SUPPLEMENTAL
STORM DRAINAGE ANALYSIS

FOR

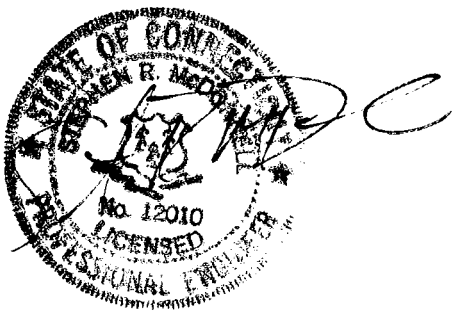
THE LOFTS AT BLACK BIRCH
COMMUNITY CENTER REDEVELOPMENT

BANNER ROAD

IN

EAST HADDAM, CONNECTICUT

OCTOBER 1, 2021



Prepared by:

WMC
CONSULTING ENGINEERS
87 Holmes Road, Newington Connecticut 06111
(860) 667-9624

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Project Calculations / Assumptions……...…… Appendix B1

Hydrograph Model Results ……..…….…….Appendix C1

Hydraflow Model Results …….Appendix D1

EXECUTIVE SUMMARY

Purpose: To provide a more focused drainage comparison of the development area contributing to the existing subsurface drainage system associated with Section B (Pinehurst Lane). An existing conditions analysis was conducted that supersedes the previous analysis that reviewed the conditions circa 2004 as "existing". The analysis here within accounts for the structures and hardscapes as they exist today along with the processed aggregate base that remained after removal of the bituminous parking facilities east of the community center. This area has partially grown in with grass and for the purpose of this analysis a runoff coefficient (C-Value) of 0.60 was utilized. The watershed areas were recalculated and depicted in Figure-6 and Figure-7

Table 3E – Existing Points of Analysis Summary (cfs)

Location	2-yr Storm	10-yr Storm	25-yr Storm	100-yr Storm
POA B	7.56	11.68	13.80	17.08

Table 4P – Proposed Points of Analysis Summary (cfs)

Location	2-yr Storm	10-yr Storm	25-yr Storm	100-yr Storm
POA B	8.21	12.67	14.97	18.53

Table 4-1 – Proposed Impact to Point of Analysis B (cfs)

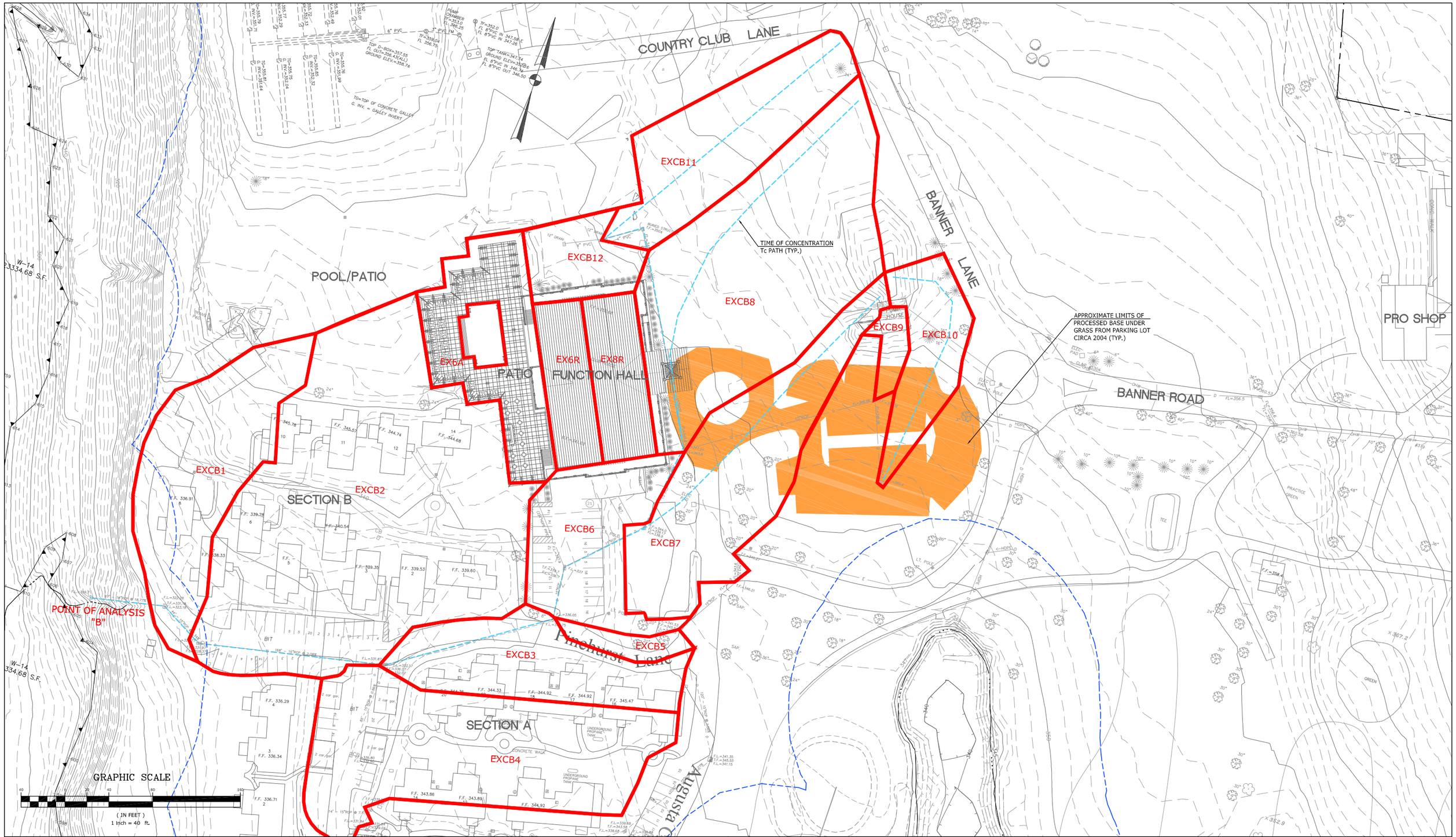
Location	2-yr Storm	10-yr Storm	25-yr Storm	100-yr Storm
POA B	+0.63	+0.99	+1.17	+1.45

CONCLUSION

The above noted increases directed to the existing outfall location west of Pinehurst Lane are negligible and do not adversely impact properties down gradient given the overall contributing watershed area directed offisite exceeds 125 acres. The existing subsurface stormwater collection system associated with Pinehurst Lane has the capacity to accommodate this small increase in discharge to this location. It is our recommendation however to improve and reconstruct the outfall to limit future erosion concerns at this location. A standard riprap swale is now proposed to convey stormwater down the steep slope to a plunge pool which will further dissipate energy.

Based on the foregoing drainage analysis, no health or safety impacts will result from the proposed redevelopment of the Community Center building and surrounding infrastructure.

FIGURES



NO.	DATE	REVISIONS
1	10/01/21	SUPPLEMENTAL DRAINAGE ANALYSIS

SUPV.	S.R.M.
DESIGN	R.E.B.
DRAWN	R.E.B.
CHECKED	S.R.M.
DATE	06/03/21

SCALE
1" = 40'

WMC
CONSULTING ENGINEERS
• WENGELL, McDONNELL & COSTELLO •
87 HOLMES ROAD
NEWINGTON, CT 06111
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PREPARED FOR
LOFTS AT BLACK BIRCH LLC.
1 BANNER ROAD
EAST HADDAM, CT 06423

EXISTING WATERSHED MAP HYDRAFLOW
COMMUNITY CENTER REDEVELOPMENT
BANNER LANE - EAST HADDAM, CONNECTICUT

SIZE	PROJECT	FILE NAME	NUMBER	REV.	SHEET	OF
D	BLACK BIRCH APTS	07056.3 PD	07056.30			FIGURE-6

COUNTRY CLUB LANE

TIME OF CONCENTRATION
Tc PATH (TYP.)

EXCB7

BANNER LANE

PCB3

PCB5

PCB4

POOL

EX6A

EX6R

PCB2R

PCB2

EXCB8

PRO SHOP

BANNER ROAD

EXCB1

EXCB2

SECTION B

PCB1

EXCB6

POINT OF ANALYSIS
"B"

Pinehurst Lane

EXCB5

EXCB3

SECTION A

EXCB4

Augusta Dr

GRAPHIC SCALE
(IN FEET)
1 inch = 40 ft.

NO.	DATE	DESCRIPTION
1	10/01/21	SUPPLEMENTAL DRAINAGE ANALYSIS

REVISIONS

SUPV.	S.R.M.
DESIGN	R.E.B.
DRAWN	R.E.B.
CHECKED	S.R.M.
DATE	06/03/21

SCALE
1" = 40'

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PREPARED FOR
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EAST HADDAM, CT 06423

PROPOSED WATERSHED MAP HYDRAFLOW
COMMUNITY CENTER REDEVELOPMENT
BANNER LANE - EAST HADDAM, CONNECTICUT

SIZE	PROJECT	FILE NAME	NUMBER	REV.	SHEET	OF	FIGURE-7
D	– BLACK BIRCH APTS	– 07056.3 PD	– 07056.30	–			

APPENDIX A1

REFERENCE TABLES, CHARTS, & GRAPHS

NOAA Atlas 14, Volume 10, Version 3
Location name: Moodus, Connecticut, USA*
Latitude: 41.5154°, Longitude: -72.462°
Elevation: 357.62 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

