

APPENDIX E

Hydraulics Data

MaineDOT Culvert Hydrology Summary Sheet

Town: Lewiston WIN (or Region): 22322.00

Route: Pleasant Street Local Road Name: Pleasant Street

Stream: Dill Brook

Lat: 44.0768 Long: -70.1800

Asset ID: 6117 Also Known As: Hart Brook Bridge

Existing Structure: 14'? Multiplate CMP (size from Mapviewer Bridge Description)

Watershed Area: 1.9 sq. mi. NWI Wetlands: 8.5 %

Wbf - calculated: 13.8 feet Wbf - measured (if known): 22 feet

Q50: 237.2 cfs

Q100: 277.6 cfs

Preliminary Pipe Size*:

* Note: this size may NOT meet fish passage regulatory requirements. Consult with ENV staff for guidance.

Comments:

Culvert Rating of 3 - Scour Critical, Severly Undermined, Repaired in 1998

By: AWM

Date: 4/20/2018

Revised:

ver: 12/7/2016

WIN:	22322.00		
Town:	Lewiston		
Route No.	Pleasant Street		
Asset ID:	6117		
Lat:	44.07684	Long:	-70.18

Project Name:	Lewiston, Hart Brook Bridge
Stream Name:	Dill Brook
Bridge Name:	Hart Brook Bridge
Analysis by:	AWM
Date:	4/20/2018

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

Enter data in blue cells only!

	km ²	mi ²	ac
A	4.79	1.85	1184.0
W	0.41	0.2	100.8
P _c	406087	4881299	
County	Androscoggin		
pptA	45.3		
SG	0.00		

Enter data in [mi²]

Watershed Area *DRNAREA*
Wetlands area (by NWI)

watershed centroid (E, N; UTM 19N; meters)

choose county from drop-down menu

mean annual precipitation (inches; by look-up)

sand & gravel aquifer as decimal fraction of watershed A

Worksheet prepared by:

Charles S. Hebson, PE
Environmental Office
Maine Dept. Transportation
Augusta, ME 04333-0016
207-557-1052
Charles.Hebson@maine.gov
ver. 2017 Jun. 09

A (km ²)	4.79	Conf Lvl	0.67
W (%)	8.51		

NWI Wetlands % *STORNWI*

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

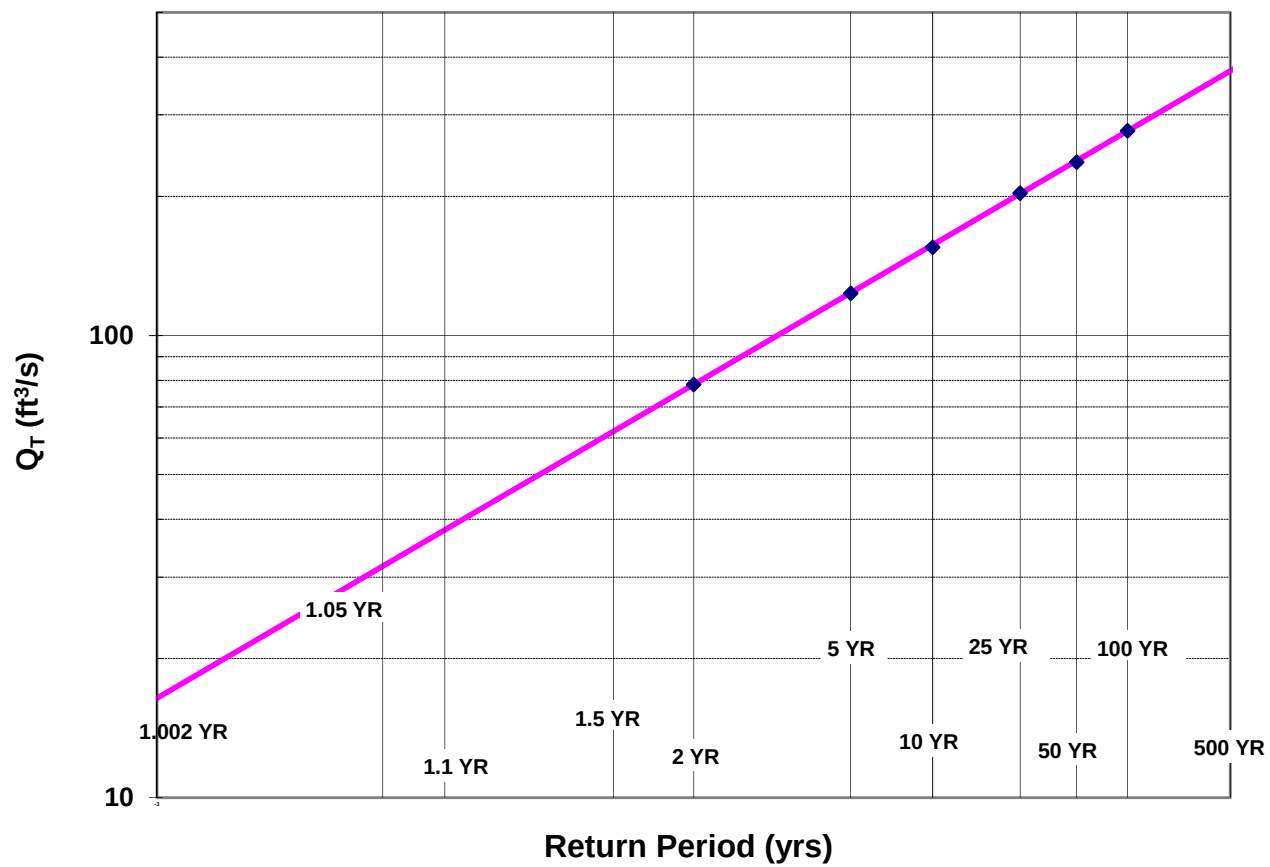
Lombard, P.J. & G.A. Hodgkins, 2015.
Peak flow regression equations for small, ungaged streams in
Maine - Comparing map-based to field-based variables
SIR 2015-4059, USGS, Augusta, ME

$$Q_T = b \times A^a \times 10^{-wW}$$

Ret Pd	Peak Flow Estimate	
T (yr)	Lower	Q _T (m ³ /s)
1.1		1.08
2		2.22
5		3.49
10		4.40
25		5.76
50		6.72
100		7.86
500		10.59

