

HYDROLOGY REPORT

Hydrology Description

SUMMARY

Watershed Area	11	mi ²
Q1.1	158	ft ³ /s
Q10	667	ft ³ /s
Q50	1028	ft ³ /s
Q100	1205	ft ³ /s
Q500	1633	ft ³ /s

Reported by: LPO

Date: September 16, 2015

Reported by: LPO

Date: June 29, 2015

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

HYDRAULIC REPORT

The hydraulic performance of the existing and replacement culverts were analyzed using HY-8 revision 7.50 software developed by the Federal Highway Administration in cooperation with Aquaveo LLC and the Environmental Modeling Research Laboratory.

The streambed of Thibodeau Brook consists of gravel, cobbles, and a scattering of small boulders. The banks of the brook are lined with heavy brush except the northeasterly downstream bank which has been armored with heavy riprap. Based on this information, a Manning's n value of 0.0500 was used to model the streambed channel roughness in HY-8.

EXISTING CULVERT

The existing culvert is a 5% vertical elliptical structural plate pipe with a 13'-5" span and a 14'-10" rise. It was modeled in HY-8 as a 14'-0" diameter circular corrugated steel pipe. The existing culvert is inlet controlled and has a headwater depth versus structure depth ratio of 0.76 at Q50, which is less than 0.9 as recommended by the MaineDOT Bridge Design Guide Section 2.3.10.2.

RECOMMENDED REPLACEMENT CULVERT

The recommended replacement culvert is a 22' wide by 12' high concrete box culvert. The culvert inverts would be embedded 2'-0" below streambed and 2'-0" of gravel and cobbles similar to the existing streambed material would be placed inside to better simulate actual stream conditions throughout the culvert. Version 7.50 of HY-8 does model embedded culverts. A Manning's n value of 0.0120 was used for the top and sides of the concrete barrel and 0.040 was assumed for the bottom, which is conservatively slightly less than the downstream channel roughness.

The recommended structure provides several hydraulic improvements over the existing culvert. The larger structure provides a 40% increase in waterway area which in turn reduces the headwater depth versus structure depth ratio at Q50 from 0.76 to 0.58, reduces the outlet velocity at Q50 from 17.40 to 11.85 feet per second and increases the freeboard at Q100 from 7.11 to 12.04 feet.

It is important to note two important limitations of HY-8's modeling of embedded culverts. First, the inlet control depth is determined by linear interpolation of coefficients derived from limited testing reported the NCHRP 15-24 report versus using the more accurate 5th degree polynomial equations developed for non-embedded culverts. Second, the inlet configuration options are limited. The "square edge with headwall" configuration was assumed for the analysis of the concrete box culvert based on a note on page 37 of the HY-8 User Manual which indicates from limited hydraulic tests, flared end sections are equivalent in operation to a headwall in both inlet and outlet control conditions.

Heavy riprap is recommended for the aprons and slopes. Heavy riprap will provide greater streambed stability for the relatively high culvert outlet velocity of 11.85 fps at Q₅₀ and will be consistent with the heavy riprap that had been previously placed to repair the eroded northeasterly downstream bank near the house after the 2008 storm.

SUMMARY

		Existing Structure	Recommended Structure		
		14' Circular Steel Plate Pipe	22' x 12' Concrete Box		
Total Area of Waterway Opening	ft ²	154	220		
Headwater elevation @ Q _{1.1} **	ft	459.60	457.65		
Headwater elevation @ Q ₁₀	ft	464.08	460.32		
Headwater elevation @ Q ₂₅ **	ft	465.44	461.18		
Headwater elevation @ Q ₅₀	ft	466.34	461.77		
Headwater elevation @ Q ₁₀₀	ft	467.39	462.46		
Headwater elevation @ Q ₅₀₀	ft	470.13	463.98		
Freeboard @ Q ₅₀	ft	8.16	12.73		
Freeboard @ Q ₁₀₀	ft	7.11	12.04		
Outlet Velocity @ Q _{1.1}	ft/s	10.59	6.10		
Outlet Velocity @ Q ₁₀	ft/s	15.63	10.25		
Outlet Velocity @ Q ₂₅ **	ft/s	16.73	11.25		
Outlet Velocity @ Q ₅₀	ft/s	17.40	11.85		
Outlet Velocity @ Q ₁₀₀	ft/s	18.10	12.32		
Outlet Velocity @ Q ₅₀₀	ft/s	19.53	13.83		

Reported by: Jack Burgess

Date: March 22, 2018

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

Appendix E

Hydraulic Data

MaineDOT Culvert Hydrology Summary Sheet

Town: Grand Isle WIN (or Region): 21884.00

Route: 1 Local Road Name:

Stream: Thibodeau Brook

Lat: 47.41417 Long: -68.1610

Asset ID: Br 2781 Also Known As:

Existing Structure:

Watershed Area: 11.0 *sq. mi.* NWI Wetlands: 8.22 %

Wbf - calculated: 26.7 *feet* Wbf - measured (if known): *feet*

Q50: 1028.2 *cfs*

Q100: 1205.4 *cfs*

Preliminary Pipe Size*:

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

Comments:

By: CSH / AWM

Date: 9/16/2015

Revised: LPO 6/29/16

ver: 5/12/2016

Project Name: Grand Isle Bridge
Stream Name: Thibodeau Brook
Bridge Name: Soucy Bridge
Route No. 1
Analysis by: LPO

PIN: 21884
Town: Grand Isle
Bridge No. 2781
USGS Quad:
Date: 7/1/2016

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

Enter data in blue cells only!

	km ²	mi ²	ac
A	28.49	11.00	7040.0
W	2.34	0.9	578.7
P _c	561415.3	5237075	
County	Aroostook N		
pptA	36.1		
SG	0.01		

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:

