

---

**TECHNICAL MEMORANDUM**

---

**TO:** A.J. Alevisos, The Alevisos Group  
**FROM:** Todd P. Morey, P.E., Principal  
**SUBJECT:** Peer Review Comment re: BLSF Determination  
444 East Central Street, Franklin, MA  
**DATE:** Revised August 27, 2025



Our office has been asked to review the extent of the Bordering Land Subject to Flooding (“BLSF”) associated with the unnamed tributary to Uncas Brook which flows from the culverts under East Central Street and through the property noted above northerly of the confluence with Uncas Brook. Prior permitting efforts on the site include the issuance of an Order of Resource Area Delineation (“ORAD”) which defined the Riverfront Area associated with the bank of the stream, the Bordering Vegetated Wetlands (“BVW”), Land Under Water (“LUW”) and, partially, Bordering Land Subject to Flooding (“BLSF”). When the ORAD was issued, the BLSF that was approved was determined to be only that portion shown on the Flood Insurance Rate Map (“FIRM”) that was in effect at the time of issuance in 2024. The FIRM noted a Zone A region without a corresponding elevation and the application materials at the time conceded to elevation 271.0 based on an overtopping elevation at Northern Spy Road, a downstream crossing of Uncas Brook. The FIRM also noted a break in the floodplain between Zone A and Zone X, which delineates a 500-year floodplain.

In April 2025, the project submitted a Notice of Intent to the Town of Franklin Conservation Commission. The project documentation included all natural resource areas delineated by the ORAD. At the time of submission, the original FIRMs were valid which showed the northern end of the site bisected by the change from the 100-year to the 500-year floodplain. On July 8, 2025, new FIRMs were issued for Franklin, and the graphic 100-year floodplain was extended further north on the site and on land across East Central Street. The overall shape of the 100-year floodplain appeared to have additional definition as well. On July 10, 2025, the peer review consultant for the Town, BETA Group, Inc. (“BETA”) issued a peer review report which included comments relative to BLSF. These comments were as follows:

*“The Applicant should provide further information regarding how the extent of BLSF at the Site was determined, as the ORAD only approved portions of the BLSF at the Site. Given the number of stream crossings/hydraulic restrictions present at the site, this evaluation should be prepared by a Professional Engineer with experience in hydraulics. The Commission may require more up to date engineering information than what is provided by FEMA per 310CMR10.57(2)(a)3., particularly given the presence of a Zone A with no published base flood elevation.”*

310 CMR 10.57(2)(a)3 defines the limit of BLSF, and where FEMA data is not available, provides alternate methodologies to determine the limits of BLSF.

*“Where NFIP profile data is unavailable, the boundary of [BLSF] shall be the maximum lateral extent of flood water which has been observed or recorded. In the event of a conflict, the issuing authority may require the applicant to determine the boundary of [BLSF] by engineering calculations which shall be:*

- a. Based upon a design storm of seven inches of precipitation in 24 hours (i.e. a Type III Rainfall as defined by the U.S. Soil Conservation Service.)*
- b. Based upon the standard methodologies set forth in U.S. Soil Conservation Service Technical Release No. 55, Urban Hydrology for Small Watersheds and Section 4 of the U.S. Soil Conservation Service, National Engineering Hydrology Handbook, and*
- c. Prepared by a registered professional engineer or other professional competent in such matters.”*

The floodplain that is located on the site extends from an unnamed stream that originates in the wetland across East Central Street to the north. The stream flows under East Central Street through a single 36-inch concrete culvert, flows southerly for a short distance under a wooden footbridge to twin 21-inch culverts that convey the stream under a constructed crossing and then daylighting again before entering a single 30-inch culvert which empties into a segment of standing water upstream of the confluence with Uncas Brook.

The presence of several culverts along this stream reach creates a condition where, given the right topography, the flow could result in a rapidly rising floodplain as each culvert could restrict flow. Because of this, it was determined that individual culvert analyses with variable tail water conditions should be analyzed. This can be handled using the HY-8 Culvert Analysis program available from the Federal Highway Administration. In order to determine the anticipated flows at each point, Stream Stats was utilized with different points of analysis for each culvert inlet.

The Stream Stats analysis is based on NOAA 14 rainfall data. For this location, that translates to the following depths over a 24-hour duration.

<b>Precipitation</b>	
<b>Recurrence interval (years)</b>	<b>Rainfall (inches)</b>
2	3.37
5	4.38
10	5.23
25	6.39
50	7.24
100	8.18
200	9.32
500	11.1

Note that the rainfall amount exceeds the WPA requirement for a 7-inch analysis. The adjustment to normalize back to a 7-inch rainfall is discussed further below.

The ORAD that was issued for the project in 2024 based the elevation of the BLSF on the likely overtopping elevation of Northern Spy Road. To remain consistent with the original analysis, the hydraulic capacity study was started at that location in order to capture tailwater conditions along the entire reach up through the site. Three Stream Stats runs were developed: one at Northern Spy Road, one at the southerly culvert

onsite and one at the northerly culvert onsite. Various flows can be entered into the HY-8 program and the reported Stream Stats flows for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500- year discharges were entered. At the date of the site visit, the downstream condition at Northern Spy Road was dry, so the analysis was started with a free discharge at that location.

The results at Northern Spy Road indicated that the roadway overtops between the 2- and 5-year events with the water levels continuing to rise throughout the various storms.

<b>Northern Spy Road Analysis</b>		
Storm Event (year)	Total Discharge (cfs)	Headwater Elevation (ft)
2	48	268.87
5	80.3	270.51
10	106	270.74
25	144	270.93
50	176	271.06
100	210	271.17
200	246	271.27
500	299	271.40

Given the consistent nature of the stream and the observed low gradient of the water surface, the headwater at Northern Spy Road becomes the tailwater at the next upstream location. This assumption would not be valid for streams with a steeper gradient or highly variable bank conditions, but given the surrounding conditions, it is our opinion that this assumption can be made to simplify the overall analysis.

The HY-8 program was used for the next culvert upstream with the following results:

<b>Southerly Culvert Analysis</b>			
Storm Event (year)	Total Discharge (cfs)	Tailwater Elevation (ft)	Headwater Elevation (ft)
2	12.8	268.87	269.03
5	21.9	270.51	270.92
10	29.3	270.74	271.21
25	40.3	270.93	271.41
50	49.6	271.06	271.50
100	59.6	271.17	271.58
200	70.6	271.27	271.65
500	86.6	271.40	271.74

Once again, the headwater for this culvert becomes the tailwater for the next upstream culvert and the analysis is run again at that point.

<b>Northerly Culvert Analysis</b>			
Storm Event (year)	Total Discharge (cfs)	Tailwater Elevation (ft)	Headwater Elevation (ft)
2	11.7	269.03	269.25
5	20.1	270.92	270.93
10	26.9	271.21	271.22
25	37.0	271.41	271.42
50	45.5	271.50	271.51
100	54.7	271.58	271.59
200	64.9	271.65	271.66
500	79.6	271.74	271.76

These analyses show that the flood elevations are mainly derived by the overtopping of the crossings resulting in overland flow of the higher storm events. This generally happens somewhere between the 2- and 5- year storm event, or between 3.37 inches and 4.38 inches of rainfall in 24 hours.

As noted above, 310 CMR 10.57 requires the analysis to be made based on a 7-inch precipitation event. Using the base analysis above, the flood elevations at Northern Spy Road, the southerly site culvert and the northerly site culvert translate from 271.17, 271.62, and 271.63 (100-year) down to 271.02, 271.46 and 271.47, respectively.

As a check, we can also overlay the FEMA map onto LiDAR topography to see how the updated flood maps correlate to the topo maps. Based on this exercise, the Zone A line correlates very well with the 270 contour throughout much of the study area. Since the culvert analysis described above yields a higher result, it should govern in this case.

### **Conclusion**

**Based on the analysis described above, our office believes the BLSF across the project site should be set at elevation 271.0 for the area downstream of the southerly site culvert, 271.5 for the area between the south culvert outlet and the north culvert outlet and 271.5 for the area between East Central Street and the northerly site culvert outlet.**

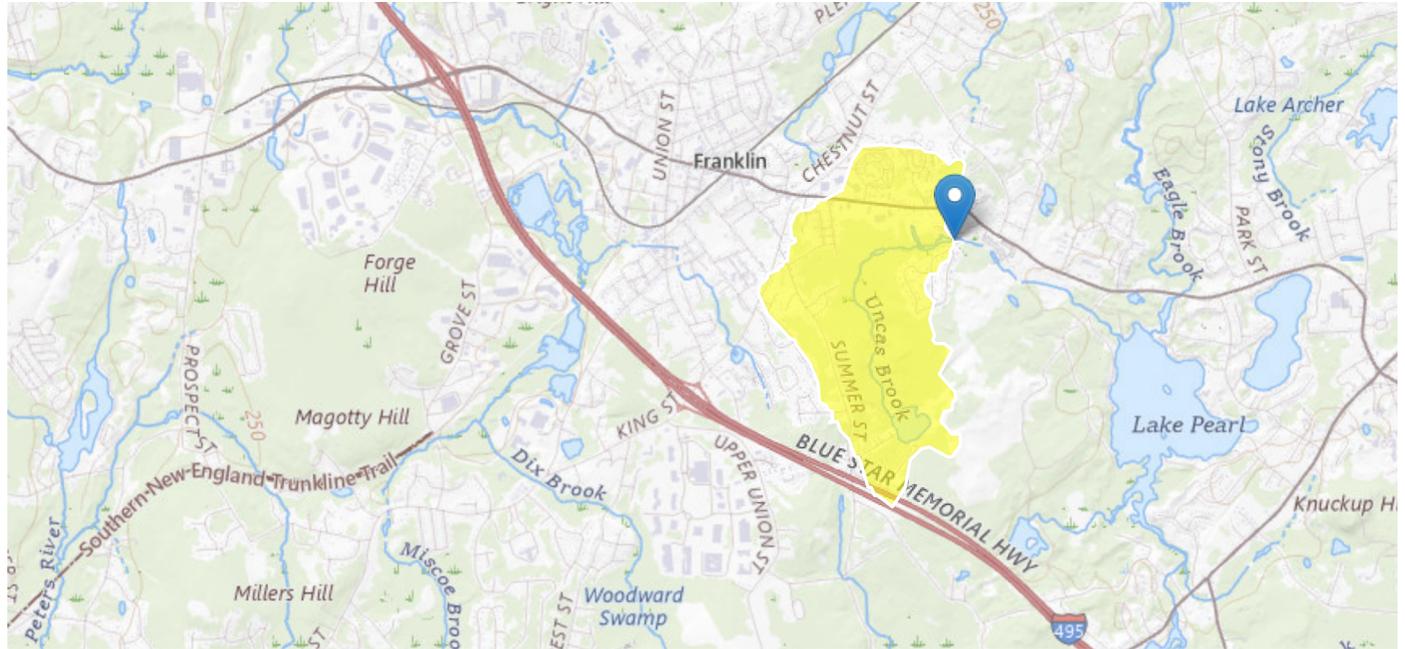
# StreamStats Report

Region ID: MA

Workspace ID: MA20250813125846561000

Clicked Point (Latitude, Longitude): 42.07725, -71.37307

Time: 2025-08-13 08:59:07 -0400



Collapse All

## ➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	5.756	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	2.509	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.25	square mile per mile
DRNAREA	Area that drains to a point on a stream	1.31	square miles
ELEV	Mean Basin Elevation	316	feet
FOREST	Percentage of area covered by forest	64.29	percent
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	8.86	percent
LFLENGTH	Length of longest flow path		miles
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
PCTSDNDRV	Percentage of land surface underlain by sand and gravel deposits	41.21	percent
WETLAND	Percentage of Wetlands	7.1	percent