Q _T (ft ³ /s)
38.0
78.4
123.4
155.3
203.3
237.2
277.6
373.8

Log-Normal Probability Plot

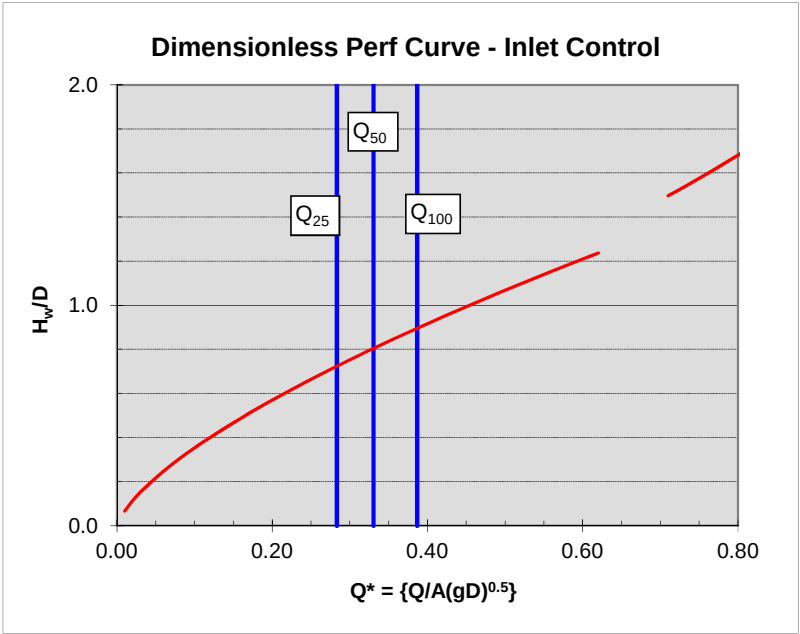
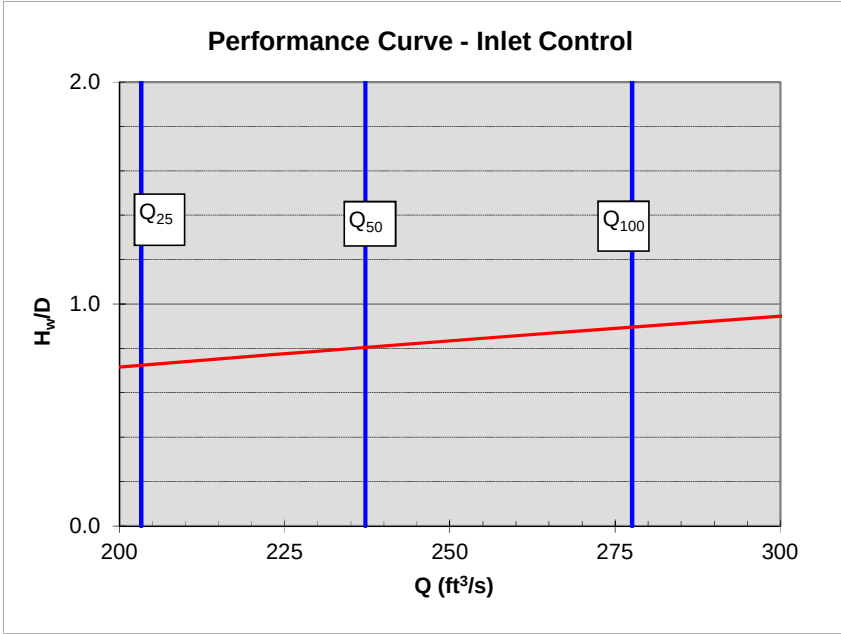


NOTE: This page is for preliminary sizing only.
Final design should be done with HY8 or HDS-5

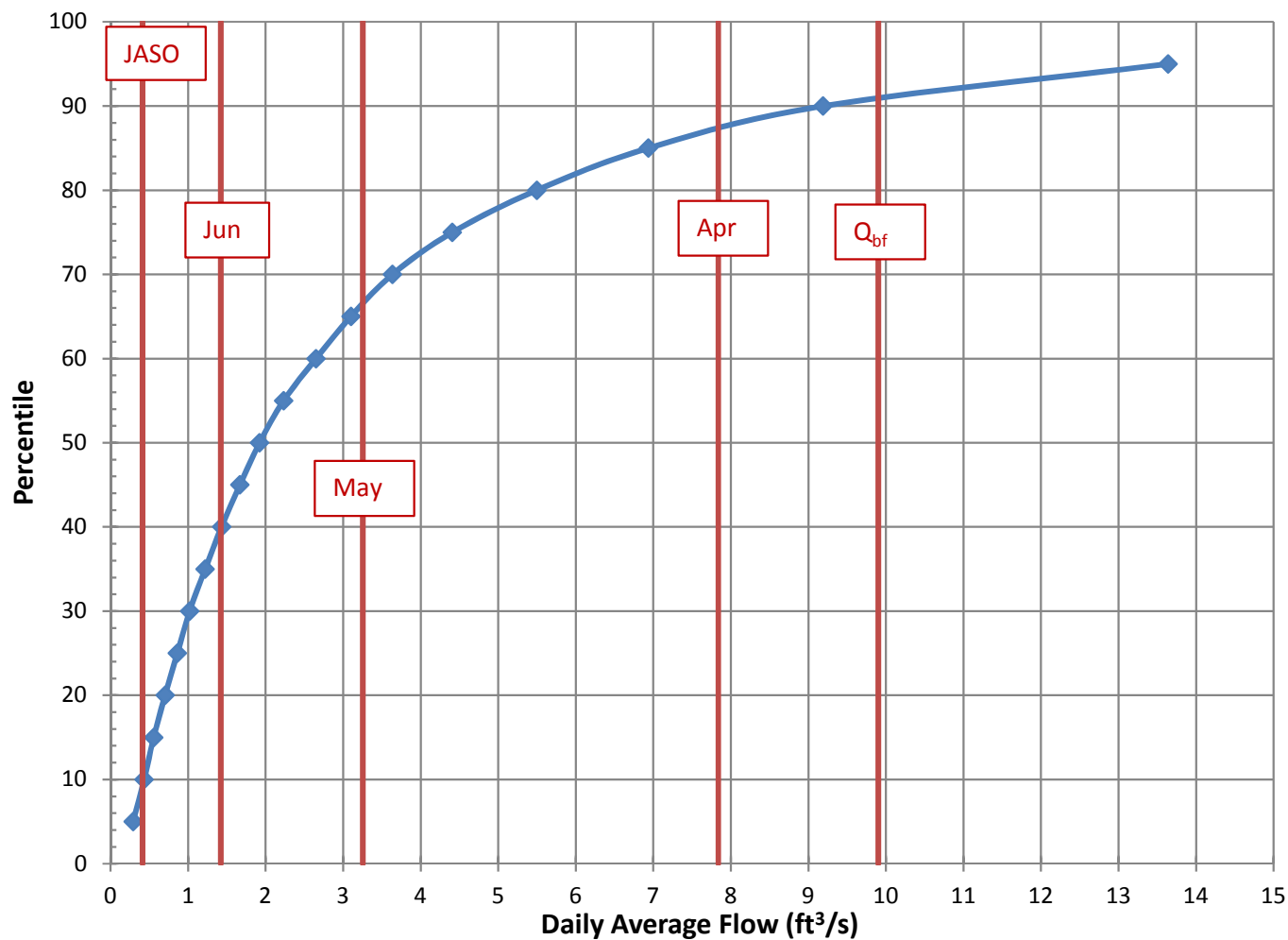
Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box			
Type:	Box 0 ww			
D or R (ft)	10	Q_{25}	203.3	trial D / R = 7.4
w (ft)	4 box width	Q_{50}	237.2	
Slope (ft/ft)	0.02	Q_{100}	277.6	trial w: BFW = 13.8
A (ft ²)	40.00			
g (ft/s ²)	32.2			

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



Daily Average Flow Distribution



Daily Avg Flow Dist

$A_{ws} = (mi^2)$ 1.9
 $Q (ft^3/s)$

Pctl	Median	84 th pctl
5	0.29	0.47
10	0.43	0.65
15	0.56	0.81
20	0.70	0.98
25	0.86	1.15
30	1.02	1.31
35	1.22	1.50
40	1.43	1.73
45	1.67	1.95
50	1.92	2.31
55	2.23	2.68
60	2.65	3.15
65	3.10	3.67
70	3.64	4.28
75	4.41	5.15
80	5.50	6.15
85	6.94	7.88
90	9.19	10.58
95	13.64	16.46

Q_{bf}	9.9
$Q_{1.002}$	16.4
$Q_{1.1}$	38.0
Q_2	78.4

WIN:	22322.00
Town:	Lewiston
Route No.	Pleasant Street
Asset ID:	6117
Lat:	44.07684
Long:	-70.18004

Project Name:	Lewiston, Hart Brook Bridge
Stream Name:	Dill Brook
Bridge Name:	Hart Brook Bridge
Analysis by:	AWM
Date:	4/20/2018