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Environmental Office

Maine Dept. Transportation

Augusta, ME 04333-0016

207-557-1052

Charles.Hebson@maine.gov

ver. 2016 Feb 05

A (km ²)	28.49
W (%)	8.22

Conf Lvl 0.67

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

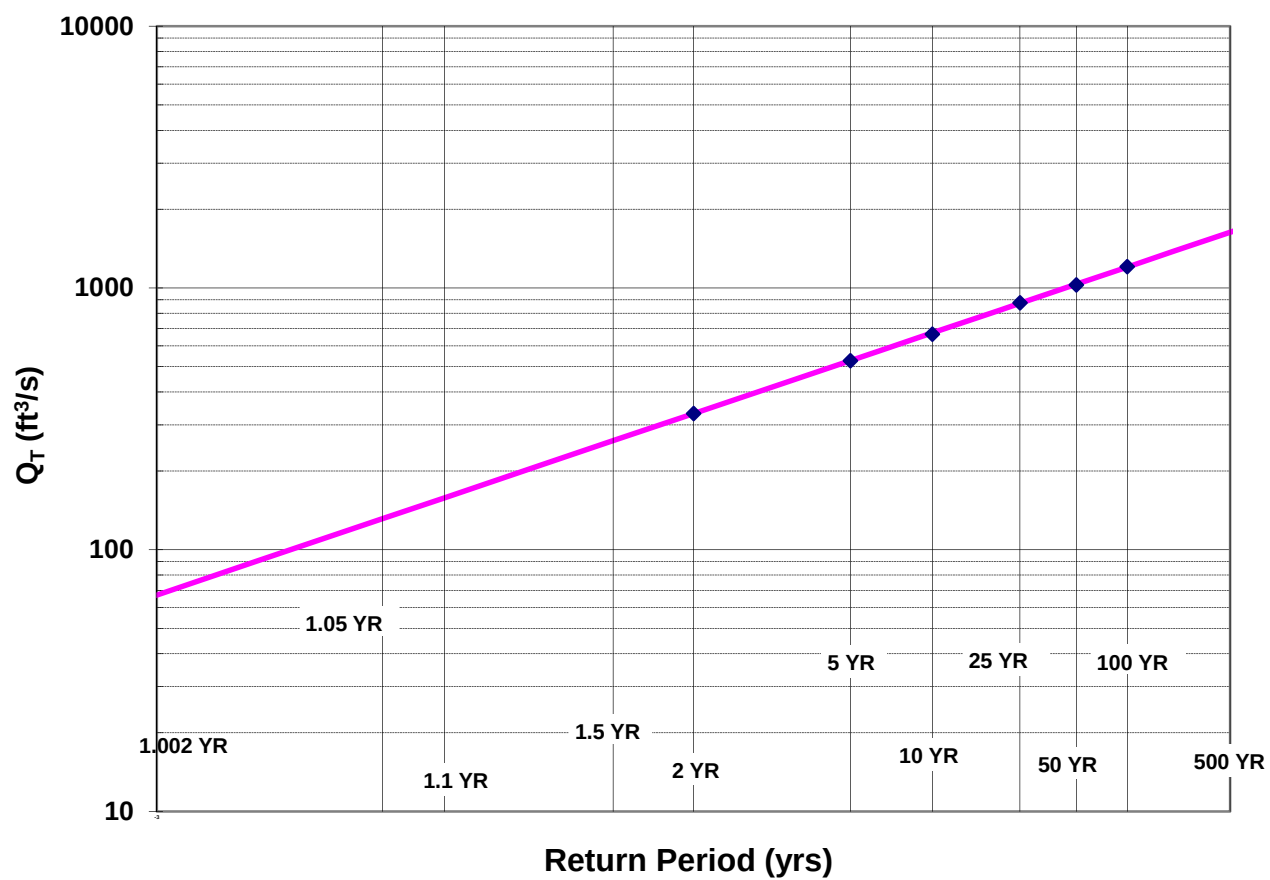
SIR 2015-4059, USGS, Augusta, ME

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

Ret Pd	Peak Flow Estimate		
T (yr)	Lower	Q _T (m ³ /s)	Upper
1.1		4.48	
2		9.38	
5		14.94	
10		18.89	
25		24.85	
50		29.12	
100		34.14	
500		46.25	

Q _T (ft ³ /s)
158.1
331.3
527.5
667.0
877.5
1028.2
1205.4
1633.2

Log-Normal Probability Plot



Project Name: Grand Isle Bridge
Stream Name: Thibodeau Brook
Bridge Name: Soucy Bridge
Route No. 1
Analysis by: LPO

PIN: 21884
Town: Grand Isle
Bridge No. 2781
USGS Quad:
Date: 7/1/2016

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

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

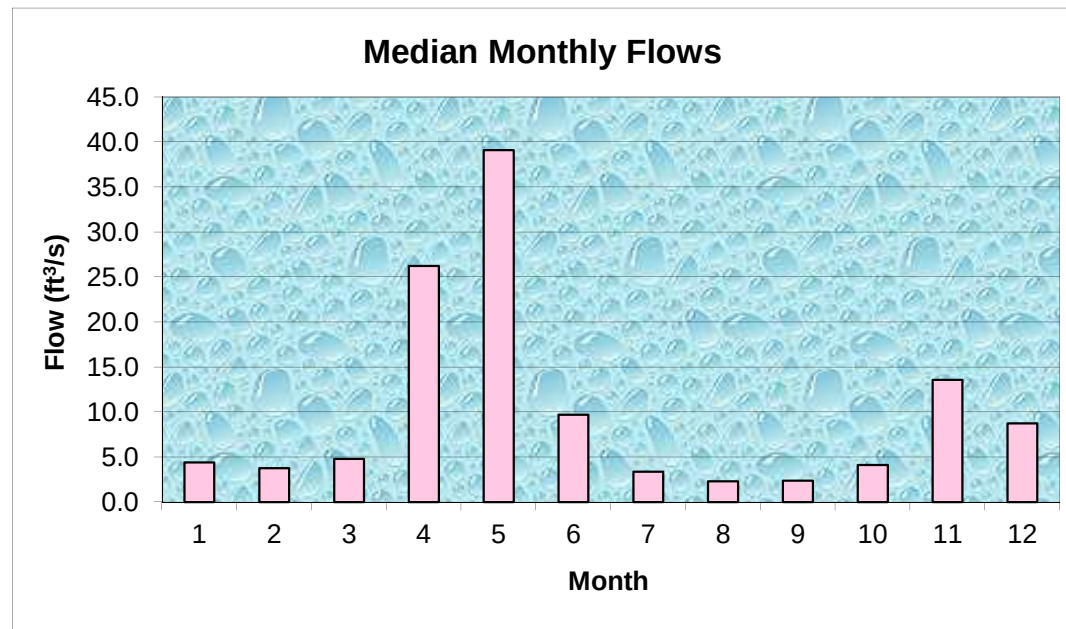
Value	Variable	Explanation
11.00	A	Area (mi ²)
561415.3	P _c	Watershed centroid (E,N; UTM; Zone 19; meters)
198.86	DIST	Distance from Coastal reference line (mi)
36.1	pptA	Mean Annual Precipitation (inches)
0.01	SG	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q _{median} (ft ³ /s)	(m ³ /s)
Jan	4.40	0.1247
Feb	3.77	0.1068
Mar	4.78	0.1355
Apr	26.22	0.7430
May	39.10	1.1082
Jun	9.69	0.2745
Jul	3.38	0.0958
Aug	2.30	0.0651
Sep	2.39	0.0678
Oct	4.14	0.1172
Nov	13.57	0.3846
Dec	8.74	0.2476

Q _{bf}	64.4
ann avg	20.0
ann med	8.7
Q _{1.002}	67.1
Q _{1.01}	91.0
Q _{1.05}	131.3
Q _{bf}	143.3

assume v = 4ft/s

W _{bf}	26.7	estimated bankfull width (ft)
d _{bf}	1.3	estimated bankfull depth (ft)
A _{bf}	35.8	estimated bankfull flow area (ft ²)



