs)	10 – Year Storm Event (cfs)	25 – Year Storm Event (cfs)
Sheridan Street	0.3	0.8	1.2

Post-development Calculations:

The one pre-development subcatchment was broken into three separate subcatchments for the post-development condition.

- Subcatchment 1 – Rooftop of the proposed building
- Subcatchment 2 – Third floor patio area
- Subcatchment 3 – Front, side, and rear runoff into Sheridan Street

The post development calculations include changes to the land use and compensation provided by the subsurface BMP system. The following table represents comparison of predevelopment and post-development condition peak runoff rates for the proposed development and tributary area.

Table 6 – Comparison of Peak Flows

Drainage Area	2 – Year Storm Event (cfs)		10 – Year Storm Event (cfs)		25 – Year Storm Event (cfs)	
Sheridan Street	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
	0.3	0.2	0.8	0.7	1.2	1.0

As shown in Table 6, the net impact of the post development peak flows shall remain below the predevelopment levels for the two, ten, and twenty-five-year storms.

A Post-Development Watershed Map created for this project can be viewed in Attachment B, and a copy of the HydroCAD calculations is included within Attachment D of this report.

Additional Quantity Provided by the Green Roof

It should be noted that the developed model and resulting peak flows do not take into consideration the additional storage and ponding as provided within the modular green roof system. The vegetation support course and drainage course within each tray will detain rainfall directly entering the system and further attenuate the site peak flows; this attenuation has not been considered within the abovementioned peak flow comparison.

STORMWATER BMP MAINTENANCE

A stormwater maintenance agreement in accordance with Chapter 7.3 has been established and submitted under separate cover to the City of Portland. The agreement outlines the maintenance and inspection requirements for the site BMPs including providing inspection logs and information on qualified inspectors as well as required maintenance activities and related inspection and maintenance frequencies. The site USSF system, storm drains, drainage manholes, vegetated areas around the retaining walls, and the modular green roof system have all been addressed within the document to be recorded with the Cumberland County Registry of Deeds.

SOILS

Onsite soil information includes the following:

- Soil Conservation Service Medium Intensity Soil Survey for Cumberland County

The existing soils are exclusively Hinckley throughout the site. The Hinckley soil series consists of very deep, excessively drained soils formed in glaciofluvial materials. The permeability of the Hinckley soil is rapid in the surface layer and subsoil and very rapid in the substratum, typically with a low groundwater table. Soils also consist of silty clays and urban fill as outlined in the above sections. Refer to the Geotechnical Report for more information. Given the soils information as listed above, no onsite wastewater is proposed and the applicant does not intend to perform a more intense hydric soil boundary delineation or permeability test due to the waiver requirements set forth in the City of Portland Technical Manual – Section 7 – Soil Survey, Rev. 6/17/11 have been met.

The area within and surrounding the project includes soils types listed in Table 7 below. The susceptibility of soils to erosion is indicated on a relative "K" scale of values over a range of 0.02 to 0.69. Higher "K" values indicate more erodible soils.

Table 7 - "K" Value		
Soils Type	**Subsurface**	**Substratum**
Hinckley	0.17	0.17

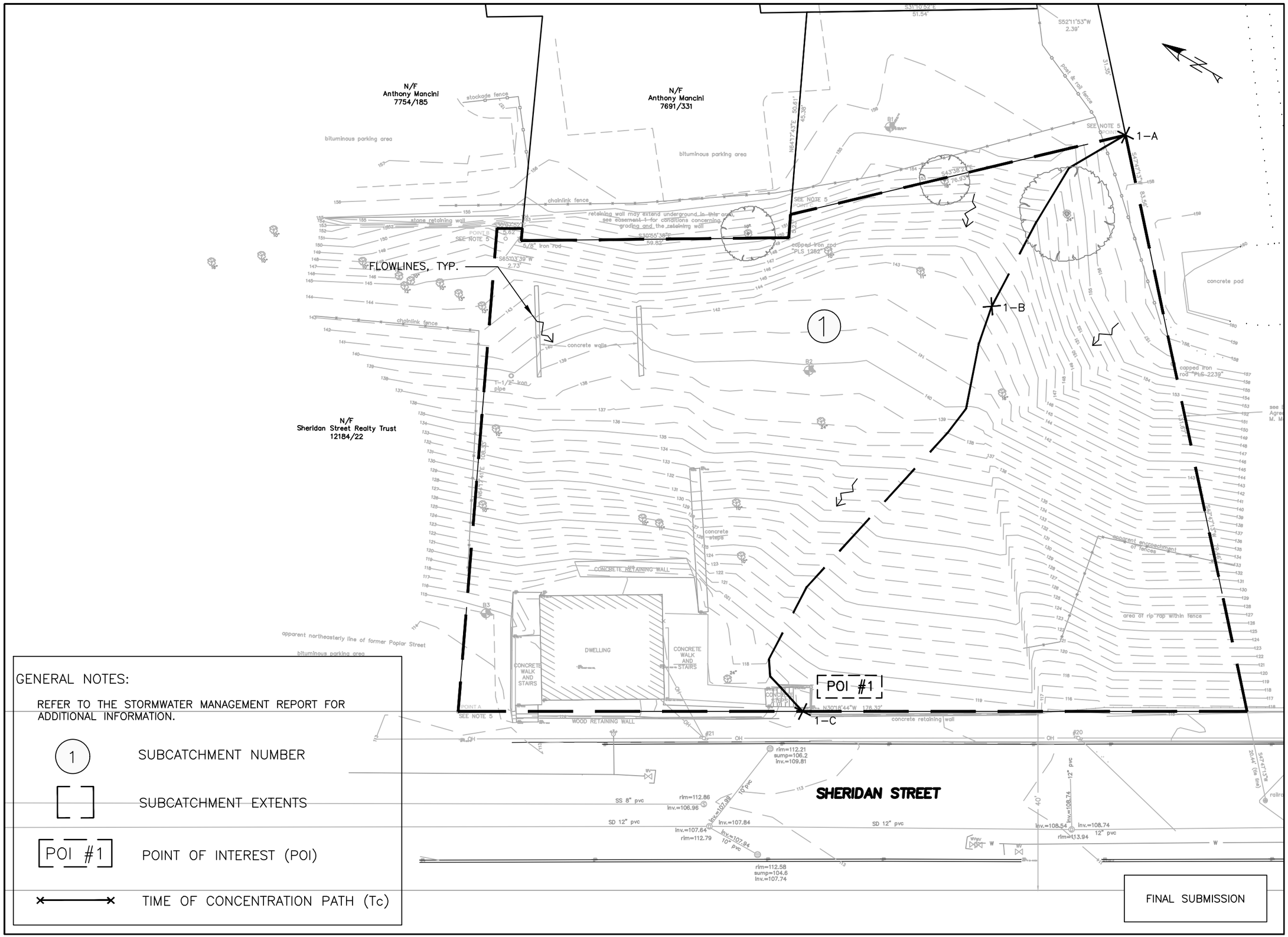
The soil "K" values for the soils, listed above, show a low susceptibility to erosion. The site's susceptibility to erosion is from the Soil Conservation Service Medium Intensity Soil Survey for Cumberland County. Although soil "K" values for the soils show a low susceptibility to erosion, implementation of the proposed Erosion & Sedimentation Measures by the contractor will still be of considerable importance.

Conclusion

The proposed development was designed to meet the requirements implemented by the MDEP under the Stormwater Management Statute (38 M.R.S.A. § 420-D) as well as the City of Portland Technical Manual – Section 5 – Portland Stormwater Management Standards. Thus, the design of the proposed development and stormwater system does not anticipate creating erosion, drainage or runoff problems either in the development or with respect to adjoining properties.

Attachments

Attachment A: Pre-Development Watershed Map
Attachment B: Post-Development Watershed Map
Attachment C: Soils Map
Attachment D: Green Roof Cut Sheets
Attachment E: HydroCAD Calculations



GENERAL NOTES:

REFER TO THE STORMWATER MANAGEMENT REPORT FOR ADDITIONAL INFORMATION.

