Project Narrative
and
Hydrologic Report

for

Parking Improvements
The Hope Community Church of Newburyport

located at

11 Hale Street
Newburyport, Massachusetts 01950

Prepared For

The Hope Community Church of Newburyport
11 Hale Street
Newburyport, MA 01950

Date: December 14, 2017

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Overview

The site is a 10.8 acre developed parcel having frontage along Hale Street and Low Street which houses the Hope Community Church and Mrs. Murray's Nursery School. The building encompasses 31,858 square feet and the associated parking and interior access aisles occupy approximately 1.54 acres. With the excepting of a grassy field area of approximately 1.5 acres in size the balance of the property is wetlands. The site has a single access from Hale Street and during times of worship and special events, the site is subject vehicular and pedestrian safety concerns resulting from poor traffic patterns and overcrowding due to lack of sufficient parking.

The project proposes to address the safety and overcrowding issues through the construction of an additional parking area which will result in the creation of 103 additional parking spaces and the construction of a second access aisle to provide for improved management of interior traffic patterns. The project also proposed to provide new sidewalks, signage, site lighting, plantings and the relocation of handicap parking spaces.

Environmental and Community Impact

Surface and Ground Water Pollution

The project is not a land use with higher potential pollution loads and is not located within any Zone II or Interim Wellhead Protect areas or in any Critical areas as defined by DEP. This results in a requirement to provide treatment to the volume of runoff generated by ½-inch times the area of impervious surfaces on the site. To meet this requirement the project includes the addition of two (2) proprietary treatment units to provide treatment of the required runoff discharges thereby affording the protection of surface and ground waters.

Presently the site contains a series of water quality swales, sediment forebays and constructed wetland detention basins which provide the required treatment for existing impervious surfaces. The proposed project includes the creation of a 112 space parking area, access aisles and 670 linear feet of new concrete sidewalk thereby creating an additional 40,000 square feet of impervious surface. Due to losses of existing spaces for the construction of access aisles the net increase of parking is 103 spaces. The project also includes the reconstruction of the existing paved surfaces at the current main entrance and the adjacent 40 space parking area and walkway.

Stormwater discharges from the newly created paved surfaces and the reconstructed entrance aisle and associated parking area are captured by the proposed stormwater drainage system and directed into two (2) proprietary stormwater units for treatment and TSS removal. Each of these units is sized to capture and treat in excess of the 80% TSS removal for required ½-inch of runoff from their contributing drainage areas thereby meeting Stormwater Standards.

The project will result in a small amount of discharge which bypasses the proposed new drainage system and treatment devices. These areas include the proposed concrete sidewalk adjacent to

the building, 1,350 square feet of the new access aisle's entrance from Hale Street and the 1,350 square feet of the same access aisle as it joins the existing parking area. However, each of these areas the stormwater discharge to the sites existing stormwater treatment system to provide the necessary treatment.

The management of stormwater for the project includes the creation of a sub-surface piped storage system to regulate stormwater discharges resulting from the increase in the sites impervious areas. This storage area provides sufficient detention thereby enabling a reduction in peak runoff from the site for all storm events up to and including the 100-year event.

Due to the presence of unsuitable clay soils throughout the site no recharge of stormwater is provided. While it is possible to provide recharge within the piped storage system, no recharge is proposed as a result of DEP's Stormwater Regulations.

DEP's Stormwater Regulations states that infiltration is not permitted within "D" soils as "D" soils have an infiltration rate which is below the required minimum rate of 0.17 inches per hour.

As a result of the inability to provide infiltration that meets DEP's regulation this results in an increase of the volume of runoff of 0.107 acre-feet (4,661 cubic feet) for the 2-year storm event and 0.145 acre-feet (6,316 cubic feet) for the 100-year storm event. All of the increased runoff discharges to the rear portion of the site consisting of a vegetated wetland of approximately 2.5 acres. This wetland extends into abutting properties creating a total wetland area of approximately 6.5 acres. Due to the size of the wetland and the small amount of excess runoff volume generated from the proposed improvements, the impact of the project will only result in a negligible increase of water surface levels of 0.02 inches during the 100 year storm event.

Soils

Site soils are comprised of clay(s), a class D soil as determined by site soil explorations and the United States Department of Agriculture Natural Resources Conservation Services (NRCS) Soil Report. A complete analysis of site soils is provided within the hydraulic report.

Site soil testing occurred on two (2) occasions. The first soil tests occurred July 9, 1997and the most recent soil test occurred on January 11, 2017. On July 9, 1996 the soil was examined in three (3) test pits. These test pits are located in the northerly portion of the site were the proposed parking expansion is to take place. These excavations occurred prior to the filling of this portion of the site with 18" to 24" of topsoil during the initial development of the property. On January 11, 2017 one additional test pit was made within the existing parking area of the main entrance to the site. The location and soils analysis of these tests are included on the project plans.

Of the 4 test pits, all indicated an 18" layer of top soil and/or fill with an underlying material of clay. In each of the test pits the estimated high ground water table was located approximately at the top surface of the clay stratum.

As these test pits confirmed the soils types as identified in the NRCS report, throughout this analysis the site was modeled utilizing soils belonging to the Hydrologic Soil Group D to establish a comparison of pre and post run-off rates and volumes.

Due to the restrictions of class "D" soils which exist within the site; the high ground water table elevation and DEP's restriction* on utilizing "D" soils for infiltration, the calculations provided within the hydrologic report were performed without taking account for any infiltration.

*Per DEP Stormwater Manual the minimum allowable infiltration rate is 0.17 inches per hour and the applicable Rawl's rate for clay is 0.02 inches per hour.

Traffic Impacts

The project provides for the creation of an additional parking area, lane markings and interior signage to improve safety within the site. The project does not include the change or expansion of the use of the site therefore, the project does not alter the existing traffic volume or trips generated by the site.

The projects design also provides for the improved management of traffic flow entering, exiting and internally within the site. The creation of a separate entrance and exit allows for a uniform access to the site and eliminates the bottle neck which presently exists from the single site access. The proposed new entrance is located along a straight portion of Hale Street. The grade of Hale Street in this area is less than 2% which results in sight distances in excess of 500 feet thereby meeting sight distance requirements.

Architectural Style

The project does not include any new additional structures.

Site Signage

The project proposes to replace the existing site sign, presently located at the existing entrance, to the proposed access aisle located along the westerly portion of the site. Due to the extent of wetland vegetation and the extended distance between the edge of the existing pavement and property line the proposed new sign has been located at the property line for visibility.

The project also proposes to install an entrance and exit guide sign at the respective access aisles. Each of these guide signs are proposed within the street layout for visibility.

Site Lighting

Additional site lighting is proposed to provide the minimal lighting levels necessary for safety and security within the parking area of the site. At the present time the proposed lighting consists of LED fixtures mounted on two 30 foot poles.

The proposed site lighting consists of LED fixtures mounted on 20 foot poles. The new lighting provides for increased safety within the site and does not permit any light trespass at the property line. A copy of the fixtures specification sheet and photometric layout plan is attached to this report.

Other Require Permits

The proposed project requires a NOI with the Conservation Commission

Pending the result of City approvals the project may require the development of an EPA general construction SWWPP. If required, the SWWPP will be submitted prior to the start of any construction.

Air and Noise Pollution

As with any construction project, there will be temporary noise associated with the construction of the new parking area and the reconstruction of the existing parking area. The majority of the noise will result during the earthwork phase; installation of the drainage system; and paving of the parking area surface. Following the installation of final pavement minimal noise will occur during the installation of plantings, signage and pavement markings. The site is located within an industrial area which abuts residential districts on the northwesterly side of Hale Street and the northeasterly side of Low Street. All work will be performed during the regulated construction hours and noise threshold limits established by City Ordinances.

During construction the contractor will be required to establish a dust control program consisting of a regular watering or application of calcium chloride for dust control during construction to preserve air quality.

Impacts to air and noise will be temporary during active constriction and the project will not have any impacts upon completion of construction.

Man-Made Environment

The project will not have any effect on the existing neighborhood land use or zoning as the project does not increase or change the current use of the site.

Public Services

The project provides for the expansion of parking facilities and safety improvements and will not have any increases of demand on public services.

Aesthetics

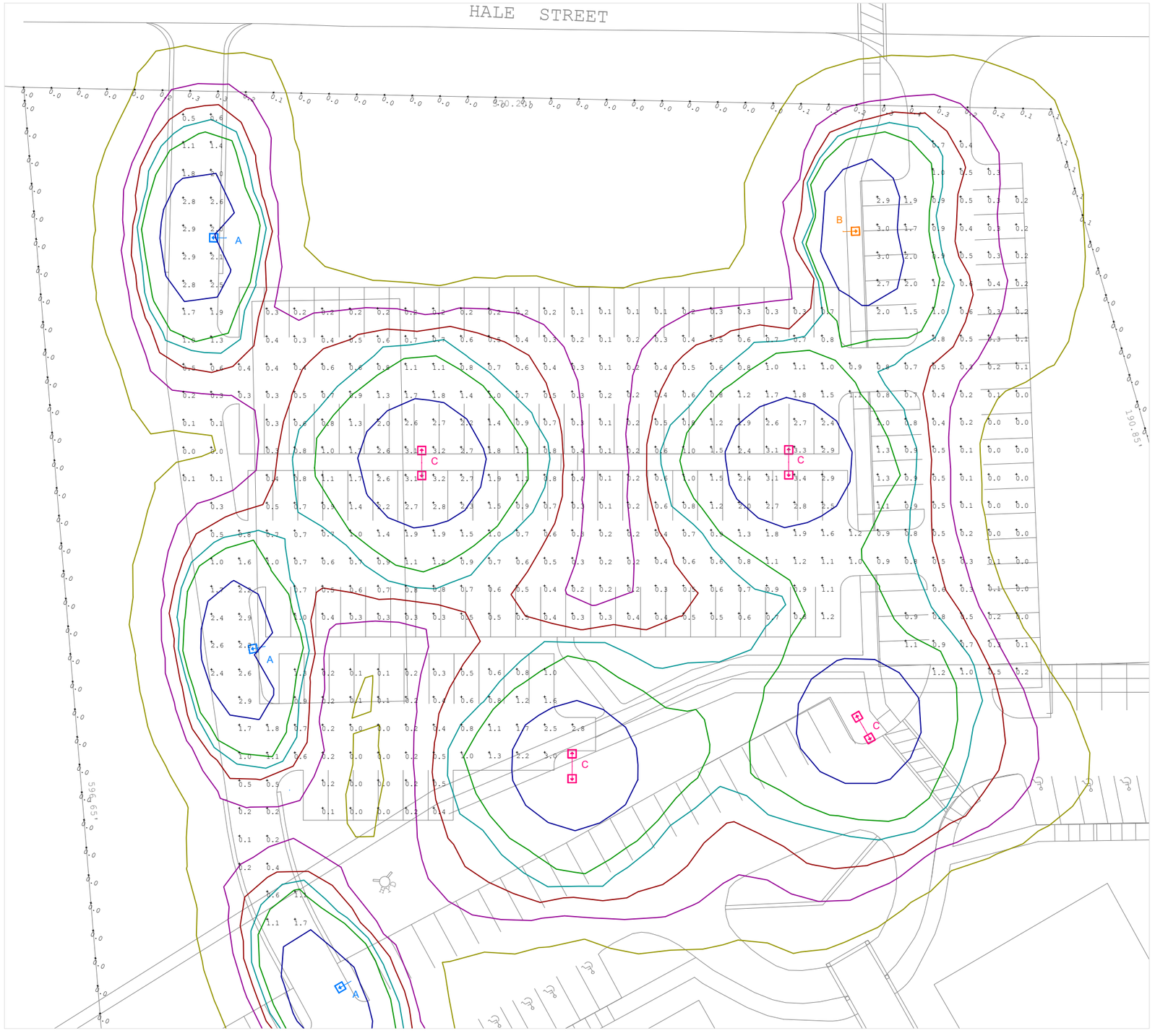
The proposed site lighting has been designed to provide the minimal lighting necessary for safety within the parking area and access aisles. The levels proposed result no increase in light levels at the property boundaries.

Additional landscaping is proposed to provide screening of the parking area from Hale Street, to provide enhancement of wetland buffer zone areas and landscaping within existing and proposed parking areas.

Photometric Study - Run 4

Luminaire Schedule									
Symbol	**Qty**	**Label**	**Description**	**Arrangement**	**Arm**	**MH**	**LLF**	**Lum. Lumens**	**Lum. Watts**
	3	A	AR18-10M2-MV-NW-2-XX-530	SINGLE	1.5	20	0.850	7730	63
	1	B	AR18-10M2-MV-NW-4-XX-700	SINGLE	1.5	20	0.850	9937	87
	4	C	AR18-10M2-MV-NW-5-XX-530	BACK-BACK	1.5	20	0.850	7628	63

Calculation Summary							
Label	**CalcType**	**Units**	**Avg**	**Max**	**Min**	**Avg/Min**	**Max/Min**
Parking	Illuminance	Fc	0.9	3.4	0.0	N.A.	N.A.
Property Line	Illuminance	Fc	N.A.	0.4	0.0	N.A.	N.A.



ISOLINE KEY

- 0.00 fc
- 0.25 fc
- 0.50 fc
- 0.75 fc
- 1.00 fc
- 2.00 fc

Project: *Hope Community Church*

Location: *Newburyport, MA*

Project No.:	*17-676*	Size:	*B*
Drawing No.:	*PH4*	Sheet:	*1 of 1*
Version:	*1*	Scale:	*N.T.S.*
Revision:	*0*	Date:	*15DEC2017*

Project

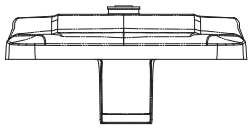
Type

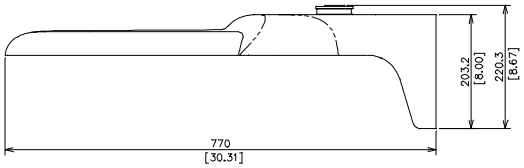
Catalog No.

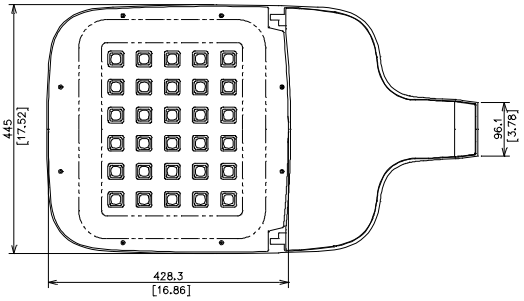
ARIETA™ 18 Architectural LED Area Luminaire
AR18 M2 Series Specification Data Sheet

Luminaire Data

Weight 24 lbs [10.9 kg]
EPA 0.55 ft²







Ordering Information

Sample Catalog No. AR18 20M2 MV NW 3 DB 700 HSS

Product	LED Code	Voltage	Nominal Color Temperature	Distribution	Finish[1]	Drive Current Code[2]	Options
AR18	**6M2** **10M2** **15M2** **18M2** **20M2** **24M2** **30M2**	**MV** 120-277V **HV** 347-480V	**WW** 3000K **NW** 4000K **CW** 5000K	**2** Type 2 **3** Type 3 **4** Type 4 **5** Type 5	**BK** Black **DB** Dark Bronze **WH** White **GY** Gray **NA** Natural Aluminum	**350** **530** **700**	**HSS**[3] House Side Shield (Factory Installed) **FDC**[4] Fixed Drive Current **FFA**[5] Full Field Adjustabilty **PCR**[6] NEMA Photocontrol Receptacle **PCR7**[6] ANSI 7-wire Photocontrol Receptacle **PCR7-CR**[7] Control Ready 7-wire Photocontrol Receptacle **MSL7**[8] Motion Sensor with L7 Lens **MSL3**[8] Motion Sensor with L3 Lens **PND1**[9] Part-Night Dimming **PND2**[9] Part-Night Dimming **PND3**[9] Part-Night Dimming **ORR** Optics Rotated Right **ORL** Optics Rotated Left **WL** Utility Wattage Label

Notes:

1 Black, Dark Bronze, White, Gray, or Natural Aluminum standard. Consult factory for other finishes.

2 Specified drive current code is the factory set maximum drive current. Field adjustable current selector enables standard dimming to lower wattage drive currents only. Consult factory if wattage limits require a special drive current.

3 Flush mounted shield factory installed, also available for field installion. House Side Shield cuts light off at 1/2 mounting height behind luminaire.

4 Non-field adjustable drive current. Specify 350mA, 530mA or 700mA setting.

5 The FFA option enables full field adjustability from the specified drive current code to all drive currents available. This option is not DLC qualified.

6 Field adjustable current selector included to enable standard dimming to lower wattage drive currents only. Field changeable connectors included to enable connection to PCR7 (wireless node dimming is disabled by default).

7 Control-ready wired at factory for wireless node dimming. Supplied at maximum drive current. If lower drive current is required, consult factory.

8 Motion Sensor available with MV or HV. See L7 or L3 Lens coverage details on page 5. Consult factory for MS specified with ANSI 7-wire Photocontrol Receptacle. PCR option is required for On/Off control using light detection.

9 For PND profile options see page 6. Only available with MV (120-277V).

10 Specify Color (GY, DB, BK, WH, NA)

11 Specify MV (120-277V) or HV (347V or 480V)

Accessories*	
HSSAR18[3,10]	House Side Shield
RPA[10]	Round Pole Adapter
PTF1[10]	Square Pole Top Fitter Single
PTF2[10]	Square Pole Top Fitter Twin at 180°
PTF4[10]	Square Pole Top Fitter Quad
WM[10]	Wall Mount
BSK	Bird Deterrent Spider Kit
PC[11]	Twist Lock Photocontrol
LLPC[11]	Long-Life Twist Lock Photocontrol
SC	Twist Lock Shorting Cap
FSIR100	Motion Sensor Configuration Tool

*Accessories are ordered separately and not to be included in the catalog number

ARIETA™ 18 Architectural LED Area Luminaire
AR18 M2 Series Specification Data Sheet

Luminaire Specifications

Housing
Die cast aluminum housing with universal mounting design allows for attachment to existing pole without redrilling for retrofit applications. Aluminum housing provides passive heat-sinking of the LEDs and has upper surfaces that shed precipitation. Mounting provisions meet 3G vibration per ANSI C136.31-2010 Normal Application, Bridge & Overpass. Electrical components are accessed without tools and are mounted on removable power door.

Light Emitting Diodes
Hi-flux/Hi-power white LEDs produce a minimum of 90% of initial intensity at 100,000 hours of life based on IES TM-21. LEDs are tested in accordance with IES LM-80 testing procedures. LEDs have correlated color temperature of 3000K (WW), 4000K (NW), or 5000K (CW) and 70 CRI minimum. LEDs are 100% mercury and lead free.

Field Adjustability
LED drive current can be changed in the field to adjust light output for local conditions (not available with PCR7-CR option). The specified drive current code will be the factory set maximum drive current and field adjustments can only be made to available lower wattage drive currents. Select the FFA option if full field adjustability to all available drive currents (700mA max) is desired. The FFA option is not DLC qualified.

Quality Control
Every luminaire is performance tested before and after a 2-hour burn-in period. Assembled in the USA.

Optical Systems
Micro-lens optical systems produce IESNA Type 2, Type 3, Type 4 or Type 5 distributions and are fully sealed to maintain an IP66 rating. Luminaire produces 0% total lumens above 90^{o} (BUG Rating, U=0). Optional house side shield (HSS) cuts light off at 1/2 mounting height behind luminaire. Optics may be rotated right or left with options ORR/ORL, respectively.

Electrical
Rated life of electrical components is 100,000 hours. Uses isolated power supply that is 1-10V dimmable. Power supply is wired with quick-disconnect terminals. Power supply features a minimum power factor of .90 and <20% Total Harmonic Distortion (THD). EMC meets or exceeds FCC CFR Part 15. Terminal block accommodates 6 to 14 gauge wire. Surge protection complies with IEEE/ANSI C62.41 Category C High, 20kV/10kA and ANSI C136.2-2015, 20kV/10kA.

Controls
3-Wire photocontrol receptacle (PCR) is available. ANSI C136.41 or 7-wire (PCR7) photocontrol receptacles are available. All photocontrol receptacles have tool-less rotatable bases. Wireless control module is provided by others.

Finish
Housing receives a fade and abrasion resistant polyester powder coat finish with 3.0 mil nominal thickness. Finish tested to withstand 5000 hours in salt spray exposure per ASTM B117. Finish meets scribe creepage rating 8 per ASTM D1654. Finish tested 500 hours in UV exposure per ASTM G154 and meets ASTM D523 gloss retention.

Listings/Ratings/Labels
Luminaires are UL listed for use in wet locations in the United States and Canada. DesignLights Consortium™ qualified product. Consult DLC QPL for Standard and Premium Classification Listings. International Dark Sky Association listed. Luminaire is qualified to operate at ambient temperatures of -40°C to 40°C.

Photometry
Luminaires photometrics are tested by certified independent testing laboratories in accordance with IES LM-79 testing procedures.

Warranty
10-year limited warranty is standard on luminaire and components. 5-year limited warranty on luminaires and components with a motion sensor.

Standards
Luminaire complies with:

ANSI: C136.2, C136.3, C136.10, C136.13, C136.15, C136.22, C136.31, C136.35, C136.37, C136.41, C62.41, C78.377, C82.77

Other: FCC 47 CFR, IEC 60598, ROHS II, UL 1449, UL 1598

ARIETA™ 18 Architectural LED Area Luminaire
AR18 M2 Series Specification Data Sheet

Performance Data 3000K (WW)

All data nominal. IES files are available at leotek.com.

			Type 2, 3, 4		Type 5	
LED Code	**Current Code**	**System Wattage (W)**	**Delivered Lumens (Lm)[1]**	**Efficacy (Lm/W)**	**Delivered Lumens (Lm) [1]**	**Efficacy (Lm/W)**
6M2	350	29	2930	101	2750	95
	530	41	4110	99	3860	93
	700	54	5040	94	4950	92
10M2	350	41	4600	112	4500	109
	530	63	6700	106	6600	104
	700	87	8500	97	8400	96
15M2	350	63	7400	117	7300	116
	530	90	9600	107	9500	106
	700	124	12900	104	12700	102
18M2	350	81	9000	111	9100	112
	530	122	12800	105	13000	107
	700	160	16400	103	16700	104
20M2	350	84	10700	127	10800	129
	530	132	15300	116	15500	117
	700	172	18200	106	18500	108
24M2	350	98	10700	109	10800	110
	530	152	15300	100	15500	102
	700	209	19500	93	19900	95
30M2	350	133	14300	107	14500	109
	530	202	20400	101	20600	102
	700	262	24500	93	24800	95

Notes:
1 Normal tolerance ± 10% due to factors including distribution type, LED bin variance, driver variance, and ambient temperatures.

ARIETA™ 18 Architectural LED Area Luminaire
AR18 M2 Series Specification Data Sheet

Performance Data 4000K (NW) & 5000K (CW)

All data nominal. IES files are available at leotek.com.

			Type 2, 3, 4		Type 5	
LED Code	**Current Code**	**System Wattage (W)**	**Delivered Lumens (Lm) [1]**	**Efficacy (Lm/W)**	**Delivered Lumens (Lm) [1]**	**Efficacy (Lm/W)**
6M2	350	29	3490	120	3480	120
	530	41	4810	116	4850	117
	700	54	5980	111	5880	109
10M2	350	41	5400	132	5300	129
	530	63	7800	124	7700	122
	700	87	10000	115	9800	113
15M2	350	63	8400	133	8300	132
	530	90	11500	128	11300	126
	700	124	15000	121	14700	119
18M2	350	81	9600	119	9700	120
	530	122	13700	112	13900	114
	700	160	17500	109	17800	111
20M2	350	84	10600	126	10800	129
	530	132	15200	115	15500	117
	700	172	19500	114	19800	115
24M2	350	98	12500	128	12700	130
	530	152	17900	118	18600	122
	700	209	23400	112	23800	114
30M2	350	133	16900	127	16800	126
	530	202	24100	119	24000	119
	700	262	28900	110	29300	112

Notes:
1 Normal tolerance ± 10% due to factors including distribution type, LED bin variance, driver variance, and ambient temperatures.

BUG Ratings: 3000K (WW)

All data nominal. IES files for all CCTs are available at leotek.com.

LED Code	Current Code	Type 2	Type 3	Type 4	Type 5
6M2	350	B1 U0 G1	B1 U0 G1	B1 U0 G1	B2 U0 G0
	530	B1 U0 G1	B1 U0 G1	B1 U0 G1	B2 U0 G1
	700	B1 U0 G1	B1 U0 G1	B1 U0 G1	B3 U0 G1
10M2	350	B1 U0 G1	B1 U0 G1	B1 U0 G1	B2 U0 G1
	530	B1 U0 G1	B1 U0 G1	B2 U0 G1	B3 U0 G1
	700	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G1
15M2	350	B1 U0 G1	B1 U0 G2	B2 U0 G2	B3 U0 G1
	530	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	700	B2 U0 G2	B2 U0 G2	B3 U0 G2	B4 U0 G2
18M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B2 U0 G2	B2 U0 G2	B3 U0 G2	B4 U0 G2
	700	B2 U0 G2	B2 U0 G2	B3 U0 G2	B4 U0 G2
20M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B3 U0 G3	B2 U0 G2	B3 U0 G2	B4 U0 G2
	700	B3 U0 G3	B3 U0 G3	B3 U0 G2	B4 U0 G2
24M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B3 U0 G3	B2 U0 G2	B2 U0 G2	B4 U0 G2
	700	B3 U0 G3	B3 U0 G3	B3 U0 G3	B4 U0 G2
30M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B4 U0 G2
	530	B3 U0 G3	B3 U0 G3	B3 U0 G3	B4 U0 G2
	700	B3 U0 G3	B3 U0 G3	B3 U0 G3	B5 U0 G3

BUG Ratings: 4000K (NW) & 5000K (CW)

All data nominal. IES files for all CCTs are available at leotek.com.

LED Code	Current Code	Type 2	Type 3	Type 4	Type 5
6M2	350	B1 U0 G1	B1 U0 G1	B1 U0 G1	B2 U0 G1
	530	B1 U0 G1	B1 U0 G1	B1 U0 G1	B3 U0 G1
	700	B1 U0 G1	B1 U0 G1	B1 U0 G1	B3 U0 G1
10M2	350	B1 U0 G1	B1 U0 G1	B1 U0 G1	B3 U0 G1
	530	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G1
	700	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
15M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G1
	530	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	700	B2 U0 G2*	B2 U0 G2	B3 U0 G2	B4 U0 G2
18M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B2 U0 G2	B2 U0 G2	B3 U0 G2	B4 U0 G2
	700	B3 U0 G3	B3 U0 G2*	B3 U0 G2	B4 U0 G2
20M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B2 U0 G2*	B2 U0 G2	B3 U0 G2	B4 U0 G2
	700	B3 U0 G3	B3 U0 G3	B3 U0 G3	B4 U0 G2
24M2	350	B2 U0 G2	B2 U0 G2	B2 U0 G2	B3 U0 G2
	530	B3 U0 G3	B3 U0 G2*	B3 U0 G2	B4 U0 G2
	700	B3 U0 G3	B3 U0 G3	B3 U0 G3	B4 U0 G2*
30M2	350	B3 U0 G3	B2 U0 G2*	B3 U0 G2	B4 U0 G2
	530	B3 U0 G3	B3 U0 G3	B3 U0 G3	B4 U0 G2*
	700	B3 U0 G3	B3 U0 G4	B3 U0 G4	B5 U0 G3

* These BUG ratings are slightly different for 5000K (CW). Refer to IES files for actual CW rating.

ARIETA™ 18 Architectural LED Area Luminaire
AR18 M2 Series Specification Data Sheet

Motion Sensor (Optional) Specifications

Description
Digital passive infrared luminaire integrated outdoor occupancy sensor provides high/low/off control based on motion detection. Initial setup and subsequent sensor adjustments are made using a handheld configuration tool. PCR option is required for On/Off control using light detection. Available with both MV and HV input voltage options.

Operation
Standard factory setting will dim the luminaire to 50% until motion is sensed and then it will power to 100%. When motion is not detected for five minutes, the luminaire will dim back to 50%. Ramp up and fade down times are adjustable, but initially set to NONE. The percent dimming and time durations may be field adjusted as required using FSIR-100 configuration tool. FSIR-100 user guide available at: www.wattstopper.com.

Optical System
Multi-cell, multi-tier Fresnel lens with a 360 degree view detects unobstructed motion within one mounting height, up to 20 ft. maximum (MSL3) or 40 ft. maximum (MSL7). Consult factory for higher mounting height requirements.

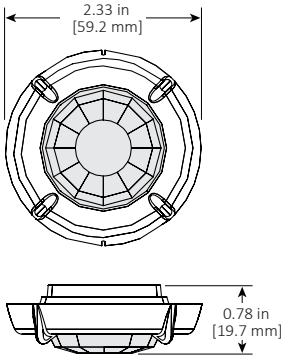
Finish
Sensor exterior ring and lens are white polycarbonate, UV and impact resistant.

Listings/Ratings
Sensor is TUV, UL and cUL listed, IP66 rated and CE compliant.

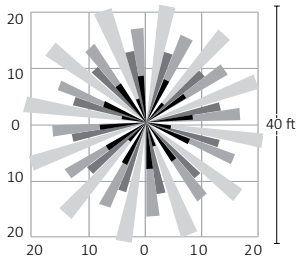
Warranty
5-year limited warranty on luminaires and components with a motion sensor.

