



Memorandum

To: Garrett Gustafson, P.E.
Maine Department of Transportation
16 State House Station
Augusta, ME 04333

Date: November 30, 2018

Project #: 55189.00

From: Julie Whitmore, P.E.
Project Engineer

Re: Hydrology, Hydraulic and Scour Report
Bridge #2914
Watchic Bridge over Page Brook
Standish, ME

VHB has prepared the following hydrologic, hydraulic, and scour analysis for the proposed replacement culvert carrying State Route 113 (Pequawket Trail) over Page Brook in Standish, Maine. Due to presence of endangered species (turtles) in the area, the project has been designed to function as a connection for wildlife passage between Page Brook and Watchic Lake. Accordingly, VHB has evaluated the proposed design for compatibility with Habitat Connectivity Design (HCD).

All elevations in this memorandum are referenced to the North American Vertical Datum of 1988 (NAVD88).

Existing Conditions

Watchic Bridge #2914 carries State Route 113 over Page Brook. The existing bridge is a 12-foot wide by 4-foot tall pile supported 3-sided frame with flared granite wingwalls. The date of construction of the existing bridge is 1919. The bridge and roadway were widened in 1941 and there is evidence of recent fascia repairs on both ends. Route 113 was recently paved in the summer of 2018, though paving was isolated to travel ways in the area of the bridge. There are overhead utilities along the highway corridor.

The existing bridge is listed in "fair" condition in the 2017 inspection report. Deficiencies consist of efflorescence, map cracking, exposed reinforcing steel, and surface scaling. Photographs are included at the end of this memorandum.

Information Collection

For this evaluation, VHB reviewed the following data:

- Topographic field survey of the existing culvert and surrounding area provided by MaineDOT and collected July 2016.
- Bridge Inspection Reports of the existing bridge dated October 10, 2017.
- Hydrologic analysis of Gagnon Brook performed by MaineDOT and dated October 5, 2017.
- VHB conducted a site visit of the crossing on August 2, 2018. VHB revisited the site and met with the Watchic Lake Dam operator on November 12, 2018. Photographs are included at the end of this memorandum.

There is an effective Flood Insurance Study (FIS) for the Town of Standish, however detailed studies are limited to Sebago Lake and the Saco River. The proposed crossing is located within flood Zone A as depicted on Flood Insurance Rate Map (FIRM) 2302070025B, Panel 25, Effective Date May 19, 1981. Zone A areas are determined by approximate methods and there is no flood elevation data or other hydrologic data for Page Brook provided by FEMA. The crossing is not located within a regulatory floodway, and therefore is not subject to the NFIP 60.3.(d)3 "No-Rise" requirement.

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Hydrologic Analysis

There is no streamgage data available for Gagnon Brook. The MaineDOT Environmental Office prepared the hydrologic evaluation for this crossing using USGS Maine regression equations for ungaged streams. VHB applied the peak flow estimates from this hydrologic analysis for hydraulic modeling. Table 1 presents a summary of peak flows at the crossing; the MaineDOT hydrologic analysis is included at the end of this memorandum.

Table 1 Hydrologic Data for Proposed Design

Drainage Area	0.5 sq. mi
Bankfull Discharge ($Q_{1.1}$)	9.2 cfs
Q_2	17.9 cfs
Q_5	27.1 cfs
Q_{10}	33.1 cfs
Q_{25}	43.1 cfs
Design Discharge (Q_{50})	48.8 cfs
Check Discharge (Q_{100})	57.0 cfs
Q_{500}	74.3 cfs
Flood of Record	Unknown

Tailwater Conditions

Page Brook is a tributary to Watchic Lake, which is dam controlled. The Watchic Lake Association owns and operates the dam, which is generally closed after ice out (typically March or April) and opened after Columbus Day (mid-October). The dam is controlled as needed to maintain the full pond elevation within a few inches during the summer. The dam was reconstructed in 2010 and a new gate was installed in 2015. Dam records, provided by the Watchic Lake Association from 2008 through 2018, indicate water levels vary a few inches during the summer and drop between 11 to 18 inches once the dam is opened in the fall. Surveyed WSE at the culvert in July 2016 indicates WSE close to assumed full pond at approximately El. 275. A review of the dam records for 2016 indicates stable WSE through the summer, with minor variations to +0.5" and -1.5". Fall site photos indicate low flow through the culvert with some velocity, indicating minimal backwater effect from Watchic Lake. Summer site photos indicate backwater from Watchic Lake at the bridge due to dam closure with very little velocity. The low lake level is at or below the elevation of the stream channel bed, therefore the analysis includes a "free discharge" tailwater condition. Table 2 below compares Watchic Lake WSEs with bridge and channel geometry at the crossing.

Table 2 Outlet Conditions

Crossing Low Chord	277.5
Pond Elev. (full)	275.0
Pond Elev. (low)	273.5
Channel Elev. At outlet	273.5

Proposed Design

The proposed design will replace the existing structure with a 45-foot-long, 21-foot wide by 6-foot high precast concrete box culvert. This structure will be located in approximately the same location as the existing and skewed to the roadway approximately twelve degrees.

The proposed design incorporates channel design through the culvert as summarized in Table 3. Channel thalweg survey profile indicates maximum pool depths of approximately one foot. Therefore, two feet of CSM above the culvert invert is adequate to protect the culvert from channel degradation.

Table 3 Channel Design

Bankfull Width (BFW) (ft)	18
Bank Height (ft)	2.5
Low Flow Channel Width (ft)	4
Low Flow Channel Depth (ft)	0.5
Culvert Streambed Material Depth (CSM)	2
Openness Ratio	0.4

Hydraulic analysis indicates that the proposed culvert functions similarly to the existing, due in part to the backwater effect from Watchic Lake and the flat channel slope at the outlet.

Hydraulic Analysis

VHB developed a hydraulic model using the Federal Highway Administration (FHWA) HY-8 software, version 7.50, to evaluate hydraulic performance of the proposed design. Hydraulic analysis included evaluation of the bankfull 1.1-year ($Q_{1.1}$), design discharge 50-year (Q_{50}), and check discharge 100-year (Q_{100}) flood events. VHB also evaluated the proposed design for low-flow conditions (represented by the annual median flow rate) to evaluate fish passage conditions. Flow discharge rates were sourced from the hydrologic analysis provided by MaineDOT.

HY-8 model geometry is based on topographic field survey performed by MaineDOT in July 2016, supplemented by structure geometry for the proposed VHB design. To account for backwater from Watchic Lake, VHB evaluated culvert hydraulic performance for two scenarios: a high-tailwater scenario associated with the typical summer water surface elevations, using surveyed WSEs from July (dam closed) as the basis for the tailwater condition, and a scenario assuming free discharge at the culvert outlet. A channel profile analysis was conducted using available survey data of approximately 400 feet downstream along channel thalweg to determine a typical channel slope for free discharge analysis. Survey data provides typical channel shape at the outlet. Results from both scenarios are presented here.

HY-8 model results are included at the end of this memorandum.

A summary of hydrologic and hydraulic data for the proposed design is presented in Tables 4 and 5 below.

Table 4 Hydraulic Data Summary for Existing and Proposed Design (Free Discharge)

	Existing Structure	Proposed 21 ft x 6 ft box culvert
Ordinary High Water (Q _{1.1}) (El.)	274.1	274.1
Discharge Velocity (Q _{1.1}) (ft/s)	1.3	1.2
Headwater Elevation (Q ₅₀)	275.2	275.2
Headwater Elevation (Q ₁₀₀)	275.4	275.4
Discharge Velocity (Q ₅₀) (ft/s)	2.5	2.4
Discharge Velocity (Q ₁₀₀) (ft/s)	2.7	2.5
Freeboard (Q ₅₀) (ft)	2.1	2.1
Freeboard (Q ₁₀₀) (ft)	1.7	1.7

Table 5 Hydraulic Data Summary for Existing and Proposed Design (Watchic Lake Backwater)

	Existing Structure	Proposed 21 ft x 6 ft box culvert
Ordinary High Water (Q _{1.1}) (El.)	275.1	275.1
Discharge Velocity (Q _{1.1}) (ft/s)	0.5	0.4
Headwater Elevation (Q ₅₀)	275.3	275.3
Headwater Elevation (Q ₁₀₀)	275.4	275.4
Discharge Velocity (Q ₅₀) (El.)	2.4	2.3
Discharge Velocity (Q ₁₀₀) (ft/s)	2.8	2.6
Freeboard (Q ₅₀) (ft)	2.2	2.2
Freeboard (Q ₁₀₀) (ft)	2.1	2.1

HY-8 model results indicate an HW/D ratio less than 0.9 and freeboard of at least 2.1 feet for the Q₅₀ design discharge, and 1.7 ft of freeboard for the Q₁₀₀ discharge. Backwater effects from Watchic Lake reduce flow velocities in the culvert and control headwater elevations during the lower frequency events. The proposed design approximates the vertical clearance of the existing structure but meets 1.2 x bankfull width and provides wildlife connectivity.