(1)	SUBCATCHMENT NUMBER
[ ]	SUBCATCHMENT EXTENTS
POI #1	POINT OF INTEREST (POI)
×——→	TIME OF CONCENTRATION PATH (Tc)

FINAL SUBMISSION

ISSUED FOR	BY DATE
PRELIM. APP.	WHS 3/28/17
FINAL APP.	WHS 8/4/17
REVISION	REV. DATE

DRAWING NAME: PRE-DEVELOPMENT WATERSHED MAP

PROJECT NAME: 155 SHERIDAN STREET

CLIENT: BD SHERIDAN, LLC
C/O VAZZA REAL ESTATE GROUP BD SHERIDAN, LLC
1266 FURNACE BROOK PARKWAY SUITE 300 QUINCY, MA 02169

ACORN ENGINEERING, INC
158 DANFORTH ST
PORTLAND, MAINE 04104
(207) 775-2655

FILE:	1069_CIVIL
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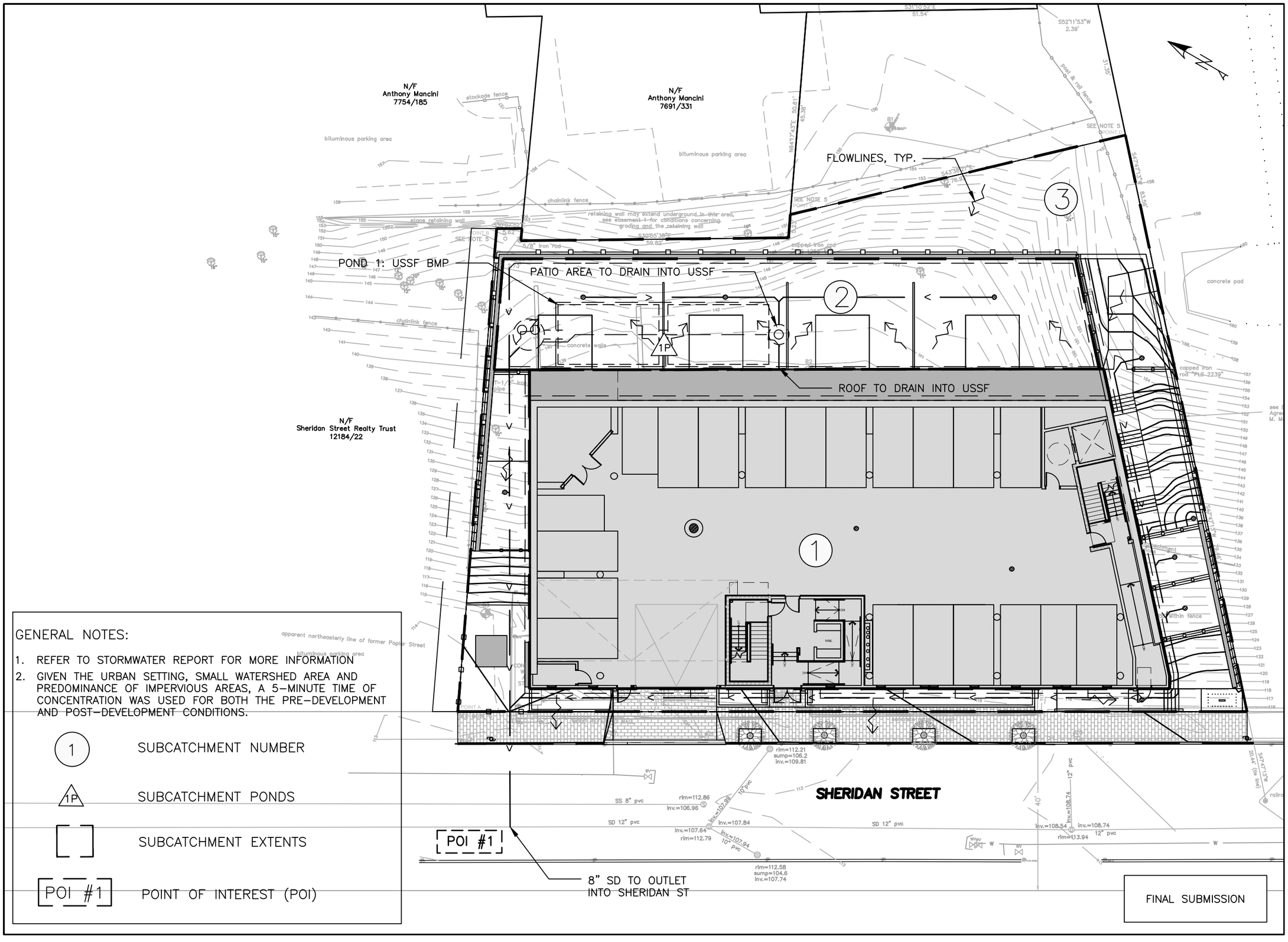
SCALE:	NTS
DESIGN BY:	OJD
DRAWN BY:	OJD
CHECKED BY:	WHS

DRAWING NO.
PRE



GENERAL NOTES:

1. REFER TO STORMWATER REPORT FOR MORE INFORMATION
2. GIVEN THE URBAN SETTING, SMALL WATERSHED AREA AND PREDOMINANCE OF IMPERVIOUS AREAS, A 5–MINUTE TIME OF CONCENTRATION WAS USED FOR BOTH THE PRE–DEVELOPMENT AND POST–DEVELOPMENT CONDITIONS.

1	SUBCATCHMENT NUMBER
1P	SUBCATCHMENT PONDS
[ ]	SUBCATCHMENT EXTENTS
POI #1	POINT OF INTEREST (POI)

FINAL SUBMISSION

ISSUED FOR	BY / DATE
PRELIM. APP.	WHS 3/28/17
FINAL APP.	WHS 8/4/17
REVISION	REV. DATE

DRAWING NAME: POST–DEVELOPMENT WATERSHED MAP

PROJECT NAME: 155 SHERIDAN STREET

CLIENT: BD SHERIDAN, LLC
VAZZA REAL ESTATE GROUP BD SHERIDAN, LLC
1266 FURNACE BROOK PARKWAY SUITE 300 QUINCY, MA 02169

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JN:	1069
SCALE:	1:20
DESIGN BY:	OJD
DRAWN BY:	OJD
CHECKED BY:	WHS

DRAWING NO.
POST

ISSUED FOR	BY DATE
PRELIM APP	WHS 3/28/17
	REV. DATE:

DRAWING NAME: SOILS MAP

PROJECT NAME: 155 SHERIDAN STREET

CLIENT: BD SHERIDAN, LLC
VAZZA REAL ESTATE GROUP

ACORN ENGINEERING, INC
ACORN ENGINEERING, INC. P.O. BOX 3372
PORTLAND, MAINE 04104 (207) 775-2655

FILE:	CIVIL 1069
JN:	1069
SCALE:	1":30'
DESIGN BY:	OJD
DRAWN BY:	OJD
CHECKED BY:	WHS

DRAWING NO.

SOILS

PRODUCT DATA SHEET

Protection Mat SSM 45

ZinCo USA, Inc.

Water and nutrient storage mat of synthetic fibres, for the application as a protection layer under green roofs, gravel fills, slab pavings, etc.

Features

- resistant to mechanical stress
- high quality protection layer
- water and nutrient storage
- non-rotting
- biologically neutral
- bitumen and polystyrene compatible
- made of recycled fibres
- quick and easy installation

Technical Data

Protection Mat SSM 45 / EDP No. 2045 / 2046
High-quality fibre mat made of polypropylene, with fleece backing.

Colour:	brown (varies)	
Thickness:	ca. 0.2 in	(ca. 5 mm)
Weight:	ca. 0.1 lb/sq ft	(ca. 470 g/m²)
Water storage capacity:	ca. 0.1 gal/sq ft	(ca. 5 l/m²)
Strength class:	3	
Tensile strength lengthwise:	> 570 lb/ft	> 8.5 kN/m)
Extension lengthwise:	> 90 %	
Dimensions:		
EDP No. 2045: rolls, ca. 1076 sqft (100 m²)	6.6 ft x 164.0 ft	(2.0 m x 50.0 m)
EDP No. 2046: ca. 215 sqft (ca. 20 m²), folded	ca. 6.6 ft x ca. 32.8 ft	(ca. 2.0 m x 10.0 m)

Health and Safety

This product does not require a material safety data sheet (MSDS) according to the OSHA Hazard Communication Standard (29 CFR 1910.1200). When used as recommended or under ordinary conditions, it should not present a health and safety hazard. However, an MSDS can be provided as a courtesy in response to a customer request.

