LAKE AVENUE CULVERT REPLACEMENT

CITY OF BRISTOL

STORMWATER DRAINAGE ANALYSIS REPORT

PREPARED BY:

Kati Mercier
Digitally signed by Kati Mercier
DN: C=US, E=kati.mercier@wsp.com, O=WSP USA, CN=Kati Mercier
Date: 2022.05.05 21:53:42-04'00'

KATI L. MERCIER, P.E.

CHECKED BY:

Richard Pettinelli, PE
Digitally signed by Richard Pettinelli, PE
DN: cn=Richard Pettinelli, PE, c=US, o=WSP USA, email=richard.pettinelli@wsp.com
Reason: I have reviewed this document
Date: 2022.05.05 22:10:58 -04'00'

RICHARD L. PETTINELLI, P.E.

DATE: MAY 2022

500 WINDING BROOK DRIVE
GLASTONBURY, CT 06033

WSP.COM

FIGURES

APPENDICES

1 INTRODUCTION

WSP USA Inc. (WSP) was engaged by the City of Bristol (City) to provide engineering services for the complete replacement of Bridge No. 017005, the Lake Avenue Culvert which carries Lake Avenue over the Cussgutter Brook ("the project").

This report documents the stormwater drainage design analysis for the two catch basin stormwater drainage system at the project in the City of Bristol and the Town of Southington, Connecticut both in Hartford County. A location map of the project site is presented in Figure 1.

2 PROJECT INFORMATION

Lake Avenue runs from Middle Street (Route 229) southerly to Welch Road where Lake Avenue then transitions into Mt Vernon Road. The Project is located immediately north of Lake Compounce Amusement Park; approximately ½ mile south of the intersection with Glenn Street. In the vicinity of the project, the eastern street line is the municipal boundary with the street lying within the City of Bristol on the west and the Town of Southington located to the east. The total project length is 291 feet. It is noted that access will need to be maintained for one residential driveway within these limits throughout construction. The travel way will remain open as the proposed culvert will be constructed with a staged construction approach.

Bridge No. 017005 shall be replaced in its entirety with a box culvert. Lake Avenue is the only roadway within the project limits. Lake Avenue is generally a north-south roadway and is classified as an urban minor arterial. For the length of the project, Lake Avenue will be constructed to a 30-foot-wide roadway with one 11-foot lane and 4-foot shoulder in each direction. The width slightly varies at the project limits to tie into the existing roadway geometry. Additionally, bituminous concrete curbing will be installed on either side of the roadway.