Scour Analysis

VHB estimated scour depths at the culvert outlet based on the methodologies presented in Hydraulic Engineering Circular (HEC) 14 (2006). Scour calculations are based on HY-8 model outputs for the Q100 design scour event and Q500 check scour event, supplemented by estimates of particle size. A summary of scour calculations is provided in Table 6 below; detailed scour calculations are provided at the end of this memorandum.

Table 6 Scour Analysis Results

	Q ₁₀₀ Design Scour Event	Q ₅₀₀ Check Scour Event
Discharge (cfs)	57	74.3
Maximum Total Downstream Scour (ft) ¹	2.3	2.6

Notes: 1.) Downstream scour calculated using HEC-14 Equation 5.1, culvert outlet scour in cohesionless soils. Scour analysis assumes a channel bed material standard deviation of 9.18 based on a Particle Sample Analysis provided by Nobis.

Scour analysis indicates the potential for up to 2.6 feet of scour at the culvert outlet. Scour calculations assume constricted flow; however, the proposed culvert is designed to meet 1.2 x bankfull width, which reduces the likelihood of substantial scour for smaller flood events. To mitigate scour potential, a plain riprap apron will be provided at the inlet and outlet as needed for the proposed grading. The apron will be buried with six inches of wetted in special fill as detailed in the Preliminary Plans to provide habitat connectivity.



Photo 1: View from bridge, looking south



Photo 2: View from bridge, looking north



Photo 3: Upstream fascia (August 2018)



Photo 4: Downstream fascia (August 2018)



Photo 5: View at outlet (October 2018)



Photo 6: View at Inlet (October 2018)

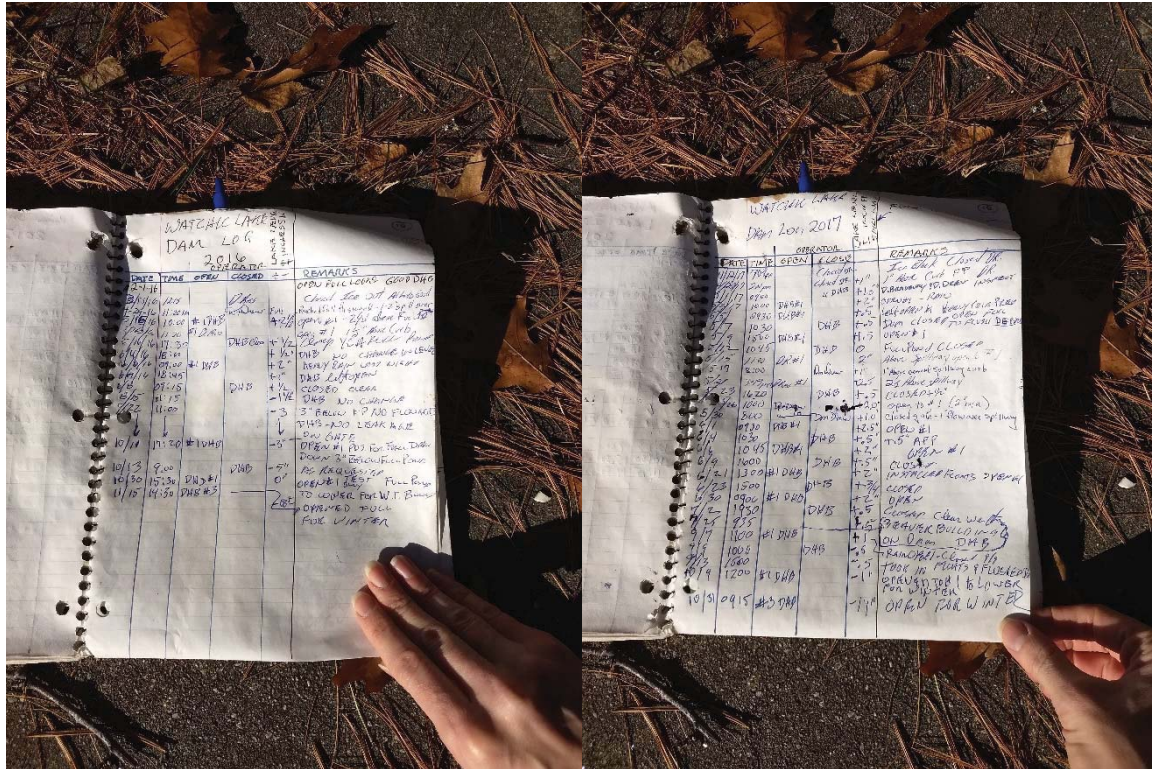


Photo 7: 2016 and 2017 Dam Records



Photo 8: Watchic Lake Dam

WIN:	21703.00
Town:	Standish
Route No.	Rt 113
Asset ID:	2914
Lat:	43.7502
	Long: -70.61110

Project Name:	Standish 21703 Watchic Bridge
Stream Name:	Page Brook
Bridge Name:	Watchic
Analysis by:	DFB
Date:	10/5/2017

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

Enter data in blue cells only!

	km ²	mi ²	ac
A	1.30	0.50	320.0
W	0.27	0.1	66.9

P _c	370793	4845707
County	Cumberland NW	
pptA	43.4	
SG	0.18	

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

A (km ²)	1.30
W (%)	20.92
Conf Lvl	0.67

NWI Wetlands % STORNWI

Worksheet prepared by:
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ver. 2017 Jun. 09

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

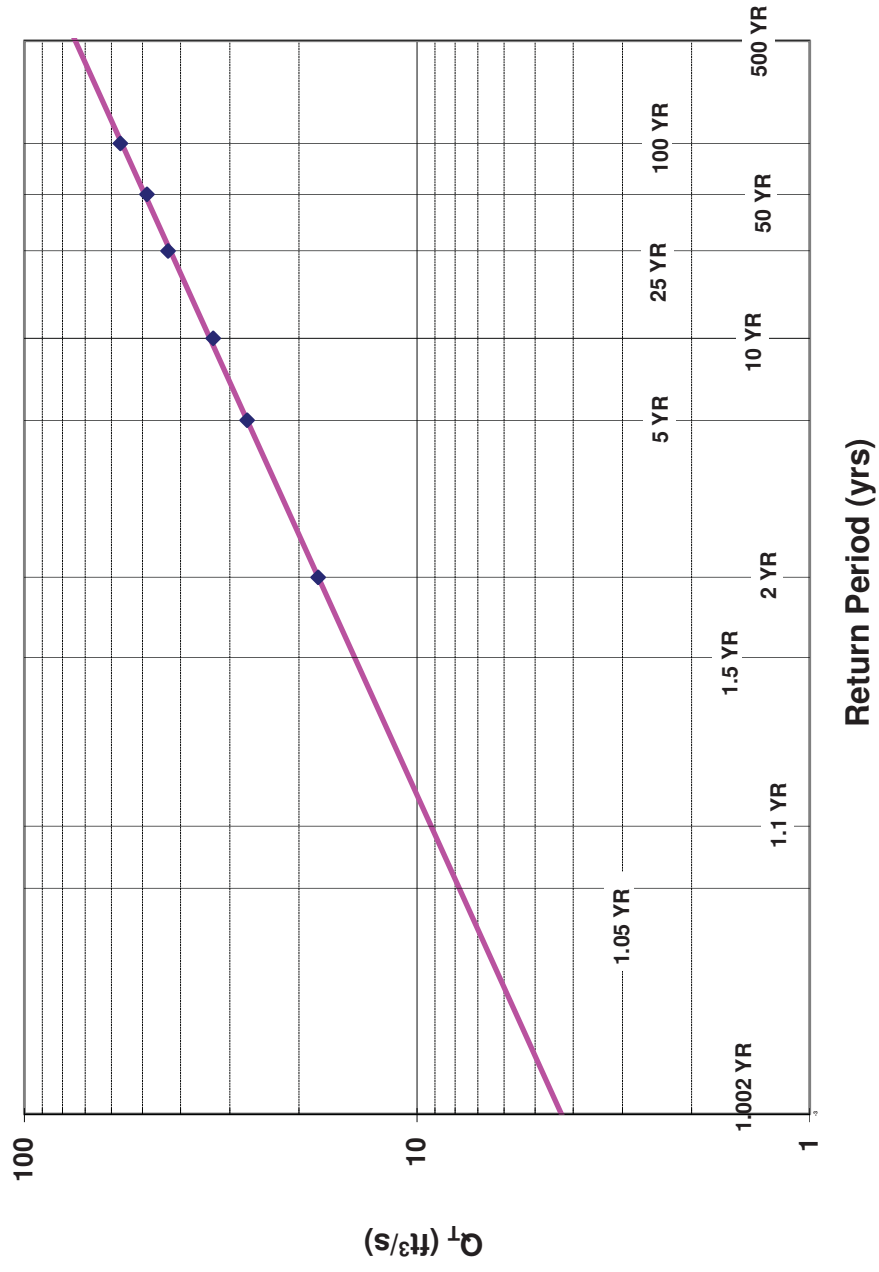
Lombard, P.J. & G.A. Hodgkins, 2015.
Peak flow regression equations for small, ungaged streams in
Maine - Comparing map-based to field-based variables
SIR 2015-4059, USGS, Augusta, ME