References

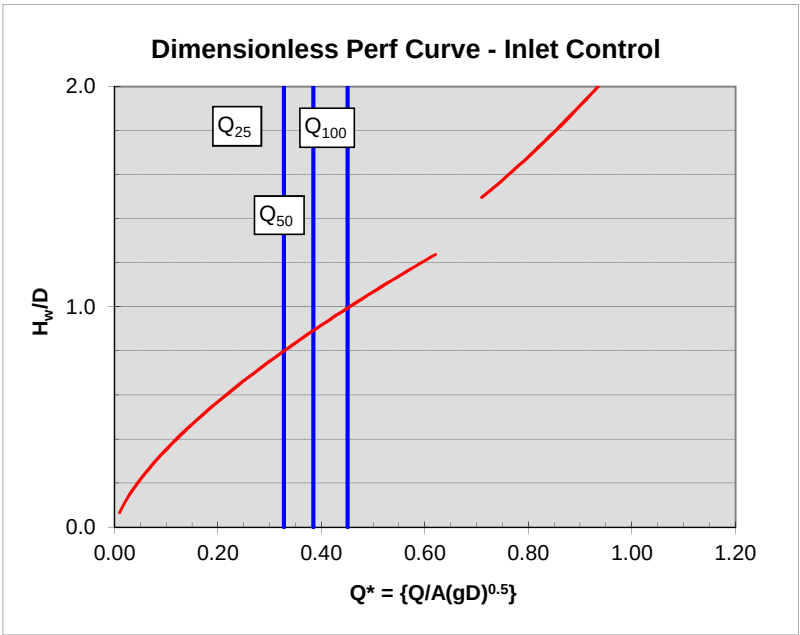
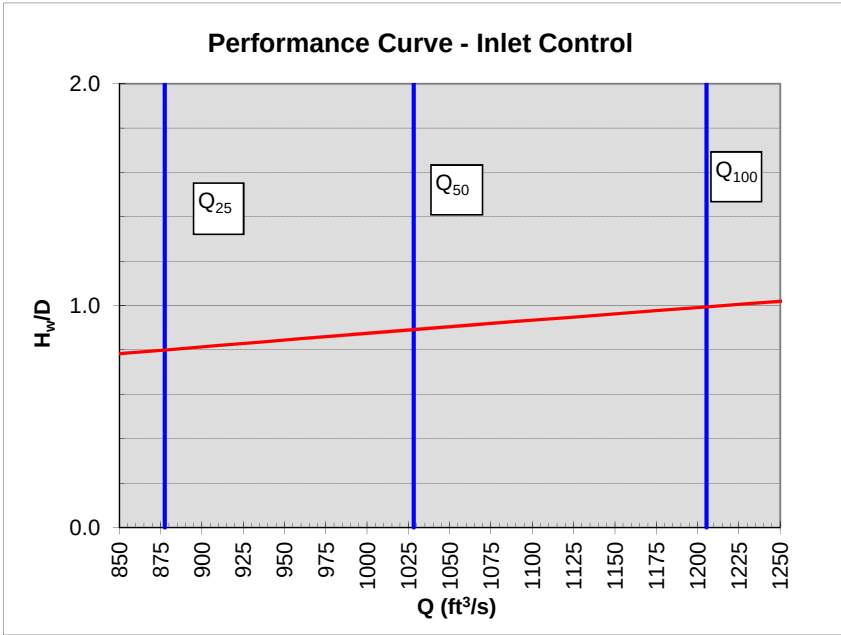
Dudley, R.W., 2004. Hydraulic Geometry Relations ..., SIR 2004-5042
Dudley, R.W., 2004. Estimating Monthly Streamflows ... , SIR 2004-5026

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

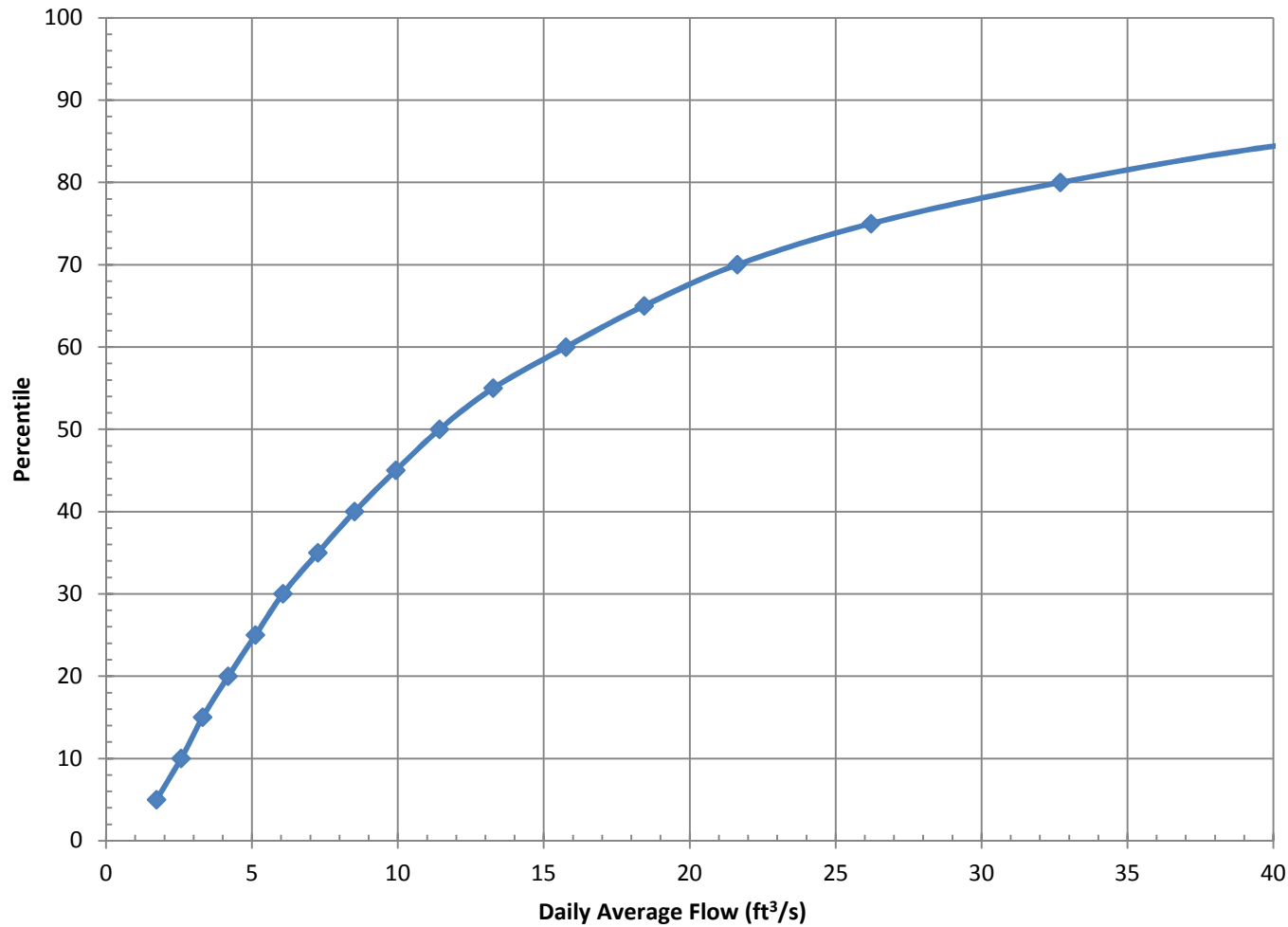
Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box			
Type:	Box 0 ww			
D or R (ft)	14	Q_{25}	877.5	
w (ft)	9 box width	Q_{50}	1028.2	trial D / R = 13.3
Slope (ft/ft)	0.02	Q_{100}	1205.4	trial w: BFW = 26.7
A (ft ²)	126.00			
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