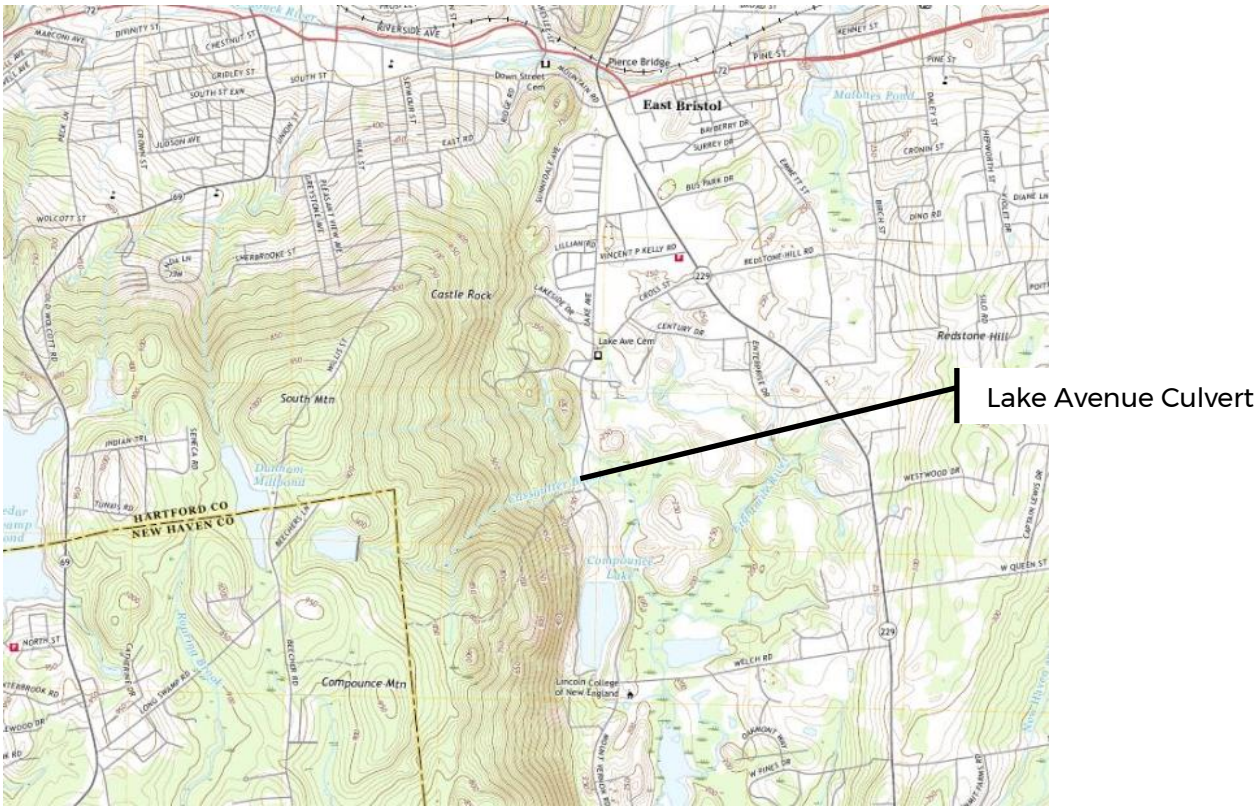


Figure 1 – Location Plan

2.1 EXISTING STORMWATER CONDITIONS

In the existing condition, Lake Avenue has curbs throughout the project limits and is on a constant longitudinal grade downward to the north with a sag located approximately 620± feet north of the project limits drained by an existing pair of Type C catch basins that outlets to the east at the sag location. Within the project limits there is an on-grade Type C catch basin grate that discharges directly into the roof of the Lake Avenue culvert on the northeast curbed gutterline. The southwest curbed gutterline has no catch basins in the vicinity of the project until the sag to the north that is previously mentioned.

2.2 PROPOSED STORMWATER CONDITIONS

The proposed project is adjusting the horizontal alignment of the road through the project but will be maintaining the 1% longitudinal slope. The road will continue to be curbed with the northwest catch basin grate shifted off of the culvert roof and instead placed up gradient of the culvert crossing with a 4' deep sump for maintenance. In addition, a catch basin will be added on the southwest curbline to intercept the flow that would otherwise travel 620± feet to the sag to the north. Both proposed catch basins will be Type C. They will be connected with a 15" RCP and the northwest catch basin will then outlet through an 18" RCP to the northeast wingwall on the downstream side of the culvert.

3 DRAINAGE COMPUTATIONS

3.1 DRAINAGE ANALYSIS AND DESIGN METHODOLOGY

The proposed storm drainage system has been designed in accordance with the Connecticut DOT Drainage Manual, October 2000 (including the most recent revisions) as well as the City of Bristol Subdivision Regulations and the Rules and Regulations Controlling Subdivision of Land of the Town of Southington, Connecticut.

The City of Bristol Subdivision Regulations Section 5.08 indicate that drainage systems shall be designed for not less than a 25-year storm; this is more stringent than the Town of Southington regulations which only require the on-grade portions of a drainage system to be designed to a 10-year storm.

Therefore, the system should be designed for a 25-year storm event without being surcharged; output reports for both the 10-year and 25-year storm events are included in the appendices of this report.

To assess the stormwater drainage system sizing the drainage areas to the individual catch basins were evaluated using the Rational Method.

The runoff coefficients used for the development of the flow were 0.95 for pavement and 0.14 for average sloped lawn in Hydrologic Soil Group A. These numbers are consistent with Tables 6-3 and 6-4 of the CTDOT Drainage Manual. It is assumed that the Time of Concentration is the minimum of 5 minutes as specified in the Manual. Rainfall intensities were determined using the frequency/intensity/duration curves for the project site from the NOAA Precipitation Frequency Data Server website (https://hdsc.nws.noaa.gov/hdsc/pfds/index.html).

Gutter flow widths and depths were analyzed to determine if additional catch basins would be required and to assign a type to them. Per Table 11-2 Pavement Drainage Design Criteria in the Connecticut DOT Drainage Manual the gutterflow allowable spread along a town road is a maximum of shoulder width plus half of a lane, which at this project would be 9.5 feet (4 foot shoulder plus half of a 11 foot lane). Gutter flow analysis was analyzed for the 25-year storm for each catch basin.

Should the City decide at a later date to tie into this stormwater drainage system there is more than enough remaining capacity with the outlet pipe sized for 10.93 cfs and the 25-year flows for the currently proposed system two catch basin system are 1.59 cfs. The 25-year peak outlet velocity is 4.41 ft/s.

3.2 COMPUTER PROGRAM

WSP utilized the Bentley computer program titled "StormCAD v8i Select Series 3". This program performs pipe system and hydraulic grade line calculations using the HEC-22 methodology. Gutter and low point analysis was completed using HEC-22 methodology as required by the Drainage Manual.

The Stormwater Drainage Map is provided in Appendix A.

The NOAA Atlas 14 Rainfall Intensities are provided in Appendix B.

The Runoff Coefficient Calculations are provided in Appendix C.