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

Ret Pd	Peak Flow Estimate	Lower	Upper
T (yr)	Q _T (m ³ /s)		
1.1	0.26		
2	0.51		
5	0.77		
10	0.94		
25	1.22		
50	1.38		
100	1.61		
500	2.10		

Q _T (ft ³ /s)
9.2
17.9
27.1
33.1
43.1
48.8
57.0
74.3

Log-Normal Probability Plot



WIN:	21703.00
Town:	Standish
Route No.	Rt 113
Asset ID:	2914
Lat:	43.75017
Long:	-70.61110

Project Name:	Standish 21703 Watchic Bridge
Stream Name:	Page Brook
Bridge Name:	Watchic
Analysis by:	DFB
Date:	10/5/2017

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
0.50	A	Area (mi ²)
370793.4	P _c	Watershed centroid (E,N; UTM; Zone 19; meters)
48.53	DIST	Distance from Coastal reference line (mi)
43.4	pptA	Mean Annual Precipitation (inches)
0.18	SG	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q _{median} (ft ³ /s)	(m ³ /s)
Jan	0.52	0.0149
Feb	0.57	0.0162
Mar	1.09	0.0309
Apr	1.85	0.0524
May	0.75	0.0212
Jun	0.35	0.0099
Jul	0.14	0.0041
Aug	0.12	0.0034
Sep	0.13	0.0037
Oct	0.23	0.0065
Nov	0.61	0.0173
Dec	0.82	0.0232

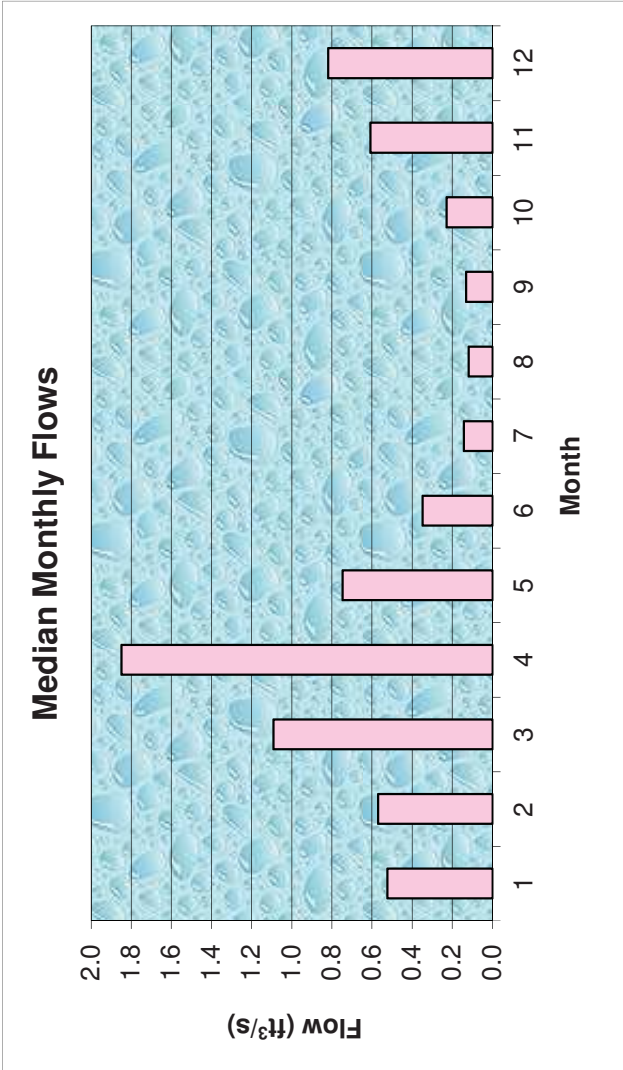
Q _{bf}	2.5
ann avg	1.0
ann med	0.5
Q _{1,002}	4.3
Q _{1,01}	5.6
Q _{1,05}	7.8
Q _{bf}	14.7

assume v = 4ft/s

W _{bf}	7.9
d _{bf}	0.5
A _{bf}	2.5

References

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



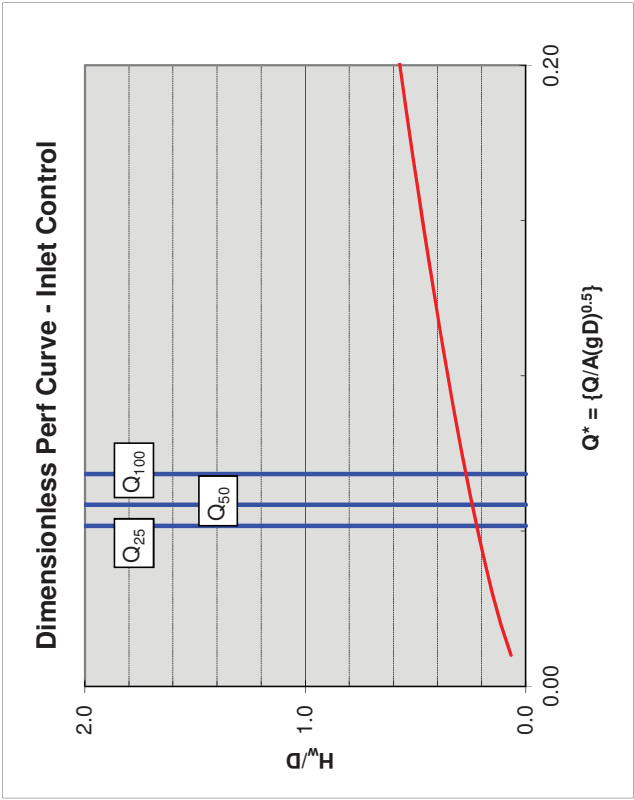
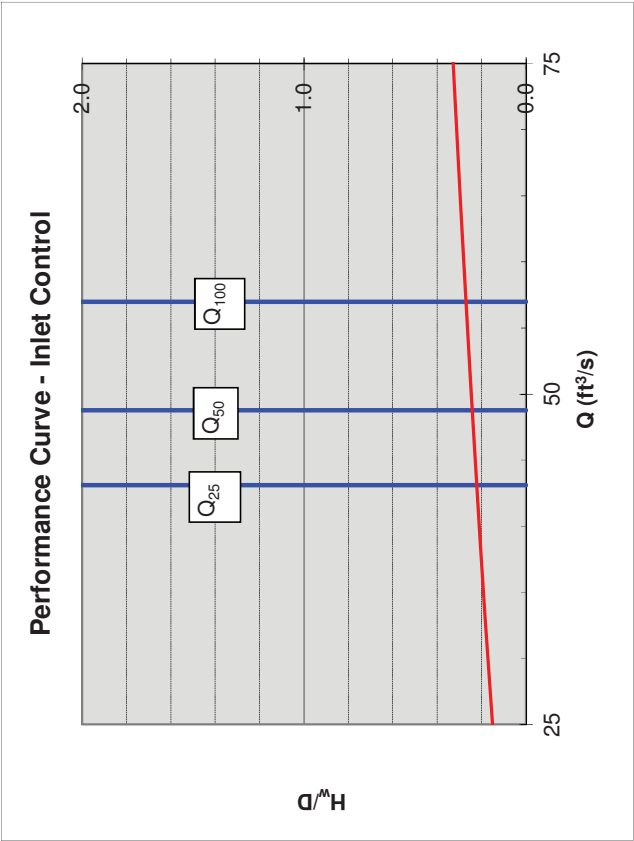
NOTE:

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

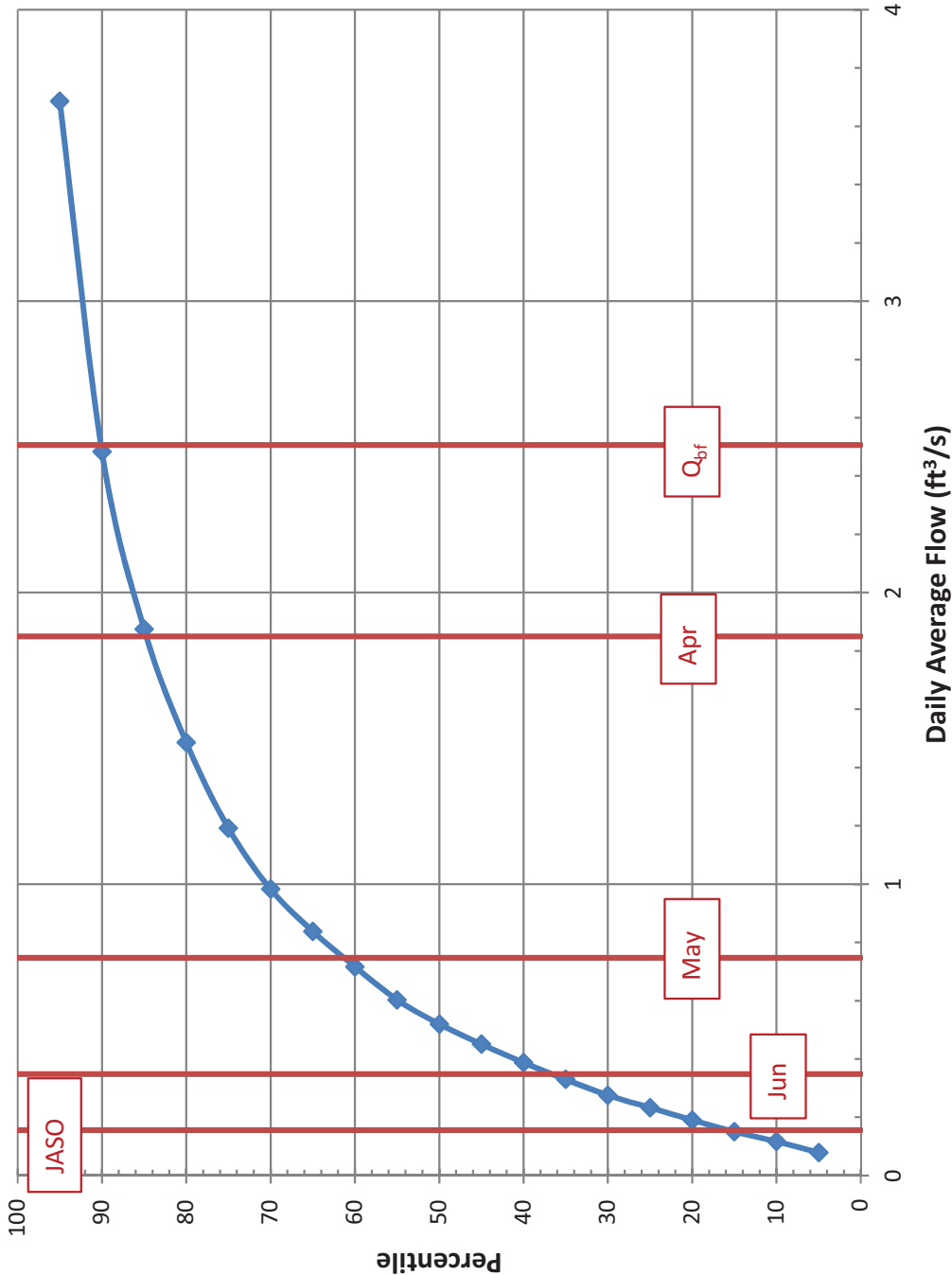
Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box		
Type:	Box 0 ww	Q ₂₅	43.1
D or R (ft)	6	Q ₅₀	48.8
w (ft)	10	Q ₁₀₀	57.0
Slope (ft/ft)	0.02	box width	
A (ft ²)	60.00	trial D / R =	
g (ft/s ²)	32.2	trial w: BFW =	

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

$A_{w/s} = (mi^2)$

Q (ft³/s)

Pctl	Median	84 th pctl
5	0.08	0.13
10	0.12	0.18
15	0.15	0.22
20	0.19	0.27
25	0.23	0.31
30	0.28	0.36
35	0.33	0.41
40	0.39	0.47
45	0.45	0.53
50	0.52	0.62
55	0.60	0.73
60	0.72	0.85
65	0.84	0.99
70	0.98	1.16
75	1.19	1.39
80	1.49	1.66
85	1.88	2.13
90	2.48	2.86
95	3.69	4.45