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.333 (0.258-0.417)	0.403 (0.311-0.505)	0.517 (0.399-0.650)	0.611 (0.468-0.772)	0.741 (0.550-0.975)	0.839 (0.611-1.13)	0.941 (0.666-1.31)	1.06 (0.709-1.49)	1.22 (0.790-1.78)	1.36 (0.858-2.02)
10-min	0.472 (0.365-0.591)	0.571 (0.441-0.715)	0.732 (0.563-0.920)	0.865 (0.663-1.09)	1.05 (0.779-1.38)	1.19 (0.865-1.59)	1.33 (0.944-1.85)	1.50 (1.00-2.12)	1.73 (1.12-2.53)	1.92 (1.22-2.86)
15-min	0.555 (0.429-0.695)	0.671 (0.518-0.841)	0.860 (0.663-1.08)	1.02 (0.779-1.29)	1.23 (0.916-1.62)	1.40 (1.02-1.88)	1.57 (1.11-2.18)	1.76 (1.18-2.49)	2.03 (1.32-2.97)	2.26 (1.43-3.36)
30-min	0.761 (0.589-0.953)	0.920 (0.711-1.15)	1.18 (0.908-1.48)	1.40 (1.07-1.76)	1.69 (1.26-2.23)	1.91 (1.39-2.57)	2.15 (1.52-2.98)	2.41 (1.62-3.41)	2.79 (1.80-4.07)	3.09 (1.96-4.60)
60-min	0.967 (0.748-1.21)	1.17 (0.903-1.47)	1.50 (1.15-1.88)	1.77 (1.36-2.24)	2.15 (1.60-2.83)	2.43 (1.77-3.26)	2.73 (1.93-3.79)	3.06 (2.06-4.33)	3.54 (2.29-5.17)	3.93 (2.48-5.84)
2-hr	1.29 (1.00-1.60)	1.54 (1.20-1.92)	1.96 (1.52-2.44)	2.30 (1.78-2.89)	2.78 (2.08-3.64)	3.14 (2.30-4.18)	3.52 (2.51-4.86)	3.95 (2.67-5.55)	4.59 (2.99-6.65)	5.13 (3.25-7.56)
3-hr	1.50 (1.18-1.86)	1.80 (1.41-2.23)	2.28 (1.78-2.83)	2.68 (2.08-3.34)	3.22 (2.43-4.20)	3.63 (2.68-4.83)	4.07 (2.92-5.60)	4.58 (3.10-6.39)	5.33 (3.47-7.68)	5.97 (3.80-8.75)
6-hr	1.93 (1.53-2.38)	2.31 (1.82-2.84)	2.92 (2.30-3.60)	3.43 (2.69-4.25)	4.13 (3.13-5.34)	4.65 (3.46-6.14)	5.21 (3.77-7.12)	5.87 (3.99-8.12)	6.85 (4.48-9.78)	7.68 (4.90-11.2)
12-hr	2.41 (1.92-2.94)	2.89 (2.30-3.52)	3.67 (2.92-4.49)	4.32 (3.41-5.32)	5.21 (3.99-6.69)	5.88 (4.40-7.69)	6.59 (4.80-8.94)	7.43 (5.08-10.2)	8.69 (5.70-12.3)	9.76 (6.24-14.0)
24-hr	2.83 (2.28-3.42)	3.42 (2.76-4.15)	4.40 (3.53-5.34)	5.21 (4.15-6.36)	6.32 (4.88-8.05)	7.14 (5.40-9.29)	8.03 (5.90-10.8)	9.11 (6.25-12.4)	10.7 (7.06-15.0)	12.1 (7.78-17.3)
2-day	3.15 (2.57-3.79)	3.87 (3.14-4.65)	5.04 (4.08-6.08)	6.01 (4.83-7.28)	7.34 (5.72-9.31)	8.32 (6.35-10.8)	9.40 (6.98-12.7)	10.7 (7.40-14.5)	12.8 (8.46-17.8)	14.6 (9.41-20.6)
3-day	3.42 (2.80-4.09)	4.20 (3.43-5.03)	5.47 (4.46-6.57)	6.53 (5.28-7.88)	7.99 (6.25-10.1)	9.06 (6.95-11.7)	10.2 (7.63-13.7)	11.7 (8.09-15.7)	14.0 (9.26-19.3)	16.0 (10.3-22.4)
4-day	3.66 (3.01-4.37)	4.49 (3.69-5.36)	5.85 (4.78-7.00)	6.97 (5.66-8.38)	8.51 (6.68-10.7)	9.65 (7.42-12.4)	10.9 (8.15-14.6)	12.4 (8.62-16.6)	14.9 (9.86-20.5)	17.0 (11.0-23.8)
7-day	4.37 (3.62-5.18)	5.29 (4.38-6.28)	6.80 (5.60-8.09)	8.05 (6.59-9.63)	9.78 (7.72-12.2)	11.0 (8.54-14.1)	12.4 (9.32-16.4)	14.1 (9.83-18.8)	16.8 (11.2-22.9)	19.1 (12.3-26.4)
10-day	5.07 (4.22-5.99)	6.05 (5.03-7.16)	7.65 (6.33-9.07)	8.98 (7.38-10.7)	10.8 (8.56-13.4)	12.2 (9.42-15.4)	13.6 (10.2-17.8)	15.4 (10.7-20.3)	18.1 (12.0-24.5)	20.3 (13.2-28.1)
20-day	7.29 (6.12-8.54)	8.34 (7.00-9.79)	10.1 (8.42-11.9)	11.5 (9.55-13.6)	13.5 (10.8-16.5)	15.0 (11.6-18.6)	16.5 (12.4-21.2)	18.3 (12.8-23.8)	20.7 (13.9-27.9)	22.7 (14.8-31.1)
30-day	9.15 (7.74-10.7)	10.3 (8.65-12.0)	12.1 (10.1-14.1)	13.5 (11.3-15.9)	15.6 (12.5-18.9)	17.2 (13.4-21.1)	18.8 (14.0-23.7)	20.4 (14.4-26.5)	22.7 (15.2-30.2)	24.4 (15.9-33.1)
45-day	11.5 (9.76-13.3)	12.6 (10.7-14.7)	14.5 (12.3-16.9)	16.1 (13.5-18.8)	18.2 (14.6-21.9)	19.9 (15.5-24.3)	21.5 (16.0-26.9)	23.1 (16.4-29.7)	25.1 (16.9-33.2)	26.5 (17.3-35.8)
60-day	13.4 (11.5-15.6)	14.6 (12.5-17.0)	16.6 (14.1-19.3)	18.2 (15.3-21.2)	20.4 (16.4-24.4)	22.2 (17.3-26.9)	23.8 (17.8-29.5)	25.3 (18.0-32.5)	27.1 (18.4-35.8)	28.4 (18.6-38.1)

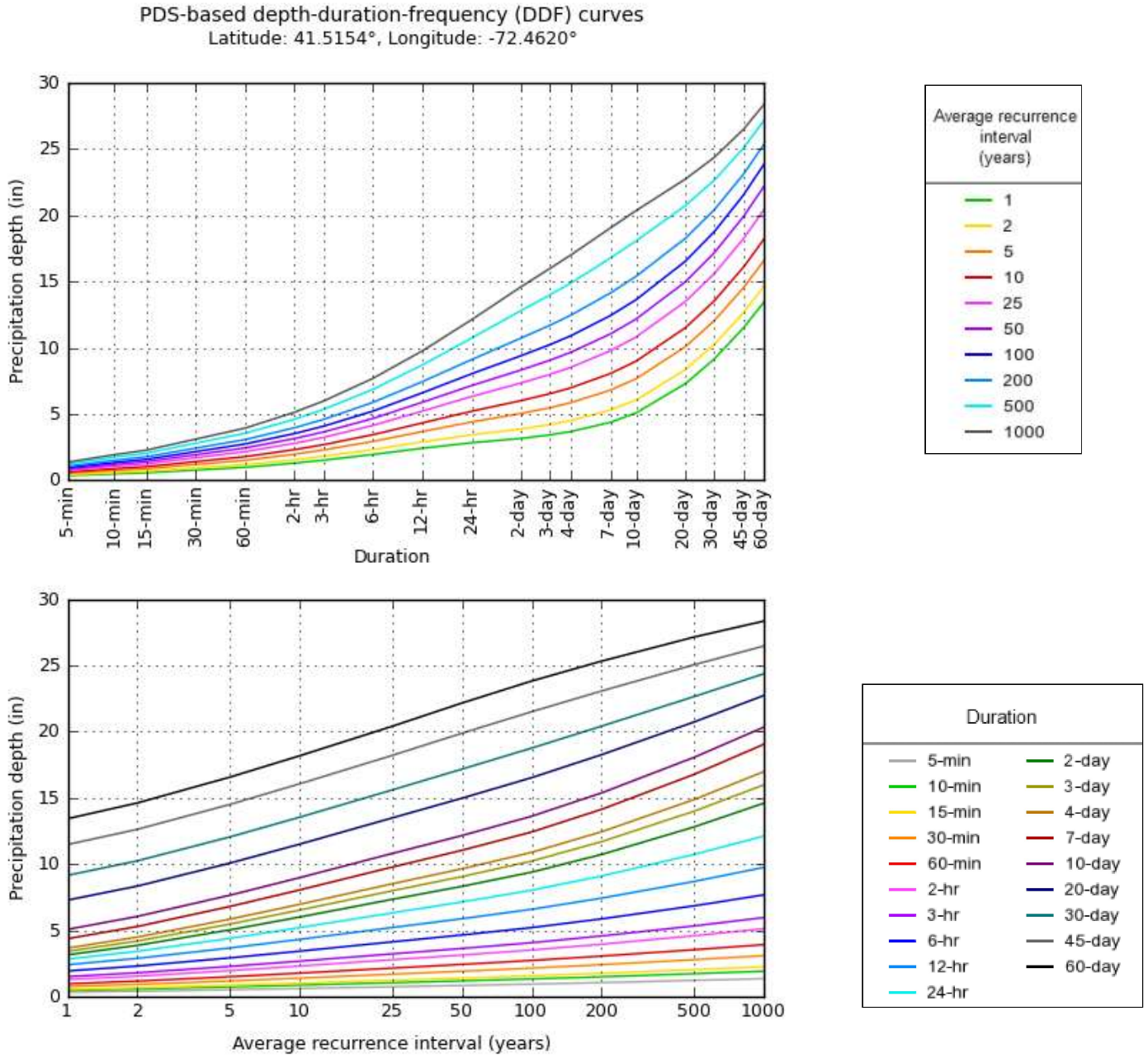
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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