Installation Instructions

Install the Protection Mat SSM 45 above a waterproofing or root barrier with an overlap of 4 inch. The Protection Mat has to be taken above the growing medium along edges and at roof penetrations. Cut the Protection Mat in situ at roof penetrations. Consider an allowance for overlap and wastage of ca. 10 – 15 %.

ZinCo USA, Inc. • Paragon Towers • 233 Needham Street • Newton MA 02464-1502
T 866 766 3155 • F 866 766 3955 • www.zinco-usa.com • info@zinco-usa.com

Subject to technical alterations and printing errors; First edition: 01/07, revised: 01/09
Authorized by ZinCo GmbH

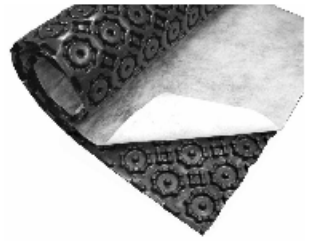
1.2

Fixodrain XD-20 drainage layer by Zinco. The composite shall satisfy the following specifications:
Material: HD-PE (REC) (Polyethylene (REC))
Color: black / grey
Height: ca. 0.80 in (ca. 20 mm)
Weight: ca. 0.20 lb/sq ft (ca. 1.00 kg/m²)
Water storage capacity: ca. 0.07 gal/sq ft (ca. 3 l/m²)
Max. compressive strength: 7.25 psi (50 kN/m²)
Waterflow rate in element level: with 1 % slope: ca. 1.75 gpm/ft (ca. 0.36 l/(s•m))
with 2 % slope: ca. 2.50 gpm/ft (ca. 0.52 l/(s•m))
with 3 % slope ca. 3.15 gpm/ft (ca. 0.65 l/(s•m²))
Dimensions: rolls ca. 3.30 ft x 65.60 ft (1.00 m x 20.00 m)

PRODUCT DATA SHEET

Fixodrain ®XD 20

ZinCo USA, Inc.



Economic, multi-functional Drainage Mat for use as alternative to single layered extensive green roof build-ups.

Features

- **no need for additional protection layer due to connectible interlocking studs**
- **tested and proven drainage capacity**
- **water retention within the element**
- **quick and easy installation**
- **100 % Polypropylene**

Technical Data

Fixodrain® XD 20 / EDP No. 3020
Drainage Mat with attached Filter Sheet, connecting lengthwise on interlocking studs.

Material:		Polypropylene	
Color:		grey / white	
Height:		ca. 0.8 in	(ca. 20 mm)
Weight:		ca. 0.2 lb/sq ft	(ca. 1.0 kg/m²)
Water storage capacity:		ca. 0.07 gal/sq ft	(ca. 3 l/m²)
Max. compressive strength:		> 7.25 psi	(> 50 kN/m²)
Waterflow rate in element level:	with 1 % slope:	ca. 1.75 gpm/ft	(ca. 0.36 l/(s-m))
	with 2 % slope:	ca. 2.50 gpm/ft	(ca. 0.52 l/(s-m))
	with 3 % slope	ca. 3.15 gpm/ft	(ca. 0.65 l/(s-m²))
Dimensions:	rolls	ca. 3.3 ft x 65.6 ft	(1.0 m x 20.0 m)

Health and Safety

This product does not require a material safety data sheet (MSDS) according to the OSHA Hazard Communication Standard (29 CFR 1910.1200). When used as recommended or under ordinary conditions, it should not present a health and safety hazard. However, an MSDS can be provided as a courtesy in response to a customer request.

Installation Instructions

Install the Drainage Mat Fixodrain®XD 20 on the root resistant and waterproof roof construction. The Fixodrain®XD 20 mats are to be connected by interlocking studs lengthwise. Cut the Fixodrain®XD 20 mat in situ at roof penetrations. Ensure that pre-attached filter sheet overlaps completely at joints. Consider ca. 3 % allowance for wastage.
Note: At roof edge and upstands the waterproofing has to be protected by a protection layer which has to be taken up above the finished surface in accordance with guidelines.

ZinCo USA, Inc. • Paragon Towers • 233 Needham Street • Newton MA 02464-1502
T 866 766 3155 • F 866 766 3955 • www.zinco-usa.com • info@zinco-usa.com

Subject to technical alterations and printing errors; First edition: 02/10
Authorized by ZinCo GmbH

2.0

Aluminum GeoEdge: Long Base aluminum restraint for media and vegetated assembly
Height: 3” x 3.25”
Weight: 4lbs (per 8’ length)
Thickness: 0.210 inch thick exposed top lip
Connection Method: Spliced together with horizontal 0.060 inch thick x 1 inch wide x 2-3/4” aluminum sliding connector
Anchors: Anchor as specified
Finish: Natural Mill Aluminum

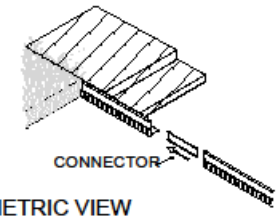
geoedge™

PERMALOC CORPORATION, 13505 BARRY STREET HOLLAND, MI 49424
(800) 356-9660 PHONE: (616) 399-9600 FAX: (616) 399-9770 WWW.PERMALOC.COM

ARCHITECT NOTE: CHECK OFF APPLICABLE SIZE & FINISH DESIRED

SIZE: ALL 8' (2.44M) LENGTHS w/ 0.250" (6.35MM) THICK EXPOSED TOP LIP

☐ 3"	x 3.25"	(76MM x 83MM)	☐MF	☐BL
☐ 3.5"	x 4.5"	(89MM x 114MM)	☐MF	☐BL
☐ 4"	x 3.25"	(102MM x 83MM)	☐MF	☐BL
☐ 4.25"	x 3.25"	(108MM x 83MM)	☐MF	☐BL
☐ 4.5"	x 3.25"	(114MM x 83MM)	☐MF	☐BL
☐ 4.5"	x 4.5"	(114MM x 114MM)	☐MF	☐BL
☐ 5.5"	x 6.5"	(140MM x 165MM)	☐MF	☐BL
☐ 6.5"	x 5.5"	(165MM x 140MM)	☐MF	☐BL
☐ 7.5"	x 8.5"	(191MM x 216MM)	☐MF	☐BL
☐ 8.5"	x 7.5"	(216MM x 191MM)	☐MF	☐BL

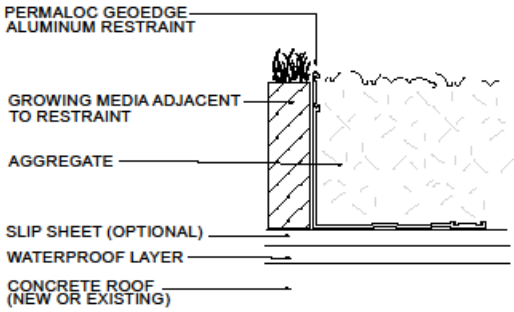


ISOMETRIC VIEW
NTS

FINISH LEGEND:
(MF) MILL FINISH-NATURAL ALUMINUM
(BL) BLACK DURAFLEX-ELECTROSTATICALLY APPLIED BAKED ON PAINT, MEETS AAMA 2603

NOTES:
1. INSTALLATION PER MANUFACTURER'S RECOMMENDED "INSTALLATION GUIDELINES" IN ACCORDANCE WITH DESIGNER'S INSTRUCTIONS.*
2. 8'-0" (2.44M) SECTIONS CONNECTED WITH 2 - 2.75" (70MM) SLIDING CONNECTORS.
3. CORNERS: REMOVE BASE TABS AND FORM A CONTINUOUS CORNER.
4. PERMALOC GEOEDGE AS MANUFACTURED BY PERMALOC CORPORATION, HOLLAND MI. (800) 356-9660 (616) 399-9600
5. CONTRACTOR'S NOTE: FOR PRODUCT AND PURCHASING INFORMATION VISIT: WWW.PERMALOC.COM

*DESIGNER MAINTAINS ULTIMATE RESPONSIBILITY FOR VALIDITY AND SAFETY OF THE INSTALLATION.