$A_{ws} = (mi^2)$ 11.0

$Q (ft^3/s)$

Pctl	Median	84 th pctl
5	1.732	2.787
10	2.572	3.867
15	3.306	4.829
20	4.187	5.856
25	5.121	6.864
30	6.061	7.818
35	7.261	8.935
40	8.515	10.275
45	9.925	11.618
50	11.426	13.716
55	13.269	15.964
60	15.759	18.740
65	18.437	21.832
70	21.625	25.472
75	26.216	30.631
80	32.694	36.572
85	41.253	46.866
90	54.646	62.931
95	81.100	97.863

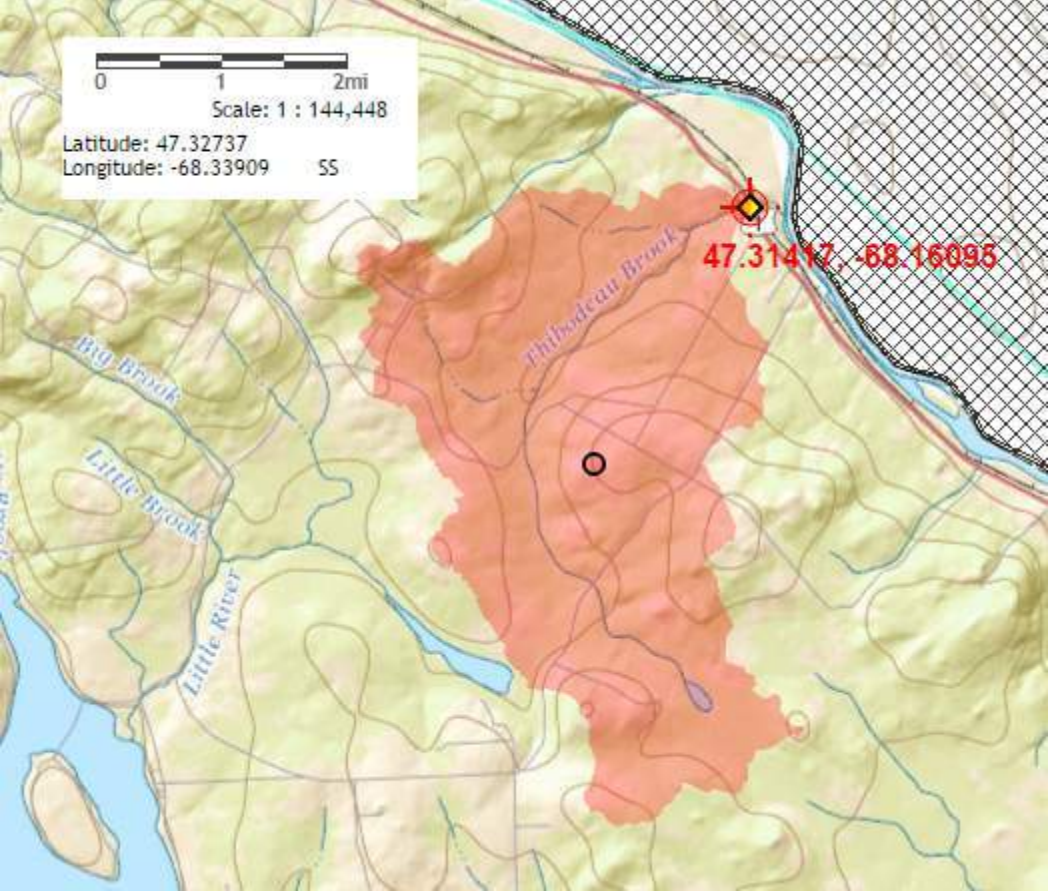
0 1 2mi

Scale: 1 : 144,448

Latitude: 47.32737

Longitude: -68.33909 SS

47.31417 -68.16095



StreamStats Version 3.0

Basin Characteristics Ungaged Site Report

Date: Fri July 1, 2016 9:15:34 AM GMT-4

Study Area: Maine

NAD 1983 Latitude: 47.3142 (47 18 51)

NAD 1983 Longitude: -68.1608 (-68 09 39)

Label	Value	Units	Definition
DRNAREA	11	square miles	Area that drains to a point on a stream
STORNWI	8.22	percent	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory
ELEV	717.6	feet	Mean Basin Elevation
PRECIP	38	inches	Mean Annual Precipitation
PRDECFEB90	7.47	inches	Basin average mean precipitation for December to February from PRISM 1961-1990
SANDGRAVAP	0.65	percent	Percentage of land surface underlain by sand and gravel aquifers
COASTDIST	200	miles	Shortest distance from the coastline to the basin centroid
CENTROIDX	561415.33	State plane coordinates	Basin centroid horizontal (x) location in state plane coordinates
CENTROIDY	5237075.34	State plane coordinates	Basin centroid vertical (y) location in state plane units
SANDGRAVAF	0.01	dimensionless	Fraction of land surface underlain by sand and gravel aquifers
LC11IMP	0.42	percent	Average percentage of impervious area determined from NLCD 2011 impervious dataset
LC11DEV	3.11	percent	Percentage of land-use from NLCD 2011 classes 21-24

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StreamStats Version 3.0

Flow Statistics Ungaged Site Report

Date: Fri July 1, 2016 9:17:22 AM GMT-4

Study Area: Maine

NAD 1983 Latitude: 47.3142 (47 18 51)

NAD 1983 Longitude: -68.1608 (-68 09 39)

Drainage Area: 11.0 mi²

Regional Hydraulic Geometry Basin Characteristics

100% Unnamed Region (11.0 mi²)

The selected watershed is entirely in an area for which flow equations were not defined.