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

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

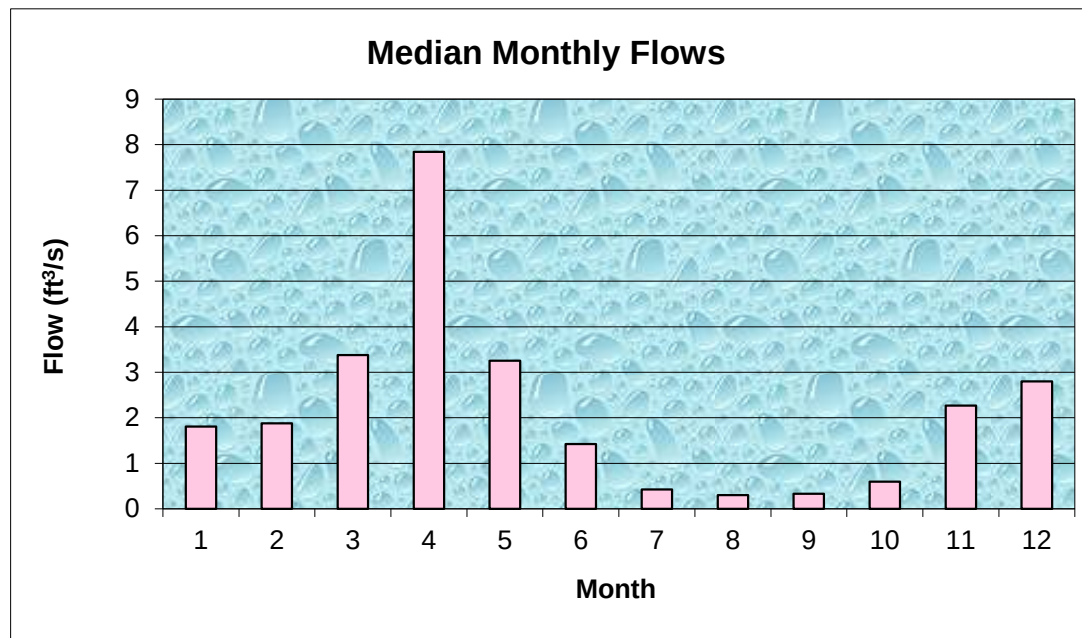
	Value	Variable	Explanation
	1.85	A	Area (mi ²)
406087	4881299	P _c	Watershed centroid (E,N; UTM; Zone 19; meters)
	56.66	DIST	Distance from Coastal reference line (mi)
	45.3	pptA	Mean Annual Precipitation (inches)
	0.00	SG	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q _{median} (ft ³ /s)	(m ³ /s)
Jan	1.81	0.0512
Feb	1.88	0.0533
Mar	3.38	0.0958
Apr	7.84	0.2222
May	3.25	0.0922
Jun	1.42	0.0403
Jul	0.43	0.0121
Aug	0.30	0.0086
Sep	0.33	0.0094
Oct	0.59	0.0168
Nov	2.27	0.0642
Dec	2.80	0.0793

Q _{bf}	9.9
ann avg	3.9
ann med	2.0
Q _{1.002}	16.4
Q _{1.01}	22.1
Q _{1.05}	31.7
Q _{bf}	40.4

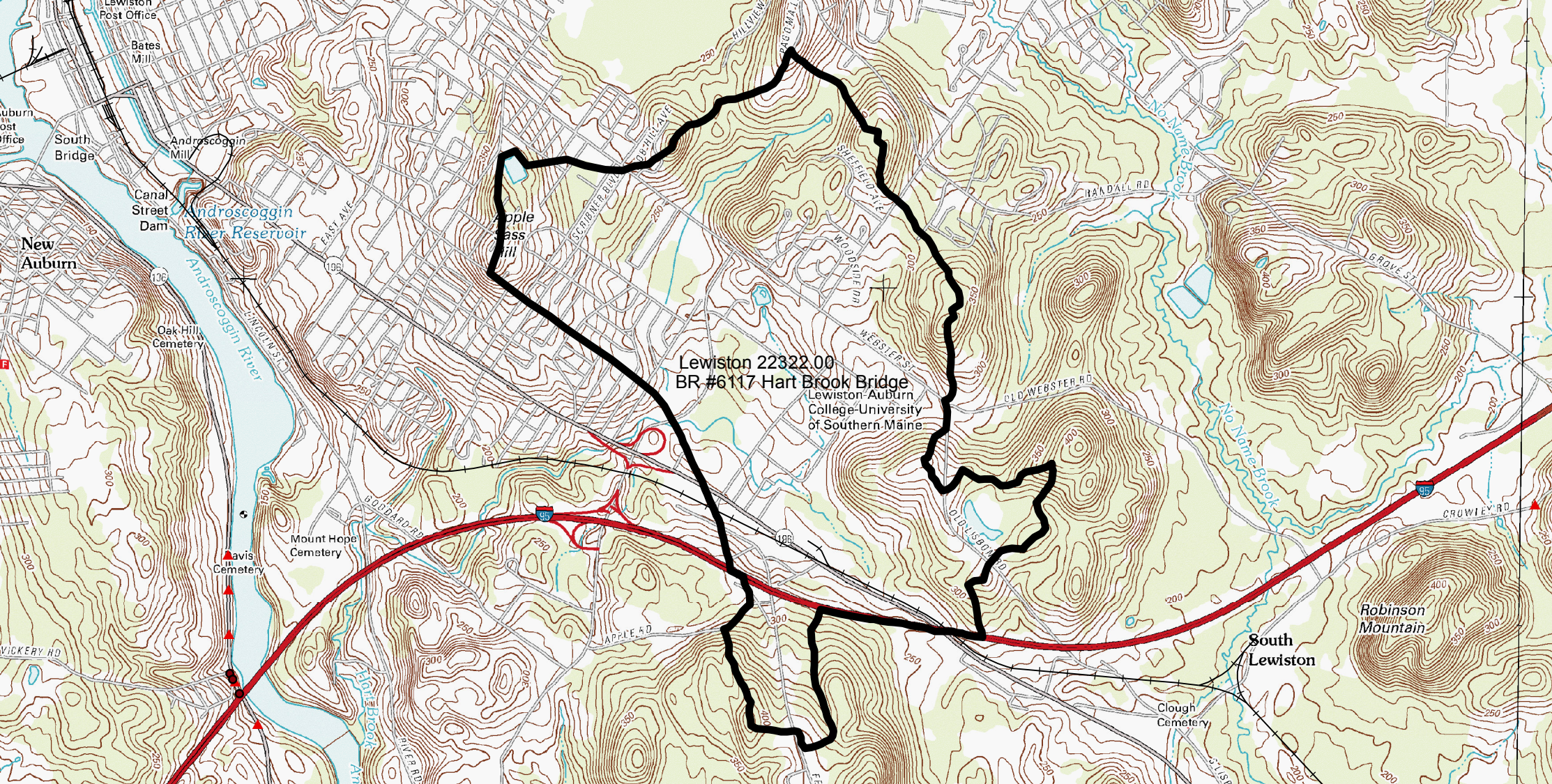
assume v = 4ft/s

W _{bf}	13.8	estimated bankfull width (ft)
d _{bf}	0.7	estimated bankfull depth (ft)
A _{bf}	7.7	estimated bankfull flow area (ft ²)



References

Dudley, R.W., 2013. FY2013 Progress Report - Phase 1 ..., USFWS QRP Project
Dudley, R.W., 2004. Estimating Monthly Streamflows ... , SIR 2004-5026



Lewiston 22322.00
BR #6117 Hart Brook Bridge
Lewiston-Auburn
College-University
of Southern Maine