ALTERNATE INSTALLATION: GEOEDGE BASE MAY BE INSTALLED UNDER THE GROWING MEDIA

EDGING FOR GREENROOF WITH AGGREGATE
SCALE: 3"=1'-0"

GE2.dwg

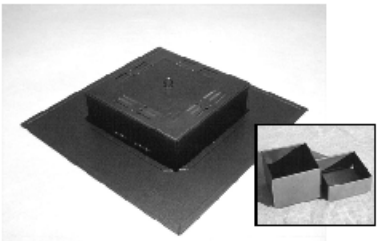
3.0

Stancils light-weight growth media.
Parameters Guiding Values * Guiding Values (metric) *
Proportion of silting components: □ 15 mass %
Volume weight apparent density
max. water capacity: 68.74 lb/cu ft
Total pore volume: approx. 60 Vol. %
Max. water capacity: approx. 50 Vol. %
Water permeability, mod Kf: 0.024–2.40 in/min 0.001–0.10 cm/s
pH-Value: 6.50–8.00

PRODUCT DATA SHEET

Inspection Chamber KS 8

ZinCo USA, Inc.



Inspection chambers for protection and inspection of roof outlets for extensive green roofs and gravel roofs.

Features

- fits all outlets, d < 10 in
- frost proof due to insulated cover
- walkable
- corrosion-resistant
- overflow function via the cover, in case of flooding
- elevation with additional extension pieces KSA

Technical Data

Inspection Chamber KS 8 / EDP No. 4286
Made of galvanized, plastic-coated steel with lateral slots for water passage. Detachable and walkable cover, with thermally insulating expanded polystyrene inlay and drainage slots according to German FLL-Guidelines.

Height:	ca. 3.1 in	(ca. 80 mm)
Aperture:	ca. 9.8 x 9.8 in	(ca. 250 x 250 mm)
Flange:	ca. 19.7 x 19.7 in	(ca. 500 x 500 mm)
Slot width:	ca. 0.1 in	(ca. 3 mm)
Weight:	ca. 7.05 lb	(ca. 3.20 kg)
Colour:	"oldsilver-antique"	
Accesories:		
Extension Piece KSA 10 / EDP No. 4249	ca. 3.9 in	ca. 100 mm
Extension Piece KSA 20 / EDP No. 4250	ca. 7.9 in	ca. 200 mm

Health and Safety

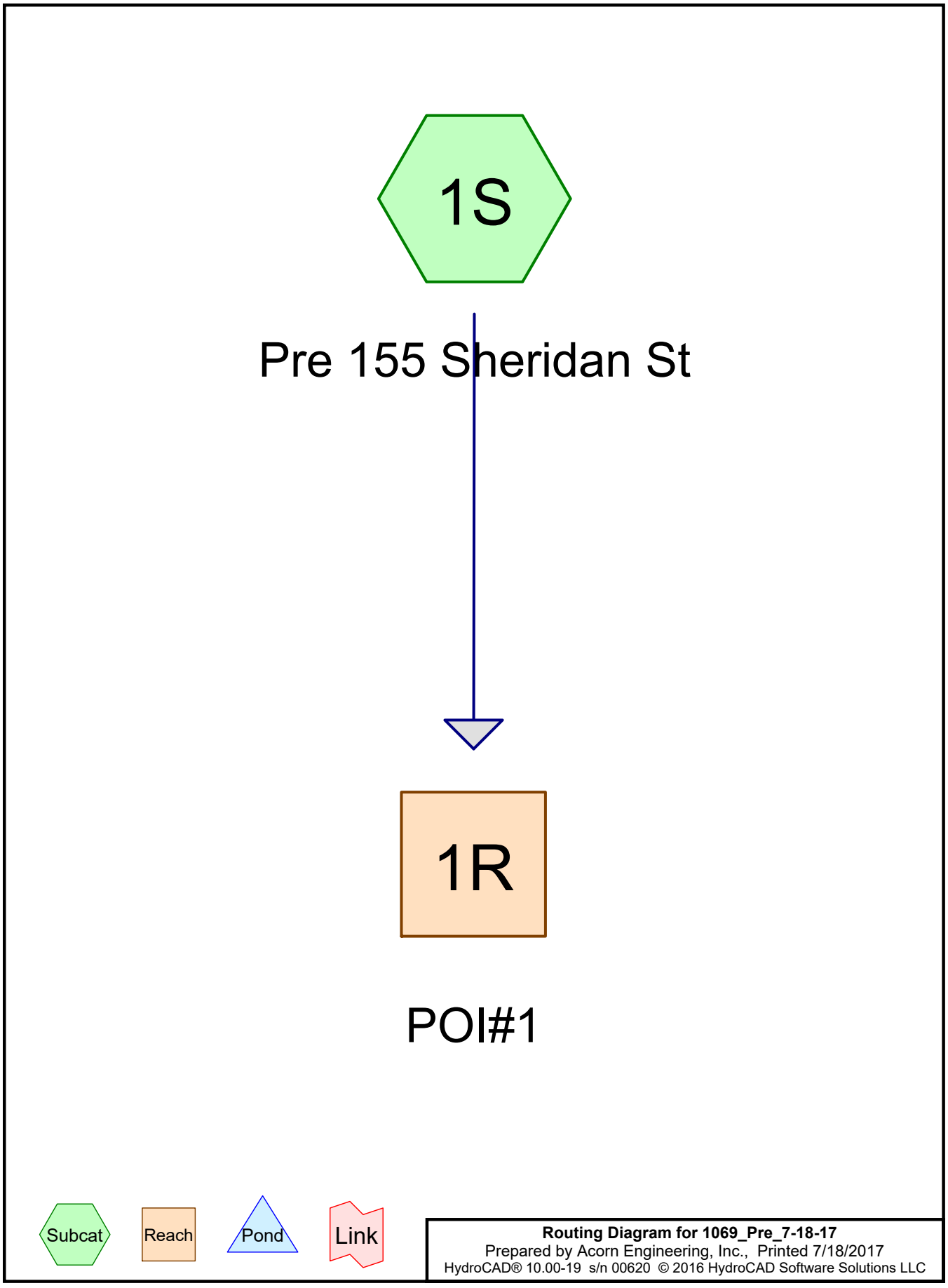
This product does not require a material safety data sheet (MSDS) according to the OSHA Hazard Communication Standard (29 CFR 1910.1200). When used as recommended or under ordinary conditions, it should not present a health and safety hazard. However, an MSDS can be provided as a courtesy in response to a customer request.

Installation Instructions

Install the Inspection Chamber KS 8 on the drainage element above the drain. Install the Filter Sheet on top of the flange of the Inspection Chamber.