Motion Sensor (Optional) Data

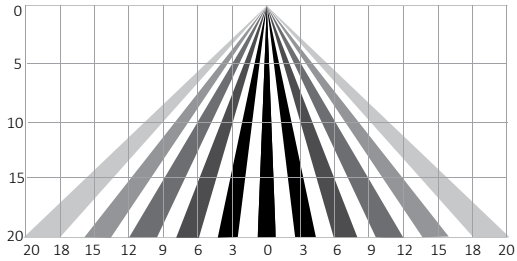
MSL3 Lens Dimensions



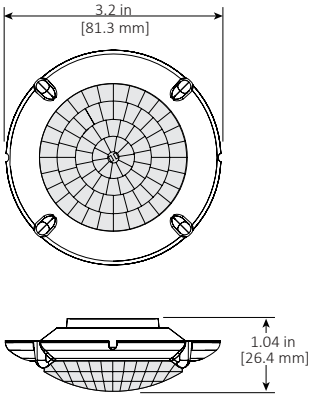
MSL3 Lens Coverage Top View



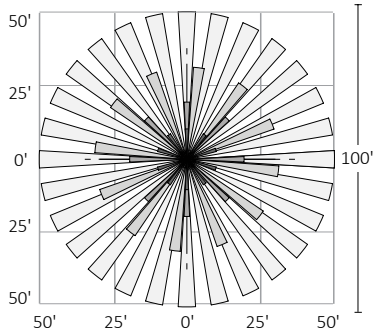
MSL3 Lens Coverage Side View



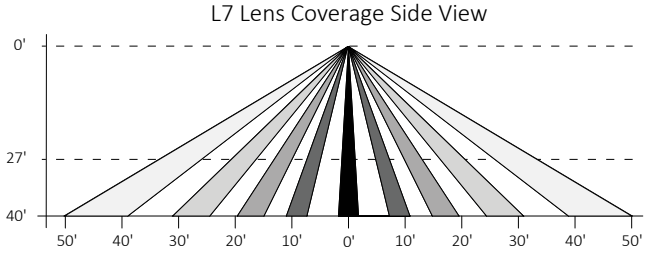
MSL7 Lens Dimensions



L7 Lens Coverage Top View



L7 Lens Coverage Side View



Part-Night Dimming Specifications

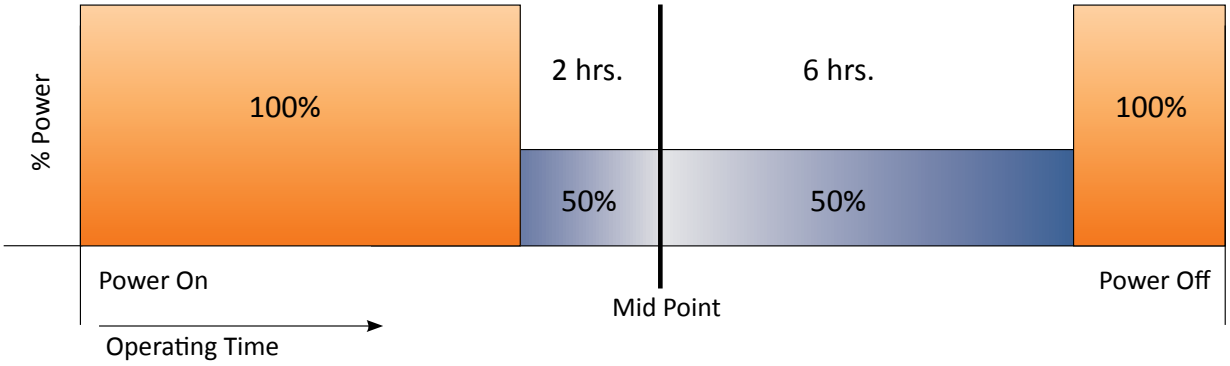
Description

Arieta's Part-Night Dimming (PND) option enables significant energy savings by automatically dimming the luminaire during early morning hours when infrequent use is expected. Factory programmed dimming profiles automatically take into account seasonal changes based on geographical location by continuously monitoring the nighttime midpoint. This option is fully compatible with photocells and time clock devices, but is not field adjustable.

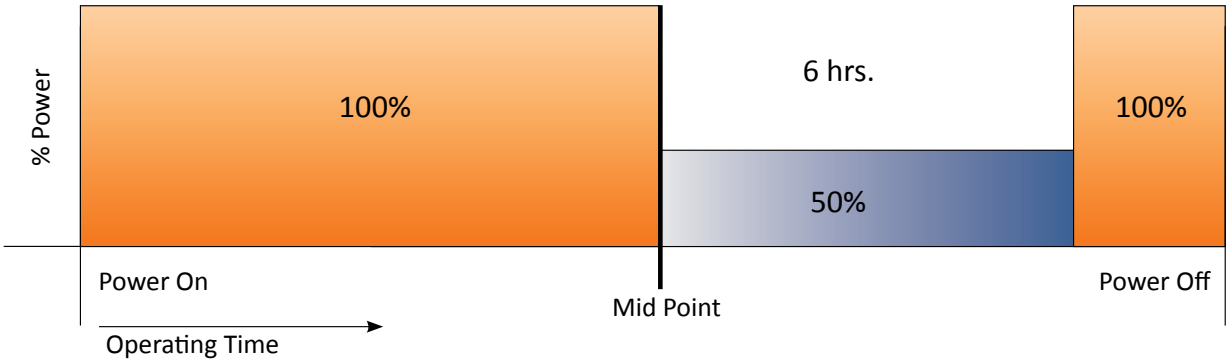
Operation

Based on the PND profile that is selected, the luminaire dims to the corresponding % power for the corresponding length of time (based on the nighttime mid-point) as shown below. Mid-point is continuously recalculated in the luminaire by monitoring the average length of time between when the light turns on (power on) and turns off (power off) over the previous two days. In effect, this functionality will take two days to initialize after installation before any dimming will occur. Power interruptions are ignored and do not affect the determination of mid-point. A motion sensor (MSL3 or MSL7) can be used with PND to temporarily override the dimming profile when motion is detected. Three factory programmed PND profiles are available for selection:

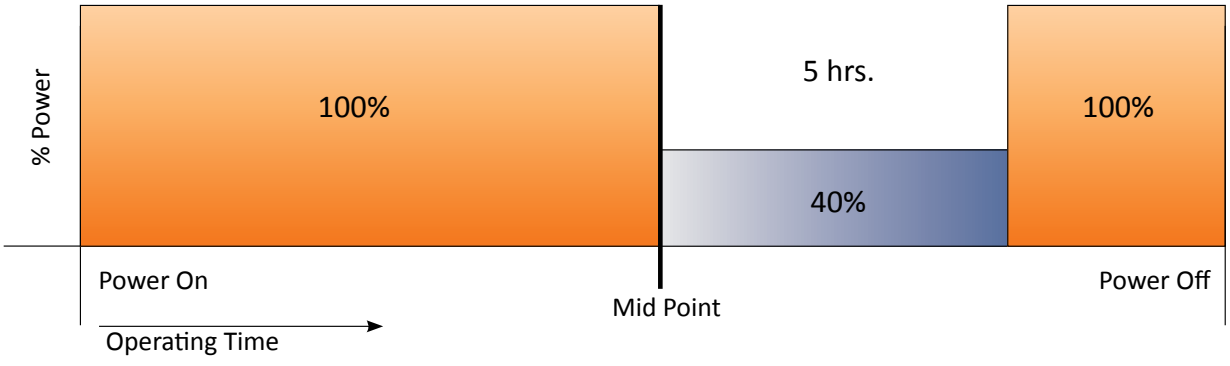
PND1



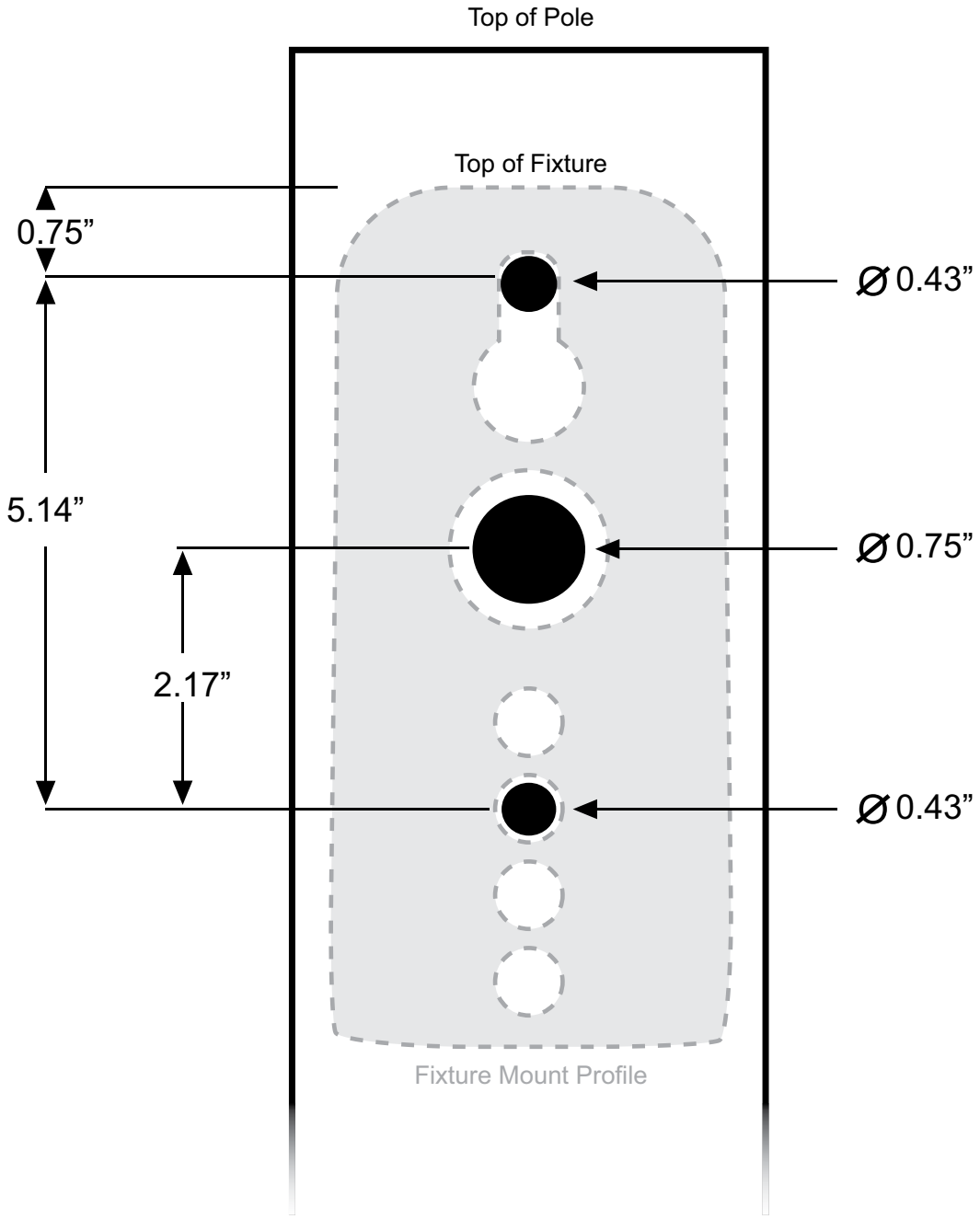
PND2



PND3



Pole Mount Drilling Specifications



Hydrologic Report

Parking Improvements

The Hope Community Church of Newburyport

located at

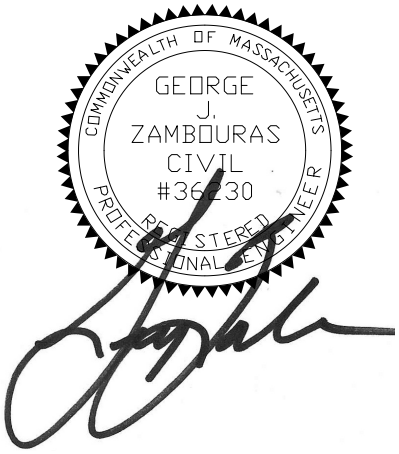
11 Hale Street

Newburyport, Massachusetts 01950

Prepared For

The Hope Community Church of Newburyport
11 Hale Street
Newburyport, MA 01950

2, 10, 25 & 100 Year Storm
24 Hour Duration



Date: December 14, 2017

Atlantic Engineering & Survey Consultants Inc.
97 Tenney Street, Georgetown, Massachusetts 01833
(978) 352-7870

TABLE OF CONTENTS

INTRODUCTION:

This report describes the pre and post hydraulic analysis and stormwater management measures to be implemented to mitigate the impacts to the environment and surrounding properties in the development of the Proposed Parking Lot and Site Improvements for The Hope Community Church of Newburyport located at 11 Hale Street, Newburyport, Massachusetts.

In analyzing the impacts of the proposed improvements only the portions of the sites watershed being affected were studied. The hydraulic report does not calculate run-off rates or quantities for the areas of the site were no work is proposed.

The design of the stormwater system's components are based on the hydraulic analysis performed utilizing "HydroCAD Storm water Modeling Software" for storm events of 25 and 100-year storm frequencies in accordance with the City of Newburyport's regulations and guidelines.

Run-off quantities are calculated using the most current data obtained from the Northeast Regional Climate Center (NRCC) and Natural Resources Conservation Service (NRCS) on July 26, 2017. The rainfall data and calculated IDF curves are located in Appendix "E".

EXISTING CONDITIONS:

The site is identified by the City of Newburyport Assessors Map 83 as Parcel 3 and is located on the southeasterly side of Hale Street approximately 350 feet southwest of the Low Street intersection. The site has frontage along Hale Street and Low Street and is accessed from Hale Street. Due to wetland constraints within the property access to the site from Low Street is not feasible. The site is a 10.8 acre developed parcel consisting of a 31,858 square foot building, 1.54 acres of impervious paved surfaces, and a grassy field area of approximately 1.5 acres. The remainder of the property is comprised of bordering vegetated wetlands and stormwater management areas which were constructed during the development of the site in 1998.

The current building houses the Hope Community Church and Mrs. Murray's Nursery School. The site also serves as a meeting area for numerous local organization events and is one of the public voting sites for the City.

The site's bordering vegetate wetlands were delineated by Rimmer Environmental Consulting (REC) on March 2, 2016 and November 9, 2016. The sites bordering vegetated wetlands are delineated by flags A1-A51, A1-A11 and B7-B15. The wetlands associated with the drainage swale along Hale Street are further explained below. REC's wetland delineation report is attached and located in Appendix "A".

As indicated in REC's report the grass and stone lined drainage swale located to the south and east of the existing parking areas was constructed as a stormwater management component during the development of the site in 1999 to 2000. This swale is delineated by flags A12-A23 and B15-B23 on the plans. This drainage swale was created as a stormwater management component during the development of the site it is not considered a wetland resource area.

It is also possible that the drainage swale along the southerly side and parallel to Hale Street was constructed during 1997 to 1998 as part of the stormwater management system for the industrial

park in the area. This swale is delineated by flags A1-A11 and B7-B15 on the plans and has been considered as a wetland for the project. However, if the needed information can be discovered that the drainage swale was created as a stormwater management component for the development of the industrial park area it is also would not be considered a wetland resource area.

PROPOSED CONDITIONS:

The proposed site development consists of constructing a new parking area which results in 103 new parking spaces, a 350 foot access drive and the rehabilitation of approximately 19,000 square feet of existing paved surfaces. The improvements also include landscaping and buffer zone enhancement plantings; new sidewalks, site lighting and traffic management signage to improve safety within the site.

To mitigate the effects of the new construction additional drainage, subsurface stromwater detention and proprietary stormwater unit are also proposed. In the area of the site were redevelopment is occurring improvements to the exiting drainage system and a proprietary stormwater unit is proposed. These stromwater components are explained in detail within this report.

SITE SOILS:

Existing soils, as identified by the United States Department of Agriculture Natural Resources Conservation Services (NRCS) Soil Report, located in Appendix "H", are comprised of Scantic silt loam, Suffield silt loam and Maybid silt loam. The portion of the site were work is proposed is comprised of Scantic silt loam soils. The Suffield silt loam soils are located at the westerly portion of the site adjacent to Low Street and Maybid silt loam soils are located within the southerly half of the site.

Scantic silt loams consist of soft fine silty glacial deposits and/or soft fine silty marine deposits over hard fine silty glacial and/or marine deposits. These soils are poorly drained, have a water table within 12 inches of the surface and belong to the Hydrologic Soil Group (HSG) C/D

Maybid silt loams consist of soft silty and clayey and/or firm silty marine deposits. These soils are very poorly drained, have a water table at or near the surface and belong to the HSG C/D

Suffield silt loams consist of soft coarse silty glacial deposits over hard clayey glacial deposits. These soils are well drained and belong to the HSG C.

Soil testing within the site occurred on two (2) occasions. The first soil tests occurred July 9, 1997and the most recent soil test occurred on January 11, 2017. On July 9, 1996 the soil was examined in three (3) test pits. These test pits are located in the northerly portion of the site were the proposed parking expansion is to take place. These excavations occurred prior to the filling of this portion of the site with 18" to 24" of topsoil. On January 11, 2017 one additional test pit was made within the existing parking area of the main entrance to the site. The location and soils analysis of these tests are included on the project plans.

Of the 4 test pits all indicated an 18" layer of top soil and/or fill with an underlying material of clay. In each of the test pits the estimated high ground water table was located approximately at the top surface of the clay stratum.

As these test pits confirmed the soils types as identified in the NRCS report, throughout this analysis the site was modeled utilizing soils belonging to the Hydrologic Soil Group D to establish a comparison of pre and post run-off rates and volumes.

Due to the restrictions of class "D" soils which exist within the site; the high ground water table elevation and DEP's restriction* on utilizing "D" soils for infiltration the calculations provided in the hydraulic report are performed without considering any infiltration.

*Per DEP Stormwater Manual the minimum allowable infiltration rate is 0.17 inches per hour and the applicable Rawl's rate for clay is 0.02 inches per hour. Additionally the Stormwater Manual stipulates no Infiltration is permitted in class "D" soils.

STORMWATER MANAGEMENT

COMPLIANCE WITH DEP STORMWATER MANAGEMENT POLICY

The sites existing stormwater runoff is managed thought the use of a catch basin collections system, these basins discharge into a stoned lined drainage channel. Runoff is then conveyed into two separate constructed wetland marsh areas which also includes pre-treatment settling basins prior to its ultimate discharge into the wetland.

The proposed stormwater management for the site improvements is divided into two areas. The first being the redevelopment of the existing parking area and the second being the new parking lot constriction.

<u>Site Redevelopment - Exsiting Parking Area and Entrance Access Aisle</u>
The drainage system in the redevelopment of the existing parking lot will be upgraded. These upgrades include new deep sumped hooded catch basins and the addition of a proprietary stormwater unit to treat stormwater. These system improvements enable TSS removal in excess of 80% as explained below.

<u>Site New Development – Proposed Parking and Secondary Access Aisle</u>

To effectively manage the impacts of the project to the environment; to surrounding properties; and to mitigate post construction run-off rates the design relies on conventional stormwater management components. The proposed improvements include components consisting of deep sumped hooded catch basins, sub-surface detention and a proprietary stormwater unit for TSS removal. A designed the proposed improvements and stormwater management system provides the following:

- A reduction in post development run-off rates when compared to pre-development rates
- Treatment of stormwater in excess of 80% TSS removal
- Planned construction BMP's to control sedimentation and erosion during construction
- Establishes a long-term Operation and Maintenance Plan to ensure the protection of the resource areas
- Enhances the value of buffer zones through plantings

Standard 1 – Untreated Stormwater
Standard 1 states that "No new stormwater conveyances (e.g. outfalls) will discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth."

The proposed site improvements do not include new conveyances that discharge directly to the resource areas without treatment and BMP's are proposed to prevent erosion to the surrounding resource areas. As no new conveyances will directly discharge untreated stormwater, the project meets this Standard.

Standard 2 – Post Development Peak Discharge Rates
"Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates."

Summary of Site Discharge Flows

Design Storm	*Pre-Development Peak Discharge (CFS.)*	*Post-Development Peak Discharge (CFS.)*
2 Yr.	***4.81***	***4.74***
10 Yr.	***7.74***	***7.46***
25 Yr.	***10.05***	***9.62***
100 Yr.	***14.52***	***14.44***

Post development discharge rates result in a reduction of pre-development rates for the 2, 10, 25 and 100-year storm events therefore the project meets Standard 2.

Standard 3 – Recharge to Groundwater

Storm Water Recharge Calculation:
Required Recharge Volume

The Required Recharge Volume (Rv) is calculated using the following formula:

Rv = F x Impervious Area
Where Target Depth Factor F: F= 0.10 inch (for HSG D Soils)
Site Impervious Area* = 30,679 square feet (4.860 acres)

*Impervious new construction only

Parking Area, Access Drive and Walkways (Sub-catchment P3)	35,755 square feet
Access Drive Dwellings (Sub-catchment P3)	12,644 square feet
Total Site Impervious New Construction	38,069 square feet

Rv = ((0.10/12) x 38,069) = 335 cubic feet

Site Recharge Volumes Provided: None

The stormwater management system provides none of the required recharge volume as a result of DEP's restriction on class D soils.

Standard 4 – Removal of 80% Total Suspended Solids (TSS)

Tss Removal Calculation:

The BMP's proposed for the management of storm water enable the development to achieve TSS removal rate of 88% for the re-development sub-catchment area P1; 91% for the new development sub-catchment area P2; 82% for the new development sub-catchment area P3; and 86% for the pre development and existing development sub-catchment area P6 as identified below.

Sub-Catchment P1 - Existing Parking – Re-development

Location: 11 Hale Street - Newburyport, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Street Sweeping - 5%	**0.05**	**1.00**	**0.05**	**0.95**
Deep Sump and Hooded Catch Basin	**0.25**	**0.95**	**0.24**	**0.71**
Proprietary Treatment Unit WQ-1	**0.835**	**0.71**	**0.59**	**0.12**
		Total TSS Removal =	**88%**	

Sub-Catchment P2 - Proposed Parking and Access Roadway – New Construction

TSS Removal Calculation Worksheet

Location: 11 Hale Street - Newburyport, MA

B BMP[1]	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Street Sweeping - 5%	**0.05**	**1.00**	**0.05**	**0.95**
Deep Sump and Hooded Catch Basin	**0.25**	**0.95**	**0.24**	**0.71**
Proprietary Treatment Unit WQ-2	**0.871**	**0.71**	**0.62**	**0.09**
		Total TSS Removal =	**91%**	

Sub-Catchment P3 - Portion of Proposed Access Roadway, Existing Wetland & Wetland Replacement – New Construction*

***Note – Discharge Flows to Existing Stormwater Constructed Sedimentation Basin & Wetland**

TSS Removal Calculation Worksheet

Location: 11 Hale Street - Newburyport, MA

B BMP[1]	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Stone Filter Strip	**0.1**	**1.00**	**0.1**	**0.90**
Exist Constructed Sed. Basin & Wetland Detention	**0.8**	**0.90**	**0.72**	**0.18**
		Total TSS Removal =	**82%**	

Sub-Catchment P5 - Proposed Access Roadway Connection to Exist Parking Area – New Construction and Existing Undisturbed Paved Area*

***Note – Discharge Flows to Existing Stormwater Drainage System and Constructed Sedimentation Basin & Wetland**

Location: 11 Hale Street - Newburyport, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Street Sweeping - 5%	**0.05**	**1.00**	**0.05**	**0.95**
Deep Sump and Hooded Catch Basin	**0.25**	**0.95**	**0.24**	**0.71**
Exist Constructed Sed. Basin & Wetland Detention	**0.80**	**0.71**	**0.57**	**0.14**
		Total TSS Removal =	**86%**	

Proprietary Treatment Units - Water Quality Treatment Volume Calculation:

Required Water Quality Treatment Volume (using MassDEP standard method reference to covert required water quality volume to a discharge rate, dated Sept. 10, 2013)

Proposed Parking Lot and Drive - New Development, Sub-Catchment Area P-2
WQV = Water quality volume in watershed inches = ½"
A = Impervious Surface = 0.82 acres = 0.0012813 sq. miles
Tc = 5 min
Qu = 773 csm/in (from figure 2 DEP reference)
$Q_{0.5}$ = flow rate associated with first ½" runoff

$Q_{0.5}$ = (Qu) (A) (WQV) = 0.5 cfs

Proposed CDS (Unit WQ-1) Treatment Capacity = 1.4 cfs*
*Refer to Contech documentation Appendix "F".

Condition met treatment capacity 1.4 cfs > required 0.5 cfs

Proposed Parking Lot Rehabilitation – Re-Development, Sub-Catchment Area P-1
WQV = Water quality volume in watershed inches = ½"
A = Impervious Surface = 0.29 acres = 0.0004453 sq. miles
Tc = 5 min
Qu = 773 csm/in (from figure 2 DEP reference)
$Q_{0.5}$ = flow rate associated with first ½" runoff

$Q_{0.5}$ = (Qu) (A) (WQV) = 0.17 cfs

Proposed CDS (Unit WQ-2) Treatment Capacity = 1.0 cfs*
*Refer to Contech documentation Appendix "F".

Condition met treatment capacity 1.0 cfs > required 0.5 cfs

The removal of Total Suspended Solids (TSS) proposed is accomplished through the use of structural and non-structural BMPs. The components are sized to adequately to treat the required water quality volume and achieve TSS removal rates in excess of 80%. A long-term pollution prevention plan (refer to Appendix"G") has been developed which establishes practices to control and prevent pollution.

Therefore the project meets Standard 4.

Standard 5 – Land Uses with Higher Potential Pollutant Loads

The project use is not a Land Use with Higher Potential Pollutant Loads. Therefore, Standard 5 is not applicable to this project.

Standard 6 – Critical Areas

The project is not located within a Zone II or Interim Wellhead Protection Area of a public water supply and the project's stormwater discharges do not discharge near or to any critical areas, therefore
The project's is not located in estimated habitat or any critical area therefore Standard 6 does not apply.

Standard 7 - Redevelopment

Standard 7 states that "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 re-development portion of the project has fully met Standards 1, 2 and 4; and Standards 5 and 6 do not apply. As the site is completely comprised of class "D" soils credit for recharge is not possible in any areas of the site due to MassDEP Stormwater Regulations which does not permit recharge in class "D" soils,

Standard 8 – Erosion and Sedimentation Controls

A Stormwater Pollution Prevention Plan for the Project has been submitted for the site (refer to the Site Management Notes Sheet No. 14 of the project drawings) and will be revised as needed or required prior to any land disturbance on the site.
Therefore the Project complies with Standard 8.

Standard 9 – Operation and Maintenance Plans

A long-term operation and maintenance plan is included in Appendix "G". The Plan includes provisions for Construction-Phase measures, as well as long term maintenance and inspections. Therefore the Project complies with Standard 9.

Standard 10 – Illicit Discharges to Drainage System

There are no known or suspected illicit discharges to the stormwater management system at the project site.
Therefore the Project complies with Standard 10.

SUMMARY:

The proposed stormwater management systems employed in the site's development provide for the removal of suspended solids and for the recharge of stormwater runoff thereby meeting DEP Stormwater Standards.

As indicated in the summary below the stormwater management system effectively mitigates the effects of the site's development by reducing peak runoff rates for the 2, 10, 25 and 100-year events.

Summary of Site Discharge Flows and Volumes

Design Storm	*Pre-Development Max. Discharge (CFS.)*	*Post-Development Max. Discharge (CFS.)*	*Pre-Development Max. Volume (Acre-FT.)*	*Post-Development Max. Volume (Acre-FT.)*
2 Yr.	*4.81*	*4.74*	*0.571*	*0.678*
10 Yr.	*7.74*	*7.46*	*1.038*	*1.164*
25 Yr.	*10.05*	*9.62*	*1.426*	*1.561*
100 Yr.	*14.52*	*14.44*	*2.251*	*2.396*

Assumptions:

The following assumptions are being used for design purposes:

1) ***2, 10, 25 & 100 year storm frequency.***
2) ***24 hour storm duration (min.)***
3) ***Hydro logic soils groups for the run-off areas are classified class as "D" – Clay.***
4) ***Existing and proposed Cn values are as noted in the report.***
5) ***Within small drainage areas a minimum Tc value of 6 min. is used.***
6) ***Exfiltration rate for Clay is 0.02 inches/hour based on DEP's Table 2.3.3 "1982 Rawls Rates". Due to the extent of "D" soils throughout the site, and DEP's Stormwater Manual's requirement that "D" soils is not permitted to be utilized for infiltration no infiltration is calculated within the analysis..***

Design Criteria:

1) ***Run-off quantities are calculated using the most current data obtained from the Northeast Regional Climate Center (NRCC) and Natural Resources Conservation Service (NRCS on July 26, 2017. A copy of the rainfall data and IDF curves are appended to this report.***
2) ***Extreme Precipitation rainfall Data***

Storm Event in Years	*Inches per 24 Hours*
2	*3.22*
10	*4.95*
25	*6.33*
50	*7.62*
100	*9.19*

3) ***Proposed Cn values are as noted in the report.***
4) ***Hyetograph shape = Custom synthetic storm generated by NRCC extreme rainfall IDF curve for eastern MA.***
5) ***The maximum post-development run-off flow rates for the 2, 10, 25 & 100 yr. design storms shall be equal or less than pre-development run-off rates.***
6) ***Conduit design capacity based on 25-year design storm.***

APPENDIX A

RIMMER ENVIRONMENTAL CONSULTING - WETLAND DELINEATION REPORT

Wetland Delineation Report

First Baptist Church/Assembly of God
11 Hale Street
Newburyport, MA
September 20, 2017

Introduction/Site Description

The project site includes portions of the First Baptist Church property with frontage on Hale Street and Low Street in Newburyport. The site contains the church building, parking area and lawn/landscaped areas.