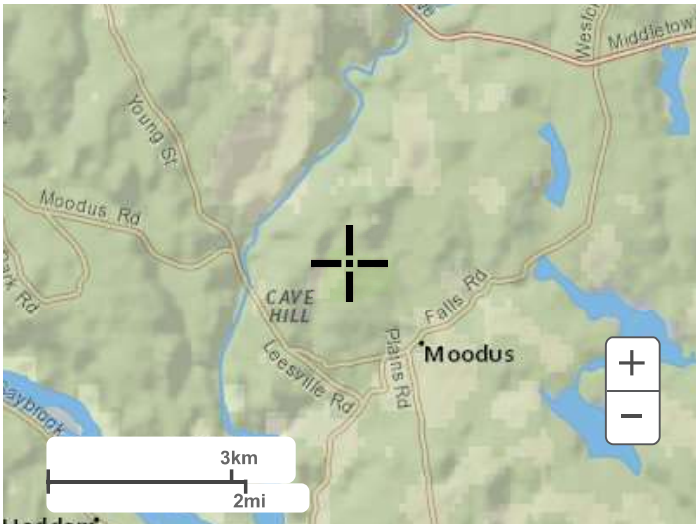
NOAA Atlas 14, Volume 10, Version 3

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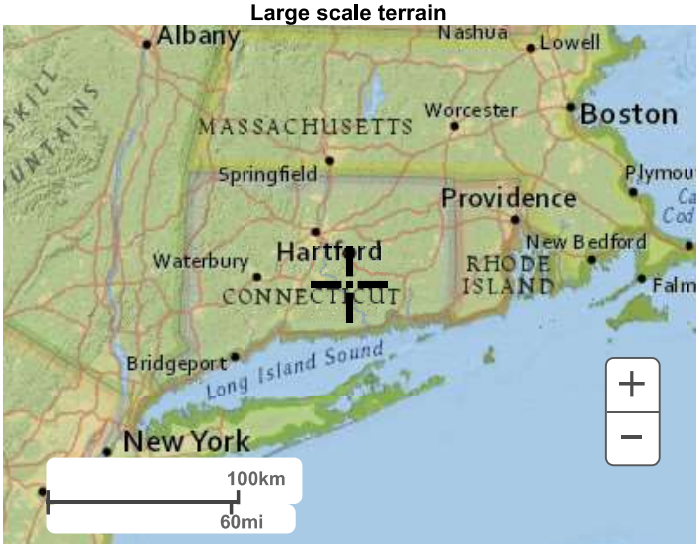
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Maps & aerials

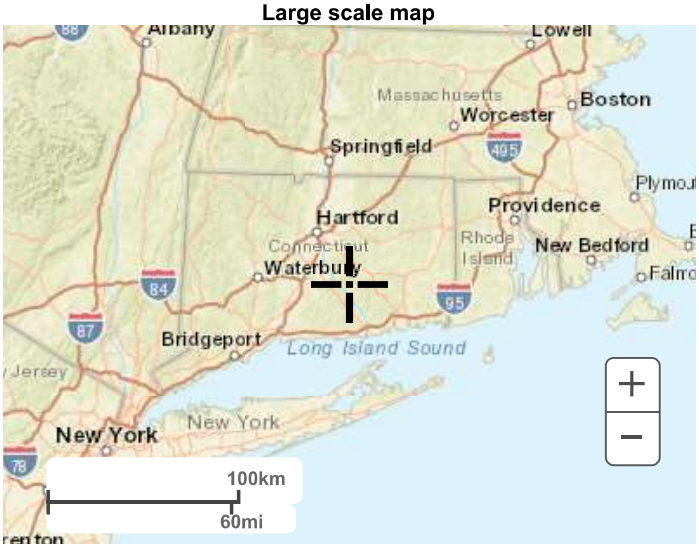
Small scale terrain



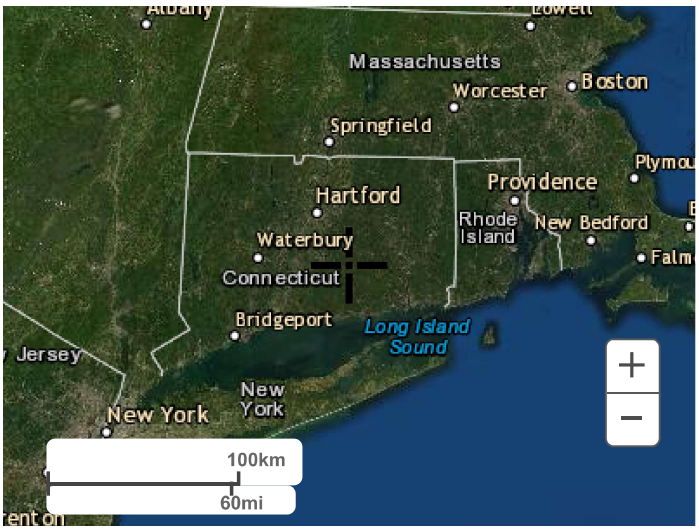
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Table 7-2. Manning's roughness coefficients for Roadside and Median Channels. *

Lining Category	ConnDOT Designations	Lining Type	n - Value for Given Depth Ranges 0-0.15 m (0-0.5 ft)	0.15-0.60 m (0.5-2.0 ft)	>0.60 m (>2.0 ft)
Rigid		Concrete	0.015	0.013	0.013
		Grouted Riprap	0.040	0.030	0.028
		Stone Masonry	0.042	0.032	0.030
		Soil Cement	0.025	0.022	0.020
		Asphalt	0.018	0.016	0.016
Unlined		Bare Soil	0.023	0.020	0.020
		Rock Cut	0.045	0.035	0.025
Erosion Control Matting** (Temporary or Permanent)	Type E	Woven Paper Net	0.016	0.015	0.015
		Jute Net	0.028	0.022	0.019
	Type F	Fiberglass Roving	0.028	0.021	0.019
	Type G	Straw with Net	0.065	0.033	0.025
		Curled Wood Mat	0.066	0.035	0.028
	Type H	Synthetic Mat	0.036	0.025	0.021
Gravel Riprap	Special	25 mm (1 in) D_{50}	0.044	0.033	0.030
		50 mm (2 in) D_{50}	0.066	0.041	0.034
Rock Riprap	Modified	125 mm (5 in) D_{50}	0.095	0.062	0.035
		150 mm (6 in) D_{50}	0.104	0.069	0.035
	Intermediate	200 mm (8 in) D_{50}	--	0.072	0.037
		300 mm (12 in) D_{50}	--	0.078	0.040
	Standard	380 mm (15 in) D_{50}	--	--	0.042

NOTE: Values listed are representative values for the respective depth ranges. Manning's roughness coefficients, n, vary with the flow depth.

* Table reproduced from HEC-15

** See Section 7.6.8

Table 7-4 Permissible Shear Stresses for Lining Materials*

Lining Category	ConnDOT Designations	Lining Type	Permissible Unit Shear Stress Pa	Permissible Unit Shear Stress lb/ft^2
Erosion Control Matting**	Type E	Woven Paper Net	7.2	0.15
		Jute Net	21.5	0.45
	Type F	Fiberglass Roving:		
		Single	28.7	0.60
		Double	40.7	0.85
	Type G	Straw with Net	69.4	1.45
		Curled Wood Mat	74.2	1.55
	Type H	Synthetic Mat	95.8	2.00
Vegetative Turf Establishment		Class A	177.2	3.70
		Class B	100.6	2.10
		Class C-Use for DOT projects	47.9	1.00
		Class D	28.7	0.60
		Class E	16.8	0.35
Gravel Riprap	Special	25 mm (1 in)	15.8	0.33
		50 mm (2 in)	31.6	0.67
Rock Riprap	Modified	125 mm (5 in)	79.8	1.68
		150 mm (6 in)	95.8	2.00
	Intermediate	200 mm (8 in)	127.7	2.68
		300 mm (12 in)	191.5	4.00
	Standard	380 mm (15 in)	239.3	5.00
Bare Soil		Non-cohesive	Figure 7-13	
		Cohesive	Figure 7-14	

* Reproduced from HEC-15
** See Section 7.6.8

7.6.8 Erosion Control Matting

Erosion control matting is evaluated by the Department for use in eight Types (A-H), grouped into two Classes. Types A through D are included in Class 1 and are designated as Slope Protection. This classification is based upon steepness of the slope and soil type. The purpose of Class 1 matting is to protect the seedbed from loss of soil, and promote the establishment of a warm-season, perennial vegetative cover.

APPENDIX B1

PROJECT CALCULATIONS / ASSUMPTIONS

Hydraulic Analysis Report

Project Data

Project Title: Banner Section B Outfall

Designer: REB

Project Date: Thursday, September 30, 2021

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis

Notes: Assume channel from 18" RCP outfall Inv. 309.7 to toe of slope Elev. 294+/-
L = 64'+/- S = 25% Use Standard Riprap D50 = 15"

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 2.0000 ft/ft

Side Slope 2 (Z2): 2.0000 ft/ft

Channel Width: 5.0000 ft

Longitudinal Slope: 0.2500 ft/ft

Manning's n: 0.0420 Table 7-2 Standard Riprap

Flow: 13.0000 cfs 10-yr Design Storm

Result Parameters

Depth: 0.3102 ft

Area of Flow: 1.7438 ft^2

Wetted Perimeter: 6.3875 ft

Hydraulic Radius: 0.2730 ft

Average Velocity: 7.4552 ft/s

Top Width: 6.2410 ft

Froude Number: 2.4855

Critical Depth: 0.5502 ft

Critical Velocity: 3.8732 ft/s

Critical Slope: 0.0348 ft/ft

Critical Top Width: 7.20 ft

Calculated Max Shear Stress: 4.8399 lb/ft^2 Less than 5 lb/sf (Table 7-4 Standard Riprap Therefore; OK

Calculated Avg Shear Stress: 4.2587 lb/ft^2

APPENDIX C1

HYDROGRAPH MODEL RESULTS

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	Rational	Existing Section B Outfall
2	Rational	Proposed Section B Outfall

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	-------	7.565	-------	10.07	11.68	13.80	15.46	17.08	Existing Section B Outfall
2	Rational	------	-------	8.208	-------	10.93	12.67	14.97	16.77	18.53	Proposed Section B Outfall

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	7.565	1	23	10,440	------	------	------	Existing Section B Outfall
2	Rational	8.208	1	23	11,327	------	------	------	Proposed Section B Outfall