ZinCo USA, Inc. • Paragon Towers • 233 Needham Street • Newton MA 02464-1502
T 866 766 3155 • F 866 766 3955 • www.zinco-usa.com • info@zinco-usa.com

Subject to technical alterations and printing errors; First edition: 01/07
Authorized by ZinCo GmbH



Routing Diagram for 1069_Pre_7-18-17
Prepared by Acorn Engineering, Inc., Printed 7/18/2017

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.015	98	Building (1S)
0.015	98	Concrete Stairs, Walkways, and walls (1S)
0.020	96	Riprap wall (1S)
0.367	65	Woods/grass comb., Fair, HSG B (1S)
0.416	**69**	**TOTAL AREA**

Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 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 1S: Pre 155 Sheridan St Runoff Area=18,140 sf 7.09% Impervious Runoff Depth=0.72"
Flow Length=160' Tc=5.8 min CN=69 Runoff=0.31 cfs 0.025 af

Reach 1R: POI#1 Inflow=0.31 cfs 0.025 af
Outflow=0.31 cfs 0.025 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.025 af Average Runoff Depth = 0.72"
92.91% Pervious = 0.387 ac 7.09% Impervious = 0.030 ac

Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 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 1S: Pre 155 Sheridan St Runoff Area=18,140 sf 7.09% Impervious Runoff Depth=1.67"
Flow Length=160' Tc=5.8 min CN=69 Runoff=0.79 cfs 0.058 af

Reach 1R: POI#1 Inflow=0.79 cfs 0.058 af
Outflow=0.79 cfs 0.058 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.058 af Average Runoff Depth = 1.67"
92.91% Pervious = 0.387 ac 7.09% Impervious = 0.030 ac

Time span=1.00-36.00 hrs, dt=0.02 hrs, 1751 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 1S: Pre 155 Sheridan St Runoff Area=18,140 sf 7.09% Impervious Runoff Depth=2.56"
Flow Length=160' Tc=5.8 min CN=69 Runoff=1.24 cfs 0.089 af

Reach 1R: POI#1 Inflow=1.24 cfs 0.089 af
Outflow=1.24 cfs 0.089 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.089 af Average Runoff Depth = 2.56"
92.91% Pervious = 0.387 ac 7.09% Impervious = 0.030 ac

Summary for Subcatchment 1S: Pre 155 Sheridan St

Manual Tc of 5 minutes applied once actual calculated dropped below 5 minutes.

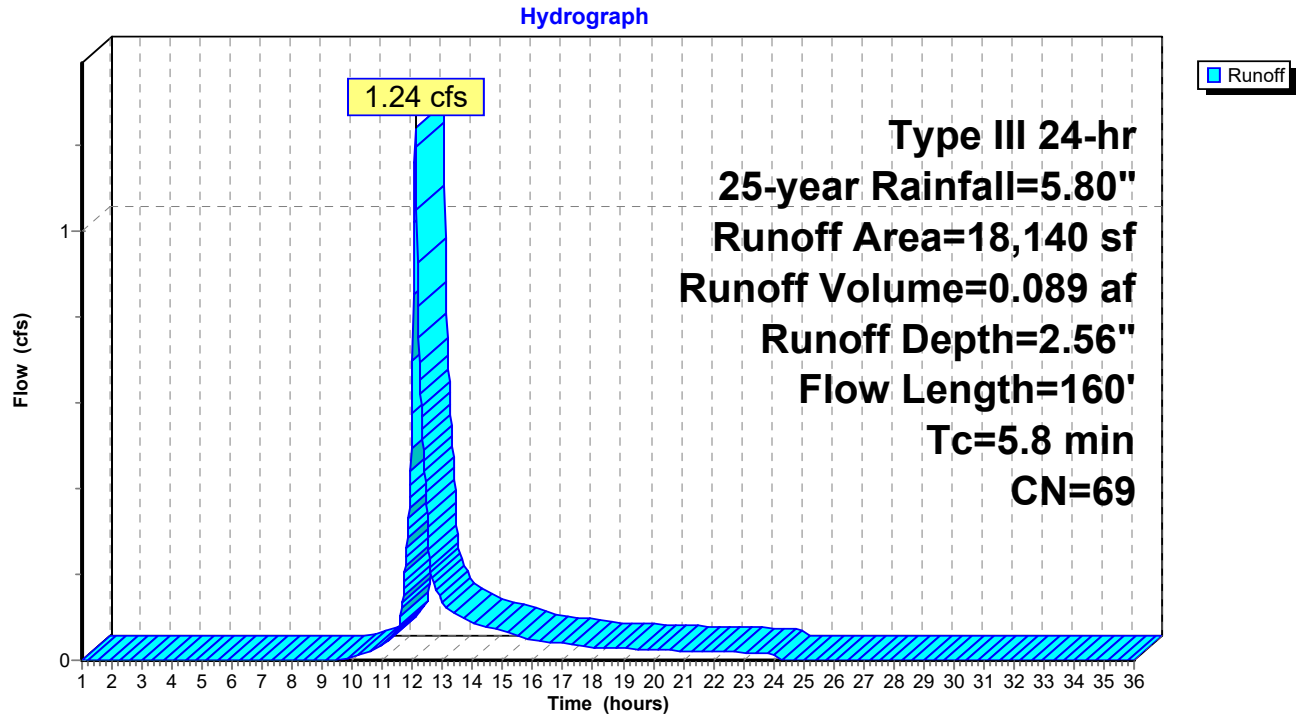
Runoff = 1.24 cfs @ 12.09 hrs, Volume= 0.089 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	640	98	Building
*	647	98	Concrete Stairs, Walkways, and walls
	15,992	65	Woods/grass comb., Fair, HSG B
*	861	96	Riprap wall
	18,140	69	Weighted Average
	16,853		92.91% Pervious Area
	1,287		7.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.4	50	0.2700	0.19		**Sheet Flow, A to B** Woods: Light underbrush n= 0.400 P2= 3.10"
1.4	110	0.2800	1.32		**Shallow Concentrated Flow, B to C** Forest w/Heavy Litter Kv= 2.5 fps
5.8	160	Total			