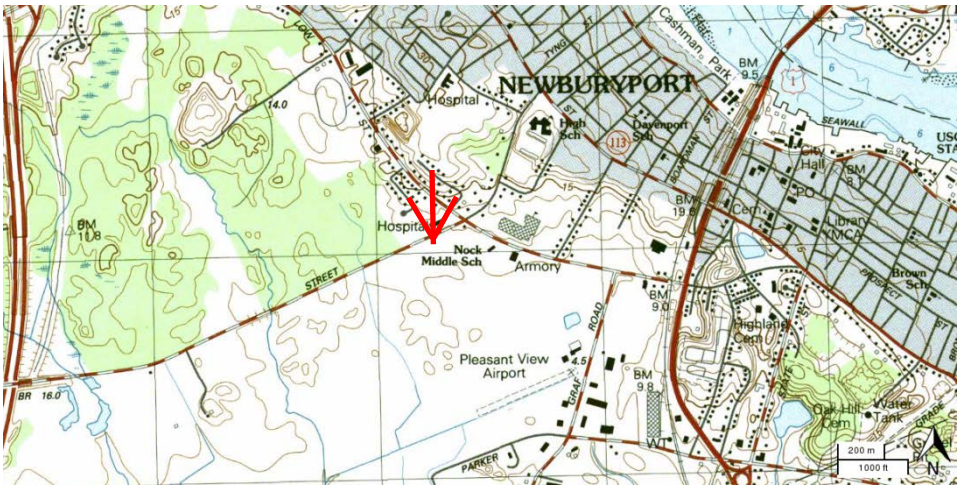


Fig. 1: USGS Topo Site Locus

Methods

Rimmer Environmental Consulting (REC) conducted a field inspection of the project area on March 2, 2016 and November 9, 2016. At those times, wetland resources subject to jurisdiction under the Massachusetts Wetlands Protection Act (MGL Ch. 131 §. 40) and City of Newburyport Wetlands Ordinance were identified. Wetlands were delineated with numbered sequences of flags placed on vegetation, in accordance with the procedures described in the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) and the City Ordinance. Vegetated wetlands were delineated based on the presence of 50% or more wetland vegetation as well as other indicators of wetland hydrology. In areas were vegetation has been altered such as by mowing, the delineation relied more heavily upon evidence of hydric soil conditions as an indicator of wetland hydrology. DEP Delineating Bordering Vegetated Wetlands Field Data Forms are attached and provide additional documentation of the wetland boundary.

Wetland Resources

The following is a summary of resource areas present:

Bordering Vegetated Wetland (BVW)

The east side of the parcel facing Low Street consists largely of wet meadow vegetation, with mowed lawn extending to the edge of the meadow. Hydric soils were found to extend into the limit of mowing at this location and therefore the wetland boundary includes a portion of the maintained lawn area. The delineated boundary extends along the east side of the center access drive where the wetland transitions to a forested swamp dominated by red maple (*Acer rubrum*). The wetland along the meadow and swamp was delineated by flags A1-A51.

Parallel to Hale Street and extending along the road shoulder is a drainage ditch that is part of the drainage system for the industrial park. This ditch contains wetland vegetation, especially common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*) and was delineated as Bordering Vegetated Wetland by flags A1-A11 and B7-B15.

Flags B1-B7 also delineate BVW associated with a drainage swale which conveys flow along the west side of the grassy field between the existing church and Hale Street into the Hale Street drainage system. This western swale contains scrub shrub wetland vegetation such as speckled alder (*Alnus rugosa*).

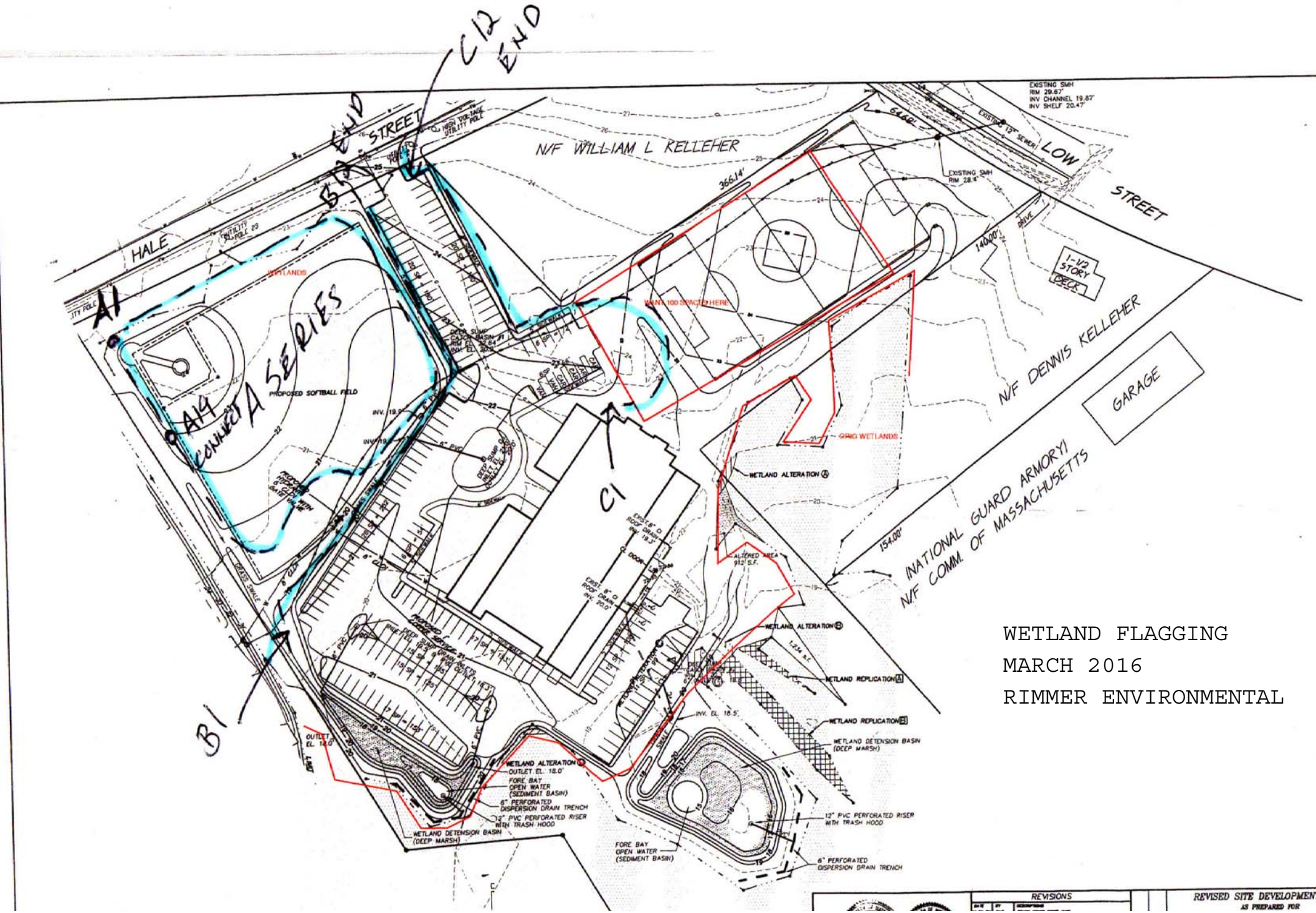
The east and south sides of the mowed field in front of the church building contain an internal drainage system consisting of grass and stone swales which are mowed and maintained drainage features that collect runoff from the parking lot. This swale was delineated by flags A12-A23 and B15-B23. This internal drainage feature was constructed for management of stormwater associated with the construction of the church in approximately 2000 and is not regulated as BVW.

It should be noted that if the drainage ditch along Hale Street is wetland that was created for the purpose of stormwater management and was installed in accordance with MassDEP stormwater management policy after November 18, 1996 it also would also not be considered BVW according to Mass. Wetlands Protection Act Regulations revised October 24, 2014 (310 CMR 10.02(2)(c).

Other Resources

The project site is not within Estimated Habitat of Rare Wetlands Wildlife or Priority Habitat and does not contain certified vernal pools as determined by reference to the most recently available data provided by the Mass. Division of Fisheries and Wildlife – Natural Heritage and Endangered Species Program available on MassGIS.

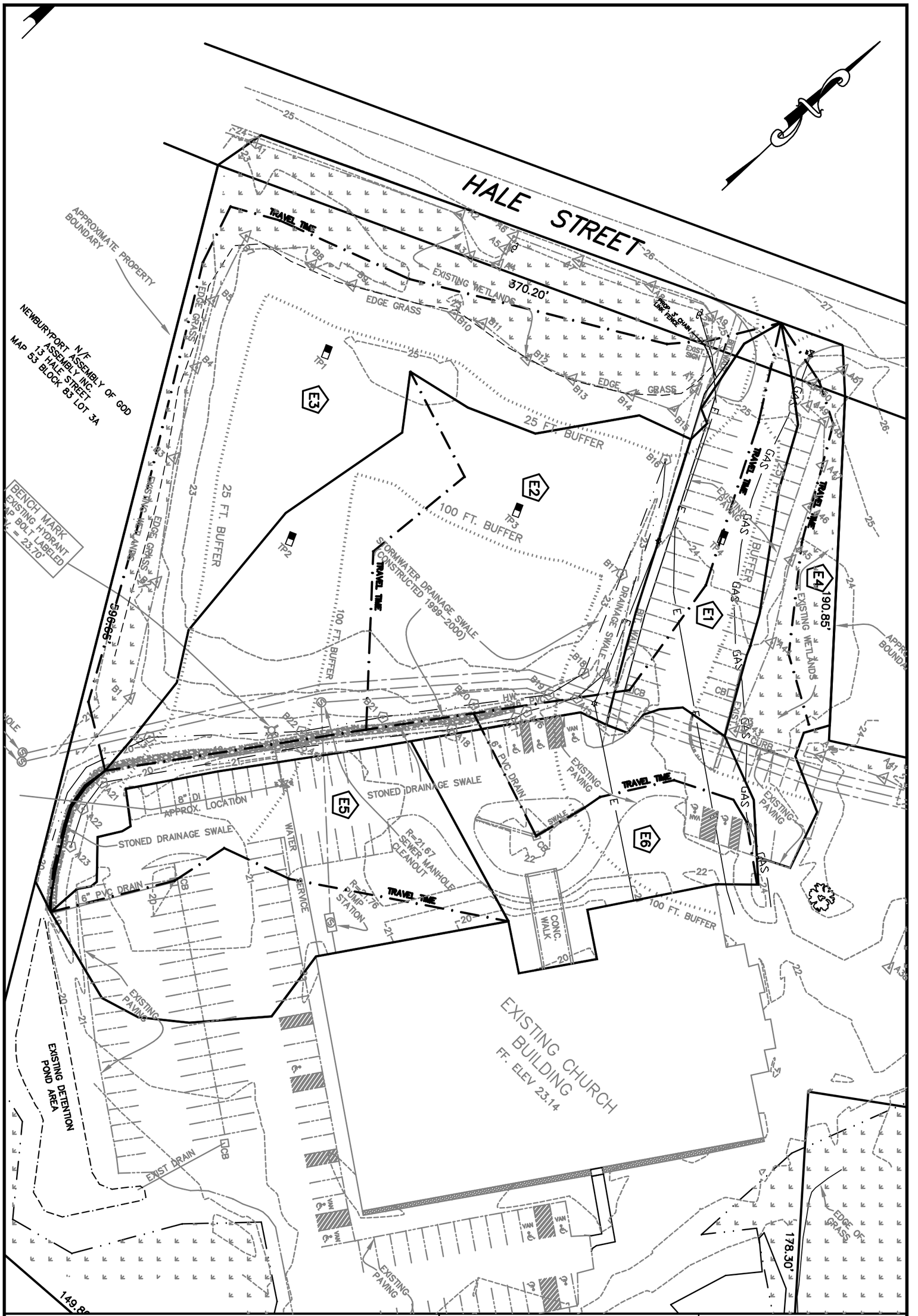

Zoom to a town
A1
WET
A51
111
WET
107
11
WET
WET
WET



WETLAND FLAGGING
MARCH 2016
RIMMER ENVIRONMENTAL

APPENDIX B

PRE- DEVELOPMENT CALCULATIONS



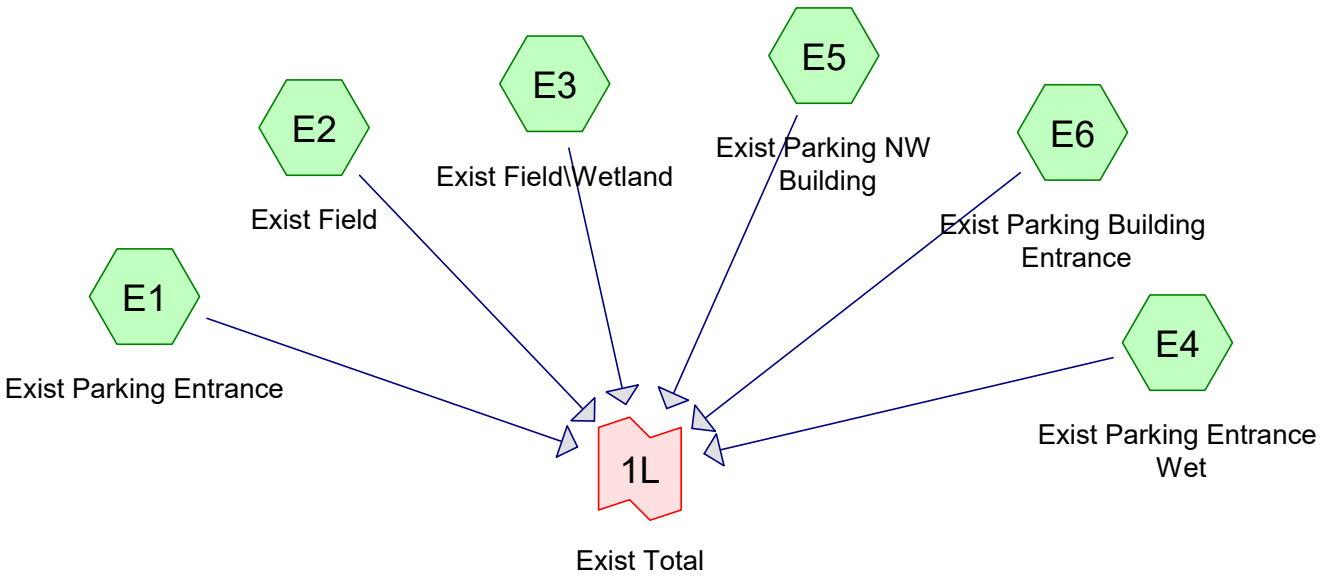
PRE-DEVELOPMENT WATERSHED
PARKING IMPROVEMENTS
THE HOPE COMMUNITY CHURCH
11 HALE STREET
NEWBURYPORT, MASSACHUSETTS

DATE: OCTOBER 12, 2017

SCALE 1"= 50'

ENGINEER:

ATLANTIC ENGINEERING & SURVEY CONSULTANTS INC.
97 TENNEY STREET – – GEORGETOWN, MA 01833
PHONE: 978-352-7870 FAX: 978-352-9940



Subcat Reach Pond Link

Routing Diagram for 11 HALE ST_IDF-071917
Prepared by George J. Zambouras, P.E., Printed 9/13/2017

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
375	84	50-75% Grass cover, Fair, HSG D (E5)
6,784	89	<50% Grass cover, Poor, HSG D (E2, E3)
79,775	80	>75% Grass cover, Good, HSG D (E1, E2, E3, E4, E5, E6)
25,941	83	Brush, Poor, HSG D (E3, E4)
44,557	98	Paved parking, HSG D (E1, E3, E4, E5, E6)
157,432	**86**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
157,432	HSG D	E1, E2, E3, E4, E5, E6
0	Other	
157,432		**TOTAL AREA**

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

Subcatchment E1: Exist Parking Entrance Runoff Area=12,326 sf 94.00% Impervious Runoff Depth>2.87"
Flow Length=602' Tc=6.0 min CN=97 Runoff=0.83 cfs 0.068 af

Subcatchment E2: Exist Field Runoff Area=42,660 sf 0.00% Impervious Runoff Depth>1.48"
Flow Length=462' Tc=15.0 min CN=81 Runoff=1.13 cfs 0.121 af

Subcatchment E3: Exist Field\Wetland Runoff Area=49,240 sf 0.92% Impervious Runoff Depth>1.54"
Flow Length=728' Tc=22.5 min CN=82 Runoff=1.12 cfs 0.145 af

Subcatchment E4: Exist Parking Entrance Runoff Area=10,694 sf 29.40% Impervious Runoff Depth>1.93"
Flow Length=234' Tc=9.0 min CN=87 Runoff=0.45 cfs 0.039 af

Subcatchment E5: Exist Parking NW Runoff Area=24,990 sf 75.84% Impervious Runoff Depth>2.56"
Flow Length=262' Tc=10.2 min CN=94 Runoff=1.31 cfs 0.122 af

Subcatchment E6: Exist Parking Building Runoff Area=17,522 sf 59.47% Impervious Runoff Depth>2.27"
Flow Length=535' Tc=7.0 min CN=91 Runoff=0.97 cfs 0.076 af

Link 1L: Exist Total Inflow=4.81 cfs 0.571 af
Primary=4.81 cfs 0.571 af

Total Runoff Area = 3.614 ac Runoff Volume = 0.571 af Average Runoff Depth = 1.90"
71.70% Pervious = 2.591 ac 28.30% Impervious = 1.023 ac

Summary for Subcatchment E1: Exist Parking Entrance

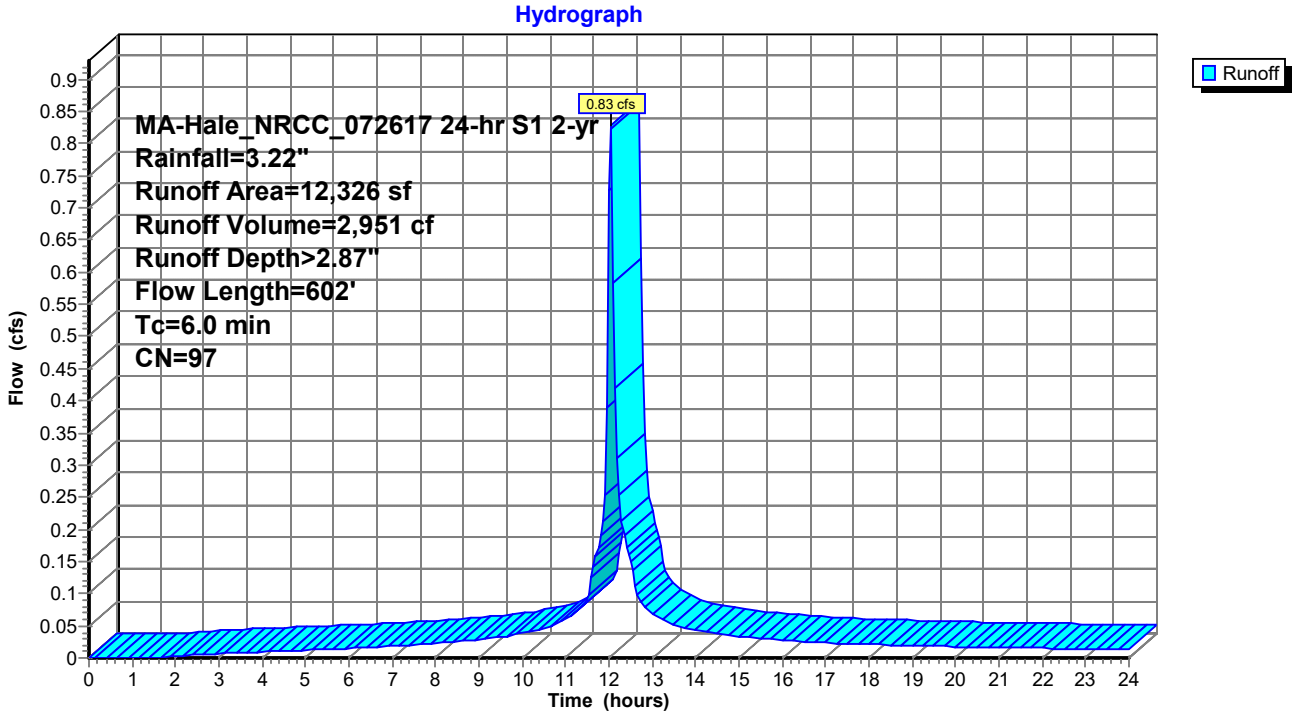
Runoff = 0.83 cfs @ 12.04 hrs, Volume= 2,951 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
740	80	>75% Grass cover, Good, HSG D
11,586	98	Paved parking, HSG D
12,326	97	Weighted Average
740		6.00% Pervious Area
11,586		94.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0250	1.31		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
1.2	173	0.0140	2.40		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.3	65	0.0116	4.00	0.79	**Pipe Channel, PVC Drain to Channell** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior
2.2	314	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
4.3	602	Total, Increased to minimum Tc = 6.0 min			

Subcatchment E1: Exist Parking Entrance



Summary for Subcatchment E2: Exist Field

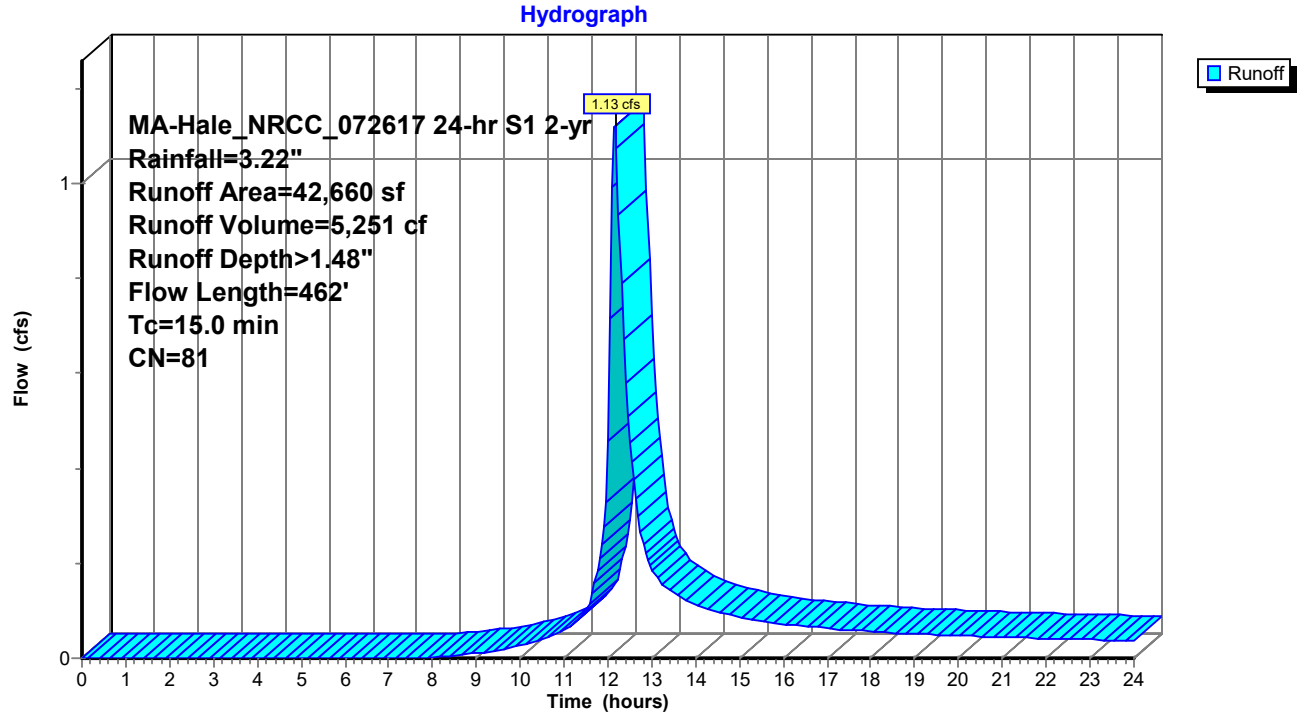
Runoff = 1.13 cfs @ 12.16 hrs, Volume= 5,251 cf, Depth> 1.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
38,610	80	>75% Grass cover, Good, HSG D
4,050	89	<50% Grass cover, Poor, HSG D
42,660	81	Weighted Average
42,660		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	50	0.0120	0.08		**Sheet Flow, Grass Field** Grass: Dense n= 0.240 P2= 3.22"
3.4	180	0.0160	0.89		**Shallow Concentrated Flow, Grass Field** Short Grass Pasture Kv= 7.0 fps
1.6	232	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
15.0	462	Total			

Subcatchment E2: Exist Field



Summary for Subcatchment E3: Exist Field\Wetland

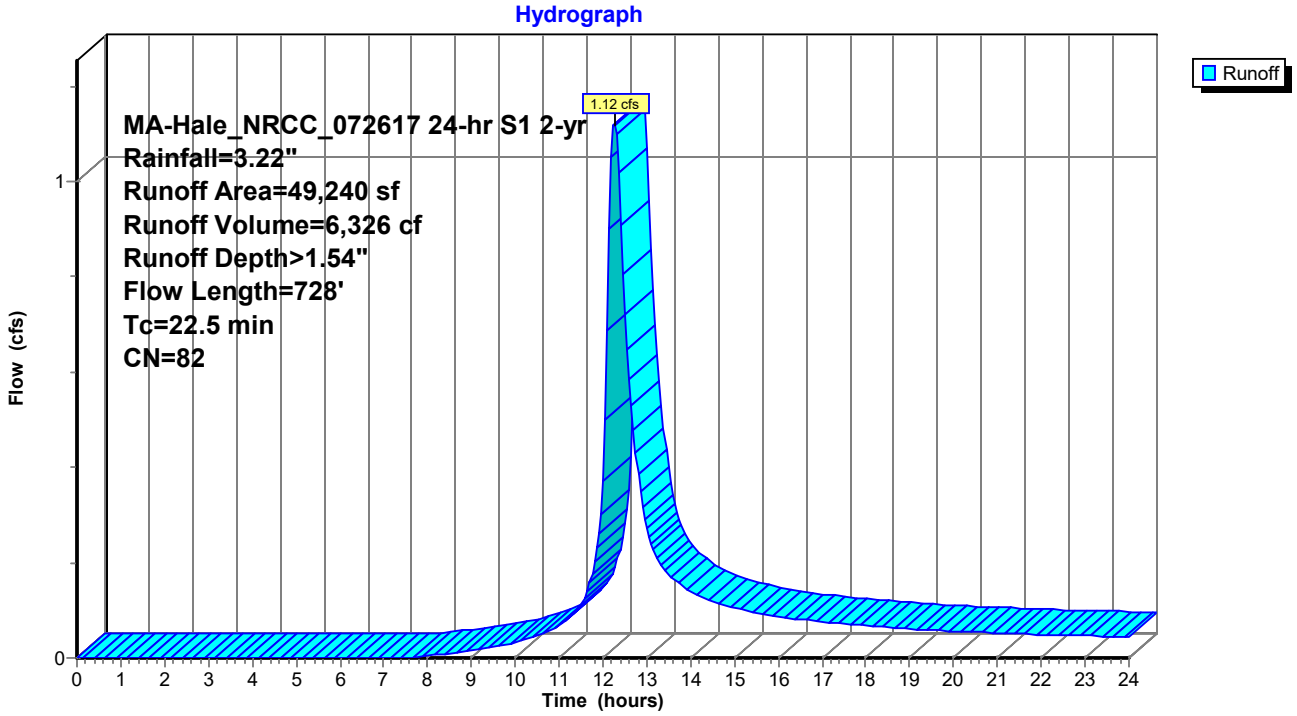
Runoff = 1.12 cfs @ 12.26 hrs, Volume= 6,326 cf, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
25,446	80	>75% Grass cover, Good, HSG D
2,734	89	<50% Grass cover, Poor, HSG D
454	98	Paved parking, HSG D
20,606	83	Brush, Poor, HSG D
49,240	82	Weighted Average
48,786		99.08% Pervious Area
454		0.92% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0150	0.93		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
3.3	25	0.0500	0.13		**Sheet Flow, Grass** Grass: Dense n= 0.240 P2= 3.22"
18.2	593	0.0060	0.54		**Shallow Concentrated Flow, Grass Wetland** Short Grass Pasture Kv= 7.0 fps
0.6	85	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
22.5	728	Total			

Subcatchment E3: Exist Field\Wetland



Summary for Subcatchment E4: Exist Parking Entrance Wet

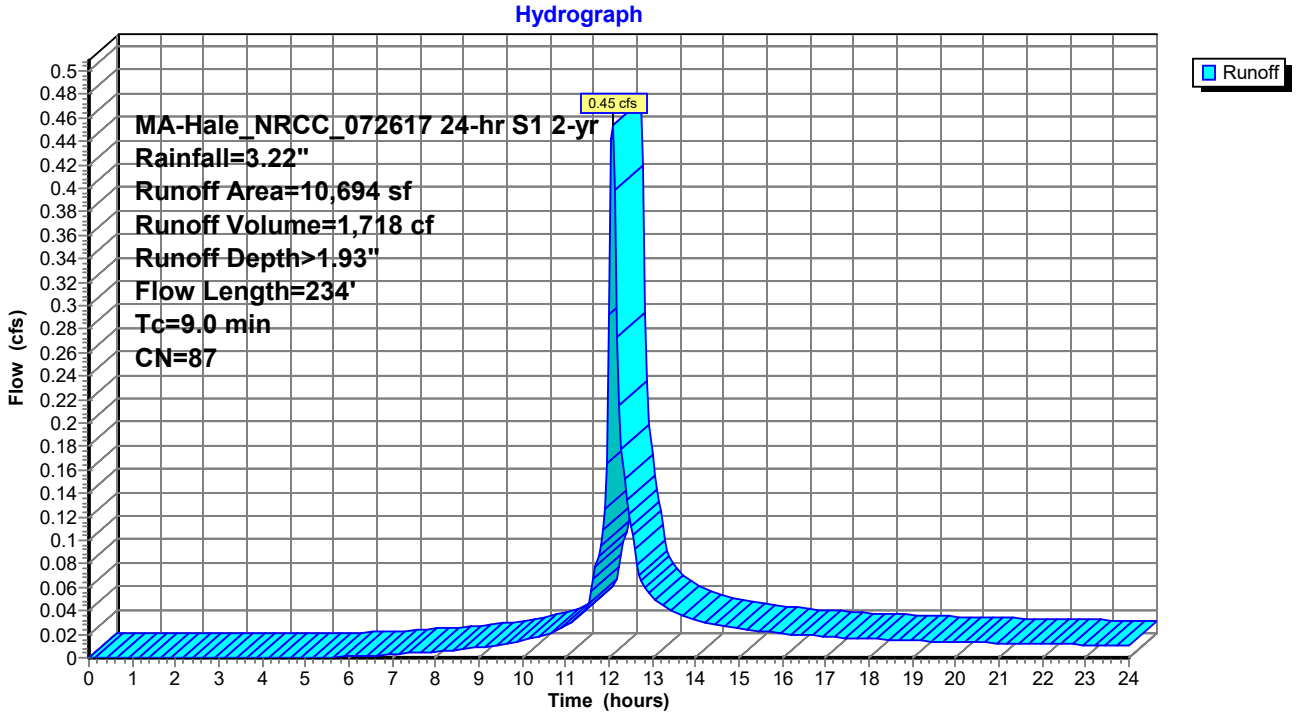
Runoff = 0.45 cfs @ 12.08 hrs, Volume= 1,718 cf, Depth> 1.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
2,215	80	>75% Grass cover, Good, HSG D
3,144	98	Paved parking, HSG D
5,335	83	Brush, Poor, HSG D
10,694	87	Weighted Average
7,550		70.60% Pervious Area
3,144		29.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0250	1.14		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
2.6	25	0.0900	0.16		**Sheet Flow, Grass** Grass: Dense n= 0.240 P2= 3.22"
6.0	184	0.0010	0.51		**Shallow Concentrated Flow, Wetland** Unpaved Kv= 16.1 fps
9.0	234	Total			