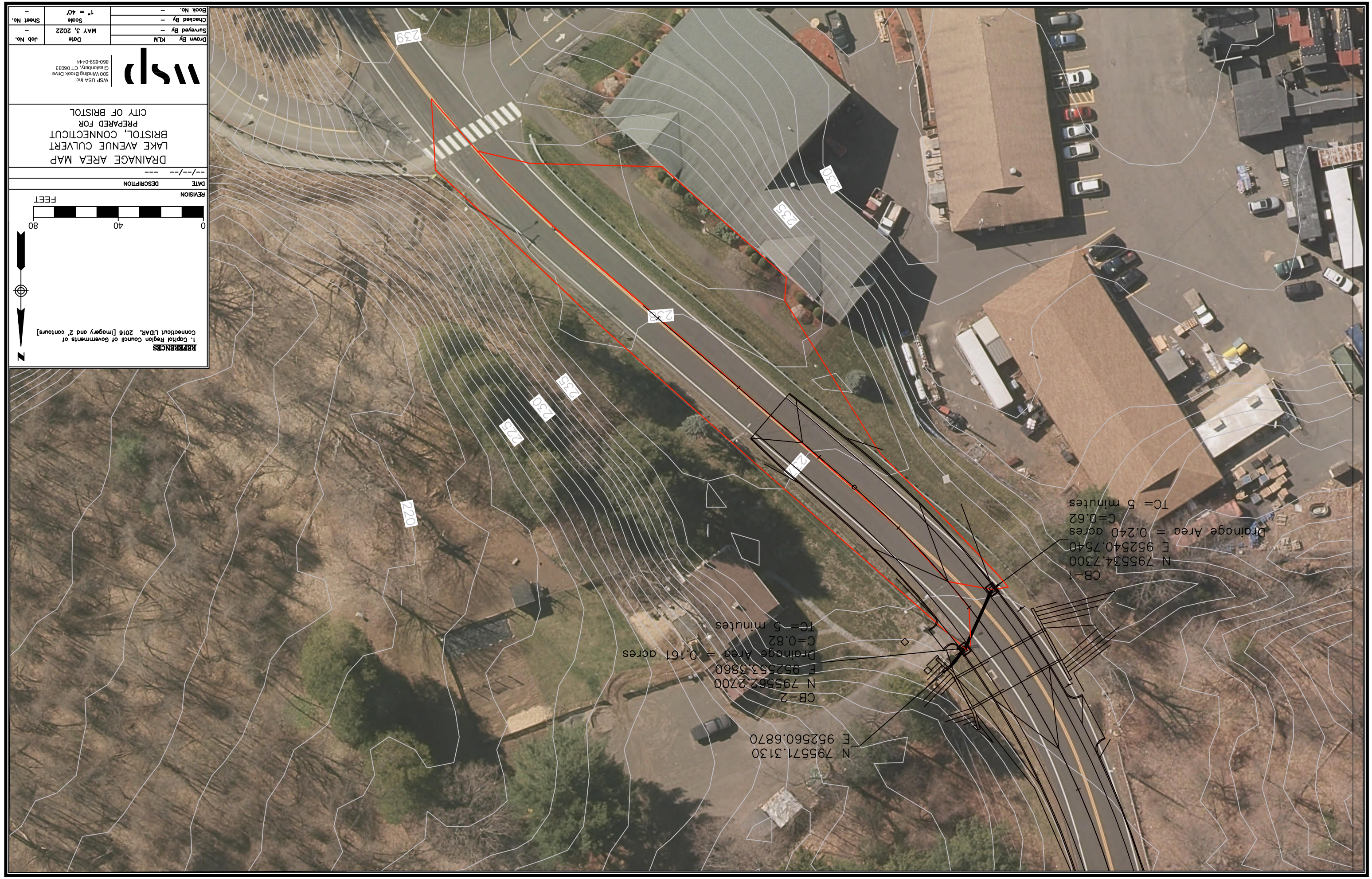
The StormCAD output reports for hydraulic grade lines as well as gutter flow are provided in Appendix D.

4 CONCLUSION

The proposed two catch basin drainage system is adequately sized to carry the required 25-year design storm.

APPENDIX

A STORMWATER DRAINAGE MAP



DRAINAGE AREA MAP
LAKE AVENUE CULVERT
BRISTOL, CONNECTICUT
PREPARED FOR
CITY OF BRISTOL

REVISION	DATE	DESCRIPTION
	--/--/--	---

0 40 80
FEET

N

REFERENCES
1. Capitol Region Council of Governments of Connecticut LiDAR, 2018 [imagery and 2' contours]

WSP USA Inc.
500 Winding Brook Drive
Glastonbury, CT 06033
860-659-0444

Drawn By	KLM	Date	Job No.
Surveyed By	–	MAY 3, 2022	–
Checked By	–	Scale	Sheet No.
Book No.	–	1" = 40'	–