## ➤ Peak-Flow Statistics

### Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	0.16	512
ELEV	Mean Basin Elevation	316	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	8.86	percent	0	32.3

### Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	48	ft^3/s	24.4	94.2	42.3
20-percent AEP flood	80.3	ft^3/s	40.3	160	43.4
10-percent AEP flood	106	ft^3/s	52	216	44.7
4-percent AEP flood	144	ft^3/s	68.2	304	47.1
2-percent AEP flood	176	ft^3/s	80.7	384	49.4
1-percent AEP flood	210	ft^3/s	93.3	473	51.8
0.5-percent AEP flood	246	ft^3/s	106	571	54.1
0.2-percent AEP flood	299	ft^3/s	123	727	57.6

#### Peak-Flow Statistics Citations

Zarriello, P.J., 2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (<https://dx.doi.org/10.3133/sir20165156>)

## ➤ Low-Flow Statistics

### Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	2.509	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.25	square mile per mile	0	1.29
DRNAREA	Drainage Area	1.31	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### Low-Flow Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.122	ft <sup>3</sup> /s
7 Day 10 Year Low Flow	0.051	ft <sup>3</sup> /s

*Low-Flow Statistics Citations*

**Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)**

➤ Flow-Duration Statistics

Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	2.509	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.25	square mile per mile	0	1.29
DRNAREA	Drainage Area	1.31	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
50 Percent Duration	1.26	ft <sup>3</sup> /s
60 Percent Duration	0.89	ft <sup>3</sup> /s
70 Percent Duration	0.557	ft <sup>3</sup> /s
75 Percent Duration	0.433	ft <sup>3</sup> /s
80 Percent Duration	0.389	ft <sup>3</sup> /s
85 Percent Duration	0.282	ft <sup>3</sup> /s
90 Percent Duration	0.225	ft <sup>3</sup> /s
95 Percent Duration	0.123	ft <sup>3</sup> /s
98 Percent Duration	0.078	ft <sup>3</sup> /s
99 Percent Duration	0.0552	ft <sup>3</sup> /s

*Flow-Duration Statistics Citations*

**Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)**

➤ August Flow-Duration Statistics

August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	2.509	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.25	square mile per mile	0	1.29
DRNAREA	Drainage Area	1.31	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
August 50 Percent Duration	0.301	ft <sup>3</sup> /s

*August Flow-Duration Statistics Citations*

Ries, K.G., III, 2000, **Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p.** (<http://pubs.usgs.gov/wri/wri004135/>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM10M	Mean Basin Slope from 10m DEM	5.756	percent	2.2	23.9
DRNAREA	Drainage Area	1.31	square miles	0.6	329

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	0.07722	940.1535

Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	3.799224	138.999861

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	0.07722	59927.7393

### Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	16.1	ft	21.3
Bankfull Depth	0.998	ft	19.8
Bankfull Area	15.9	ft^2	29
Bankfull Streamflow	38.6	ft^3/s	55

### Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	17	ft
Bieger_D_channel_depth	1.21	ft
Bieger_D_channel_cross_sectional_area	20.9	ft^2

### Bankfull Statistics Disclaimers [New England P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### Bankfull Statistics Flow Report [New England P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	27.3	ft
Bieger_P_channel_depth	1.46	ft
Bieger_P_channel_cross_sectional_area	39.7	ft^2

### Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	13.6	ft
Bieger_USA_channel_depth	1.28	ft
Bieger_USA_channel_cross_sectional_area	19.8	ft^2

### Bankfull Statistics Flow Report [Area-Averaged]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	16.1	ft	21.3
Bankfull Depth	0.998	ft	19.8
Bankfull Area	15.9	ft^2	29
Bankfull Streamflow	38.6	ft^3/s	55

Statistic	Value	Unit	ASEp
Bieger_D_channel_width	17	ft	
Bieger_D_channel_depth	1.21	ft	
Bieger_D_channel_cross_sectional_area	20.9	ft^2	
Bieger_P_channel_width	27.3	ft	
Bieger_P_channel_depth	1.46	ft	
Bieger_P_channel_cross_sectional_area	39.7	ft^2	
Bieger_USA_channel_width	13.6	ft	
Bieger_USA_channel_depth	1.28	ft	
Bieger_USA_channel_cross_sectional_area	19.8	ft^2	

*Bankfull Statistics Citations*

**Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (<http://pubs.usgs.gov/sir/2013/5155/>)**

**Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. ([https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm\\_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm\\_medium=PDF&utm\\_campaign=PDFCoverPages](https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPages))**

➤ Probability Statistics

Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	0.01	1.99
FOREST	Percent Forest	64.29	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1
PCTSNDGRV	Percent Underlain By Sand And Gravel	41.21	percent	0	100

Probability Statistics Flow Report [Perennial Flow Probability]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.884	dim	71

*Probability Statistics Citations*

**Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. ([http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR\\_2006-5031rev.pdf](http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf))**

## ➤ Maximum Probable Flood Statistics

### Maximum Probable Flood Statistics Parameters [Crippen Bue Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.31	square miles	0.1	3000

### Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 2]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	6760	ft <sup>3</sup> /s

#### *Maximum Probable Flood Statistics Citations*

**Crippen, J.R. and Bue, Conrad D. 1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)**

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.29.2

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

# StreamStats Report

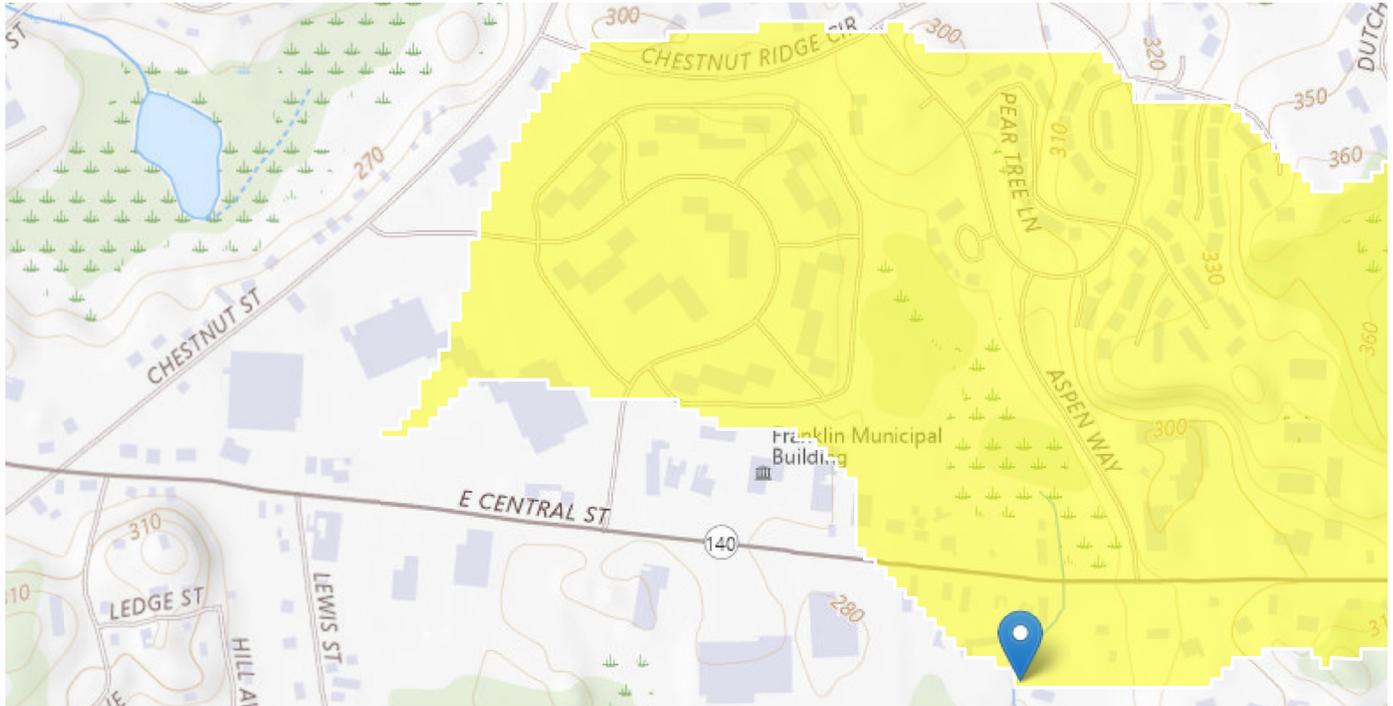
Region ID: MA

Workspace ID: MA20250812144027845000

Clicked Point (Latitude, Longitude): 42.07873, -71.37753

NHD Stream GNIS Name of Click Point: 📍 Stream name not found

Time: 2025-08-12 10:40:58 -0400



📄 Collapse All

## ➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	5.248	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	0.994	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.83	square mile per mile
DRNAREA	Area that drains to a point on a stream	0.19	square miles
ELEV	Mean Basin Elevation	300	feet
FOREST	Percentage of area covered by forest	27.31	percent
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	86.7	percent

Parameter Code	Parameter Description	Value	Unit
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	44.4	percent
LFPLENGTH	Length of longest flow path		miles
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	58.98	percent
WETLAND	Percentage of Wetlands	5.38	percent

## ➤ Peak-Flow Statistics

### Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	0.16	512
ELEV	Mean Basin Elevation	300	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	0	percent	0	32.3

### Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR<sup>2</sup>: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	12.8	ft <sup>3</sup> /s	6.41	25.5	42.3
20-percent AEP flood	21.9	ft <sup>3</sup> /s	10.8	44.4	43.4
10-percent AEP flood	29.3	ft <sup>3</sup> /s	14.1	61	44.7
4-percent AEP flood	40.3	ft <sup>3</sup> /s	18.7	87.1	47.1
2-percent AEP flood	49.6	ft <sup>3</sup> /s	22.2	111	49.4
1-percent AEP flood	59.6	ft <sup>3</sup> /s	25.8	138	51.8
0.5-percent AEP flood	70.6	ft <sup>3</sup> /s	29.6	168	54.1
0.2-percent AEP flood	86.6	ft <sup>3</sup> /s	34.6	217	57.6

#### Peak-Flow Statistics Citations

Zarriello, P.J., 2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016-5156, 99 p. (<https://dx.doi.org/10.3133/sir20165156>)

## ➤ Low-Flow Statistics

### Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	0.994	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.83	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.19	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### Low-Flow Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.0248	ft <sup>3</sup> /s
7 Day 10 Year Low Flow	0.0105	ft <sup>3</sup> /s

#### Low-Flow Statistics Citations

**Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)**

## ➤ Flow-Duration Statistics

### Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	0.994	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.83	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.19	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

## Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
50 Percent Duration	0.176	ft <sup>3</sup> /s
60 Percent Duration	0.132	ft <sup>3</sup> /s
70 Percent Duration	0.1	ft <sup>3</sup> /s
75 Percent Duration	0.0821	ft <sup>3</sup> /s
80 Percent Duration	0.0828	ft <sup>3</sup> /s
85 Percent Duration	0.0574	ft <sup>3</sup> /s
90 Percent Duration	0.0508	ft <sup>3</sup> /s
95 Percent Duration	0.0247	ft <sup>3</sup> /s
98 Percent Duration	0.0164	ft <sup>3</sup> /s
99 Percent Duration	0.011	ft <sup>3</sup> /s

### Flow-Duration Statistics Citations

**Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p.**  
[\(http://pubs.usgs.gov/wri/wri004135/\)](http://pubs.usgs.gov/wri/wri004135/)

## ➤ August Flow-Duration Statistics

### August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	0.994	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.83	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.19	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### August Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
August 50 Percent Duration	0.0658	ft <sup>3</sup> /s

### August Flow-Duration Statistics Citations

Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)

## ➤ Bankfull Statistics

### Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM10M	Mean Basin Slope from 10m DEM	5.248	percent	2.2	23.9
DRNAREA	Drainage Area	0.19	square miles	0.6	329

### Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	0.07722	940.1535

### Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	3.799224	138.999861

### Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	0.07722	59927.7393

### Bankfull Statistics Disclaimers [Bankfull Statewide SIR2013 5155]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

Statistic	Value	Unit
Bankfull Width	7.42	ft
Bankfull Depth	0.565	ft
Bankfull Area	4.12	ft <sup>2</sup>
Bankfull Streamflow	8.39	ft <sup>3</sup> /s

### Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	7.63	ft

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_D_channel_depth	0.696	ft
Bieger_D_channel_cross_sectional_area	5.36	ft <sup>2</sup>

#### Bankfull Statistics Disclaimers [New England P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

#### Bankfull Statistics Flow Report [New England P Bieger 2015]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_P_channel_width	15.9	ft
Bieger_P_channel_depth	0.954	ft
Bieger_P_channel_cross_sectional_area	14.8	ft <sup>2</sup>

#### Bankfull Statistics Flow Report [USA Bieger 2015]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_USA_channel_width	6.9	ft
Bieger_USA_channel_depth	0.846	ft
Bieger_USA_channel_cross_sectional_area	6.97	ft <sup>2</sup>

#### Bankfull Statistics Flow Report [Area-Averaged]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bankfull Width	7.42	ft
Bankfull Depth	0.565	ft
Bankfull Area	4.12	ft <sup>2</sup>
Bankfull Streamflow	8.39	ft <sup>3</sup> /s
Bieger_D_channel_width	7.63	ft
Bieger_D_channel_depth	0.696	ft
Bieger_D_channel_cross_sectional_area	5.36	ft <sup>2</sup>
Bieger_P_channel_width	15.9	ft
Bieger_P_channel_depth	0.954	ft
Bieger_P_channel_cross_sectional_area	14.8	ft <sup>2</sup>
Bieger_USA_channel_width	6.9	ft
Bieger_USA_channel_depth	0.846	ft
Bieger_USA_channel_cross_sectional_area	6.97	ft <sup>2</sup>

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (<http://pubs.usgs.gov/sir/2013/5155/>)

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. ([https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm\\_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm\\_medium=PDF&utm\\_campaign=PDFCov](https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCov))

## ➤ Probability Statistics

### Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	0.01	1.99
FOREST	Percent Forest	27.31	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1
PCTSNDGRV	Percent Underlain By Sand And Gravel	58.98	percent	0	100

### Probability Statistics Flow Report [Perennial Flow Probability]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR<sup>2</sup>: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.766	dim	71

#### *Probability Statistics Citations*

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. ([http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR\\_2006-5031rev.pdf](http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf))

## ➤ Maximum Probable Flood Statistics

### Maximum Probable Flood Statistics Parameters [Crippen Bue Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.19	square miles	0.1	3000

## Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 2]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	1710	ft <sup>3</sup> /s

### *Maximum Probable Flood Statistics Citations*

**Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)**

## ➤ NHD Features of Delineated Basin

### NHD Streams Intersecting Basin Delineation Boundary

This functionality attempts to find the stream name at the delineation point. The name of the nearest intersecting National Hydrography Dataset (NHD) stream is selected by default to appear in the report above. NHD streams do not correspond to the StreamStats stream grid and may not be accurate. If you would like a different stream to appear in the above section, please make a selection below.

**No NHD streams intersect the delineated basin.**

### Watershed Boundary Dataset (WBD) HUC 8 Intersecting Basin Delineation Boundary

This functionality attempts to find the intersecting HUC 8 of the delineated watershed. HUC boundaries do not correspond to the StreamStats data and may not be accurate.

HUC 8	Name
01090001	Charles

### *NHD Hydrologic Features Citations*

**U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL <https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6>. (<https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6>) U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL <https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4>. (<https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4>)**

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the

USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.29.2

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

# StreamStats Report - Upstream of North Onsite Culvert

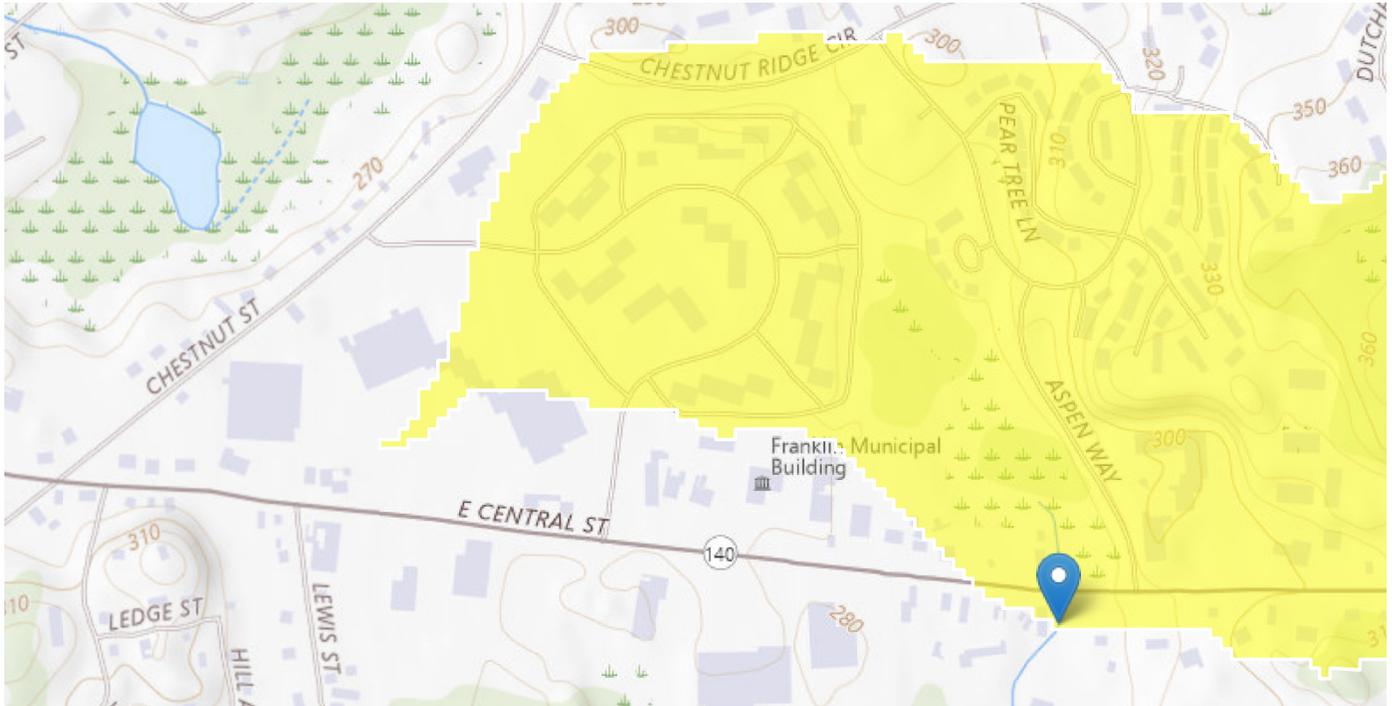
Region ID: MA

Workspace ID: MA20250812143746647000

Clicked Point (Latitude, Longitude): 42.07935, -71.37704

NHD Stream GNIS Name of Click Point: 📍 Stream name not found

Time: 2025-08-12 10:38:07 -0400



[+ Collapse All](#)

## ➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	5.405	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.063	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	1.13	square mile per mile
DRNAREA	Area that drains to a point on a stream	0.17	square miles
ELEV	Mean Basin Elevation	301	feet
FOREST	Percentage of area covered by forest	28.51	percent
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	85.8	percent

<b>Parameter Code</b>	<b>Parameter Description</b>	<b>Value</b>	<b>Unit</b>
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	43.3	percent
LFPLENGTH	Length of longest flow path		miles
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	56.11	percent
WETLAND	Percentage of Wetlands	5.76	percent

## ➤ Peak-Flow Statistics

### Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

<b>Parameter Code</b>	<b>Parameter Name</b>	<b>Value</b>	<b>Units</b>	<b>Min Limit</b>	<b>Max Limit</b>
DRNAREA	Drainage Area	0.17	square miles	0.16	512
ELEV	Mean Basin Elevation	301	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	0	percent	0	32.3

### Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR<sup>2</sup>: Pseudo R Squared (other -- see report)