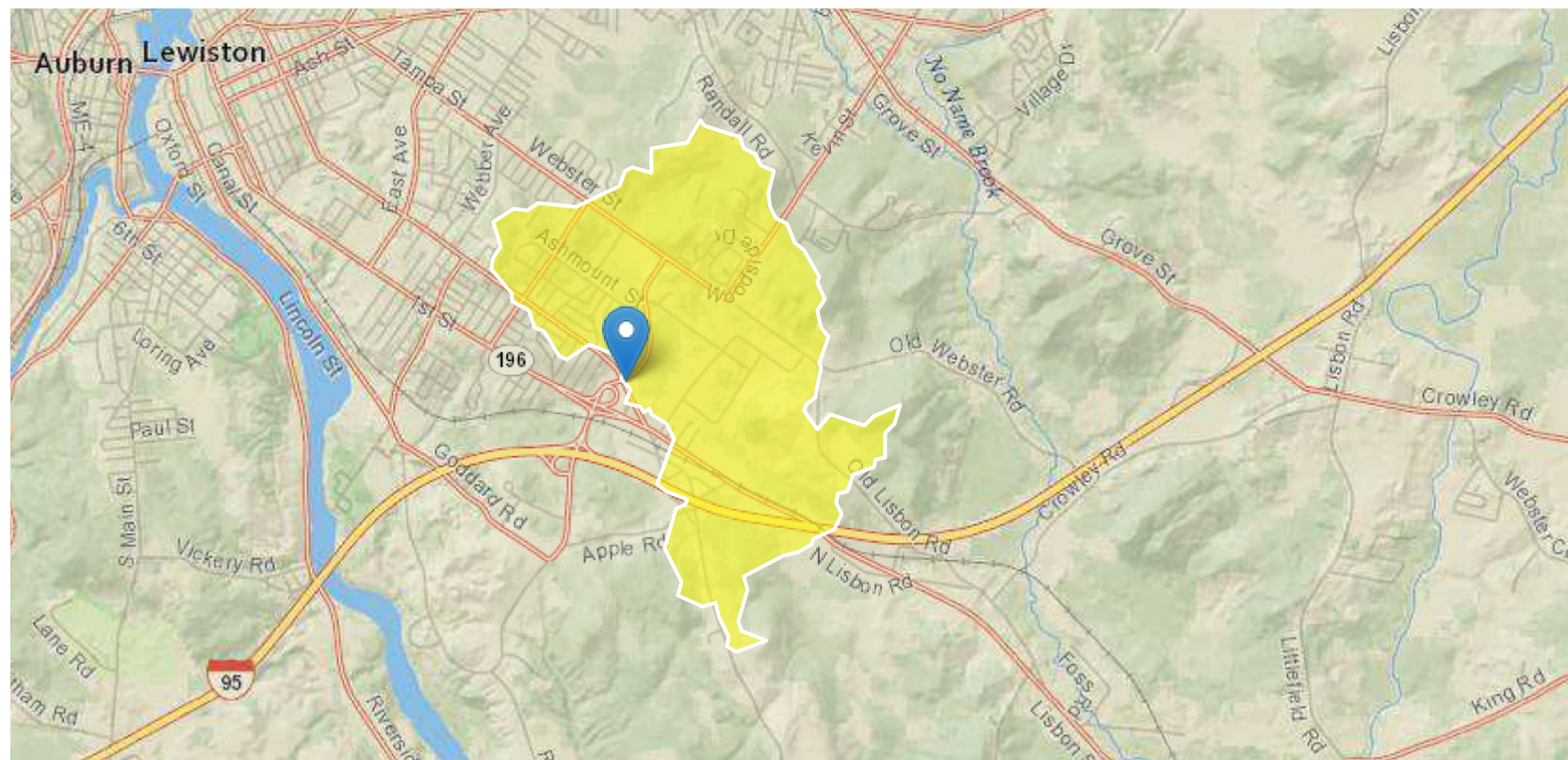
Lewiston 22322.00 Hart Brook Bridge 6117 on Pleasant Street

Region ID: ME

Workspace ID: ME20180521151547076000

Clicked Point (Latitude, Longitude): 44.07683, -70.18006

Time: 2018-05-21 11:16:02 -0400



This drainage basin has a significant amount of development so the flows may be higher than calculated.

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.9	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory	8.51	percent
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0	dimensionless
ELEV	Mean Basin Elevation	280.3	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	6.91	percent
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	406086.58	
CENTROIDY	Basin centroid vertical (y) location in state plane units	4881298.71	
COASTDIST	Shortest distance from the coastline to the basin centroid	57	miles
ELEVMAX	Maximum basin elevation	467.9	feet
LC06WATER	Percent of open water, class 11, from NLCD 2006	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	57.2	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	24.1	percent
PRECIP	Mean Annual Precipitation	45.9	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	0	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	17.4	percent

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.9	square miles	2.92	298

Bankfull Statistics Disclaimers [Central and Coastal Bankfull 2004 5042]

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

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

Statistic	Value	Unit
Bankfull Streamflow	10.2	ft^3/s
Bankfull Width	10.7	ft
Bankfull Depth	0.739	ft
Bankfull Area	7.9	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>)

Peak-Flow Statistics Parameters [Statewide Peak Flow DA LT 12sqmi 2015 5049]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.9	square miles	0.31	12
STORNWI	Percentage of Storage from NWI	8.51	percent	0	22.2

Peak-Flow Statistics Flow Report [Statewide Peak Flow DA LT 12sqmi 2015 5049]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
1.01 Year Peak Flood	23.9	ft^3/s	38
2 Year Peak Flood	80	ft^3/s	34

Statistic	Value	Unit	SEp
5 Year Peak Flood	126	ft^3/s	35
10 Year Peak Flood	159	ft^3/s	37
25 Year Peak Flood	208	ft^3/s	39
50 Year Peak Flood	242	ft^3/s	41
100 Year Peak Flood	284	ft^3/s	42
250 Year Peak Flood	321	ft^3/s	44
500 Year Peak Flood	382	ft^3/s	47

Peak-Flow Statistics Citations

Lombard, P.J., and Hodgkins, G.A.,2015, Peak flow regression equations for small, ungaged streams in Maine– Comparing map-based to field-based variables: U.S. Geological Survey Scientific Investigations Report 2015–5049, 12 p. (<http://dx.doi.org/10.3133/sir20155049>)

Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.9	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionlesstest	0	0.212
ELEV	Mean Basin Elevation	280.3	feet	239	2120

Annual Flow Statistics Disclaimers [Statewide Annual SIR 2015 5151]

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

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

Statistic	Value	Unit
Mean Annual Flow	4.25	ft ³ /s

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	1.9	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.212
ELEV	Mean Basin Elevation	280.3	feet	239	2120

Flow-Duration Statistics Disclaimers [Statewide Annual SIR 2015 5151]

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

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

Statistic	Value	Unit
1 Percent Duration	0.00324	ft ³ /s
5 Percent Duration	0.0243	ft ³ /s
10 Percent Duration	0.0755	ft ³ /s
25 Percent Duration	0.457	ft ³ /s
50 Percent Duration	1.7	ft ³ /s

Statistic	Value	Unit
75 Percent Duration	4.5	ft ³ /s
90 Percent Duration	10.3	ft ³ /s
95 Percent Duration	16.5	ft ³ /s
99 Percent Duration	44.1	ft ³ /s

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>)