Q_{bf}

$Q_{1.002}$

$Q_{1.1}$

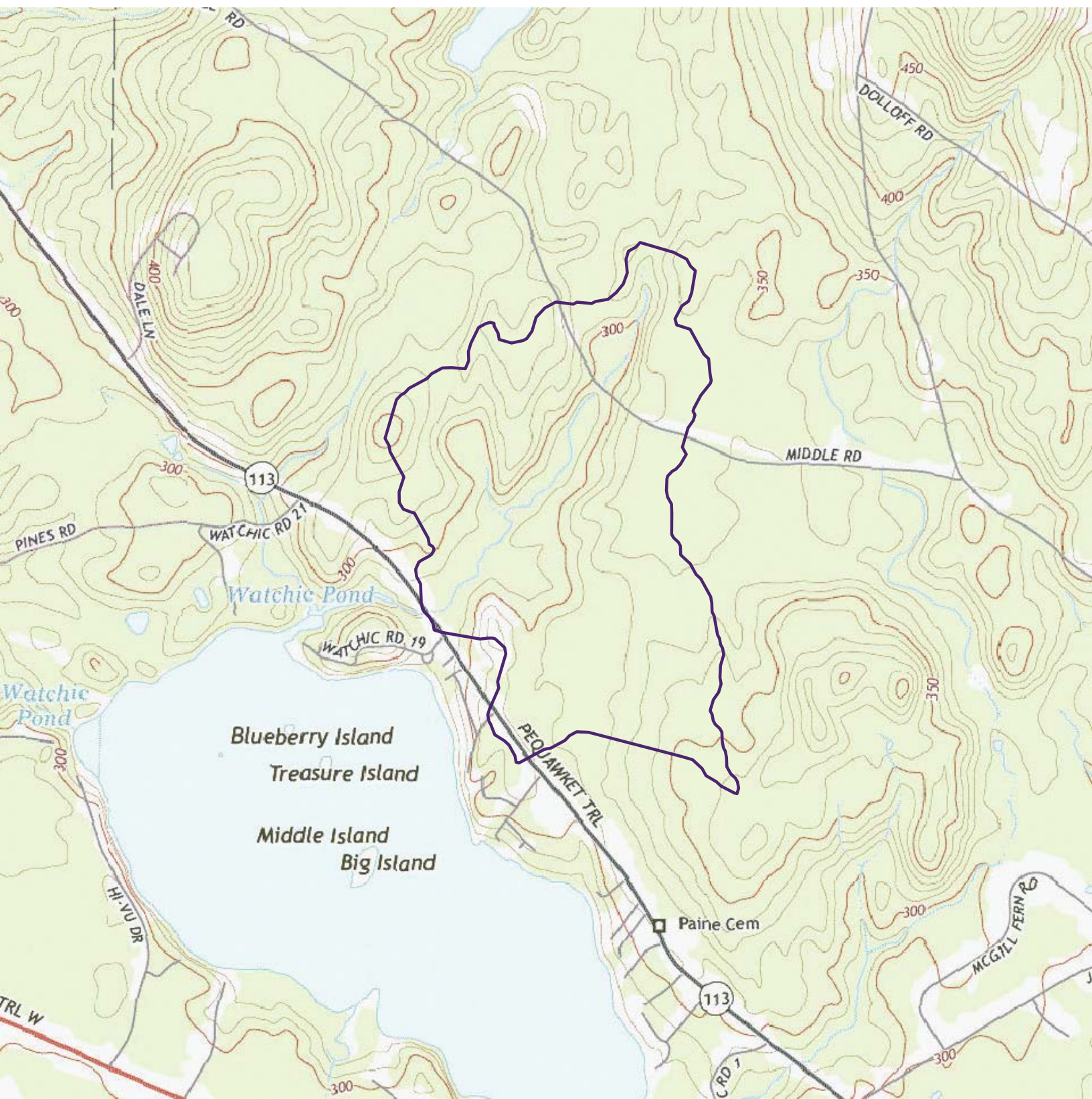
Q_2

2.5

4.3

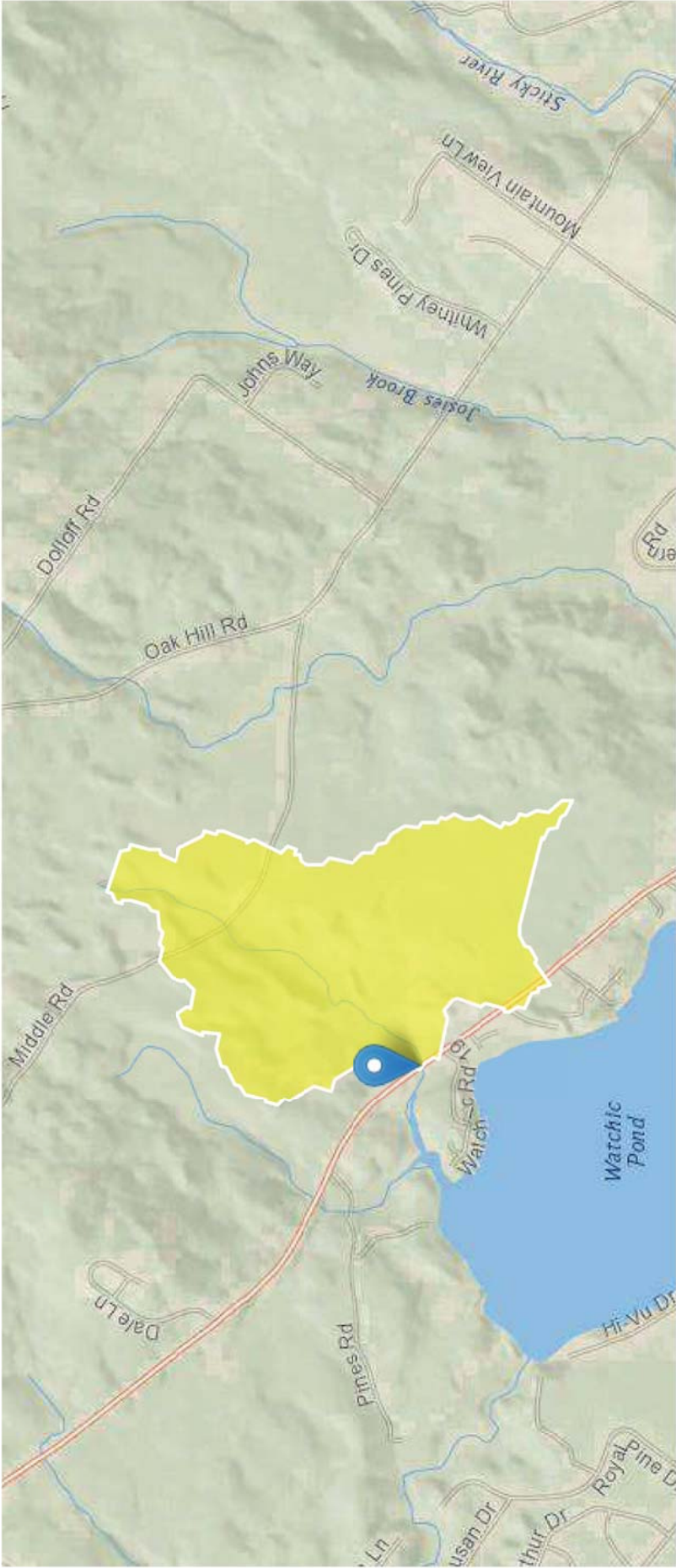
9.2

17.9



Standish 21703 Watchic Bridge

Region ID: ME
Workspace ID: ME20171005191736111000
Clicked Point (Latitude, Longitude): 43.75017, -70.61110
Time: 2017-10-05 15:17:55 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.5	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory	20.92	percent

Parameter Code	Parameter Description	Value	Unit
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0.176	dimensionless
ELEV	Mean Basin Elevation	316.8	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	4.91	percent
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	370793.41	
CENTROIDY	Basin centroid vertical (y) location in state plane units	4845706.92	
COASTDIST	Shortest distance from the coastline to the basin centroid	49	miles
ELEVMAX	Maximum basin elevation	368.6	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	3.45	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.6	percent
PRECIP	Mean Annual Precipitation	45	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	17.58	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	63	percent

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.5	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	2.51	ft^3/s
Bankfull Width	5.35	ft

Statistic	Value	Unit
Bankfull Depth	0.469	ft
Bankfull Area	2.51	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	0.5	square miles	0.31	12
STORNWI	Percentage of Storage from NWI	20.92	percent	0	22.2

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

PLI: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEP: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEP
1.01 Year Peak Flood	5.88	ft^3/s	38
2 Year Peak Flood	17.8	ft^3/s	34
5 Year Peak Flood	27.1	ft^3/s	35
10 Year Peak Flood	33	ft^3/s	37
25 Year Peak Flood	43.1	ft^3/s	39
50 Year Peak Flood	48.7	ft^3/s	41
100 Year Peak Flood	57	ft^3/s	42
250 Year Peak Flood	62.6	ft^3/s	44
500 Year Peak Flood	74.2	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>)

Low-Flow Statistics Parameters [Statewide LowFlow SIR 2004 5026]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.5	square miles	9.79	1418
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.176	dimensionless	0	0.455

Low-Flow Statistics Disclaimers [Statewide LowFlow SIR 2004 5026]

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

Low-Flow Statistics Flow Report [Statewide LowFlow SIR 2004 5026]

Statistic	Value	Unit
7 Day 10 Year Low Flow	0.0286	ft^3/s

Low-Flow Statistics Citations

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

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

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.5	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.176	dimensionless	0	0.212
ELEV	Mean Basin Elevation	316.8	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	0.00353	ft^3/s
5 Percent Duration	0.0151	ft^3/s
10 Percent Duration	0.0368	ft^3/s
25 Percent Duration	0.176	ft^3/s
50 Percent Duration	0.608	ft^3/s
75 Percent Duration	1.39	ft^3/s
90 Percent Duration	2.9	ft^3/s
95 Percent Duration	4.53	ft^3/s
99 Percent Duration	13.5	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>)

Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.5	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.176	dimensionless	0	0.212
ELEV	Mean Basin Elevation	316.8	feet	239	2120

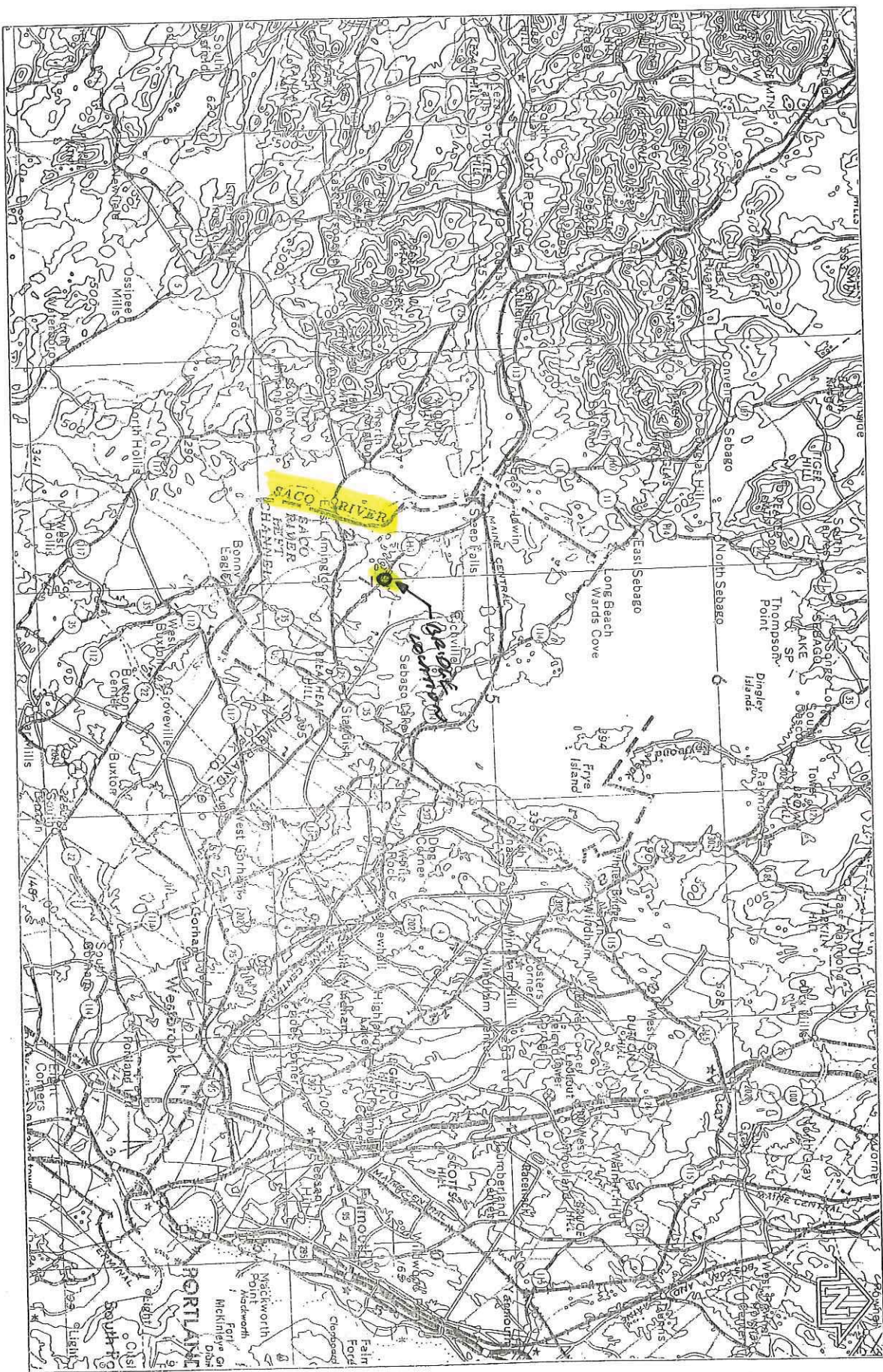
Annual Flow Statistics Disclaimers [Statewide Annual SIR 2015 5151]