Subcatchment 1S: Pre 155 Sheridan St

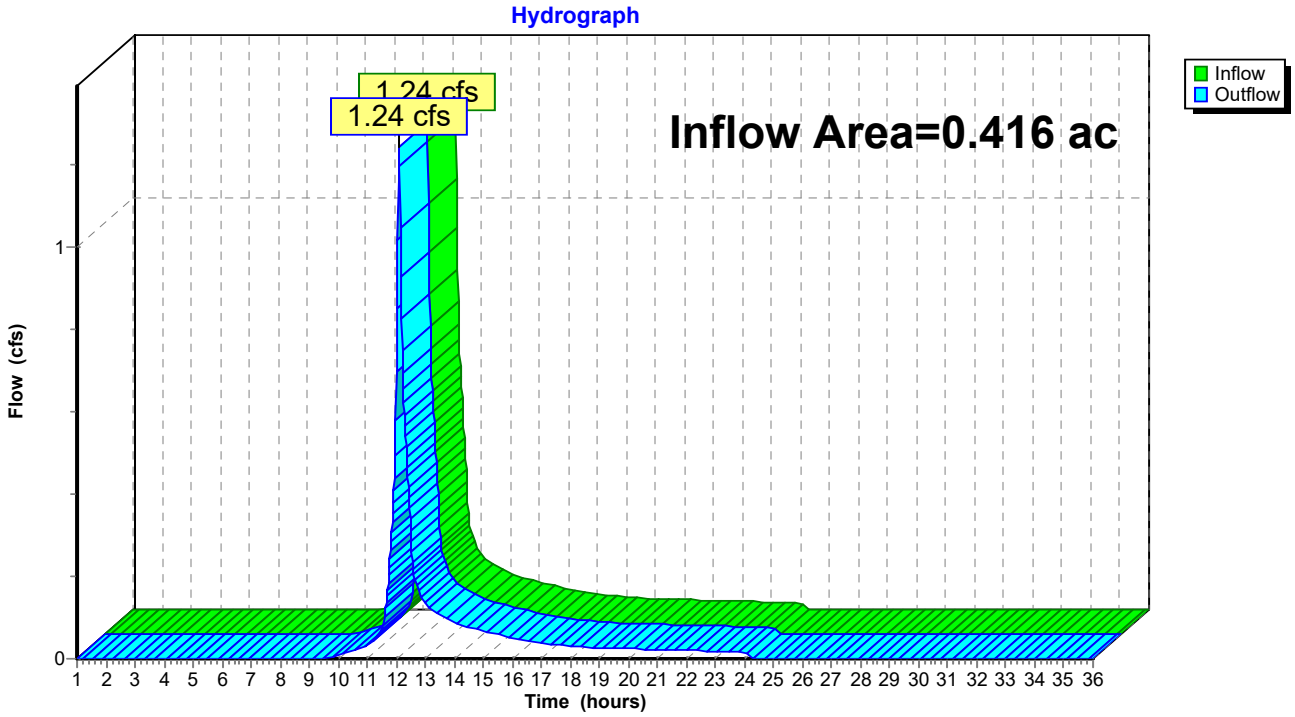


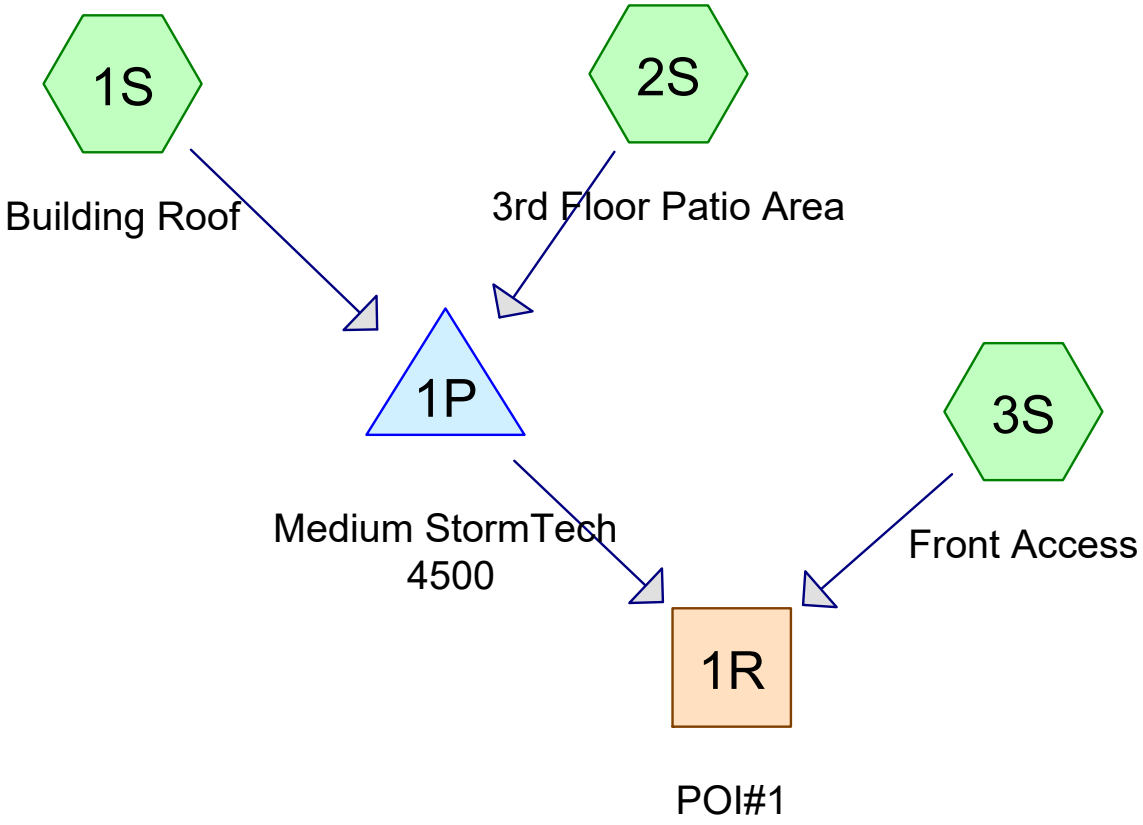
Summary for Reach 1R: POI#1

Inflow Area = 0.416 ac, 7.09% Impervious, Inflow Depth = 2.56" for 25-year event
Inflow = 1.24 cfs @ 12.09 hrs, Volume= 0.089 af
Outflow = 1.24 cfs @ 12.09 hrs, Volume= 0.089 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-36.00 hrs, dt= 0.02 hrs

Reach 1R: POI#1





Subcat Reach Pond Link

Routing Diagram for 1069_Post_7-19-17
Prepared by Acorn Engineering, Inc., Printed 7/19/2017

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.134	61	>75% Grass cover, Good, HSG B (2S, 3S)
0.080	84	Green Roof, HSG B (1S)
0.017	98	Patio/Wall (2S)
0.042	98	Patio/Walls, Walkways (3S)
0.143	98	Roofs, HSG B (1S)
0.416	**83**	**TOTAL AREA**

Time span=0.00-48.00 hrs, dt=0.001 hrs, 48001 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 1S: Building Roof Runoff Area=9,708 sf 64.28% Impervious Runoff Depth=2.35"
Tc=5.0 min CN=93 Runoff=0.62 cfs 0.044 af

Subcatchment 2S: 3rd Floor Patio Area Runoff Area=3,317 sf 22.85% Impervious Runoff Depth=0.72"
Tc=5.0 min CN=69 Runoff=0.06 cfs 0.005 af

Subcatchment 3S: Front Access Runoff Area=5,115 sf 35.60% Impervious Runoff Depth=0.97"
Tc=5.0 min CN=74 Runoff=0.13 cfs 0.010 af

Reach 1R: POI#1 Inflow=0.20 cfs 0.055 af
Outflow=0.20 cfs 0.055 af

Pond 1P: Medium StormTech 4500 Peak Elev=124.88' Storage=0.025 af Inflow=0.68 cfs 0.048 af
Outflow=0.16 cfs 0.046 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.058 af Average Runoff Depth = 1.66"
51.38% Pervious = 0.214 ac 48.62% Impervious = 0.202 ac

Time span=0.00-48.00 hrs, dt=0.001 hrs, 48001 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 1S: Building Roof Runoff Area=9,708 sf 64.28% Impervious Runoff Depth=3.81"
Tc=5.0 min CN=93 Runoff=0.98 cfs 0.071 af

Subcatchment 2S: 3rd Floor Patio Area Runoff Area=3,317 sf 22.85% Impervious Runoff Depth=1.67"
Tc=5.0 min CN=69 Runoff=0.15 cfs 0.011 af

Subcatchment 3S: Front Access Runoff Area=5,115 sf 35.60% Impervious Runoff Depth=2.05"
Tc=5.0 min CN=74 Runoff=0.29 cfs 0.020 af

Reach 1R: POI#1 Inflow=0.65 cfs 0.098 af
Outflow=0.65 cfs 0.098 af

Pond 1P: Medium StormTech 4500 Peak Elev=125.88' Storage=0.033 af Inflow=1.12 cfs 0.081 af
Outflow=0.46 cfs 0.078 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.101 af Average Runoff Depth = 2.92"
51.38% Pervious = 0.214 ac 48.62% Impervious = 0.202 ac

Time span=0.00-48.00 hrs, dt=0.001 hrs, 48001 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 1S: Building Roof Runoff Area=9,708 sf 64.28% Impervious Runoff Depth=4.99"
Tc=5.0 min CN=93 Runoff=1.26 cfs 0.093 af

Subcatchment 2S: 3rd Floor Patio Area Runoff Area=3,317 sf 22.85% Impervious Runoff Depth=2.56"
Tc=5.0 min CN=69 Runoff=0.23 cfs 0.016 af

Subcatchment 3S: Front Access Runoff Area=5,115 sf 35.60% Impervious Runoff Depth=3.02"
Tc=5.0 min CN=74 Runoff=0.43 cfs 0.030 af

Reach 1R: POI#1 Inflow=0.96 cfs 0.135 af
Outflow=0.96 cfs 0.135 af

Pond 1P: Medium StormTech 4500 Peak Elev=126.86' Storage=0.040 af Inflow=1.49 cfs 0.109 af
Outflow=0.63 cfs 0.106 af

Total Runoff Area = 0.416 ac Runoff Volume = 0.138 af Average Runoff Depth = 3.99"
51.38% Pervious = 0.214 ac 48.62% Impervious = 0.202 ac