Subcatchment E4: Exist Parking Entrance Wet



Summary for Subcatchment E5: Exist Parking NW Building

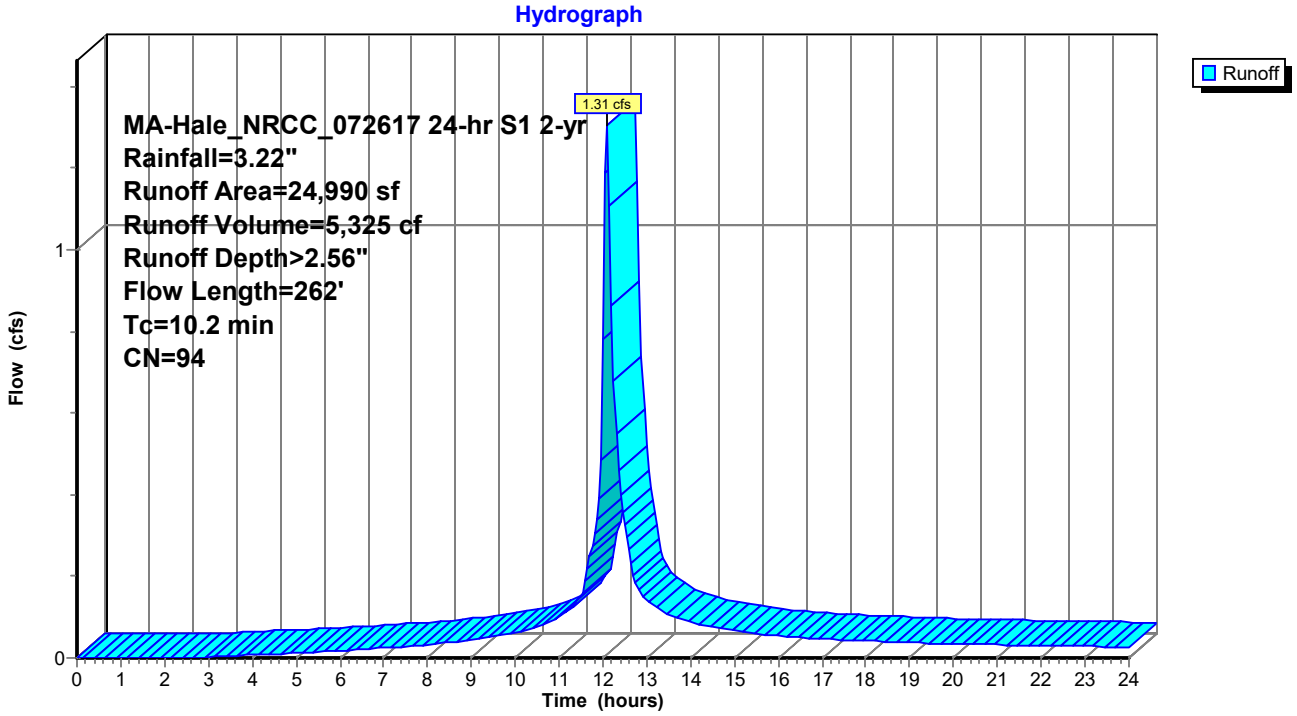
Runoff = 1.31 cfs @ 12.09 hrs, Volume= 5,325 cf, Depth> 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
5,662	80	>75% Grass cover, Good, HSG D
375	84	50-75% Grass cover, Fair, HSG D
18,953	98	Paved parking, HSG D
24,990	94	Weighted Average
6,037		24.16% Pervious Area
18,953		75.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.0170	0.10		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.22"
0.6	72	0.0170	1.96		**Shallow Concentrated Flow, Lawn** Grassed Waterway Kv= 15.0 fps
0.5	73	0.0170	2.65		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.4	67	0.0070	3.11	0.61	**Pipe Channel, 6" Pipe** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior
10.2	262	Total			

Subcatchment E5: Exist Parking NW Building



Summary for Subcatchment E6: Exist Parking Building Entrance

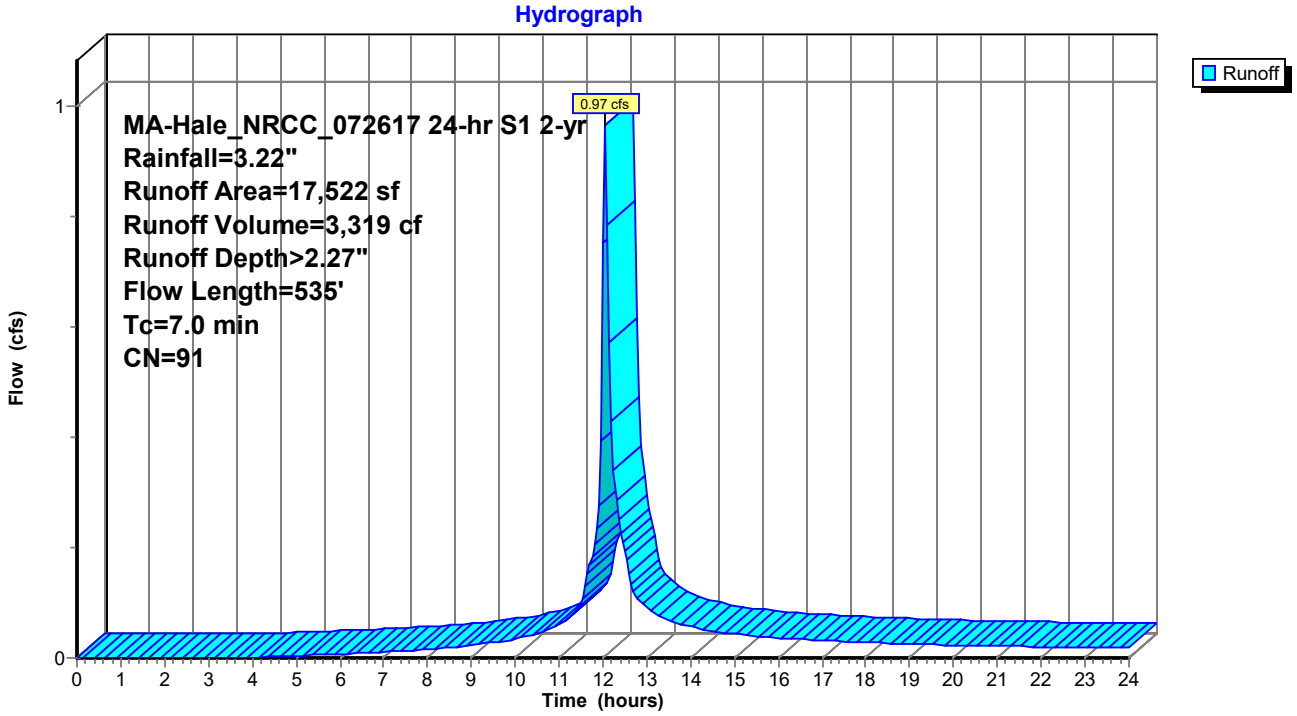
Runoff = 0.97 cfs @ 12.05 hrs, Volume= 3,319 cf, Depth> 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
7,102	80	>75% Grass cover, Good, HSG D
10,420	98	Paved parking, HSG D
17,522	91	Weighted Average
7,102		40.53% Pervious Area
10,420		59.47% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	17	0.0250	0.09		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.22"
0.7	33	0.0100	0.84		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.5	87	0.0200	2.87		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	31	0.0300	2.60		**Shallow Concentrated Flow, Grass** Grassed Waterway Kv= 15.0 fps
0.4	75	0.0070	3.11	0.61	**Pipe Channel, 6" Pipe** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior
2.0	292	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
7.0	535	Total			

Subcatchment E6: Exist Parking Building Entrance

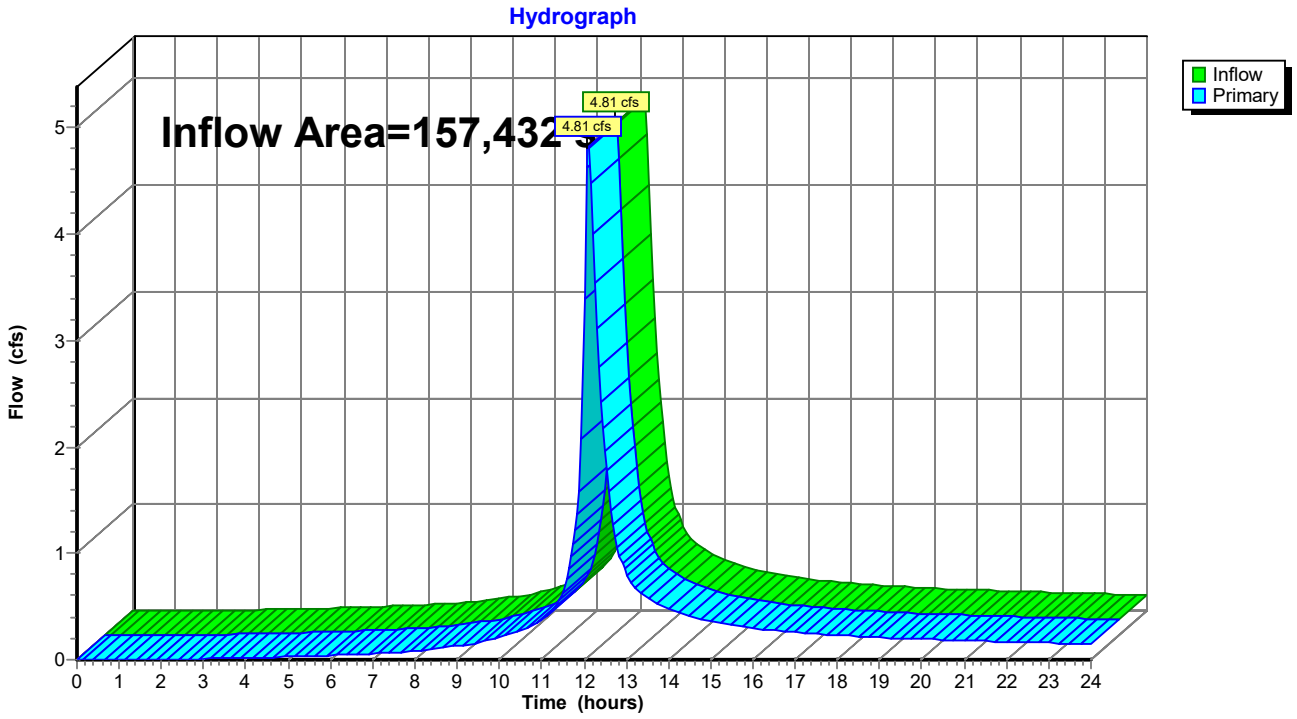


Summary for Link 1L: Exist Total

Inflow Area = 157,432 sf, 28.30% Impervious, Inflow Depth > 1.90" for 2-yr event
Inflow = 4.81 cfs @ 12.09 hrs, Volume= 24,891 cf
Primary = 4.81 cfs @ 12.09 hrs, Volume= 24,891 cf, Atten= 0%, Lag= 0.0 min

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

Link 1L: Exist Total



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 E1: Exist Parking Entrance Runoff Area=12,326 sf 94.00% Impervious Runoff Depth>4.59"
Flow Length=602' Tc=6.0 min CN=97 Runoff=1.14 cfs 0.108 af

Subcatchment E2: Exist Field Runoff Area=42,660 sf 0.00% Impervious Runoff Depth>2.93"
Flow Length=462' Tc=15.0 min CN=81 Runoff=2.03 cfs 0.239 af

Subcatchment E3: Exist Field\Wetland Runoff Area=49,240 sf 0.92% Impervious Runoff Depth>3.01"
Flow Length=728' Tc=22.5 min CN=82 Runoff=2.01 cfs 0.284 af

Subcatchment E4: Exist Parking Entrance Runoff Area=10,694 sf 29.40% Impervious Runoff Depth>3.51"
Flow Length=234' Tc=9.0 min CN=87 Runoff=0.74 cfs 0.072 af

Subcatchment E5: Exist Parking NW Runoff Area=24,990 sf 75.84% Impervious Runoff Depth>4.25"
Flow Length=262' Tc=10.2 min CN=94 Runoff=1.88 cfs 0.203 af

Subcatchment E6: Exist Parking Building Runoff Area=17,522 sf 59.47% Impervious Runoff Depth>3.93"
Flow Length=535' Tc=7.0 min CN=91 Runoff=1.44 cfs 0.132 af

Link 1L: Exist Total Inflow=7.74 cfs 1.038 af
Primary=7.74 cfs 1.038 af

Total Runoff Area = 3.614 ac Runoff Volume = 1.038 af Average Runoff Depth = 3.44"
71.70% Pervious = 2.591 ac 28.30% Impervious = 1.023 ac

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 E1: Exist Parking Entrance Runoff Area=12,326 sf 94.00% Impervious Runoff Depth>5.97"
Flow Length=602' Tc=6.0 min CN=97 Runoff=1.39 cfs 0.141 af

Subcatchment E2: Exist Field Runoff Area=42,660 sf 0.00% Impervious Runoff Depth>4.17"
Flow Length=462' Tc=15.0 min CN=81 Runoff=2.75 cfs 0.340 af

Subcatchment E3: Exist Field\Wetland Runoff Area=49,240 sf 0.92% Impervious Runoff Depth>4.26"
Flow Length=728' Tc=22.5 min CN=82 Runoff=2.71 cfs 0.401 af

Subcatchment E4: Exist Parking Entrance Runoff Area=10,694 sf 29.40% Impervious Runoff Depth>4.82"
Flow Length=234' Tc=9.0 min CN=87 Runoff=0.95 cfs 0.099 af

Subcatchment E5: Exist Parking NW Runoff Area=24,990 sf 75.84% Impervious Runoff Depth>5.61"
Flow Length=262' Tc=10.2 min CN=94 Runoff=2.33 cfs 0.268 af

Subcatchment E6: Exist Parking Building Runoff Area=17,522 sf 59.47% Impervious Runoff Depth>5.27"
Flow Length=535' Tc=7.0 min CN=91 Runoff=1.80 cfs 0.177 af

Link 1L: Exist Total Inflow=10.05 cfs 1.426 af
Primary=10.05 cfs 1.426 af

Total Runoff Area = 3.614 ac Runoff Volume = 1.426 af Average Runoff Depth = 4.73"
71.70% Pervious = 2.591 ac 28.30% Impervious = 1.023 ac

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 E1: Exist Parking Entrance Runoff Area=12,326 sf 94.00% Impervious Runoff Depth>8.82"
Flow Length=602' Tc=6.0 min CN=97 Runoff=1.86 cfs 0.208 af

Subcatchment E2: Exist Field Runoff Area=42,660 sf 0.00% Impervious Runoff Depth>6.84"
Flow Length=462' Tc=15.0 min CN=81 Runoff=4.13 cfs 0.558 af

Subcatchment E3: Exist Field\Wetland Runoff Area=49,240 sf 0.92% Impervious Runoff Depth>6.95"
Flow Length=728' Tc=22.5 min CN=82 Runoff=4.07 cfs 0.655 af

Subcatchment E4: Exist Parking Entrance Runoff Area=10,694 sf 29.40% Impervious Runoff Depth>7.59"
Flow Length=234' Tc=9.0 min CN=87 Runoff=1.35 cfs 0.155 af

Subcatchment E5: Exist Parking NW Runoff Area=24,990 sf 75.84% Impervious Runoff Depth>8.45"
Flow Length=262' Tc=10.2 min CN=94 Runoff=3.18 cfs 0.404 af

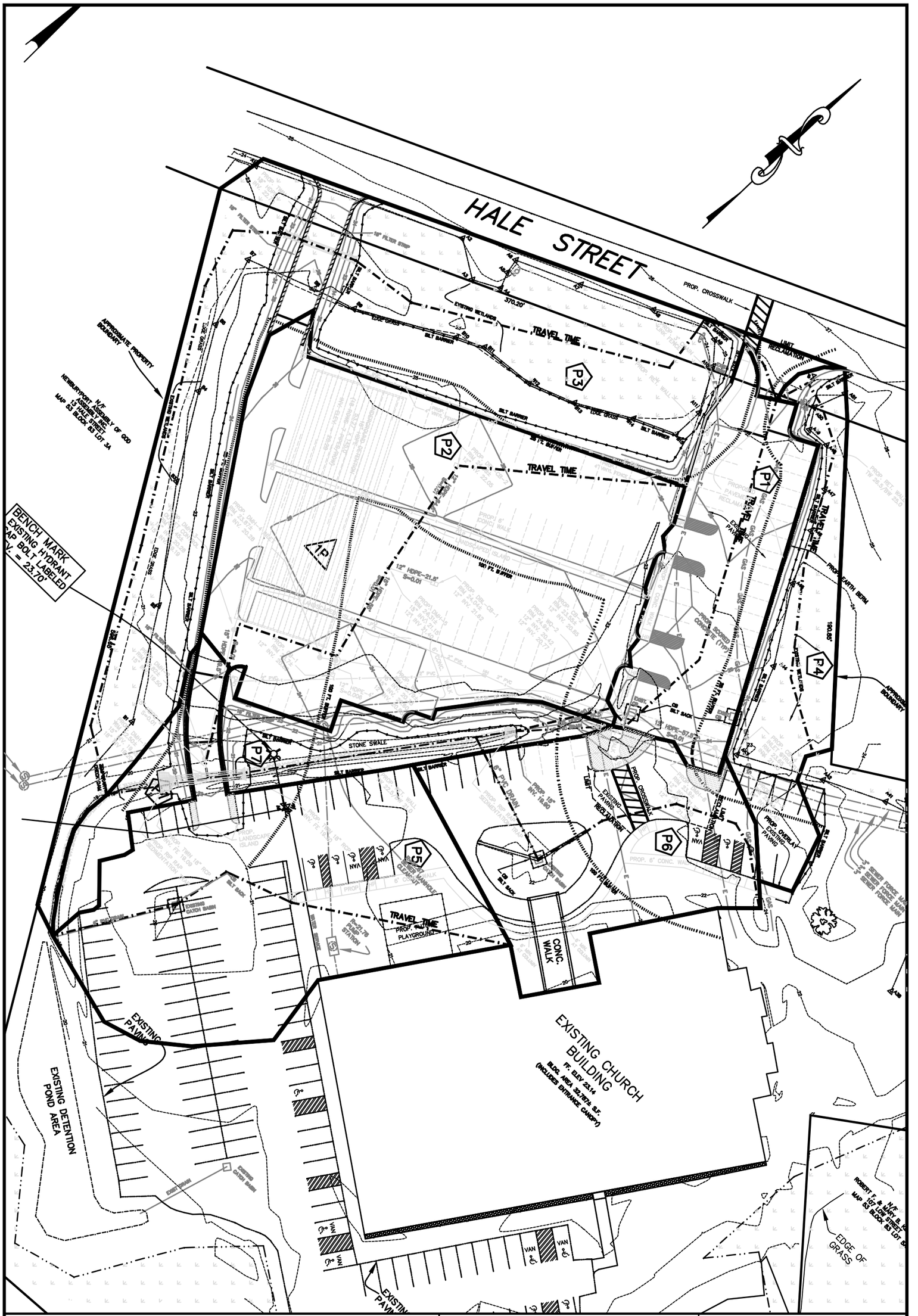
Subcatchment E6: Exist Parking Building Runoff Area=17,522 sf 59.47% Impervious Runoff Depth>8.09"
Flow Length=535' Tc=7.0 min CN=91 Runoff=2.49 cfs 0.271 af

Link 1L: Exist Total Inflow=14.52 cfs 2.251 af
Primary=14.52 cfs 2.251 af

Total Runoff Area = 3.614 ac Runoff Volume = 2.251 af Average Runoff Depth = 7.47"
71.70% Pervious = 2.591 ac 28.30% Impervious = 1.023 ac

APPENDIX C

POST DEVELOPMENT CALCULATIONS

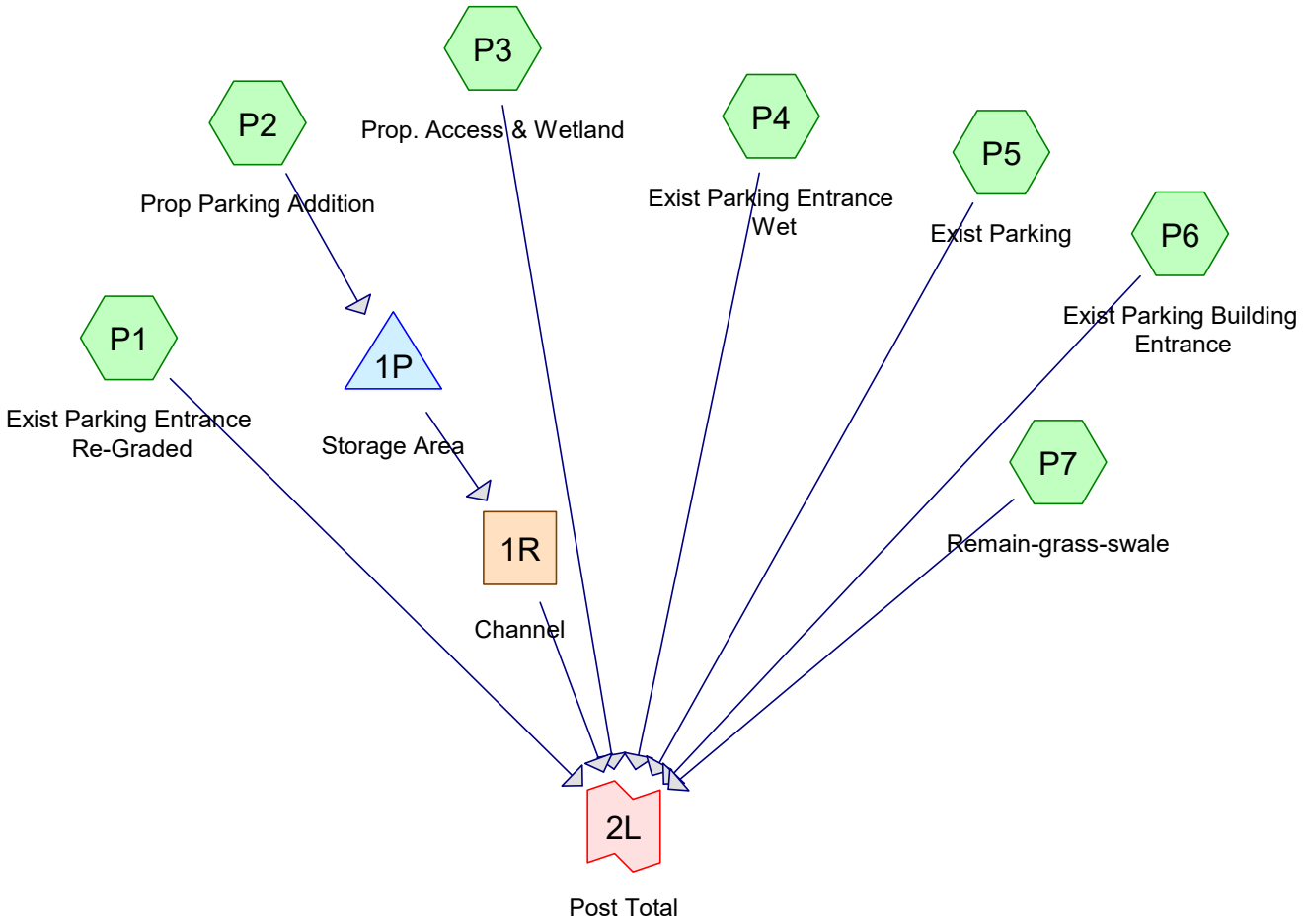


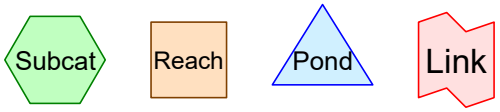
POST-DEVELOPMENT WATERSHED
PARKING IMPROVEMENTS
THE HOPE COMMUNITY CHURCH
11 HALE STREET
NEWBURYPORT, MASSACHUSETTS

DATE: OCTOBER 12, 2017

SCALE 1"= 50'

ENGINEER:
ATLANTIC ENGINEERING & SURVEY CONSULTANTS INC.
97 TENNEY STREET – – GEORGETOWN, MA 01833
PHONE: 978-352-7870 FAX: 978-352-9940





Routing Diagram for 11 HALE ST_IDF-071917
Prepared by George J. Zambouras, P.E., Printed 9/13/2017

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
1,770	84	50-75% Grass cover, Fair, HSG D (P5, P7)
5,990	89	<50% Grass cover, Poor, HSG D (P3, P7)
38,096	80	>75% Grass cover, Good, HSG D (P1, P2, P3, P4, P5, P6, P7)
26,961	83	Brush, Poor, HSG D (P3, P4)
84,615	98	Paved parking, HSG D (P1, P2, P3, P4, P5, P6)
157,432	**91**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
0	HSG C	
157,432	HSG D	P1, P2, P3, P4, P5, P6, P7
0	Other	
157,432		**TOTAL AREA**

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

Subcatchment P1: Exist Parking Entrance Runoff Area=13,181 sf 94.42% Impervious Runoff Depth>2.87"
Flow Length=636' Tc=6.0 min CN=97 Runoff=0.89 cfs 0.072 af

Subcatchment P2: Prop Parking Addition Runoff Area=39,868 sf 89.68% Impervious Runoff Depth>2.77"
Flow Length=251' Tc=6.0 min CN=96 Runoff=2.63 cfs 0.211 af

Subcatchment P3: Prop. Access & Wetland Runoff Area=40,675 sf 5.69% Impervious Runoff Depth>1.61"
Flow Length=728' Tc=22.5 min CN=83 Runoff=0.97 cfs 0.126 af

Subcatchment P4: Exist Parking Entrance Runoff Area=9,994 sf 21.55% Impervious Runoff Depth>1.77"
Flow Length=230' Tc=9.0 min CN=85 Runoff=0.39 cfs 0.034 af

Subcatchment P5: Exist Parking Runoff Area=26,482 sf 79.57% Impervious Runoff Depth>2.56"
Flow Length=262' Tc=10.2 min CN=94 Runoff=1.39 cfs 0.130 af

Subcatchment P6: Exist Parking Building Runoff Area=17,458 sf 62.29% Impervious Runoff Depth>2.27"
Flow Length=535' Tc=7.0 min CN=91 Runoff=0.96 cfs 0.076 af

Subcatchment P7: Remain-grass-swale Runoff Area=9,774 sf 0.00% Impervious Runoff Depth>1.70"
Flow Length=364' Tc=7.5 min CN=84 Runoff=0.40 cfs 0.032 af

Reach 1R: Channel Avg. Flow Depth=0.19' Max Vel=0.73 fps Inflow=0.75 cfs 0.210 af
n=0.040 L=122.0' S=0.0040 '/' Capacity=28.72 cfs Outflow=0.74 cfs 0.209 af

Pond 1P: Storage Area Peak Elev=21.15' Storage=2,338 cf Inflow=2.63 cfs 0.211 af
Outflow=0.75 cfs 0.210 af

Link 2L: Post Total Inflow=4.74 cfs 0.678 af
Primary=4.74 cfs 0.678 af

Total Runoff Area = 3.614 ac Runoff Volume = 0.680 af Average Runoff Depth = 2.26"
46.25% Pervious = 1.672 ac 53.75% Impervious = 1.942 ac

Summary for Subcatchment P1: Exist Parking Entrance Re-Graded

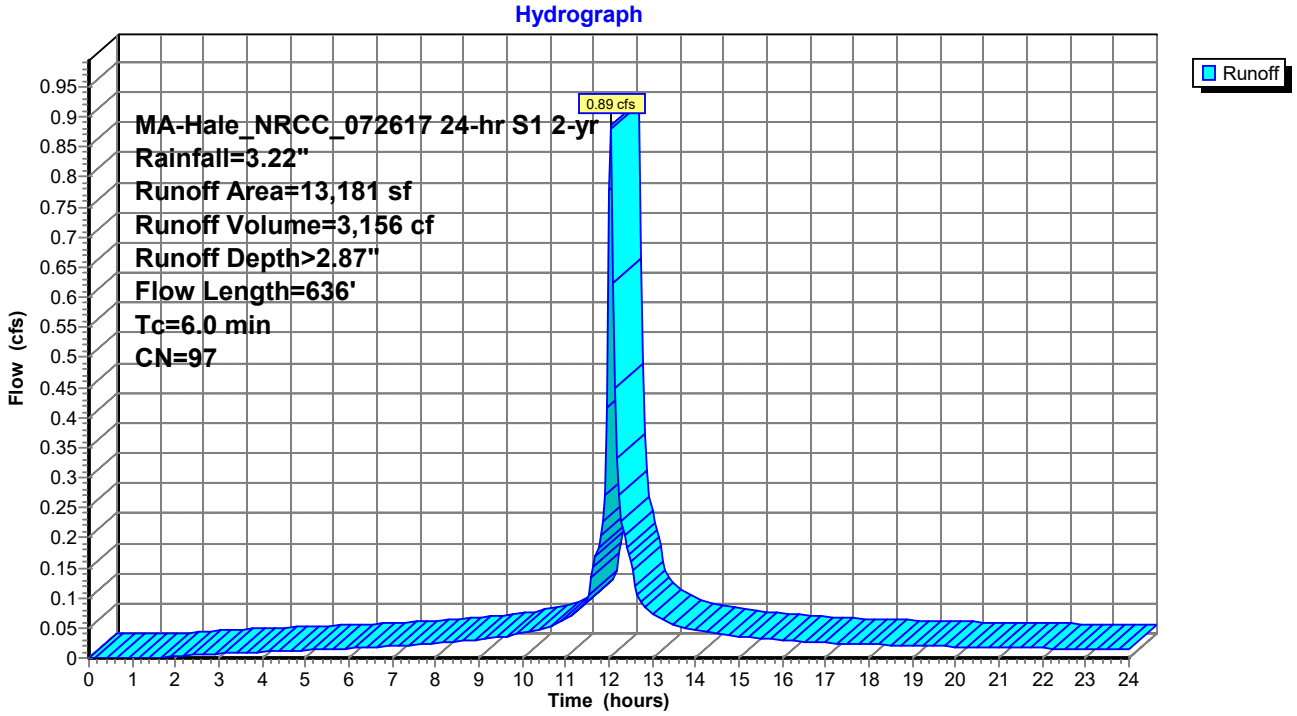
Runoff = 0.89 cfs @ 12.04 hrs, Volume= 3,156 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
736	80	>75% Grass cover, Good, HSG D
12,445	98	Paved parking, HSG D
13,181	97	Weighted Average
736		5.58% Pervious Area
12,445		94.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	50	0.0125	1.00		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
1.1	155	0.0125	2.27		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.4	117	0.0100	4.54	3.56	**Pipe Channel, PVC Drain to WQ to Channell** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
2.2	314	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
4.5	636	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P1: Exist Parking Entrance Re-Graded