APPENDIX

B NOAA ATLAS 14 RAINFALL INTENSITIES

NOAA Atlas 14, Volume 10, Version 3
Location name: Bristol, Connecticut, USA*
Latitude: 41.6434°, Longitude: -72.9305°
Elevation: 519.46 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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.28** (3.30-5.54)	**5.14** (3.95-6.65)	**6.53** (4.99-8.46)	**7.67** (5.84-10.0)	**9.25** (6.84-12.6)	**10.5** (7.57-14.6)	**11.7** (8.23-16.9)	**13.0** (8.76-19.4)	**14.9** (9.66-23.0)	**16.4** (10.4-25.8)
10-min	**3.04** (2.33-3.92)	**3.64** (2.80-4.70)	**4.62** (3.53-6.00)	**5.44** (4.14-7.10)	**6.56** (4.84-8.95)	**7.41** (5.36-10.3)	**8.29** (5.83-12.0)	**9.24** (6.20-13.7)	**10.6** (6.85-16.3)	**11.6** (7.36-18.3)
15-min	**2.38** (1.83-3.08)	**2.85** (2.19-3.69)	**3.62** (2.77-4.70)	**4.26** (3.25-5.57)	**5.14** (3.80-7.02)	**5.81** (4.20-8.10)	**6.50** (4.57-9.38)	**7.25** (4.86-10.8)	**8.29** (5.37-12.8)	**9.12** (5.78-14.3)
30-min	**1.62** (1.25-2.09)	**1.94** (1.49-2.51)	**2.46** (1.88-3.19)	**2.89** (2.20-3.77)	**3.48** (2.57-4.75)	**3.93** (2.85-5.48)	**4.40** (3.10-6.35)	**4.91** (3.29-7.28)	**5.62** (3.64-8.64)	**6.19** (3.92-9.72)
60-min	**1.02** (0.788-1.32)	**1.23** (0.941-1.59)	**1.55** (1.19-2.02)	**1.82** (1.39-2.38)	**2.20** (1.62-3.00)	**2.48** (1.80-3.46)	**2.77** (1.95-4.01)	**3.10** (2.08-4.59)	**3.54** (2.29-5.45)	**3.91** (2.47-6.14)
2-hr	**0.672** (0.520-0.864)	**0.798** (0.616-1.03)	**1.00** (0.772-1.30)	**1.17** (0.898-1.53)	**1.41** (1.05-1.91)	**1.59** (1.15-2.20)	**1.77** (1.25-2.55)	**1.97** (1.33-2.92)	**2.26** (1.47-3.46)	**2.49** (1.58-3.90)
3-hr	**0.521** (0.404-0.667)	**0.618** (0.479-0.793)	**0.778** (0.600-1.00)	**0.910** (0.699-1.18)	**1.09** (0.813-1.48)	**1.23** (0.898-1.70)	**1.37** (0.975-1.97)	**1.53** (1.03-2.26)	**1.76** (1.15-2.69)	**1.95** (1.24-3.04)
6-hr	**0.332** (0.259-0.423)	**0.398** (0.309-0.507)	**0.506** (0.392-0.646)	**0.595** (0.459-0.765)	**0.718** (0.538-0.969)	**0.810** (0.595-1.12)	**0.907** (0.650-1.31)	**1.02** (0.691-1.50)	**1.19** (0.775-1.81)	**1.33** (0.847-2.06)
12-hr	**0.204** (0.159-0.258)	**0.249** (0.194-0.315)	**0.322** (0.251-0.409)	**0.383** (0.297-0.489)	**0.466** (0.352-0.628)	**0.528** (0.391-0.729)	**0.595** (0.431-0.859)	**0.677** (0.459-0.989)	**0.801** (0.524-1.22)	**0.908** (0.581-1.40)
24-hr	**0.120** (0.094-0.151)	**0.149** (0.117-0.188)	**0.197** (0.155-0.249)	**0.237** (0.185-0.302)	**0.293** (0.222-0.393)	**0.333** (0.249-0.460)	**0.377** (0.276-0.547)	**0.434** (0.295-0.632)	**0.524** (0.343-0.791)	**0.602** (0.387-0.928)
2-day	**0.067** (0.053-0.084)	**0.085** (0.067-0.107)	**0.115** (0.091-0.144)	**0.140** (0.109-0.176)	**0.173** (0.133-0.233)	**0.198** (0.149-0.274)	**0.226** (0.167-0.329)	**0.262** (0.179-0.381)	**0.322** (0.212-0.485)	**0.376** (0.242-0.577)
3-day	**0.049** (0.039-0.061)	**0.062** (0.049-0.077)	**0.084** (0.066-0.105)	**0.102** (0.080-0.128)	**0.127** (0.097-0.170)	**0.145** (0.110-0.200)	**0.165** (0.123-0.241)	**0.193** (0.132-0.279)	**0.238** (0.157-0.357)	**0.278** (0.180-0.426)
4-day	**0.039** (0.031-0.049)	**0.050** (0.040-0.062)	**0.067** (0.053-0.084)	**0.082** (0.064-0.103)	**0.102** (0.078-0.136)	**0.116** (0.088-0.160)	**0.133** (0.099-0.192)	**0.154** (0.106-0.223)	**0.191** (0.126-0.285)	**0.223** (0.144-0.341)
7-day	**0.027** (0.021-0.033)	**0.034** (0.027-0.042)	**0.045** (0.036-0.056)	**0.054** (0.043-0.068)	**0.067** (0.051-0.089)	**0.076** (0.058-0.104)	**0.086** (0.064-0.124)	**0.100** (0.069-0.144)	**0.123** (0.081-0.183)	**0.142** (0.092-0.217)
10-day	**0.022** (0.017-0.027)	**0.027** (0.021-0.033)	**0.035** (0.028-0.043)	**0.042** (0.033-0.052)	**0.051** (0.040-0.068)	**0.058** (0.044-0.079)	**0.066** (0.049-0.094)	**0.076** (0.052-0.108)	**0.092** (0.061-0.136)	**0.106** (0.068-0.160)
20-day	**0.016** (0.013-0.019)	**0.018** (0.015-0.022)	**0.023** (0.018-0.028)	**0.026** (0.021-0.032)	**0.031** (0.024-0.041)	**0.035** (0.026-0.047)	**0.039** (0.029-0.054)	**0.044** (0.030-0.062)	**0.051** (0.034-0.075)	**0.057** (0.037-0.086)
30-day	**0.013** (0.011-0.016)	**0.015** (0.012-0.018)	**0.018** (0.014-0.022)	**0.020** (0.016-0.025)	**0.024** (0.018-0.030)	**0.026** (0.020-0.035)	**0.029** (0.021-0.040)	**0.032** (0.022-0.045)	**0.036** (0.024-0.053)	**0.040** (0.026-0.060)
45-day	**0.011** (0.009-0.013)	**0.012** (0.010-0.015)	**0.014** (0.011-0.017)	**0.016** (0.013-0.019)	**0.018** (0.014-0.023)	**0.020** (0.015-0.026)	**0.022** (0.016-0.029)	**0.023** (0.016-0.033)	**0.026** (0.017-0.038)	**0.028** (0.018-0.042)
60-day	**0.010** (0.008-0.012)	**0.010** (0.009-0.013)	**0.012** (0.010-0.015)	**0.013** (0.011-0.016)	**0.015** (0.012-0.019)	**0.016** (0.012-0.021)	**0.018** (0.013-0.024)	**0.019** (0.013-0.027)	**0.021** (0.014-0.030)	**0.022** (0.014-0.033)