Questions concerning the VERTCON process may be mailed to NGS

Latitude: 44 04 36.26

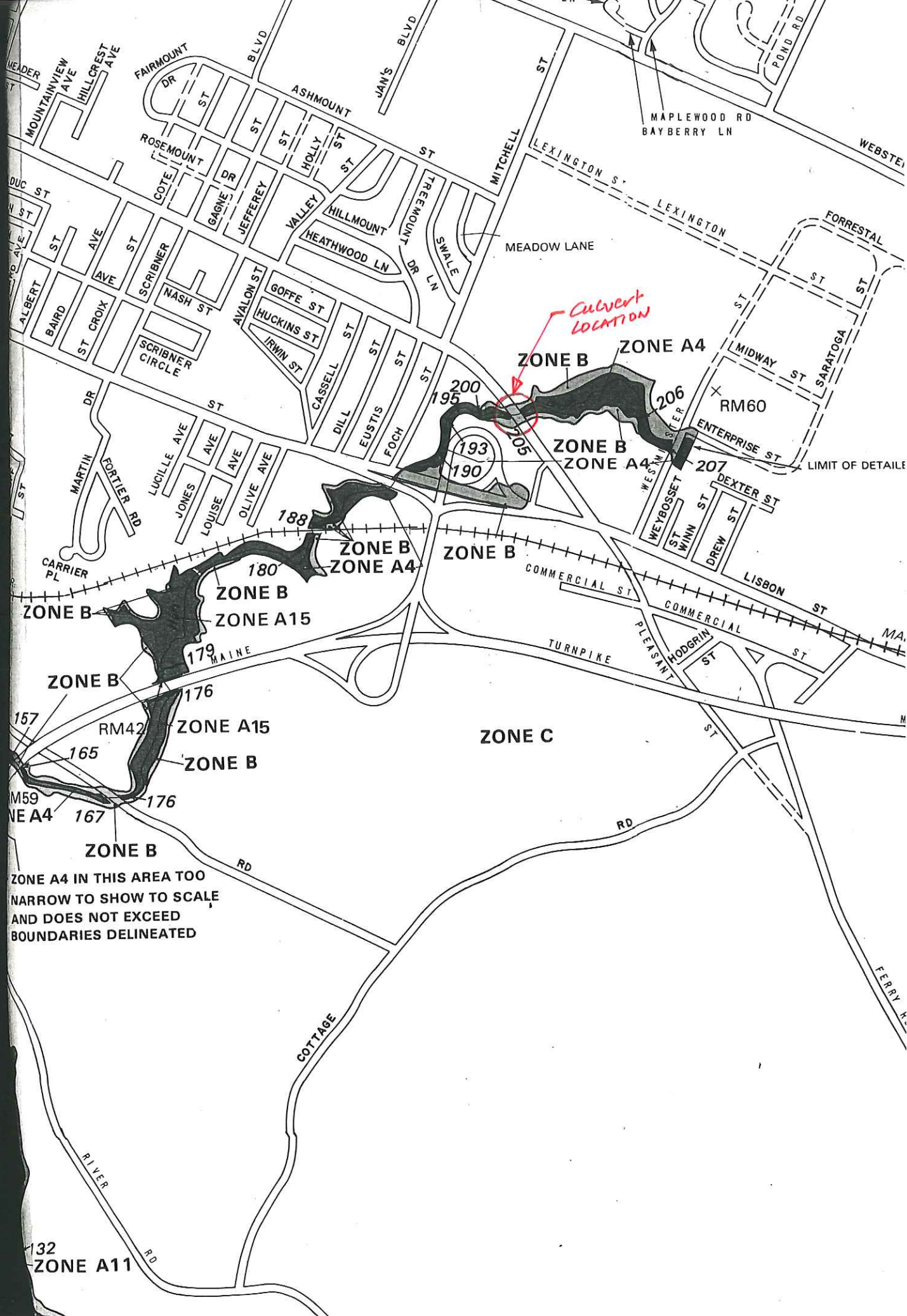
Longitude: 070 10 48.32

NGVD 29 height:

Datum shift (NAVD 88 minus NGVD 29): -0.191 meter

$$\checkmark \text{NAVD } 88 - \text{NGVD } 29 = -0.191 \text{ m} = -0.63'$$

$$\checkmark \text{NAVD } 88 = -0.63' + \text{NAVD } 29 = \underline{\underline{\text{NAVD } 29 - 0.63'}}$$