Hydrograph Report

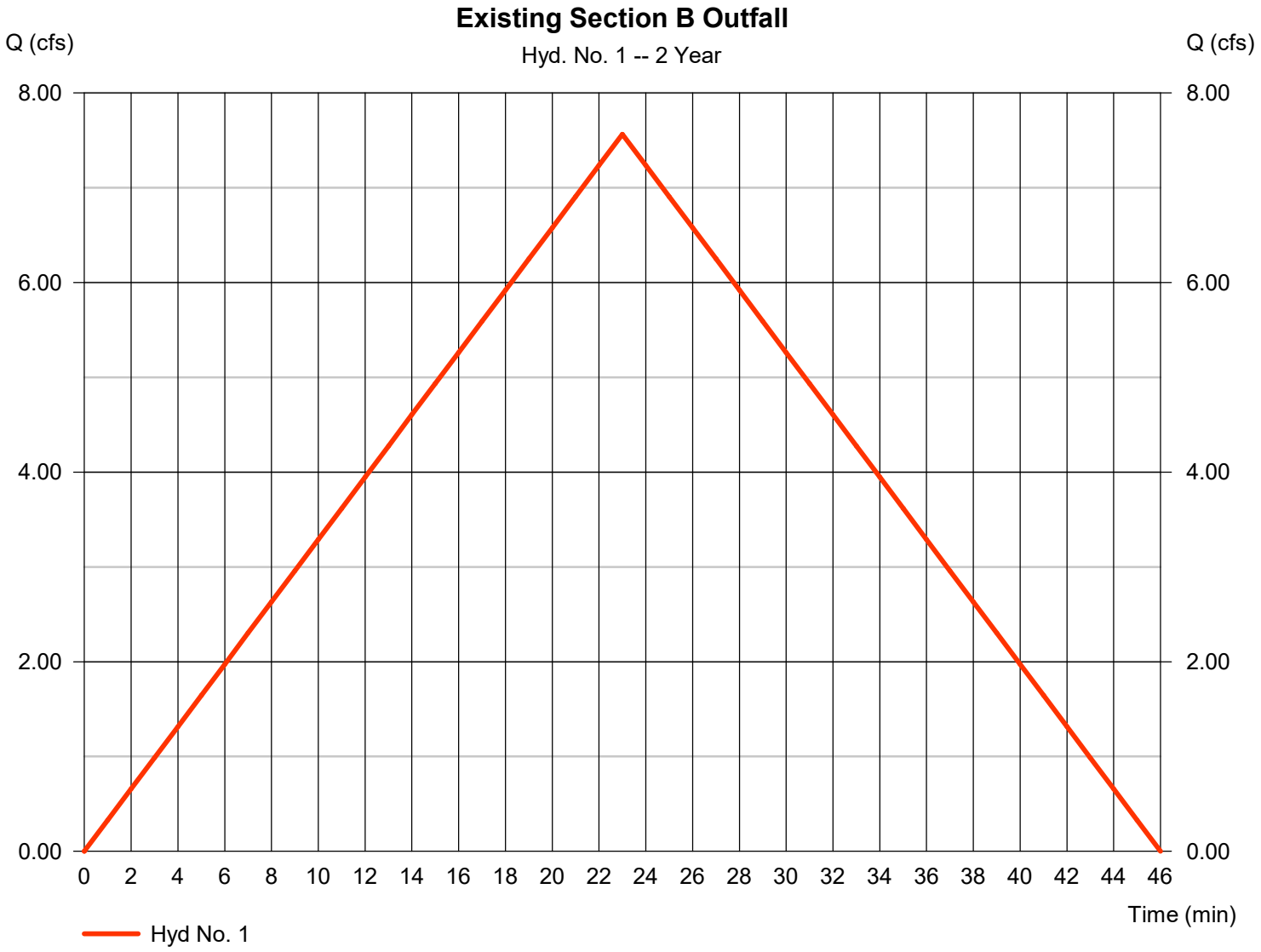
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 1

Existing Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	7.565 cfs
Storm frequency	=	2 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	10,440 cuft
Drainage area	=	6.700 ac	Runoff coeff.	=	0.52*
Intensity	=	2.171 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.150 x 0.90) + (4.080 x 0.30)] / 6.700



Hydrograph Report

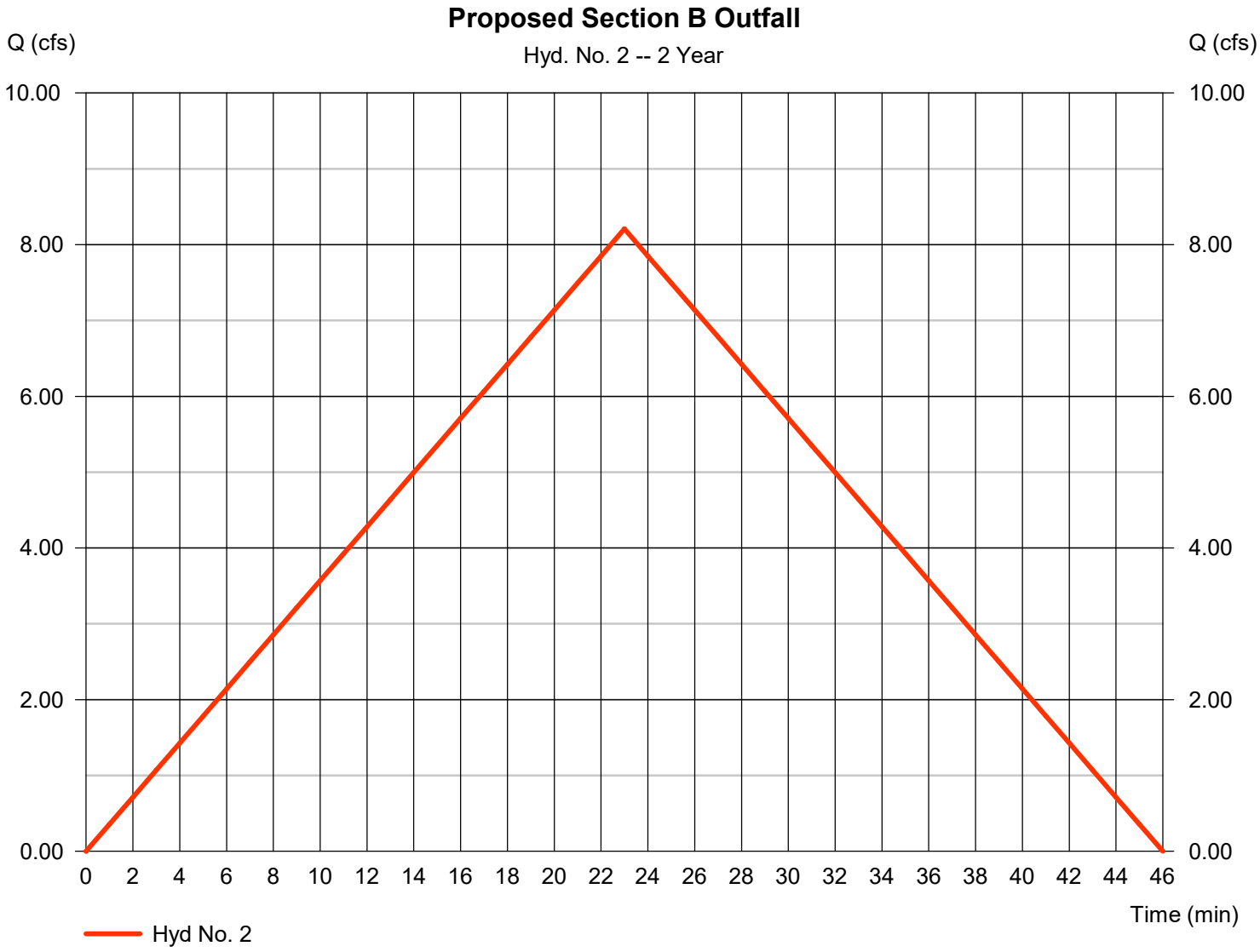
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 2

Proposed Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	8.208 cfs
Storm frequency	=	2 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	11,327 cuft
Drainage area	=	6.750 ac	Runoff coeff.	=	0.56*
Intensity	=	2.171 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(2.950 x 0.90) + (3.840 x 0.30)] / 6.750



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	11.68	1	23	16,114	------	------	------	Existing Section B Outfall
2	Rational	12.67	1	23	17,483	------	------	------	Proposed Section B Outfall

Hydrograph Report

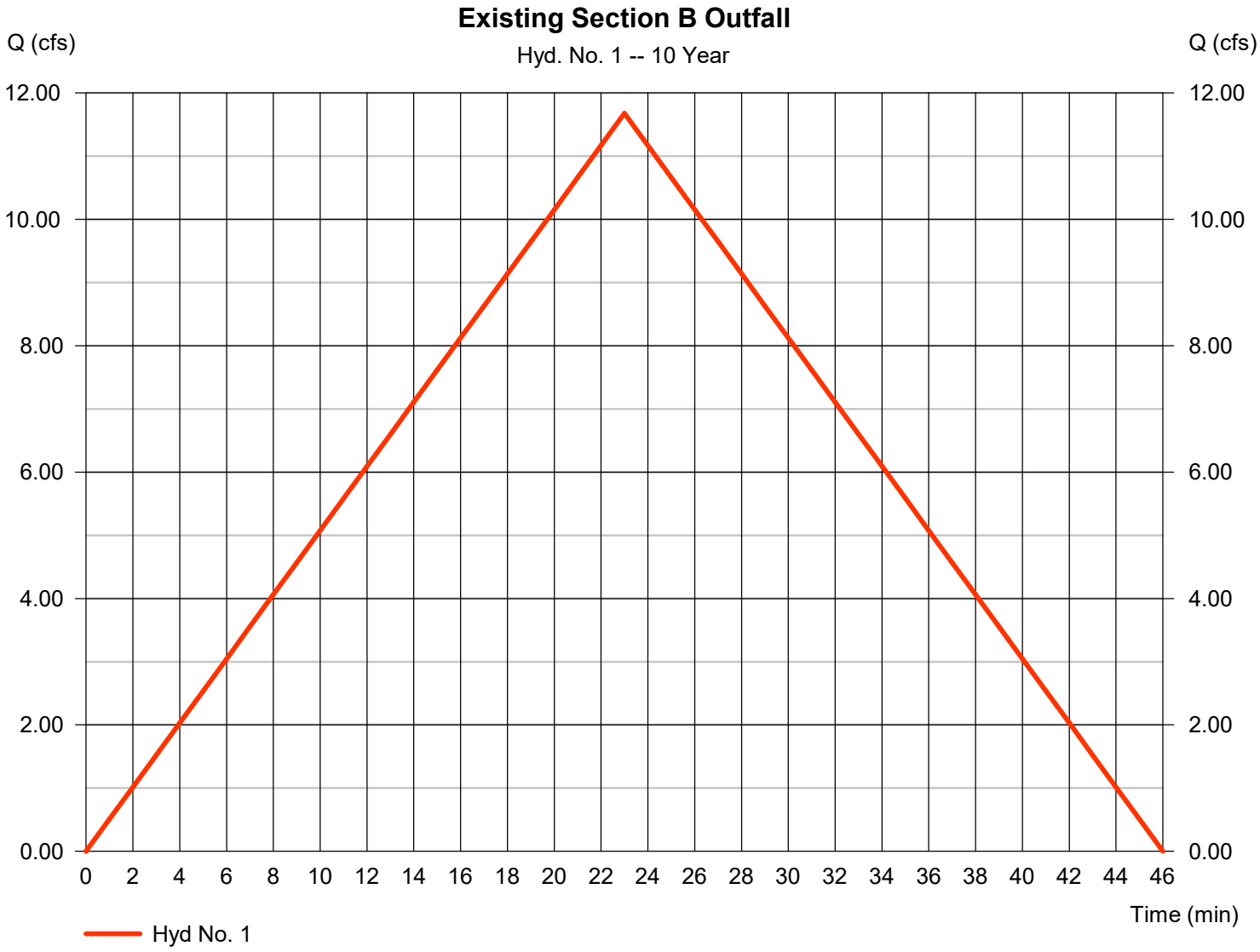
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 1