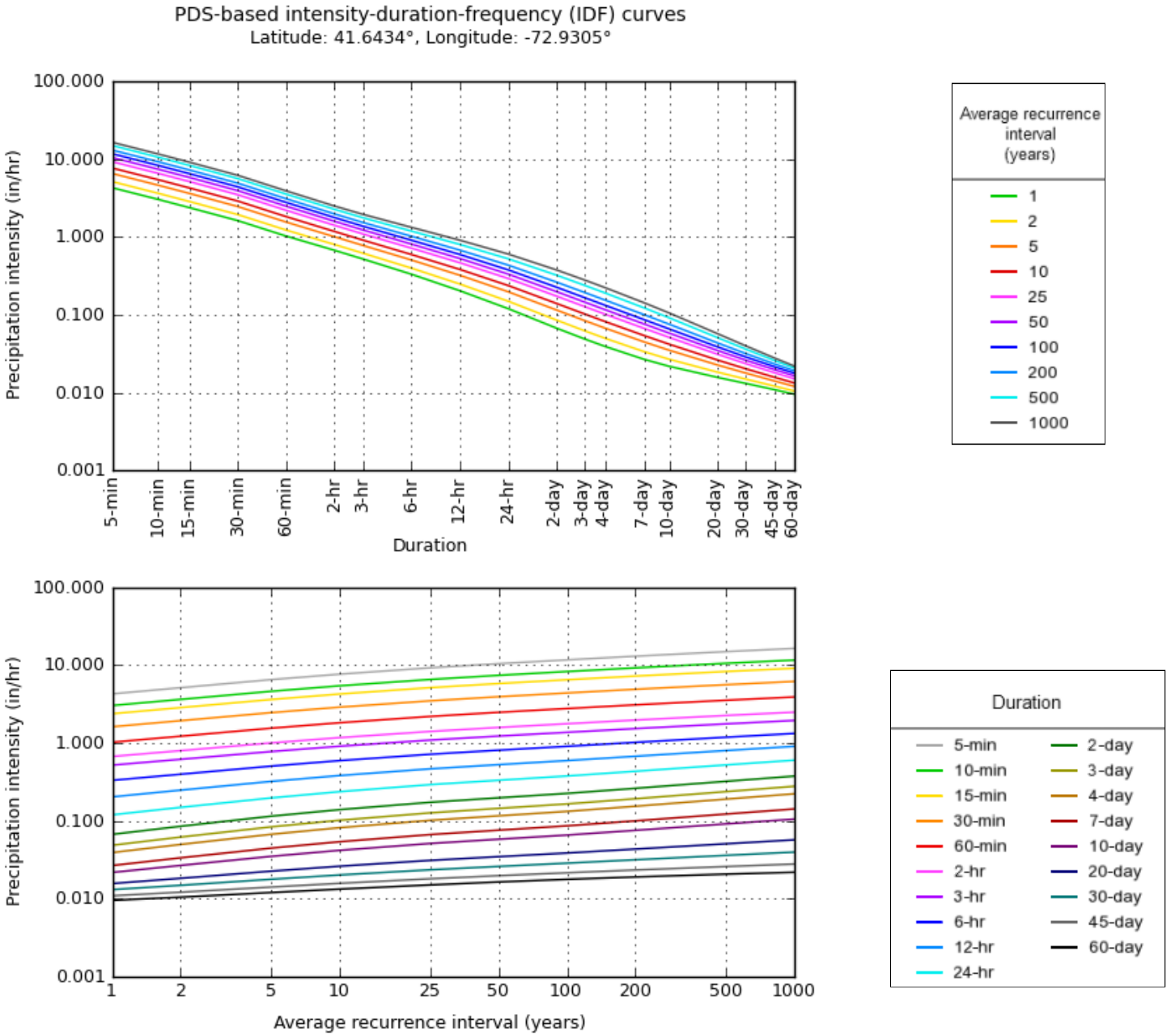
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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.