KEY TO MAP

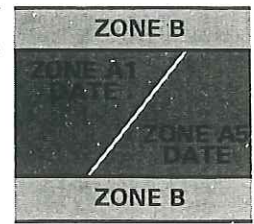
500-Year Flood Boundary →

100-Year Flood Boundary →

Zone Designations* With
Date of Identification
e.g., 12/2/74

100-Year Flood Boundary →

500-Year Flood Boundary →



Base Flood Elevation Line
With Elevation In Feet**

~~~~~ 573 ~~~~~

Base Flood Elevation in Feet  
Where Uniform Within Zone\*\*

(EL 987)

Elevation Reference Mark

RM7<sub>x</sub>

River Mile

• M1.5

\*\*Referenced to the National Geodetic Vertical Datum of 1929

## \*EXPLANATION OF ZONE DESIGNATIONS

| ZONE   | EXPLANATION                                                                                                                                                                                                                                                                                      |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A      | Areas of 100-year flood; base flood elevations and flood hazard factors not determined.                                                                                                                                                                                                          |
| A0     | Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.                                                                                                                      |
| 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 flood protection system under construction; base flood elevations and flood hazard factors not determined.                                                                                                                                            |
| B      | Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading) |
| C      | Areas of minimal flooding. (No shading)                                                                                                                                                                                                                                                          |
| 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 factors determined.                                                                                                                                                                          |

## NOTES TO USER

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

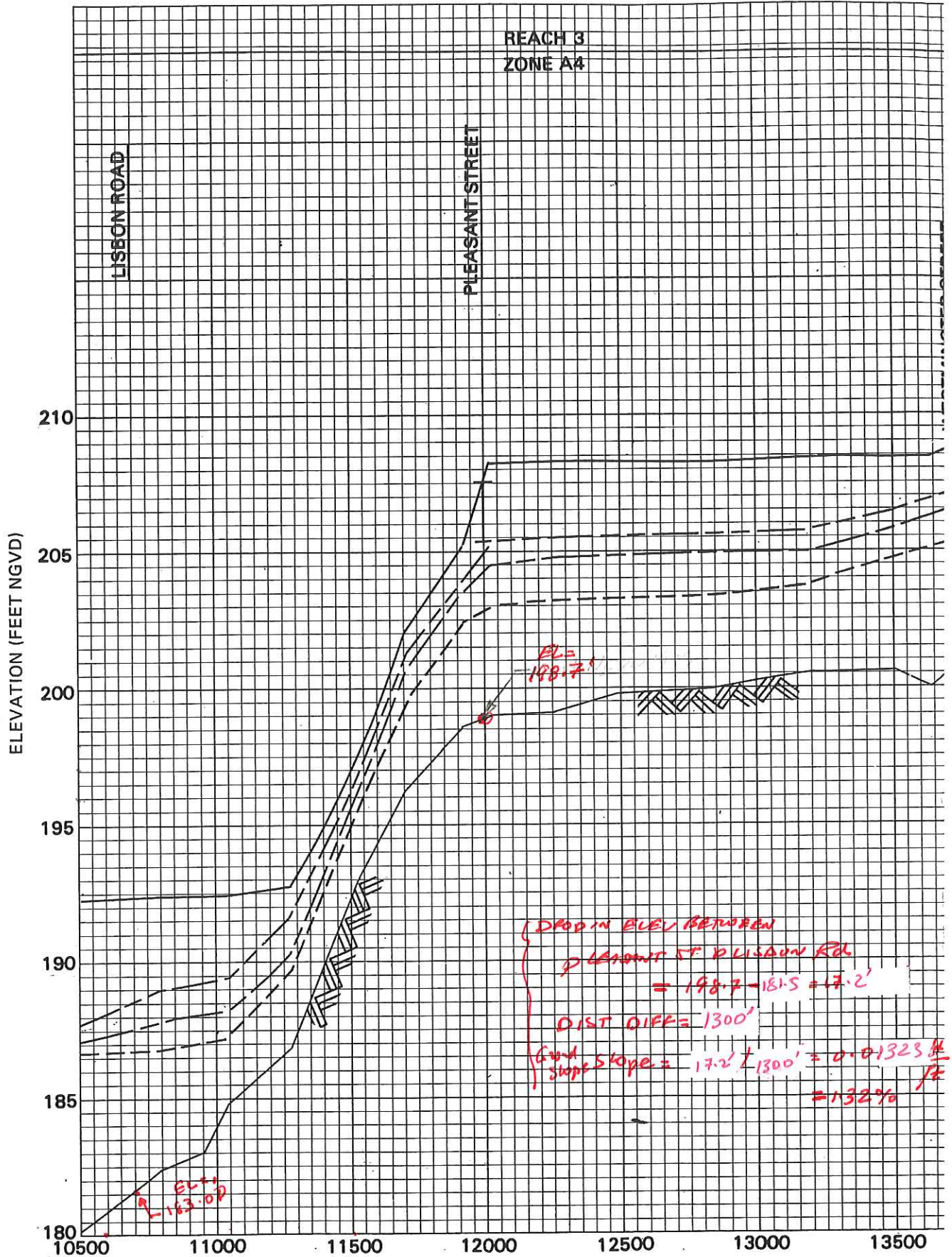
This map is for flood insurance purposes only; it does not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas.

For adjoining map panels, see separately printed Index To Map Panels.

INITIAL IDENTIFICATION:

APRIL 5, 1974

FLOOD HAZARD BOUNDARY MAP REVISIONS:



$$NGVD 29 = 198.7'$$

$$NAVD 88 = -0.63' + 198.7' = 198.1' \quad NAVD 88$$

STREAM DISTANCE

TABLE 1 - SUMMARY OF DISCHARGES-continued

## NO NAME BROOK TRIBUTARY A

|                         |      |     |     |     |     |
|-------------------------|------|-----|-----|-----|-----|
| Above No Name Pond Road | 2.19 | 156 | 281 | 351 | 573 |
| At Sabattus Street      | 1.64 | 131 | 236 | 295 | 432 |

## SALMON BROOK

|                   |      |     |     |     |       |
|-------------------|------|-----|-----|-----|-------|
| Cotton Road       | 4.71 | 331 | 565 | 693 | 1,070 |
| Above Moody Brook | 3.59 | 257 | 441 | 542 | 842   |

## MOODY BROOK

|          |      |    |     |     |     |
|----------|------|----|-----|-----|-----|
| At Mouth | 1.19 | 91 | 161 | 199 | 317 |
|----------|------|----|-----|-----|-----|

## HART BROOK

|                 |      |     |     |     |     |
|-----------------|------|-----|-----|-----|-----|
| At Mouth        | 3.72 | 290 | 500 | 610 | 950 |
| River Road      | 3.41 | 260 | 450 | 560 | 870 |
| Lisbon Street   | 2.18 | 220 | 380 | 480 | 760 |
| Pleasant Street | 2.10 | 200 | 360 | 440 | 710 |

## STETSON BROOK

|                      |      |     |       |       |       |
|----------------------|------|-----|-------|-------|-------|
| At Dam               | 10.8 | 630 | 1,050 | 1,270 | 1,920 |
| Fairgrounds Crossing | 9.64 | 540 | 890   | 1,070 | 1,620 |
| Lower College Road   | 9.03 | 520 | 850   | 1,030 | 1,560 |
| Hamel Road           | 6.54 | 440 | 745   | 910   | 1,400 |
| Upper College Road   | 6.32 | 430 | 730   | 890   | 1,370 |

## JEPSON BROOK

|                 |      |     |     |     |     |
|-----------------|------|-----|-----|-----|-----|
| At Mouth        | 2.66 | 106 | 253 | 311 | 491 |
| Brooks Avenue   | 2.34 | 132 | 231 | 286 | 454 |
| Morris Avenue   | 1.54 | 106 | 190 | 237 | 383 |
| Sabattus Street | 1.21 | 88  | 159 | 200 | 323 |
| Farwell Street  | 1.04 | 79  | 142 | 179 | 292 |

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each stream studied in detail.

Cross section data for the streams studied were obtained by photogrammetry from aerial photographs which were taken on April 30, 1975 (Reference 6). The below-water section were obtained by field measurement. All bridges and culverts were surveyed to obtain elevation data and structural geometry. The locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit I). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 3).

Roughness coefficients (Manning's "n") for the smaller streams were estimated by field inspection at each cross section. Roughness values for the main channel of the Androscoggin River were assigned on the basis of aerial photographs and field inspection of flood plain areas by USGS personnel.

The following roughness coefficients were used in the hydraulic analyses:

| STREAM                       | Range of Values for Roughness Coefficients |            |
|------------------------------|--------------------------------------------|------------|
|                              | MAIN CHANNEL                               | FLOODPLAIN |
| Androscoggin River           | .030-.042                                  | .030-.100  |
| No Name Brook                | .020-.042                                  | .042-.085  |
| No Name Brook<br>Tributary A | .035-.040                                  | .055-.080  |
| Salmon Brook                 | .035-.040                                  | .050-.080  |
| Moody Brook                  | .035-.045                                  | .050-.080  |
| Hart Brook                   | .020-.050                                  | .030-.075  |
| Jepson Brook                 | .016-.055                                  | .050-.085  |
| Stetson Brook                | .030-.042                                  | .040-.080  |

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 feet for floods of the selected recurrence intervals (Exhibit I).

Water-surface profiles for all streams were developed using the USGS computer step-backwater program known as E43I (Reference 7). On Jepson Brook, where supercritical flow was encountered, a new version of this program called J635 was used (Reference 8). The backwater model was calibrated using profile information available for the 1936 flood (Reference 1). A good comparison of present river conditions to those of the 1936 flood can be made because structures in the Androscoggin River and their alignment have not changed significantly. Profiles on No Name Brook were coordinated with those shown in adjacent studies conducted by the SCS. Jepson Brook profiles were compared to work by Camp, Dresser and McKee Inc., Consultant Engineers.