Summary for Subcatchment P2: Prop Parking Addition

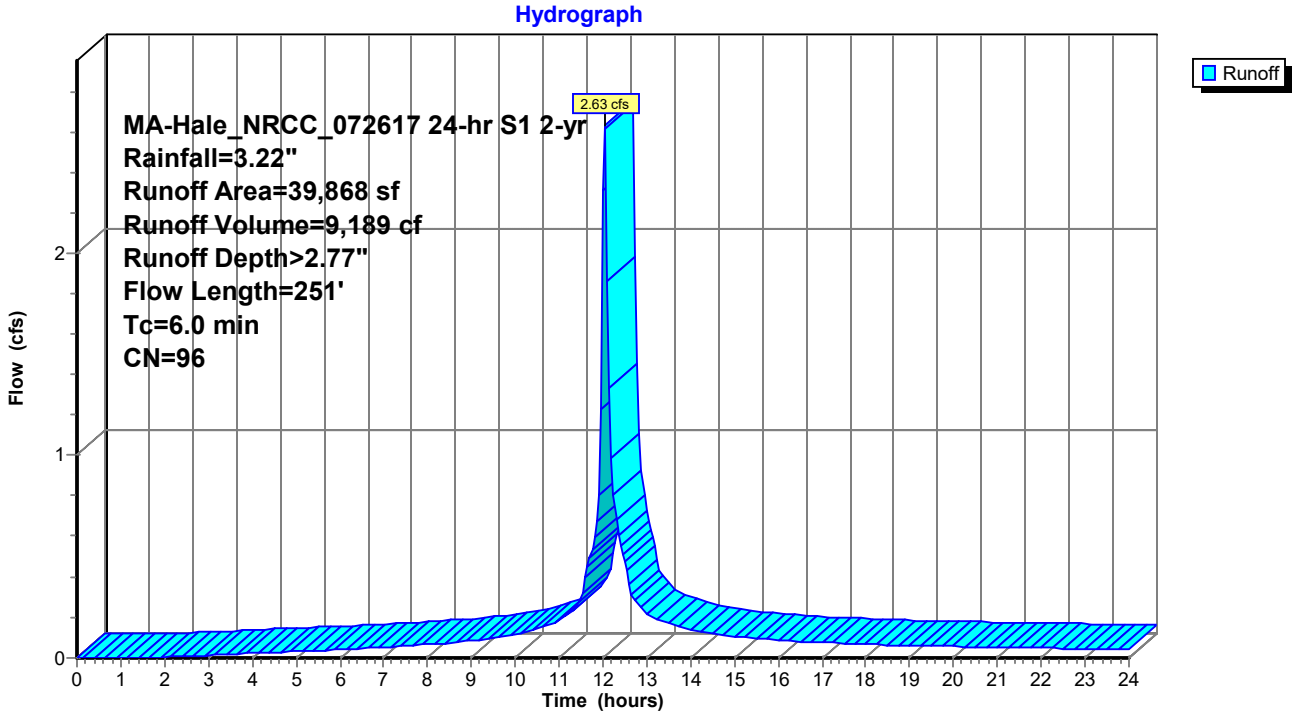
Runoff = 2.63 cfs @ 12.04 hrs, Volume= 9,189 cf, Depth> 2.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
4,113	80	>75% Grass cover, Good, HSG D
35,755	98	Paved parking, HSG D
39,868	96	Weighted Average
4,113		10.32% Pervious Area
35,755		89.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.6	76	0.0100	2.03		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	65	0.0100	4.54	3.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.2	55	0.0100	5.26	6.46	**Pipe Channel, DMH to WQ1** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.2	5	0.0001	0.53	0.65	**Pipe Channel, WQ1 to Storgae** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
2.1	251	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P2: Prop Parking Addition



Summary for Subcatchment P3: Prop. Access & Wetland

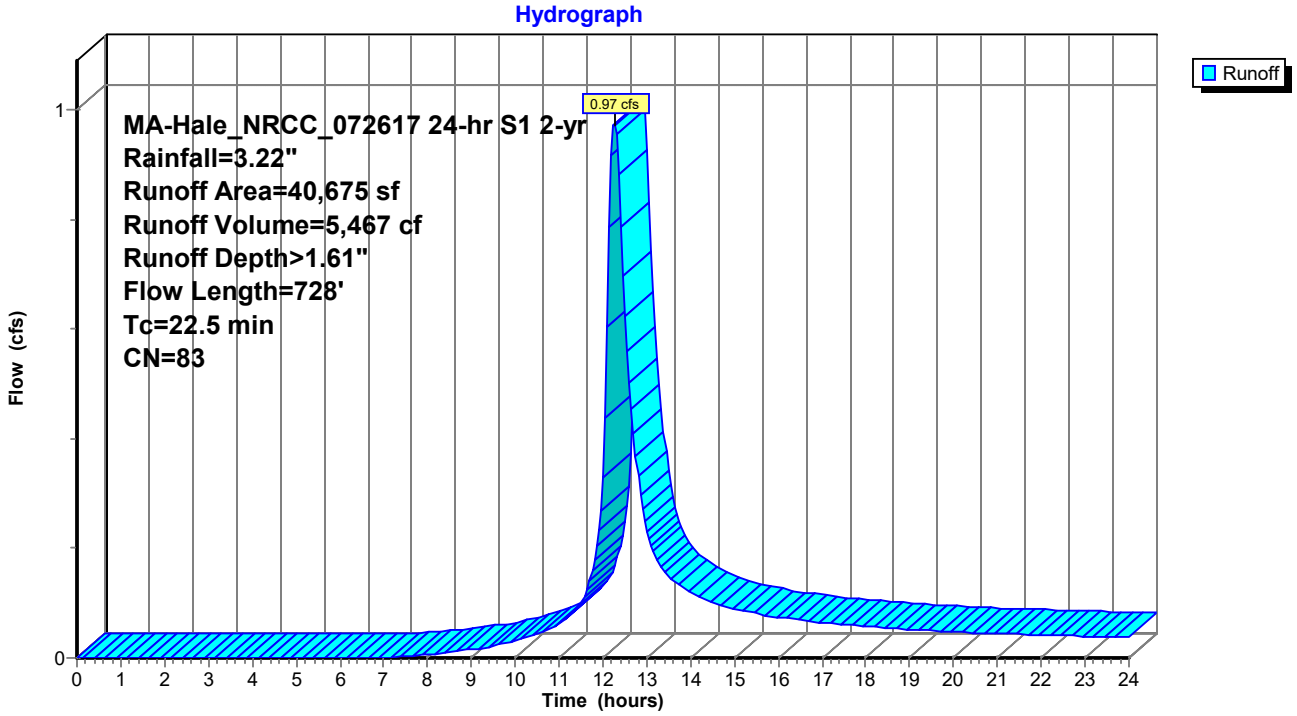
Runoff = 0.97 cfs @ 12.26 hrs, Volume= 5,467 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
14,795	80	>75% Grass cover, Good, HSG D
1,940	89	<50% Grass cover, Poor, HSG D
2,314	98	Paved parking, HSG D
18,726	83	Brush, Poor, HSG D
2,900	83	Brush, Poor, HSG D
40,675	83	Weighted Average
38,361		94.31% Pervious Area
2,314		5.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	25	0.0150	0.93		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
3.3	25	0.0500	0.13		**Sheet Flow, Grass** Grass: Dense n= 0.240 P2= 3.22"
18.2	593	0.0060	0.54		**Shallow Concentrated Flow, Grass Wetland** Short Grass Pasture Kv= 7.0 fps
0.6	85	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
22.5	728	Total			

Subcatchment P3: Prop. Access & Wetland



Summary for Subcatchment P4: Exist Parking Entrance Wet

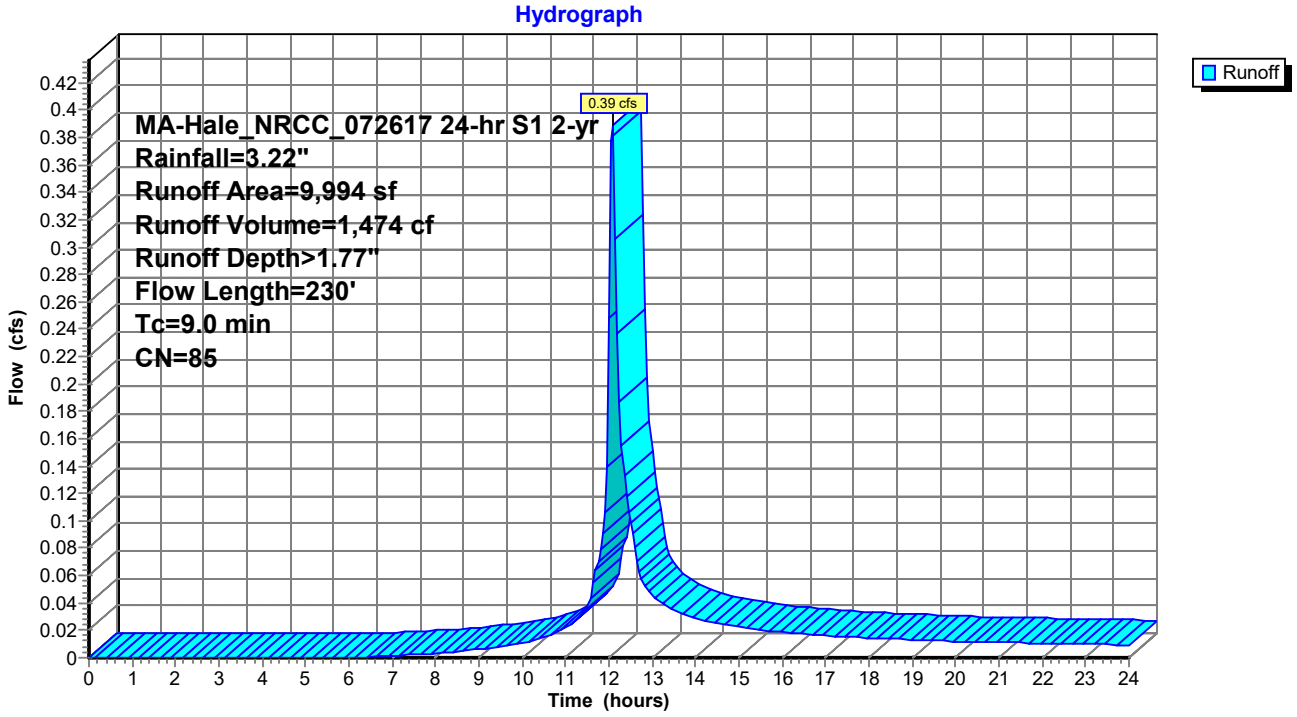
Runoff = 0.39 cfs @ 12.08 hrs, Volume= 1,474 cf, Depth> 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
2,505	80	>75% Grass cover, Good, HSG D
5,335	83	Brush, Poor, HSG D
2,154	98	Paved parking, HSG D
9,994	85	Weighted Average
7,840		78.45% Pervious Area
2,154		21.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	20	0.0150	0.89		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
2.2	15	0.0500	0.12		**Sheet Flow, Grass** Grass: Dense n= 0.240 P2= 3.22"
6.4	195	0.0010	0.51		**Shallow Concentrated Flow, Wetland** Unpaved Kv= 16.1 fps
9.0	230	Total			

Subcatchment P4: Exist Parking Entrance Wet



Summary for Subcatchment P5: Exist Parking

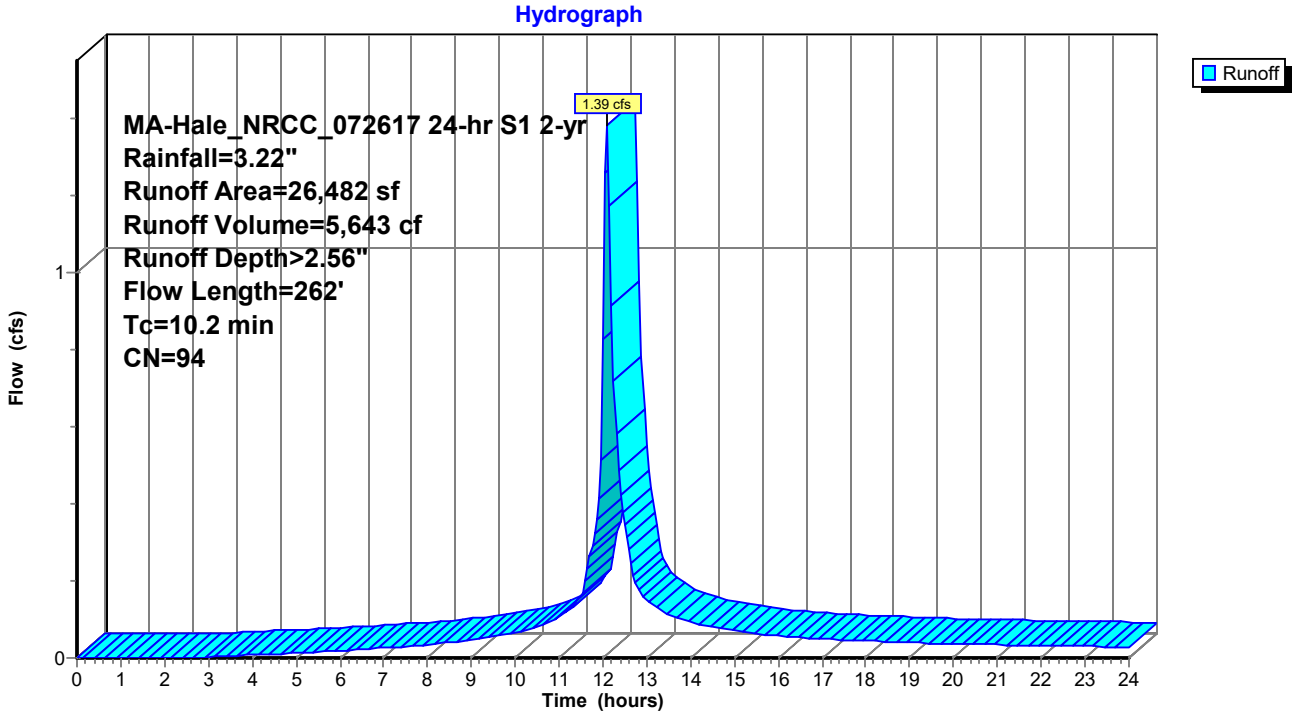
Runoff = 1.39 cfs @ 12.09 hrs, Volume= 5,643 cf, Depth> 2.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
5,035	80	>75% Grass cover, Good, HSG D
375	84	50-75% Grass cover, Fair, HSG D
21,072	98	Paved parking, HSG D
26,482	94	Weighted Average
5,410		20.43% Pervious Area
21,072		79.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.0170	0.10		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.22"
0.6	72	0.0170	1.96		**Shallow Concentrated Flow, Lawn** Grassed Waterway Kv= 15.0 fps
0.5	73	0.0170	2.65		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.4	67	0.0070	3.11	0.61	**Pipe Channel, 6" Pipe** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior
10.2	262	Total			

Subcatchment P5: Exist Parking



Summary for Subcatchment P6: Exist Parking Building Entrance

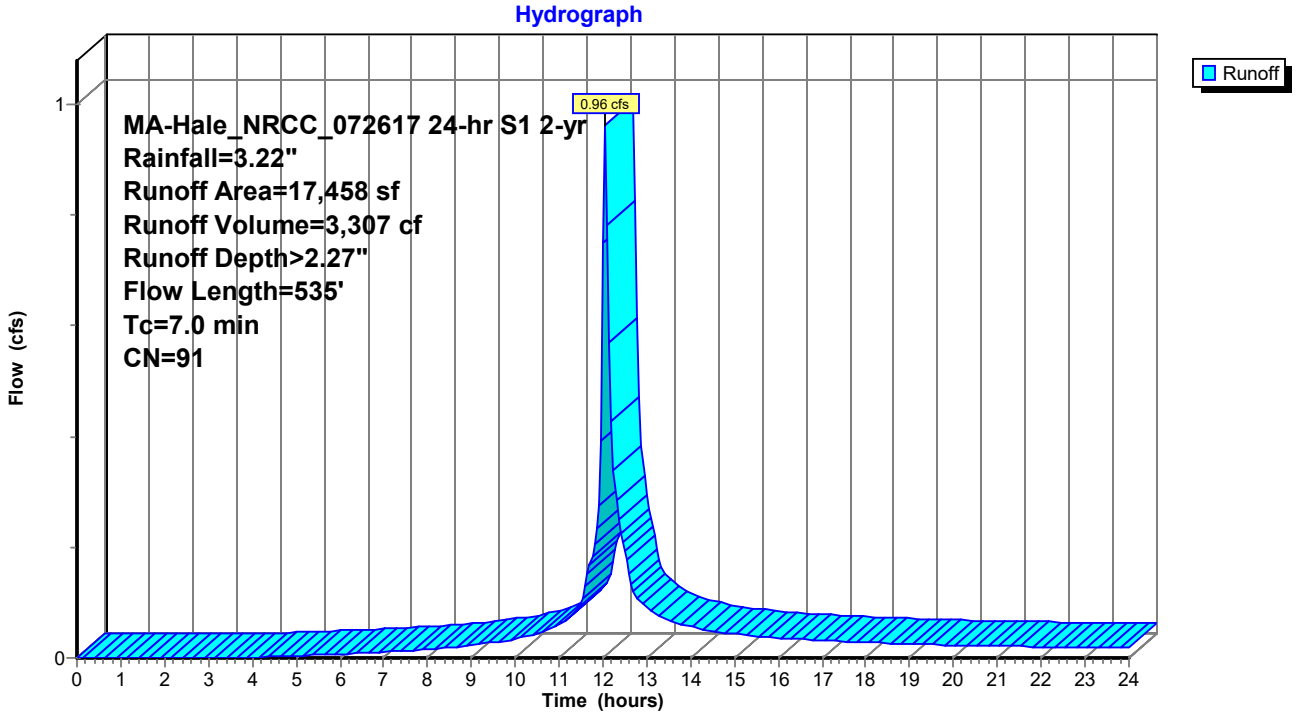
Runoff = 0.96 cfs @ 12.05 hrs, Volume= 3,307 cf, Depth> 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
6,583	80	>75% Grass cover, Good, HSG D
10,875	98	Paved parking, HSG D
17,458	91	Weighted Average
6,583		37.71% Pervious Area
10,875		62.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	17	0.0250	0.09		**Sheet Flow, Lawn** Grass: Dense n= 0.240 P2= 3.22"
0.7	33	0.0100	0.84		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.5	87	0.0200	2.87		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	31	0.0300	2.60		**Shallow Concentrated Flow, Grass** Grassed Waterway Kv= 15.0 fps
0.4	75	0.0070	3.11	0.61	**Pipe Channel, 6" Pipe** 6.0" Round Area= 0.2 sf Perim= 1.6' r= 0.13' n= 0.010 PVC, smooth interior
2.0	292	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
7.0	535	Total			

Subcatchment P6: Exist Parking Building Entrance



Summary for Subcatchment P7: Remain-grass-swale

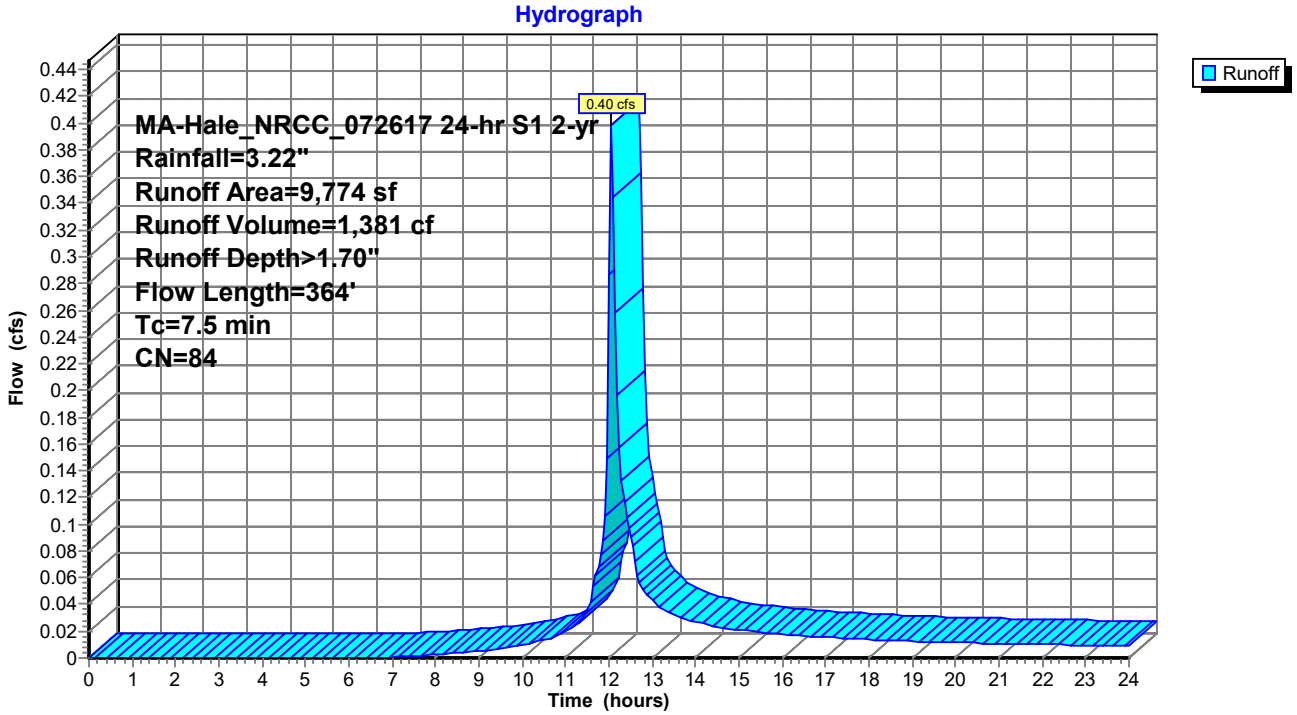
Runoff = 0.40 cfs @ 12.06 hrs, Volume= 1,381 cf, Depth> 1.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 2-yr Rainfall=3.22"

Area (sf)	CN	Description
4,329	80	>75% Grass cover, Good, HSG D
1,395	84	50-75% Grass cover, Fair, HSG D
4,050	89	<50% Grass cover, Poor, HSG D
9,774	84	Weighted Average
9,774		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.0600	0.16		**Sheet Flow, Grass** Grass: Dense n= 0.240 P2= 3.22"
2.2	314	0.0040	2.39	28.66	**Trap/Vee/Rect Channel Flow, Channel** Bot.W=5.00' D=1.50' Z= 2.0 '/' Top.W=11.00' n= 0.040 Earth, cobble bottom, clean sides
7.5	364	Total			

Subcatchment P7: Remain-grass-swale



Summary for Reach 1R: Channel

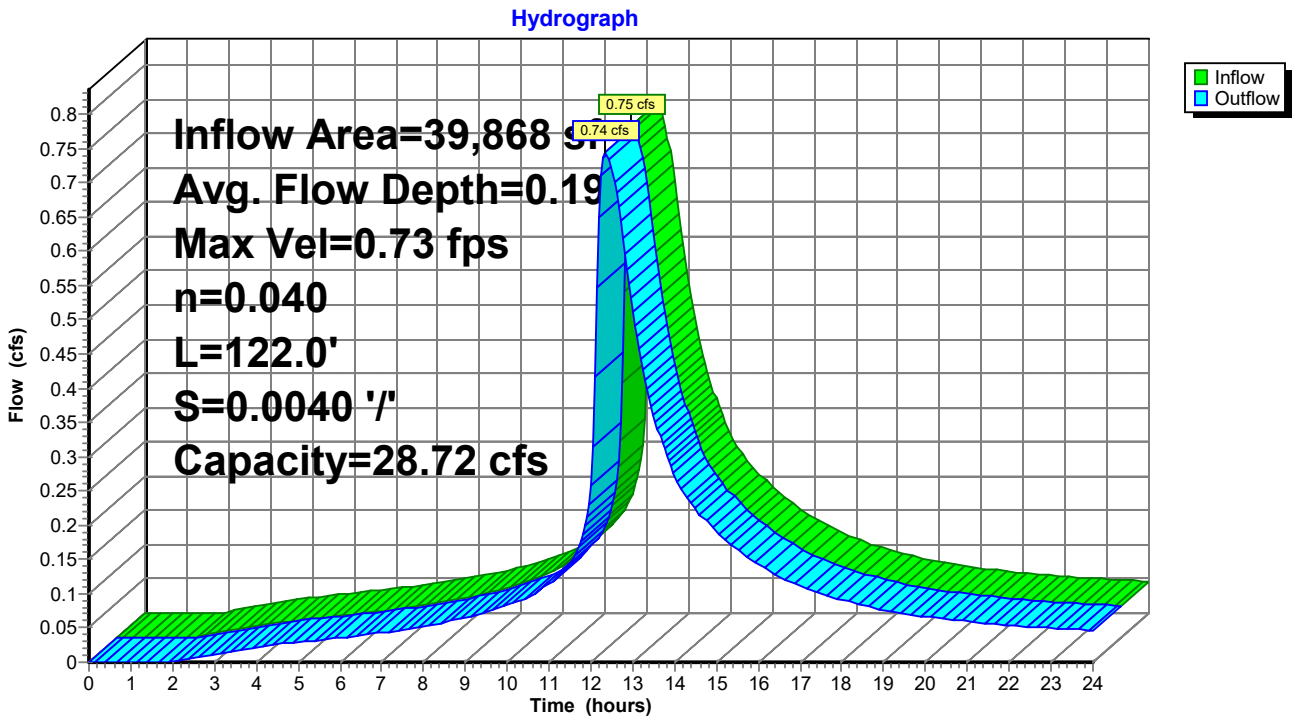
Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 2.75" for 2-yr event
Inflow = 0.75 cfs @ 12.27 hrs, Volume= 9,135 cf
Outflow = 0.74 cfs @ 12.36 hrs, Volume= 9,106 cf, Atten= 0%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.73 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 6.3 min

Peak Storage= 124 cf @ 12.31 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 28.72 cfs

5.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 122.0' Slope= 0.0040 '/'
Inlet Invert= 18.91', Outlet Invert= 18.42'

‡



Summary for Pond 1P: Storage Area

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 2.77" for 2-yr event
Inflow = 2.63 cfs @ 12.04 hrs, Volume= 9,189 cf
Outflow = 0.75 cfs @ 12.27 hrs, Volume= 9,135 cf, Atten= 72%, Lag= 14.1 min
Primary = 0.75 cfs @ 12.27 hrs, Volume= 9,135 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 21.15' @ 12.27 hrs Surf.Area= 7,737 sf Storage= 2,338 cf

Plug-Flow detention time= 49.7 min calculated for 9,116 cf (99% of inflow)
Center-of-Mass det. time= 45.8 min (826.8 - 781.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	19.78'	0 cf	**53.27'W x 145.00'L x 2.75'H Field A** 21,245 cf Overall - 5,841 cf Embedded = 15,404 cf x 0.0% Voids
#2A	20.28'	4,722 cf	**ADS N-12 18** x 126 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf 18 Rows of 7 Chambers 51.77' Header x 1.80 sf x 2 = 186.4 cf Inside
#3	20.27'	46 cf	**4.00'D x 3.65'H Vertical Cone/Cylinder**
#4	23.70'	2,397 cf	**Lower Parking Lot (Prismatic)** Listed below (Recalc)
		7,165 cf	Total Available Storage

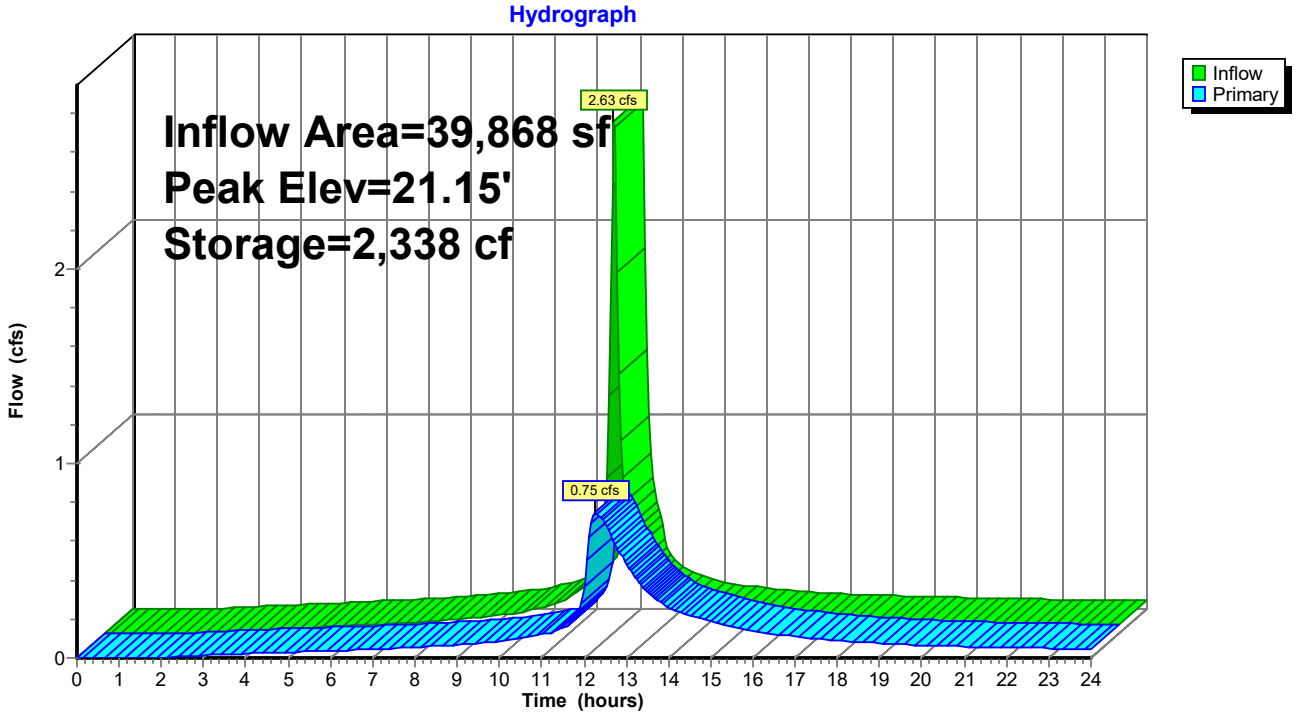
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
23.70	2	0	0
24.00	1,764	265	265
25.00	2,500	2,132	2,397