Existing Section B Outfall

Hydrograph type	= Rational	Peak discharge	= 11.68 cfs
Storm frequency	= 10 yrs	Time to peak	= 23 min
Time interval	= 1 min	Hyd. volume	= 16,114 cuft
Drainage area	= 6.700 ac	Runoff coeff.	= 0.52*
Intensity	= 3.352 in/hr	Tc by User	= 23.00 min
IDF Curve	= Middlesex.idf	Asc/Rec limb fact	= 1/1

* Composite (Area/C) = [(3.150 x 0.90) + (4.080 x 0.30)] / 6.700



Hydrograph Report

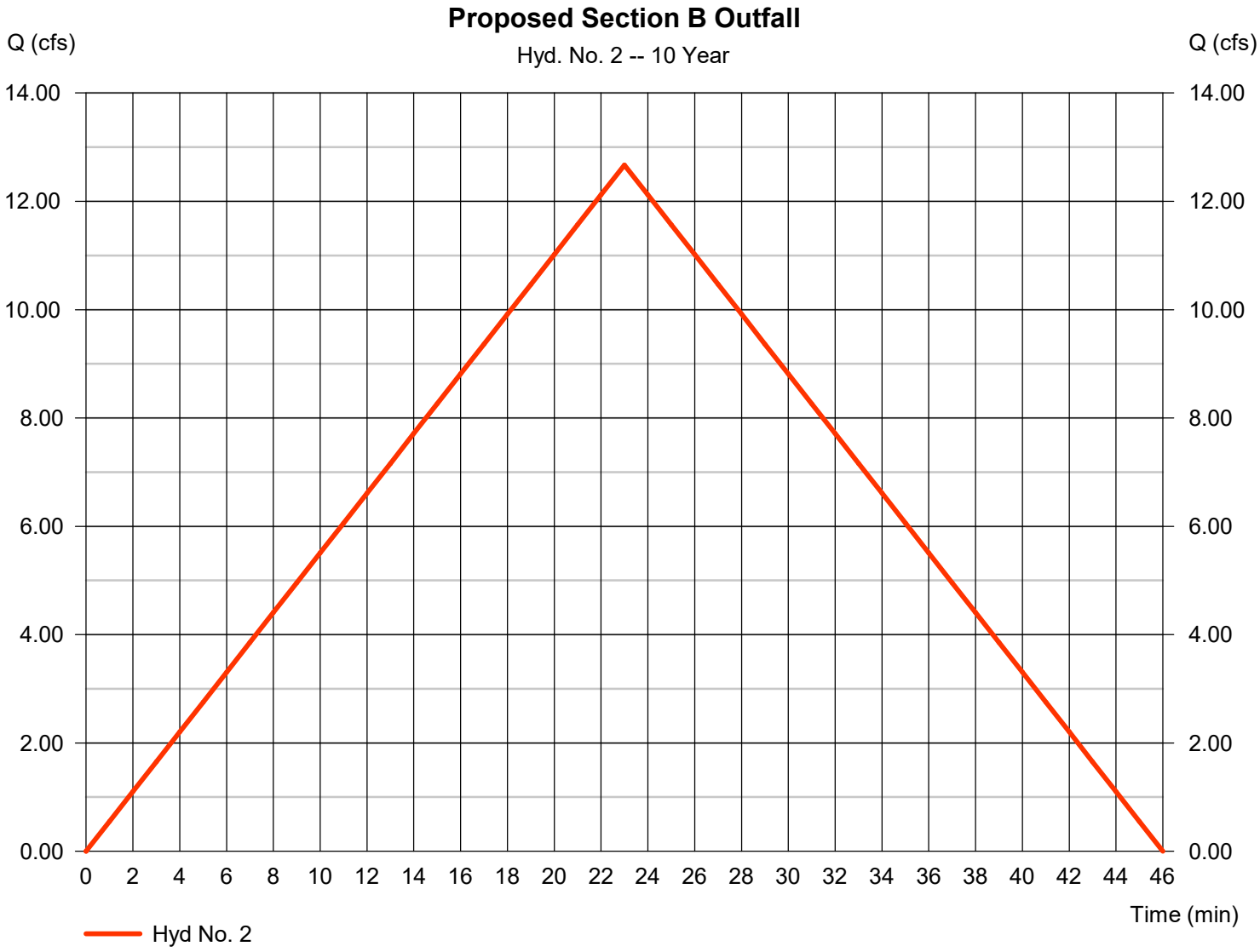
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 2

Proposed Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	12.67 cfs
Storm frequency	=	10 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	17,483 cuft
Drainage area	=	6.750 ac	Runoff coeff.	=	0.56*
Intensity	=	3.352 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(2.950 x 0.90) + (3.840 x 0.30)] / 6.750



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	13.80	1	23	19,038	------	------	------	Existing Section B Outfall
2	Rational	14.97	1	23	20,655	------	------	------	Proposed Section B Outfall

Hydrograph Report

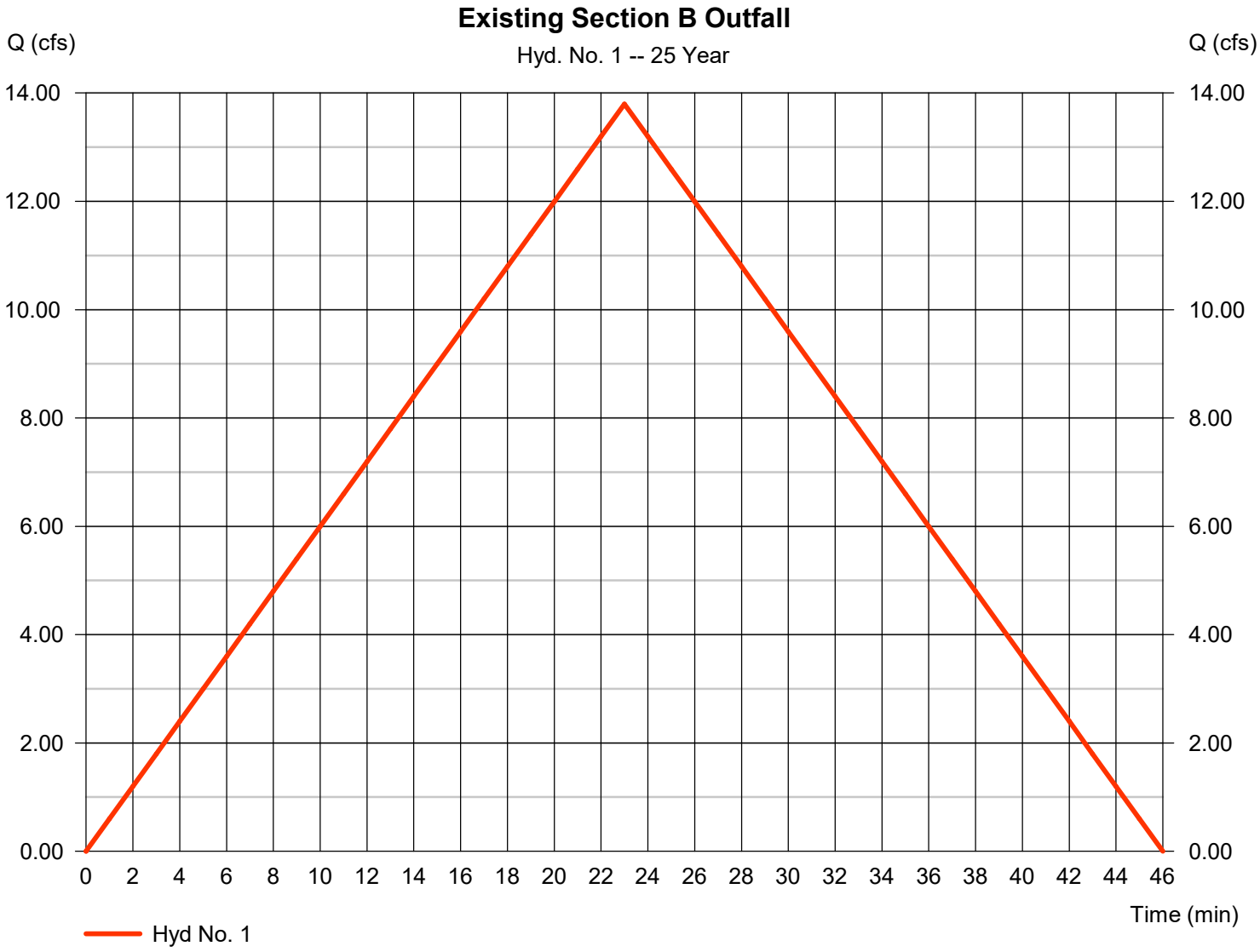
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 1

Existing Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	13.80 cfs
Storm frequency	=	25 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	19,038 cuft
Drainage area	=	6.700 ac	Runoff coeff.	=	0.52*
Intensity	=	3.960 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.150 x 0.90) + (4.080 x 0.30)] / 6.700