# **HY-8 Culvert Analysis Report**

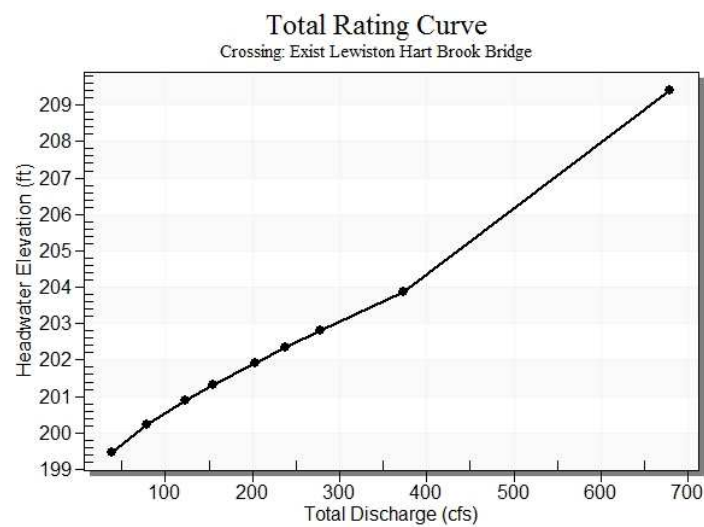
## Crossing Discharge Data

Discharge Selection Method: User Defined

**Table 1 - Summary of Culvert Flows at Crossing: Exist Lewiston Hart Brook Bridge**

| Headwater<br>Elevation (ft) | Discharge Names | Total Discharge<br>(cfs) | Culvert 1<br>Discharge (cfs) | Roadway<br>Discharge (cfs) | Iterations  |
|-----------------------------|-----------------|--------------------------|------------------------------|----------------------------|-------------|
| 199.48                      | Q1.1            | 38.00                    | 38.00                        | 0.00                       | 1           |
| 200.21                      | Q2              | 78.40                    | 78.40                        | 0.00                       | 1           |
| 200.88                      | Q5              | 123.40                   | 123.40                       | 0.00                       | 1           |
| 201.32                      | Q10             | 155.30                   | 155.30                       | 0.00                       | 1           |
| 201.92                      | Q25             | 203.30                   | 203.30                       | 0.00                       | 1           |
| 202.33                      | Q50             | 237.20                   | 237.20                       | 0.00                       | 1           |
| 202.80                      | Q100            | 277.60                   | 277.60                       | 0.00                       | 1           |
| 203.87                      | Q500            | 373.80                   | 373.80                       | 0.00                       | 1           |
| 207.50                      | Overtopping     | 679.45                   | 679.45                       | 0.00                       | Overtopping |

Rating Curve Plot for Crossing: Exist Lewiston Hart Brook Bridge

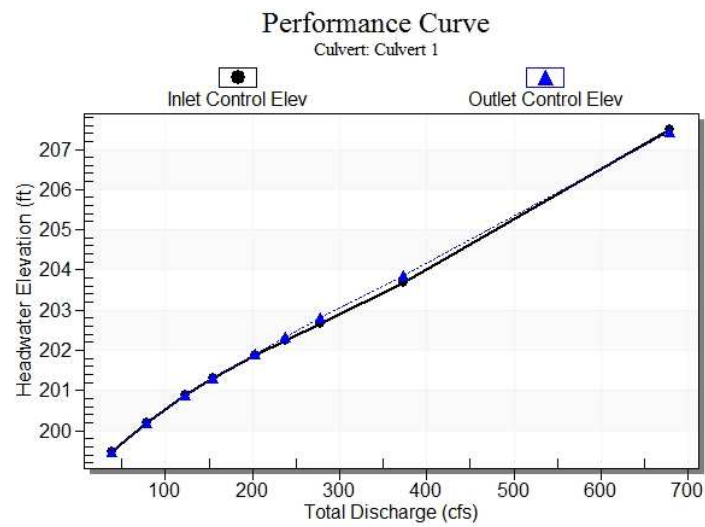


**Table 2 - Culvert Summary Table: Culvert 1**

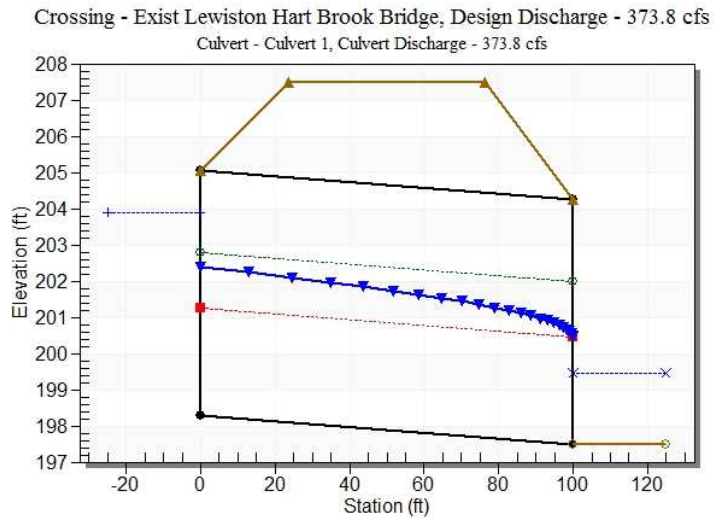
| Discharge Names | Total Discharge (cfs) | Culvert Discharge (cfs) | Headwater Elevation (ft) | Inlet Control Depth (ft) | Outlet Control Depth (ft) | Flow Type | Normal Depth (ft) | Critical Depth (ft) | Outlet Depth (ft) | Tailwater Depth (ft) | Outlet Velocity (ft/s) | Tailwater Velocity (ft/s) | ***** |
|-----------------|-----------------------|-------------------------|--------------------------|--------------------------|---------------------------|-----------|-------------------|---------------------|-------------------|----------------------|------------------------|---------------------------|-------|
| Q1.1            | 38.00                 | 38.00                   | 199.48                   | 1.179                    | 1.173                     | 2-M2c     | 0.879             | 0.637               | 0.637             | 0.518                | 4.596                  | 5.223                     | ***** |
| Q2              | 78.40                 | 78.40                   | 200.21                   | 1.913                    | 1.897                     | 2-M2c     | 1.401             | 1.034               | 1.034             | 0.794                | 5.855                  | 6.764                     | ***** |
| Q5              | 123.40                | 123.40                  | 200.88                   | 2.581                    | 2.574                     | 2-M2c     | 1.898             | 1.419               | 1.419             | 1.035                | 6.735                  | 7.908                     | ***** |
| Q10             | 155.30                | 155.30                  | 201.32                   | 3.018                    | 3.015                     | 2-M2c     | 2.224             | 1.649               | 1.649             | 1.183                | 7.306                  | 8.544                     | ***** |
| Q25             | 203.30                | 203.30                  | 201.92                   | 3.590                    | 3.623                     | 2-M2c     | 2.700             | 1.970               | 1.970             | 1.381                | 8.037                  | 9.337                     | ***** |
| Q50             | 237.20                | 237.20                  | 202.33                   | 3.945                    | 4.030                     | 2-M2c     | 3.031             | 2.184               | 2.184             | 1.509                | 8.485                  | 9.816                     | ***** |
| Q100            | 277.60                | 277.60                  | 202.80                   | 4.370                    | 4.499                     | 2-M2c     | 3.430             | 2.425               | 2.425             | 1.650                | 8.978                  | 10.323                    | ***** |
| Q500            | 373.80                | 373.80                  | 203.87                   | 5.374                    | 5.571                     | 2-M2c     | 4.472             | 2.946               | 2.946             | 1.951                | 10.056                 | 11.333                    | ***** |

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 Straight Culvert  
 Inlet Elevation (invert):  
 198.30 ft, Outlet  
 Elevation (invert):  
 197.50 ft  
 Culvert Length: 100.00  
 ft, Culvert Slope:  
 0.0080  
 \*\*\*\*\*  
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Culvert Performance Curve Plot: Culvert 1



## Water Surface Profile Plot for Culvert: Culvert 1



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Inlet Station: 0.00 ft

Inlet Elevation: 198.30 ft

Outlet Station: 100.00 ft

Outlet Elevation: 197.50 ft

Number of Barrels: 1

### Culvert Data Summary - Culvert 1

Barrel Shape: Arch, Open Bottom

Barrel Span: 13.00 ft

Barrel Rise: 6.75 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

**Table 3 - Downstream Channel Rating Curve (Crossing: Exist Lewiston Hart Brook**

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|------------|-------------------------|------------|-----------------|-------------|---------------|
| 38.00      | 198.02                  | 0.52       | 5.22            | 0.04        | 1.32          |
| 78.40      | 198.29                  | 0.79       | 6.76            | 0.06        | 1.41          |
| 123.40     | 198.54                  | 1.04       | 7.91            | 0.08        | 1.46          |
| 155.30     | 198.68                  | 1.18       | 8.54            | 0.09        | 1.49          |
| 203.30     | 198.88                  | 1.38       | 9.34            | 0.10        | 1.52          |
| 237.20     | 199.01                  | 1.51       | 9.82            | 0.11        | 1.54          |
| 277.60     | 199.15                  | 1.65       | 10.32           | 0.12        | 1.55          |
| 373.80     | 199.45                  | 1.95       | 11.33           | 0.15        | 1.59          |

**Bridge)****Tailwater Channel Data - Exist Lewiston Hart Brook Bridge**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 13.00 ft

Side Slope (H:V): 2.00 (\_:1)

Channel Slope: 0.0012

Channel Manning's n: 0.0060

Channel Invert Elevation: 197.50 ft

**Roadway Data for Crossing: Exist Lewiston Hart Brook Bridge**

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 207.50 ft

Roadway Surface: Paved

Roadway Top Width: 53.00 ft

# **HY-8 Culvert Analysis Report**

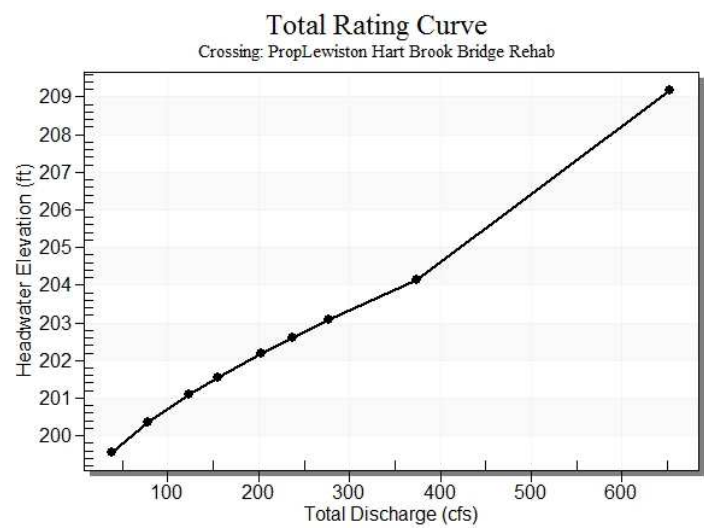