Device	Routing	Invert	Outlet Devices
#1	Primary	20.19'	**15.0" Round Culvert** L= 74.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.19' / 19.45' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	20.28'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.50 0.50 3.00 3.00 3.50 Width (feet) 0.20 0.20 0.50 0.50 4.00 4.00

Primary OutFlow Max=0.74 cfs @ 12.27 hrs HW=21.15' (Free Discharge)
↑**1=Culvert** (Passes 0.74 cfs of 2.65 cfs potential flow)
↑**2=Custom Weir/Orifice** (Weir Controls 0.74 cfs @ 2.63 fps)

Pond 1P: Storage Area

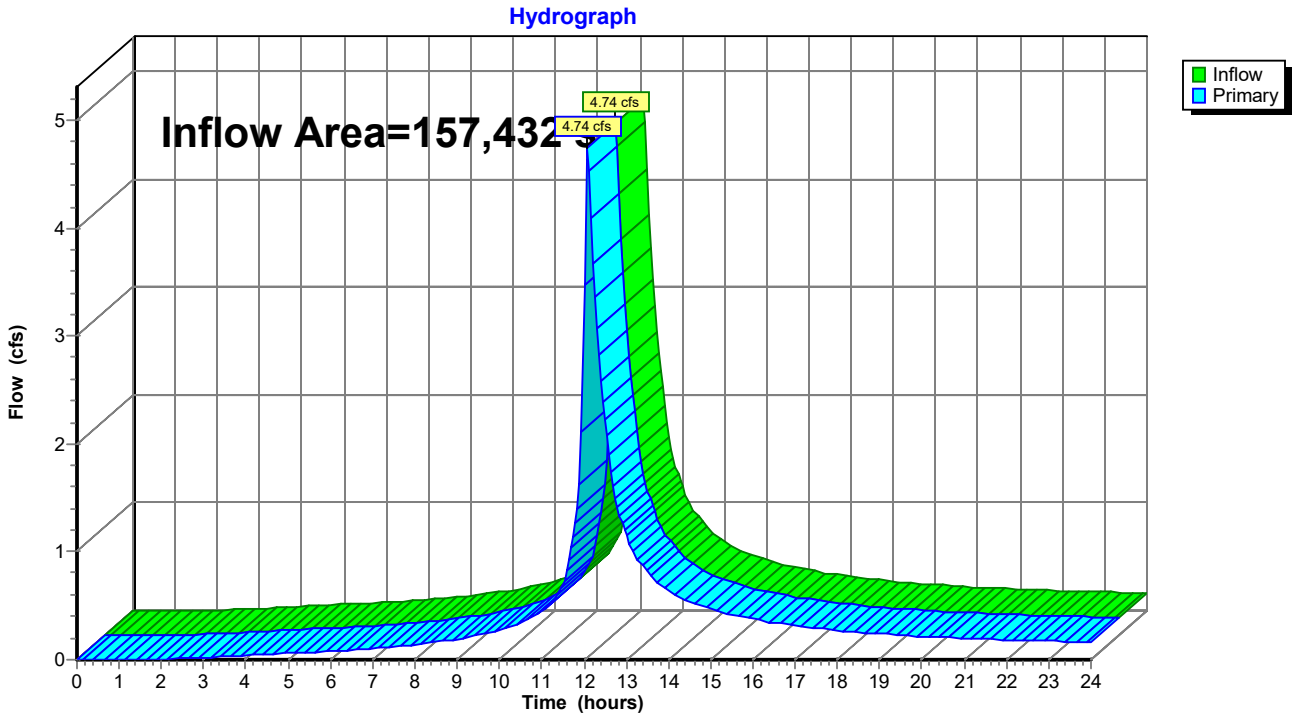


Summary for Link 2L: Post Total

Inflow Area = 157,432 sf, 53.75% Impervious, Inflow Depth > 2.25" for 2-yr event
Inflow = 4.74 cfs @ 12.07 hrs, Volume= 29,534 cf
Primary = 4.74 cfs @ 12.07 hrs, Volume= 29,534 cf, Atten= 0%, Lag= 0.0 min

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

Link 2L: Post Total



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 P1: Exist Parking Entrance Runoff Area=13,181 sf 94.42% Impervious Runoff Depth>4.59"
Flow Length=636' Tc=6.0 min CN=97 Runoff=1.22 cfs 0.116 af

Subcatchment P2: Prop Parking Addition Runoff Area=39,868 sf 89.68% Impervious Runoff Depth>4.48"
Flow Length=251' Tc=6.0 min CN=96 Runoff=3.65 cfs 0.342 af

Subcatchment P3: Prop. Access & Wetland Runoff Area=40,675 sf 5.69% Impervious Runoff Depth>3.11"
Flow Length=728' Tc=22.5 min CN=83 Runoff=1.71 cfs 0.242 af

Subcatchment P4: Exist Parking Entrance Runoff Area=9,994 sf 21.55% Impervious Runoff Depth>3.31"
Flow Length=230' Tc=9.0 min CN=85 Runoff=0.64 cfs 0.063 af

Subcatchment P5: Exist Parking Runoff Area=26,482 sf 79.57% Impervious Runoff Depth>4.25"
Flow Length=262' Tc=10.2 min CN=94 Runoff=1.99 cfs 0.215 af

Subcatchment P6: Exist Parking Building Runoff Area=17,458 sf 62.29% Impervious Runoff Depth>3.93"
Flow Length=535' Tc=7.0 min CN=91 Runoff=1.43 cfs 0.131 af

Subcatchment P7: Remain-grass-swale Runoff Area=9,774 sf 0.00% Impervious Runoff Depth>3.22"
Flow Length=364' Tc=7.5 min CN=84 Runoff=0.67 cfs 0.060 af

Reach 1R: Channel Avg. Flow Depth=0.26' Max Vel=0.89 fps Inflow=1.28 cfs 0.337 af
n=0.040 L=122.0' S=0.0040 '/' Capacity=28.72 cfs Outflow=1.28 cfs 0.336 af

Pond 1P: Storage Area Peak Elev=21.41' Storage=3,372 cf Inflow=3.65 cfs 0.342 af
Outflow=1.28 cfs 0.337 af

Link 2L: Post Total Inflow=7.46 cfs 1.164 af
Primary=7.46 cfs 1.164 af

Total Runoff Area = 3.614 ac Runoff Volume = 1.169 af Average Runoff Depth = 3.88"
46.25% Pervious = 1.672 ac 53.75% Impervious = 1.942 ac

Summary for Subcatchment P2: Prop Parking Addition

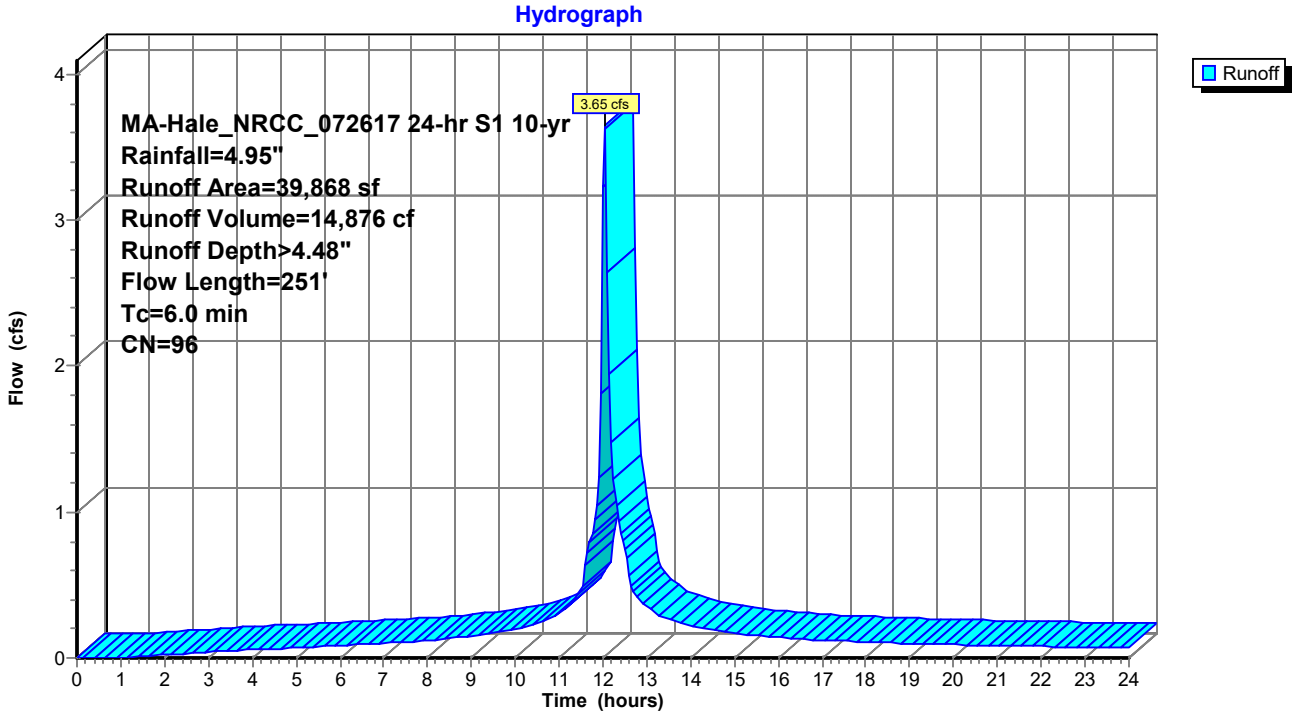
Runoff = 3.65 cfs @ 12.04 hrs, Volume= 14,876 cf, Depth> 4.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 10-yr Rainfall=4.95"

Area (sf)	CN	Description
4,113	80	>75% Grass cover, Good, HSG D
35,755	98	Paved parking, HSG D
39,868	96	Weighted Average
4,113		10.32% Pervious Area
35,755		89.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.6	76	0.0100	2.03		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	65	0.0100	4.54	3.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.2	55	0.0100	5.26	6.46	**Pipe Channel, DMH to WQ1** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.2	5	0.0001	0.53	0.65	**Pipe Channel, WQ1 to Storgae** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
2.1	251	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P2: Prop Parking Addition



Summary for Reach 1R: Channel

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 4.42" for 10-yr event
Inflow = 1.28 cfs @ 12.24 hrs, Volume= 14,697 cf
Outflow = 1.28 cfs @ 12.31 hrs, Volume= 14,657 cf, Atten= 0%, Lag= 4.1 min

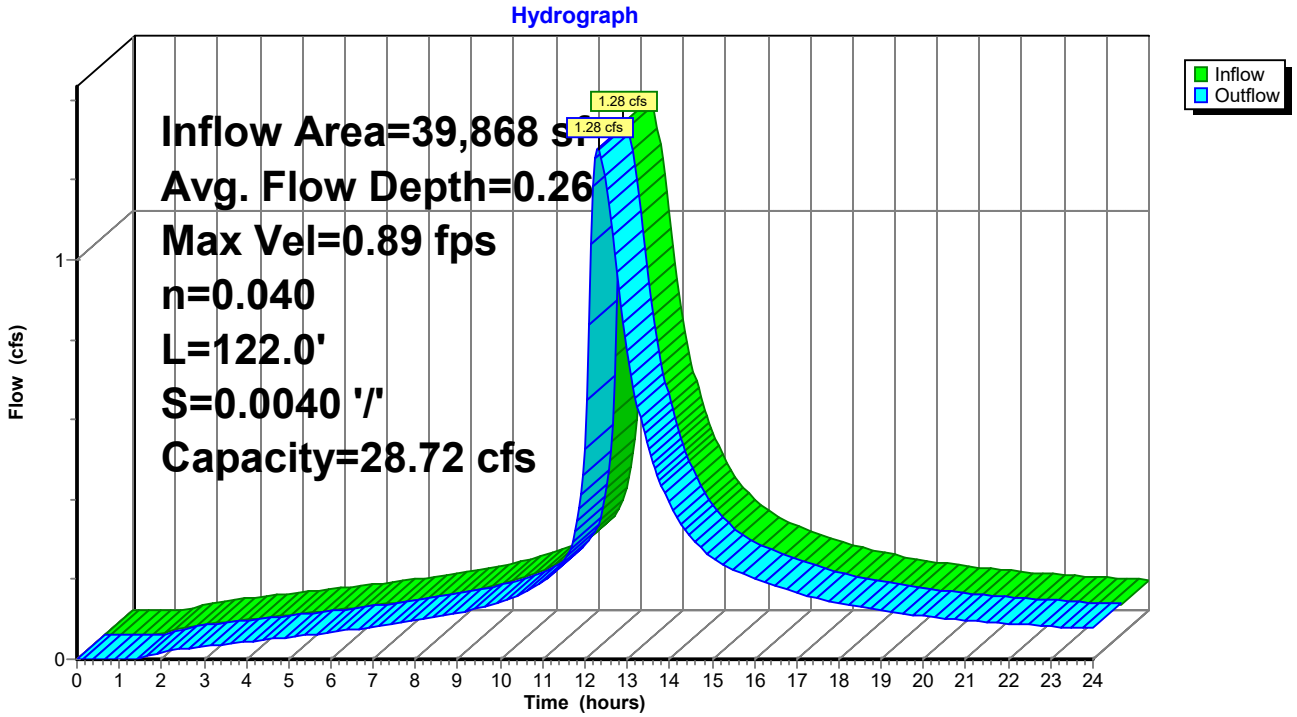
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.89 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.38 fps, Avg. Travel Time= 5.3 min

Peak Storage= 175 cf @ 12.27 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 28.72 cfs

5.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 122.0' Slope= 0.0040 '/'
Inlet Invert= 18.91', Outlet Invert= 18.42'

‡

Reach 1R: Channel



Summary for Pond 1P: Storage Area

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 4.48" for 10-yr event
Inflow = 3.65 cfs @ 12.04 hrs, Volume= 14,876 cf
Outflow = 1.28 cfs @ 12.24 hrs, Volume= 14,697 cf, Atten= 65%, Lag= 12.1 min
Primary = 1.28 cfs @ 12.24 hrs, Volume= 14,697 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 21.41' @ 12.24 hrs Surf.Area= 7,737 sf Storage= 3,372 cf

Plug-Flow detention time= 52.7 min calculated for 14,667 cf (99% of inflow)
Center-of-Mass det. time= 44.7 min (812.1 - 767.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	19.78'	0 cf	**53.27'W x 145.00'L x 2.75'H Field A** 21,245 cf Overall - 5,841 cf Embedded = 15,404 cf x 0.0% Voids
#2A	20.28'	4,722 cf	**ADS N-12 18** x 126 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf 18 Rows of 7 Chambers 51.77' Header x 1.80 sf x 2 = 186.4 cf Inside
#3	20.27'	46 cf	**4.00'D x 3.65'H Vertical Cone/Cylinder**
#4	23.70'	2,397 cf	**Lower Parking Lot (Prismatic)** Listed below (Recalc)
		7,165 cf	Total Available Storage

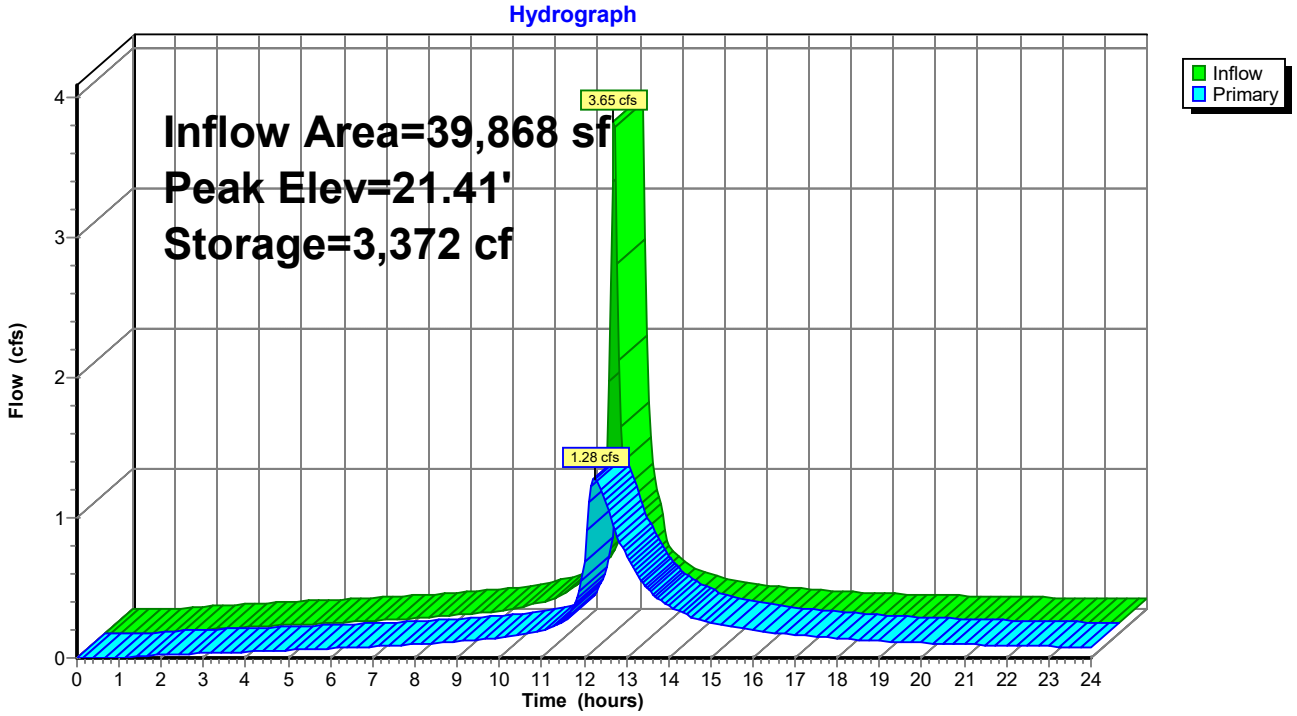
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
23.70	2	0	0
24.00	1,764	265	265
25.00	2,500	2,132	2,397

Device	Routing	Invert	Outlet Devices
#1	Primary	20.19'	**15.0" Round Culvert** L= 74.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.19' / 19.45' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	20.28'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.50 0.50 3.00 3.00 3.50 Width (feet) 0.20 0.20 0.50 0.50 4.00 4.00

Primary OutFlow Max=1.28 cfs @ 12.24 hrs HW=21.41' (Free Discharge)
↑**1=Culvert** (Passes 1.28 cfs of 3.62 cfs potential flow)
↑**2=Custom Weir/Orifice** (Weir Controls 1.28 cfs @ 3.08 fps)

Pond 1P: Storage Area



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

Subcatchment P1: Exist Parking Entrance Runoff Area=13,181 sf 94.42% Impervious Runoff Depth>5.97"
Flow Length=636' Tc=6.0 min CN=97 Runoff=1.48 cfs 0.150 af

Subcatchment P2: Prop Parking Addition Runoff Area=39,868 sf 89.68% Impervious Runoff Depth>5.85"
Flow Length=251' Tc=6.0 min CN=96 Runoff=4.46 cfs 0.446 af

Subcatchment P3: Prop. Access & Wetland Runoff Area=40,675 sf 5.69% Impervious Runoff Depth>4.37"
Flow Length=728' Tc=22.5 min CN=83 Runoff=2.29 cfs 0.340 af

Subcatchment P4: Exist Parking Entrance Runoff Area=9,994 sf 21.55% Impervious Runoff Depth>4.60"
Flow Length=230' Tc=9.0 min CN=85 Runoff=0.85 cfs 0.088 af

Subcatchment P5: Exist Parking Runoff Area=26,482 sf 79.57% Impervious Runoff Depth>5.61"
Flow Length=262' Tc=10.2 min CN=94 Runoff=2.47 cfs 0.284 af

Subcatchment P6: Exist Parking Building Runoff Area=17,458 sf 62.29% Impervious Runoff Depth>5.27"
Flow Length=535' Tc=7.0 min CN=91 Runoff=1.80 cfs 0.176 af

Subcatchment P7: Remain-grass-swale Runoff Area=9,774 sf 0.00% Impervious Runoff Depth>4.50"
Flow Length=364' Tc=7.5 min CN=84 Runoff=0.88 cfs 0.084 af

Reach 1R: Channel Avg. Flow Depth=0.31' Max Vel=1.00 fps Inflow=1.76 cfs 0.439 af
n=0.040 L=122.0' S=0.0040 '/' Capacity=28.72 cfs Outflow=1.74 cfs 0.438 af

Pond 1P: Storage Area Peak Elev=21.61' Storage=4,081 cf Inflow=4.46 cfs 0.446 af
Outflow=1.76 cfs 0.439 af

Link 2L: Post Total Inflow=9.62 cfs 1.561 af
Primary=9.62 cfs 1.561 af

Total Runoff Area = 3.614 ac Runoff Volume = 1.569 af Average Runoff Depth = 5.21"
46.25% Pervious = 1.672 ac 53.75% Impervious = 1.942 ac

Summary for Subcatchment P2: Prop Parking Addition

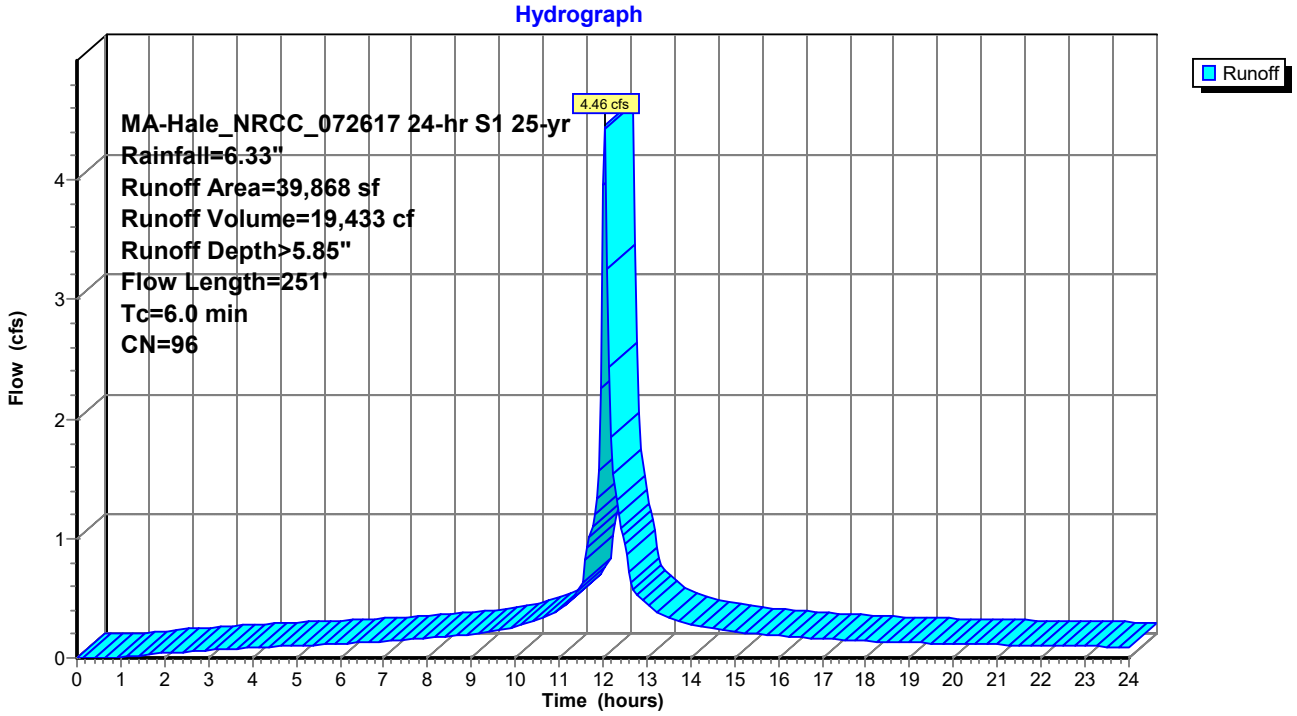
Runoff = 4.46 cfs @ 12.04 hrs, Volume= 19,433 cf, Depth> 5.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 25-yr Rainfall=6.33"

Area (sf)	CN	Description
4,113	80	>75% Grass cover, Good, HSG D
35,755	98	Paved parking, HSG D
39,868	96	Weighted Average
4,113		10.32% Pervious Area
35,755		89.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.6	76	0.0100	2.03		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	65	0.0100	4.54	3.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.2	55	0.0100	5.26	6.46	**Pipe Channel, DMH to WQ1** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.2	5	0.0001	0.53	0.65	**Pipe Channel, WQ1 to Storgae** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
2.1	251	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P2: Prop Parking Addition



Summary for Reach 1R: Channel

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 5.76" for 25-yr event
Inflow = 1.76 cfs @ 12.22 hrs, Volume= 19,142 cf
Outflow = 1.74 cfs @ 12.28 hrs, Volume= 19,094 cf, Atten= 1%, Lag= 3.8 min

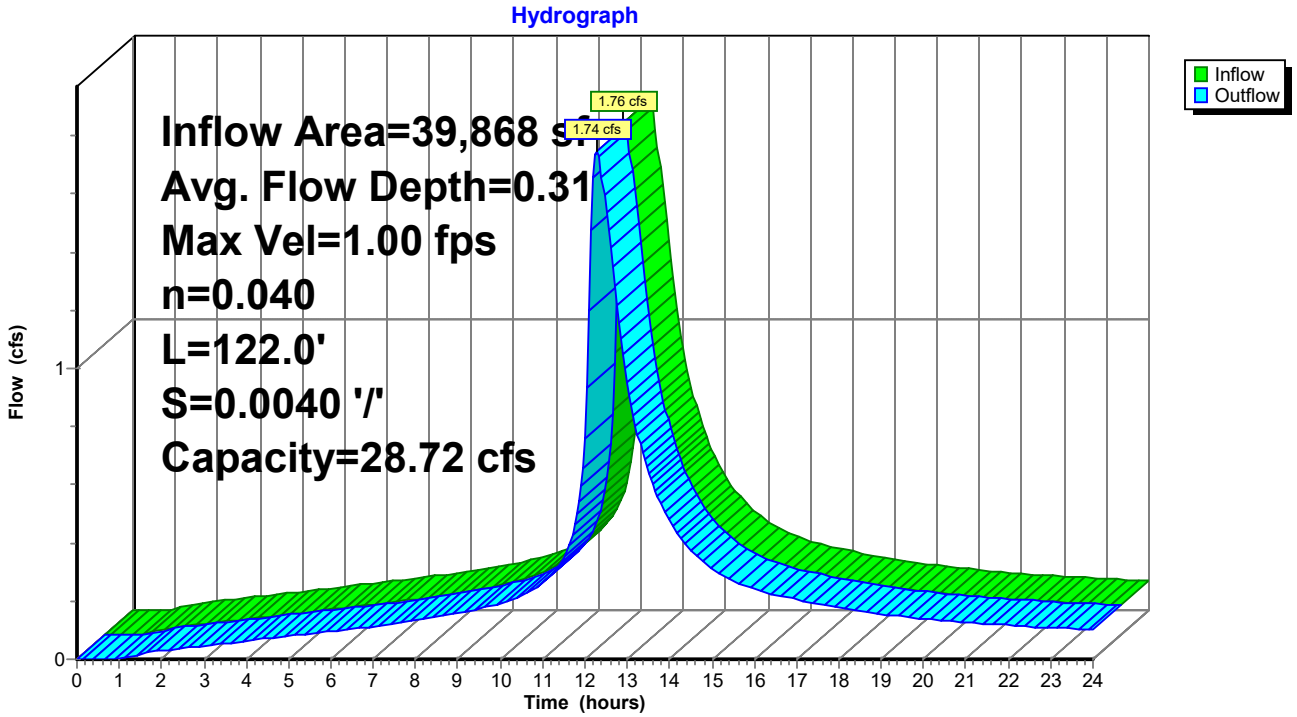
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.00 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 4.8 min

Peak Storage= 215 cf @ 12.25 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 28.72 cfs

5.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 122.0' Slope= 0.0040 '/'
Inlet Invert= 18.91', Outlet Invert= 18.42'

‡

Reach 1R: Channel



Summary for Pond 1P: Storage Area

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 5.85" for 25-yr event
Inflow = 4.46 cfs @ 12.04 hrs, Volume= 19,433 cf
Outflow = 1.76 cfs @ 12.22 hrs, Volume= 19,142 cf, Atten= 61%, Lag= 10.8 min
Primary = 1.76 cfs @ 12.22 hrs, Volume= 19,142 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 21.61' @ 12.22 hrs Surf.Area= 7,737 sf Storage= 4,081 cf