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>	<b>PIL</b>	<b>PIU</b>	<b>ASEp</b>
50-percent AEP flood	11.7	ft <sup>3</sup> /s	5.86	23.4	42.3
20-percent AEP flood	20.1	ft <sup>3</sup> /s	9.9	40.8	43.4
10-percent AEP flood	26.9	ft <sup>3</sup> /s	12.9	56	44.7
4-percent AEP flood	37	ft <sup>3</sup> /s	17.1	80	47.1
2-percent AEP flood	45.5	ft <sup>3</sup> /s	20.3	102	49.4
1-percent AEP flood	54.7	ft <sup>3</sup> /s	23.6	127	51.8
0.5-percent AEP flood	64.9	ft <sup>3</sup> /s	27.2	155	54.1
0.2-percent AEP flood	79.6	ft <sup>3</sup> /s	31.7	200	57.6

#### *Peak-Flow Statistics Citations*

**Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p.**  
<https://dx.doi.org/10.3133/sir20165156>

## ➤ Low-Flow Statistics

### Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	1.063	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	1.13	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.17	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### Low-Flow Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
7 Day 2 Year Low Flow	0.0284	ft <sup>3</sup> /s
7 Day 10 Year Low Flow	0.0133	ft <sup>3</sup> /s

#### *Low-Flow Statistics Citations*

**Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)**

## ➤ Flow-Duration Statistics

### Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	1.063	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	1.13	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.17	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

## Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
50 Percent Duration	0.157	ft <sup>3</sup> /s
60 Percent Duration	0.122	ft <sup>3</sup> /s
70 Percent Duration	0.0981	ft <sup>3</sup> /s
75 Percent Duration	0.0821	ft <sup>3</sup> /s
80 Percent Duration	0.0905	ft <sup>3</sup> /s
85 Percent Duration	0.0638	ft <sup>3</sup> /s
90 Percent Duration	0.061	ft <sup>3</sup> /s
95 Percent Duration	0.0297	ft <sup>3</sup> /s
98 Percent Duration	0.0199	ft <sup>3</sup> /s
99 Percent Duration	0.0134	ft <sup>3</sup> /s

### Flow-Duration Statistics Citations

**Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p.**  
[\(http://pubs.usgs.gov/wri/wri004135/\)](http://pubs.usgs.gov/wri/wri004135/)

## ➤ August Flow-Duration Statistics

### August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM250	Mean Basin Slope from 250K DEM	1.063	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	1.13	square mile per mile	0	1.29
DRNAREA	Drainage Area	0.17	square miles	1.61	149
MAREGION	Massachusetts Region	0	dimensionless	0	1

### August Flow-Duration Statistics Disclaimers [Statewide Low Flow WRIR00 4135]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

Statistic	Value	Unit
August 50 Percent Duration	0.0727	ft <sup>3</sup> /s

### August Flow-Duration Statistics Citations

Ries, K.G., III, 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (<http://pubs.usgs.gov/wri/wri004135/>)

## ➤ Bankfull Statistics

### Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
BSLDEM10M	Mean Basin Slope from 10m DEM	5.405	percent	2.2	23.9
DRNAREA	Drainage Area	0.17	square miles	0.6	329

### Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.17	square miles	0.07722	940.1535

### Bankfull Statistics Parameters [New England P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.17	square miles	3.799224	138.999861

### Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.17	square miles	0.07722	59927.7393

### Bankfull Statistics Disclaimers [Bankfull Statewide SIR2013 5155]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

### Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

Statistic	Value	Unit
Bankfull Width	7.14	ft
Bankfull Depth	0.55	ft
Bankfull Area	3.85	ft <sup>2</sup>
Bankfull Streamflow	7.89	ft <sup>3</sup> /s

### Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	7.28	ft

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_D_channel_depth	0.674	ft
Bieger_D_channel_cross_sectional_area	4.95	ft <sup>2</sup>

#### Bankfull Statistics Disclaimers [New England P Bieger 2015]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

#### Bankfull Statistics Flow Report [New England P Bieger 2015]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_P_channel_width	15.4	ft
Bieger_P_channel_depth	0.931	ft
Bieger_P_channel_cross_sectional_area	14	ft <sup>2</sup>

#### Bankfull Statistics Flow Report [USA Bieger 2015]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bieger_USA_channel_width	6.64	ft
Bieger_USA_channel_depth	0.827	ft
Bieger_USA_channel_cross_sectional_area	6.56	ft <sup>2</sup>

#### Bankfull Statistics Flow Report [Area-Averaged]

<b>Statistic</b>	<b>Value</b>	<b>Unit</b>
Bankfull Width	7.14	ft
Bankfull Depth	0.55	ft
Bankfull Area	3.85	ft <sup>2</sup>
Bankfull Streamflow	7.89	ft <sup>3</sup> /s
Bieger_D_channel_width	7.28	ft
Bieger_D_channel_depth	0.674	ft
Bieger_D_channel_cross_sectional_area	4.95	ft <sup>2</sup>
Bieger_P_channel_width	15.4	ft
Bieger_P_channel_depth	0.931	ft
Bieger_P_channel_cross_sectional_area	14	ft <sup>2</sup>
Bieger_USA_channel_width	6.64	ft
Bieger_USA_channel_depth	0.827	ft
Bieger_USA_channel_cross_sectional_area	6.56	ft <sup>2</sup>

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (<http://pubs.usgs.gov/sir/2013/5155/>)

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. ([https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm\\_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm\\_medium=PDF&utm\\_campaign=PDFCov](https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCov))

## ➤ Probability Statistics

### Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.17	square miles	0.01	1.99
FOREST	Percent Forest	28.51	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1
PCTSNDGRV	Percent Underlain By Sand And Gravel	56.11	percent	0	100

### Probability Statistics Flow Report [Perennial Flow Probability]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR<sup>2</sup>: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	PC
Probability Stream Flowing Perennially	0.734	dim	71

#### *Probability Statistics Citations*

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. ([http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR\\_2006-5031rev.pdf](http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf))

## ➤ Maximum Probable Flood Statistics

### Maximum Probable Flood Statistics Parameters [Crippen Bue Region 2]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.17	square miles	0.1	3000

## Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 2]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	1570	ft <sup>3</sup> /s

### *Maximum Probable Flood Statistics Citations*

**Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)**

## ➤ NHD Features of Delineated Basin

### NHD Streams Intersecting Basin Delineation Boundary

This functionality attempts to find the stream name at the delineation point. The name of the nearest intersecting National Hydrography Dataset (NHD) stream is selected by default to appear in the report above. NHD streams do not correspond to the StreamStats stream grid and may not be accurate. If you would like a different stream to appear in the above section, please make a selection below.

**No NHD streams intersect the delineated basin.**

### Watershed Boundary Dataset (WBD) HUC 8 Intersecting Basin Delineation Boundary

This functionality attempts to find the intersecting HUC 8 of the delineated watershed. HUC boundaries do not correspond to the StreamStats data and may not be accurate.

HUC 8	Name
01090001	Charles

### *NHD Hydrologic Features Citations*

**U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL <https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6>. (<https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6>)** **U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL <https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4>. (<https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4>)**

USGS Data Disclaimer: Unless otherwise stated, all data, metadata and related materials are considered to satisfy the quality standards relative to the purpose for which the data were collected. Although these data and associated metadata have been reviewed for accuracy and completeness and approved for release by the U.S. Geological Survey (USGS), no warranty expressed or implied is made regarding the display or utility of the data for other purposes, nor on all computer systems, nor shall the act of distribution constitute any such warranty.

USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the software and related material nor shall the fact of release constitute any such warranty. Furthermore, the software is released on condition that neither the

USGS nor the U.S. Government shall be held liable for any damages resulting from its authorized or unauthorized use.

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.29.2

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1



**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
5-min	0.321 (0.252-0.406)	0.391 (0.306-0.495)	0.506 (0.395-0.642)	0.601 (0.466-0.767)	0.732 (0.549-0.978)	0.831 (0.610-1.14)	0.934 (0.665-1.33)	1.05 (0.708-1.53)	1.21 (0.787-1.83)	1.35 (0.852-2.08)
10-min	0.455 (0.357-0.575)	0.554 (0.434-0.701)	0.716 (0.559-0.908)	0.851 (0.659-1.09)	1.04 (0.778-1.39)	1.18 (0.864-1.61)	1.32 (0.943-1.88)	1.49 (1.00-2.16)	1.72 (1.11-2.59)	1.91 (1.21-2.94)
15-min	0.535 (0.419-0.676)	0.652 (0.510-0.824)	0.843 (0.658-1.07)	1.00 (0.777-1.28)	1.22 (0.915-1.63)	1.38 (1.02-1.89)	1.56 (1.11-2.21)	1.75 (1.18-2.54)	2.02 (1.31-3.05)	2.24 (1.42-3.46)
30-min	0.734 (0.575-0.927)	0.895 (0.700-1.13)	1.16 (0.903-1.47)	1.38 (1.07-1.76)	1.68 (1.26-2.24)	1.90 (1.40-2.60)	2.14 (1.52-3.04)	2.40 (1.62-3.50)	2.78 (1.80-4.20)	3.09 (1.96-4.76)
60-min	0.933 (0.731-1.18)	1.14 (0.890-1.44)	1.47 (1.15-1.87)	1.75 (1.36-2.23)	2.13 (1.60-2.85)	2.42 (1.78-3.31)	2.72 (1.94-3.87)	3.06 (2.06-4.45)	3.54 (2.30-5.34)	3.93 (2.49-6.06)
2-hr	1.19 (0.942-1.50)	1.47 (1.16-1.85)	1.92 (1.51-2.42)	2.30 (1.80-2.92)	2.82 (2.13-3.76)	3.20 (2.38-4.38)	3.62 (2.62-5.16)	4.12 (2.78-5.95)	4.87 (3.16-7.30)	5.51 (3.50-8.43)
3-hr	1.38 (1.10-1.72)	1.71 (1.35-2.13)	2.24 (1.77-2.81)	2.68 (2.10-3.38)	3.29 (2.50-4.37)	3.73 (2.79-5.09)	4.22 (3.07-6.02)	4.82 (3.27-6.94)	5.74 (3.74-8.58)	6.54 (4.16-9.96)
6-hr	1.79 (1.43-2.21)	2.20 (1.75-2.72)	2.87 (2.28-3.57)	3.43 (2.71-4.29)	4.19 (3.21-5.54)	4.76 (3.57-6.44)	5.38 (3.94-7.62)	6.14 (4.18-8.78)	7.33 (4.79-10.9)	8.36 (5.33-12.6)
12-hr	2.29 (1.84-2.81)	2.79 (2.24-3.43)	3.61 (2.89-4.46)	4.29 (3.42-5.33)	5.23 (4.03-6.84)	5.92 (4.47-7.94)	6.68 (4.90-9.36)	7.59 (5.20-10.8)	9.00 (5.90-13.2)	10.2 (6.53-15.3)
24-hr	2.75 (2.23-3.35)	3.37 (2.73-4.11)	4.38 (3.54-5.37)	5.23 (4.19-6.44)	6.39 (4.96-8.30)	7.24 (5.50-9.65)	8.18 (6.04-11.4)	9.32 (6.41-13.1)	11.1 (7.30-16.2)	12.6 (8.10-18.8)
2-day	3.10 (2.53-3.75)	3.86 (3.15-4.68)	5.11 (4.16-6.22)	6.15 (4.97-7.53)	7.59 (5.93-9.81)	8.63 (6.62-11.5)	9.79 (7.32-13.6)	11.3 (7.77-15.7)	13.6 (8.98-19.7)	15.6 (10.1-23.1)
3-day	3.37 (2.77-4.06)	4.20 (3.44-5.06)	5.55 (4.53-6.71)	6.66 (5.41-8.12)	8.20 (6.44-10.6)	9.33 (7.18-12.3)	10.6 (7.93-14.7)	12.2 (8.41-16.9)	14.7 (9.72-21.2)	16.9 (10.9-24.8)
4-day	3.64 (3.00-4.37)	4.49 (3.69-5.40)	5.89 (4.82-7.10)	7.05 (5.74-8.56)	8.64 (6.80-11.1)	9.81 (7.57-12.9)	11.1 (8.33-15.3)	12.7 (8.82-17.7)	15.3 (10.2-22.0)	17.6 (11.4-25.7)
7-day	4.38 (3.63-5.23)	5.29 (4.38-6.32)	6.77 (5.58-8.11)	7.99 (6.54-9.64)	9.68 (7.65-12.3)	10.9 (8.44-14.2)	12.3 (9.21-16.7)	13.9 (9.70-19.2)	16.5 (11.0-23.5)	18.7 (12.1-27.2)
10-day	5.09 (4.24-6.05)	6.03 (5.01-7.17)	7.55 (6.25-9.02)	8.82 (7.25-10.6)	10.6 (8.37-13.3)	11.9 (9.18-15.3)	13.3 (9.92-17.8)	14.9 (10.4-20.4)	17.4 (11.6-24.7)	19.5 (12.6-28.2)
20-day	7.18 (6.02-8.47)	8.18 (6.85-9.66)	9.82 (8.19-11.6)	11.2 (9.25-13.3)	13.0 (10.4-16.2)	14.4 (11.2-18.4)	15.9 (11.9-21.0)	17.5 (12.3-23.8)	19.8 (13.3-27.8)	21.6 (14.0-31.0)
30-day	8.92 (7.52-10.5)	9.97 (8.39-11.7)	11.7 (9.78-13.8)	13.1 (10.9-15.5)	15.0 (12.0-18.6)	16.5 (12.8-20.8)	18.1 (13.4-23.5)	19.6 (13.8-26.5)	21.7 (14.6-30.3)	23.3 (15.2-33.3)
45-day	11.1 (9.40-13.0)	12.2 (10.3-14.3)	14.0 (11.8-16.4)	15.5 (12.9-18.3)	17.5 (14.0-21.5)	19.2 (14.9-23.9)	20.7 (15.4-26.6)	22.2 (15.7-29.8)	24.1 (16.3-33.5)	25.4 (16.6-36.2)
60-day	12.9 (11.0-15.1)	14.1 (11.9-16.4)	16.0 (13.5-18.7)	17.5 (14.7-20.6)	19.6 (15.8-23.9)	21.3 (16.6-26.5)	22.9 (17.0-29.3)	24.4 (17.3-32.6)	26.1 (17.7-36.2)	27.2 (17.8-38.6)

<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.

[Back to Top](#)

**PF graphical**

# HY-8 Culvert Analysis Report

## Northern Spy Road

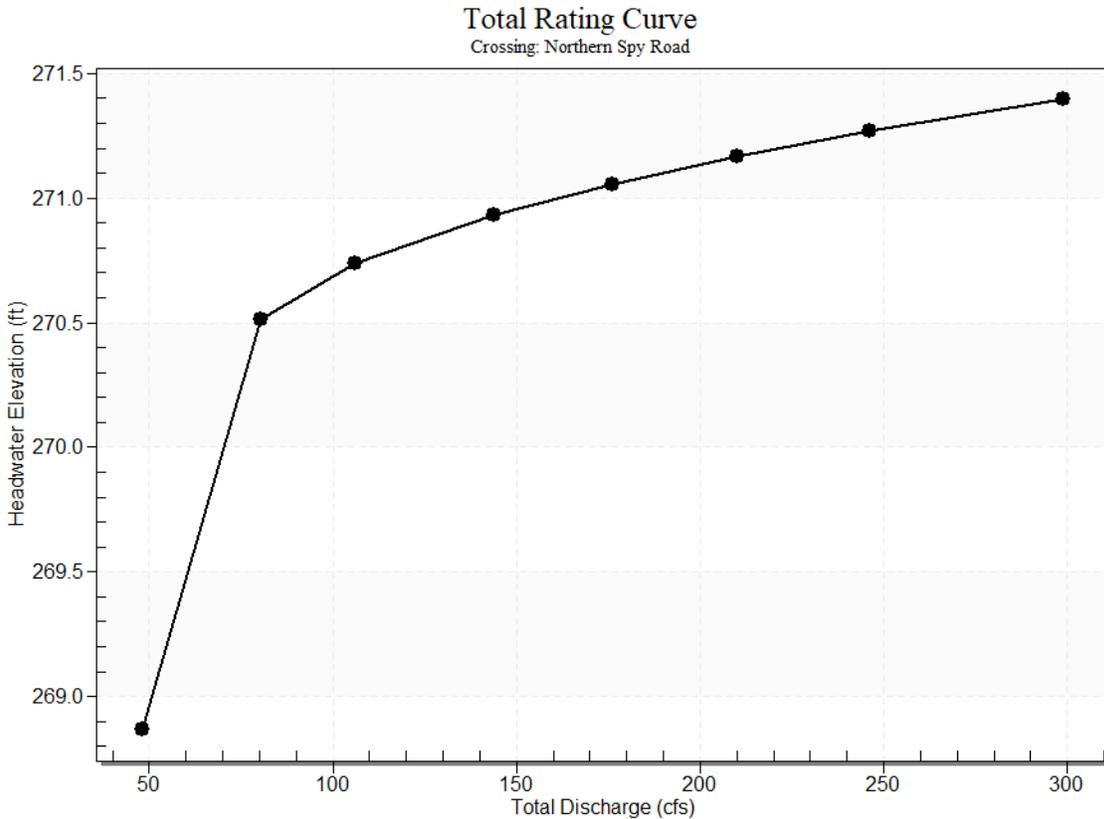
### Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 1 - Summary of Culvert Flows at Crossing: Northern Spy Road

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
268.87	2 year	48.00	48.00	0.00	1
270.51	5 year	80.30	77.77	2.44	15
270.74	10 year	106.00	80.86	24.94	9
270.93	25 year	144.00	83.51	60.28	7
271.06	50 year	176.00	85.14	90.55	5
271.17	100 year	210.00	86.56	123.34	5
271.27	200 year	246.00	87.83	157.97	4
271.40	500 year	299.00	89.44	209.51	4
270.40	Overtopping	76.11	76.11	0.00	Overtopping

### Rating Curve Plot for Crossing: Northern Spy Road



## Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Disc harg e Nam es	Total Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head water Eleva tion (ft)	Inle t Con trol Dep th (ft)	Out let Con trol Dep th (ft)	Fl o w Ty pe	Nor mal Dep th (ft)	Crit ical De pth (ft)	Ou tle t De pth (ft)	Tail water r Dept h (ft)	Outl et Vel ocit y (ft/ s)	Tail water r Velo city (ft/s)
2 year	48.00 cfs	48.00 cfs	268.8 7	2.37	1.71 6	6- FF c	1.10	1.4 4	1.4 4	0.67	6.60	6.30
5 year	80.30 cfs	77.77 cfs	270.5 1	4.01	3.42 3	6- FF c	1.55	1.7 8	1.7 8	0.91	8.76	7.51
10 year	106.0 0 cfs	80.86 cfs	270.7 4	4.24	3.59 9	6- FF c	1.61	1.8 1	1.8 1	1.06	9.03	8.23
25 year	144.0 0 cfs	83.51 cfs	270.9 3	4.43	3.75 5	6- FF c	1.67	1.8 3	1.8 3	1.27	9.26	9.08
50 year	176.0 0 cfs	85.14 cfs	271.0 6	4.56	3.85 2	6- FF c	1.71	1.8 4	1.8 4	1.42	9.40	9.68
100 year	210.0 0 cfs	86.56 cfs	271.1 7	4.67	3.93 8	6- FF c	1.75	1.8 4	1.8 4	1.56	9.53	10.22
200 year	246.0 0 cfs	87.83 cfs	271.2 7	4.77	4.01 6	6- FF c	2.00	1.8 5	1.8 5	1.71	9.65	10.73
500 year	299.0 0 cfs	89.44 cfs	271.4 0	4.90	4.09 0	6- FF t	2.00	1.8 6	1.9 0	1.90	9.66	11.38

### Culvert Barrel Data

Culvert Barrel Type Straight Culvert

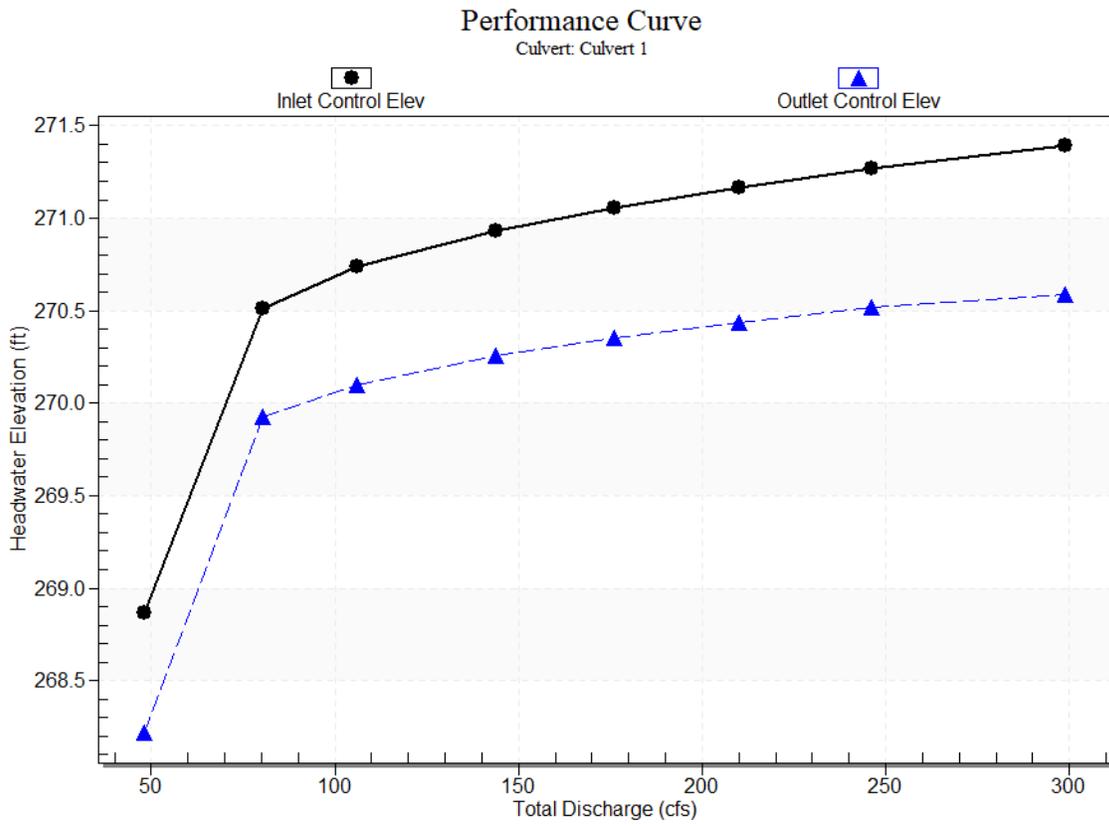
Inlet Elevation (invert): 266.50 ft,

Outlet Elevation (invert): 266.00 ft

Culvert Length: 40.00 ft,

Culvert Slope: 0.0125

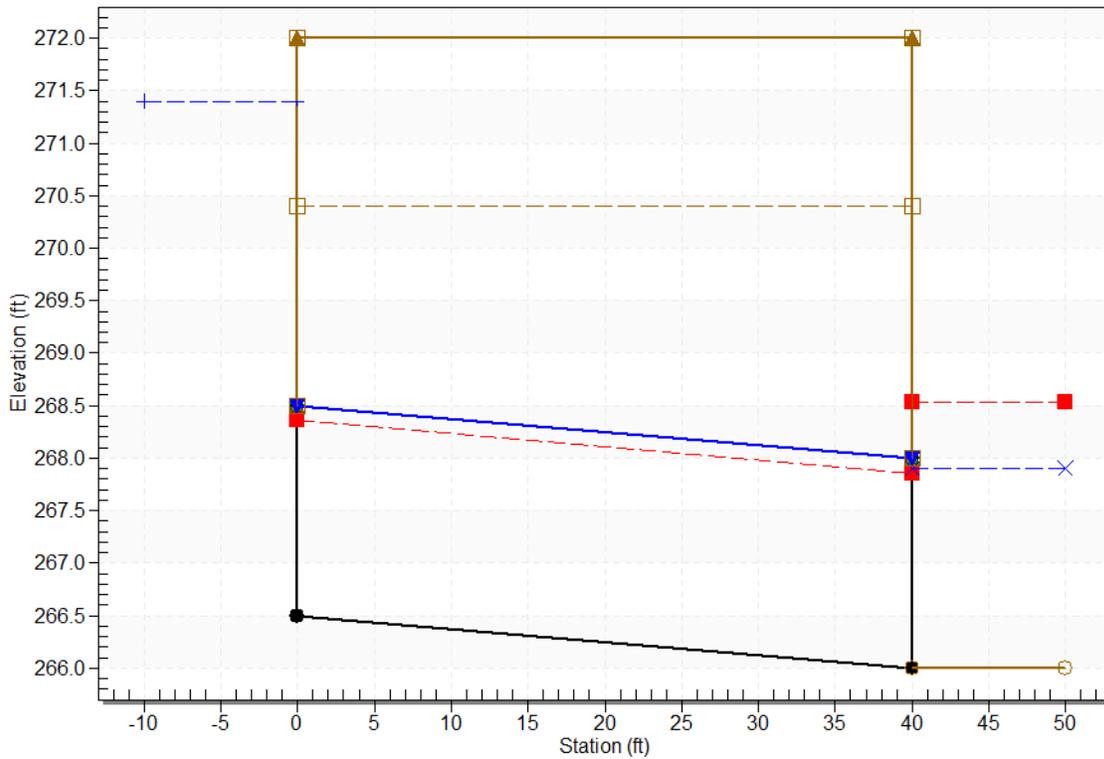
### Culvert Performance Curve Plot: Culvert 1



## Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Northern Spy Road, Design Discharge - 299.0 cfs

Culvert - Culvert 1, Culvert Discharge - 89.4 cfs



### Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 266.50 ft

Outlet Station: 40.00 ft

Outlet Elevation: 266.00 ft

Number of Barrels: 3

### Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ( $K_e=0.5$ )

Inlet Depression: None

### Tailwater Data for Crossing: Northern Spy Road

Table 3 - Downstream Channel Rating Curve (Crossing: Northern Spy Road)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
48.00	266.67	0.67	6.30	1.88	1.43
80.30	266.91	0.91	7.51	2.54	1.49
106.00	267.06	1.06	8.23	2.98	1.53
144.00	267.27	1.27	9.08	3.55	1.56
176.00	267.42	1.42	9.68	3.98	1.58
210.00	267.56	1.56	10.22	4.39	1.60
246.00	267.71	1.71	10.73	4.80	1.62
299.00	267.90	1.90	11.38	5.35	1.64

### Tailwater Channel Data - Northern Spy Road

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 2.00 (2:1)

Channel Slope: 0.0450

Channel Manning's n: 0.0350

Channel Invert Elevation: 266.00 ft

### Roadway Data for Crossing: Northern Spy Road

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

#### Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	0.00	272.00
1	68.00	271.00
2	75.00	270.50
3	100.00	270.40
4	125.00	270.50
5	155.00	271.00
6	200.00	272.00

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

# Southern Site Culvert

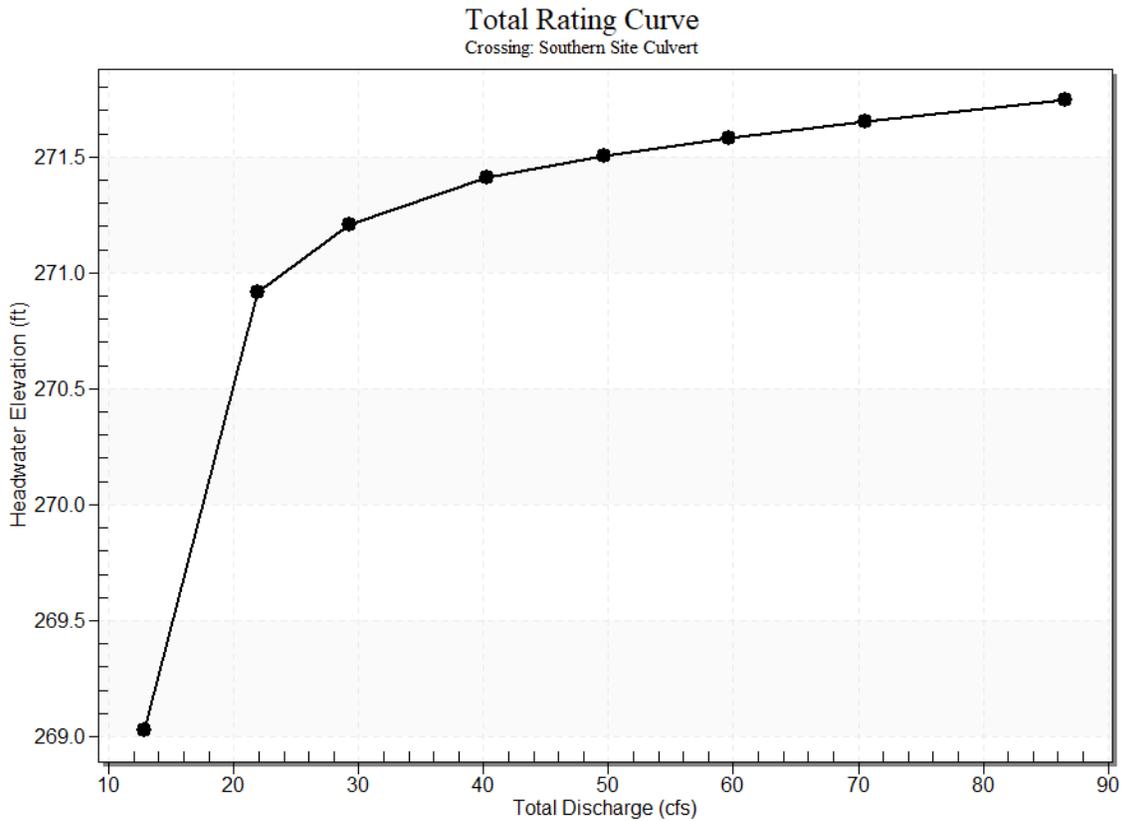
## Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 4 - Summary of Culvert Flows at Crossing: Southern Site Culvert

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
269.03	2 year	12.80	12.80	0.00	1
270.92	5 year	21.90	18.68	3.23	3
271.21	10 year	29.30	20.05	9.12	12
271.41	25 year	40.30	20.28	19.91	7
271.50	50 year	49.60	19.48	30.05	5
271.58	100 year	59.60	18.74	40.76	4
271.65	200 year	70.60	18.10	52.47	4
271.74	500 year	86.60	17.18	69.27	3
270.34	Overtopping	18.68	18.68	0.00	Overtopping

## Rating Curve Plot for Crossing: Southern Site Culvert



## Culvert Data: Culvert 1

Table 5 - Culvert Summary Table: Culvert 1

Disc harg e Nam es	Total Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head water Eleva tion (ft)	Inle t Con trol Dep th (ft)	Out let Con trol Dep th (ft)	Fl ow Ty pe	Nor mal Dep th (ft)	Crit ical De pth (ft)	Ou tle t De pth (ft)	Tail water r Dept h (ft)	Outl et Vel ocit y (ft/ s)	Tail water r Velo city (ft/s)
<b>2 year</b>	12.80 cfs	12.80 cfs	269.0 3	1.76	2.65 9	7- H2 f	- 1.00	1.2 0	2.5 0	3.87	2.61	0.00
<b>5 year</b>	21.90 cfs	18.68 cfs	270.9 2	2.23	4.54 8	4- FF f	- 1.00	1.4 6	2.5 0	5.51	3.81	0.00
<b>10 year</b>	29.30 cfs	20.05 cfs	271.2 1	2.33	4.83 9	4- FF f	- 1.00	1.5 2	2.5 0	5.74	4.08	0.00
<b>25 year</b>	40.30 cfs	20.28 cfs	271.4 1	2.35	5.04 1	4- FF f	- 1.00	1.5 3	2.5 0	5.93	4.13	0.00
<b>50 year</b>	49.60 cfs	19.48 cfs	271.5 0	2.29	5.13 3	4- FF f	- 1.00	1.5 0	2.5 0	6.06	3.97	0.00
<b>100 year</b>	59.60 cfs	18.74 cfs	271.5 8	2.23	5.21 0	4- FF f	- 1.00	1.4 7	2.5 0	6.17	3.82	0.00
<b>200 year</b>	70.60 cfs	18.10 cfs	271.6 5	2.18	5.28 3	4- FF f	- 1.00	1.4 4	2.5 0	6.27	3.69	0.00
<b>500 year</b>	86.60 cfs	17.18 cfs	271.7 4	2.11	5.37 5	4- FF f	- 1.00	1.4 0	2.5 0	6.40	3.50	0.00

### Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 266.37 ft,

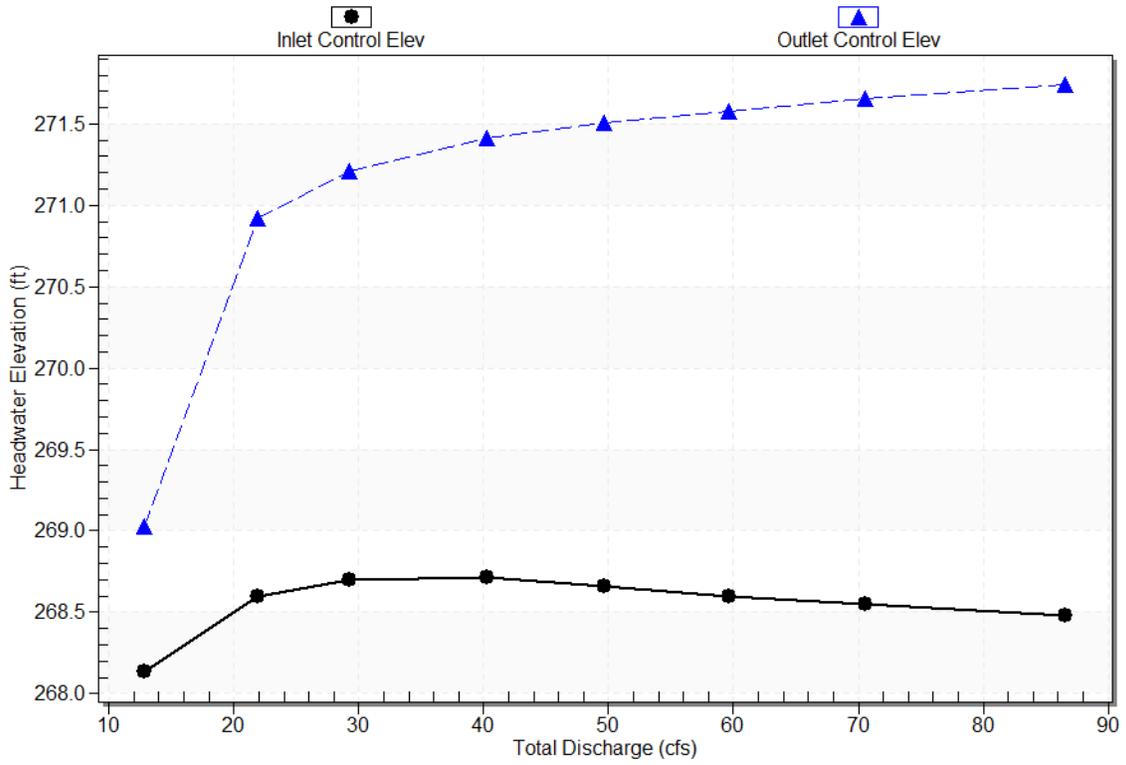
Outlet Elevation (invert): 266.37 ft

Culvert Length: 40.00 ft,

Culvert Slope: 0.0000

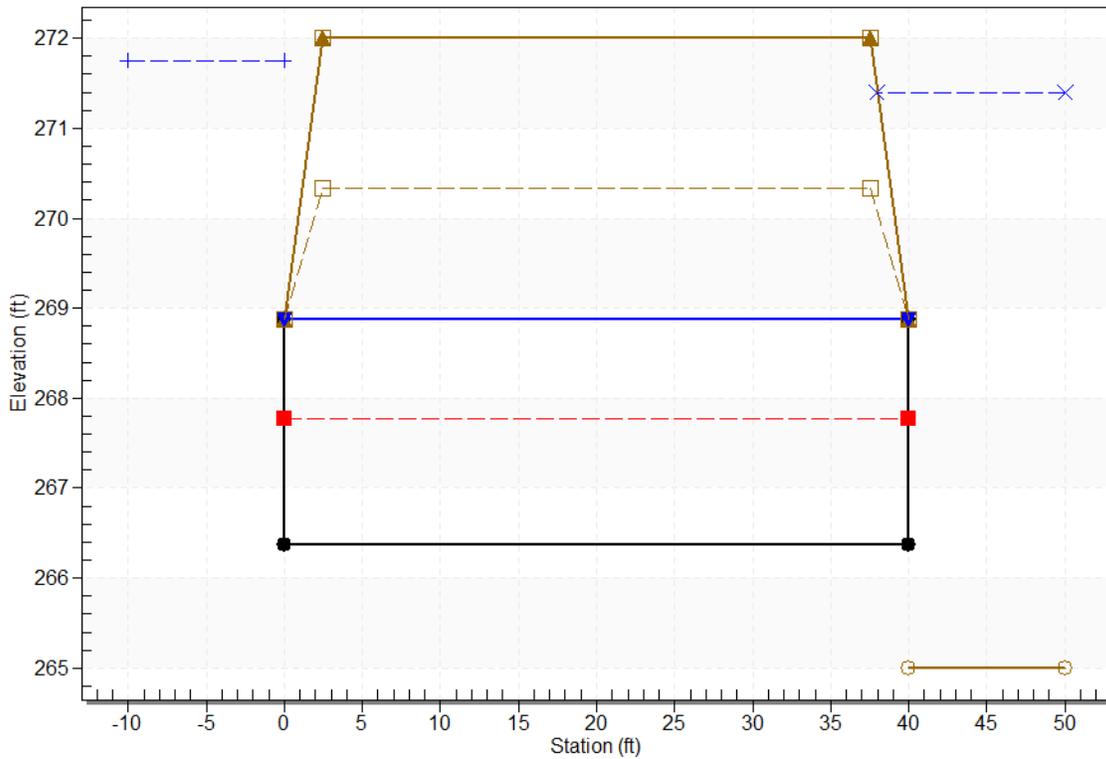
### Culvert Performance Curve Plot: Culvert 1

Performance Curve  
Culvert: Culvert 1



### Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Southern Site Culvert, Design Discharge - 86.6 cfs  
Culvert - Culvert 1, Culvert Discharge - 17.2 cfs



### Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 266.37 ft

Outlet Station: 40.00 ft

Outlet Elevation: 266.37 ft

Number of Barrels: 1

### Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

### Tailwater Data for Crossing: Southern Site Culvert

Table 6 - Downstream Channel Rating Curve (Crossing: Southern Site Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
12.80	268.87	268.87	0.00
21.90	270.51	270.51	0.00
29.30	270.74	270.74	0.00
40.30	270.93	270.93	0.00
49.60	271.06	271.06	0.00
59.60	271.17	271.17	0.00
70.60	271.27	271.27	0.00
86.60	271.40	271.40	0.00

### Tailwater Channel Data - Southern Site Culvert

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: Enter Rating Curve

### Roadway Data for Crossing: Southern Site Culvert

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

#### Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	0.00	272.00
1	29.00	271.80
2	47.00	270.34
3	48.00	271.41
4	53.00	271.48
5	64.00	271.23
6	98.00	271.34
7	98.10	272.00

Roadway Surface: Gravel

Roadway Top Width: 35.00 ft

# Northern Site Culvert

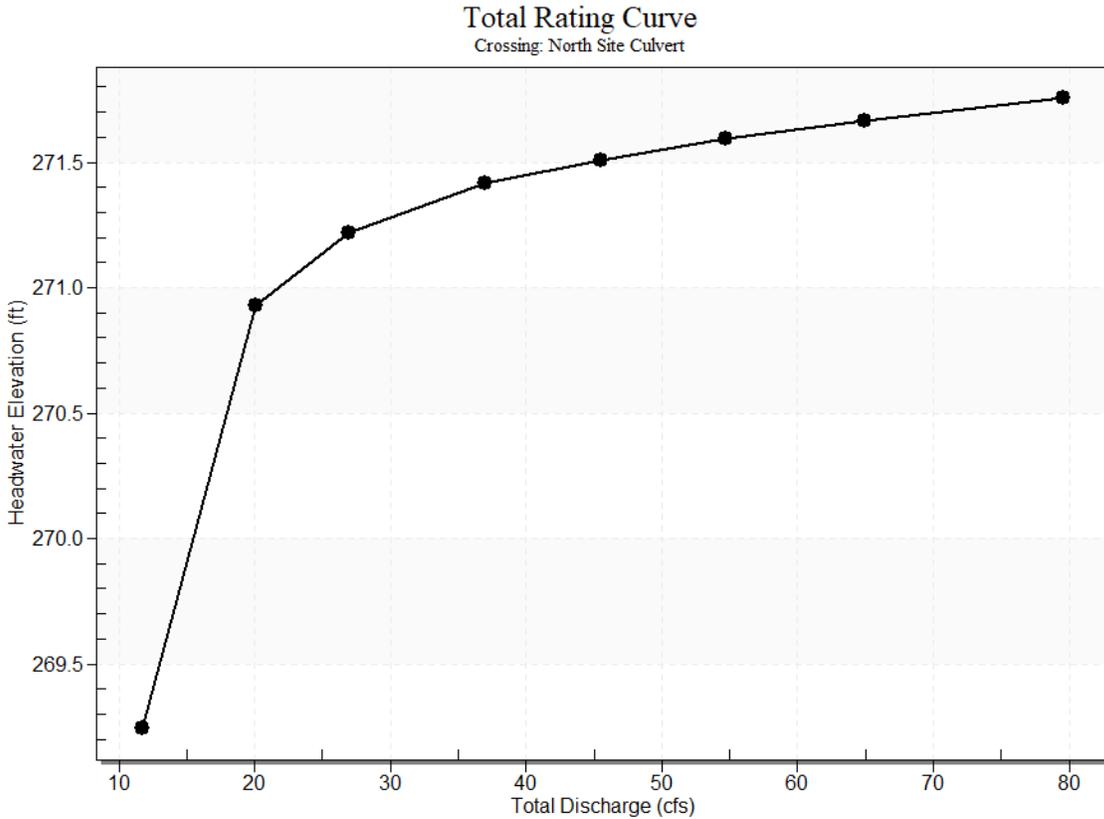
## Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 7 - Summary of Culvert Flows at Crossing: North Site Culvert

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
269.25	2 year	11.70	11.70	0.00	1
270.93	5 year	20.10	2.60	17.58	3
271.22	10 year	26.90	2.28	24.65	10
271.42	25 year	37.00	2.40	34.82	8
271.51	50 year	45.50	2.55	42.95	7
271.59	100 year	54.70	2.77	51.92	7
271.66	200 year	64.90	2.95	61.36	5
271.76	500 year	79.60	3.18	76.44	3
270.52	Overtopping	16.48	16.48	0.00	Overtopping

## Rating Curve Plot for Crossing: North Site Culvert



## Culvert Data: Culvert 1

Table 8 - Culvert Summary Table: Culvert 1

Disc harg e Nam es	Total Disc harg e (cfs)	Culv ert Disc harg e (cfs)	Head water Eleva tion (ft)	Inle t Con trol Dep th (ft)	Out let Con trol Dep th (ft)	Fl o w Ty pe	Nor mal Dep th (ft)	Crit ical De pth (ft)	Ou tle t De pth (ft)	Tail water r Dept h (ft)	Outl et Vel ocit y (ft/ s)	Tail water r Velo city (ft/s)
2 year	11.70 cfs	11.70 cfs	269.2 5	1.32	1.76 5	7- H2 t	- 1.00	0.8 9	1.5 5	7.03	2.60	0.00
5 year	20.10 cfs	2.60 cfs	270.9 3	0.56	3.45 0	4- FF f	- 1.00	0.4 1	1.7 5	8.92	0.54	0.00
10 year	26.90 cfs	2.28 cfs	271.2 2	0.52	3.73 8	4- FF f	- 1.00	0.3 8	1.7 5	9.21	0.47	0.00
25 year	37.00 cfs	2.40 cfs	271.4 2	0.54	3.93 9	4- FF f	- 1.00	0.3 9	1.7 5	9.41	0.50	0.00
50 year	45.50 cfs	2.55 cfs	271.5 1	0.55	4.03 0	4- FF f	- 1.00	0.4 0	1.7 5	9.50	0.53	0.00
100 year	54.70 cfs	2.77 cfs	271.5 9	0.58	4.11 2	4- FF f	- 1.00	0.4 2	1.7 5	9.58	0.58	0.00
200 year	64.90 cfs	2.95 cfs	271.6 6	0.60	4.18 3	4- FF f	- 1.00	0.4 4	1.7 5	9.65	0.61	0.00
500 year	79.60 cfs	3.18 cfs	271.7 6	0.62	4.27 5	4- FF f	- 1.00	0.4 5	1.7 5	9.74	0.66	0.00

### Culvert Barrel Data

Culvert Barrel Type Straight Culvert

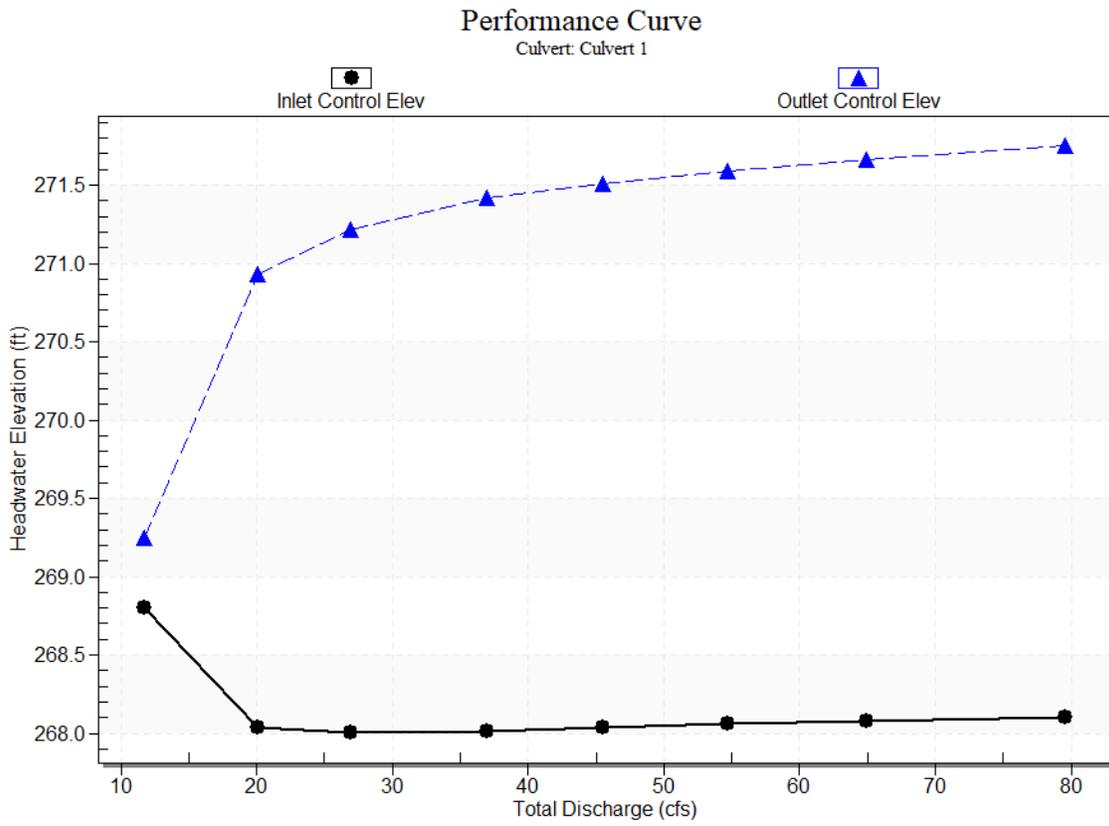
Inlet Elevation (invert): 267.48 ft,

Outlet Elevation (invert): 267.48 ft

Culvert Length: 60.00 ft,

Culvert Slope: 0.0000

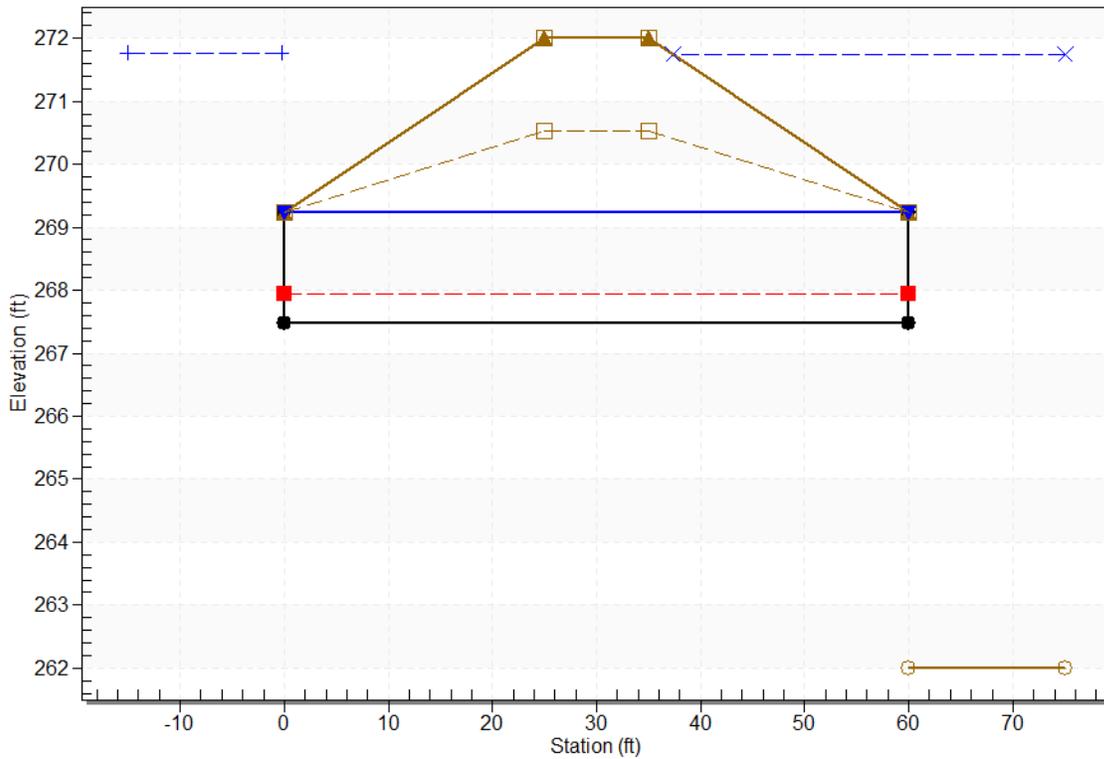
### Culvert Performance Curve Plot: Culvert 1



## Water Surface Profile Plot for Culvert: Culvert 1

Crossing - North Site Culvert, Design Discharge - 79.6 cfs

Culvert - Culvert 1, Culvert Discharge - 3.2 cfs



## Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 267.48 ft

Outlet Station: 60.00 ft

Outlet Elevation: 267.48 ft

Number of Barrels: 2

## Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.75 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

### Tailwater Data for Crossing: North Site Culvert

Table 9 - Downstream Channel Rating Curve (Crossing: North Site Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
11.70	269.03	7.03	0.00
20.10	270.92	8.92	0.00
26.90	271.21	9.21	0.00
37.00	271.41	9.41	0.00
45.50	271.50	9.50	0.00
54.70	271.58	9.58	0.00
64.90	271.65	9.65	0.00
79.60	271.74	9.74	0.00

### Tailwater Channel Data - North Site Culvert

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: Enter Rating Curve

### Roadway Data for Crossing: North Site Culvert

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

#### Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	0.00	272.00
1	1.10	271.00
2	8.60	270.52
3	20.10	270.56
4	62.60	270.66
5	72.20	271.00
6	99.80	272.00

Roadway Surface: Gravel

Roadway Top Width: 10.00 ft