## Crossing Discharge Data

Discharge Selection Method: User Defined

**Table 1 - Summary of Culvert Flows at Crossing: PropLewiston Hart Brook Bridge Rehab**

| Headwater<br>Elevation (ft) | Discharge Names | Total Discharge<br>(cfs) | Culvert 1<br>Discharge (cfs) | Roadway<br>Discharge (cfs) | Iterations  |
|-----------------------------|-----------------|--------------------------|------------------------------|----------------------------|-------------|
| 199.57                      | Q1.1            | 38.00                    | 38.00                        | 0.00                       | 1           |
| 200.35                      | Q2              | 78.40                    | 78.40                        | 0.00                       | 1           |
| 201.08                      | Q5              | 123.40                   | 123.40                       | 0.00                       | 1           |
| 201.54                      | Q10             | 155.30                   | 155.30                       | 0.00                       | 1           |
| 202.18                      | Q25             | 203.30                   | 203.30                       | 0.00                       | 1           |
| 202.59                      | Q50             | 237.20                   | 237.20                       | 0.00                       | 1           |
| 203.07                      | Q100            | 277.60                   | 277.60                       | 0.00                       | 1           |
| 204.15                      | Q500            | 373.80                   | 373.80                       | 0.00                       | 1           |
| 207.50                      | Overtopping     | 652.81                   | 652.81                       | 0.00                       | Overtopping |

Rating Curve Plot for Crossing: PropLewiston Hart Brook Bridge Rehab

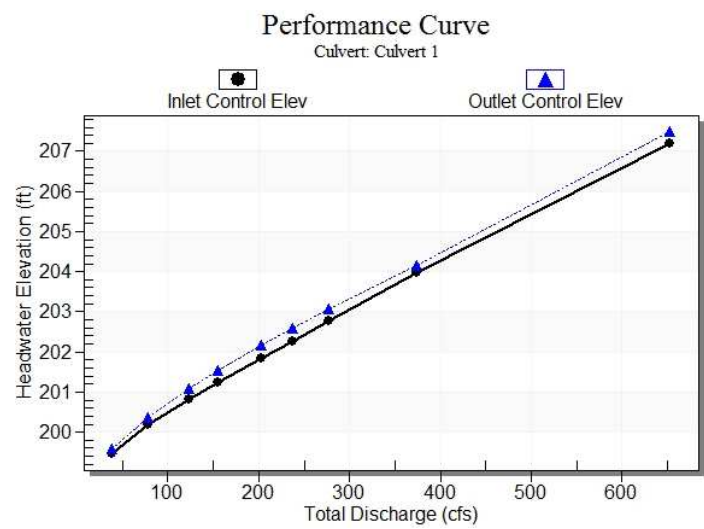


**Table 2 - Culvert Summary Table: Culvert 1**

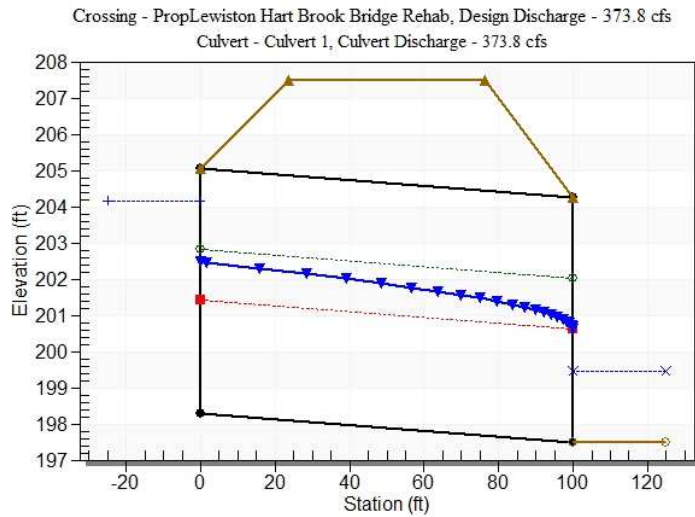
| Discharge Names | Total Discharge (cfs) | Culvert Discharge (cfs) | Headwater Elevation (ft) | Inlet Control Depth (ft) | Outlet Control Depth (ft) | Flow Type | Normal Depth (ft) | Critical Depth (ft) | Outlet Depth (ft) | Tailwater Depth (ft) | Outlet Velocity (ft/s) | Tailwater Velocity (ft/s) | ***** |
|-----------------|-----------------------|-------------------------|--------------------------|--------------------------|---------------------------|-----------|-------------------|---------------------|-------------------|----------------------|------------------------|---------------------------|-------|
| Q1.1            | 38.00                 | 38.00                   | 199.57                   | 1.160                    | 1.271                     | 2-M2c     | 0.924             | 0.668               | 0.668             | 0.518                | 4.741                  | 5.223                     | ***** |
| Q2              | 78.40                 | 78.40                   | 200.35                   | 1.875                    | 2.054                     | 2-M2c     | 1.473             | 1.093               | 1.093             | 0.794                | 5.977                  | 6.764                     | ***** |
| Q5              | 123.40                | 123.40                  | 201.08                   | 2.529                    | 2.778                     | 2-M2c     | 1.988             | 1.496               | 1.496             | 1.035                | 6.873                  | 7.908                     | ***** |
| Q10             | 155.30                | 155.30                  | 201.54                   | 2.949                    | 3.242                     | 2-M2c     | 2.321             | 1.742               | 1.742             | 1.183                | 7.428                  | 8.544                     | ***** |
| Q25             | 203.30                | 203.30                  | 202.18                   | 3.543                    | 3.879                     | 2-M2c     | 2.790             | 2.080               | 2.080             | 1.381                | 8.144                  | 9.337                     | ***** |
| Q50             | 237.20                | 237.20                  | 202.59                   | 3.969                    | 4.295                     | 2-M2c     | 3.105             | 2.305               | 2.305             | 1.509                | 8.574                  | 9.816                     | ***** |
| Q100            | 277.60                | 277.60                  | 203.07                   | 4.477                    | 4.769                     | 2-M2c     | 3.467             | 2.559               | 2.559             | 1.650                | 9.039                  | 10.323                    | ***** |
| Q500            | 373.80                | 373.80                  | 204.15                   | 5.665                    | 5.846                     | 2-M2c     | 4.532             | 3.119               | 3.119             | 1.951                | 9.987                  | 11.333                    | ***** |

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 Straight Culvert  
 Inlet Elevation (invert):  
 198.30 ft, Outlet  
 Elevation (invert):  
 197.50 ft  
 Culvert Length: 100.00  
 ft, Culvert Slope:  
 0.0080  
 \*\*\*\*\*  
 \*\*\*\*\*

Culvert Performance Curve Plot: Culvert 1



## Water Surface Profile Plot for Culvert: Culvert 1



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Inlet Station: 0.00 ft

Inlet Elevation: 198.30 ft

Outlet Station: 100.00 ft

Outlet Elevation: 197.50 ft

Number of Barrels: 1

### Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 12.00 ft

Barrel Rise: 6.75 ft

Barrel Material: Corrugated Metal Riveted or Welded

Embedment: 0.00 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

**Table 3 - Downstream Channel Rating Curve (Crossing: PropLewiston Hart Brook Bridge**

| Flow (cfs) | Water Surface Elev (ft) | Depth (ft) | Velocity (ft/s) | Shear (psf) | Froude Number |
|------------|-------------------------|------------|-----------------|-------------|---------------|
| 38.00      | 198.02                  | 0.52       | 5.22            | 0.04        | 1.32          |
| 78.40      | 198.29                  | 0.79       | 6.76            | 0.06        | 1.41          |
| 123.40     | 198.54                  | 1.04       | 7.91            | 0.08        | 1.46          |
| 155.30     | 198.68                  | 1.18       | 8.54            | 0.09        | 1.49          |
| 203.30     | 198.88                  | 1.38       | 9.34            | 0.10        | 1.52          |
| 237.20     | 199.01                  | 1.51       | 9.82            | 0.11        | 1.54          |
| 277.60     | 199.15                  | 1.65       | 10.32           | 0.12        | 1.55          |
| 373.80     | 199.45                  | 1.95       | 11.33           | 0.15        | 1.59          |

**Rehab)****Tailwater Channel Data - PropLewiston Hart Brook Bridge Rehab**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 13.00 ft

Side Slope (H:V): 2.00 (\_:1)

Channel Slope: 0.0012

Channel Manning's n: 0.0060

Channel Invert Elevation: 197.50 ft

**Roadway Data for Crossing: PropLewiston Hart Brook Bridge Rehab**

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 207.50 ft

Roadway Surface: Paved

Roadway Top Width: 53.00 ft