Regional Median Flows Basin Characteristics

100% East Aroostook 2 Variable WRI 03 4225 (11 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	11	0.38	43.06
Mean Basin Elevation (feet)	717.6	437	1024

Monthly Mean Flows Basin Characteristics

100% Statewide Mean Monthly SIR 2004 5026 (11 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	11	9.79	1418
Fraction of Sand and Gravel Aquifers (dimensionless)	0.01	0	0.455
Mean Annual Precipitation (inches)	38	37.8	47.9
Distance From Coast To Basin Centroid (miles)	200 (above max value 193)	42.7	193

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Monthly Median Flows Basin Characteristics

100% Statewide Median Monthly SIR 2004 5026 (11 mi²)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	11	9.79	1418
Fraction of Sand and Gravel Aquifers (dimensionless)	0.01	0	0.455

Mean Annual Precipitation (inches)	38	37.8	47.9
Distance From Coast To Basin Centroid (miles)	200 (above max value 193)	42.7	193

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Peak Flow Basin Characteristics			
100% Statewide Peak Flow Full WRI 99 4008 (11 mi2)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	11	0.93	1653
Percentage of Storage from NWI (percent)	8.22	0.7	26.7

Annual Flows Basin Characteristics			
100% Statewide Annual SIR 2004 5026 (11 mi2)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	11	9.79	1418
Fraction of Sand and Gravel Aquifers (dimensionless)	0.01	0	0.455
Basin Ave Precip Dec Feb PRISM 1990 (inches)	7.47 (below min value 7.71)	7.71	12.6

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Regional Median Flows Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
AUGD50	3.48	ft3/s	51			

<http://water.usgs.gov/pubs/wri/wri034225/pdf/wrir03-4225.pdf> (<http://water.usgs.gov/pubs/wri/wri034225/pdf/wrir03-4225.pdf>)

Lombard_ P. J._ Tasker_ G. D._ and Nielsen_ M. G._ 2003_ August Median Streamflow on Ungaged Streams in Eastern Aroostook County_ Maine: U.S. Geological Survey Water-Resources Investigations Report 03-4225_ 20 p.

Monthly Mean Flows Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
Q1	6.84	ft3/s				
Q2	6.23	ft3/s				
Q3	13.9	ft3/s				
Q4	47.4	ft3/s				
Q5	55	ft3/s				
Q6	16.2	ft3/s				

Q7	6.56	ft3/s				
Q8	4.74	ft3/s				
Q9	5.47	ft3/s				
Q10	11.7	ft3/s				
Q11	24.2	ft3/s				
Q12	14.2	ft3/s				

<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf> (<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf>)

Dudley_ R.W._ 2004_ Estimating Monthly_ Annual_ and Low 7-Day_ 10-Year Streamflows for Ungaged Rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026_ 22 p.

Monthly Median Flows Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
JAND50	4.38	ft3/s				
FEBD50	3.75	ft3/s				
MARD50	4.75	ft3/s				
APRD50	29.6	ft3/s				
MAYD50	39.2	ft3/s				
JUND50	9.69	ft3/s				
JULD50	3.38	ft3/s				
AUGD50	2.3	ft3/s				
SEPD50	2.39	ft3/s				
OCTD50	4.14	ft3/s				
NOVD50	13.6	ft3/s				
DECD50	8.71	ft3/s				

<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf> (<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf>)

Dudley_ R.W._ 2004_ Estimating Monthly_ Annual_ and Low 7-Day_ 10-Year Streamflows for Ungaged Rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026_ 22 p.

Peak Flow Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PK2	393	ft3/s	35	1.8	218	707
PK5	623	ft3/s	36	2.5	342	1130
PK10	796	ft3/s	37	3.2	431	1470
PK25	1030	ft3/s	39	4.1	544	1960
PK50	1220	ft3/s	40	4.8	628	2360
PK100	1420	ft3/s	41	5.4	715	2810
PK500	1920	ft3/s	45	6.4	914	4040

<http://me.water.usgs.gov/99-4008.pdf> (<http://me.water.usgs.gov/99-4008.pdf>)

Hodgkins_ G. A._ 1999_ Estimating the Magnitude of Peak Flows for Streams in Maine for Selected Recurrence Intervals: U.S. Geological Survey Water-Resources Investigations Report 99-4008_ 45 p.

Annual Flows Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
QA	18.4	ft3/s				
MEDAN	7.11	ft3/s				
M7D10Y	0.41	ft3/s				

<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf> (<http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf>)

Dudley_ R.W._ 2004_ Estimating Monthly_ Annual_ and Low 7-Day_ 10-Year Streamflows for Ungaged Rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026_ 22 p.

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HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Existing Bridge #2781 Grand Isle, ME

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Existing 14' Dia Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
459.60	Q1.1	158.10	158.10	0.00	1
461.44	Q2	331.30	331.30	0.00	1
463.06	Q5	527.50	527.50	0.00	1
464.08	Q10	667.00	667.00	0.00	1
465.44	Q25	877.50	877.50	0.00	1
466.34	Q50	1028.20	1028.20	0.00	1
467.39	Q100	1205.40	1205.40	0.00	1
470.13	Q500	1633.20	1633.20	0.00	1
474.50	Overtopping	2169.71	2169.71	0.00	Overtopping