Back to Top

PF graphical



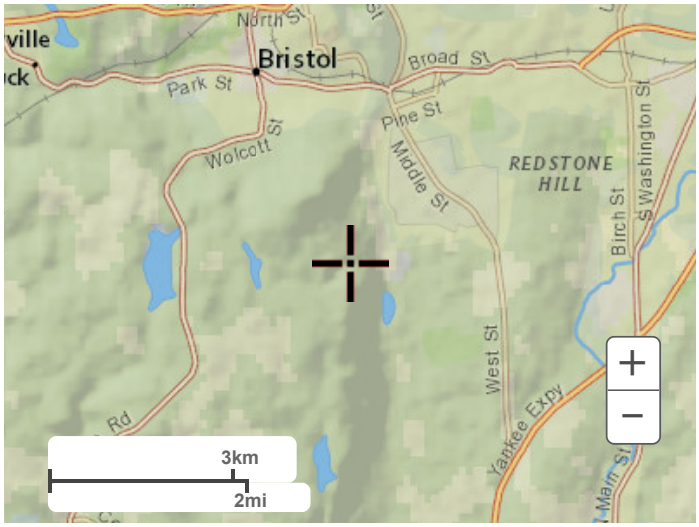
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Mon Jan 25 18:11:17 2021

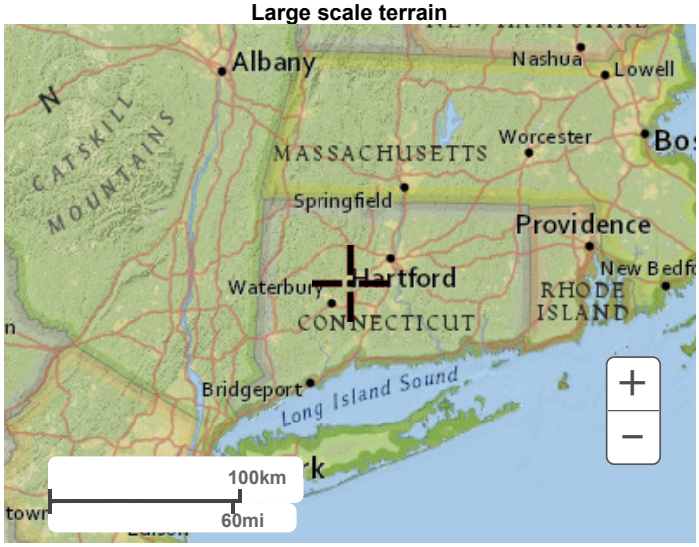
Back to Top

Maps & aerials

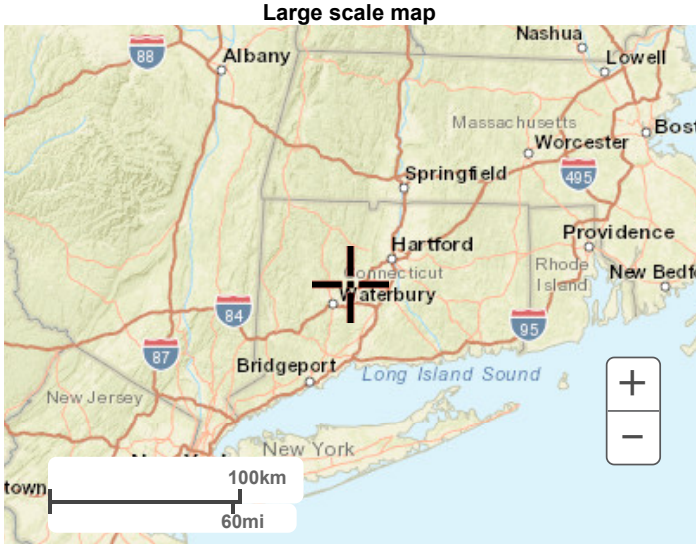
Small scale terrain



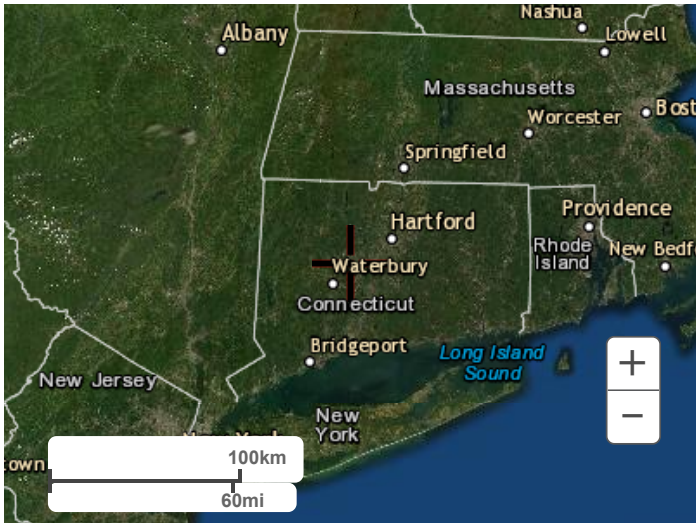
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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

APPENDIX

C RUNOFF COEFFICIENT CALCULATIONS

PROJECT: Lake Ave
PROJECT NO.: 52862B
TOWN: Bristol
ROUTE: Lake Ave

DESIGNED BY: KLM DATE: 4/14/2022

Subcatchment Areas

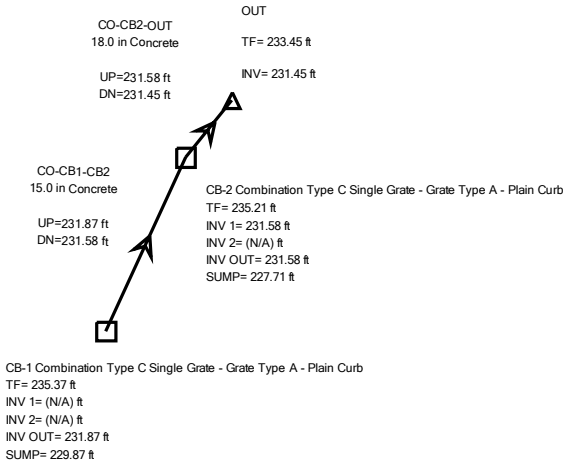
Discharge Location	Catchment Area	Receiving Structure	Total Area (SF)	Area Total (AC)	Weighted C Value	Pavement Area (SF)	C Value	Lawn Area (SF)	C Value
Cherry Brook									
	CB1 (SW)	CB1	10,440	**0.240**	**0.62**	6,220	0.95	4,220	0.14
	CB2 (NE)	CB2	7,020	**0.161**	**0.82**	5,880	0.95	1,140	0.14