Plug-Flow detention time= 53.3 min calculated for 19,102 cf (98% of inflow)
Center-of-Mass det. time= 43.3 min (803.9 - 760.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	19.78'	0 cf	**53.27'W x 145.00'L x 2.75'H Field A** 21,245 cf Overall - 5,841 cf Embedded = 15,404 cf x 0.0% Voids
#2A	20.28'	4,722 cf	**ADS N-12 18** x 126 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf 18 Rows of 7 Chambers 51.77' Header x 1.80 sf x 2 = 186.4 cf Inside
#3	20.27'	46 cf	**4.00'D x 3.65'H Vertical Cone/Cylinder**
#4	23.70'	2,397 cf	**Lower Parking Lot (Prismatic)** Listed below (Recalc)
		7,165 cf	Total Available Storage

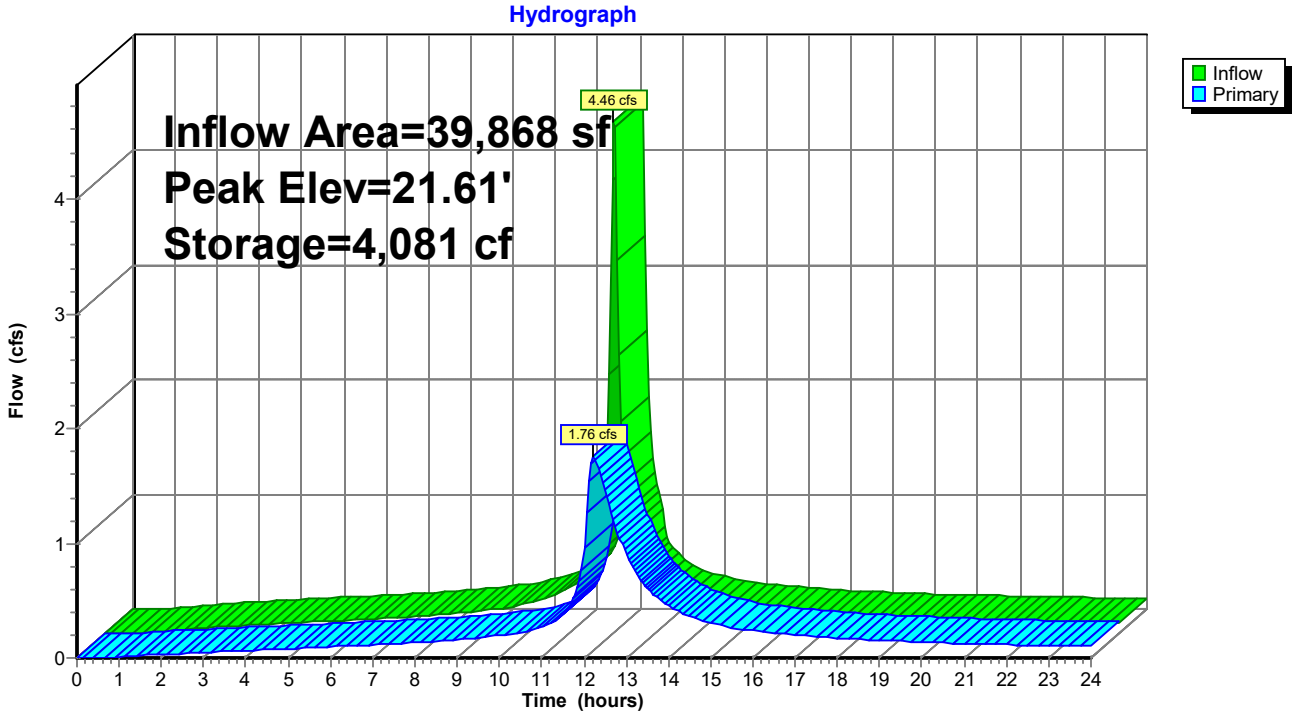
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
23.70	2	0	0
24.00	1,764	265	265
25.00	2,500	2,132	2,397

Device	Routing	Invert	Outlet Devices
#1	Primary	20.19'	**15.0" Round Culvert** L= 74.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.19' / 19.45' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	20.28'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.50 0.50 3.00 3.00 3.50 Width (feet) 0.20 0.20 0.50 0.50 4.00 4.00

Primary OutFlow Max=1.75 cfs @ 12.22 hrs HW=21.61' (Free Discharge)
↑**1=Culvert** (Passes 1.75 cfs of 4.16 cfs potential flow)
↑**2=Custom Weir/Orifice** (Weir Controls 1.75 cfs @ 3.39 fps)

Pond 1P: Storage Area



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

Subcatchment P1: Exist Parking Entrance Runoff Area=13,181 sf 94.42% Impervious Runoff Depth>8.82"
Flow Length=636' Tc=6.0 min CN=97 Runoff=1.99 cfs 0.222 af

Subcatchment P2: Prop Parking Addition Runoff Area=39,868 sf 89.68% Impervious Runoff Depth>8.70"
Flow Length=251' Tc=6.0 min CN=96 Runoff=6.00 cfs 0.663 af

Subcatchment P3: Prop. Access & Wetland Runoff Area=40,675 sf 5.69% Impervious Runoff Depth>7.07"
Flow Length=728' Tc=22.5 min CN=83 Runoff=3.41 cfs 0.550 af

Subcatchment P4: Exist Parking Entrance Runoff Area=9,994 sf 21.55% Impervious Runoff Depth>7.35"
Flow Length=230' Tc=9.0 min CN=85 Runoff=1.23 cfs 0.141 af

Subcatchment P5: Exist Parking Runoff Area=26,482 sf 79.57% Impervious Runoff Depth>8.45"
Flow Length=262' Tc=10.2 min CN=94 Runoff=3.36 cfs 0.428 af

Subcatchment P6: Exist Parking Building Runoff Area=17,458 sf 62.29% Impervious Runoff Depth>8.09"
Flow Length=535' Tc=7.0 min CN=91 Runoff=2.48 cfs 0.270 af

Subcatchment P7: Remain-grass-swale Runoff Area=9,774 sf 0.00% Impervious Runoff Depth>7.23"
Flow Length=364' Tc=7.5 min CN=84 Runoff=1.27 cfs 0.135 af

Reach 1R: Channel Avg. Flow Depth=0.51' Max Vel=1.31 fps Inflow=5.15 cfs 0.651 af
n=0.040 L=122.0' S=0.0040 '/' Capacity=28.72 cfs Outflow=3.94 cfs 0.650 af

Pond 1P: Storage Area Peak Elev=22.72' Storage=4,753 cf Inflow=6.00 cfs 0.663 af
Outflow=5.15 cfs 0.651 af

Link 2L: Post Total Inflow=14.44 cfs 2.396 af
Primary=14.44 cfs 2.396 af

Total Runoff Area = 3.614 ac Runoff Volume = 2.410 af Average Runoff Depth = 8.00"
46.25% Pervious = 1.672 ac 53.75% Impervious = 1.942 ac

Summary for Subcatchment P2: Prop Parking Addition

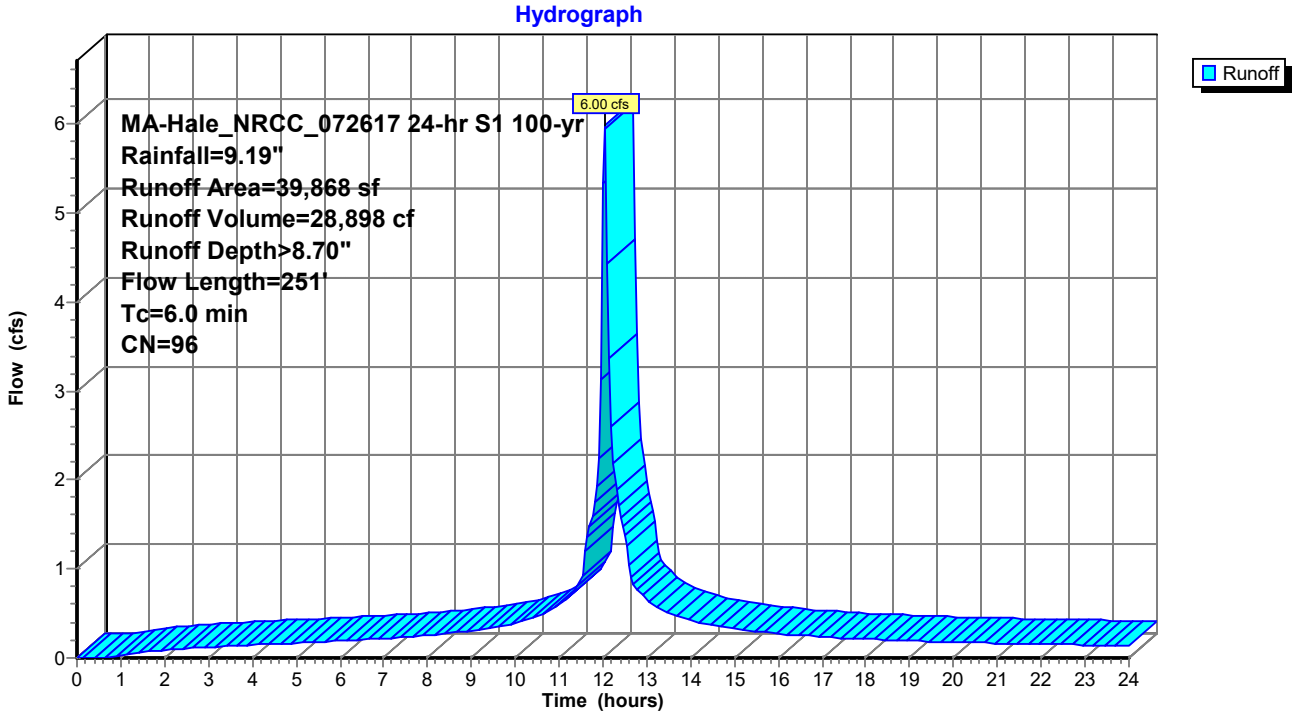
Runoff = 6.00 cfs @ 12.04 hrs, Volume= 28,898 cf, Depth> 8.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MA-Hale_NRCC_072617 24-hr S1 100-yr Rainfall=9.19"

Area (sf)	CN	Description
4,113	80	>75% Grass cover, Good, HSG D
35,755	98	Paved parking, HSG D
39,868	96	Weighted Average
4,113		10.32% Pervious Area
35,755		89.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.91		**Sheet Flow, Pavement** Smooth surfaces n= 0.011 P2= 3.22"
0.6	76	0.0100	2.03		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
0.2	65	0.0100	4.54	3.56	**Pipe Channel, CB to DMH** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
0.2	55	0.0100	5.26	6.46	**Pipe Channel, DMH to WQ1** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.2	5	0.0001	0.53	0.65	**Pipe Channel, WQ1 to Storgae** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
2.1	251	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P2: Prop Parking Addition



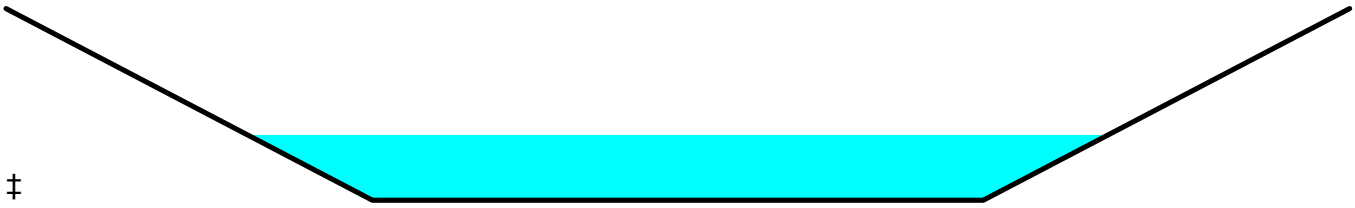
Summary for Reach 1R: Channel

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 8.54" for 100-yr event
Inflow = 5.15 cfs @ 12.10 hrs, Volume= 28,357 cf
Outflow = 3.94 cfs @ 12.16 hrs, Volume= 28,297 cf, Atten= 24%, Lag= 3.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.31 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 0.49 fps, Avg. Travel Time= 4.1 min

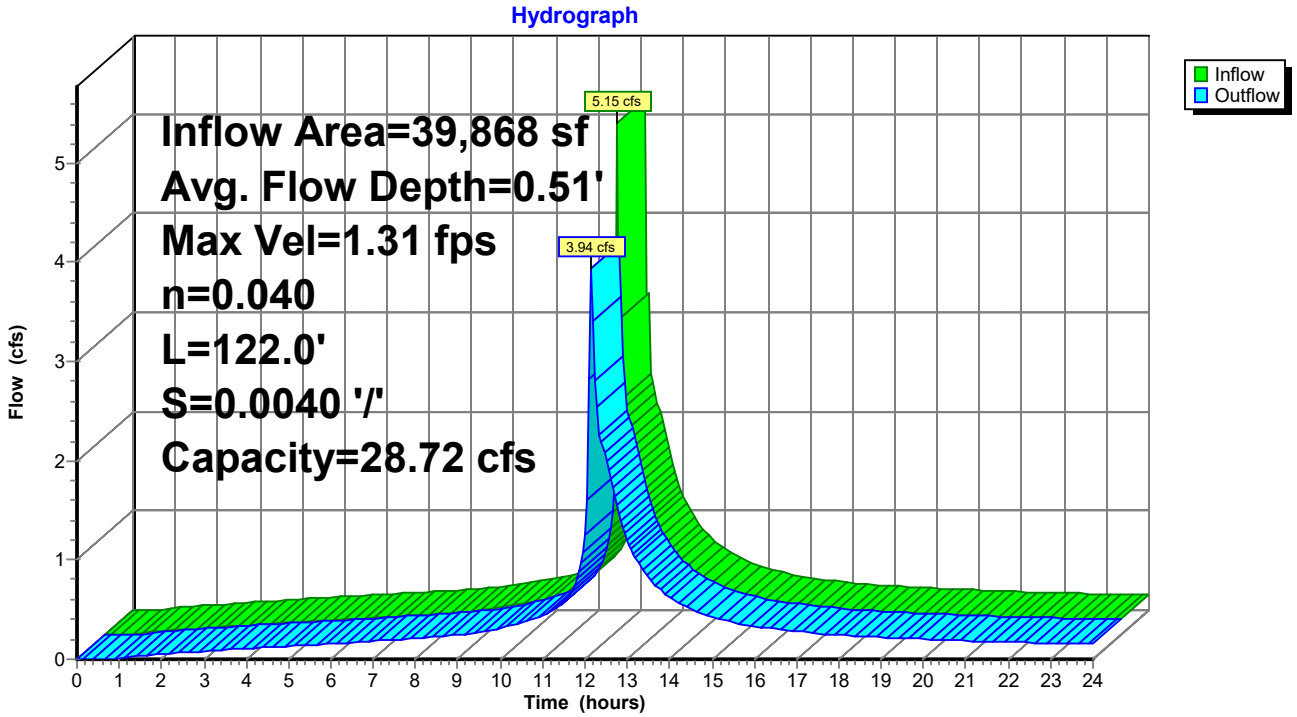
Peak Storage= 376 cf @ 12.13 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 28.72 cfs

5.00' x 1.50' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 122.0' Slope= 0.0040 '/'
Inlet Invert= 18.91', Outlet Invert= 18.42'



‡

Reach 1R: Channel



Summary for Pond 1P: Storage Area

Inflow Area = 39,868 sf, 89.68% Impervious, Inflow Depth > 8.70" for 100-yr event
Inflow = 6.00 cfs @ 12.04 hrs, Volume= 28,898 cf
Outflow = 5.15 cfs @ 12.10 hrs, Volume= 28,357 cf, Atten= 14%, Lag= 3.8 min
Primary = 5.15 cfs @ 12.10 hrs, Volume= 28,357 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 22.72' @ 12.10 hrs Surf.Area= 7,737 sf Storage= 4,753 cf

Plug-Flow detention time= 52.0 min calculated for 28,357 cf (98% of inflow)
Center-of-Mass det. time= 39.5 min (791.2 - 751.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	19.78'	0 cf	**53.27'W x 145.00'L x 2.75'H Field A** 21,245 cf Overall - 5,841 cf Embedded = 15,404 cf x 0.0% Voids
#2A	20.28'	4,722 cf	**ADS N-12 18** x 126 Inside #1 Inside= 18.2"W x 18.2"H => 1.80 sf x 20.00'L = 36.0 cf Outside= 21.0"W x 21.0"H => 2.23 sf x 20.00'L = 44.5 cf 18 Rows of 7 Chambers 51.77' Header x 1.80 sf x 2 = 186.4 cf Inside
#3	20.27'	46 cf	**4.00'D x 3.65'H Vertical Cone/Cylinder**
#4	23.70'	2,397 cf	**Lower Parking Lot (Prismatic)** Listed below (Recalc)
		7,165 cf	Total Available Storage

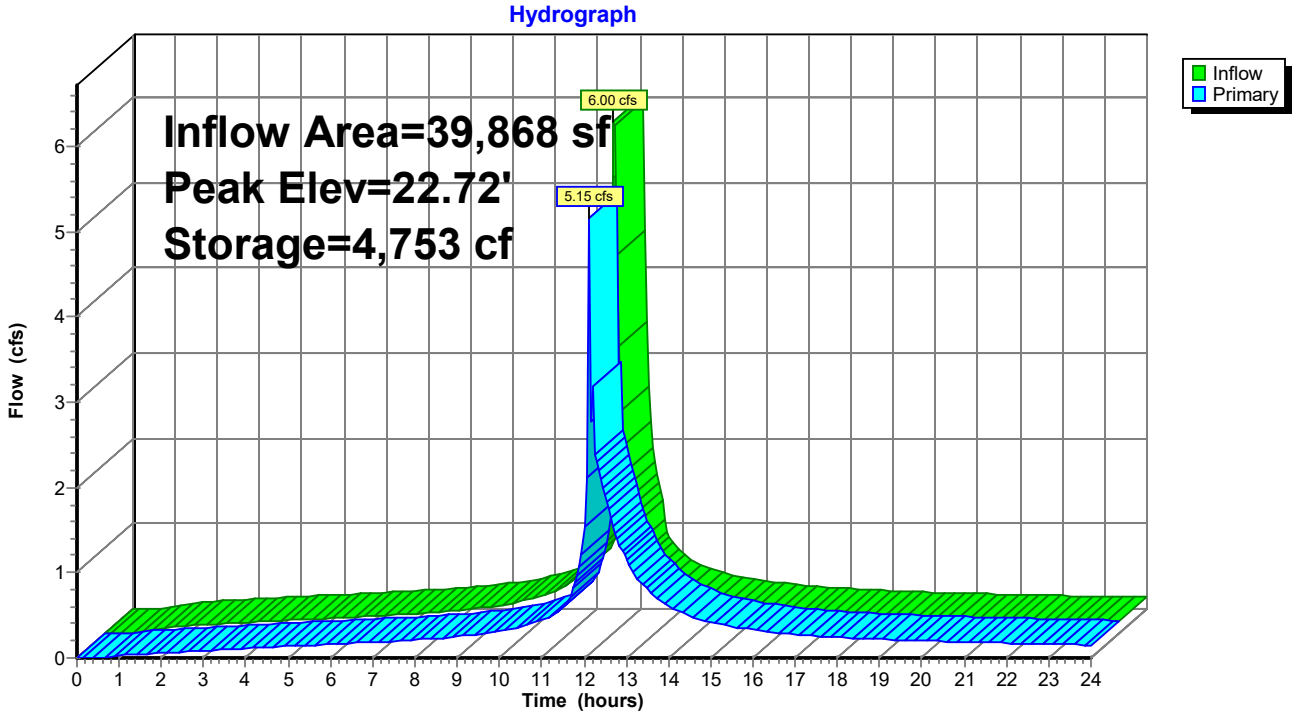
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
23.70	2	0	0
24.00	1,764	265	265
25.00	2,500	2,132	2,397

Device	Routing	Invert	Outlet Devices
#1	Primary	20.19'	**15.0" Round Culvert** L= 74.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.19' / 19.45' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	20.28'	**Custom Weir/Orifice, Cv= 2.62 (C= 3.28)** Head (feet) 0.00 0.50 0.50 3.00 3.00 3.50 Width (feet) 0.20 0.20 0.50 0.50 4.00 4.00

Primary OutFlow Max=4.99 cfs @ 12.10 hrs HW=22.67' (Free Discharge)
↑**1=Culvert** (Passes 4.99 cfs of 6.36 cfs potential flow)
↑**2=Custom Weir/Orifice** (Weir Controls 4.99 cfs @ 4.76 fps)

Pond 1P: Storage Area



APPENDIX D

DRAINAGE SYSTEM DESIGN CAPACITIES

HOPE CHURCH - 11 HALE STREET, NEWBURYPORT

DRAINAGE SYSTEM DESIGN FLOWS AND CAPACITIES

DEC. 14, 2017

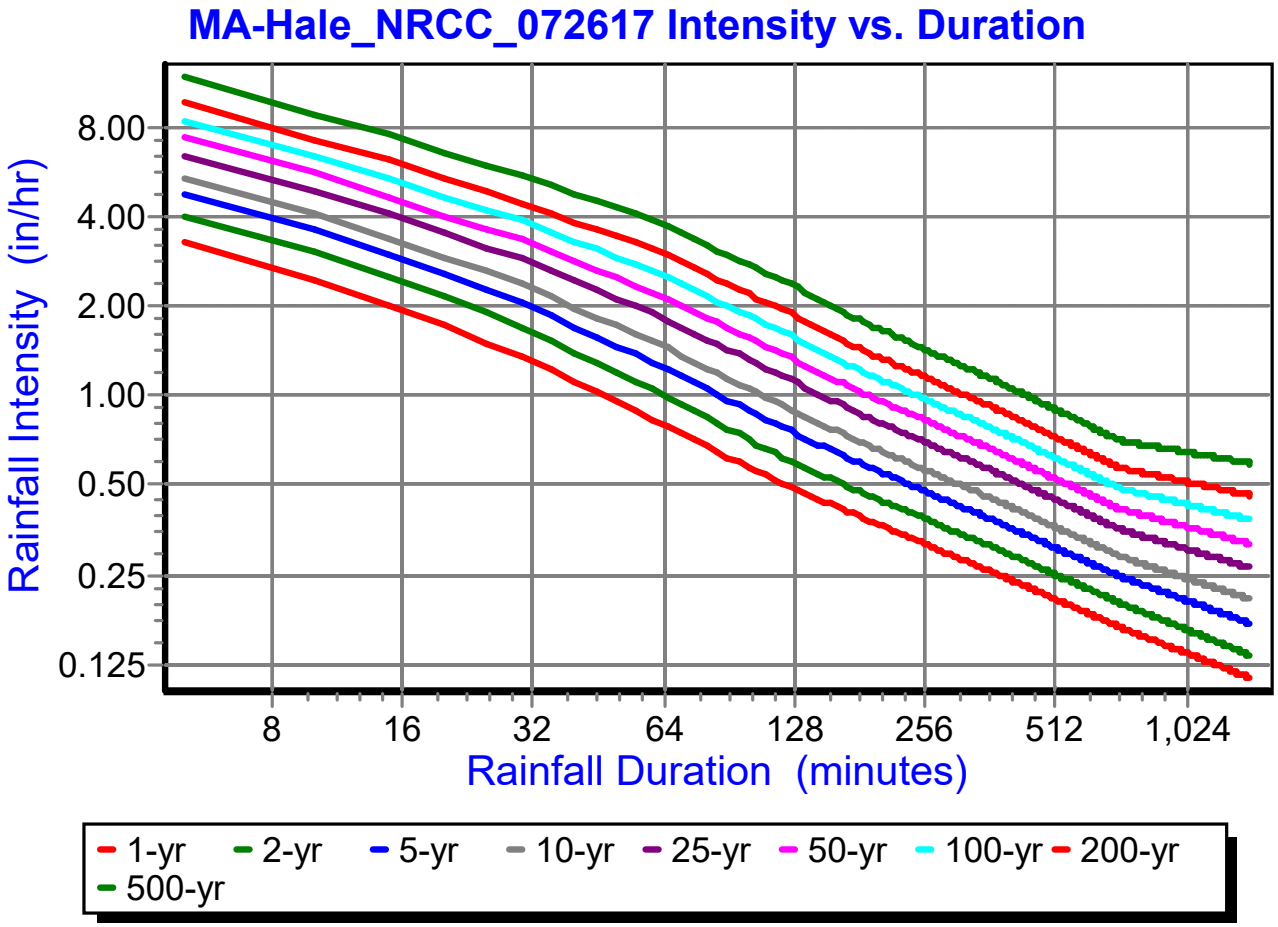
DESIGN STORM - 25 YEAR

STRUCTURE			STRUCTURE			PIPE					FLOWS AND CAPACITIES			
UPSTREAM	RIM	INV. OUT	DOWNSTREAM	RIM	INV. IN	DIA. (INCHES)	MATERIAL	LENGTH	SLOPE	MANNING - N	TOTAL FLOW	VELOCITY (FPS)	DEPTH FLOW	% FULL
DBL-CB-2	24.68	22.05	DMH-5	24.31	21.40	12	HDPE	64.5	0.010	0.012	1.64	4.71	5.46	45.5%
DBL-CB-1	24.04	21.62	DMH-5	24.31	21.40	12	HDPE	21.5	0.010	0.012	1.75	4.79	5.67	47.2%
DMH-5	24.31	21.15	WQ-1	23.79	20.60	15	HDPE	55	0.010	0.012	3.39	5.66	7.36	49.1%
CB-1	23.7	20.88	WQ-1	23.79	20.85	12	HDPE	5	0.006	0.012	1.07	3.49	4.96	41.3%
WQ-1	23.79	20.33	DMH-4 INLET	23.87	20.28	15	HDPE	5	0.010	0.012	4.46	6.04	8.70	58.0%
DMH-4 INLET	23.87	20.28	DMH-3 OUTLET	24.45	20.28	18	HDPE	NA	0.000	0.012	SYSTEM STORAGE			
DMH-3 OUTLET	24.45	20.19	DMH-2	22.82	19.50	15	HDPE	69	0.010	0.012	1.76	4.75	5.13	34.2%
DMH-2	22.82	19.50	DMH-1	22.5	19.45	15	HDPE	5	0.010	0.012	1.76	4.75	5.13	34.2%
DMH-1	22.5	19.20	18" OUTFALL	NA	19.09	18	RCP	21	0.005	0.015	3.84	4.93	8.16	45.3%
18" INLET	NA	19.30	18" OUTFALL	NA	19.09	18	RCP	42	0.005	0.015	2.08	4.18	5.85	32.5%
CB-4	23.65	21.40	DMH-6	23.9	21.35	12	HDPE	6	0.008	0.012	0			
CB-3	23.6	21.42	DMH-6	23.9	21.35	12	HDPE	6.5	0.010	0.012	0.74	3.79	3.56	29.7%
DMH-6	23.9	21.35	WQ-2	24.9	20.77	12	HDPE	58	0.010	0.012	0.74	3.79	3.56	29.7%
CB-2	23.55	20.85	WQ-2	24.9	20.77	12	HDPE	8	0.010	0.012	0.74	3.79	3.56	29.7%
WQ-2	24.9	20.42	OUTFALL	NA	19.9	15	HDPE	52	0.010	0.012	1.48	4.52	4.68	31.2%