Rating Curve Plot for Crossing: Existing Bridge #2781 Grand Isle, ME

Total Rating Curve

Crossing: Existing Bridge #2781 Grand Isle, ME

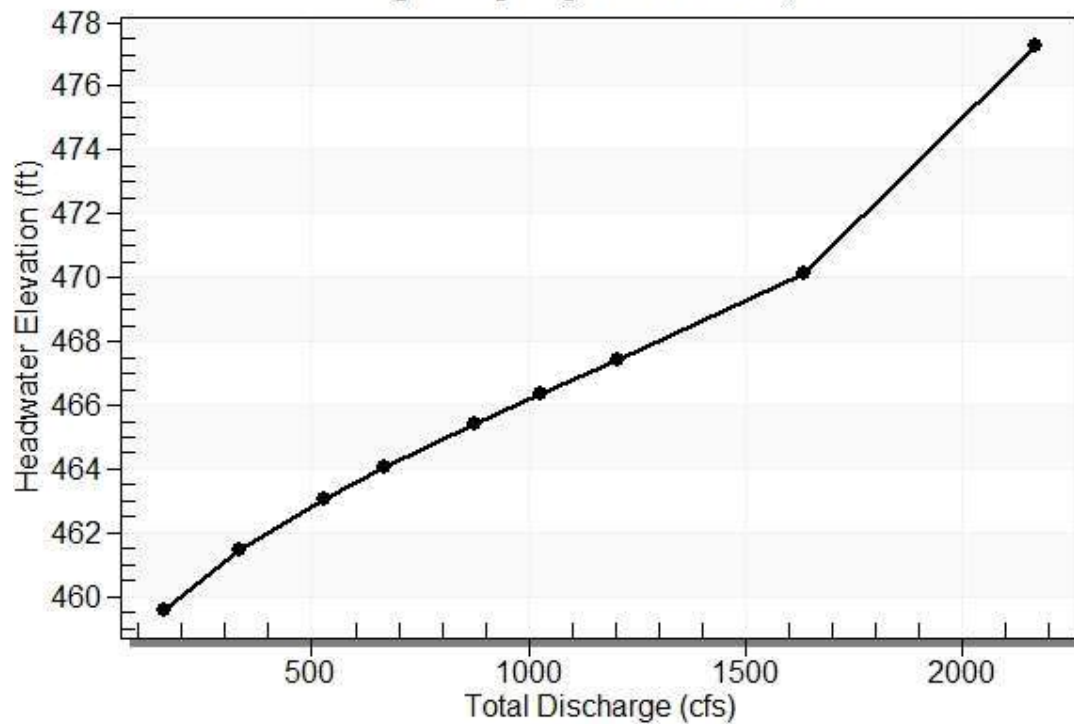


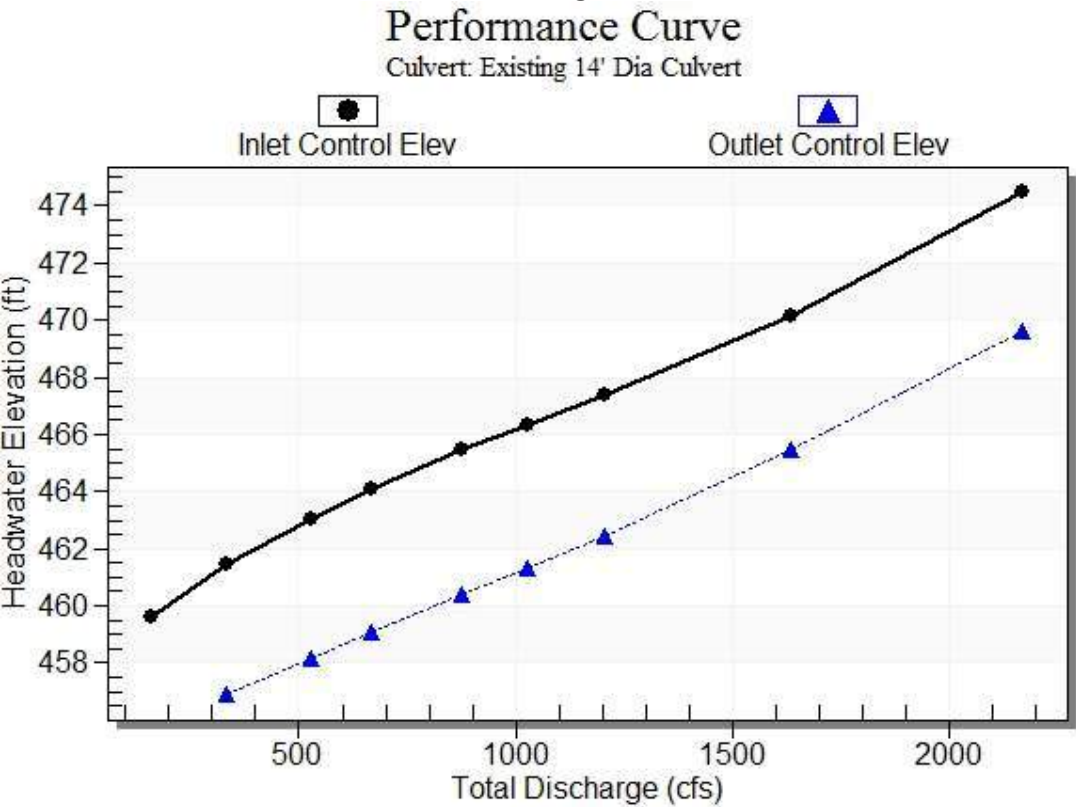
Table 2 - Culvert Summary Table: Existing 14' Dia Culvert

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	158.10	158.10	459.60	3.864	0.0*	1-S2n	2.010	2.663	2.088	1.713	10.588	3.940
Q2	331.30	331.30	461.44	5.698	1.162	1-S2n	2.897	3.892	3.025	2.618	13.033	5.015
Q5	527.50	527.50	463.06	7.324	2.451	1-S2n	3.659	4.950	3.857	3.398	14.743	5.793
Q10	667.00	667.00	464.08	8.342	3.322	1-S2n	4.126	5.592	4.379	3.868	15.634	6.218
Q25	877.50	877.50	465.44	9.700	4.633	1-S2n	4.765	6.458	5.094	4.491	16.734	6.741
Q50	1028.20	1028.20	466.34	10.603	5.584	1-S2n	5.187	7.014	5.568	4.891	17.404	7.058
Q100	1205.40	1205.40	467.39	11.651	6.733	1-S2n	5.658	7.621	6.098	5.324	18.097	7.387
Q500	1633.20	1633.20	470.13	14.392	9.707	5-S2n	6.723	8.931	7.283	6.247	19.534	8.046

* Full Flow Headwater elevation is below inlet invert.

Straight Culvert
Inlet Elevation (invert): 455.74 ft, Outlet Elevation (invert): 452.86 ft
Culvert Length: 124.65 ft, Culvert Slope: 0.0231

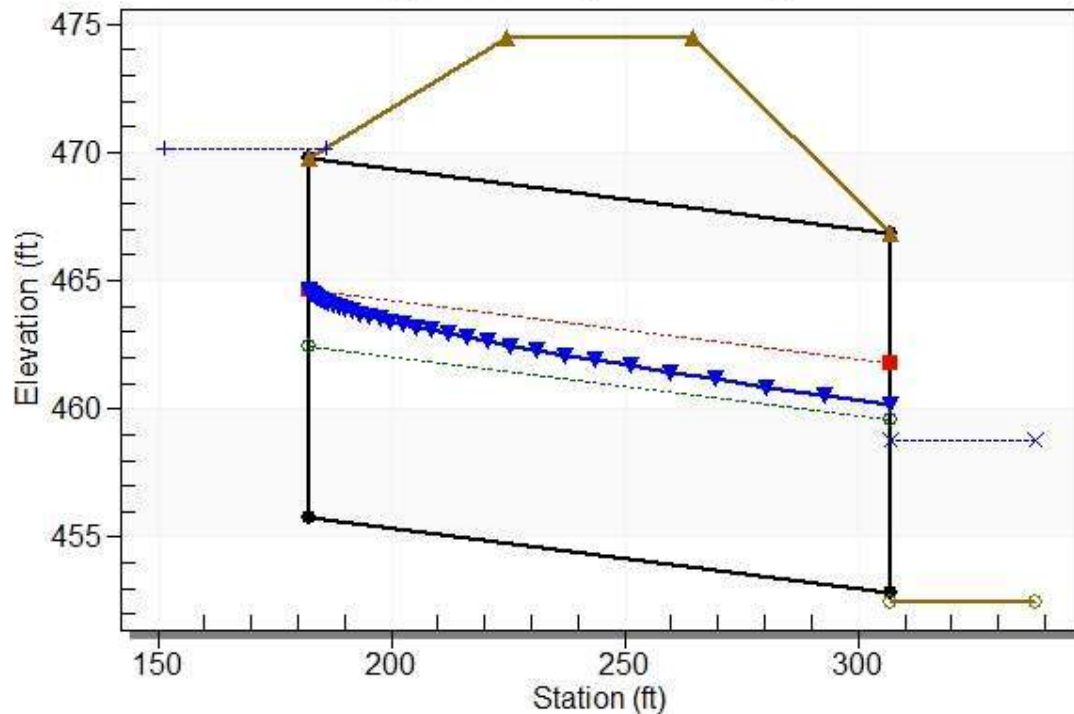
Culvert Performance Curve Plot: Existing 14' Dia Culvert