Hydrograph Report

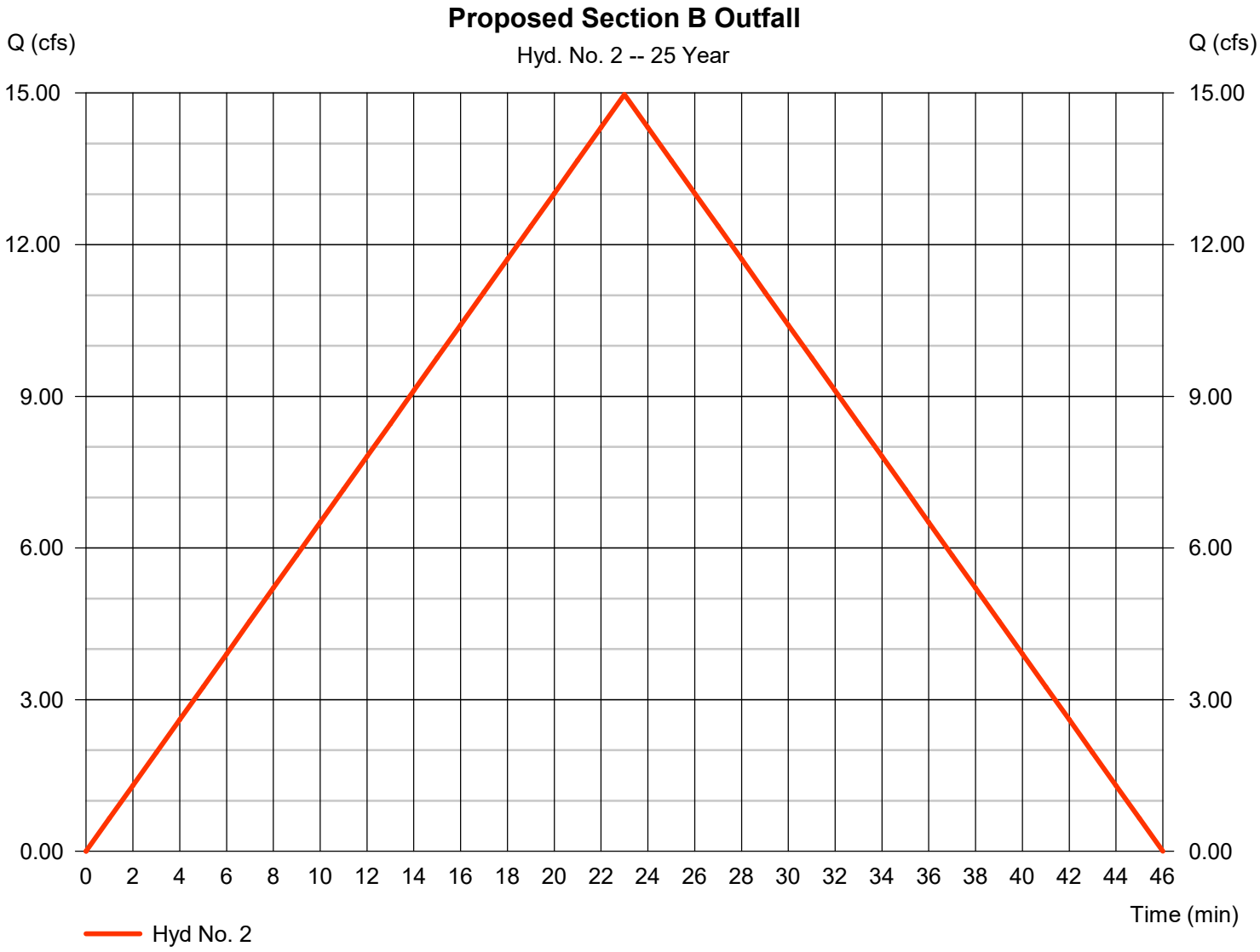
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 2

Proposed Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	14.97 cfs
Storm frequency	=	25 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	20,655 cuft
Drainage area	=	6.750 ac	Runoff coeff.	=	0.56*
Intensity	=	3.960 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(2.950 x 0.90) + (3.840 x 0.30)] / 6.750



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	17.08	1	23	23,570	------	------	------	Existing Section B Outfall
2	Rational	18.53	1	23	25,573	------	------	------	Proposed Section B Outfall

Hydrograph Report

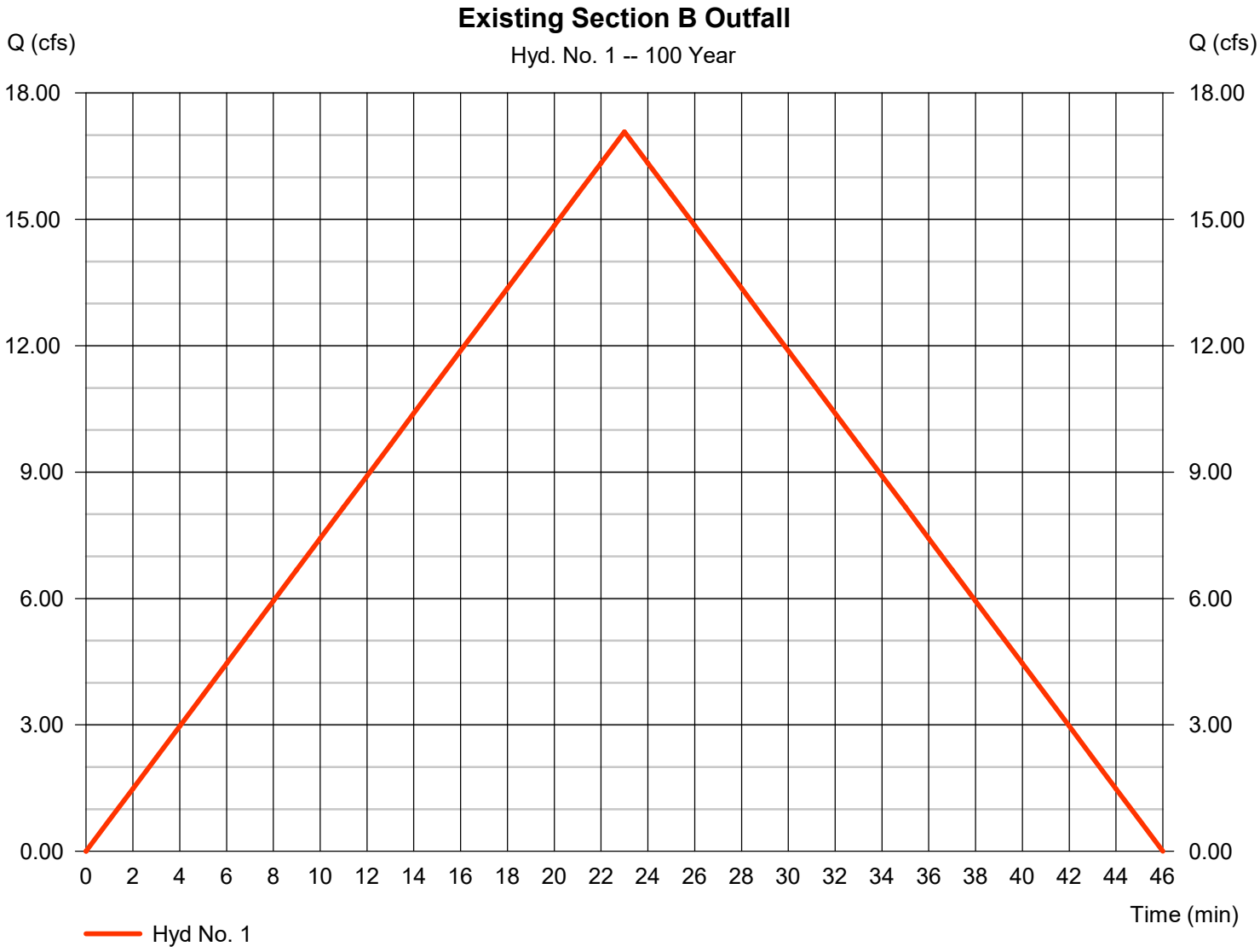
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 1

Existing Section B Outfall

Hydrograph type	= Rational	Peak discharge	= 17.08 cfs
Storm frequency	= 100 yrs	Time to peak	= 23 min
Time interval	= 1 min	Hyd. volume	= 23,570 cuft
Drainage area	= 6.700 ac	Runoff coeff.	= 0.52*
Intensity	= 4.902 in/hr	Tc by User	= 23.00 min
IDF Curve	= Middlesex.idf	Asc/Rec limb fact	= 1/1

* Composite (Area/C) = [(3.150 x 0.90) + (4.080 x 0.30)] / 6.700



Hydrograph Report

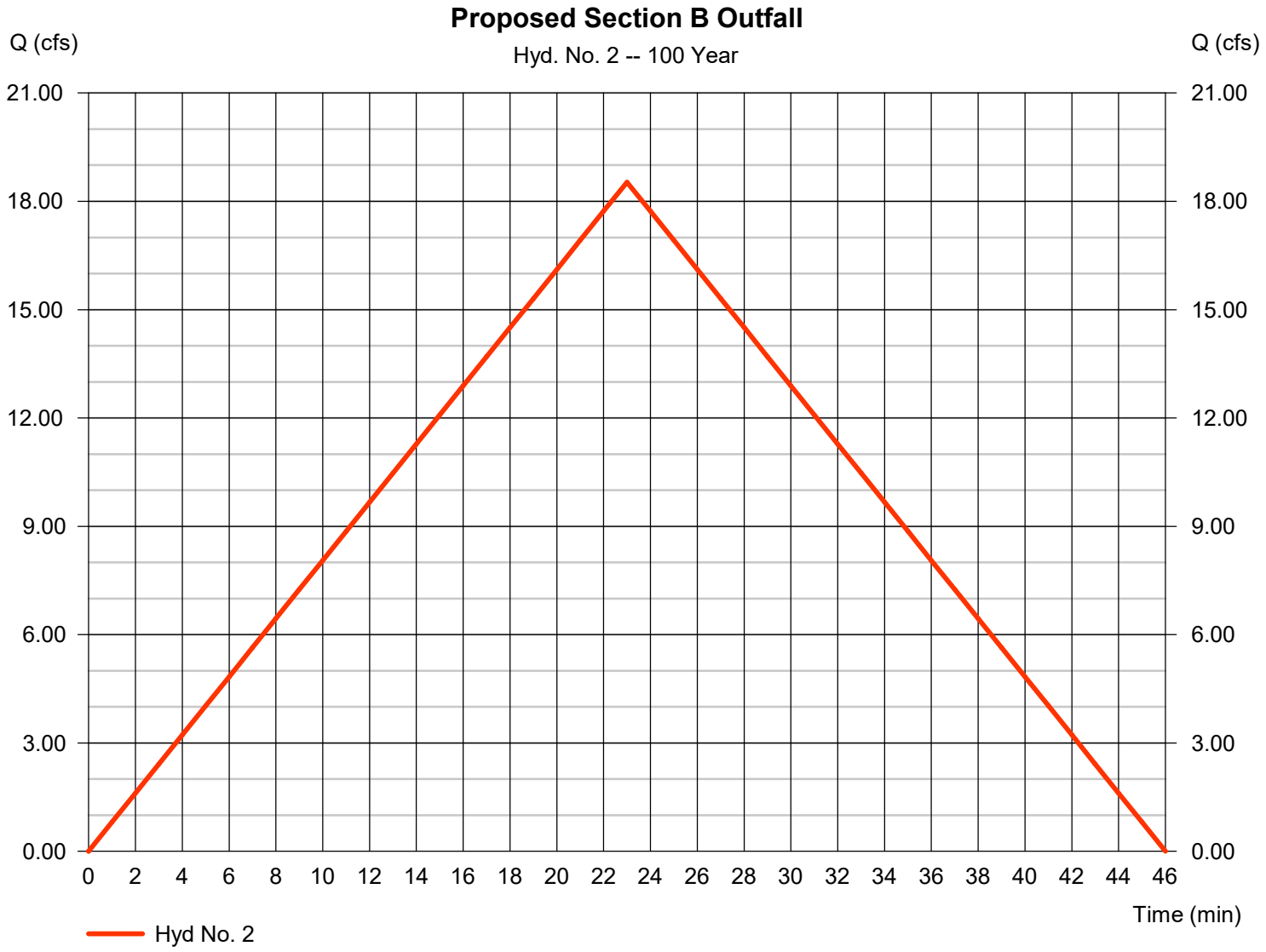
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 2