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
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Statistic	Value	Unit
Mean Annual Flow	1.31	ft ³ /s
<i>Annual Flow Statistics Citations</i>		
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)		

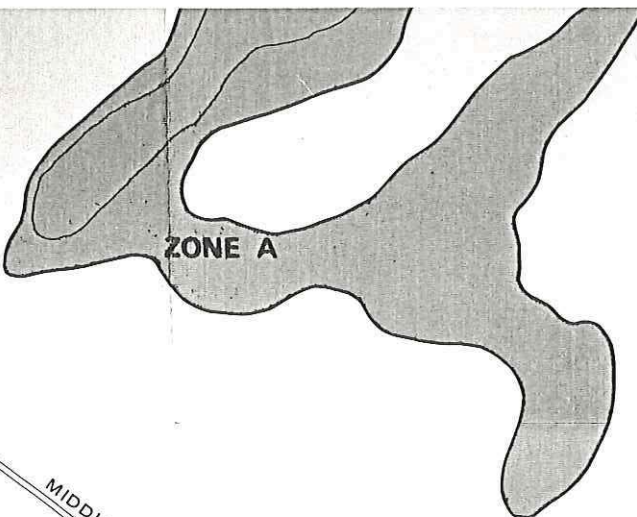


FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF STANDISH, ME (CUMBERLAND CO.)

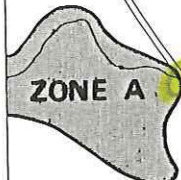


VICINITY MAP



MIDDLE

ROAD



ZONE A

113

WATCHIC
BRIDGE
#2914

PAGE BROOK
Flow

ACCESS

ROAD



ZONE A
WATCHIC POND

ZONE C

STANDISH WATCHILL KICK OFF MEETING

- 18' B.F WIDTH ✓
- STRUCTURE 112 x 18' = 21.2' say 21' ✓
- Box Culvert structure open on buried bottom.
natural stream bed ✓
- TEMP DETOUR - DOWNSTREAM SIDE ✓
- Material done in 2014 the existing fascia has been done (Donnie)
the frame face had a face lift. Damage was extensive prior
to face lift of FRAME FACIA.
- NO ISSUE with traffic down to one lane, DOWN TO 1 LANE 4 WEEKS
- Additional survey may be needed ✓
- Geotesting two shallow borings, deep loose soil, coarse sand, gravel
expected. ✓

September 30th PDR

NO FLOODING issue according to Donnie (BRIDGE MAINTENANCE MANAGER)

- RAIL MOUNTED ON FRAME HEAD WALLS.
- UTILITY on upstream side. underground utilities are unexpected.
need to verify utilities.
- Will coordinate traffic control method. high traffic area
and accidents mostly because of deer.
- Deer presence area & TURTLE Buried ground
- 4-5 Month for PDR
- Most likely widen Bridge so that shoulders will match
approaches.

MaineDOT

MaineDOT

Naous, Roger

From: Chamberlain, Kristen
Sent: Tuesday, May 30, 2017 11:16 AM
To: Kittredge, Joel; Naous, Roger
Subject: Standish 21703.00

Hi-

I have a conflict with the Standish, Watchic Bridge Initial Team Meeting. Here are the ENV points of interest-

1. Bankfull Width: 18 feet.
2. Documented presence of State Endangered Turtles. Project will need to incorporate turtle passage (that means 1.2 BFW structure with banks high enough to stay dry and possibly some fencing -see Lyman Bartlett (WIN 21857.00) and Standish Station Bridge (WIN 18947.00) for guidance and let's meet once preliminary design gets underway). We may also need to coordinate with (state) IF&W to avoid take of turtles during construction.
3. Expect summer in-water work window (July 15-September 30)
4. No historic or cultural resources identified.
5. Hazardous waste review in progress.

Please let me know if you have any questions.

Thanks,
Kristen

*Kristen Chamberlain
Bridge, Multi Modal and Traffic Team Leader
Environmental Office
Maine Department of Transportation
(207) 557-5089
(207) 624-3101 Fax*

STANDISH - WATCHIC

8:00 am

5/27/16 DRIZZLING

- POSTED SPEED : 50 mph
- Property on N.W. corner is for sale
- Narrows @ bridge
- N. approach
~~6' shoulders / no g/r~~ west side : 12' & 5' t.w./s.
- S. approach
12' & 5' t.w./s.
- Bridge ~ 27'-6" curb-curb
- Guardrail flattened in most places by plows;
typ. 2'-6" from pavement (t.o. post)
- Wide flat floodplains
- Downstream, joins a ponded section behind
old restaurant and widens out considerably
- Survey some of side roads and back of
restaurant area

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Existing Standish Watchic Bridge

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
275.11	Q1.1	9.20	9.20	0.00	1
275.13	Q2	17.90	17.90	0.00	1
275.16	Q5	27.10	27.10	0.00	1
275.19	Q10	33.10	33.10	0.00	1
275.25	Q25	43.10	43.10	0.00	1
275.29	Q50	48.80	48.80	0.00	1
275.35	Q100	57.00	57.00	0.00	1
275.52	Q500	74.30	74.30	0.00	1
281.50	Overtopping	487.41	487.41	0.00	Overtopping

Rating Curve Plot for Crossing: Existing Standish Watchic Bridge (wDam)

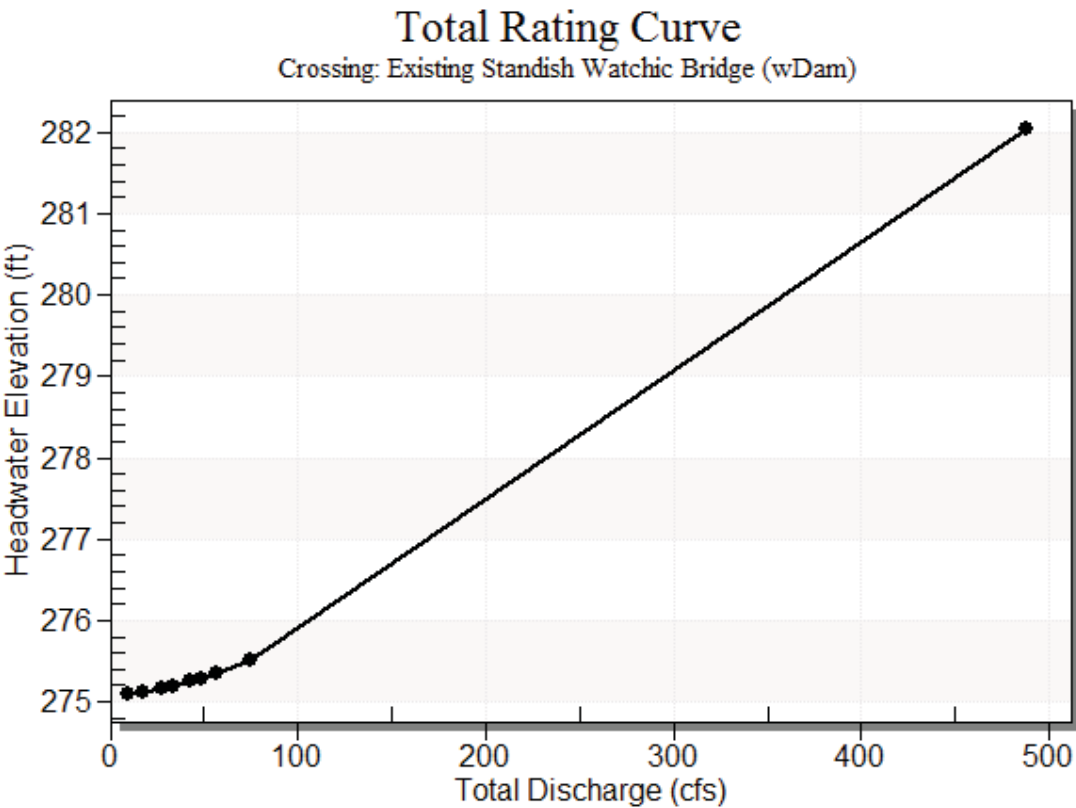
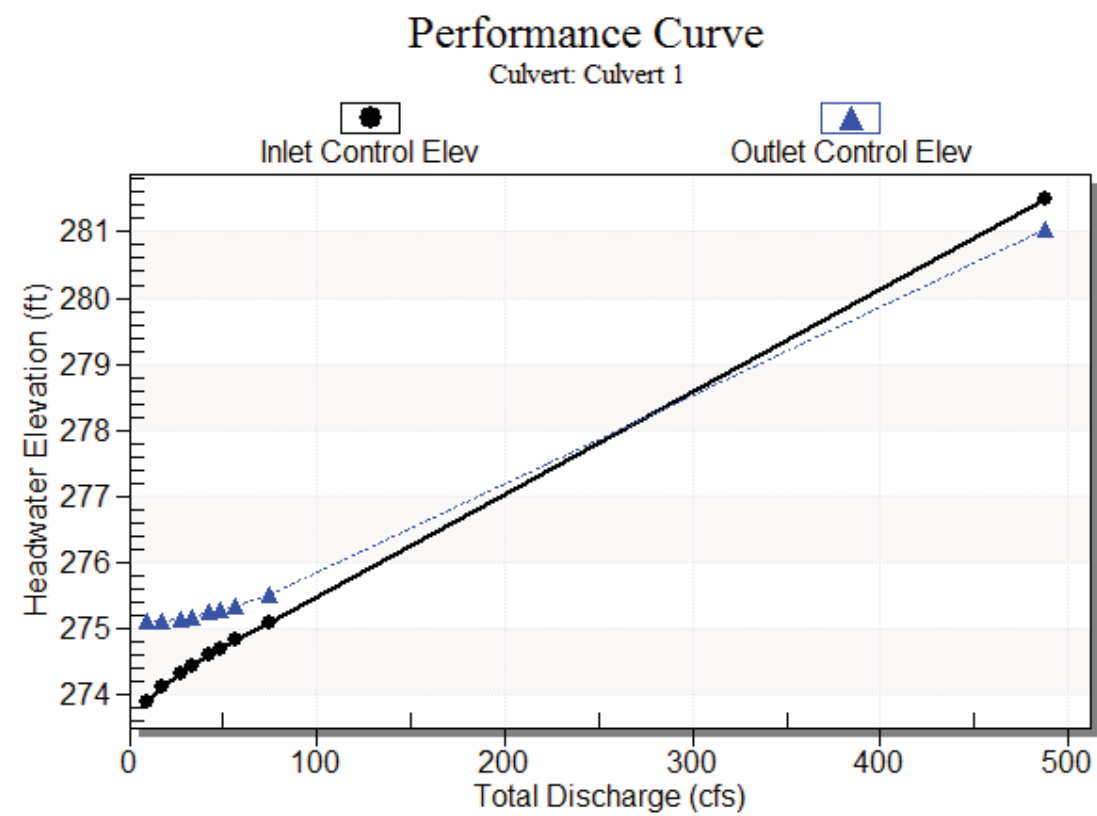


Table 2 - Culvert Summary Table: Culvert 1

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)
Q1.1	9.20	9.20	275.11	0.389	1.607	3-M1t	0.489	0.257	1.700	1.700	0.451
Q2	17.90	17.90	275.13	0.616	1.626	3-M1t	0.730	0.402	1.700	1.700	0.877
Q5	27.10	27.10	275.16	0.812	1.659	3-M1t	0.936	0.534	1.700	1.700	1.328
Q10	33.10	33.10	275.19	0.928	1.688	3-M1t	1.056	0.613	1.700	1.700	1.623
Q25	43.10	43.10	275.25	1.106	1.747	3-M1t	1.237	0.744	1.700	1.700	2.113
Q50	48.80	48.80	275.29	1.202	1.788	3-M1t	1.333	0.807	1.700	1.700	2.392
Q100	57.00	57.00	275.35	1.333	1.854	3-M1t	1.463	0.893	1.700	1.700	2.794
Q500	74.30	74.30	275.52	1.590	2.019	3-M2t	1.715	1.067	1.700	1.700	3.642

Straight Culvert
Inlet Elevation (invert): 273.50 ft, Outlet Elevation (invert): 273.40 ft
Culvert Length: 35.00 ft, Culvert Slope: 0.0029

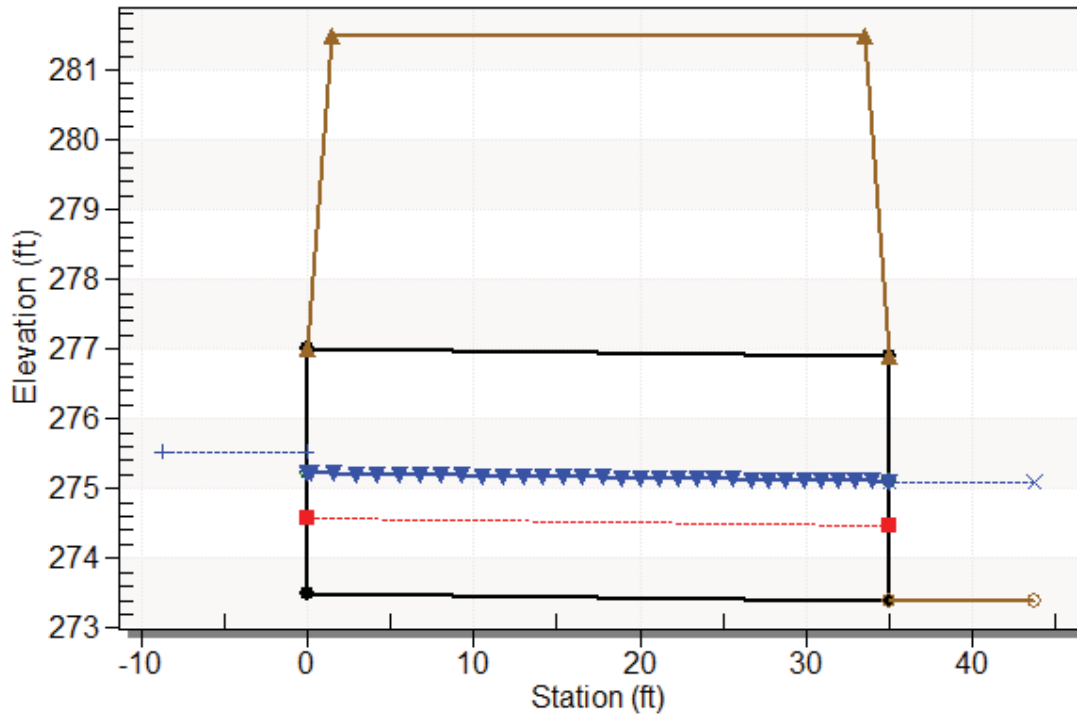
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Existing Standish Watchic Bridge (wDam), Design Discharge - 74.3 cfs

Culvert - Culvert 1, Culvert Discharge - 74.3 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 273.50 ft

Outlet Station: 35.00 ft

Outlet Elevation: 273.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 12.00 ft

Barrel Rise: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0330 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Existing Standish Watchic Bridge)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
9.20	275.10	1.70
17.90	275.10	1.70
27.10	275.10	1.70
33.10	275.10	1.70
43.10	275.10	1.70
48.80	275.10	1.70
57.00	275.10	1.70
74.30	275.10	1.70

Tailwater Channel Data - Existing Standish Watchic Bridge (wDam)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 275.10 ft

Roadway Data for Crossing: Existing Standish Watchic Bridge (wDam)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 281.50 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 4 - Summary of Culvert Flows at Crossing: Existing Standish Watchic Bridge

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
274.10	Q1.1	9.20	9.20	0.00	1
274.42	Q2	17.90	17.90	0.00	1
274.69	Q5	27.10	27.10	0.00	1
274.85	Q10	33.10	33.10	0.00	1
275.10	Q25	43.10	43.10	0.00	1
275.23	Q50	48.80	48.80	0.00	1
275.40	Q100	57.00	57.00	0.00	1
275.75	Q500	74.30	74.30	0.00	1
281.50	Overtopping	387.51	387.51	0.00	Overtopping