Summary for Subcatchment 1S: Building Roof

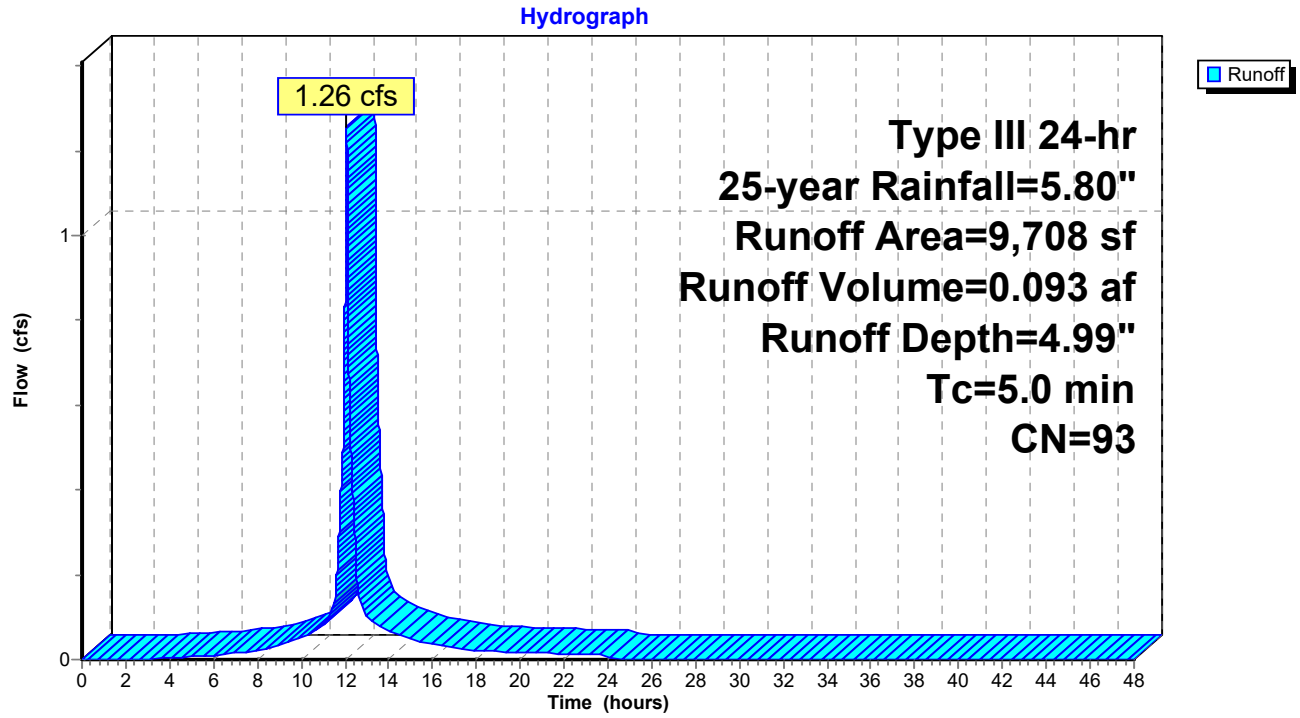
Runoff = 1.26 cfs @ 12.07 hrs, Volume= 0.093 af, Depth= 4.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.001 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	6,240	98	Roofs, HSG B
*	3,468	84	Green Roof, HSG B
	9,708	93	Weighted Average
	3,468		35.72% Pervious Area
	6,240		64.28% Impervious Area

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

Subcatchment 1S: Building Roof



Summary for Subcatchment 2S: 3rd Floor Patio Area

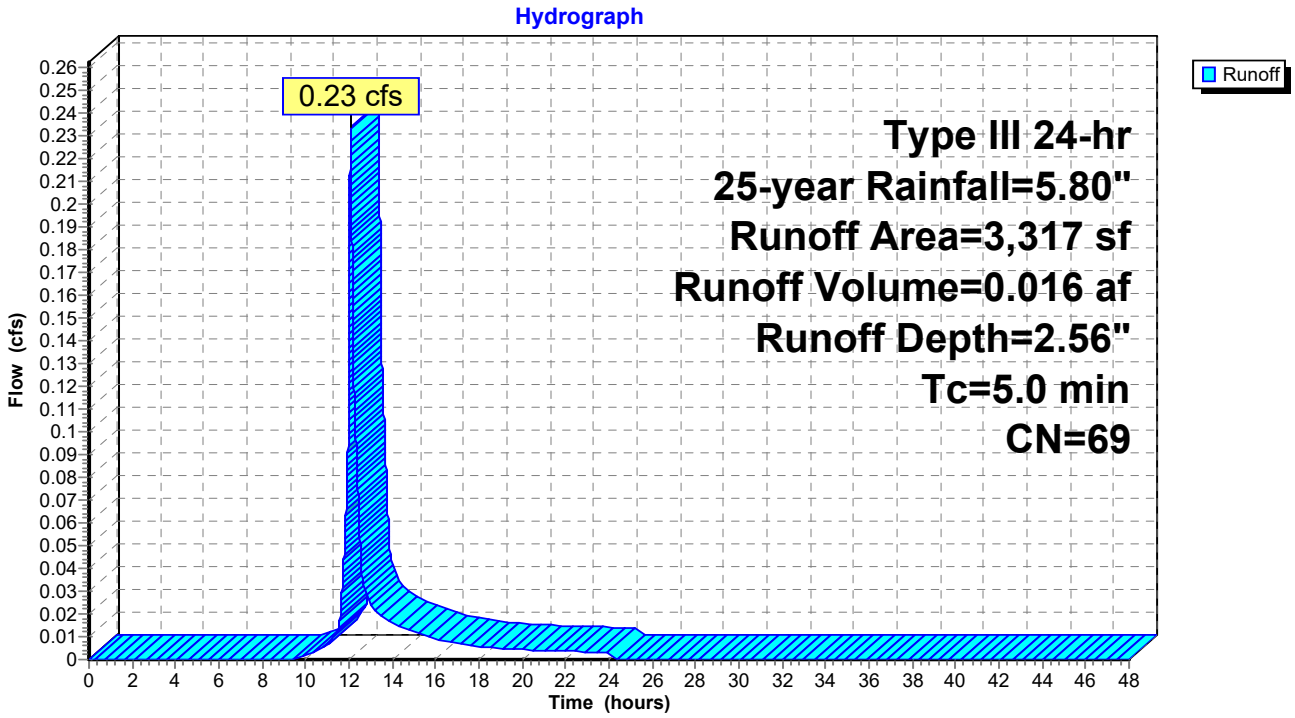
Runoff = 0.23 cfs @ 12.08 hrs, Volume= 0.016 af, Depth= 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.001 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	758	98	Patio/Wall
	2,559	61	>75% Grass cover, Good, HSG B
	3,317	69	Weighted Average
	2,559		77.15% Pervious Area
	758		22.85% Impervious Area

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

Subcatchment 2S: 3rd Floor Patio Area



Summary for Subcatchment 3S: Front Access

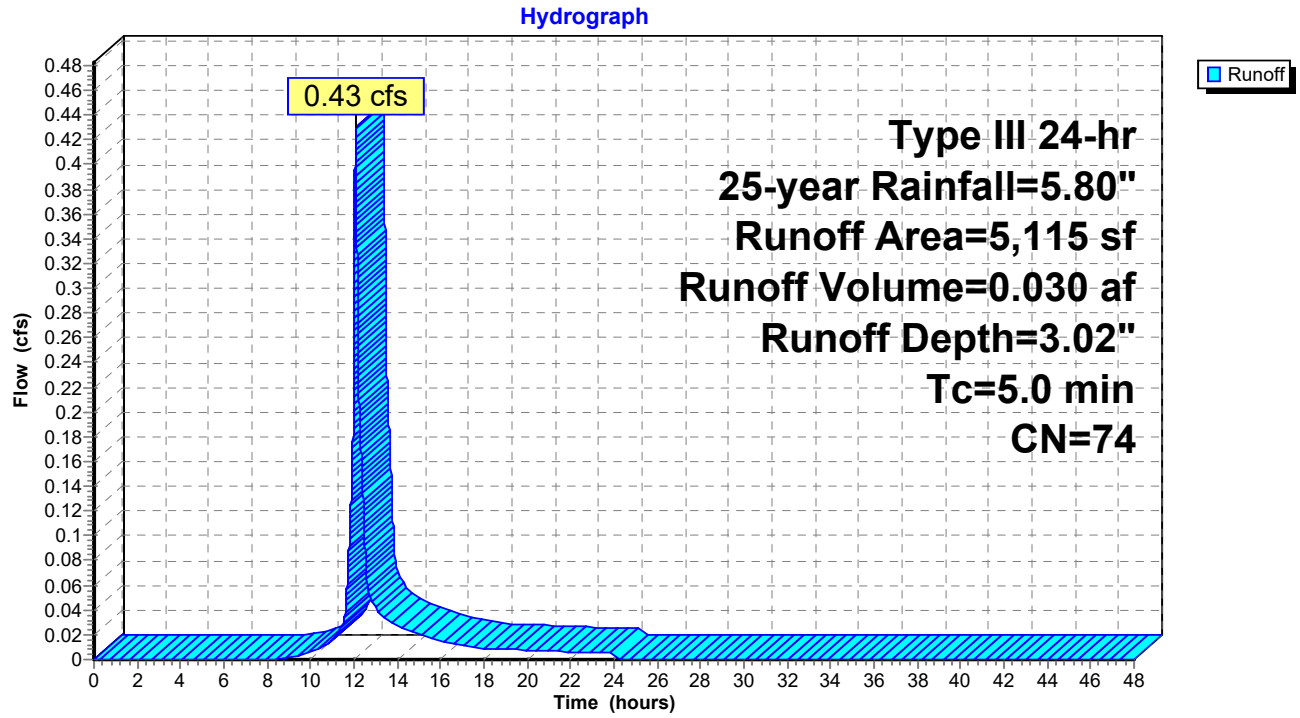
Runoff = 0.43 cfs @ 12.07 hrs, Volume= 0.030 af, Depth= 3.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.001 hrs
Type III 24-hr 25-year Rainfall=5.80"

	Area (sf)	CN	Description
*	1,821	98	Patio/Walls, Walkways
	3,294	61	>75% Grass cover, Good, HSG B
	5,115	74	Weighted Average
	3,294		64.40% Pervious Area
	1,821		35.60% Impervious Area

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

Subcatchment 3S: Front Access

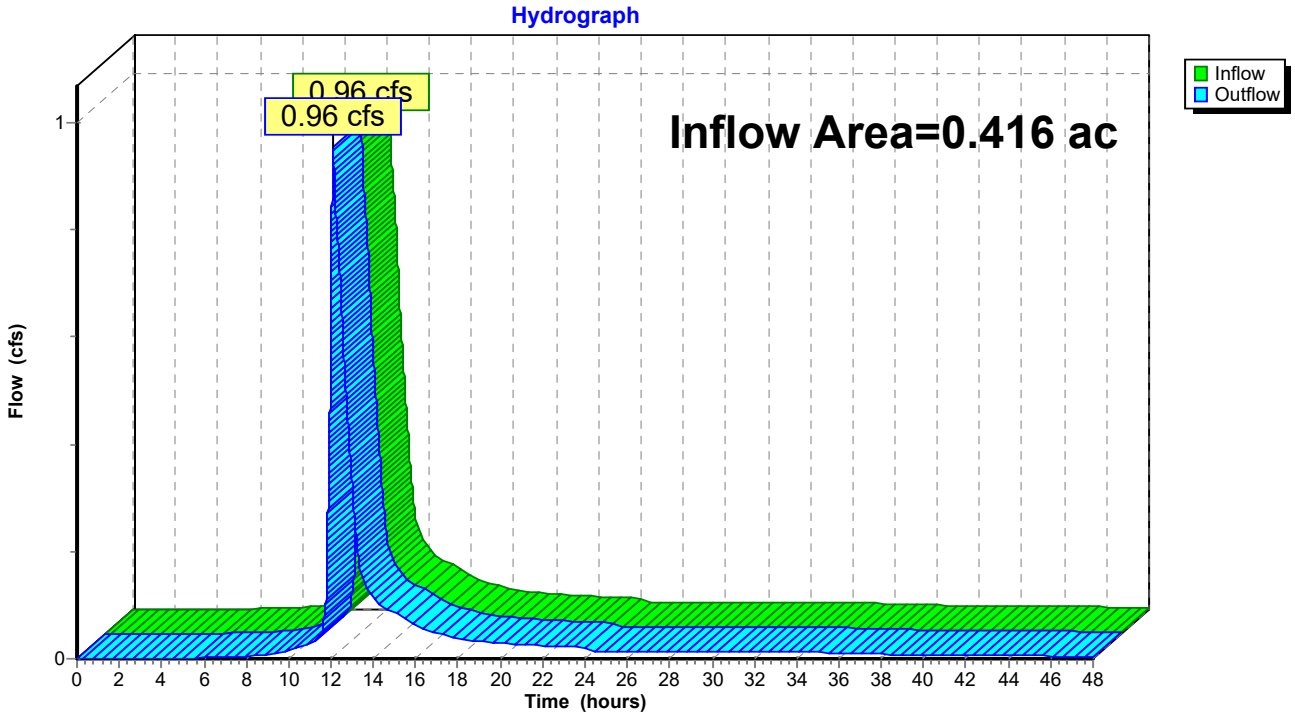


Summary for Reach 1R: POI#1

Inflow Area = 0.416 ac, 48.62% Impervious, Inflow Depth > 3.90" for 25-year event
Inflow = 0.96 cfs @ 12.10 hrs, Volume= 0.135 af
Outflow = 0.96 cfs @ 12.10 hrs, Volume= 0.135 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.001 hrs

Reach 1R: POI#1



Summary for Pond 1P: Medium StormTech 4500

Inflow Area = 0.299 ac, 53.73% Impervious, Inflow Depth = 4.37" for 25-year event
Inflow = 1.49 cfs @ 12.07 hrs, Volume= 0.109 af
Outflow = 0.63 cfs @ 12.26 hrs, Volume= 0.106 af, Atten= 58%, Lag= 11.1 min
Primary = 0.63 cfs @ 12.26 hrs, Volume= 0.106 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.001 hrs
Peak Elev= 126.86' @ 12.26 hrs Surf.Area= 0.041 ac Storage= 0.040 af

Plug-Flow detention time= 291.6 min calculated for 0.106 af (97% of inflow)
Center-of-Mass det. time= 274.5 min (1,057.8 - 783.2)

Volume	Invert	Avail.Storage	Storage Description
#1	122.72'	0.030 af	**13.33'W x 45.08'L x 6.75'H Stone** 0.093 af Overall - 0.018 af Embedded = 0.075 af x 40.0% Voids
#2	123.47'	0.018 af	**ADS_StormTech MC-4500 +Cap @ 4.03' L** x 6 Inside #1 Effective Size= 90.4"W x 60.0"H => 26.46 sf x 4.03'L = 106.6 cf Overall Size= 100.0"W x 60.0"H x 4.33'L with 0.31' Overlap 2 Rows of 3 Chambers Cap Storage= +35.7 cf x 2 x 2 rows = 142.8 cf
#3	121.22'	0.001 af	**13.33'W x 45.08'L x 1.50'H Sand** 0.021 af Overall x 5.0% Voids
#4	119.88'	0.007 af	**13.33'W x 45.08'L x 1.33'H Crushed Stone** 0.018 af Overall - 0.000 af Embedded = 0.018 af x 40.0% Voids
#5	120.21'	0.000 af	**4.0" Round Underdrain Storage** Inside #4 L= 42.0'
		0.056 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	119.90'	**8.0" Round Culvert** L= 107.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 119.90' / 107.00' S= 0.1206 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.35 sf
#2	Device 1	120.00'	**0.5" Vert. Vert Water Quality** C= 0.600
#3	Device 1	124.60'	**4.0" Vert. Vert Quantity** C= 0.600
#4	Primary	128.00'	**6.0' long x 0.7' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32

Primary OutFlow Max=0.63 cfs @ 12.26 hrs HW=126.86' (Free Discharge)
- **1=Culvert** (Passes 0.63 cfs of 3.42 cfs potential flow)
  - **2=Vert Water Quality** (Orifice Controls 0.02 cfs @ 12.59 fps)
  - **3=Vert Quantity** (Orifice Controls 0.61 cfs @ 6.97 fps)
- **4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)