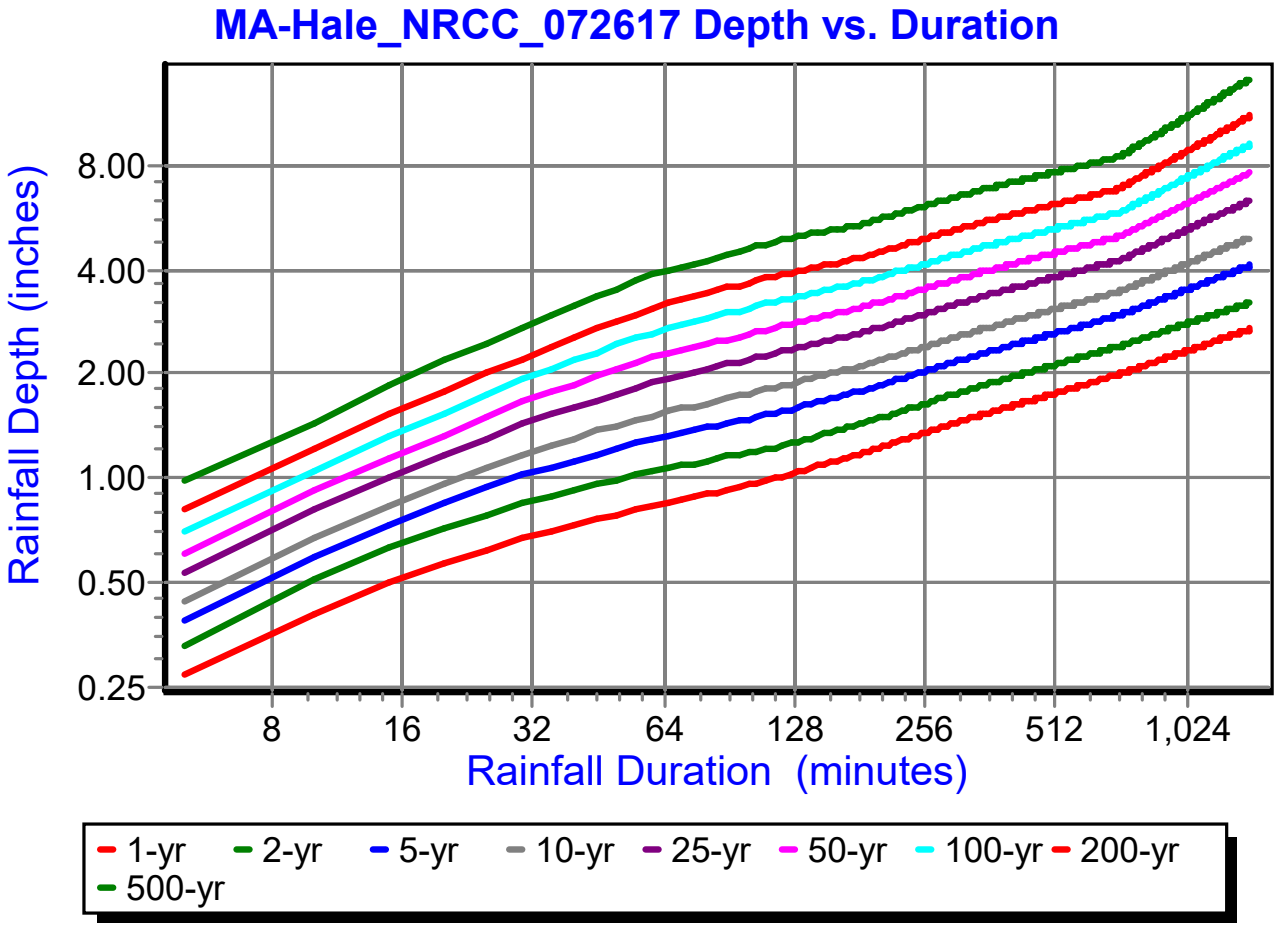
APPENDIX E

NRCC EXTREME PRECIPITATION RAINFALL DATA

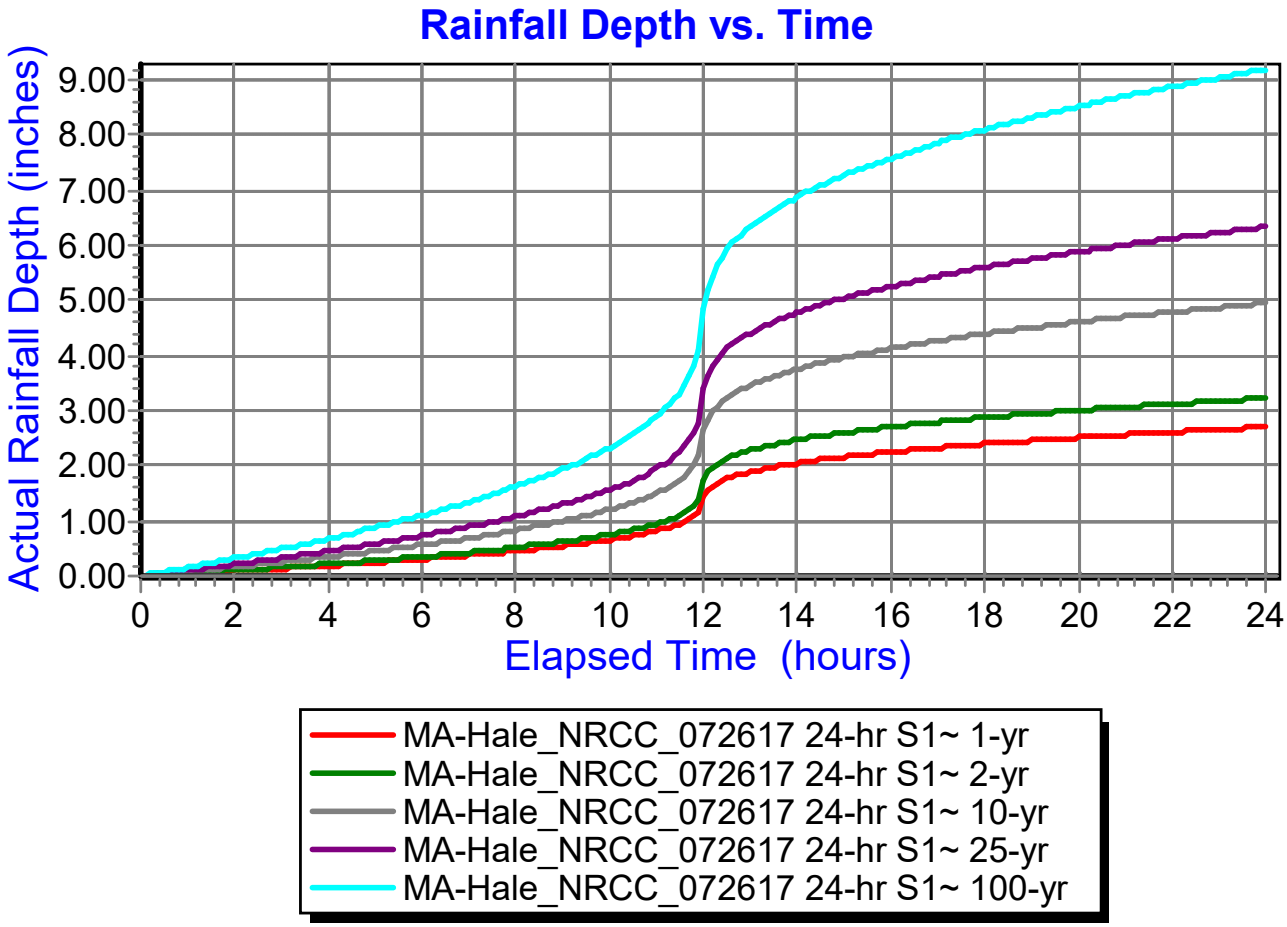
IDF Curve Report



IDF Curve Report



Storm Distribution Report



Northeast Regional Climate Center Extreme Precipitation estimates (inches)
Point Estimates, Unsmoothed
Data series, Partial duration series
State, Massachusetts
Location,
Lon (dd), -70.891
Lat (dd), 42.808
Elev (feet), 0
MEAN PRECIPITATION FREQUENCY ESTIMATES
Freq
(yr),5-min,10-min,15-min,30-min,60-min,120-min,3-hr,6-hr,12-hr,24-hr,2-day,4-day,7-day,10-day
1, 0.27, 0.41, 0.50, 0.68, 0.83, 1.01, 1.18, 1.55, 2.00, 2.70, 2.98, 3.30, 4.00, 4.68
2, 0.33, 0.51, 0.63, 0.85, 1.05, 1.24, 1.43, 1.88, 2.41, 3.22, 3.59, 3.97, 4.71, 5.38
5, 0.39, 0.60, 0.74, 1.02, 1.30, 1.56, 1.78, 2.32, 2.96, 4.12, 4.62, 5.11, 6.03, 6.78
10, 0.44, 0.68, 0.84, 1.18, 1.52, 1.85, 2.10, 2.73, 3.46, 4.95, 5.59, 6.18, 7.26, 8.09
25, 0.53, 0.81, 1.01, 1.44, 1.89, 2.32, 2.61, 3.39, 4.26, 6.33, 7.18, 7.96, 9.30,10.22
50, 0.61, 0.93, 1.15, 1.66, 2.23, 2.75, 3.09, 3.99, 4.99, 7.62, 8.69, 9.64,11.21,12.20
100, 0.70, 1.06, 1.33, 1.92, 2.63, 3.27, 3.65, 4.70, 5.85, 9.19,10.53,11.69,13.52,14.56
200, 0.81, 1.21, 1.54, 2.22, 3.10, 3.88, 4.31, 5.54, 6.85,11.08,12.75,14.16,16.32,17.40
500, 0.98, 1.45, 1.87, 2.72, 3.87, 4.88, 5.38, 6.88, 8.46,14.20,16.42,18.27,20.94,22.02

UPPER LIMIT PRECIPITATION FREQUENCY ESTIMATES
Freq
(yr),5-min,10-min,15-min,30-min,60-min,120-min,3-hr,6-hr,12-hr,24-hr,2-day,4-day,7-day,10-day
1, 0.29, 0.45, 0.55, 0.74, 0.91, 1.08, 1.31, 1.71, 2.17, 2.88, 3.18, 3.54, 4.34, 4.98
2, 0.34, 0.53, 0.65, 0.88, 1.08, 1.30, 1.51, 1.97, 2.52, 3.30, 3.69, 4.08, 4.90, 5.56
5, 0.42, 0.64, 0.80, 1.09, 1.39, 1.68, 1.93, 2.54, 3.24, 4.39, 4.93, 5.48, 6.45, 7.24
10, 0.50, 0.76, 0.95, 1.32, 1.71, 2.06, 2.35, 3.11, 3.93, 5.48, 6.17, 6.89, 8.05, 8.91
25, 0.63, 0.95, 1.18, 1.69, 2.22, 2.70, 3.06, 4.06, 5.08, 7.35, 8.31, 9.32,10.81,11.75
50, 0.74, 1.13, 1.40, 2.02, 2.71, 3.32, 3.74, 4.97, 6.21, 9.21,10.41,11.75,13.54,14.49
100, 0.88, 1.34, 1.67, 2.42, 3.32, 4.06, 4.57, 6.10,

7.58,11.56,13.06,14.80,17.02,17.88
200, 1.05, 1.58, 2.01, 2.90, 4.05, 4.99, 5.61, 7.49,
9.24,14.53,16.41,18.69,21.36,22.07
500, 1.33, 1.98, 2.55, 3.70, 5.26, 6.53, 7.33,
9.85,12.06,19.71,22.18,25.39,28.85,29.27

LOWER LIMIT PRECIPITATION FREQUENCY ESTIMATES
Freq
(yr),5-min,10-min,15-min,30-min,60-min,120-min,3-hr,6-hr,12-hr,24-hr,2-day,4-day,7-d
ay,10-day
1, 0.24, 0.37, 0.45, 0.60, 0.74, 0.87, 1.00, 1.31, 1.64, 2.49, 2.63, 2.97, 3.55,
4.23
2, 0.32, 0.49, 0.61, 0.82, 1.02, 1.22, 1.39, 1.83, 2.34, 3.17, 3.53, 3.88, 4.61,
5.29
5, 0.37, 0.56, 0.70, 0.96, 1.22, 1.45, 1.65, 2.13, 2.73, 3.85, 4.31, 4.77, 5.64,
6.37
10, 0.41, 0.63, 0.78, 1.08, 1.40, 1.67, 1.86, 2.40, 3.06, 4.47, 5.01, 5.56, 6.50,
7.29
25, 0.47, 0.72, 0.89, 1.27, 1.67, 2.00, 2.17, 2.77, 3.56, 5.41, 6.12, 6.78, 7.82,
8.69
50, 0.52, 0.80, 0.99, 1.42, 1.92, 2.30, 2.43, 3.09, 3.97, 6.25, 7.10, 7.88, 8.99,
9.92
100, 0.59, 0.89, 1.12, 1.61, 2.21, 2.65, 2.73, 3.45, 4.43, 7.21, 8.22,
9.15,10.30,11.26
200, 0.66, 0.99, 1.26, 1.82, 2.54, 3.04, 3.06, 3.84, 4.93, 8.30,
9.54,10.61,11.78,12.77
500, 0.78, 1.16, 1.49, 2.16, 3.07, 3.67, 3.57, 4.41, 5.70,
9.94,11.59,12.91,13.97,15.07

Date/time: Wed Jul 26 13:51:21 EDT 2017

APPENDIX F

PROPRIETARY TREATMENT UNITS - WATER QUALITY TREATMENT VOLUME CALCULATIONS

Project: Parking Improvement - Hope Church
Location: Newburyport, MA
Prepared For: Atlantic Engineering & Survey Consultants, Inc.

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 1/2" 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

Given:

Structure Name	Impv. (acres)	A ($miles^2$)	t_c (min)	t_c (hr)	WQV (in)
WQ-1	0.82	0.0012813	5.0	0.083	0.50
WQ-2	0.29	0.0004453	5.0	0.083	0.50

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).

Structure Name	qu (csm/in.)
WQ-1	773.00
WQ-2	773.00

1. Compute Q Rate using the following equation:

$$Q_1 = (qu)\ (A)\ (WQV)$$

where:

Q1 = flow rate associated with first 1/2" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1/2" in this case)

Structure Name	Q (cfs)
WQ-1	0.50
WQ-2	0.17

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

PARKING IMPROVEMENT - HOPE CHURCH
NEWBURYPORT, MA

Area	0.82 ac	Unit Site Designation	WQ-1
Weighted C	0.9	Rainfall Station #	69
t_c	6 min		
CDS Model	2015-4	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Removal Efficiency (%)	Incremental Removal (%)
0.02	10.2%	10.2%	0.01	0.01	96.5	9.8
0.04	9.6%	19.8%	0.03	0.03	95.8	9.2
0.06	9.4%	29.3%	0.04	0.04	95.1	9.0
0.08	7.7%	37.0%	0.06	0.06	94.3	7.3
0.10	8.6%	45.6%	0.07	0.07	93.6	8.0
0.12	6.3%	51.9%	0.09	0.09	92.9	5.9
0.14	4.7%	56.5%	0.10	0.10	92.2	4.3
0.16	4.6%	61.2%	0.12	0.12	91.5	4.2
0.18	3.5%	64.7%	0.13	0.13	90.8	3.2
0.20	4.3%	69.1%	0.15	0.15	90.0	3.9
0.25	8.0%	77.1%	0.18	0.18	88.2	7.1
0.30	5.6%	82.7%	0.22	0.22	86.4	4.8
0.35	4.4%	87.0%	0.26	0.26	84.6	3.7
0.40	2.5%	89.5%	0.30	0.30	82.9	2.1
0.45	2.5%	92.1%	0.33	0.33	81.1	2.0
0.50	1.4%	93.5%	0.37	0.37	79.3	1.1
0.75	5.0%	98.5%	0.55	0.55	70.3	3.5
1.00	1.0%	99.5%	0.74	0.74	61.3	0.6
1.50	0.0%	99.5%	1.11	1.11	43.4	0.0
2.00	0.0%	99.5%	1.48	1.40	29.1	0.0
3.00	0.5%	100.0%	2.21	1.40	29.1	0.1
						90.0
					Removal Efficiency Adjustment[2] =	6.5%
					Predicted % Annual Rainfall Treated =	93.4%
					Predicted Net Annual Load Removal Efficiency =	**83.5%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

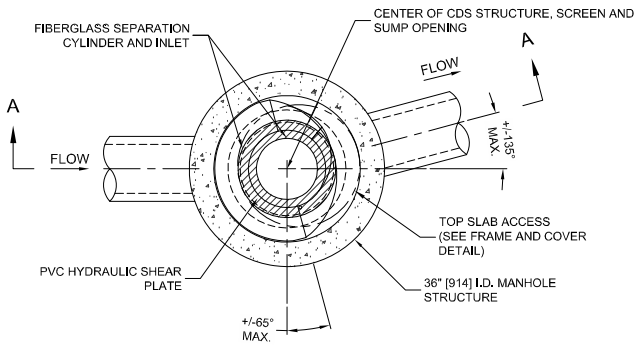
CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

PARKING IMPROVEMENT - HOPE CHURCH
NEWBURYPORT, MA

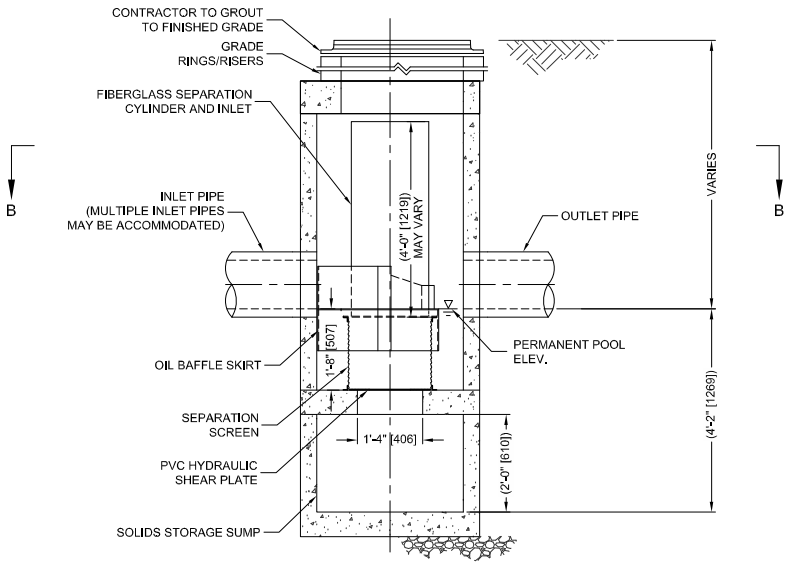
Area	0.29 ac	Unit Site Designation	WQ-2
Weighted C	0.9	Rainfall Station #	69
t_c	6 min		
CDS Model	1515-3	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Removal Efficiency (%)	Incremental Removal (%)
0.02	10.2%	10.2%	0.01	0.01	96.9	9.9
0.04	9.6%	19.8%	0.01	0.01	96.5	9.3
0.06	9.4%	29.3%	0.02	0.02	96.2	9.1
0.08	7.7%	37.0%	0.02	0.02	95.8	7.4
0.10	8.6%	45.6%	0.03	0.03	95.4	8.2
0.12	6.3%	51.9%	0.03	0.03	95.1	6.0
0.14	4.7%	56.5%	0.04	0.04	94.7	4.4
0.16	4.6%	61.2%	0.04	0.04	94.4	4.4
0.18	3.5%	64.7%	0.05	0.05	94.0	3.3
0.20	4.3%	69.1%	0.05	0.05	93.7	4.1
0.25	8.0%	77.1%	0.07	0.07	92.8	7.4
0.30	5.6%	82.7%	0.08	0.08	91.9	5.1
0.35	4.4%	87.0%	0.09	0.09	91.0	4.0
0.40	2.5%	89.5%	0.10	0.10	90.1	2.3
0.45	2.5%	92.1%	0.12	0.12	89.2	2.3
0.50	1.4%	93.5%	0.13	0.13	88.3	1.2
0.75	5.0%	98.5%	0.20	0.20	83.9	4.2
1.00	1.0%	99.5%	0.26	0.26	79.4	0.8
1.50	0.0%	99.5%	0.39	0.39	70.5	0.0
2.00	0.0%	99.5%	0.52	0.52	61.7	0.0
3.00	0.5%	100.0%	0.78	0.78	43.9	0.2
						93.6
					Removal Efficiency Adjustment[2] =	6.5%
					Predicted % Annual Rainfall Treated =	93.5%
					Predicted Net Annual Load Removal Efficiency =	**87.1%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.



PLAN VIEW B-B
N.T.S.

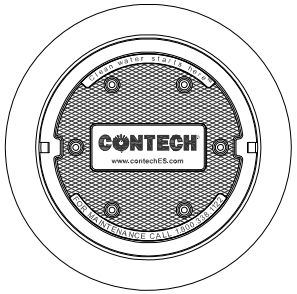


ELEVATION A-A
N.T.S.

CDS1515-3-C DESIGN NOTES

CDS1515-3-C RATED TREATMENT CAPACITY IS 1.0 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS1515-3-C CONFIGURATION IS SHOWN.



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS OR L/s)	*
PEAK FLOW RATE (CFS OR L/s)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*
SCREEN APERTURE (2400 OR 4700)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

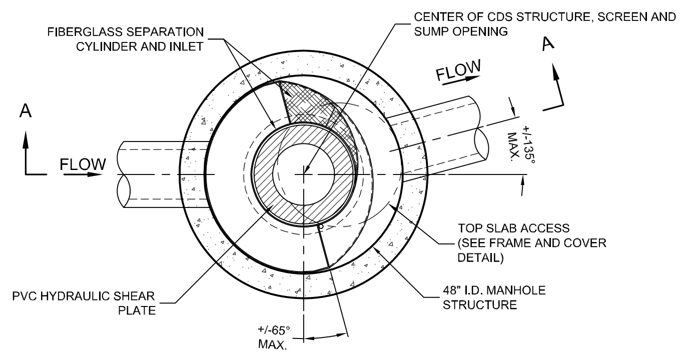
* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO..
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

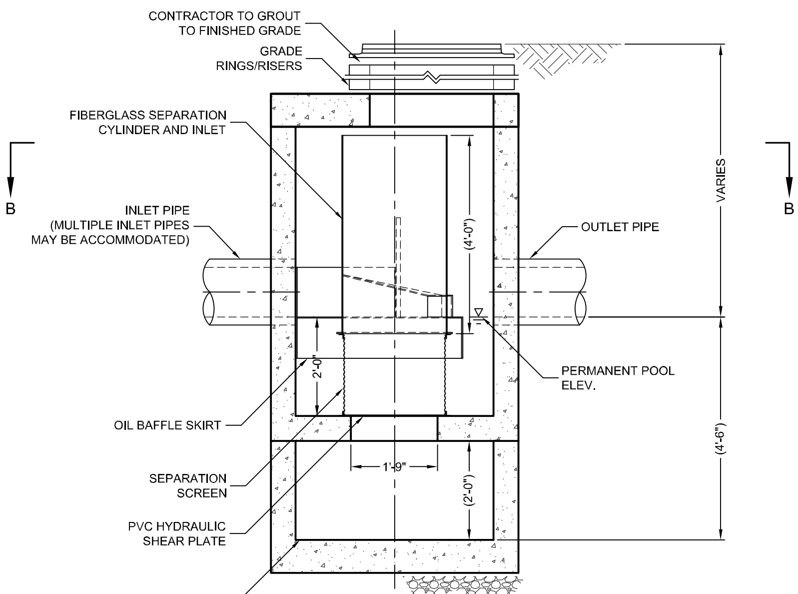
INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH ENGINEERED SOLUTIONS LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS1515-3-C
ONLINE CDS
STANDARD DETAIL



PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.

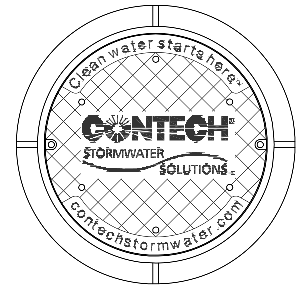
THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,788,848 6,641,720 6,511,595 6,581,783 RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

CDS2015-4-C DESIGN NOTES

CDS2015-4-C RATED TREATMENT CAPACITY IS 1.4 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS)			*
PEAK FLOW RATE (CFS)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST		WIDTH	HEIGHT
		*	*
NOTES/SPECIAL REQUIREMENTS:			

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH CONSTRUCTION PRODUCTS REPRESENTATIVE. www.contech-cpi.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
5. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH® CONSTRUCTION PRODUCTS INC.
www.contech-cpl.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS2015-4-C
CDS INLINE
STANDARD DETAIL

APPENDIX G

LONG TERM POLLUTION PREVENTION - STORMWATER OPERATION AND MAINTENANCE PLAN

Long Term Pollution Prevention

StormWater

Operation and Maintenance Plan

for

Parking Improvements

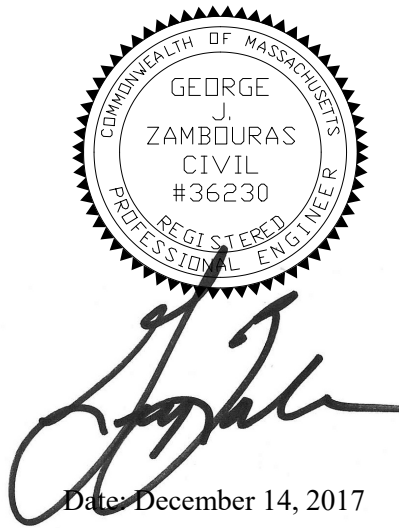
The Hope Community Church of Newburyport
located at

11 Hale Street

Newburyport, Massachusetts 01950

Prepared For

The Hope Community Church of Newburyport
11 Hale Street
Newburyport, MA 01950



Date: December 14, 2017

Atlantic Engineering & Survey Consultants Inc.
97 Tenney Street, Georgetown, Massachusetts 01833
(978) 352-7870

TABLE OF CONTENTS

Stormwater Pollution Prevention Plan

Site: 11 Hale Street
Newburyport, MA 01950

Owner: The Hope Community Church of Newburyport
11 Hale Street
Newburyport, MA 01950
Tel. No.
Email:

Operator - TBD
Name:
Tel. No.
Email:

Preparation Date:

December 14, 2017

Post Construction Operation and Maintenance Plan

POST CONSTRUCTION MAINTENANCE RESPONSIBILITIES

Long-term post construction operation, monitoring and maintenance of the drainage system BMP's will be the responsibility of The Hope Community Church of Newburyport. A copy of all maintenance inspections, cleanings and repairs should be maintained on site and made available to public officials upon request. The following is the recommended maintenance program for the installed devices.

GENERAL CONDITIONS

- A rain event shall be considered a major storm event when rainfall exceeds 2 inches in a 24 hour period.
- In the event the paved surfaces of site experiences a chemical release equal to or greater than five (5) gallons, the property owners shall immediately remediate the spill, and notify the Local Board of Health and Mass Department of Environmental Protection.

SITE AND DRAINAGE SYSTEM BMPs

SNOW MANAGEMENT

It is recommended winter snow operations are managed as follows:

- Snow storage shall be stored in areas and in a manor to prevent blockage of BMP's and to insure all snow run-off is directed to the stormwater management system's components.
- Snow storage shall be managed to prevent blockage of the stoned filter strips, drainage swales. Inlets and outfalls, catch basins, sedimentation and detention basins. Snow combined with sand and debris may block a storm drainage system, diminish the infiltration capacity of the system and causing localized flooding.
- Sand and debris deposited on the pavement parking areas shall be cleared from the site and properly disposed of at the end of the snow season, no later than May 15.

SITE SWEEPING

- All asphalt pavement areas shall be swept a minimum of two times per year to maintain design performance. All sweepings shall be removed and properly disposed.
- All paved areas shall be swept of winter sand as soon as possible in the spring and in early fall as needed.
- Recommended sweeping schedule:
  Apr/May
  Oct/Nov

DEEP SUMP CATCH BASIN

Inspections and Cleaning

- The catch basin grates should be inspected bi-annually and cleaned as necessary.

- The catch basin sump should be inspected early Spring and if there is less than two feet of clearance below the invert, the sump should be cleaned.
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

ROADWAY STONE FILTER STRIP

- The roadway stoned filter strip shall be inspected annually and after major storms for accumulation of debris and sediments.
- The top layer of stone shall be kept free of debris and yard waste; and removed as observed.
- Areas found to be clogged shall be removed and replaced to a depth necessary to assure proper functioning of the filter strip.

CULTEC CDS SEPARATOR

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants depends more heavily on site activities than the size of the unit. Unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspections

Pollutant transport and deposition may vary from year to year and regular inspections ensure that the system is cleaned at the appropriate time.

- At a minimum, inspections should be performed twice per year (e.g. spring and fall). More frequent inspections may be necessary when excessive winter sanding operations occur.
- The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen.
- The inspection should quantify the accumulation of hydrocarbons, trash, and sediment in the system.
- The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated.
- If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. When absorbent material is used, it should be replaced when significant discoloration has occurred.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system.

- The system should be completely drained down and the sump fully evacuated of sediment.
- The screen should be cleaned to ensure it is free of trash and debris.
- The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

- Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed with absorbent pads when an appreciable layer has been captured.
- In the event of a petroleum spills the system should be cleaned out immediately.
- Disposal of all material removed from the CDS system should be done in accordance with local regulations

SUB-SURFACE DETENTION UNITS

Subsurface detention basin is used to capture regulate storm water runoff. To maintain functionality, this system requires regular inspection and cleaning when necessary.

The systems entrance manhole and outlet control manhole should be inspected early Spring and cleaned of the accumulation of sediments or debris.

Inspections and Cleaning

- The subsurface infiltration systems will be inspected at least once each year, in the spring, by inspecting the access manhole or port during a rainstorm to determine if the systems operation is operating normally.
- If the system is not receiving runoff or does not drain after storms the system should be future evaluated and repaired or replaced as necessary.
- The control structure sump should be inspected early Spring and Fall and if there is less than two feet of clearance below the invert, the sump should be cleaned.
- Inspect and observe system following significant rainfalls to determine if it is operating properly.

RIP RAP DRAINAGE OUTFALLS, WEIRS AND CHECK DAMS

- Rip rap outfalls and check dams shall be inspected for stability and damage following major storm events. All damaged areas shall be repair as needed.

- The rip rap check dams and rip rap adjacent to and down-gradient of the outfall swale should be inspected annually. Disturbed rip rap should be restored to prevent erosion and insure stability of the channel and slopes.

DRAINAGE OUTFALL PIPE

- The rip rap adjacent to and down-gradient of the drainage systems outfall pipes should be inspected annually and after major storm events.
- Disturbed rip rap should be restored to prevent erosion and insure stability of the slope

DRAIANGE SWALE

- Drainage swales should be inspected on a semi-annual basis for soil stability, slope integrity, soil erosion, ponding and sedimentation. All damaged areas shall be repaired upon discovery.
- Sediments and debris shall be removed annually or more frequently if needed.

APPENDIX H

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NRCS SOILS RESOURCE REPORT

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 Essex County, Massachusetts, Northern Part

11 Hale Street - Newburyport, MA

August 1, 2017

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

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: 1:2,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

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 1:15,800.

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 12, Sep 14, 2016

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

Date(s) aerial images were photographed: Mar 30, 2011—Apr 8, 2011

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

Essex County, Massachusetts, Northern Part (MA605)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12A	Maybid silt loam, 0 to 3 percent slopes	4.7	45.6%
16A	Scantic silt loam, 0 to 3 percent slopes	5.4	52.0%
719B	Suffield silt loam, 3 to 8 percent slopes	0.2	2.4%
Totals for Area of Interest		**10.4**	**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.

Essex County, Massachusetts, Northern Part

12A—Maybid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vjhj
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

Maybid and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Maybid

Setting

Landform: Depressions, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft silty and clayey glaciolacustrine deposits and/or firm silty marine deposits

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 19 inches: silty clay
H3 - 19 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Scantic

Percent of map unit: 12 percent
Landform: Depressions
Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Bogs
Hydric soil rating: Yes

16A—Scantic silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vjrl
Elevation: 10 to 900 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

Scantic and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scantic

Setting

Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft fine-silty glaciolacustrine deposits and/or soft fine-silty glaciomarine deposits over hard fine-silty glaciolacustrine deposits and/or hard fine-silty glaciomarine deposits

Typical profile

H1 - 0 to 11 inches: silt loam
H2 - 11 to 26 inches: silty clay loam
H3 - 26 to 60 inches: clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Maybid
Percent of map unit: 10 percent
Landform: Depressions
Hydric soil rating: Yes

Buxton
Percent of map unit: 5 percent
Hydric soil rating: No

719B—Suffield silt loam, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: vjsr
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
Suffield and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Suffield

Setting
Landform: Lakebeds (relict), lakebeds (relict)
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Soft coarse-silty glaciolacustrine deposits over hard clayey glaciolacustrine deposits

Typical profile
H1 - 0 to 7 inches: silt loam
H2 - 7 to 35 inches: silt loam
H3 - 35 to 60 inches: silty clay

Properties and qualities
Slope: 3 to 8 percent
Depth to restrictive feature: 18 to 40 inches to strongly contrasting textural stratification
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Buxton

Percent of map unit: 10 percent
Hydric soil rating: No

Scantic

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes