

# **Hydrology and Hydraulics Report**

for

**Argyle Township, Hemlock Stream Bridge #3735**

WIN 021687.00

## HYDROLOGY REPORT

---

Hemlock Bridge carries State Route 116 over Hemlock Stream in Argyle TWP. Hemlock Stream has a drainage basin of 21 square miles, 20.4% of which is wetlands, and its mean annual precipitation is 42 inches. It originates in an area of wetlands approximately 11.5 miles northwest of Hemlock Bridge, in the town of Lagrange. Hemlock Stream flows approximately 1,400 feet downstream from Hemlock Bridge until its confluence with the Penobscot River.

Though Hemlock Stream was included in a 1985 FEMA Flood Insurance map of Argyle TWP, the map did not include flood elevation data. Only the area within the stream's watershed affected by a Q100 flood was shown. Q100 flood elevations for the Penobscot River were included in a 1987 FEMA Flood Insurance Study for the town of Greenbush (located across the Penobscot River from Argyle). This study determined the elevation of Q100 backwater at Hemlock Bridge to be 125.3' (when adjusted to NAVD 88).

The nearest USGS monitoring station is USGS 01034500 – Penobscot River at West Enfield, Maine. This station is 12.4 miles upstream of Hemlock Stream's confluence with the Penobscot River. The flood of record at this location occurred on May 1, 1923, and the recorded river surface was 25.2 feet above the gage datum at the bed of the Penobscot River (the contemporary NGVD 29 elevation for this flood/datum could not be verified).

Flow data was prepared using USGS Regression equations (Hodgkins 1999 and Hodgkins/Lombard 2015) and data from USGS StreamStats.

### SUMMARY

|               |      |                    |
|---------------|------|--------------------|
| Drainage Area | 21   | mi <sup>2</sup>    |
| Q1.1          | 210  | ft <sup>3</sup> /s |
| Q10           | 650  | ft <sup>3</sup> /s |
| Q25           | 790  | ft <sup>3</sup> /s |
| Q50           | 910  | ft <sup>3</sup> /s |
| Q100          | 1020 | ft <sup>3</sup> /s |
| Q500          | 1285 | ft <sup>3</sup> /s |

Reported by: Casey, William

Date: October 4, 2022

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.

## HYDRAULIC REPORT

---

### INTRODUCTION

Hemlock Bridge carries State Route 116 over Hemlock Stream in Argyle TWP. Hemlock Stream flows approximately 1,400 feet downstream from Hemlock Bridge to its confluence with the Penobscot River.

### STREAM GEOMORPHOLOGY

The stream channel bends at the bridge site and bends again 250' downstream of the bridge. There is a 6' waterfall 125' downstream of the bridge and a secondary channel 70' downstream. The channel is sinuous (sinuosity of 1.32) in the reach analyzed. The channel shape varies between trapezoidal and triangular over the length of the reach. The streambed is rocky, with exposed bedrock, cobbles, some pebbles, and a few larger rocks.

The overbanks are mostly overgrown with grass, brush, and trees. Near the bridge they are steep but flatten as the stream approaches the Penobscot River. The overbanks are a flat floodplain by the end of the reach.

### MODELING PARAMETERS

Boundary conditions were chosen based on available data. The known water surface from Penobscot River backwater is from a 1987 FEMA flood insurance study for the town of Greenbush, which is across the Penobscot River from Argyle.

The other boundary condition checked was the Normal Depth. These values were the streambed slope both up and downstream of the bridge. Sensitivity analysis showed that the model is not sensitive to the normal depth. Changes in this parameter barely changed the elevation results.

Manning's Roughness Coefficients for the channel and overbanks were selected from *Publication FHWA-HIF-12-018, Hydraulic Design of Safe Bridges*. A sensitivity analysis showed that the model is only sensitive to large changes in channel coefficient values. For example, doubling the coefficient value caused a 36% increase in the water surface elevation.

Sensitivity analyses were done by changing coefficients in 5% increments, running the model, and recording changes in the water surface elevation.

Ineffective flow areas were determined via expansion and contraction coefficients. The provided bankfull width was checked by inputting the bankfull flow and running the model to see if the bank stations at that flow matched the bankfull width. The analysis showed that they did for most cross sections, and only differed by about 1' for the cross sections where they did not match.

### Stream Parameters

|                                    |                                                          |
|------------------------------------|----------------------------------------------------------|
| Cross Sections & Alignment         | Extracted from survey data                               |
| Channel Manning's Coefficient (n)  | 0.040, 0.045; Cobbles, mountain stream                   |
| Overbank Manning's Coefficient (n) | 0.11, 0.12; Undergrowth and trees                        |
| Abutment Manning's Coefficient (n) | 0.03; Concrete                                           |
| Expansion Coefficient              | 0.3                                                      |
| Contraction Coefficient            | 0.1                                                      |
| Boundary Conditions                | 0.023; Upstream Normal Depth (S), streambed slope        |
|                                    | 0.006; downstream Normal Depth (S), streambed slope      |
|                                    | 125.6'; Known Elevation, Q100 Backwater, Penobscot River |

### EXISTING BRIDGE

The existing bridge is an arched concrete slab on cast-in-place concrete abutments. It has a clear span of 25', an out-to-out width of 25.4', and a 15° skew.

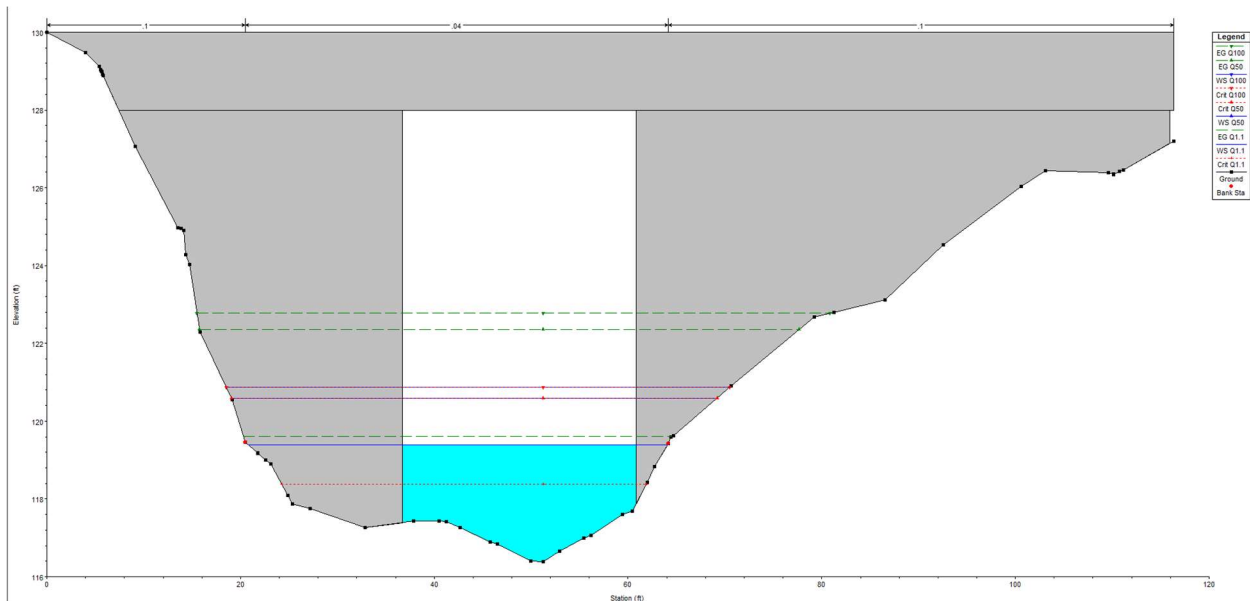
Two boundary conditions were used for analysis. The first boundary condition tested was a known water surface. The surface used was the backwater surface elevation from the Penobscot River. From FEMA floodmaps, the Q100 water height of the river is 125.6'. This is 4' deeper than the Q100 flow from Hemlock Stream. As such, this condition controlled the analysis for headwater depth. The second condition tested was a normal depth approximation based on the upstream and downstream slope. This option did not control the analysis, but it was used to check flow velocities.

The flow regime was assumed to be mixed for headwater depth. This is because the constriction of the bridge causes the stream to briefly become critical at higher rates of flow.

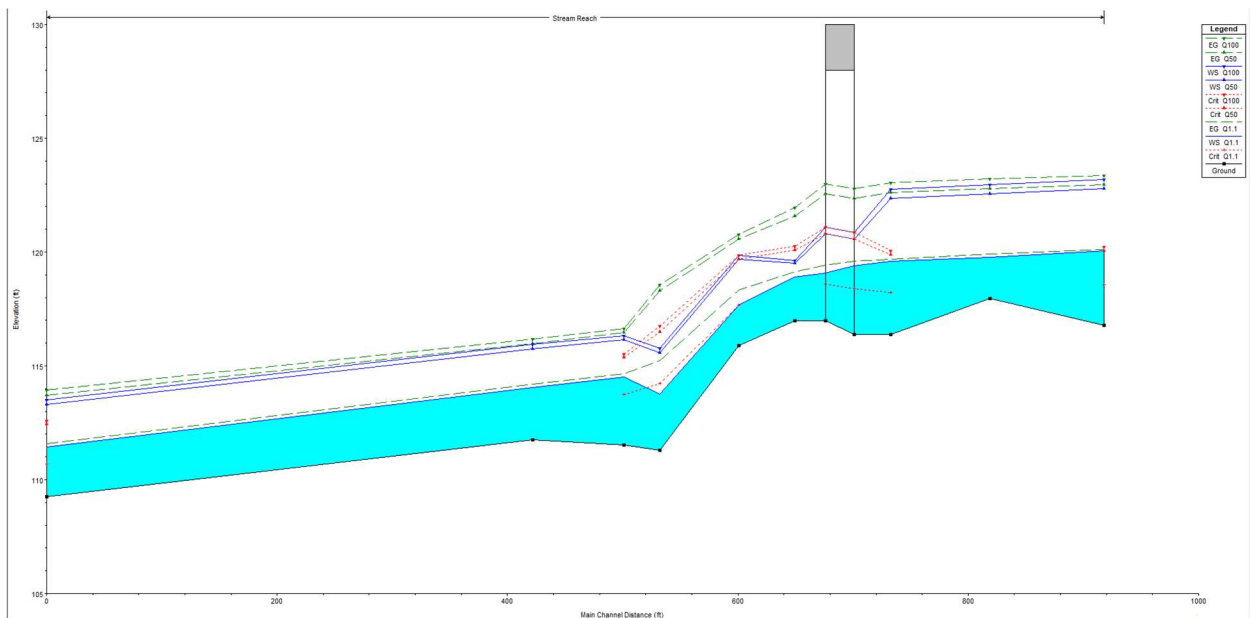
The existing bridge was analyzed for Q50 and Q100 flows. When analyzing for the Normal depth boundary condition (under flows from Hemlock Stream only), the model shows 7.5' of freeboard at Q50 and 7.2' of freeboard at Q100. This is well within allowable clearance. However, the constriction of the bridge causes an increase in velocity.

It was determined via a preliminary simultaneous occurrence assessment that none of the joint probability events cause flooding greater than the Q100 flood of the Penobscot River. Furthermore, the hydraulic model showed that during Q100 floods of the Penobscot River,

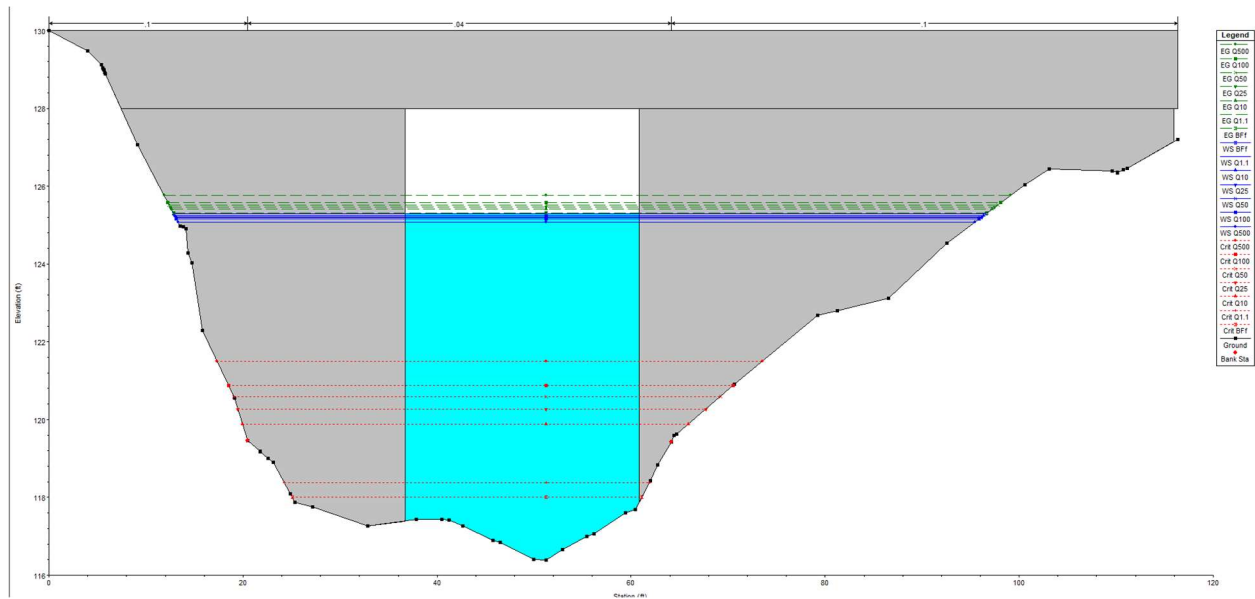
varying flows from Hemlock Stream (from Q1.1 to Q500) had a negligible effect on the water surface elevation, with the backwater elevation controlling.



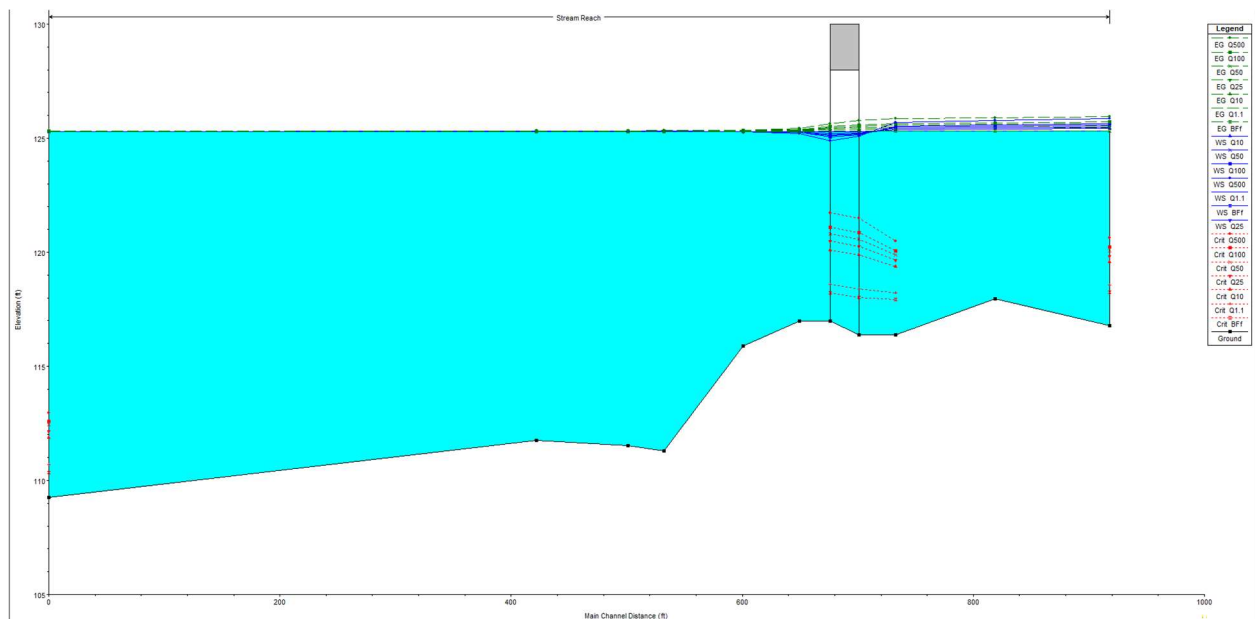
**Figure 1:** Cross section of the upstream side of existing Hemlock Bridge, showing Q1.1, Q50, and Q100 water surface elevations for flows from Hemlock Stream.



**Figure 2:** Water surface profile of stream reach for existing Hemlock Bridge, showing Q1.1, Q50, and Q100 water surface elevations for flows from Hemlock Stream.



**Figure 3:** Cross section of the upstream side of existing Hemlock Bridge with backwater from a Q100 flood of the Penobscot River.



**Figure 4:** Water Surface profile of stream reach for existing Hemlock Bridge with backwater from a Q100 flood of the Penobscot River.

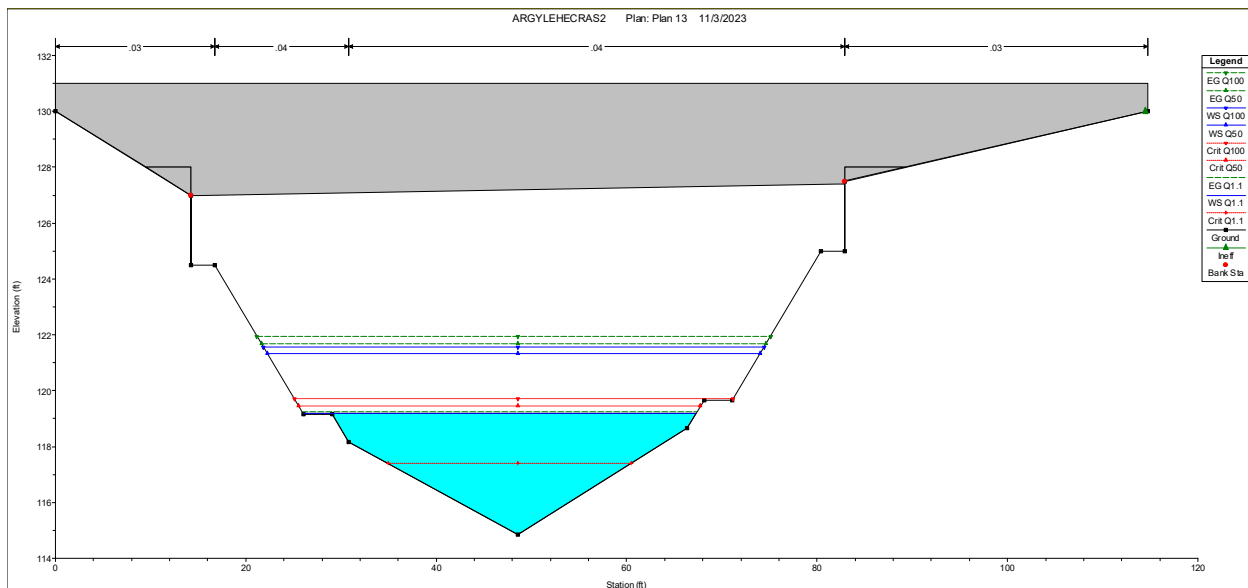
Prior inspection reports indicate that the banks are stable for scour. Any existing scour damage is likely caused by the elevated velocities experienced during floods. For example, the Q1.1 velocity is 3.6 ft/s, and it jumps to 9.43 ft/s during a Q10 flood.

## PROPOSED BRIDGE

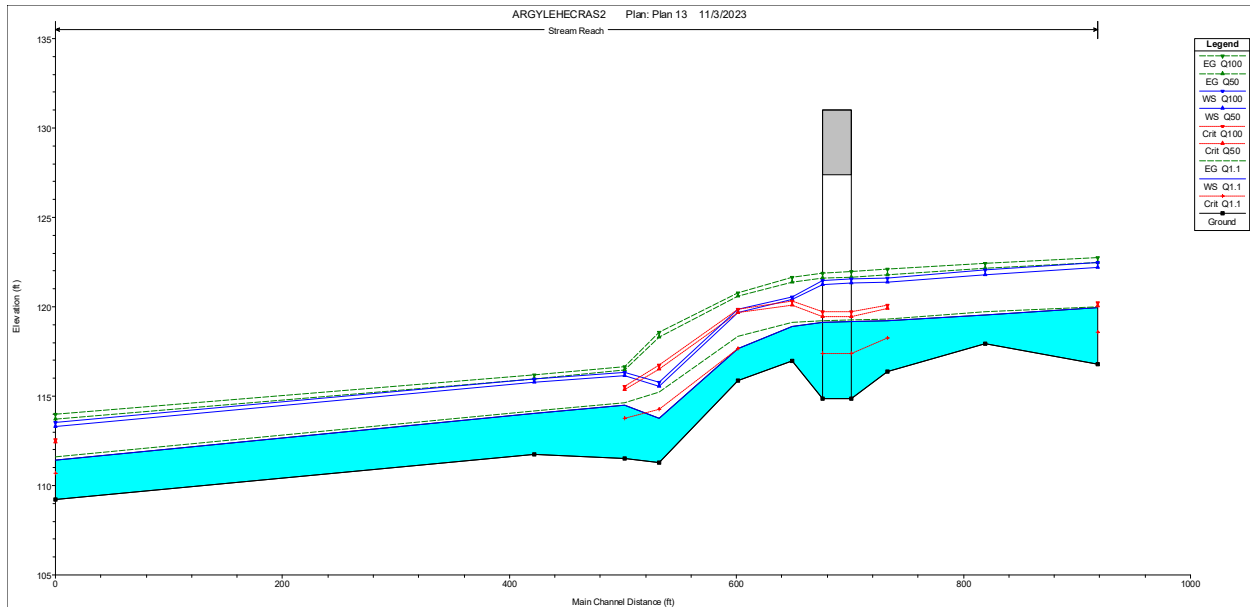
Hemlock Stream's geometry will change because of the new bridge. The existing bridge functions as a constriction. Because Hemlock Stream is a Tier 1 Atlantic salmon habitat, the constriction will be eliminated. The proposed NEXT Beam structure will have a 75' span to accommodate a 46' 1.2 bankfull width with riprap slopes and 4' wildlife shelves below the abutments. Additionally, the new bridge abutments will have a skew of 17°. The rest of the stream will remain as unchanged as possible.

The flow regimes for the proposed bridge were checked for the mixed condition. Though the hydraulic opening is wider than the existing bridge, it is still not as wide as the natural overbanks. Modelling showed that the stream goes critical under the bridge and at the bottom of the downstream waterfall.

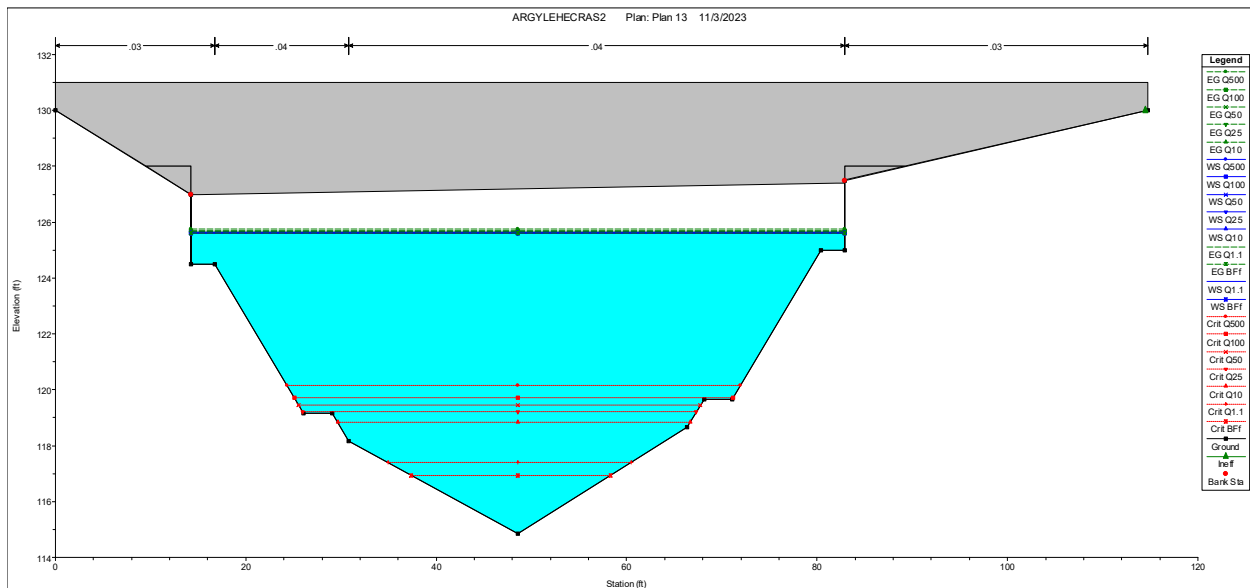
Q100 backwater from the Penobscot River reaches an elevation of 125.6'. When the Penobscot River floods, flows from Hemlock Stream have a negligible effect on the water surface elevation. As such, the backwater condition controls the proposed bridge. The bottom of the NEXT Beams has an elevation of 127. This leaves 1.4' of freeboard clearance at the Q100 flooding event, which is adequate, as per the Bridge Design Guide.



**Figure 5:** Cross section of the upstream side of the proposed new Hemlock Bridge, showing Q1.1, Q50, and Q100 water surface elevations for flows from Hemlock Stream.

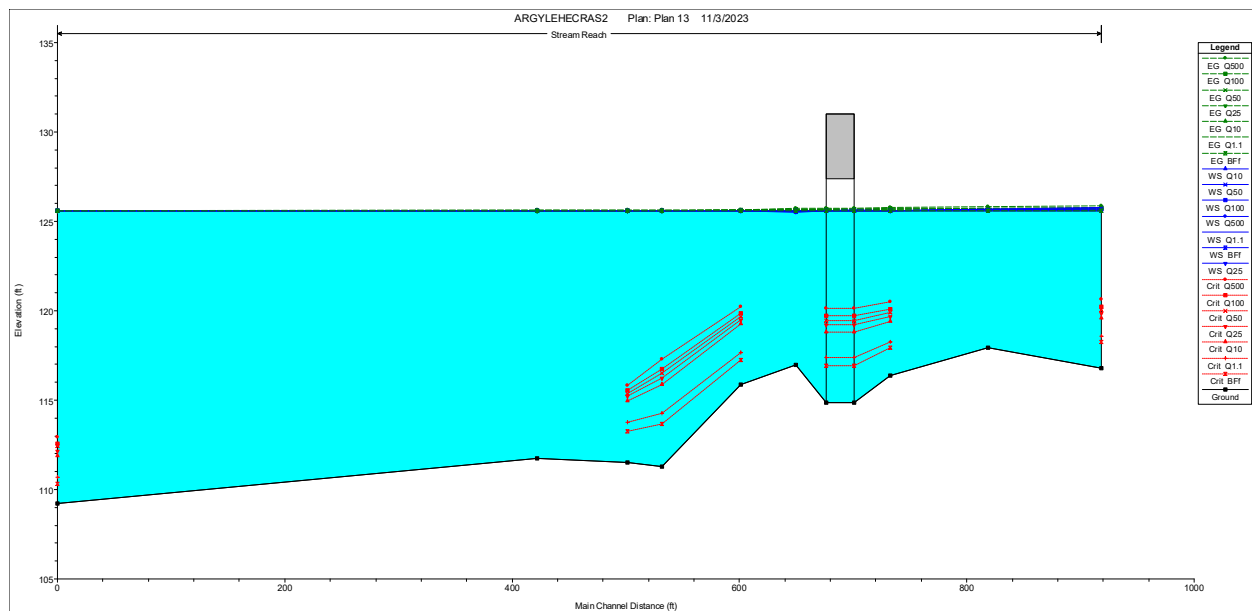


**Figure 6:** Water surface profile of stream reach for the proposed new Hemlock Bridge, showing Q1.1, Q50, and Q100 water surface elevations for flows from Hemlock Stream.



**Figure 7:** Cross section of the upstream side of the proposed new Hemlock Bridge with backwater from a Q100 flood of the Penobscot River.





**Figure 8:** Water Surface profile of stream reach for the proposed new Hemlock Bridge with backwater from a Q100 flood of the Penobscot River.

### SUMMARY

|                                                                 |                 | Existing Structure   | Recommended Structure |
|-----------------------------------------------------------------|-----------------|----------------------|-----------------------|
|                                                                 |                 | 25' Span Arched Slab | 75' Span NEXT F Beam  |
| Total Area of Waterway Opening                                  | ft <sup>2</sup> | 268.5                | 493.8                 |
| Headwater elevation @ Q <sub>1.1</sub>                          | ft              | 119.6                | 119.2                 |
| Headwater elevation @ Q <sub>10</sub>                           | ft              | 121.3                | 120.8                 |
| Headwater elevation @ Q <sub>25</sub>                           | ft              | 121.9                | 121.1                 |
| Headwater elevation @ Q <sub>50</sub>                           | ft              | 122.4                | 121.4                 |
| Headwater elevation @ Q <sub>100</sub>                          | ft              | 122.8                | 121.6                 |
| Headwater elevation @ Q <sub>100</sub> ,<br>Penobscot Backwater | ft              | 125.6                | 125.6                 |
| Headwater elevation @ Q <sub>500</sub>                          | ft              | 123.7                | 122.2                 |
| Freeboard @ Q <sub>50</sub>                                     | ft              | 5.8                  | 5.6                   |
| Freeboard @ Q <sub>100</sub>                                    | ft              | 5.4                  | 5.4                   |
| Freeboard @ Q <sub>100</sub> ,<br>Penobscot Backwater           | ft              | 2.7                  | 1.4                   |
| Outlet Velocity @ Q <sub>1.1</sub>                              | ft/s            | 4.7                  | 3.9                   |
| Outlet Velocity @ Q <sub>10</sub>                               | ft/s            | 9.5                  | 6.3                   |
| Outlet Velocity @ Q <sub>25</sub>                               | ft/s            | 10.2                 | 7.2                   |
| Outlet Velocity @ Q <sub>50</sub>                               | ft/s            | 10.8                 | 7.9                   |
| Outlet Velocity @ Q <sub>100</sub>                              | ft/s            | 11.7                 | 8.5                   |
| Outlet Velocity @ Q <sub>100</sub> ,<br>Penobscot Backwater     | ft/s            | 5.23                 | 2.9                   |
| Outlet Velocity @ Q <sub>500</sub>                              | ft/s            | 11.8                 | 9.9                   |

Reported by: Casey, William

Date: November 3, 2023

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.

## Existing Bridge

HEC-RAS Plan: 13 River: Stream Reach: Reach

| Reach | River Sta | Profile | Q Total<br>(cfs) | Min Ch El<br>(ft) | W.S. Elev<br>(ft) | Crit W.S.<br>(ft) | E.G. Elev<br>(ft) | E.G. Slope<br>(ft/ft) | Vel Chnl<br>(ft/s) | Flow Area<br>(sq ft) | Top Width<br>(ft) | Froude # Chl |
|-------|-----------|---------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Reach | 918.1637  | Q1.1    | 210.00           | 116.78            | 119.95            | 118.57            | 120.02            | 0.001456              | 2.02               | 104.01               | 50.23             | 0.25         |
| Reach | 918.1637  | Q10     | 650.00           | 116.78            | 121.53            | 119.60            | 121.72            | 0.002141              | 3.47               | 195.32               | 78.40             | 0.33         |
| Reach | 918.1637  | Q25     | 790.00           | 116.78            | 121.91            | 119.84            | 122.13            | 0.002231              | 3.79               | 226.69               | 91.78             | 0.34         |
| Reach | 918.1637  | Q50     | 910.00           | 116.78            | 122.21            | 120.04            | 122.46            | 0.002267              | 4.01               | 256.24               | 100.21            | 0.35         |
| Reach | 918.1637  | Q100    | 1020.00          | 116.78            | 122.48            | 120.24            | 122.75            | 0.002278              | 4.19               | 283.97               | 105.05            | 0.35         |
| Reach | 918.1637  | Q500    | 1285.00          | 116.78            | 123.11            | 120.63            | 123.41            | 0.002238              | 4.54               | 351.63               | 109.96            | 0.35         |
| Reach | 818.9958  | Q1.1    | 210.00           | 117.95            | 119.55            |                   | 119.72            | 0.008078              | 3.37               | 62.22                | 50.85             | 0.54         |
| Reach | 818.9958  | Q10     | 650.00           | 117.95            | 121.12            |                   | 121.41            | 0.004601              | 4.39               | 164.32               | 70.44             | 0.47         |
| Reach | 818.9958  | Q25     | 790.00           | 117.95            | 121.49            |                   | 121.81            | 0.004419              | 4.67               | 190.70               | 72.73             | 0.47         |
| Reach | 818.9958  | Q50     | 910.00           | 117.95            | 121.79            |                   | 122.15            | 0.004265              | 4.88               | 213.04               | 74.63             | 0.46         |
| Reach | 818.9958  | Q100    | 1020.00          | 117.95            | 122.06            |                   | 122.44            | 0.004132              | 5.05               | 233.33               | 76.31             | 0.46         |
| Reach | 818.9958  | Q500    | 1285.00          | 117.95            | 122.68            |                   | 123.11            | 0.003826              | 5.39               | 282.23               | 80.32             | 0.46         |
| Reach | 732.6505  | Q1.1    | 210.00           | 116.38            | 119.21            | 118.24            | 119.33            | 0.002707              | 2.82               | 74.56                | 41.59             | 0.37         |
| Reach | 732.6505  | Q10     | 650.00           | 116.38            | 120.75            | 119.40            | 121.08            | 0.003243              | 4.59               | 145.57               | 50.66             | 0.45         |
| Reach | 732.6505  | Q25     | 790.00           | 116.38            | 121.08            | 119.67            | 121.47            | 0.003460              | 5.06               | 162.61               | 52.84             | 0.47         |
| Reach | 732.6505  | Q50     | 910.00           | 116.38            | 121.35            | 119.89            | 121.80            | 0.003570              | 5.39               | 177.43               | 54.68             | 0.48         |
| Reach | 732.6505  | Q100    | 1020.00          | 116.38            | 121.60            | 120.08            | 122.10            | 0.003631              | 5.67               | 191.14               | 56.33             | 0.49         |
| Reach | 732.6505  | Q500    | 1285.00          | 116.38            | 122.19            | 120.53            | 122.78            | 0.003649              | 6.21               | 225.30               | 60.23             | 0.51         |
| Reach | 688       |         | Bridge           |                   |                   |                   |                   |                       |                    |                      |                   |              |
| Reach | 649.3790  | Q1.1    | 210.00           | 116.98            | 118.90            |                   | 119.14            | 0.009705              | 3.94               | 53.31                | 39.04             | 0.59         |
| Reach | 649.3790  | Q10     | 650.00           | 116.98            | 120.11            |                   | 120.73            | 0.011443              | 6.31               | 103.85               | 44.16             | 0.71         |
| Reach | 649.3790  | Q25     | 790.00           | 116.98            | 120.28            |                   | 121.08            | 0.013622              | 7.18               | 111.15               | 44.93             | 0.78         |
| Reach | 649.3790  | Q50     | 910.00           | 116.98            | 120.42            | 120.11            | 121.37            | 0.015199              | 7.85               | 117.45               | 45.58             | 0.83         |
| Reach | 649.3790  | Q100    | 1020.00          | 116.98            | 120.53            | 120.30            | 121.64            | 0.016637              | 8.45               | 122.77               | 46.12             | 0.88         |
| Reach | 649.3790  | Q500    | 1285.00          | 116.98            | 120.75            | 120.75            | 122.26            | 0.020607              | 9.87               | 133.04               | 47.15             | 0.99         |
| Reach | 601.0290  | Q1.1    | 210.00           | 115.89            | 117.67            | 117.67            | 118.34            | 0.028879              | 6.57               | 31.94                | 23.80             | 1.00         |
| Reach | 601.0290  | Q10     | 650.00           | 115.89            | 119.25            | 119.25            | 120.03            | 0.018155              | 7.33               | 114.18               | 96.55             | 0.87         |
| Reach | 601.0290  | Q25     | 790.00           | 115.89            | 119.51            | 119.51            | 120.34            | 0.017191              | 7.69               | 140.43               | 103.04            | 0.86         |
| Reach | 601.0290  | Q50     | 910.00           | 115.89            | 119.70            | 119.70            | 120.58            | 0.016902              | 8.01               | 160.70               | 108.44            | 0.87         |
| Reach | 601.0290  | Q100    | 1020.00          | 115.89            | 119.87            | 119.87            | 120.79            | 0.016472              | 8.25               | 179.73               | 111.92            | 0.86         |
| Reach | 601.0290  | Q500    | 1285.00          | 115.89            | 120.21            | 120.21            | 121.24            | 0.016565              | 8.91               | 217.96               | 115.70            | 0.88         |
| Reach | 532.0808  | Q1.1    | 210.00           | 111.29            | 113.75            | 114.25            | 115.24            | 0.074210              | 9.80               | 21.42                | 16.80             | 1.53         |
| Reach | 532.0808  | Q10     | 650.00           | 111.29            | 115.02            | 115.86            | 117.57            | 0.079048              | 12.94              | 54.86                | 35.08             | 1.69         |
| Reach | 532.0808  | Q25     | 790.00           | 111.29            | 115.32            | 116.24            | 118.00            | 0.073585              | 13.34              | 65.76                | 37.77             | 1.66         |
| Reach | 532.0808  | Q50     | 910.00           | 111.29            | 115.57            | 116.50            | 118.31            | 0.069574              | 13.53              | 75.47                | 40.39             | 1.64         |
| Reach | 532.0808  | Q100    | 1020.00          | 111.29            | 115.78            | 116.75            | 118.58            | 0.066838              | 13.69              | 84.19                | 42.69             | 1.62         |
| Reach | 532.0808  | Q500    | 1285.00          | 111.29            | 116.27            | 117.28            | 119.11            | 0.059446              | 13.86              | 107.49               | 51.93             | 1.56         |
| Reach | 501.4070  | Q1.1    | 210.00           | 111.53            | 114.51            | 113.74            | 114.65            | 0.005021              | 3.18               | 88.71                | 74.12             | 0.44         |
| Reach | 501.4070  | Q10     | 650.00           | 111.53            | 115.68            | 114.98            | 115.94            | 0.006132              | 4.74               | 248.85               | 168.01            | 0.51         |
| Reach | 501.4070  | Q25     | 790.00           | 111.53            | 115.95            | 115.22            | 116.24            | 0.006099              | 5.02               | 294.66               | 172.55            | 0.52         |
| Reach | 501.4070  | Q50     | 910.00           | 111.53            | 116.15            | 115.39            | 116.46            | 0.006128              | 5.25               | 330.47               | 176.01            | 0.53         |
| Reach | 501.4070  | Q100    | 1020.00          | 111.53            | 116.33            | 115.54            | 116.66            | 0.006121              | 5.44               | 362.50               | 179.31            | 0.53         |
| Reach | 501.4070  | Q500    | 1285.00          | 111.53            | 116.73            | 115.83            | 117.11            | 0.006259              | 5.94               | 438.54               | 203.77            | 0.55         |
| Reach | 422.0456  | Q1.1    | 210.00           | 111.74            | 114.06            |                   | 114.20            | 0.006331              | 3.09               | 84.60                | 82.70             | 0.48         |
| Reach | 422.0456  | Q10     | 650.00           | 111.74            | 115.26            |                   | 115.46            | 0.005245              | 4.06               | 265.80               | 174.63            | 0.48         |
| Reach | 422.0456  | Q25     | 790.00           | 111.74            | 115.54            |                   | 115.75            | 0.005043              | 4.22               | 316.64               | 180.72            | 0.47         |
| Reach | 422.0456  | Q50     | 910.00           | 111.74            | 115.76            |                   | 115.98            | 0.004878              | 4.39               | 356.11               | 186.45            | 0.47         |
| Reach | 422.0456  | Q100    | 1020.00          | 111.74            | 115.95            |                   | 116.18            | 0.004729              | 4.52               | 392.05               | 191.34            | 0.47         |
| Reach | 422.0456  | Q500    | 1285.00          | 111.74            | 116.38            |                   | 116.64            | 0.004423              | 4.80               | 477.15               | 202.98            | 0.46         |
| Reach | -0.0000   | Q1.1    | 210.00           | 109.24            | 111.43            | 110.68            | 111.59            | 0.006002              | 3.24               | 68.61                | 53.59             | 0.47         |
| Reach | -0.0000   | Q10     | 650.00           | 109.24            | 112.78            | 111.88            | 113.11            | 0.006008              | 4.80               | 168.15               | 89.32             | 0.52         |
| Reach | -0.0000   | Q25     | 790.00           | 109.24            | 113.08            | 112.15            | 113.46            | 0.006002              | 5.12               | 195.59               | 90.15             | 0.53         |
| Reach | -0.0000   | Q50     | 910.00           | 109.24            | 113.32            | 112.43            | 113.73            | 0.006002              | 5.37               | 217.66               | 92.77             | 0.54         |
| Reach | -0.0000   | Q100    | 1020.00          | 109.24            | 113.53            | 112.59            | 113.97            | 0.006000              | 5.58               | 237.54               | 96.68             | 0.54         |
| Reach | -0.0000   | Q500    | 1285.00          | 109.24            | 114.00            | 112.95            | 114.49            | 0.006012              | 6.02               | 284.25               | 105.28            | 0.55         |

# Proposed Bridge

HEC-RAS Plan: 13 River: Stream Reach: Reach

| Reach | River Sta | Profile | Q Total<br>(cfs) | Min Ch El<br>(ft) | W.S. Elev<br>(ft) | Crit W.S.<br>(ft) | E.G. Elev<br>(ft) | E.G. Slope<br>(ft/ft) | Vel Chnl<br>(ft/s) | Flow Area<br>(sq ft) | Top Width<br>(ft) | Froude # Chl |
|-------|-----------|---------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Reach | 918.1637  | Q1.1    | 210.00           | 116.78            | 125.60            | 118.57            | 125.61            | 0.000014              | 0.46               | 636.61               | 120.64            | 0.03         |
| Reach | 918.1637  | Q10     | 650.00           | 116.78            | 125.65            | 119.60            | 125.67            | 0.000128              | 1.42               | 641.69               | 121.04            | 0.09         |
| Reach | 918.1637  | Q25     | 790.00           | 116.78            | 125.67            | 119.85            | 125.71            | 0.000188              | 1.72               | 644.43               | 121.25            | 0.11         |
| Reach | 918.1637  | Q50     | 910.00           | 116.78            | 125.69            | 120.05            | 125.75            | 0.000246              | 1.98               | 647.23               | 121.47            | 0.13         |
| Reach | 918.1637  | Q100    | 1020.00          | 116.78            | 125.72            | 120.24            | 125.78            | 0.000306              | 2.21               | 650.16               | 121.70            | 0.14         |
| Reach | 918.1637  | Q500    | 1285.00          | 116.78            | 125.79            | 120.63            | 125.89            | 0.000470              | 2.75               | 658.71               | 122.37            | 0.17         |
| Reach | 918.1637  | BFf     | 126.90           | 116.78            | 125.60            | 118.25            | 125.60            | 0.000005              | 0.28               | 636.23               | 120.61            | 0.02         |
| Reach | 818.9958  | Q1.1    | 210.00           | 117.95            | 125.60            |                   | 125.61            | 0.000016              | 0.50               | 581.90               | 118.13            | 0.03         |
| Reach | 818.9958  | Q10     | 650.00           | 117.95            | 125.63            |                   | 125.66            | 0.000156              | 1.54               | 584.75               | 118.30            | 0.10         |
| Reach | 818.9958  | Q25     | 790.00           | 117.95            | 125.64            |                   | 125.69            | 0.000229              | 1.87               | 586.30               | 118.40            | 0.12         |
| Reach | 818.9958  | Q50     | 910.00           | 117.95            | 125.65            |                   | 125.72            | 0.000302              | 2.15               | 587.90               | 119.59            | 0.14         |
| Reach | 818.9958  | Q100    | 1020.00          | 117.95            | 125.67            |                   | 125.75            | 0.000377              | 2.40               | 589.60               | 119.70            | 0.16         |
| Reach | 818.9958  | Q500    | 1285.00          | 117.95            | 125.71            |                   | 125.84            | 0.000586              | 3.01               | 594.65               | 120.01            | 0.20         |
| Reach | 818.9958  | BFf     | 126.90           | 117.95            | 125.60            |                   | 125.60            | 0.000006              | 0.30               | 581.69               | 118.11            | 0.02         |
| Reach | 732.6505  | Q1.1    | 210.00           | 116.38            | 125.60            | 118.24            | 125.60            | 0.000014              | 0.56               | 476.22               | 85.15             | 0.03         |
| Reach | 732.6505  | Q10     | 650.00           | 116.38            | 125.60            | 119.40            | 125.65            | 0.000136              | 1.73               | 476.48               | 85.17             | 0.11         |
| Reach | 732.6505  | Q25     | 790.00           | 116.38            | 125.61            | 119.67            | 125.67            | 0.000201              | 2.10               | 476.62               | 85.19             | 0.13         |
| Reach | 732.6505  | Q50     | 910.00           | 116.38            | 125.61            | 119.89            | 125.69            | 0.000267              | 2.42               | 476.78               | 85.20             | 0.15         |
| Reach | 732.6505  | Q100    | 1020.00          | 116.38            | 125.61            | 120.08            | 125.72            | 0.000335              | 2.71               | 476.96               | 85.22             | 0.17         |
| Reach | 732.6505  | Q500    | 1285.00          | 116.38            | 125.62            | 120.53            | 125.78            | 0.000530              | 3.41               | 477.52               | 85.26             | 0.21         |
| Reach | 732.6505  | BFf     | 126.90           | 116.38            | 125.60            | 117.94            | 125.60            | 0.000005              | 0.34               | 476.21               | 85.15             | 0.02         |
| Reach | 688       | Bridge  |                  |                   |                   |                   |                   |                       |                    |                      |                   |              |
| Reach | 649.3790  | Q1.1    | 210.00           | 116.98            | 125.60            |                   | 125.60            | 0.000021              | 0.60               | 410.16               | 68.57             | 0.04         |
| Reach | 649.3790  | Q10     | 650.00           | 116.98            | 125.58            |                   | 125.63            | 0.000208              | 1.85               | 408.97               | 68.50             | 0.12         |
| Reach | 649.3790  | Q25     | 790.00           | 116.98            | 125.57            |                   | 125.64            | 0.000308              | 2.25               | 408.33               | 68.46             | 0.14         |
| Reach | 649.3790  | Q50     | 910.00           | 116.98            | 125.56            |                   | 125.66            | 0.000411              | 2.60               | 407.67               | 68.42             | 0.16         |
| Reach | 649.3790  | Q100    | 1020.00          | 116.98            | 125.55            |                   | 125.67            | 0.000518              | 2.92               | 406.98               | 68.38             | 0.18         |
| Reach | 649.3790  | Q500    | 1285.00          | 116.98            | 125.52            |                   | 125.72            | 0.000834              | 3.69               | 404.96               | 68.26             | 0.23         |
| Reach | 649.3790  | BFf     | 126.90           | 116.98            | 125.60            |                   | 125.60            | 0.000008              | 0.36               | 410.25               | 68.57             | 0.02         |
| Reach | 601.0290  | Q1.1    | 210.00           | 115.89            | 125.60            | 117.67            | 125.60            | 0.000008              | 0.39               | 984.91               | 166.71            | 0.02         |
| Reach | 601.0290  | Q10     | 650.00           | 115.89            | 125.60            | 119.25            | 125.61            | 0.000081              | 1.21               | 984.70               | 166.70            | 0.07         |
| Reach | 601.0290  | Q25     | 790.00           | 115.89            | 125.60            | 119.51            | 125.62            | 0.000120              | 1.47               | 984.59               | 166.70            | 0.09         |
| Reach | 601.0290  | Q50     | 910.00           | 115.89            | 125.60            | 119.70            | 125.63            | 0.000159              | 1.69               | 984.49               | 166.69            | 0.10         |
| Reach | 601.0290  | Q100    | 1020.00          | 115.89            | 125.60            | 119.87            | 125.63            | 0.000200              | 1.90               | 984.37               | 166.69            | 0.11         |
| Reach | 601.0290  | Q500    | 1285.00          | 115.89            | 125.59            | 120.21            | 125.65            | 0.000317              | 2.39               | 984.05               | 166.68            | 0.14         |
| Reach | 601.0290  | BFf     | 126.90           | 115.89            | 125.60            | 117.26            | 125.60            | 0.000003              | 0.24               | 984.92               | 166.71            | 0.01         |
| Reach | 532.0808  | Q1.1    | 210.00           | 111.29            | 125.60            | 114.25            | 125.60            | 0.000002              | 0.22               | 1950.11              | 276.47            | 0.01         |
| Reach | 532.0808  | Q10     | 650.00           | 111.29            | 125.60            | 115.86            | 125.61            | 0.000020              | 0.69               | 1950.86              | 276.49            | 0.04         |
| Reach | 532.0808  | Q25     | 790.00           | 111.29            | 125.60            | 116.24            | 125.61            | 0.000030              | 0.84               | 1951.26              | 276.51            | 0.05         |
| Reach | 532.0808  | Q50     | 910.00           | 111.29            | 125.61            | 116.50            | 125.62            | 0.000040              | 0.97               | 1951.67              | 276.52            | 0.05         |
| Reach | 532.0808  | Q100    | 1020.00          | 111.29            | 125.61            | 116.75            | 125.62            | 0.000050              | 1.09               | 1952.09              | 276.54            | 0.06         |
| Reach | 532.0808  | Q500    | 1285.00          | 111.29            | 125.61            | 117.28            | 125.63            | 0.000079              | 1.37               | 1953.31              | 276.58            | 0.07         |
| Reach | 532.0808  | BFf     | 126.90           | 111.29            | 125.60            | 113.67            | 125.60            | 0.000001              | 0.14               | 1950.05              | 276.47            | 0.01         |
| Reach | 501.4070  | Q1.1    | 210.00           | 111.53            | 125.60            | 113.74            | 125.60            | 0.000001              | 0.18               | 2533.32              | 256.96            | 0.01         |
| Reach | 501.4070  | Q10     | 650.00           | 111.53            | 125.60            | 114.98            | 125.61            | 0.000011              | 0.56               | 2534.27              | 257.03            | 0.03         |
| Reach | 501.4070  | Q25     | 790.00           | 111.53            | 125.61            | 115.22            | 125.61            | 0.000016              | 0.68               | 2534.78              | 257.07            | 0.03         |
| Reach | 501.4070  | Q50     | 910.00           | 111.53            | 125.61            | 115.39            | 125.61            | 0.000021              | 0.79               | 2535.29              | 257.12            | 0.04         |
| Reach | 501.4070  | Q100    | 1020.00          | 111.53            | 125.61            | 115.54            | 125.62            | 0.000027              | 0.88               | 2535.83              | 257.16            | 0.04         |
| Reach | 501.4070  | Q500    | 1285.00          | 111.53            | 125.62            | 115.83            | 125.63            | 0.000043              | 1.11               | 2537.37              | 257.28            | 0.06         |
| Reach | 501.4070  | BFf     | 126.90           | 111.53            | 125.60            | 113.24            | 125.60            | 0.000000              | 0.11               | 2533.25              | 256.95            | 0.01         |
| Reach | 422.0456  | Q1.1    | 210.00           | 111.74            | 125.60            |                   | 125.60            | 0.000001              | 0.15               | 2930.32              | 280.08            | 0.01         |
| Reach | 422.0456  | Q10     | 650.00           | 111.74            | 125.60            |                   | 125.61            | 0.000007              | 0.46               | 2931.28              | 280.08            | 0.02         |
| Reach | 422.0456  | Q25     | 790.00           | 111.74            | 125.61            |                   | 125.61            | 0.000010              | 0.56               | 2931.79              | 280.08            | 0.03         |
| Reach | 422.0456  | Q50     | 910.00           | 111.74            | 125.61            |                   | 125.61            | 0.000013              | 0.64               | 2932.32              | 280.08            | 0.03         |
| Reach | 422.0456  | Q100    | 1020.00          | 111.74            | 125.61            |                   | 125.61            | 0.000017              | 0.72               | 2932.86              | 280.08            | 0.04         |
| Reach | 422.0456  | Q500    | 1285.00          | 111.74            | 125.62            |                   | 125.62            | 0.000027              | 0.91               | 2934.41              | 280.08            | 0.05         |
| Reach | 422.0456  | BFf     | 126.90           | 111.74            | 125.60            |                   | 125.60            | 0.000000              | 0.09               | 2930.25              | 280.08            | 0.00         |
| Reach | -0.0000   | Q1.1    | 210.00           | 109.24            | 125.60            | 110.68            | 125.60            | 0.000001              | 0.17               | 2295.72              | 187.66            | 0.01         |
| Reach | -0.0000   | Q10     | 650.00           | 109.24            | 125.60            | 111.88            | 125.60            | 0.000007              | 0.53               | 2295.72              | 187.66            | 0.02         |
| Reach | -0.0000   | Q25     | 790.00           | 109.24            | 125.60            | 112.15            | 125.60            | 0.000010              | 0.64               | 2295.72              | 187.66            | 0.03         |
| Reach | -0.0000   | Q50     | 910.00           | 109.24            | 125.60            | 112.43            | 125.61            | 0.000014              | 0.74               | 2295.72              | 187.66            | 0.03         |
| Reach | -0.0000   | Q100    | 1020.00          | 109.24            | 125.60            | 112.59            | 125.61            | 0.000017              | 0.82               | 2295.72              | 187.66            | 0.04         |
| Reach | -0.0000   | Q500    | 1285.00          | 109.24            | 125.60            | 112.95            | 125.61            | 0.000027              | 1.04               | 2295.72              | 187.66            | 0.05         |
| Reach | -0.0000   | BFf     | 126.90           | 109.24            | 125.60            | 110.34            | 125.60            | 0.000000              | 0.10               | 2295.72              | 187.66            | 0.00         |

WIN: 21687.00  
 Town: Argyle  
 Route No. ME 116 / Edinburg Rd  
 Asset ID: 3735  
 Lat: 45.0853 Long: -68.6715

Project Name: Argyle - Hemlock Bridge  
 Stream Name: Hemlock  
 Bridge Name: Hemlock  
 Analysis by: csh  
 Date: 4/21/2022

## Peak Flow Calculations by USGS Regression Equations (Lombard/Hodgkins, 2021; Hodgkins, 1999 & Lombard/Hodgkins, 2015)

*Enter data in blue cells only!*

|                | km <sup>2</sup> | mi <sup>2</sup> | ac      |
|----------------|-----------------|-----------------|---------|
| A              | 54.39           | 21.00           | 13440.0 |
| W              | 11.07           | 4.3             | 2735.0  |
| P <sub>c</sub> | 520773          | 4999937         |         |
| County         | Penobscot N     |                 |         |

*Enter data in [mi<sup>2</sup>]*

Watershed Area *DRNAREA*  
 Wetlands area (by NWI)

watershed centroid (E, N; UTM 19N; meters)  
 choose county from drop-down menu

*ver. 2021 Jan 01*

**Worksheet prepared by:**

Charles S. Hebson, PE  
 Environmental Office  
 Maine Dept. Transportation  
 Augusta, ME 04333-0016  
 207-557-1052  
[Charles.Hebson@maine.gov](mailto:Charles.Hebson@maine.gov)

## Watershed Characteristics from StreamStats

|           |       |                                                          |
|-----------|-------|----------------------------------------------------------|
| STORNWI   | 20.35 | NWI Wetlands %                                           |
| SANDGRAV  | 0.00  | sand & gravel aquifer as decimal fraction of watershed A |
| ELEV      | 240   | mean basin elevation (ft)                                |
| BSLDEM10M | 2.64  | mean basin slope (%)                                     |
| COASTDIST | 85.00 | distance from the coast (mi)                             |
| ELEVMAX   | 573   | maximum basin elevation (ft)                             |
| LC06WATER | 0.37  | percent of drainage basin land cover as open water       |
| PRECIP    | 42.0  | mean annual precipitation                                |
| STATSGOA  | 8.49  | mean basin percentage of hydrological soil group A       |

## References:

Hodgkins, G.A., 1999.  
 Estimating the magnitude of peak flows for streams in Maine  
 for Selected Recurrence Intervals  
*WRIR 99-4008*, USGS Augusta, ME

Lombard, P.J. & G.A. Hodgkins, 2015.  
 Peak flow regression equations for small, ungaged streams:  
 in Maine: Comparing Map-Based to Field-Based Variables  
*SIR 2015-4059*, USGS, Augusta, ME

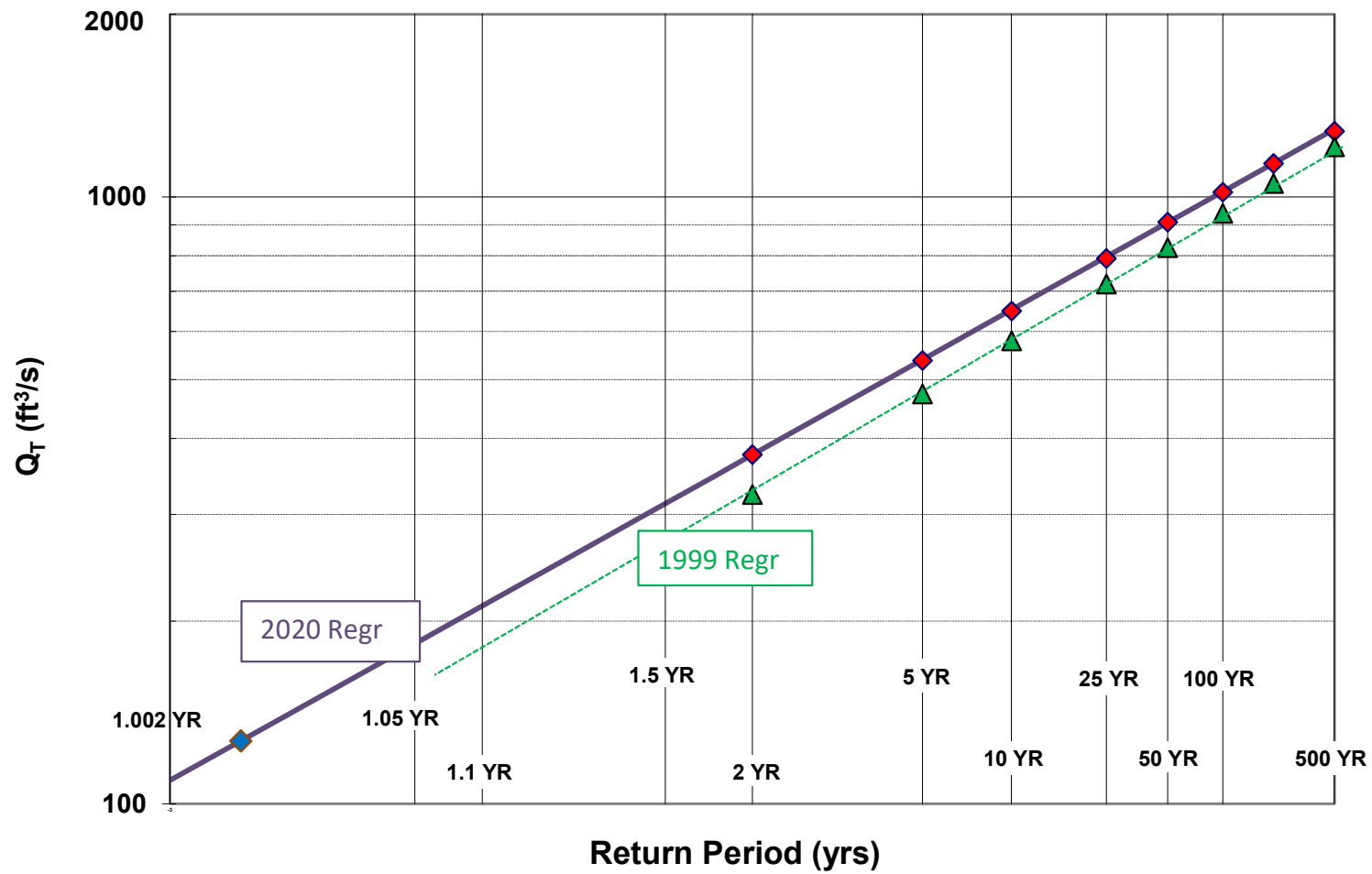
Lombard, P.J. & G.A. Hodgkins, 2020.  
 Estimating Flood Magnitude and Frequency on Gaged and  
 Ungaged Streams in Maine  
*SIR 2020-5092*, USGS, Augusta, ME.

| Ret Pd | I24  | Q <sub>T</sub> (ft <sup>3</sup> /s) |      | Q <sub>T</sub> (ft <sup>3</sup> /s) |
|--------|------|-------------------------------------|------|-------------------------------------|
| T (yr) |      | 1999 / 2015                         | 2021 | Design                              |
| 1.1    |      |                                     | 212  | 210                                 |
| 2      | 2.85 | 323                                 | 376  | 375                                 |
| 5      | 3.49 | 473                                 | 538  | 540                                 |
| 10     | 4.02 | 580                                 | 649  | 650                                 |
| 25     | 4.75 | 719                                 | 791  | 790                                 |
| 50     | 5.30 | 825                                 | 909  | 910                                 |
| 100    | 5.87 | 939                                 | 1019 | 1020                                |
| 200    | 6.45 | 1053                                | 1136 | 1135                                |
| 500    | 7.24 | 1209                                | 1283 | 1285                                |

## Instructions:

*Enter values in blue cells only, watershed data from StreamStats*  
 Copy I24 values from Stream Stats  
 Use results under "Design"  
 Check against gage data and FEMA studies if available  
 Questions? Check with ENV / Hydrology Section

## Log-Normal Probability Plot



WIN: 21687.00  
 Town: Argyle  
 Route No. ME 116 / Edinburg Rd  
 Asset ID: 3735  
 Lat: 0.00000 Long: 0.00000

Project Name: Argyle - Hemlock Bridge  
 Stream Name: Hemlock  
 Bridge Name: Hemlock  
 Analysis by: csh  
 Date: 4/21/2022

**DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED**

**MAINE MONTHLY MEDIAN FLOWS and HYDRAULIC GEOMETRY BY USGS REGRESSION EQUATIONS (2004, 2013, 2015)**

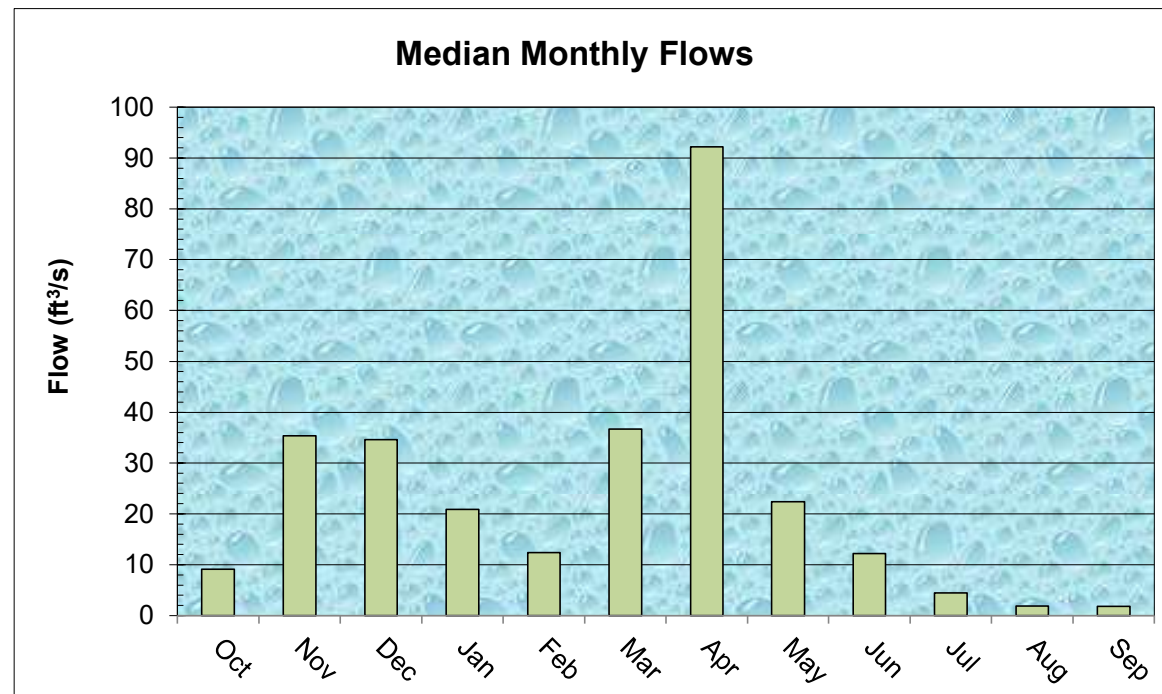
| Value  | Variable       | Explanation                                                |
|--------|----------------|------------------------------------------------------------|
| 21.00  | A              | Area (mi <sup>2</sup> )                                    |
| 520773 | P <sub>c</sub> | Watershed centroid (E,N; UTM; Zone 19; meters)             |
| 84.66  | DIST           | Distance from Coastal reference line (mi)                  |
| 42.0   | pptA           | Mean Annual Precipitation (inches)                         |
| 0.00   | SG             | Sand & Gravel Aquifer (decimal fraction of watershed area) |

| Month | Q <sub>median</sub><br>(ft <sup>3</sup> /s) | (m <sup>3</sup> /s) |
|-------|---------------------------------------------|---------------------|
| Jan   | 20.91                                       | 0.5925              |
| Feb   | 12.40                                       | 0.3515              |
| Mar   | 36.69                                       | 1.0397              |
| Apr   | 92.21                                       | 2.6131              |
| May   | 22.39                                       | 0.6345              |
| Jun   | 12.22                                       | 0.3463              |
| Jul   | 4.47                                        | 0.1268              |
| Aug   | 1.86                                        | 0.0528              |
| Sep   | 1.79                                        | 0.0506              |
| Oct   | 9.13                                        | 0.2586              |
| Nov   | 35.38                                       | 1.0025              |
| Dec   | 34.57                                       | 0.9797              |

|                    |       |
|--------------------|-------|
| Q <sub>bf</sub>    | 126.9 |
| ann avg            | 42.4  |
| ann med            | 18.4  |
| Q <sub>1.002</sub> | 109.3 |
| Q <sub>1.01</sub>  | 138.3 |
| Q <sub>1.05</sub>  | 183.7 |
| Q <sub>bf</sub>    | 262.1 |

assume v = 4ft/s

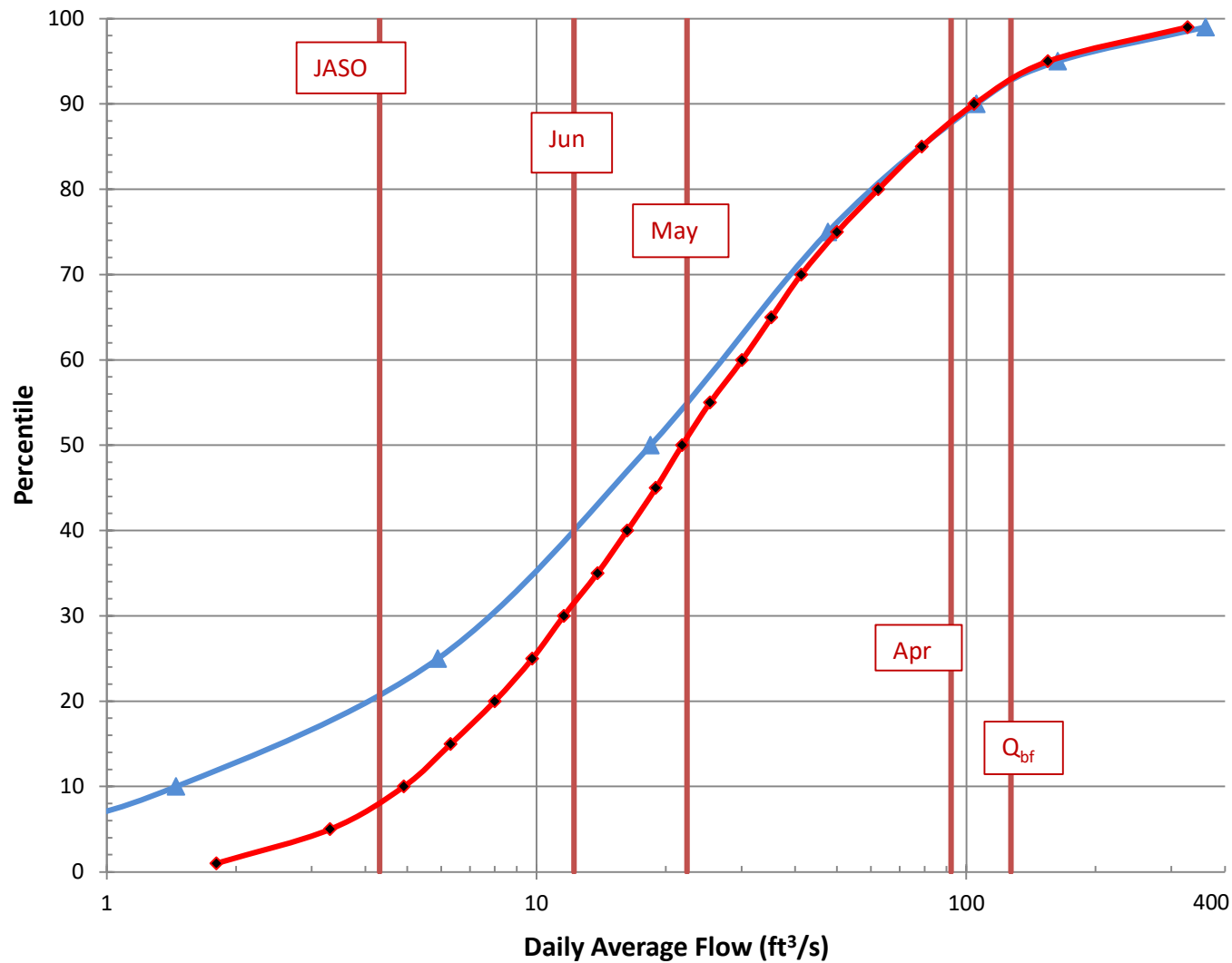
|                 |      |                                                 |
|-----------------|------|-------------------------------------------------|
| W <sub>bf</sub> | 39.2 | estimated bankfull width (ft)                   |
| d <sub>bf</sub> | 1.7  | estimated bankfull depth (ft)                   |
| A <sub>bf</sub> | 62.4 | estimated bankfull flow area (ft <sup>2</sup> ) |



**References**

Dudley, 2013. FY2013 Progress Report - Phase 1 ..., USFWS QRP Project  
 Dudley, 2004. Estimating Monthly Streamflows ..., SIR 2004-5026  
 Dudley, 2015. Regression Equations for Monthly & Annual Mean..., USGS SIR 2015-5151

## Daily Average Flow Distribution



### Daily Avg Flow Dist

$A_{ws} = (mi^2)$  21.0

$Q (ft^3/s)$

| Pctl     | Median | 84 <sup>th</sup> pctl |
|----------|--------|-----------------------|
| 1.00E-06 | 0.00   | 0.00                  |
| 1        | 1.80   | 3.19                  |
| 5        | 3.31   | 5.32                  |
| 10       | 4.91   | 7.38                  |
| 15       | 6.31   | 9.22                  |
| 20       | 7.99   | 11.18                 |
| 25       | 9.78   | 13.10                 |
| 30       | 11.57  | 14.92                 |
| 35       | 13.86  | 17.06                 |
| 40       | 16.26  | 19.62                 |
| 45       | 18.95  | 22.18                 |
| 50       | 21.81  | 26.19                 |
| 55       | 25.33  | 30.48                 |
| 60       | 30.09  | 35.78                 |
| 65       | 35.20  | 41.68                 |
| 70       | 41.28  | 48.63                 |
| 75       | 50.05  | 58.48                 |
| 80       | 62.42  | 69.82                 |
| 85       | 78.76  | 89.47                 |
| 90       | 104.32 | 120.14                |
| 95       | 154.83 | 186.83                |
| 99       | 327.41 | 431.04                |

$Q_{bf}$  126.9

$Q_{1.002}$  109.3

$Q_{1.1}$  212.0

$Q_2$  376.0



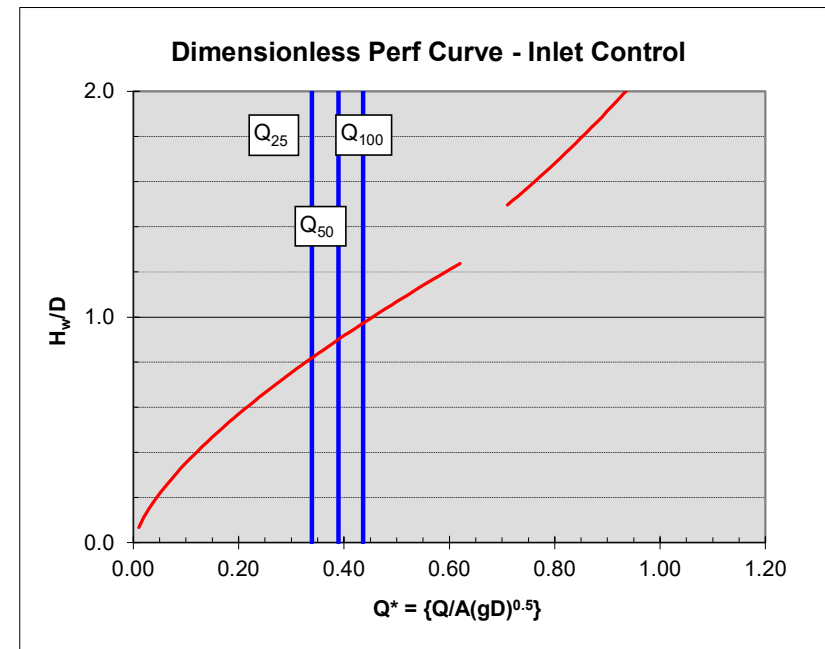
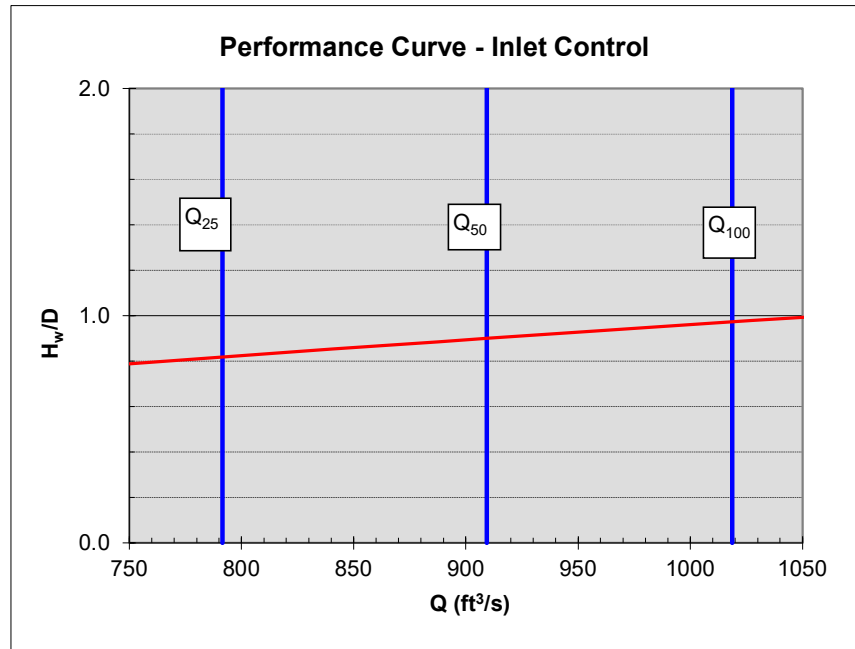
**NOTE:** This page is for preliminary sizing only.  
Final design should be done with HY8 or HDS-5

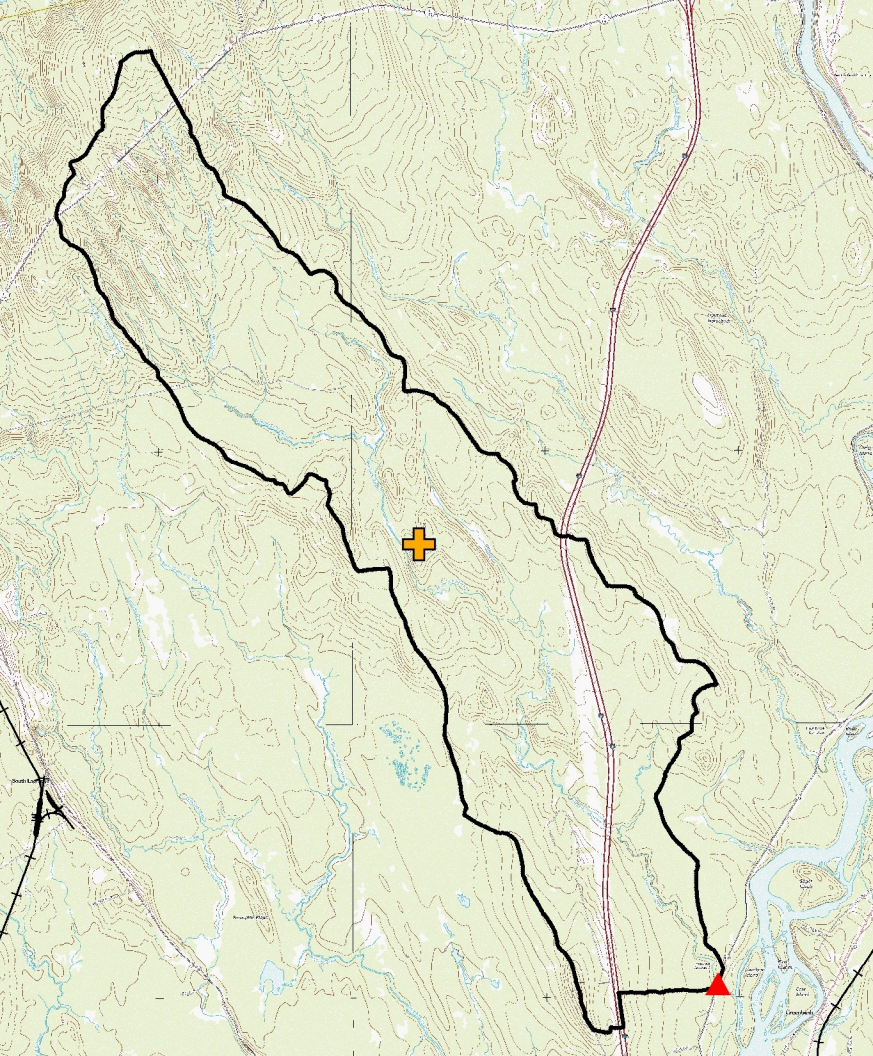
**Note:**  
culvert dimensions are for open flow area; adjust for lost capacity  
due to embedding / backfilling (min {2' / 25% rise} embedment)  
Finish analysis with HY-8

### Preliminary Culvert Sizing - Round & Box Culverts

|                        |          |             |                  |                     |
|------------------------|----------|-------------|------------------|---------------------|
| Shape:                 | Box      |             |                  |                     |
| Inlet Type:            | Box 0 ww |             |                  |                     |
| D or R (ft)            | 6        | diam / rise | $Q_{25}$ 791.5   |                     |
| w (ft)                 | 28       | box span    | $Q_{50}$ 909.3   | trial D / R = 12.4  |
| Slope (ft/ft)          | 0.02     |             | $Q_{100}$ 1018.8 | trial w: BFW = 39.2 |
| A (ft <sup>2</sup> )   | 168.00   |             |                  |                     |
| g (ft/s <sup>2</sup> ) | 32.2     |             |                  |                     |

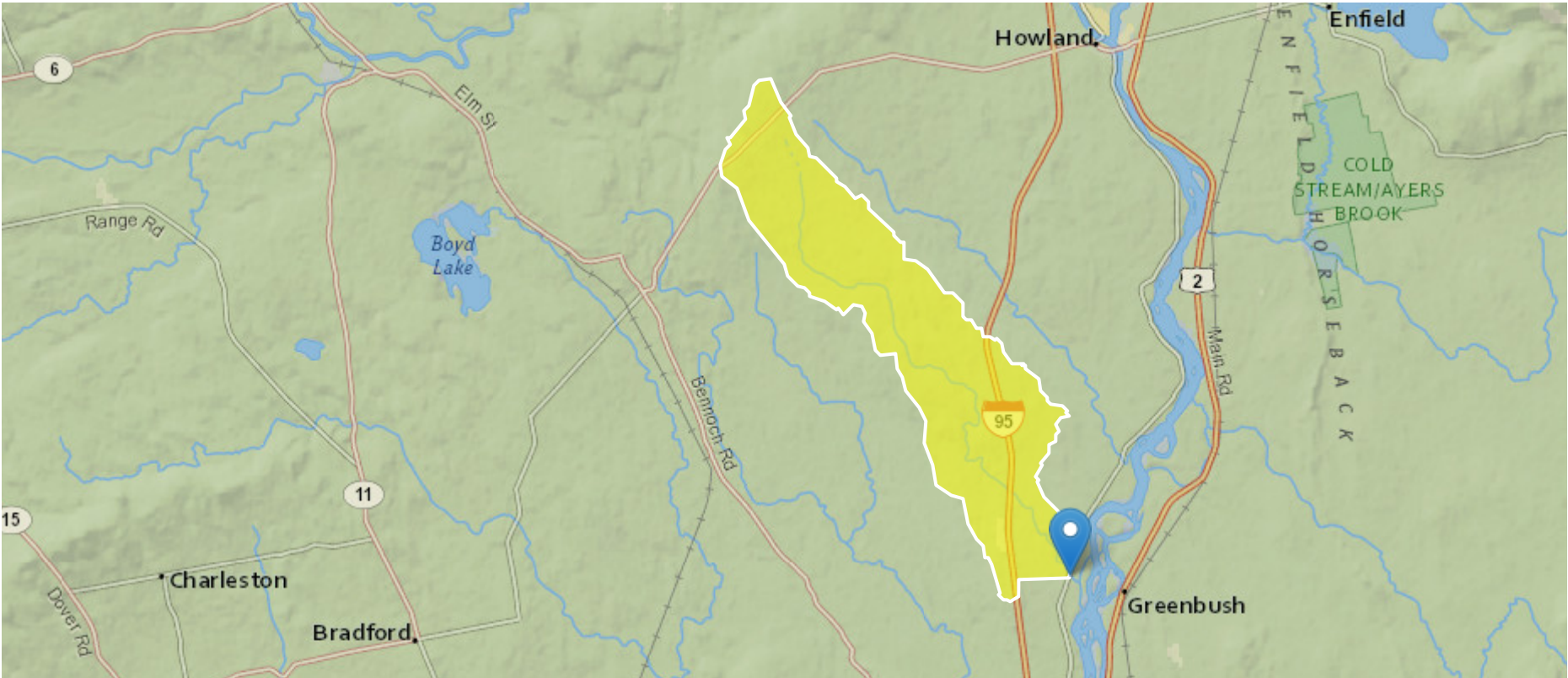
Choose shape and inlet type by pull-down menu in green cells





# Argyle 21687 Hemlock Bridge #3735

Region ID: ME  
Workspace ID: ME20220421180051354000  
Clicked Point (Latitude, Longitude): 45.08531, -68.67150  
Time: 2022-04-21 14:01:28 -0400



## Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|----------------|-----------------------|-------|------|
|----------------|-----------------------|-------|------|

| Parameter Code | Parameter Description                                                                                              | Value      | Unit         |
|----------------|--------------------------------------------------------------------------------------------------------------------|------------|--------------|
| BSLDEM10M      | Mean basin slope computed from 10 m DEM                                                                            | 2.64       | percent      |
| CENTROIDX      | Basin centroid horizontal (x) location in state plane coordinates                                                  | 520772.64  | meters       |
| CENTROIDY      | Basin centroid vertical (y) location in state plane units                                                          | 4999936.77 | meters       |
| COASTDIST      | Shortest distance from the coastline to the basin centroid                                                         | 85         | miles        |
| DRNAREA        | Area that drains to a point on a stream                                                                            | 20.96      | square miles |
| ELEV           | Mean Basin Elevation                                                                                               | 240.4      | feet         |
| ELEVMAX        | Maximum basin elevation                                                                                            | 572.5      | feet         |
| I24H100Y       | Maximum 24-hour precipitation that occurs on average once in 100 years                                             | 5.87       | inches       |
| I24H10Y        | Maximum 24-hour precipitation that occurs on average once in 10 years                                              | 4.02       | inches       |
| I24H200Y       | Maximum 24-hour precipitation that occurs on average once in 200 years                                             | 6.45       | inches       |
| I24H25Y        | Maximum 24-hour precipitation that occurs on average once in 25 years                                              | 4.75       | inches       |
| I24H2Y         | Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index | 2.85       | inches       |
| I24H500Y       | Maximum 24-hour precipitation that occurs on average once in 500 years                                             | 7.24       | inches       |
| I24H50Y        | Maximum 24-hour precipitation that occurs on average once in 50 years                                              | 5.3        | inches       |
| I24H5Y         | Maximum 24-hour precipitation that occurs on average once in 5 years                                               | 3.49       | inches       |
| LC06WATER      | Percent of open water, class 11, from NLCD 2006                                                                    | 0.37       | percent      |
| LC11DEV        | Percentage of developed (urban) land from NLCD 2011 classes 21-24                                                  | 3.56       | percent      |
| LC11IMP        | Average percentage of impervious area determined from NLCD 2011 impervious dataset                                 | 0.71       | percent      |
| PRDEC FEB90    | Basin average mean precipitation for December to February from PRISM 1961-1990                                     | 9.95       | inches       |
| PRECIP         | Mean Annual Precipitation                                                                                          | 42         | inches       |

| Parameter Code | Parameter Description                                                                           | Value  | Unit          |
|----------------|-------------------------------------------------------------------------------------------------|--------|---------------|
| SANDGRAVAF     | Fraction of land surface underlain by sand and gravel aquifers                                  | 0      | dimensionless |
| SANDGRAVAP     | Percentage of land surface underlain by sand and gravel aquifers                                | 0      | percent       |
| STATSGOA       | Percentage of area of Hydrologic Soil Type A from STATSGO                                       | 8.49   | percent       |
| STORAGE        | Percentage of area of storage (lakes ponds reservoirs wetlands)                                 | 20.351 | percent       |
| STORNWI        | Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory | 19.05  | percent       |

### Peak-Flow Statistics Parameters [Statewide multiparameter peakflows SIR 2020 5092]

| Parameter Code | Parameter Name                 | Value  | Units        | Min Limit | Max Limit |
|----------------|--------------------------------|--------|--------------|-----------|-----------|
| DRNAREA        | Drainage Area                  | 20.96  | square miles | 0.26      | 5680      |
| I24H2Y         | 24 Hour 2 Year Precipitation   | 2.85   | inches       | 1.92      | 4.17      |
| STORAGE        | Percent Storage                | 20.351 | percent      | 0         | 29.4      |
| I24H5Y         | 24 Hour 5 Year Precipitation   | 3.49   | inches       | 2.48      | 5.38      |
| I24H10Y        | 24 Hour 10 Year Precipitation  | 4.02   | inches       | 2.84      | 6.38      |
| I24H25Y        | 24 Hour 25 Year Precipitation  | 4.75   | inches       | 3.3       | 7.75      |
| I24H50Y        | 24 Hour 50 Year Precipitation  | 5.3    | inches       | 3.65      | 8.79      |
| I24H100Y       | 24 Hour 100 Year Precipitation | 5.87   | inches       | 3.99      | 9.88      |
| I24H200Y       | 24 Hour 200 Year Precipitation | 6.45   | inches       | 5.26      | 11.1      |
| I24H500Y       | 24 Hour 500 Year Precipitation | 7.24   | inches       | 5.95      | 13.1      |

### Peak-Flow Statistics Flow Report [Statewide multiparameter peakflows SIR 2020 5092]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic             | Value | Unit               | PII | Plu  | ASEp |
|-----------------------|-------|--------------------|-----|------|------|
| 50-percent AEP flood  | 376   | ft <sup>3</sup> /s | 202 | 701  | 39.1 |
| 20-percent AEP flood  | 537   | ft <sup>3</sup> /s | 292 | 986  | 38.1 |
| 10-percent AEP flood  | 651   | ft <sup>3</sup> /s | 350 | 1210 | 38.9 |
| 4-percent AEP flood   | 796   | ft <sup>3</sup> /s | 422 | 1500 | 39.9 |
| 2-percent AEP flood   | 908   | ft <sup>3</sup> /s | 474 | 1740 | 39.7 |
| 1-percent AEP flood   | 1020  | ft <sup>3</sup> /s | 536 | 1940 | 40.7 |
| 0.5-percent AEP flood | 1140  | ft <sup>3</sup> /s | 579 | 2240 | 42.8 |
| 0.2-percent AEP flood | 1290  | ft <sup>3</sup> /s | 646 | 2570 | 43.8 |

#### *Peak-Flow Statistics Citations*

**Lombard, P.J., and Hodgkins, G.A., 2020, Estimating flood magnitude and frequency on gaged and ungaged streams in Maine: U.S. Geological Survey Scientific Investigations Report 2020–5092, 56 p. (<https://doi.org/10.3133/sir20205092>)**

#### Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

| Parameter Code | Parameter Name                       | Value | Units         | Min Limit | Max Limit |
|----------------|--------------------------------------|-------|---------------|-----------|-----------|
| DRNAREA        | Drainage Area                        | 20.96 | square miles  | 14.9      | 1419      |
| SANDGRAVAF     | Fraction of Sand and Gravel Aquifers | 0     | dimensionless | 0         | 0.212     |
| ELEV           | Mean Basin Elevation                 | 240.4 | feet          | 239       | 2120      |

#### Annual Flow Statistics Flow Report [Statewide Annual SIR 2015 5151]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic        | Value | Unit               | ASEp |
|------------------|-------|--------------------|------|
| Mean Annual Flow | 42.4  | ft <sup>3</sup> /s | 16   |

#### *Annual Flow Statistics Citations*

**Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p.**  
(<http://dx.doi.org/10.3133/sir20155151>)

#### Flow-Duration Statistics Parameters [Statewide Annual SIR 2015 5151]

| Parameter Code | Parameter Name                       | Value | Units         | Min Limit | Max Limit |
|----------------|--------------------------------------|-------|---------------|-----------|-----------|
| DRNAREA        | Drainage Area                        | 20.96 | square miles  | 14.9      | 1419      |
| SANDGRAVAF     | Fraction of Sand and Gravel Aquifers | 0     | dimensionless | 0         | 0.212     |
| ELEV           | Mean Basin Elevation                 | 240.4 | feet          | 239       | 2120      |

#### Flow-Duration Statistics Flow Report [Statewide Annual SIR 2015 5151]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic           | Value | Unit               | ASEp |
|---------------------|-------|--------------------|------|
| 1 Percent Duration  | 0.126 | ft <sup>3</sup> /s | 144  |
| 5 Percent Duration  | 0.603 | ft <sup>3</sup> /s | 62   |
| 10 Percent Duration | 1.45  | ft <sup>3</sup> /s | 41   |
| 25 Percent Duration | 5.88  | ft <sup>3</sup> /s | 22   |
| 50 Percent Duration | 18.4  | ft <sup>3</sup> /s | 20   |

| Statistic           | Value | Unit               | ASEp |
|---------------------|-------|--------------------|------|
| 75 Percent Duration | 47.6  | ft <sup>3</sup> /s | 17   |
| 90 Percent Duration | 105   | ft <sup>3</sup> /s | 17   |
| 95 Percent Duration | 163   | ft <sup>3</sup> /s | 18   |
| 99 Percent Duration | 360   | ft <sup>3</sup> /s | 29   |

*Flow-Duration Statistics Citations*

**Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p.**  
 (<http://dx.doi.org/10.3133/sir20155151>)

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

| Parameter Code | Parameter Name | Value | Units        | Min Limit | Max Limit |
|----------------|----------------|-------|--------------|-----------|-----------|
| DRNAREA        | Drainage Area  | 20.96 | square miles | 2.92      | 298       |

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

| Parameter Code | Parameter Name | Value | Units        | Min Limit | Max Limit |
|----------------|----------------|-------|--------------|-----------|-----------|
| DRNAREA        | Drainage Area  | 20.96 | 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  | 20.96 | 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  | 20.96 | square miles | 0.07722   | 59927.7393 |

### Bankfull Statistics Flow Report [Central and Coastal Bankfull 2004 5042]

| Statistic           | Value | Unit               |
|---------------------|-------|--------------------|
| Bankfull Streamflow | 127   | ft <sup>3</sup> /s |
| Bankfull Width      | 37.3  | ft                 |
| Bankfull Depth      | 1.67  | ft                 |
| Bankfull Area       | 62.3  | ft <sup>2</sup>    |

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

| Statistic                             | Value | Unit            |
|---------------------------------------|-------|-----------------|
| Bieger_D_channel_width                | 53.7  | ft              |
| Bieger_D_channel_depth                | 2.68  | ft              |
| Bieger_D_channel_cross_sectional_area | 147   | ft <sup>2</sup> |

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

| Statistic                             | Value | Unit            |
|---------------------------------------|-------|-----------------|
| Bieger_P_channel_width                | 59.2  | ft              |
| Bieger_P_channel_depth                | 2.69  | ft              |
| Bieger_P_channel_cross_sectional_area | 163   | ft <sup>2</sup> |

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

| Statistic | Value | Unit |
|-----------|-------|------|
|-----------|-------|------|

| Statistic                               | Value | Unit |
|-----------------------------------------|-------|------|
| Bieger_USA_channel_width                | 36.1  | ft   |
| Bieger_USA_channel_depth                | 2.3   | ft   |
| Bieger_USA_channel_cross_sectional_area | 88.4  | ft^2 |

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

| Statistic                               | Value | Unit   |
|-----------------------------------------|-------|--------|
| Bankfull Streamflow                     | 127   | ft^3/s |
| Bankfull Width                          | 37.3  | ft     |
| Bankfull Depth                          | 1.67  | ft     |
| Bankfull Area                           | 62.3  | ft^2   |
| Bieger_D_channel_width                  | 53.7  | ft     |
| Bieger_D_channel_depth                  | 2.68  | ft     |
| Bieger_D_channel_cross_sectional_area   | 147   | ft^2   |
| Bieger_P_channel_width                  | 59.2  | ft     |
| Bieger_P_channel_depth                  | 2.69  | ft     |
| Bieger_P_channel_cross_sectional_area   | 163   | ft^2   |
| Bieger_USA_channel_width                | 36.1  | ft     |
| Bieger_USA_channel_depth                | 2.3   | ft     |
| Bieger_USA_channel_cross_sectional_area | 88.4  | ft^2   |

### *Bankfull Statistics Citations*

**Dudley, R.W., 2004, Hydraulic-Geometry Relations for Rivers in Coastal and Central Maine: U.S. Geological Survey Scientific Investigations Report 2004-5042, 30 p (<http://pubs.usgs.gov/sir/2004/5042/pdf/sir2004-5042.pdf>)**

**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))**

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.

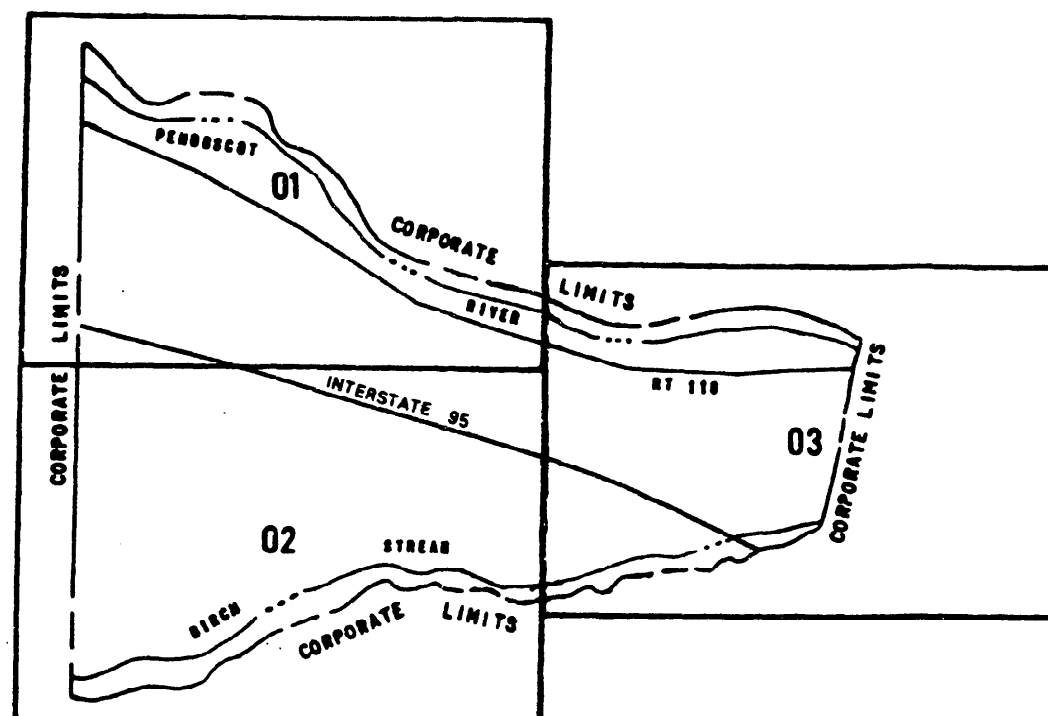
USGS Software Disclaimer: This software has been approved for release by the U.S. Geological Survey (USGS). Although the software has been subjected to rigorous review, the USGS reserves the right to update the software as needed pursuant to further analysis and review. No warranty, expressed or implied, 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: 4.8.1

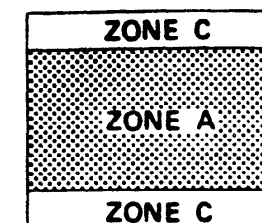
StreamStats Services Version: 1.2.22

NSS Services Version: 2.1.2



# KEY TO SYMBOLS

## ZONE DESIGNATIONS\*



|                                                  |          |
|--------------------------------------------------|----------|
| Base Flood Elevation Line with elevation in feet | 513      |
| Base Flood Elevation where uniform within zone   | (EL 987) |
| Elevation Reference Mark                         | RM7x     |
| River Mile                                       | M1.5     |

## \*EXPLANATION OF ZONE DESIGNATIONS

A flood insurance map displays the zone designations for a community according to areas of designated flood hazards. The zone designations used by FEMA are:

| Zone   | Explanation                                                                                                                                                         |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A      | Areas of 100-year flood, base flood elevations and flood hazard factors not determined                                                                              |
| A0     | Areas of 100-year shallow flooding, flood depth 1 to 3 feet, product of flood depth (feet) and velocity (feet per second) less than 15                              |
| AH     | Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet, base flood elevations are shown, but no flood hazard factors are determined |
| A1-A30 | Areas of 100-year flood, base flood elevations and flood hazard factors determined                                                                                  |
| A99    | Areas of 100-year flood to be protected by a flood protection system under construction, base flood elevations and flood hazard factors not determined              |
| B      | Area between limits of 100-year flood and 500-year flood, areas of 100-year shallow flooding where depths less than 1 foot                                          |
| C      | Areas outside 500-year flood                                                                                                                                        |
| D      | Areas of undetermined, but possible, flood hazards                                                                                                                  |
| V      | Areas of 100-year coastal flood with velocity (wave action), base flood elevations and flood hazard factors not determined                                          |
| V1-V30 | Areas of 100-year coastal flood with velocity (wave action), base flood elevations and flood hazard factor determined                                               |

## NOTES TO USER

Certain areas not in the special flood hazard areas (zones A and V) may be protected by flood control structures.

This map is for flood insurance purposes only, it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

To determine if flood insurance is available in this community, contact your insurance agent, or call the National Flood Insurance Program at (800) 638 6620.

INITIAL IDENTIFICATION: FEBRUARY 21, 1975

FLOOD HAZARD BOUNDARY MAP REVISIONS: NONE

FLOOD INSURANCE RATE MAP EFFECTIVE: SEPTEMBER 18, 1985

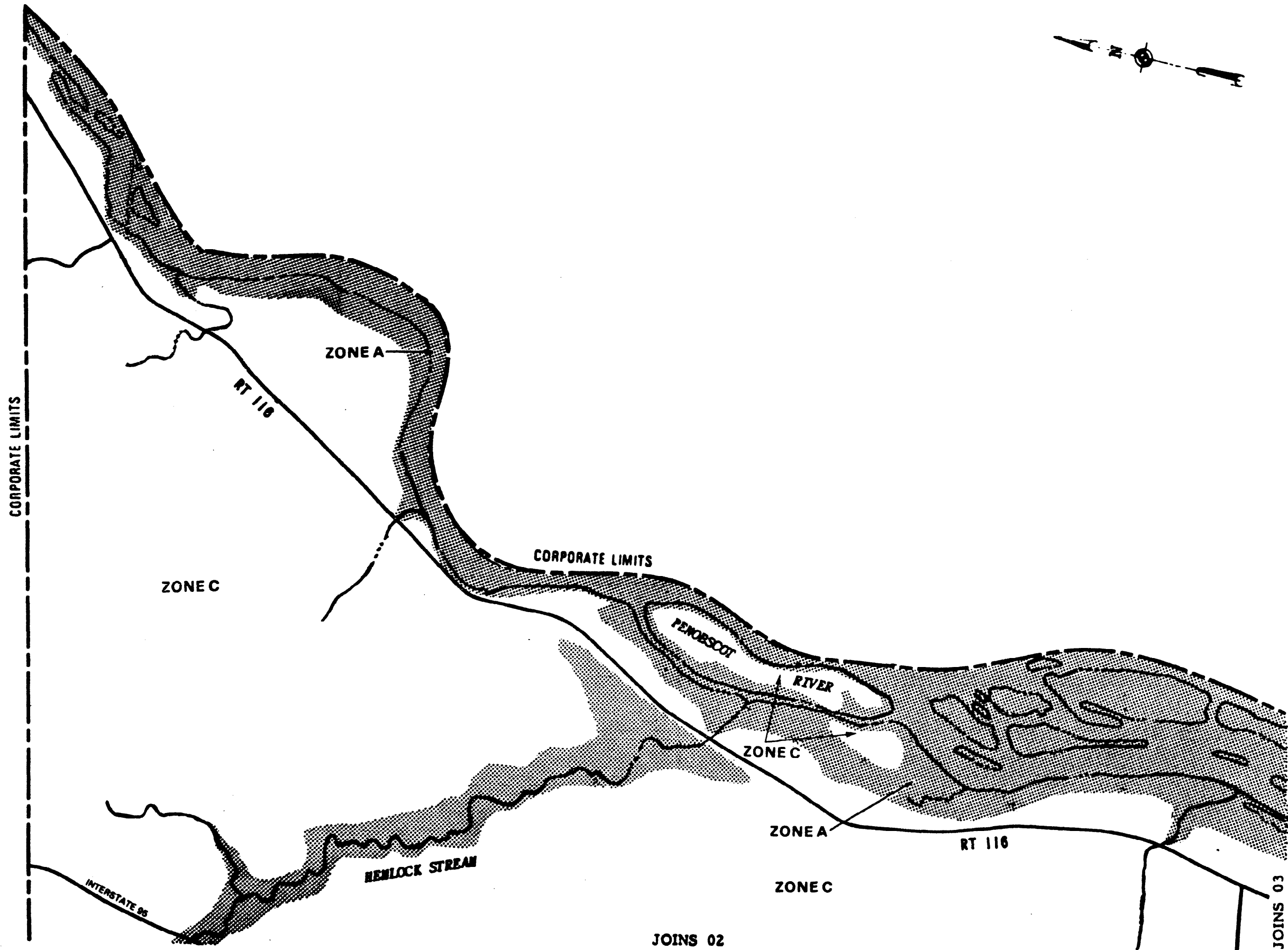
FLOOD INSURANCE RATE MAP REVISIONS:

federal emergency management agency

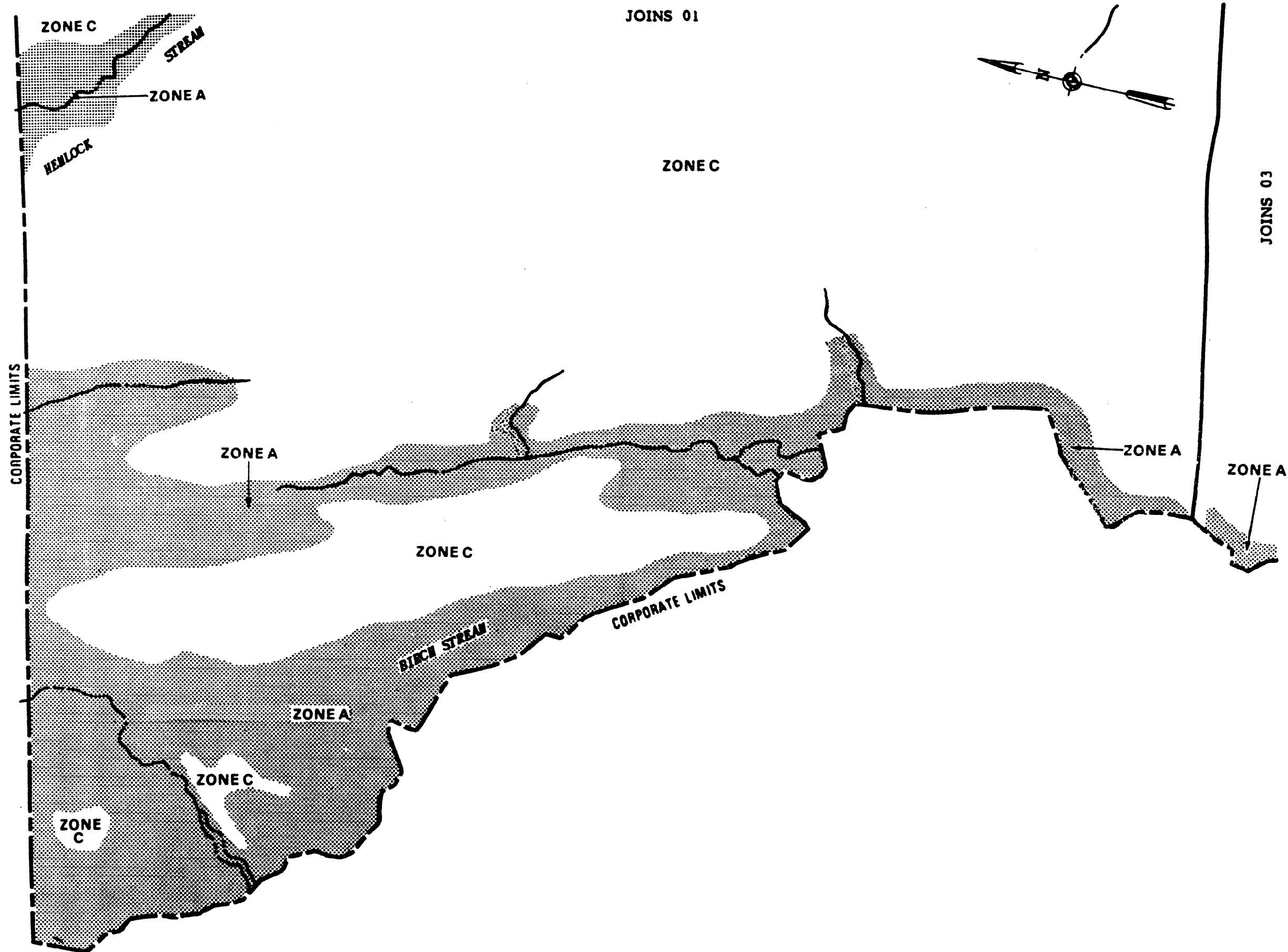


**FIRM**  
**FLOOD INSURANCE RATE MAP 01-03**  
**MAP INDEX**  
**TOWNSHIP OF ARGYLE, ME**  
**PENOBSCOT COUNTY**

COMMUNITY NUMBER 230464 A



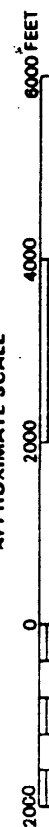
|    |                                     |                                            |                                          |                                                       |                                      |
|----|-------------------------------------|--------------------------------------------|------------------------------------------|-------------------------------------------------------|--------------------------------------|
| 01 | federal emergency management agency | TOWNSHIP OF ARGYLE, ME<br>PENOBSCOT COUNTY | APPROXIMATE SCALE<br>2000 4000 6000 FEET | FLOOD INSURANCE RATE MAP<br>COMMUNITY NUMBER 230464 A | EFFECTIVE DATE<br>SEPTEMBER 18, 1985 |
|    |                                     |                                            |                                          |                                                       |                                      |



federal emergency management agency

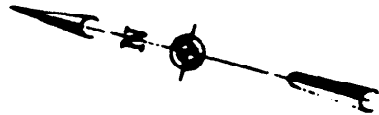
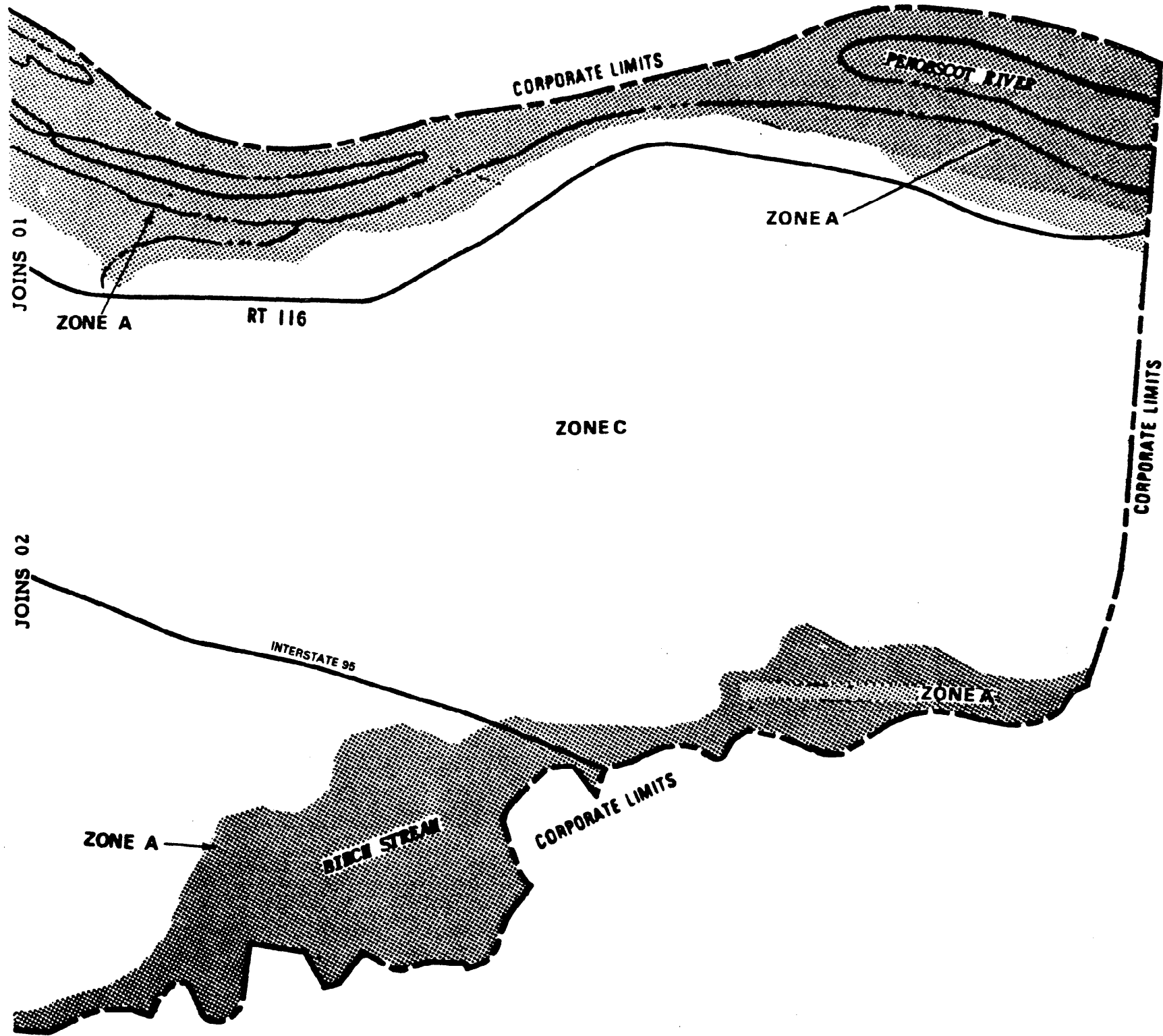
**TOWNSHIP OF ARGYLE, ME**  
PENOBSCOT COUNTY

APPROXIMATE SCALE



**FLOOD INSURANCE RATE MAP**  
COMMUNITY NUMBER 230464 A

EFFECTIVE DATE  
SEPTEMBER 18, 1985

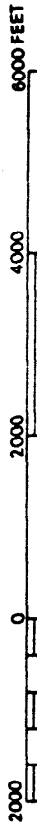


federal emergency management agency

**TOWNSHIP OF ARGYLE, ME**

PENOBSCOT COUNTY

APPROXIMATE SCALE



**FLOOD INSURANCE RATE MAP**

EFFECTIVE DATE