Proposed Section B Outfall

Hydrograph type	=	Rational	Peak discharge	=	18.53 cfs
Storm frequency	=	100 yrs	Time to peak	=	23 min
Time interval	=	1 min	Hyd. volume	=	25,573 cuft
Drainage area	=	6.750 ac	Runoff coeff.	=	0.56*
Intensity	=	4.902 in/hr	Tc by User	=	23.00 min
IDF Curve	=	Middlesex.idf	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(2.950 x 0.90) + (3.840 x 0.30)] / 6.750



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	22.4465	3.7000	0.7111	--------
3	0.0000	0.0000	0.0000	--------
5	75.4607	12.3000	0.9153	--------
10	41.9134	5.0000	0.7581	--------
25	38.1345	3.2000	0.6935	--------
50	39.3485	2.6000	0.6731	--------
100	38.4123	1.8000	0.6412	--------

File name: Middlesex.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	4.82	3.49	2.80	2.36	2.06	1.84	1.67	1.53	1.42	1.32	1.24	1.17
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	5.55	4.40	3.66	3.14	2.75	2.45	2.21	2.02	1.86	1.72	1.60	1.50
10	7.32	5.38	4.33	3.65	3.18	2.83	2.56	2.34	2.16	2.01	1.88	1.77
25	8.86	6.37	5.10	4.31	3.76	3.36	3.05	2.80	2.59	2.42	2.28	2.15
50	10.05	7.15	5.71	4.82	4.22	3.77	3.42	3.15	2.92	2.73	2.57	2.43
100	11.24	7.89	6.29	5.32	4.66	4.18	3.81	3.51	3.26	3.06	2.88	2.73

Tc = time in minutes. Values may exceed 60.

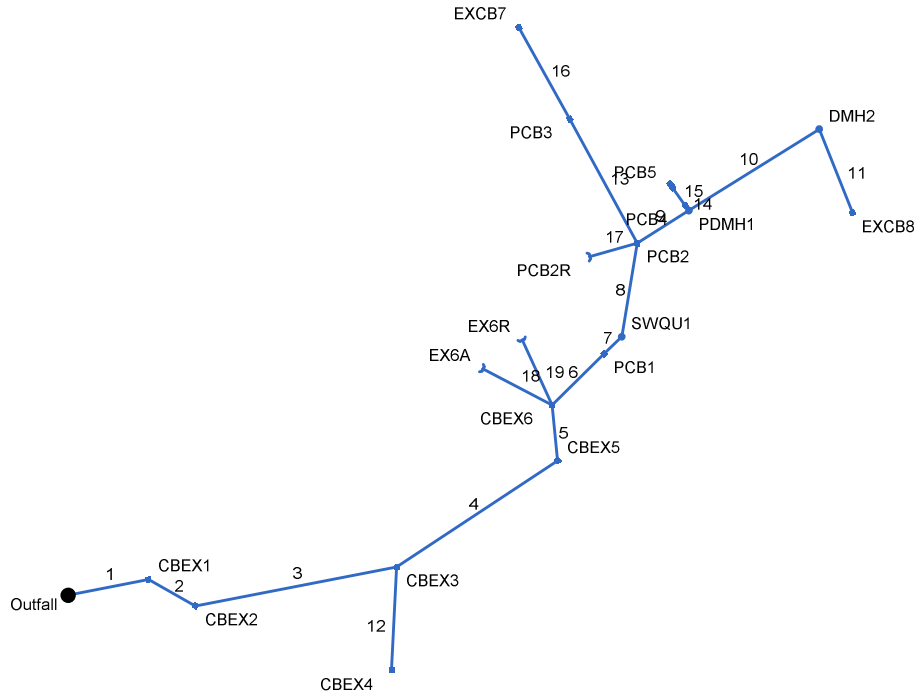
Precip. file name: Middlesex.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	3.42	0.00	4.40	5.21	6.32	7.14	8.03
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX D1

HYDRAFLOW MODEL RESULTS

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



Project File: Supplemental Pinehurst Section B.stm	Number of lines: 19	Date: 10/4/2021

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	67.000	-11.183	Grate	0.00	0.52	0.54	15.0	309.70	18.78	322.28	18	Cir	0.013	1.05	331.18	CBEX1 TO OUTFALL
2	1	44.000	40.767	Grate	0.00	1.59	0.50	20.0	323.18	1.34	323.77	15	Cir	0.013	1.05	331.97	CBEX2 TO CBEX1
3	2	168.000	-40.592	Comb	0.00	0.37	0.62	10.0	328.37	2.08	331.87	15	Cir	0.013	1.50	336.07	CBEX3 TO CBEX2
4	3	158.000	-22.513	Comb	0.00	0.06	0.67	5.0	332.17	5.05	340.15	15	Cir	0.013	1.35	340.15	CBEX5 TO CBEX3
5	4	46.000	-61.894	Grate	0.00	0.35	0.66	10.0	336.05	1.41	336.70	15	Cir	0.013	1.30	339.70	CBEX6 TO CBEX5
6	5	60.000	50.593	Comb	0.00	0.40	0.58	10.0	337.00	2.50	338.50	15	Cir	0.013	0.50	343.70	PCB1 TO CBEX6
7	6	20.000	0.865	MH	0.00	0.00	0.00	0.0	338.50	3.35	339.17	15	Cir	0.012	0.65	344.50	SWQU1 TO PCB1
8	7	78.000	-36.733	Comb	0.00	0.14	0.66	5.0	339.17	5.81	343.70	15	Cir	0.013	1.50	347.50	PCB2 TO SWQU1
9	8	50.000	48.378	MH	0.00	0.00	0.00	0.0	343.80	1.20	344.40	15	Cir	0.013	1.00	349.50	PDMH1 TO PCB2
10	9	126.000	0.243	MH	0.00	0.00	0.00	0.0	344.40	1.32	346.06	15	Cir	0.013	1.00	352.50	DMH2 TO PDMH1
11	10	74.000	100.465	Grate	0.00	0.05	0.55	10.0	346.06	1.68	347.30	15	Cir	0.013	1.00	350.40	EXCB8 TO DMH2
12	3	85.000	103.858	Grate	0.00	0.78	0.62	15.0	332.07	0.86	332.80	15	Cir	0.013	1.00	336.80	CBEX4 TO CBEX3
13	8	116.000	-37.719	Comb	0.00	0.43	0.37	20.0	343.70	0.95	344.80	15	Cir	0.013	0.50	349.60	PCB3 TO PCB2
14	9	5.000	-93.379	Comb	0.00	0.36	0.49	10.0	344.40	2.00	344.50	15	Cir	0.011	0.50	349.00	PCB4 TO PDMH1
15	14	20.000	0.233	Comb	0.00	0.48	0.69	10.0	344.50	2.50	345.00	15	Cir	0.012	1.00	348.70	PCB5 TO PCB4
16	13	86.000	-0.630	Grate	0.00	0.58	0.30	20.0	344.80	0.81	345.50	15	Cir	0.013	1.00	350.00	EXCB7 TO PCB3
17	8	40.371	-115.203	Hdwl	0.00	0.15	0.90	5.0	343.70	2.01	344.51	6	Cir	0.011	1.00	348.00	PCB2R TO PCB2
18	5	63.974	-56.897	Hdwl	0.00	0.34	0.70	5.0	336.70	2.00	337.98	6	Cir	0.011	1.00	340.00	EX6A TO CBEX6
19	5	58.616	-19.285	Hdwl	0.00	0.15	0.90	5.0	336.70	2.00	337.87	6	Cir	0.011	1.00	340.00	EX6R TO CBEX6

Project File: Supplemental Pinehurst Section B.stm | Number of lines: 19 | Date: 10/4/2021

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	CBEX1 TO OUTFALL	12.55	18	Cir	67.000	309.70	322.28	18.776	311.12	323.61	n/a	323.61 j	End	Grate
2	CBEX2 TO CBEX1	11.64	15	Cir	44.000	323.18	323.77	1.341	324.43*	325.86*	1.47	327.33	1	Grate
3	CBEX3 TO CBEX2	9.07	15	Cir	168.000	328.37	331.87	2.083	329.37	333.03	n/a	333.03	2	Combination
4	CBEX5 TO CBEX3	6.73	15	Cir	158.000	332.17	340.15	5.051	333.03	341.19	n/a	341.19	3	Combination
5	CBEX6 TO CBEX5	6.62	15	Cir	46.000	336.05	336.70	1.413	341.19*	341.68*	0.59	342.26	4	Grate
6	PCB1 TO CBEX6	4.58	15	Cir	60.000	337.00	338.50	2.500	342.26*	342.57*	0.11	342.67	5	Combination
7	SWQU1 TO PCB1	3.79	15	Cir	20.000	338.50	339.17	3.350	342.67*	342.73*	0.10	342.83	6	Manhole
8	PCB2 TO SWQU1	3.83	15	Cir	78.000	339.17	343.70	5.808	342.83	344.49	n/a	344.49 j	7	Combination
9	PDMH1 TO PCB2	2.53	15	Cir	50.000	343.80	344.40	1.200	344.49	345.04	n/a	345.04 j	8	Manhole
10	DMH2 TO PDMH1	0.14	15	Cir	126.000	344.40	346.06	1.317	345.04	346.21	n/a	346.21 j	9	Manhole
11	EXCB8 TO DMH2	0.15	15	Cir	74.000	346.06	347.30	1.676	346.21	347.45	n/a	347.45	10	Grate
12	CBEX4 TO CBEX3	2.09	15	Cir	85.000	332.07	332.80	0.859	333.03	333.38	n/a	333.38 j	3	Grate
13	PCB3 TO PCB2	1.19	15	Cir	116.000	343.70	344.80	0.948	344.49	345.23	n/a	345.23 j	8	Combination
14	PCB4 TO PDMH1	2.72	15	Cir	5.000	344.40	344.50	2.000	345.04	345.16	n/a	345.16	9	Combination
15	PCB5 TO PCB4	1.78	15	Cir	20.000	344.50	345.00	2.500	345.16	345.53	n/a	345.53 j	14	Combination
16	EXCB7 TO PCB3	0.64	15	Cir	86.000	344.80	345.50	0.814	345.23	345.81	n/a	345.81 j	13	Grate
17	PCB2R TO PCB2	0.99	6	Cir	40.371	343.70	344.51	2.006	344.49*	345.39*	0.39	345.78	8	OpenHeadwall
18	EX6A TO CBEX6	1.74	6	Cir	63.974	336.70	337.98	2.001	342.26*	346.68*	1.22	347.90	5	OpenHeadwall
19	EX6R TO CBEX6	0.99	6	Cir	58.616	336.70	337.87	1.996	342.26*	343.57*	0.39	343.96	5	OpenHeadwall

Project File: Supplemental Pinehurst Section B.stm | Number of lines: 19 | Run Date: 10/4/2021

NOTES: Return period = 10 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	67.000	0.52	6.75	0.54	0.28	3.76	15.0	23.1	3.3	12.55	45.50	7.41	18	18.78	309.70	322.28	311.12	323.61	312.00	331.18	CBEX1 TO OUTF
2	1	44.000	1.59	6.23	0.50	0.80	3.48	20.0	23.1	3.3	11.64	7.48	9.49	15	1.34	323.18	323.77	324.43	325.86	331.18	331.97	CBEX2 TO CBEX
3	2	168.000	0.37	4.64	0.62	0.23	2.68	10.0	22.7	3.4	9.07	9.32	8.15	15	2.08	328.37	331.87	329.37	333.03	331.97	336.07	CBEX3 TO CBEX
4	3	158.000	0.06	3.49	0.67	0.04	1.97	5.0	22.3	3.4	6.73	14.51	6.83	15	5.05	332.17	340.15	333.03	341.19	336.07	340.15	CBEX5 TO CBEX
5	4	46.000	0.35	3.43	0.66	0.23	1.93	10.0	22.2	3.4	6.62	7.68	5.39	15	1.41	336.05	336.70	341.19	341.68	340.15	339.70	CBEX6 TO CBEX
6	5	60.000	0.40	2.59	0.58	0.23	1.33	10.0	21.9	3.5	4.58	10.21	3.73	15	2.50	337.00	338.50	342.26	342.57	339.70	343.70	PCB1 TO CBEX6
7	6	20.000	0.00	2.19	0.00	0.00	1.10	0.0	21.8	3.5	3.79	12.80	3.09	15	3.35	338.50	339.17	342.67	342.73	343.70	344.50	SWQU1 TO PCB1
8	7	78.000	0.14	2.19	0.66	0.09	1.10	5.0	21.5	3.5	3.83	15.56	3.90	15	5.81	339.17	343.70	342.83	344.49	344.50	347.50	PCB2 TO SWQU1
9	8	50.000	0.00	0.89	0.00	0.00	0.54	0.0	12.8	4.7	2.53	7.07	3.84	15	1.20	343.80	344.40	344.49	345.04	347.50	349.50	PDMH1 TO PCB2
10	9	126.000	0.00	0.05	0.00	0.00	0.03	0.0	10.7	5.2	0.14	7.41	1.01	15	1.32	344.40	346.06	345.04	346.21	349.50	352.50	DMH2 TO PDMH
11	10	74.000	0.05	0.05	0.55	0.03	0.03	10.0	10.0	5.4	0.15	8.36	1.83	15	1.68	346.06	347.30	346.21	347.45	352.50	350.40	EXCB8 TO DMH2
12	3	85.000	0.78	0.78	0.62	0.48	0.48	15.0	15.0	4.3	2.09	5.98	2.93	15	0.86	332.07	332.80	333.03	333.38	336.07	336.80	CBEX4 TO CBEX
13	8	116.000	0.43	1.01	0.37	0.16	0.33	20.0	20.7	3.6	1.19	6.29	2.32	15	0.95	343.70	344.80	344.49	345.23	347.50	349.60	PCB3 TO PCB2
14	9	5.000	0.36	0.84	0.49	0.18	0.51	10.0	10.1	5.4	2.72	10.79	4.22	15	2.00	344.40	344.50	345.04	345.16	349.50	349.00	PCB4 TO PDMH1
15	14	20.000	0.48	0.48	0.69	0.33	0.33	10.0	10.0	5.4	1.78	11.06	3.15	15	2.50	344.50	345.00	345.16	345.53	349.00	348.70	PCB5 TO PCB4
16	13	86.000	0.58	0.58	0.30	0.17	0.17	20.0	20.0	3.7	0.64	5.83	2.18	15	0.81	344.80	345.50	345.23	345.81	349.60	350.00	EXCB7 TO PCB3
17	8	40.371	0.15	0.15	0.90	0.14	0.14	5.0	5.0	7.3	0.99	0.94	5.03	6	2.01	343.70	344.51	344.49	345.39	347.50	348.00	PCB2R TO PCB2
18	5	63.974	0.34	0.34	0.70	0.24	0.24	5.0	5.0	7.3	1.74	0.94	8.87	6	2.00	336.70	337.98	342.26	346.68	339.70	340.00	EX6A TO CBEX6
19	5	58.616	0.15	0.15	0.90	0.14	0.14	5.0	5.0	7.3	0.99	0.94	5.03	6	2.00	336.70	337.87	342.26	343.57	339.70	340.00	EX6R TO CBEX6

Project File: Supplemental Pinehurst Section B.stm

Number of lines: 19

Run Date: 10/4/2021

NOTES:Intensity = 41.91 / (Inlet time + 5.00) ^ 0.76; Return period =Yrs. 10 ; c = cir e = ellip b = box

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q Byp (cfs)	Junc Type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp Line No
							Ht (in)	L (ft)	Area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	CBEX1	1.21	0.00	1.21	0.00	Grate	0.0	0.00	3.11	2.30	1.35	Sag	2.00	0.020	0.050	0.013	0.09	3.00	0.26	3.00	2.0	Off
2	CBEX2	2.90	0.46	3.36	0.00	Grate	0.0	0.00	3.11	2.30	1.35	Sag	2.00	0.030	0.030	0.013	0.28	9.29	0.45	9.29	2.0	1
3	CBEX3	1.23	0.05	0.82	0.46	Comb	6.0	2.30	0.00	2.30	1.35	0.050	2.00	0.030	0.030	0.013	0.13	4.20	0.25	2.87	2.0	2
4	CBEX5	0.29	0.00	0.25	0.05	Comb	6.0	2.30	0.00	2.30	1.35	0.040	2.00	0.030	0.030	0.013	0.08	2.52	0.21	1.28	2.0	3
5	CBEX6	1.24	0.00	1.24	0.00	Grate	0.0	0.00	3.11	2.30	1.35	Sag	2.00	0.020	0.020	0.013	0.09	4.65	0.26	4.65	2.0	4
6	PCB1	1.25	0.27	1.52	0.00	Comb	6.0	2.30	3.11	2.30	1.35	Sag	2.00	0.030	0.030	0.013	0.16	5.46	0.33	5.46	2.0	5
7	SWQU1	0.00	0.27	0.00	0.27	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	6
8	PCB2	0.68	0.00	0.41	0.27	Comb	6.0	2.30	0.00	2.30	1.35	0.020	2.00	0.020	0.020	0.013	0.10	5.06	0.24	3.58	2.0	7
9	PDMH1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	8
10	DMH2	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.013	0.00	0.00	0.00	0.00	0.0	9
11	EXCB8	0.15	0.00	0.14	0.00	Grate	0.0	0.00	0.00	2.30	1.35	0.040	2.00	0.040	0.040	0.013	0.07	1.63	0.02	0.38	0.0	Off
12	CBEX4	2.09	0.00	2.09	0.00	Grate	0.0	0.00	3.11	2.30	1.35	Sag	2.00	0.030	0.030	0.013	0.18	5.95	0.35	5.95	2.0	3
13	PCB3	0.58	0.00	0.58	0.00	Comb	6.0	2.30	3.11	2.30	1.35	Sag	2.00	0.030	0.030	0.013	0.06	2.04	0.23	2.04	2.0	8
14	PCB4	0.95	0.00	0.95	0.00	Comb	6.0	2.30	3.11	2.30	1.35	Sag	2.00	0.040	0.050	0.013	0.12	2.71	0.28	2.71	2.0	9
15	PCB5	1.78	0.00	1.78	0.00	Comb	6.0	4.60	6.21	4.60	1.35	Sag	2.00	0.040	0.040	0.013	0.14	3.61	0.31	3.61	2.0	14
16	EXCB7	0.64	0.00	0.64	0.00	Grate	0.0	0.00	3.11	2.30	1.35	Sag	5.00	0.050	0.050	0.013	0.16	3.10	0.16	3.10	0.0	13
17	PCB2R	0.99	0.00	0.99	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.013	0.00	0.00	0.00	0.00	0.0	8
18	EX6A	1.74	0.00	1.74	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.013	0.00	0.00	0.00	0.00	0.0	5
19	EX6R	0.99	0.00	0.99	0.00	Hdwl	0.0	0.00	0.00	0.00	0.00	Sag	2.00	0.050	0.020	0.013	0.00	0.00	0.00	0.00	0.0	5

Project File: Supplemental Pinehurst Section B.stm | Number of lines: 19 | Run Date: 10/4/2021

NOTES: Inlet N-Values = 0.016; Intensity = 41.91 / (Inlet time + 5.00) ^ 0.76; Return period = 10 Yrs. ; * Indicates Known Q added. All curb inlets are Horiz throat.