*Lawn, Hydrologic Soil Group A, Average Slopes, CTDOT Drainage Manual, Table 6-3, Coefficient = 0.14

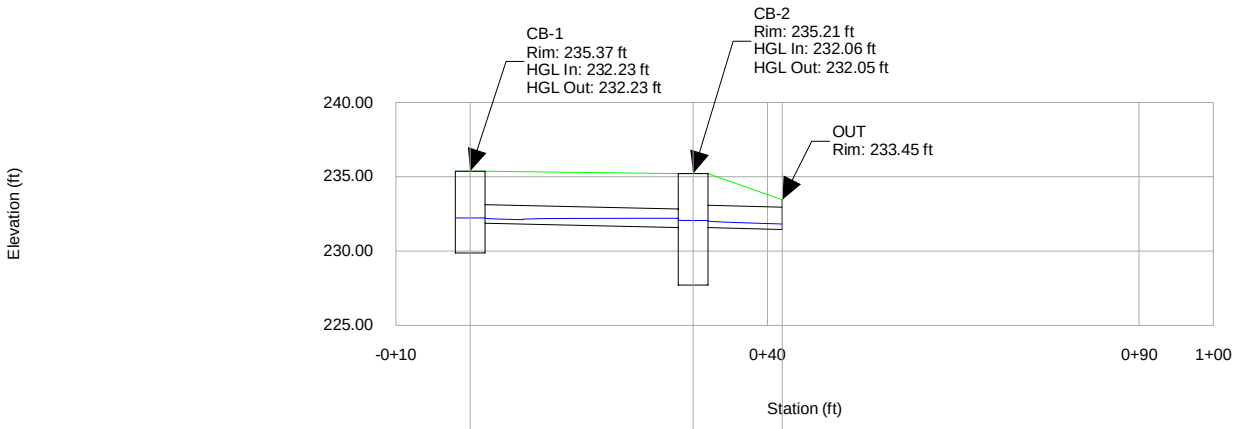
APPENDIX

D STORMCAD OUTPUT

LakeAve.stsw
Scenario: 25 yr
Active Scenario: 25 yr

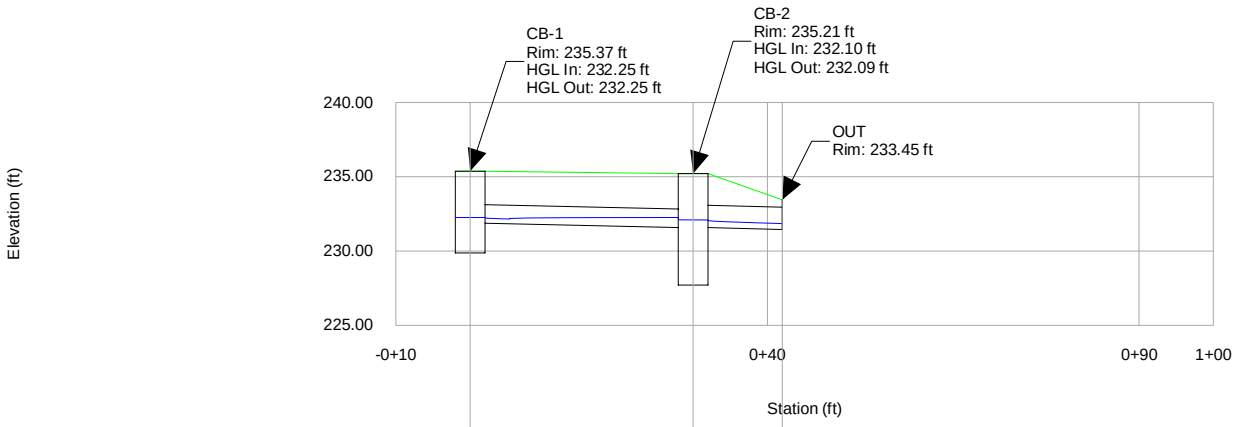


LakeAve.stsw
Profile Report
Engineering Profile - System (LakeAve.stsw)
Active Scenario: 10 yr



Element ID\Label	651\CO-CB1-CB2	574\CO-CB2-OUT	
Length (Unified) (ft)	30.0	12.0	
Rise (Unified) (ft)\Material	1.25\Concrete	1.50\Concrete	
Flow (ft³/s)	0.73	1.38	
Slope (Calculated) (ft/ft)	0.010	0.011	
Element ID\Label	649\CB-1	245\CB-2	667\OUT
Elevation (Ground) (ft)	235.37	235.21	233.45
Elevation (Invert) (ft)	229.87	227.71	231.45
Station (ft)	0+00	0+30	0+42

LakeAve.stsw
Profile Report
Engineering Profile - System (LakeAve.stsw)
Active Scenario: 25 yr



