

# WESLEYAN NEIGHBORHOOD PRESCHOOL PROPOSED BUILDING

## Drainage Memorandum

Prepared for:

Wesleyan University

170 Long Lane

Middletown, CT

141.15993.00022

July 2, 2021



## Drainage Memorandum

Wesleyan Neighborhood Preschool  
Proposed Building  
170 Long Lane  
Middletown, Connecticut  
July 2, 2021  
141.15993.00022

This Drainage Memorandum has been prepared in support of a proposed neighborhood preschool building to be built on the Wesleyan University campus. The entrance to the site will be off the northern access road to the Cady Building, which will be newly curbed. A drop-off loop and parking in front of the school building as well as a sidewalk that extends to Long Lane are proposed. The new preschool building will have outdoor play areas and a bicycle track.



**Figure 1 – Project Area, Current Aerial**



Figure 2 – 2008 Aerial



Figure 3 – 2004 Aerial

**Table 1 – Stormwater Data**

<b>Parcel Size Total</b>	3.1 acres
<b>Proposed Impervious Area (Development Area)</b>	0.54 acres
<b>Proposed Land Use</b>	Open space, playground, sidewalks, bituminous roadway, and building
<b>Design Storm for Stormwater Management</b>	First-flush runoff retention (CTDEEP WQV)
<b>Water Quality Measures</b>	2-foot-sump catch basin, riprap energy dissipator, and retention storage
<b>Design Storm for Storm Drainage</b>	100-year storm

**STORMWATER MANAGEMENT APPROACH**

The stormwater management system for this site has been designed utilizing Best Management Practices (BMPs) to provide water quality management. The design goal is to provide adequate storage for the calculated water quality volume (WQV) in accordance with Connecticut Department of Energy & Environmental Protection (CTDEEP) requirements, while providing appropriate measures to encourage infiltration of stormwater and to provide the removal of total suspended solids and other potential stormwater pollutants prior to discharge to the adjacent water resources. Peak-flow attenuation has not been provided as no increase in peak rates of runoff is expected since this site historically has had impervious coverage. Figures 2 and 3 show the historic aerials and the impervious coverage at those times. The existing impervious coverage in 2008 within the project watershed area is estimated at 20,700 square feet, while proposed coverage is estimated at 21,900 square feet. This minor difference is handled in the proposed water quality volume sizing of the proposed basins. Existing drainage patterns will be maintained to the maximum extent practicable, and a new stormwater treatment train proposes a catch basin with a 2-foot sump, a riprap energy dissipator, and WQV within the two vegetated bioretention basins. The ultimate discharge from the bioretention basins will be directed to an existing storm drainage system located east of the site.

The computer program entitled *Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2019* by Autodesk, Inc., Version 2018.3, was used for designing the proposed storm drainage collection system. Storm drainage computations performed include pipe capacity and hydraulic grade line computations. The contributing watershed to each bioretention basin and catch basin inlet was delineated to determine the drainage area and land coverage. These values were used to determine the stormwater runoff to each inlet using the Rational Method. The rainfall intensities for the site were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Precipitation Frequency Data Server (PFDS). The proposed storm drainage system is designed to provide adequate capacity to convey the 100-year storm event.

**WATER QUALITY MANAGEMENT**

Stormwater runoff from the proposed development will be directed to the two bioretention basins via overland flow through a curbless design of the proposed internal driveway. Runoff from the area south of the site and the existing access road will be collected by a subsurface pipe and catch basin drainage

system. The proposed drainage system will include a catch basin with a 2-foot sump to trap sediment and debris.

The proposed bioretention basins will filter sediment and other pollutants that may be present in the stormwater runoff from the proposed driveway and building areas prior to the stormwater flows reaching the existing storm drainage system east of the site. A 3-foot-wide stone edge will be set 2 inches below the finished pavement elevation upslope of the bioretention basin. This stone will reduce the velocity of runoff entering the bioretention basin from the paved area, therefore helping to prevent erosion.

Each bioretention basin will provide retention volume along its bottom, thus creating a water quality feature within it. This serves several purposes, including stormwater renovation and first-flush retention. The vegetation will provide pollutant removal by filtering stormwater runoff and utilizing excess nutrients that may be present in the stormwater. The *CTDEEP 2004 Stormwater Quality Manual* (Chapter 7) recommends methods for sizing stormwater treatment measures with WQV computations. The WQV addresses the initial stormwater runoff, also commonly referred to as the "first-flush" runoff. The WQV provides adequate volume to store the runoff associated with the first 1 inch of rainfall, which tends to contain the highest concentration of potential pollutants. The bioretention soil will serve as a filter for the water quality volume and ongoing filtration throughout the storm event. The bioretention basins will have adequate storage below the proposed overflows to provide the required WQV from the contributing watershed. Supporting calculations have been included in the Appendix of this report.

## **CONCLUSION**

The focus of the water quality measures was to remove suspended solids and other potential pollutants as well as protect against excessive erosion during and after construction. The stormwater management design meets the recommendations set forth in the *CTDEEP Stormwater Quality Manual* following the approach outlined above. The proposed development will introduce a new stormwater treatment train consisting of several water quality measures such as a catch basin with a 2-foot sump, a riprap energy dissipator, and WQV within the proposed bioretention basins.

All supporting documentation and stormwater-related computations are attached to this report along *Hydraflow Storm Sewers* model results for the proposed storm drainage system. Illustrative watershed maps for proposed conditions are also attached to this report.

## **Attachments**

- Attachment A – Water Quality Computations
- Attachment B – Storm Drainage Computations
- Attachment C – Soil Testing Data

## ATTACHMENT A

## WATER QUALITY COMPUTATIONS

### **Drainage Memorandum**

Wesleyan Neighborhood Preschool

Proposed Building

170 Long Lane

Middletown, Connecticut

July 2, 2021

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**STORMWATER QUALITY CALCULATIONS**  
**Water Quality Volume (WQV)**

<b>Basin ID</b>	<b>Total Area (ac.)</b>	<b>Impervious Area (ac.)*</b>	<b>Percent Impervious</b>	<b>Volumetric Runoff Coeff., R</b>	<b>WQV (ac-ft)</b>	<b>Total Volume Required (ac-ft)</b>	<b>Total Volume Provided (ac-ft)</b>
BIO 1	0.60	0.23	38%	0.40	0.020	0.020	<b>0.025</b>
BIO 2	0.94	0.31	33%	0.35	0.027	0.027	<b>0.029</b>

$$WQV = \frac{(1.0 \text{ inches}) \times A \times R}{12}$$

Where:

- WQV = Water Quality Volume in acre-feet
- A = Contributing Area in acres
- R =  $0.05 + 0.009 ( I )$
- I = Site Imperviousness as percent

**STORMWATER QUALITY CALCULATIONS**  
**Water Quality Volume (WQV)**

**Bioretention Basin 1**

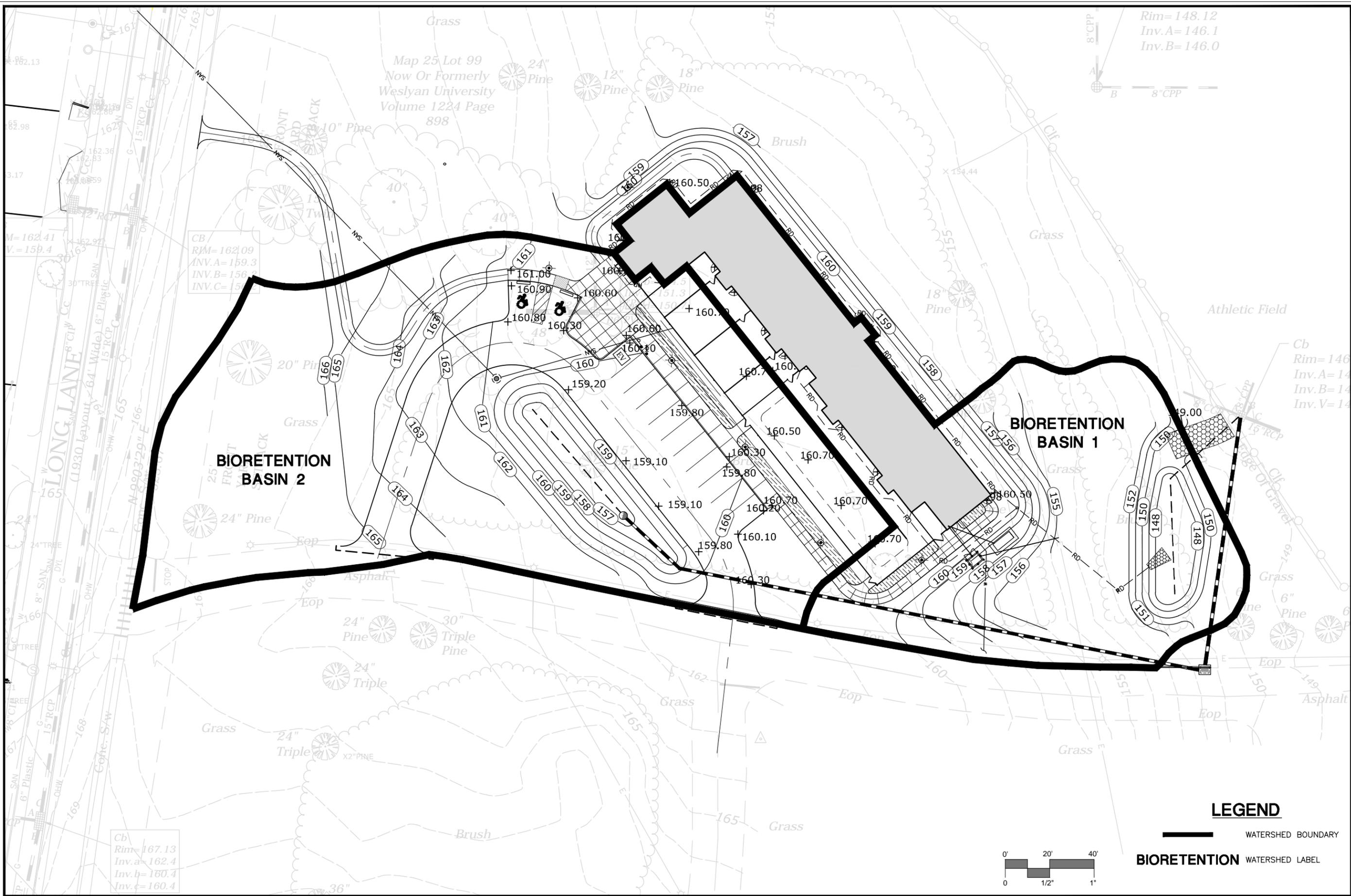
<b>Elevation (ft)</b>	<b>Surface Area (ft<sup>2</sup>)</b>	<b>Volume (ft<sup>3</sup>)</b>	<b>Volume (ac-ft)</b>	<b>Cumulative Volume (ac-ft)</b>
148.0	867	0.0	0.000	0.000
149.0	1,294	1,080.5	0.025	0.025

**Bioretention Basin 2**

<b>Elevation (ft)</b>	<b>Surface Area (ft<sup>2</sup>)</b>	<b>Volume (ft<sup>3</sup>)</b>	<b>Volume (ac-ft)</b>	<b>Cumulative Volume (ac-ft)</b>
157.0	689	0.0	0.000	0.000
158.0	1,544	1,116.5	0.026	0.026
158.1	1,637	159.0	0.004	0.029

Drawing: W:\CAD\DESIGN\15993.00022-DC-CAD\WU-HYDRO01.DWG Layout: 10-PRWS

Plotted by: MBERARDI On this date: Thu, 2023 July 1 - 14:47pm



Rim= 148.12  
 Inv. A= 146.1  
 Inv. B= 146.0

CB  
 R/M= 162.09  
 INV. A= 159.3  
 INV. B= 158.0  
 INV. C= 157.0

Cb  
 Rim= 167.13  
 Inv. a= 162.4  
 Inv. b= 160.4  
 Inv. c= 160.4



REVISIONS

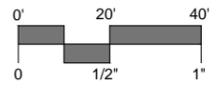
WATERSHED AREAS TO BIORETENTION BASINS  
 WESLEYAN NEIGHBORHOOD PRESCHOOL  
 PROPOSED BUILDING  
 170 LONG LANE  
 MIDDLETOWN, CONNECTICUT

FAB DESIGNED	MCB DRAWN	FAB CHECKED
SCALE 1"=40'		
DATE JULY 1, 2021		
PROJECT NO. 15993.00022		

PRWS

**LEGEND**

WATERSHED BOUNDARY  
 BIORETENTION WATERSHED LABEL



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## ATTACHMENT B

## STORM DRAINAGE COMPUTATIONS

### **Drainage Memorandum**

Wesleyan Neighborhood Preschool

Proposed Building

170 Long Lane

Middletown, Connecticut

July 2, 2021

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## Rational Method Individual Basin Calculations

Project: Wesleyan Preschool - Proposed Building  
 Location: Middletown, Connecticut

By: MCB Date: 7/1/21  
 Checked: \_\_\_\_\_ Date: \_\_\_\_\_

Basin Name	Impervious Area C=0.90 (sf)	Grassed Area C=0.3 (sf)	Wooded Area C=0.2 (sf)	Total Area (sf)	Total Area (ac)	Weighted C	Tc to Inlet (min)
Bioretention 2	13,611	27,219	0	40,830	0.94	0.50	13.0
CCB 1	12,427	42,158	39,691	94,276	2.16	0.34	23.0
Bioretention 1	9,825	16,430	0	26,255	0.60	0.52	10.0





**NOAA Atlas 14, Volume 10, Version 3**  
**Location name: Middletown, Connecticut, USA\***  
**Latitude: 41.5479°, Longitude: -72.6645°**  
**Elevation: 179.1 ft\*\***  
 \* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

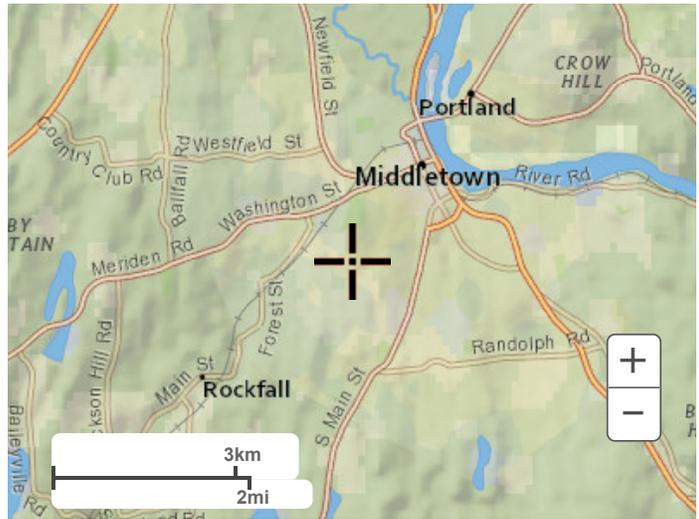
**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	3.95 (3.10-4.90)	4.81 (3.77-5.98)	6.24 (4.87-7.76)	7.42 (5.75-9.29)	9.05 (6.78-11.8)	10.3 (7.55-13.7)	11.5 (8.22-16.0)	13.0 (8.75-18.4)	15.0 (9.72-22.1)	16.7 (10.5-25.0)
10-min	2.80 (2.19-3.47)	3.41 (2.67-4.24)	4.42 (3.45-5.50)	5.26 (4.07-6.59)	6.41 (4.80-8.39)	7.27 (5.34-9.73)	8.18 (5.83-11.4)	9.19 (6.20-13.1)	10.6 (6.89-15.6)	11.8 (7.46-17.7)
15-min	2.19 (1.72-2.72)	2.68 (2.10-3.32)	3.47 (2.70-4.32)	4.12 (3.20-5.17)	5.02 (3.77-6.58)	5.70 (4.19-7.63)	6.42 (4.57-8.90)	7.21 (4.86-10.2)	8.34 (5.40-12.3)	9.25 (5.86-13.9)
30-min	1.50 (1.18-1.87)	1.83 (1.43-2.27)	2.36 (1.84-2.93)	2.80 (2.17-3.50)	3.40 (2.55-4.45)	3.86 (2.83-5.16)	4.33 (3.09-6.02)	4.86 (3.28-6.92)	5.63 (3.65-8.28)	6.25 (3.95-9.39)
60-min	0.956 (0.749-1.19)	1.16 (0.907-1.44)	1.49 (1.16-1.86)	1.77 (1.37-2.21)	2.15 (1.61-2.81)	2.43 (1.79-3.25)	2.73 (1.95-3.79)	3.06 (2.07-4.35)	3.54 (2.30-5.22)	3.93 (2.49-5.91)
2-hr	0.634 (0.502-0.780)	0.760 (0.601-0.937)	0.968 (0.762-1.20)	1.14 (0.892-1.42)	1.38 (1.04-1.79)	1.55 (1.15-2.07)	1.74 (1.26-2.42)	1.96 (1.33-2.77)	2.30 (1.50-3.36)	2.58 (1.64-3.85)
3-hr	0.492 (0.392-0.603)	0.589 (0.468-0.722)	0.747 (0.591-0.919)	0.878 (0.691-1.09)	1.06 (0.807-1.38)	1.19 (0.891-1.59)	1.34 (0.971-1.86)	1.51 (1.03-2.13)	1.78 (1.16-2.59)	2.00 (1.27-2.98)
6-hr	0.313 (0.252-0.381)	0.375 (0.301-0.457)	0.477 (0.381-0.582)	0.561 (0.446-0.689)	0.677 (0.521-0.873)	0.763 (0.574-1.01)	0.856 (0.626-1.18)	0.969 (0.661-1.35)	1.14 (0.748-1.65)	1.29 (0.825-1.91)
12-hr	0.191 (0.155-0.231)	0.231 (0.187-0.279)	0.296 (0.239-0.359)	0.350 (0.281-0.427)	0.425 (0.329-0.544)	0.480 (0.364-0.630)	0.540 (0.397-0.739)	0.612 (0.420-0.849)	0.723 (0.475-1.04)	0.818 (0.523-1.20)
24-hr	0.113 (0.092-0.135)	0.138 (0.113-0.166)	0.180 (0.147-0.217)	0.215 (0.174-0.260)	0.263 (0.206-0.335)	0.298 (0.228-0.389)	0.336 (0.250-0.459)	0.384 (0.265-0.529)	0.458 (0.302-0.653)	0.522 (0.335-0.759)
2-day	0.064 (0.053-0.076)	0.080 (0.066-0.095)	0.106 (0.087-0.126)	0.127 (0.104-0.153)	0.157 (0.124-0.199)	0.178 (0.138-0.233)	0.203 (0.153-0.277)	0.234 (0.162-0.319)	0.283 (0.187-0.401)	0.327 (0.211-0.472)
3-day	0.046 (0.039-0.055)	0.058 (0.048-0.069)	0.077 (0.064-0.092)	0.093 (0.077-0.111)	0.115 (0.091-0.145)	0.131 (0.102-0.170)	0.149 (0.113-0.203)	0.172 (0.119-0.234)	0.209 (0.139-0.295)	0.243 (0.156-0.349)
4-day	0.037 (0.031-0.044)	0.047 (0.039-0.055)	0.062 (0.052-0.073)	0.075 (0.062-0.089)	0.092 (0.074-0.116)	0.105 (0.082-0.136)	0.119 (0.090-0.162)	0.138 (0.096-0.187)	0.168 (0.111-0.235)	0.194 (0.125-0.278)
7-day	0.025 (0.021-0.030)	0.031 (0.026-0.037)	0.041 (0.034-0.048)	0.049 (0.041-0.058)	0.060 (0.048-0.075)	0.069 (0.054-0.088)	0.078 (0.059-0.104)	0.089 (0.062-0.120)	0.108 (0.072-0.150)	0.124 (0.080-0.176)
10-day	0.021 (0.017-0.024)	0.025 (0.021-0.029)	0.032 (0.027-0.038)	0.038 (0.032-0.045)	0.046 (0.037-0.058)	0.053 (0.041-0.067)	0.059 (0.045-0.079)	0.068 (0.047-0.091)	0.081 (0.054-0.112)	0.092 (0.060-0.130)
20-day	0.015 (0.013-0.017)	0.017 (0.015-0.020)	0.021 (0.018-0.024)	0.024 (0.021-0.028)	0.029 (0.023-0.035)	0.032 (0.025-0.040)	0.035 (0.027-0.046)	0.039 (0.028-0.052)	0.045 (0.030-0.063)	0.050 (0.033-0.071)
30-day	0.012 (0.011-0.014)	0.014 (0.012-0.016)	0.017 (0.014-0.019)	0.019 (0.016-0.022)	0.022 (0.018-0.027)	0.024 (0.019-0.030)	0.027 (0.020-0.034)	0.029 (0.021-0.038)	0.033 (0.022-0.045)	0.035 (0.023-0.050)
45-day	0.010 (0.009-0.012)	0.012 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.020)	0.019 (0.015-0.023)	0.020 (0.015-0.025)	0.022 (0.015-0.029)	0.024 (0.016-0.032)	0.025 (0.017-0.035)
60-day	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.010-0.013)	0.013 (0.011-0.014)	0.014 (0.012-0.017)	0.015 (0.012-0.019)	0.017 (0.013-0.021)	0.018 (0.013-0.023)	0.019 (0.013-0.026)	0.020 (0.013-0.028)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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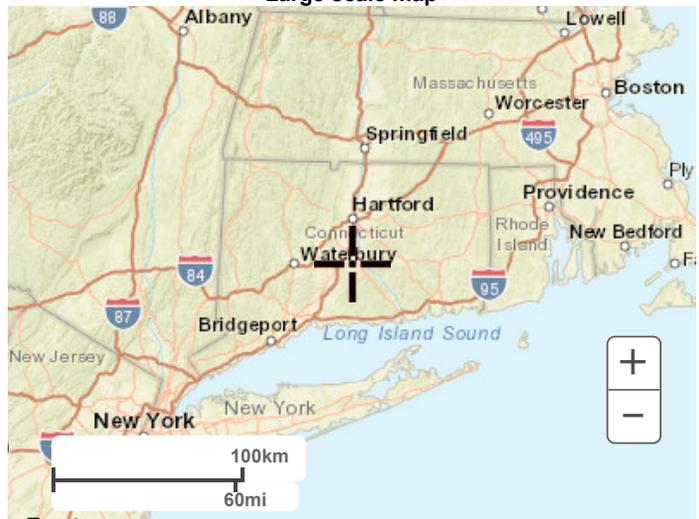
**PF graphical**



Large scale terrain



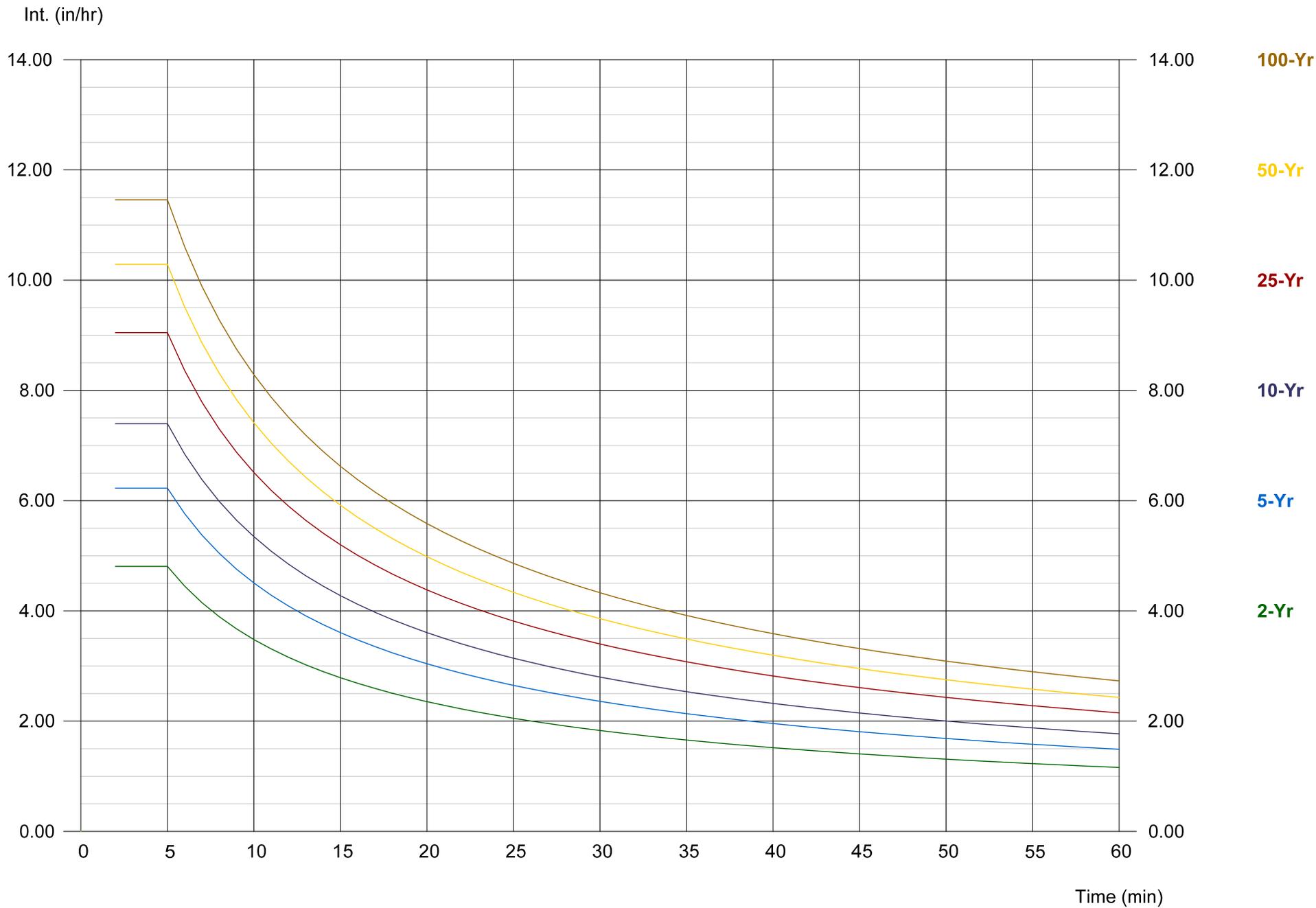
Large scale map



Large scale aerial

# Storm Sewer IDF Curves

IDF file: Middletown IDF.IDF



## Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ ) Worksheet

Project: Wesleyan Preschool By: MCB Date: 07/01/21  
 Location: Middletown, CT Checked: \_\_\_\_\_ Date: \_\_\_\_\_  
 Circle one: Present Developed Watershed: Bioretention Basin 1  
 Circle one:  $T_c$   $T_t$  Subwatershed: \_\_\_\_\_

### Sheet flow (applicable to $T_c$ only)

1. Surface description (Table 3-1)	Segment ID	<b>A-B</b>	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		GRASS	
3. Flow Length, L (< 300ft)	ft.	0.240	
4. Two-year 24-hr rainfall, $P_2$	in.	100	
5. Land slope, s	ft./ft.	3.32	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.055	
		0.156	= 0.156

### Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description	Segment ID	<b>B-C</b>			
8. Manning's roughness coeff., n		GRASS			
9. Paved or unpaved		0.080			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.	ft.	UNPVD			
11. Flow Length, L	ft.	0.40			
12. Watercourse slope, s	ft./ft.	46			
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3}) (s^{1/2})$	fps.	0.120			
14. $T_t = \frac{L}{3600 * V}$	hr.	3.50			
		0.004	+		+
					+
					= 0.004

### Channel flow

15. Channel Bottom width, b	Segment ID				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. <sup>2</sup>				
19. Wetted perimeter, $P_w$	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3}) (s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.				
26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25)	hr.		+		= 0.000
					0.159



## Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ ) Worksheet

Project: Wesleyan Preschool By: MCB Date: 07/01/21  
 Location: Middletown, CT Checked: \_\_\_\_\_ Date: \_\_\_\_\_  
 Circle one: Present Developed Watershed: Bioretention Basin 2  
 Circle one:  $T_c$   $T_t$  Subwatershed: \_\_\_\_\_

### Sheet flow (applicable to $T_c$ only)

	Segment ID	<b>A-B</b>
1. Surface description (Table 3-1)		GRASS
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240
3. Flow Length, L (< 300ft)	ft.	100
4. Two-year 24-hr rainfall, $P_2$	in.	3.32
5. Land slope, s	ft./ft.	0.025
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.214 = 0.214

### Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	<b>B-C</b>	<b>C-D</b>	<b>D-E</b>	
7. Surface description		GRASS	BIT	GRASS	
8. Manning's roughness coeff., n		0.080	0.015	0.080	
9. Paved or unpaved		UNPVD	PVD	UNPVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved)	ft.	0.40	0.20	0.40	
11. Flow Length, L	ft.	15	37	23	
12. Watercourse slope, s	ft./ft.	0.050	0.047	0.130	
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3}) (s^{1/2})$	fps.	2.26	7.36	3.65	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.002	+ 0.001	+ 0.002	+ = 0.005

### Channel flow

	Segment ID				
15. Channel Bottom width, b	ft.				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. <sup>2</sup>				
19. Wetted perimeter, $P_w$	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3}) (s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.				+ = 0.000
26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25)	hr.				0.219

## Time of Concentration ( $T_c$ ) or Travel Time ( $T_t$ ) Worksheet

Project: Wesleyan Preschool By: MCB Date: 07/01/21  
 Location: Middletown, CT Checked: \_\_\_\_\_ Date: \_\_\_\_\_  
 Circle one: Present Developed Watershed: CCB 1  
 Circle one:  $T_c$   $T_t$  Subwatershed: \_\_\_\_\_

### Sheet flow (applicable to $T_c$ only)

1. Surface description (Table 3-1)	Segment ID	<b>A-B</b>	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		GRASS	
3. Flow Length, L (< 300ft)	ft.	0.240	
4. Two-year 24-hr rainfall, $P_2$	in.	100	
5. Land slope, s	ft./ft.	3.32	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.014	
		0.269	= 0.269

### Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description	Segment ID	<b>B-C</b>	<b>C-D</b>	<b>D-E</b>	<b>E-F</b>	
8. Manning's roughness coeff., n		GRASS	WOODS	GRASS	BIT	
9. Paved or unpaved		0.080	0.100	0.080	0.015	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		UNPVD	UNPVD	UNPVD	PVD	
11. Flow Length, L	ft.	0.40	0.40	0.40	0.20	
12. Watercourse slope, s	ft./ft.	67	390	23	294	
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3}) (s^{1/2})$	fps.	0.007	0.029	0.065	0.037	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.85	1.38	2.58	6.53	
		0.022	0.079	0.002	0.012	= 0.116

### Channel flow

15. Channel Bottom width, b	Segment ID					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapazoidal)	ft. <sup>2</sup>					
19. Wetted perimeter, $P_w$	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n} (R^{2/3}) (s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.					
26. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 14 & 25)	hr.					= 0.000
						0.385





**NOAA Atlas 14, Volume 10, Version 3**  
**Location name: Middletown, Connecticut, USA\***  
**Latitude: 41.5479°, Longitude: -72.6645°**  
**Elevation: 179.1 ft\*\***  
\* source: ESRI Maps  
\*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

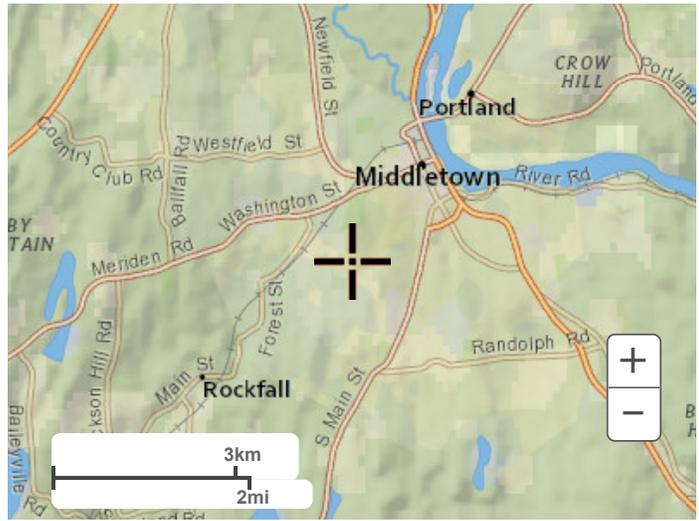
**PF tabular**

<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
<b>5-min</b>	<b>0.329</b> (0.258-0.408)	<b>0.401</b> (0.314-0.498)	<b>0.520</b> (0.406-0.647)	<b>0.618</b> (0.479-0.774)	<b>0.754</b> (0.565-0.987)	<b>0.856</b> (0.629-1.15)	<b>0.962</b> (0.685-1.34)	<b>1.08</b> (0.729-1.54)	<b>1.25</b> (0.810-1.84)	<b>1.39</b> (0.878-2.09)
<b>10-min</b>	<b>0.466</b> (0.365-0.578)	<b>0.569</b> (0.445-0.706)	<b>0.737</b> (0.575-0.917)	<b>0.876</b> (0.679-1.10)	<b>1.07</b> (0.800-1.40)	<b>1.21</b> (0.890-1.62)	<b>1.36</b> (0.971-1.89)	<b>1.53</b> (1.03-2.18)	<b>1.77</b> (1.15-2.61)	<b>1.97</b> (1.24-2.96)
<b>15-min</b>	<b>0.548</b> (0.430-0.680)	<b>0.669</b> (0.524-0.830)	<b>0.867</b> (0.676-1.08)	<b>1.03</b> (0.799-1.29)	<b>1.26</b> (0.942-1.65)	<b>1.43</b> (1.05-1.91)	<b>1.60</b> (1.14-2.23)	<b>1.80</b> (1.22-2.56)	<b>2.08</b> (1.35-3.07)	<b>2.31</b> (1.46-3.48)
<b>30-min</b>	<b>0.752</b> (0.590-0.933)	<b>0.914</b> (0.716-1.14)	<b>1.18</b> (0.919-1.47)	<b>1.40</b> (1.08-1.75)	<b>1.70</b> (1.27-2.23)	<b>1.93</b> (1.42-2.58)	<b>2.17</b> (1.54-3.01)	<b>2.43</b> (1.64-3.46)	<b>2.81</b> (1.82-4.14)	<b>3.12</b> (1.98-4.69)
<b>60-min</b>	<b>0.956</b> (0.749-1.19)	<b>1.16</b> (0.907-1.44)	<b>1.49</b> (1.16-1.86)	<b>1.77</b> (1.37-2.21)	<b>2.15</b> (1.61-2.81)	<b>2.43</b> (1.79-3.25)	<b>2.73</b> (1.95-3.79)	<b>3.06</b> (2.07-4.35)	<b>3.54</b> (2.30-5.22)	<b>3.93</b> (2.49-5.91)
<b>2-hr</b>	<b>1.27</b> (1.00-1.56)	<b>1.52</b> (1.20-1.87)	<b>1.94</b> (1.52-2.39)	<b>2.28</b> (1.78-2.83)	<b>2.75</b> (2.09-3.59)	<b>3.11</b> (2.31-4.14)	<b>3.48</b> (2.51-4.84)	<b>3.93</b> (2.66-5.55)	<b>4.60</b> (2.99-6.72)	<b>5.16</b> (3.28-7.70)
<b>3-hr</b>	<b>1.48</b> (1.18-1.81)	<b>1.77</b> (1.41-2.17)	<b>2.24</b> (1.78-2.76)	<b>2.64</b> (2.08-3.26)	<b>3.18</b> (2.42-4.13)	<b>3.58</b> (2.68-4.76)	<b>4.01</b> (2.92-5.57)	<b>4.54</b> (3.08-6.38)	<b>5.34</b> (3.48-7.77)	<b>6.02</b> (3.83-8.94)
<b>6-hr</b>	<b>1.88</b> (1.51-2.28)	<b>2.25</b> (1.80-2.73)	<b>2.86</b> (2.28-3.49)	<b>3.36</b> (2.67-4.13)	<b>4.05</b> (3.12-5.23)	<b>4.57</b> (3.44-6.04)	<b>5.12</b> (3.75-7.07)	<b>5.80</b> (3.96-8.10)	<b>6.85</b> (4.48-9.90)	<b>7.75</b> (4.94-11.4)
<b>12-hr</b>	<b>2.30</b> (1.87-2.78)	<b>2.78</b> (2.26-3.36)	<b>3.57</b> (2.88-4.32)	<b>4.22</b> (3.39-5.14)	<b>5.12</b> (3.97-6.56)	<b>5.78</b> (4.39-7.59)	<b>6.50</b> (4.79-8.90)	<b>7.38</b> (5.06-10.2)	<b>8.71</b> (5.72-12.5)	<b>9.86</b> (6.31-14.4)
<b>24-hr</b>	<b>2.71</b> (2.22-3.24)	<b>3.32</b> (2.72-3.98)	<b>4.32</b> (3.53-5.20)	<b>5.16</b> (4.18-6.24)	<b>6.30</b> (4.93-8.03)	<b>7.15</b> (5.47-9.33)	<b>8.07</b> (6.00-11.0)	<b>9.22</b> (6.35-12.7)	<b>11.0</b> (7.24-15.7)	<b>12.5</b> (8.04-18.2)
<b>2-day</b>	<b>3.07</b> (2.54-3.64)	<b>3.83</b> (3.17-4.55)	<b>5.08</b> (4.18-6.05)	<b>6.11</b> (5.00-7.33)	<b>7.53</b> (5.96-9.55)	<b>8.57</b> (6.64-11.2)	<b>9.72</b> (7.33-13.3)	<b>11.2</b> (7.75-15.3)	<b>13.6</b> (8.99-19.3)	<b>15.7</b> (10.1-22.7)
<b>3-day</b>	<b>3.34</b> (2.78-3.95)	<b>4.18</b> (3.48-4.95)	<b>5.56</b> (4.61-6.60)	<b>6.70</b> (5.51-8.00)	<b>8.28</b> (6.58-10.5)	<b>9.42</b> (7.33-12.2)	<b>10.7</b> (8.11-14.6)	<b>12.4</b> (8.57-16.8)	<b>15.1</b> (9.98-21.2)	<b>17.5</b> (11.3-25.1)
<b>4-day</b>	<b>3.59</b> (3.00-4.22)	<b>4.49</b> (3.75-5.29)	<b>5.95</b> (4.95-7.04)	<b>7.17</b> (5.92-8.53)	<b>8.84</b> (7.06-11.1)	<b>10.1</b> (7.86-13.0)	<b>11.4</b> (8.68-15.5)	<b>13.2</b> (9.17-17.9)	<b>16.1</b> (10.7-22.6)	<b>18.6</b> (12.0-26.7)
<b>7-day</b>	<b>4.26</b> (3.60-4.99)	<b>5.27</b> (4.44-6.17)	<b>6.91</b> (5.79-8.12)	<b>8.27</b> (6.88-9.78)	<b>10.1</b> (8.14-12.7)	<b>11.5</b> (9.03-14.8)	<b>13.0</b> (9.92-17.5)	<b>15.0</b> (10.5-20.2)	<b>18.1</b> (12.0-25.3)	<b>20.8</b> (13.5-29.6)
<b>10-day</b>	<b>4.95</b> (4.20-5.77)	<b>6.01</b> (5.09-7.01)	<b>7.74</b> (6.53-9.06)	<b>9.18</b> (7.68-10.8)	<b>11.2</b> (8.99-13.8)	<b>12.6</b> (9.92-16.1)	<b>14.2</b> (10.8-18.9)	<b>16.2</b> (11.4-21.8)	<b>19.3</b> (12.9-26.9)	<b>22.1</b> (14.3-31.3)
<b>20-day</b>	<b>7.12</b> (6.10-8.23)	<b>8.25</b> (7.06-9.55)	<b>10.1</b> (8.61-11.7)	<b>11.6</b> (9.85-13.6)	<b>13.8</b> (11.1-16.8)	<b>15.3</b> (12.1-19.2)	<b>17.0</b> (12.9-22.1)	<b>19.0</b> (13.4-25.2)	<b>21.8</b> (14.6-30.0)	<b>24.2</b> (15.7-34.0)
<b>30-day</b>	<b>8.95</b> (7.72-10.3)	<b>10.1</b> (8.71-11.7)	<b>12.0</b> (10.3-13.9)	<b>13.6</b> (11.6-15.8)	<b>15.8</b> (12.8-19.1)	<b>17.4</b> (13.8-21.6)	<b>19.1</b> (14.5-24.5)	<b>21.0</b> (14.9-27.7)	<b>23.5</b> (15.9-32.2)	<b>25.6</b> (16.6-35.8)
<b>45-day</b>	<b>11.2</b> (9.74-12.8)	<b>12.4</b> (10.8-14.2)	<b>14.4</b> (12.4-16.6)	<b>16.0</b> (13.7-18.6)	<b>18.3</b> (14.9-21.9)	<b>20.0</b> (15.9-24.5)	<b>21.8</b> (16.4-27.5)	<b>23.5</b> (16.7-30.8)	<b>25.7</b> (17.4-35.1)	<b>27.4</b> (17.9-38.2)
<b>60-day</b>	<b>13.1</b> (11.4-15.0)	<b>14.4</b> (12.5-16.4)	<b>16.4</b> (14.2-18.8)	<b>18.1</b> (15.5-20.8)	<b>20.4</b> (16.7-24.3)	<b>22.2</b> (17.6-27.0)	<b>24.0</b> (18.1-30.1)	<b>25.6</b> (18.3-33.5)	<b>27.7</b> (18.8-37.6)	<b>29.1</b> (19.0-40.5)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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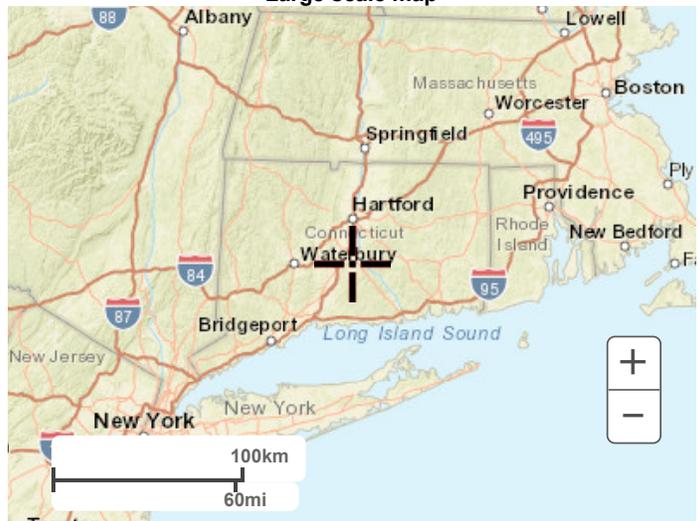
**PF graphical**



Large scale terrain

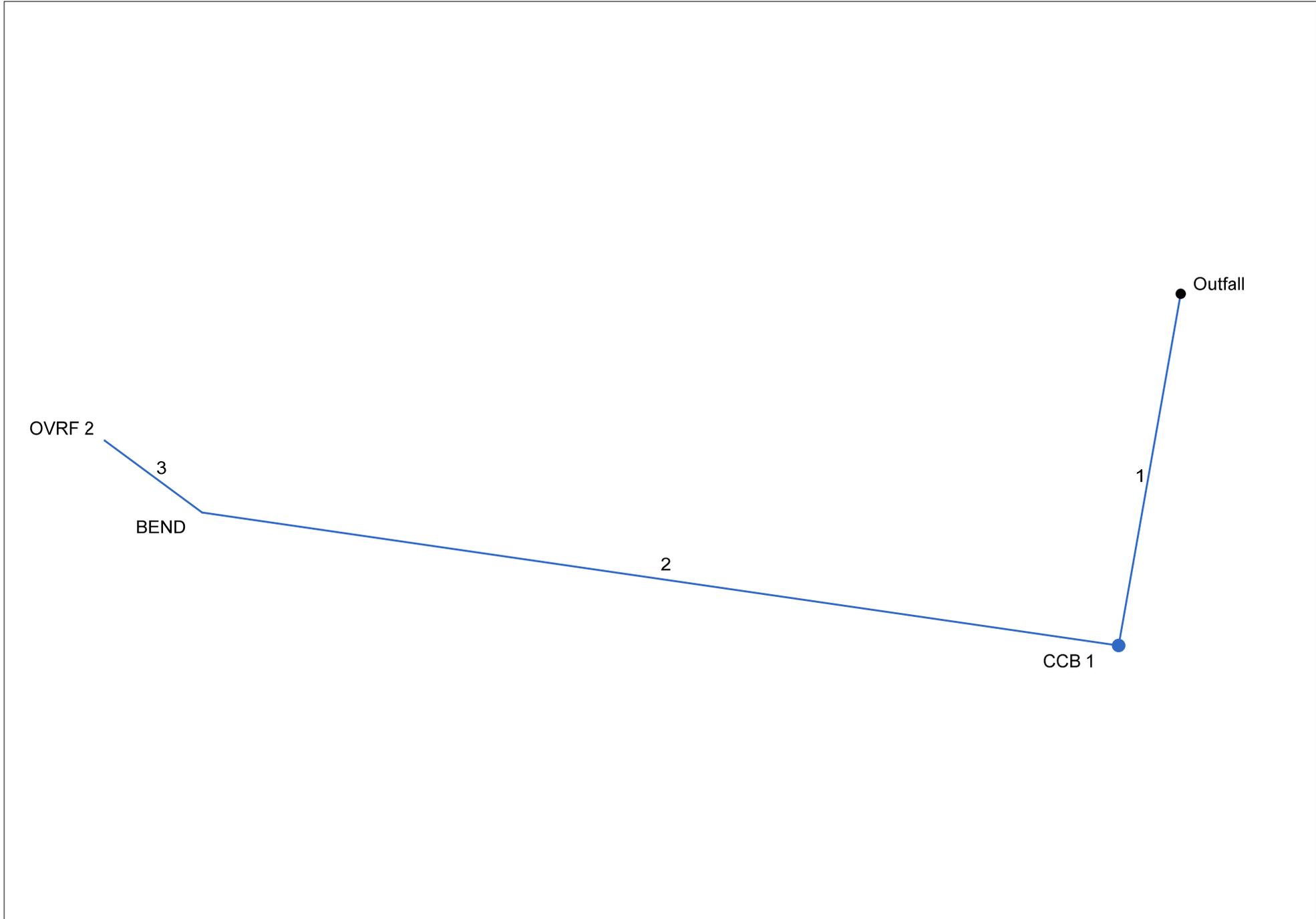


Large scale map



Large scale aerial

# Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: STORM.stm

Number of lines: 3

Date: 7/1/2021

# Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data							Line ID	
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)		Inlet/ Rim El (ft)
1	End	113.000	98.138	Comb	0.00	2.16	0.34	23.0	144.80	1.95	147.00	15	Cir	0.012	1.50	151.50	EXCB - CCB 1
2	1	240.000	92.014	None	0.00	0.00	0.00	0.0	147.50	2.37	153.20	12	Cir	0.012	0.59	159.00	CCB 1 - BEND
3	2	34.000	32.132	None	3.35	0.00	0.00	0.0	153.20	2.35	154.00	12	Cir	0.012	1.00	158.10	BEND - OVFW 2

Project File: STORM.stm

Number of lines: 3

Date: 7/1/2021

# Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	113.000	2.16	2.16	0.34	0.73	0.73	23.0	23.0	5.1	7.11	9.76	6.09	15	1.95	144.80	147.00	146.05	148.07	146.91	151.50	EXCB - CCB 1
2	1	240.000	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	3.35	5.95	6.19	12	2.37	147.50	153.20	148.07	153.98	151.50	159.00	CCB 1 - BEND
3	2	34.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	3.35	5.92	5.08	12	2.35	153.20	154.00	153.98	154.78	159.00	158.10	BEND - OVFW 2

Project File: STORM.stm

Number of lines: 3

Run Date: 7/1/2021

NOTES: Intensity =  $56.23 / (\text{Inlet time} + 3.90)^{0.73}$ ; Return period = Yrs. 100 ; c = cir e = ellip b = box

# Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	15	7.11	144.80	146.05	1.25	1.12	5.80	0.52	146.57	1.034	113.000	147.00	148.07 j	1.07**	1.12	6.38	0.63	148.70	0.969	1.001	n/a	1.50	0.95
2	12	3.35	147.50	148.07	0.57	0.46	7.30	0.40	148.47	0.000	240.000	153.20	153.98	0.78**	0.66	5.08	0.40	154.38	0.000	0.000	n/a	0.59	n/a
3	12	3.35	153.20	153.98	0.78*	0.66	5.08	0.40	154.38	0.000	34.000	154.00	154.78	0.78**	0.66	5.08	0.40	155.18	0.000	0.000	n/a	1.00	n/a

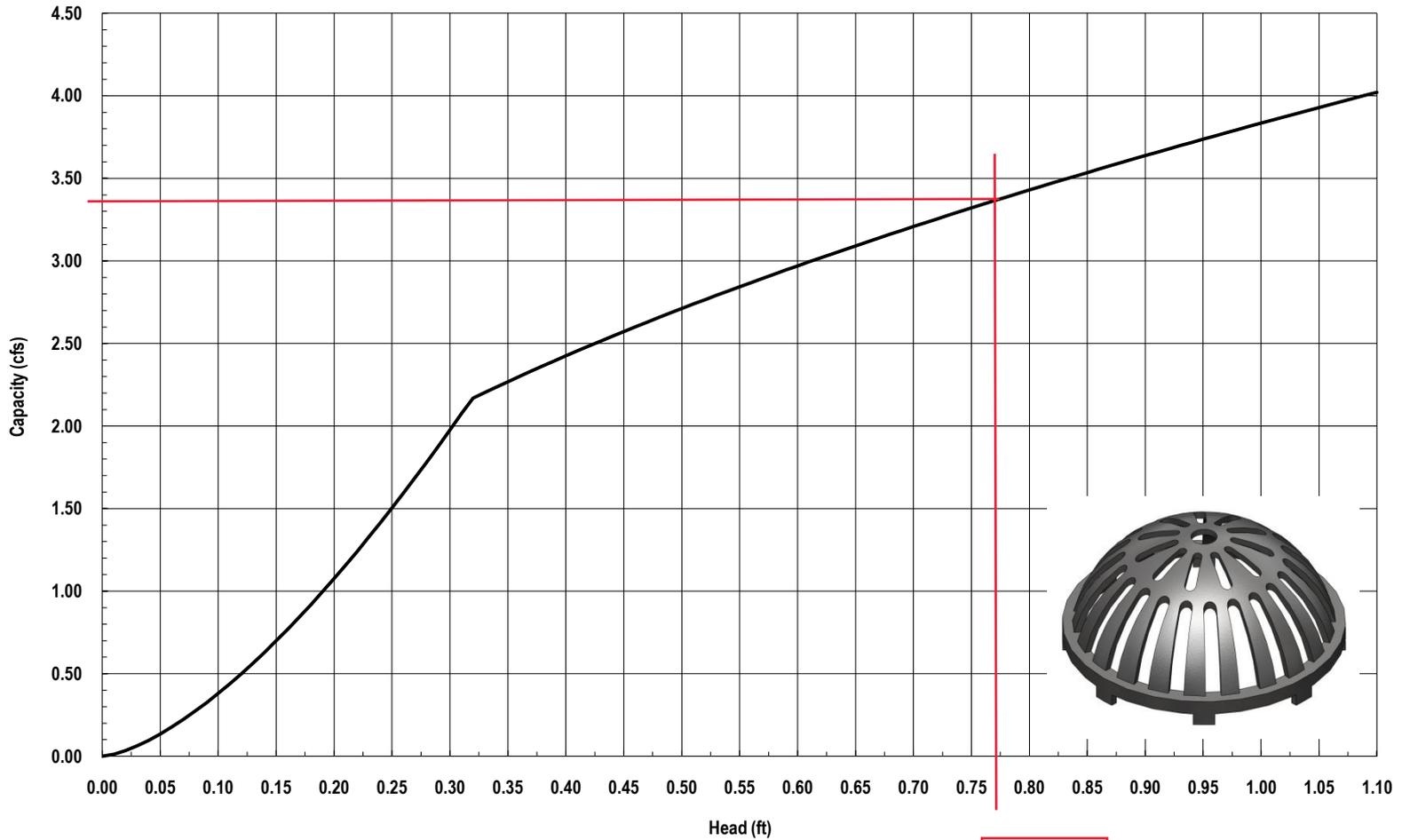
Project File: STORM.stm

Number of lines: 3

Run Date: 7/1/2021

Notes: \* depth assumed; \*\* Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

# Nyloplast 15" Dome Grate Inlet Capacity Chart



H=0.77'  
=>elev.  
158.87

100-YR STORM =  
3.35 CFS



3130 Verona Avenue • Buford, GA 30518  
(866) 888-8479 / (770) 932-2443 • Fax: (770) 932-2490  
© Nyloplast Inlet Capacity Charts June 2012

# Channel Report

## 8-IN 1.0% HDPE

### Circular

Diameter (ft) = 0.67

Invert Elev (ft) = 100.00

Slope (%) = 1.00

N-Value = 0.012

### Calculations

Compute by: Q vs Depth

No. Increments = 10

### Highlighted

Depth (ft) = 0.60

Q (cfs) = 1.414

Area (sqft) = 0.33

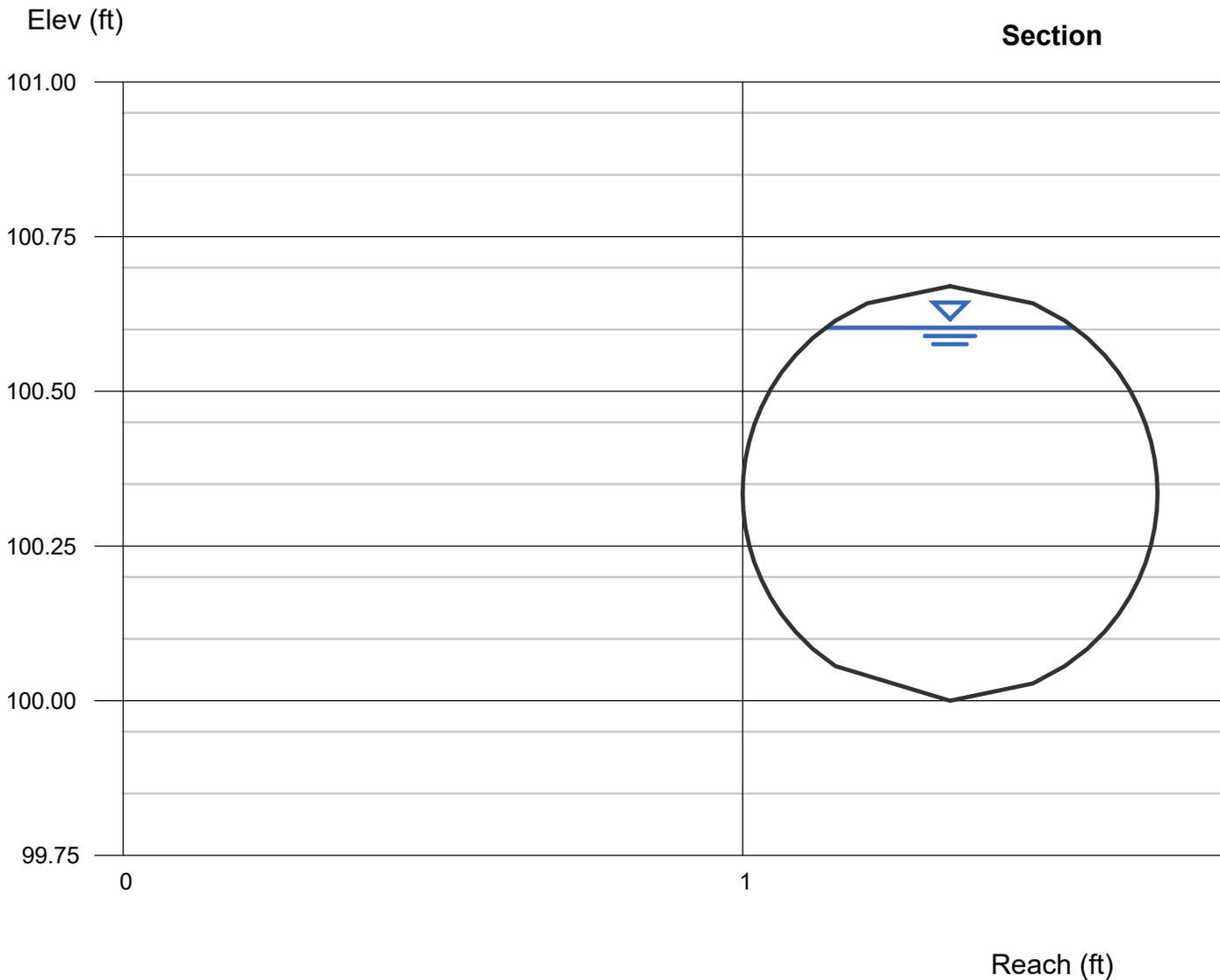
Velocity (ft/s) = 4.23

Wetted Perim (ft) = 1.68

Crit Depth,  $Y_c$  (ft) = 0.56

Top Width (ft) = 0.40

EGL (ft) = 0.88



# Channel Report

## 10-IN 1.0% HDPE

### Circular

Diameter (ft) = 0.83

Invert Elev (ft) = 100.00

Slope (%) = 1.00

N-Value = 0.012

### Calculations

Compute by: Q vs Depth

No. Increments = 10

### Highlighted

Depth (ft) = 0.83

Q (cfs) = 2.347

Area (sqft) = 0.54

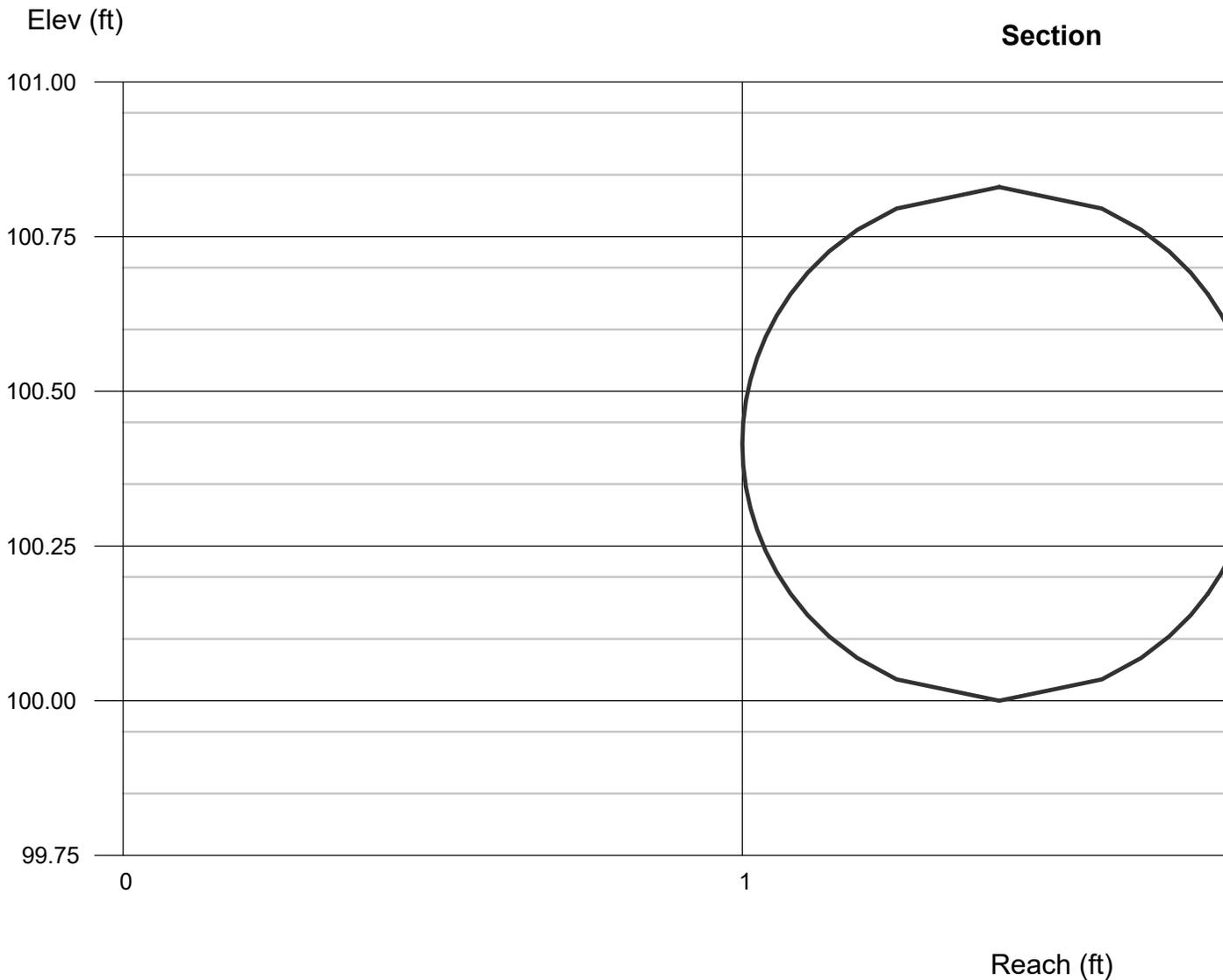
Velocity (ft/s) = 4.34

Wetted Perim (ft) = 2.61

Crit Depth, Yc (ft) = 0.69

Top Width (ft) = 0.00

EGL (ft) = 1.12



# Weir Report

## Bioretention Basin Spillway

### Trapezoidal Weir

Crest = Broad  
Bottom Length (ft) = 12.00  
Total Depth (ft) = 1.00  
Side Slope (z:1) = 3.00

### Highlighted

Depth (ft) = 0.20  
Q (cfs) = 2.902  
Area (sqft) = 2.52  
Velocity (ft/s) = 1.15  
Top Width (ft) = 13.20

### Calculations

Weir Coeff. Cw = 2.60  
Compute by: Q vs Depth  
No. Increments = 10

Q100 = 2.55 cfs  
< 2.902 cfs  
OK



## Outlet Protection Calculations

Project: Wesleyan Preschool - Proposed Building      By: MCB      Date: 07/01/21  
Location: 170 Long Lane, Middletown, CT      Checked:      Date:  
Outlet I.D.: **Roof Drain**

\*Based on Connecticut DOT Drainage Manual, Section 11.13

**Description:**

Roof Drain

**Design Criteria (10-yr Storm Event):**

Q (cfs) = 1.31       $R_p$  (ft) = 0.83  
 D (in) = 10       $S_p$  (ft) = 0.83  
 V (fps) = 4.51       $T_w$  (ft) = 0.83

Q= Flow rate at discharge point in cubic feet per second (cfs)  
 D= Outlet pipe diameter (in)  
 V= Flow velocity at discharge point (ft/s)  
 $R_p$ = Maximum inside pipe rise (ft)  
 $S_p$ = inside diameters for circular sections of maximum inside pipe span for non-circular sections (ft)  
 $T_w$ = Tailwater depth (ft)

Based on **Table 11-13.1** use Type 'B' ---->  $TW \geq 0.5 R_p$

**Rip Rap Stone Size:**

<u>Velocity</u>	<u>Rip Rap Specification</u>	<u>D<sub>50</sub> Stone Size</u>
0-8 fps	Modified	5 inches

**Preformed Scour Hole Dimensions:**

$F$ (ft) =  $0.5(R_p)$  = n/a  
 $C$ (ft) =  $3.0(S_p) + 6.0(F)$  = n/a  
 $B$ (ft) =  $2.0(S_p) + 6.0(F)$  = n/a

**Rip Rap Splash Pad Dimensions:**

$L_a$  = 10 ft  
 $W1 = 3.0(S_p)$  min. = 3 ft  
 $W2 = 3.0(S_p) + 0.4(L_a)$  min. = 7 ft  
 $d$  (Depth of Stone) = 12 inches



SMH#1  
 RIM=162.46  
 INV.A=158.4  
 INV.B=156.0  
 INV.C=157.0  
 INV.D=156.0  
 INV.E=158.0  
 INV.F=156.1

CB  
 RIM=167.13  
 INV.a=162.4  
 INV.b=160.4  
 INV.e=170.4

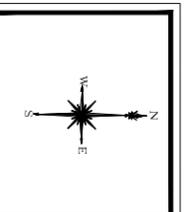
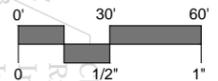
CB  
 RIM=169.15  
 INV.A=163.3  
 INV.B=162.7

CB  
 RIM=162.09  
 INV.A=159.9  
 INV.B=157.2  
 INV.D=156.2

SMH  
 RIM=160.82  
 INV=154.5

**LEGEND**

-  DRAINAGE AREA BOUNDARY
- CCB 1** DRAINAGE AREA LABEL
-  TIME OF CONCENTRATION PATH



NO.	REVISIONS

**DRAINAGE AREA MAP - STORM DRAINAGE SYSTEM**  
**WESLEYAN NEIGHBORHOOD PRESCHOOL**  
**PROPOSED BUILDING**  
 170 LONG LANE  
 MIDDLETOWN, CONNECTICUT

FAB DESIGNED	MCB DRAWN	FAB CHECKED
SCALE: 1"=60'		
DATE: JULY 1, 2021		
PROJECT NO: 15993.00022		
SHEET NO:		

**CB**

## ATTACHMENT C

## SOIL TESTING DATA

### **Drainage Memorandum**

Wesleyan Neighborhood Preschool

Proposed Building

170 Long Lane

Middletown, Connecticut

July 2, 2021

---

6/24/2021 170 Long Lane, Middletown, CT

Test Pit 1: > Abandoned Clay Pipe (4") @ 56"  
0'-4" TS > Possible ETC ± 5' West

4-7" Gray V. Gravelly Sand (Processed) Geotextile

7-46" RB V. Silty Sand w/ Clay

46"-72" ~~RB Sand w/ Silt~~ Gray Silty Sand w/ some Gravel  
Samples @ 24" & 48"

Test Pit 2:

0'-11" TS

11"-~~24"~~ RB Fine Sand w/ Silt & some gravel

24"-73" RB ~~Med~~ Silty Sand

Samples @ 22" & 40"

Water Seepage @ 65"

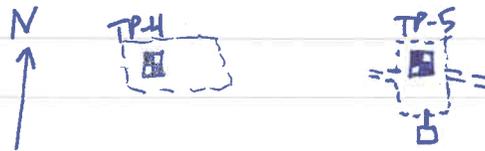
Test Pit 3:

0'-12" TS

12"-36" RB ~~Med~~ Sand w/ Silty & some gravel

36"-73" RB Silty Sand - Hard (Mottling @ 36")

Geotech Test Pits



TP-6: Level of Effort: Easy 3-4', Harder after 4'  
More compacted, moist

0'-12" TS

Samples @ 48", 84"

12"-24" RB Med. Sand w/ Silt

24"-96" RB Med. Sand w/ Silt & Gravel (well graded)

Water @ 84" (Seepage)

TP-5: Level of Effort: High effort thru Fill, Average to

0'-2" TS

2"-42" - RB Bouldery Fill w/ Cobbles (Mix. Debris, 2" Clay Pipe)

42"-96" - RB Med. Sand w/ Silt & some gravel Bricks →

96"-114" - RB Bouldery Fill, less cobbles

PIPE @ 99" (T.O.P.) 8"-12" Conc. Pipe



TP-4 Level of Effort: Hard in firm

0"-2" TS

2"-20" Fill (Bazko, Gravel, RB+Grey Sand w/ Silt)

Move 15' East

TP-4.1

Trap Rock @ 68"

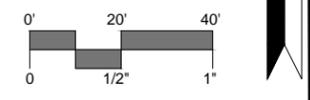
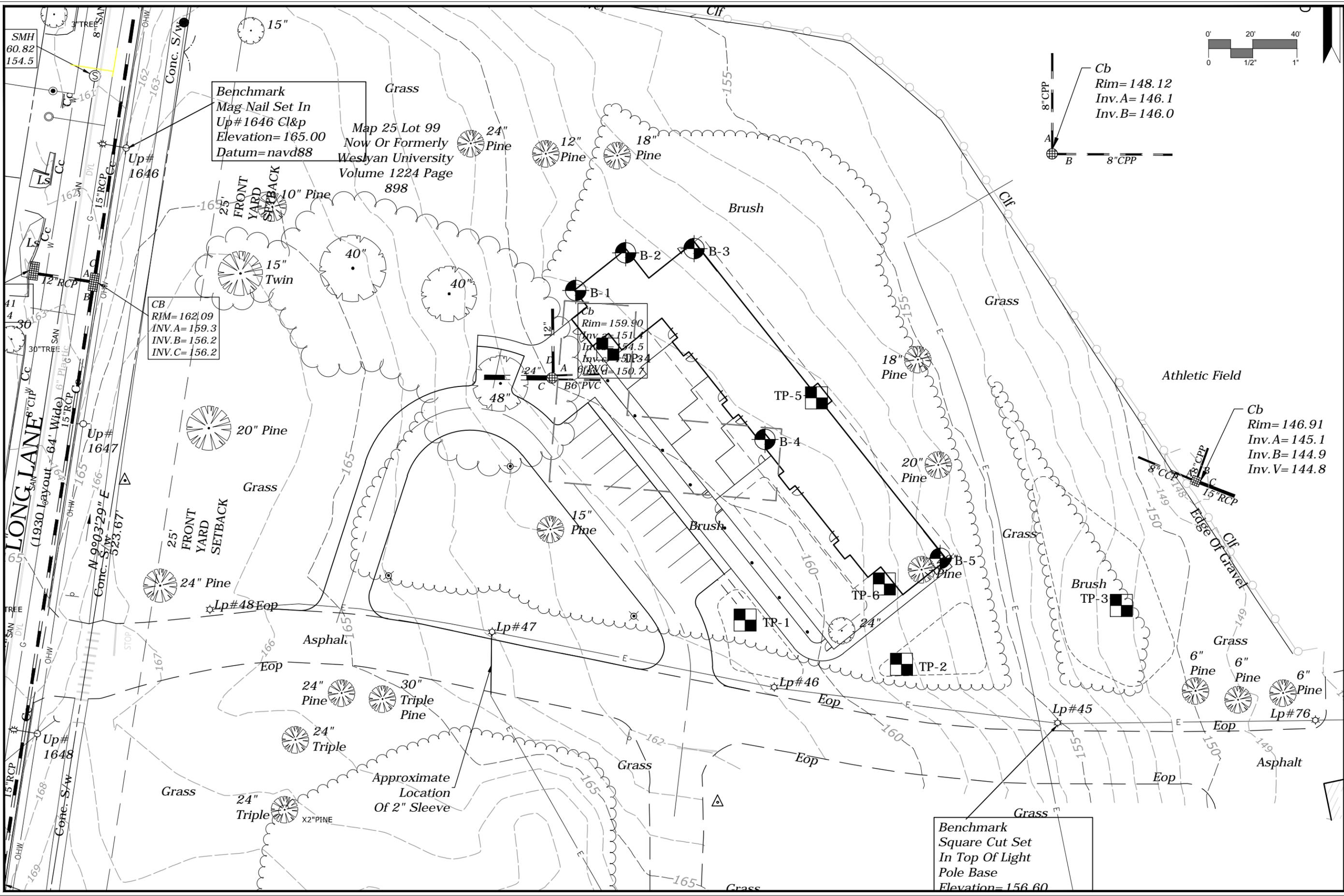
0"-2" TS

Geotextile @ 30"

2"-96"

RB ~~fill~~ Sand w/ silt & gravel

Drawing: W:\CAD\DESIGN\15993.00022-DE-CAD\NONPLANSET\STORMWATER AND GEOTECH TEST PIT LOCATIONS.DWG Layout: TAP1P  
 Plotted by: MERRADU On this date: Fri, 2021 July 2 - 11:09am



REVISIONS

**TEST PIT AND BORING LOCATIONS**  
**WESLEYAN NEIGHBORHOOD PRESCHOOL**  
**PROPOSED BUILDING**  
 170 LONG LANE  
 MIDDLETOWN, CONNECTICUT

STN DESIGNED	JRH	JK
SCALE	1"=40'	
DATE	JULY 1, 2021	
PROJECT NO.	15993.00022	

SHEET NO. **TP**  
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