Water Surface Profile Plot for Culvert: Existing 14' Dia Culvert

Crossing - Existing Bridge #2781 Grand Isle, ME, Design Discharge - 1633.2 cfs

Culvert - Existing 14' Dia Culvert, Culvert Discharge - 1633.2 cfs



Site Data - Existing 14' Dia Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 182.37 ft

Inlet Elevation: 455.74 ft

Outlet Station: 306.99 ft

Outlet Elevation: 452.86 ft

Number of Barrels: 1

Culvert Data Summary - Existing 14' Dia Culvert

Barrel Shape: Circular

Barrel Diameter: 14.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Existing Bridge #2781 Grand Isle, ME)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
158.10	454.21	1.71	3.94	1.14	0.57
331.30	455.12	2.62	5.01	1.75	0.60
527.50	455.90	3.40	5.79	2.27	0.62
667.00	456.37	3.87	6.22	2.58	0.63
877.50	456.99	4.49	6.74	3.00	0.64
1028.20	457.39	4.89	7.06	3.27	0.65
1205.40	457.82	5.32	7.39	3.55	0.65
1633.20	458.75	6.25	8.05	4.17	0.67

Tailwater Channel Data - Existing Bridge #2781 Grand Isle, ME

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 20.00 ft

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

Channel Slope: 0.0107

Channel Manning's n: 0.0500

Channel Invert Elevation: 452.50 ft

Roadway Data for Crossing: Existing Bridge #2781 Grand Isle, ME

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 150.00 ft

Crest Elevation: 474.50 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: New Bridge #2781 Grand Isle, ME

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	New 22' span x 12' rise Conc Box Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
457.65	Q1.1	158.10	158.10	0.00	1
458.71	Q2	331.30	331.30	0.00	1
459.70	Q5	527.50	527.50	0.00	1
460.32	Q10	667.00	667.00	0.00	1
461.18	Q25	877.50	877.50	0.00	1
461.77	Q50	1028.20	1028.20	0.00	1
462.46	Q100	1205.40	1205.40	0.00	1
463.98	Q500	1633.20	1633.20	0.00	1
474.50	Overtopping	3929.32	3929.32	0.00	Overtopping

Rating Curve Plot for Crossing: New Bridge #2781 Grand Isle, ME

Total Rating Curve

Crossing: New Bridge #2781 Grand Isle, ME

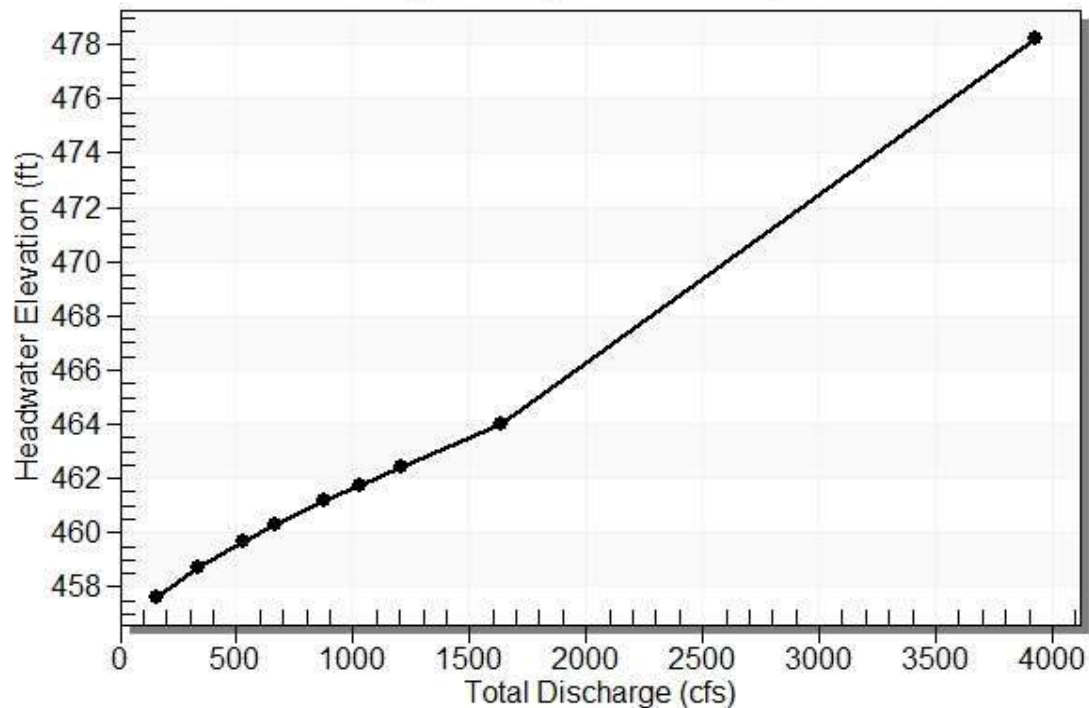


Table 2 - Culvert Summary Table: New 22' span x 12' rise Conc Box Culvert

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	158.10	158.10	457.65	1.654	0.0*	1-S2n	1.147	1.165	1.147	1.713	6.103	3.940
Q2	331.30	331.30	458.71	2.710	0.0*	1-S2n	1.834	1.918	1.834	2.618	7.999	5.015
Q5	527.50	527.50	459.70	3.696	0.084	1-S2n	2.474	2.621	2.474	3.398	9.445	5.793
Q10	667.00	667.00	460.32	4.322	0.665	1-S2n	2.883	3.061	2.883	3.868	10.246	6.218
Q25	877.50	877.50	461.18	5.183	1.506	1-S2n	3.456	3.675	3.456	4.491	11.247	6.741
Q50	1028.20	1028.20	461.77	5.768	2.098	1-S2n	3.842	4.088	3.842	4.891	11.851	7.058
Q100	1205.40	1205.40	462.46	6.456	2.796	1-S2n	4.232	4.540	4.333	5.324	12.320	7.387
Q500	1633.20	1633.20	463.98	7.977	4.531	1-S2n	5.079	5.547	5.229	6.247	13.832	8.046

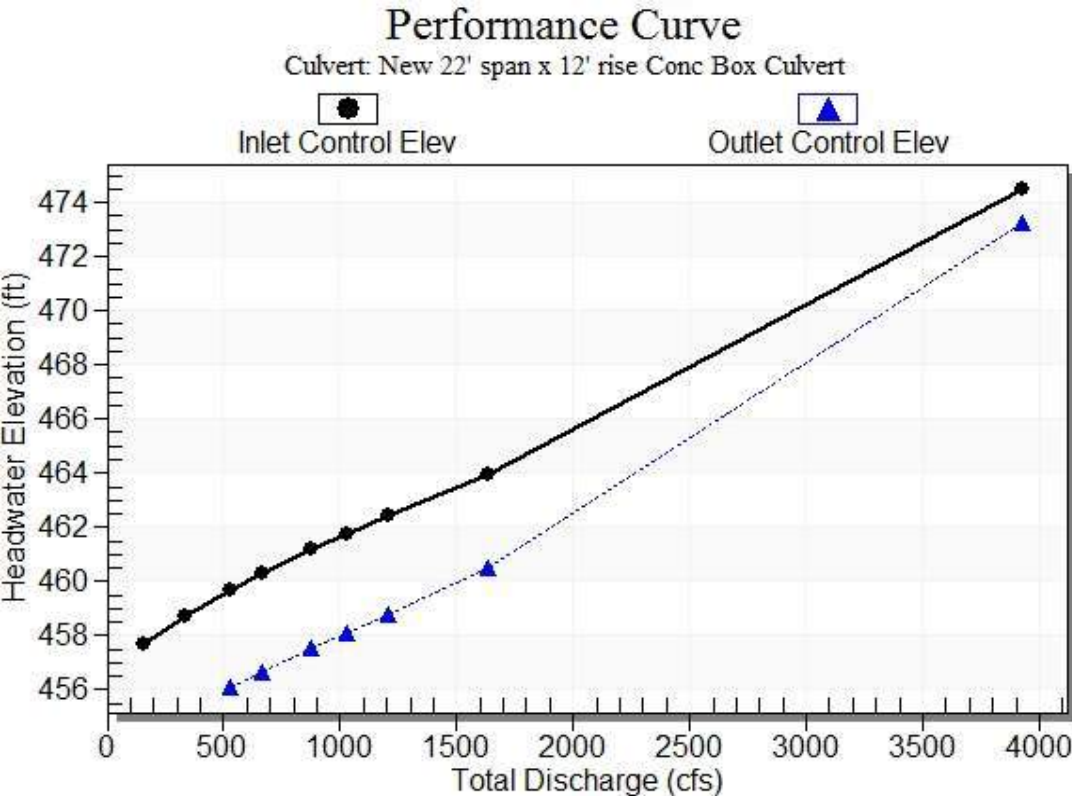
* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

Inlet Elevation (invert): 456.00 ft, Outlet Elevation (invert): 452.50 ft

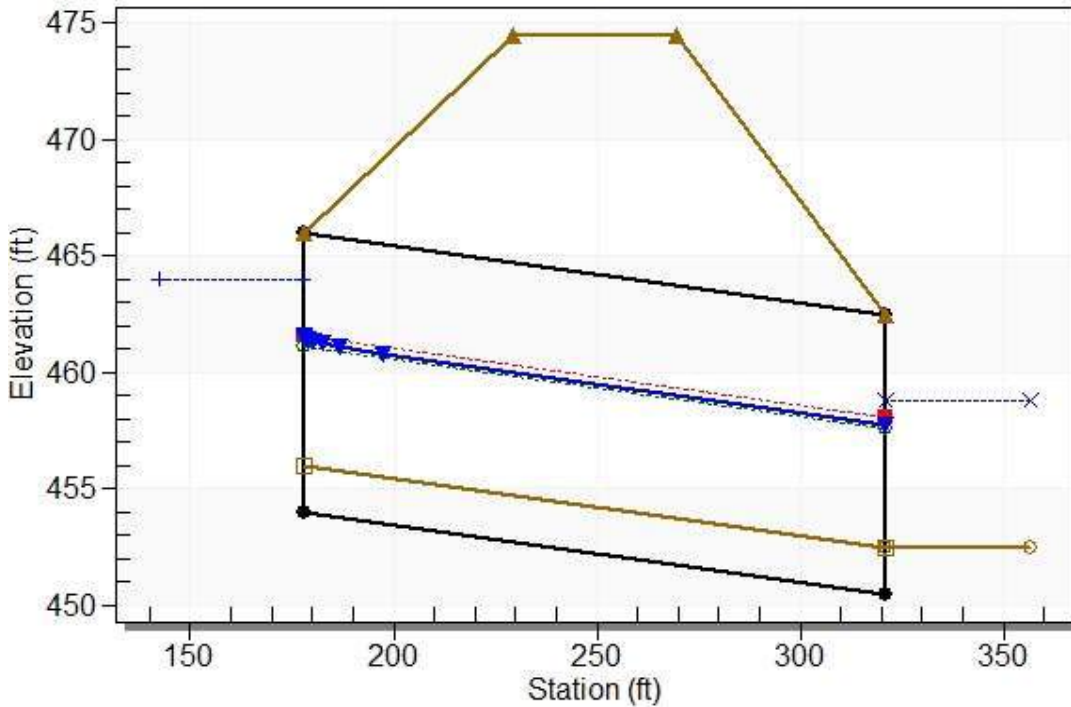
Culvert Length: 143.04 ft, Culvert Slope: 0.0245

Culvert Performance Curve Plot: New 22' span x 12' rise Conc Box Culvert



Water Surface Profile Plot for Culvert: New 22' span x 12' rise Conc Box Culvert

Culvert - New 22' span x 12' rise Conc Box Culvert, Culvert Discharge - 1633.2 cfs



Site Data - New 22' span x 12' rise Conc Box Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 178.00 ft

Inlet Elevation: 454.00 ft

Outlet Station: 321.00 ft

Outlet Elevation: 450.50 ft

Number of Barrels: 1

Culvert Data Summary - New 22' span x 12' rise Conc Box Culvert

Barrel Shape: Concrete Box

Barrel Span: 22.00 ft

Barrel Rise: 12.00 ft

Barrel Material: Concrete

Embedment: 24.00 in

Barrel Manning's n: 0.0120 (top and sides)

Manning's n: 0.0400 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: New Bridge #2781 Grand Isle, ME)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
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667.00	456.37	3.87	6.22	2.58	0.63
877.50	456.99	4.49	6.74	3.00	0.64
1028.20	457.39	4.89	7.06	3.27	0.65
1205.40	457.82	5.32	7.39	3.55	0.65
1633.20	458.75	6.25	8.05	4.17	0.67

Tailwater Channel Data - New Bridge #2781 Grand Isle, ME

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 20.00 ft

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

Channel Slope: 0.0107

Channel Manning's n: 0.0500

Channel Invert Elevation: 452.50 ft

Roadway Data for Crossing: New Bridge #2781 Grand Isle, ME

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 150.00 ft

Crest Elevation: 474.50 ft

Roadway Surface: Paved

Roadway Top Width: 40.00 ft