Element ID\Label	651\CO-CB1-CB2	574\CO-CB2-OUT	
Length (Unified) (ft)	30.0	12.0	
Rise (Unified) (ft)\Material	1.25\Concrete	1.50\Concrete	
Flow (ft³/s)	0.84	1.59	
Slope (Calculated) (ft/ft)	0.010	0.011	
Element ID\Label	649\CB-1	245\CB-2	667\OUT
Elevation (Ground) (ft)	235.37	235.21	233.45
Elevation (Invert) (ft)	229.87	227.71	231.45
Station (ft)	0+00	0+30	0+42

LakeAve.stsw

Conduit FlexTable: Storm Drain Analysis

Active Scenario: 10 yr

Label	Length (Unified) (ft)	System CA (acres)	Time (Pipe Flow) (min)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Diameter (in)
CO-CB1-CB2	30.0	0.094	0.1	5.000	7.67	0.73	6.35	15.0
CO-CB2-OUT	12.0	0.180	0.0	5.145	7.61	1.38	10.93	18.0

Manning's n	Slope (ft/ft)	Velocity (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
0.013	0.010	3.44	231.87	231.58	235.37	235.21
0.013	0.011	4.24	231.58	231.45	235.21	233.45

LakeAve.stsw

Conduit FlexTable: Storm Drain Analysis

Active Scenario: 25 yr

Label	Length (Unified) (ft)	System CA (acres)	Time (Pipe Flow) (min)	System Flow Time (min)	System Intensity (in/h)	System Rational Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Diameter (in)
CO-CB1-CB2	30.0	0.090	0.1	5.000	9.25	0.84	6.35	15.0
CO-CB2-OUT	12.0	0.172	0.0	5.139	9.18	1.59	10.93	18.0

Manning's n	Slope (ft/ft)	Velocity (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
0.013	0.010	3.59	231.87	231.58	235.37	235.21
0.013	0.011	4.41	231.58	231.45	235.21	233.45

LakeAve.stsw
Conduit FlexTable: HGL Report
Active Scenario: 10 yr

Label	Diameter (in)	Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Length (Unified) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)	Velocity Head (Downstream Conduit) (ft)
CO-CB2-OUT	18.0	1.38	10.93	12.0	3.19	4.08	(N/A)
CO-CB1-CB2	15.0	0.73	6.35	30.0	2.77	1.18	0.16

Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
232.18	232.08	232.02	231.82	235.21	233.45
232.32	232.23	232.20	232.21	235.37	235.21

LakeAve.stsw

Conduit FlexTable: HGL Report

Active Scenario: 25 yr

Label	Diameter (in)	Flow (ft^3/s)	Capacity (Full Flow) (ft^3/s)	Length (Unified) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)	Velocity Head (Downstream Conduit) (ft)
CO-CB2-OUT	18.0	1.59	10.93	12.0	3.33	4.23	(N/A)
CO-CB1-CB2	15.0	0.84	6.35	30.0	2.88	1.24	0.17

Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)
232.23	232.13	232.05	231.85	235.21	233.45
232.36	232.28	232.23	232.26	235.37	235.21

LakeAve.stsw

FlexTable: Catch Basin Table: Gutter Flow

Active Scenario: 10 yr

Label	Inlet Location	Inlet Drainage Area (acres)	Inlet C	Total Inlet Tc (min)	Total Inlet Intensity (in/h)	Local CA (acres)	Total Inlet CA (acres)	QT to Inlet (ft³/s)	Gutter Slope (ft/ft)	Road Cross Slope (ft/ft)	Depth (Gutter) (in)
CB-1	On Grade	0.240	0.62	5.0	7.67	0.149	0.149	1.15	0.010	0.020	1.7
CB-2	On Grade	0.161	0.82	5.0	7.67	0.132	0.132	1.02	0.010	0.020	1.6

Width of Flow (ft)	Allowable Spread	Bypass Q (ft³/s)	Bypassed CA (acres)	Intercepted CA (acres)	Inlet
7.0	9.5	0.42	0.054	0.094	Combination Type C Single Grate - Grate Type A - Plain Curb
6.7	9.5	0.36	0.046	0.086	Combination Type C Single Grate - Grate Type A - Plain Curb

LakeAve.stsw

FlexTable: Catch Basin Table: Gutter Flow

Active Scenario: 25 yr

Label	Inlet Location	Inlet Drainage Area (acres)	Inlet C	Total Inlet Tc (min)	Total Inlet Intensity (in/h)	Local CA (acres)	Total Inlet CA (acres)	QT to Inlet (ft³/s)	Gutter Slope (ft/ft)	Road Cross Slope (ft/ft)	Depth (Gutter) (in)
CB-1	On Grade	0.240	0.62	5.0	9.25	0.149	0.149	1.39	0.010	0.020	1.8
CB-2	On Grade	0.161	0.82	5.0	9.25	0.132	0.132	1.23	0.010	0.020	1.7

Width of Flow (ft)	Allowable Spread	Bypass Q (ft³/s)	Bypassed CA (acres)	Intercepted CA (acres)	Inlet
7.5	9.5	0.55	0.059	0.090	Combination Type C Single Grate - Grate Type A - Plain Curb
7.2	9.5	0.46	0.050	0.082	Combination Type C Single Grate - Grate Type A - Plain Curb