Rating Curve Plot for Crossing: Existing Standish Watchic Bridge (w/oDam)

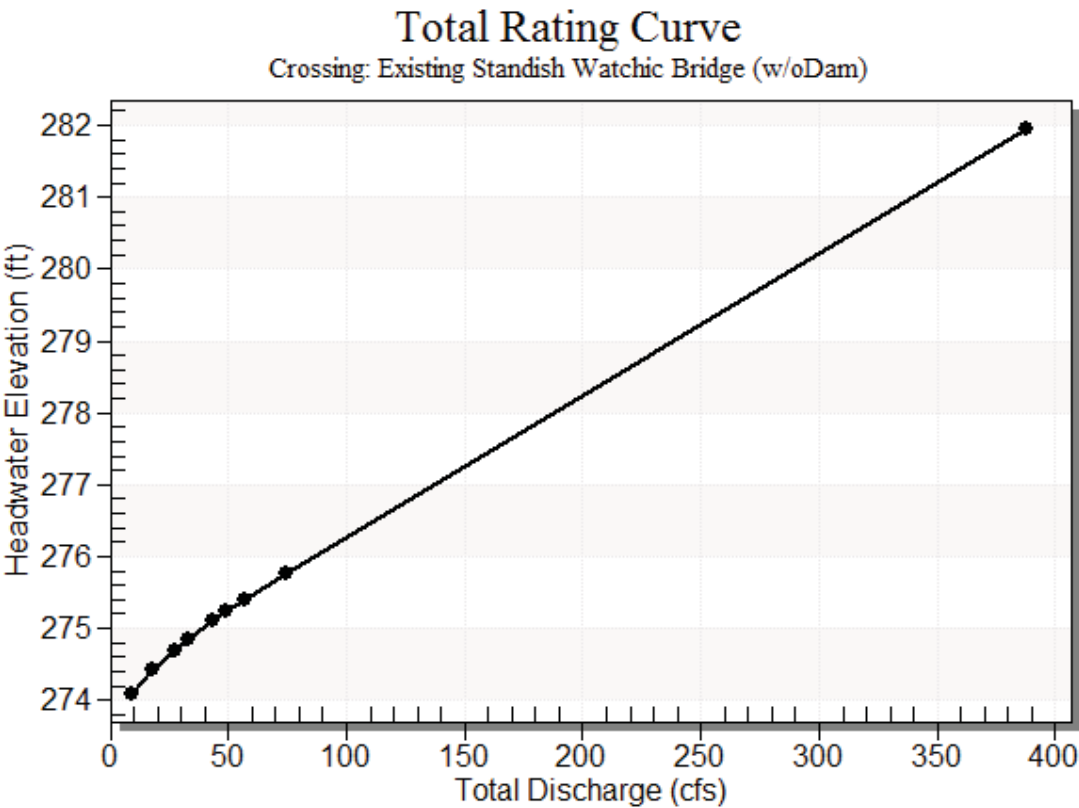
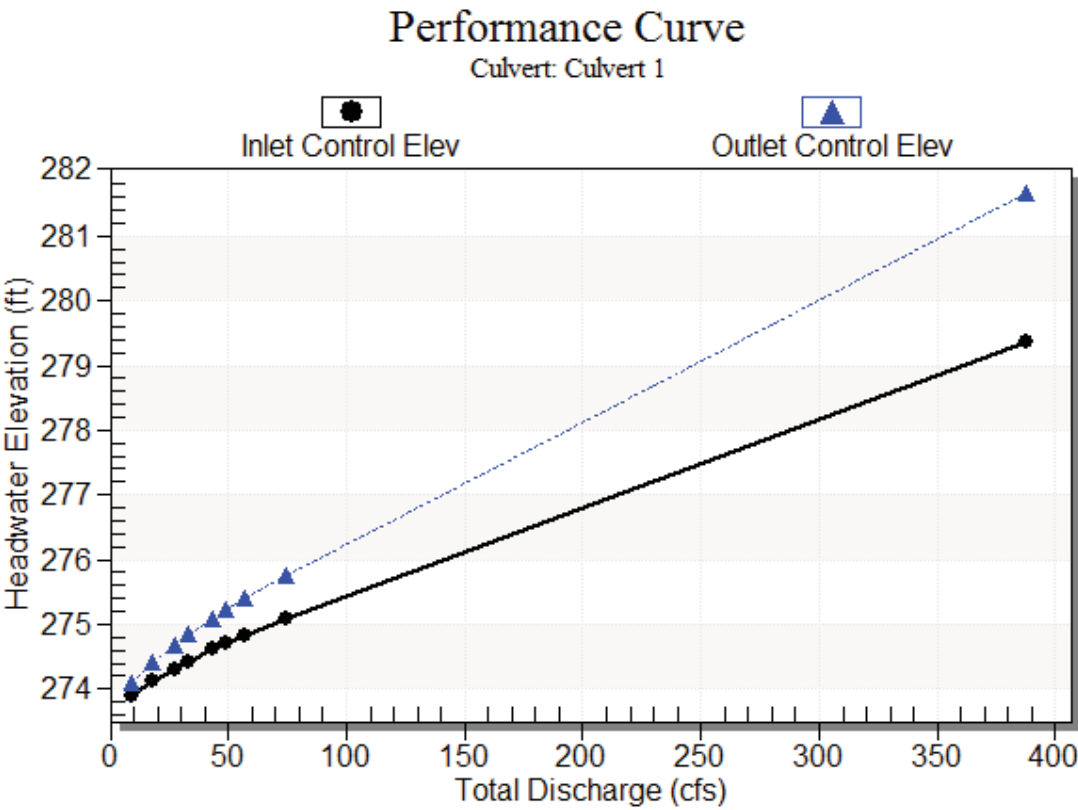


Table 5 - Culvert Summary Table: Culvert 1

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)
Q1.1	9.20	9.20	274.10	0.389	0.599	3-M1t	0.489	0.257	0.593	0.593	1.293
Q2	17.90	17.90	274.42	0.616	0.916	3-M1t	0.730	0.402	0.884	0.884	1.687
Q5	27.10	27.10	274.69	0.812	1.191	3-M1t	0.936	0.534	1.135	1.135	1.990
Q10	33.10	33.10	274.85	0.928	1.352	3-M1t	1.056	0.613	1.280	1.280	2.156
Q25	43.10	43.10	275.10	1.106	1.597	3-M1t	1.237	0.744	1.499	1.499	2.396
Q50	48.80	48.80	275.23	1.202	1.726	3-M1t	1.333	0.807	1.615	1.615	2.518
Q100	57.00	57.00	275.40	1.333	1.903	3-M1t	1.463	0.893	1.773	1.773	2.680
Q500	74.30	74.30	275.75	1.590	2.253	3-M1t	1.715	1.067	2.077	2.077	2.982

Straight Culvert
Inlet Elevation (invert): 273.50 ft, Outlet Elevation (invert): 273.40 ft
Culvert Length: 35.00 ft, Culvert Slope: 0.0029

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 273.50 ft

Outlet Station: 35.00 ft

Outlet Elevation: 273.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 12.00 ft

Barrel Rise: 3.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0330 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Existing Standish Watchic

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.20	273.99	0.59	0.83	0.03	0.19
17.90	274.28	0.88	1.07	0.04	0.21
27.10	274.53	1.13	1.25	0.05	0.21
33.10	274.68	1.28	1.34	0.06	0.22
43.10	274.90	1.50	1.47	0.07	0.22
48.80	275.02	1.62	1.54	0.07	0.22
57.00	275.17	1.77	1.63	0.08	0.22
74.30	275.48	2.08	1.78	0.09	0.23

Tailwater Channel Data - Existing Standish Watchic Bridge (w/oDam)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 18.00 ft

Side Slope (H:V): 1.00 (1:1)

Channel Slope: 0.0007

Channel Manning's n: 0.0320

Channel Invert Elevation: 273.40 ft

Roadway Data for Crossing: Existing Standish Watchic Bridge (w/oDam)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 281.50 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 7 - Summary of Culvert Flows at Crossing: Standish Watchic Bridge (wDam)

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
275.11	Q1.1	9.20	9.20	0.00	1
275.13	Q2	17.90	17.90	0.00	1
275.16	Q5	27.10	27.10	0.00	1
275.19	Q10	33.10	33.10	0.00	1
275.25	Q25	43.10	43.10	0.00	1
275.29	Q50	48.80	48.80	0.00	1
275.36	Q100	57.00	57.00	0.00	1
275.52	Q500	74.30	74.30	0.00	1
281.50	Overtopping	749.29	749.29	0.00	Overtopping

Rating Curve Plot for Crossing: Standish Watchic Bridge (wDam)

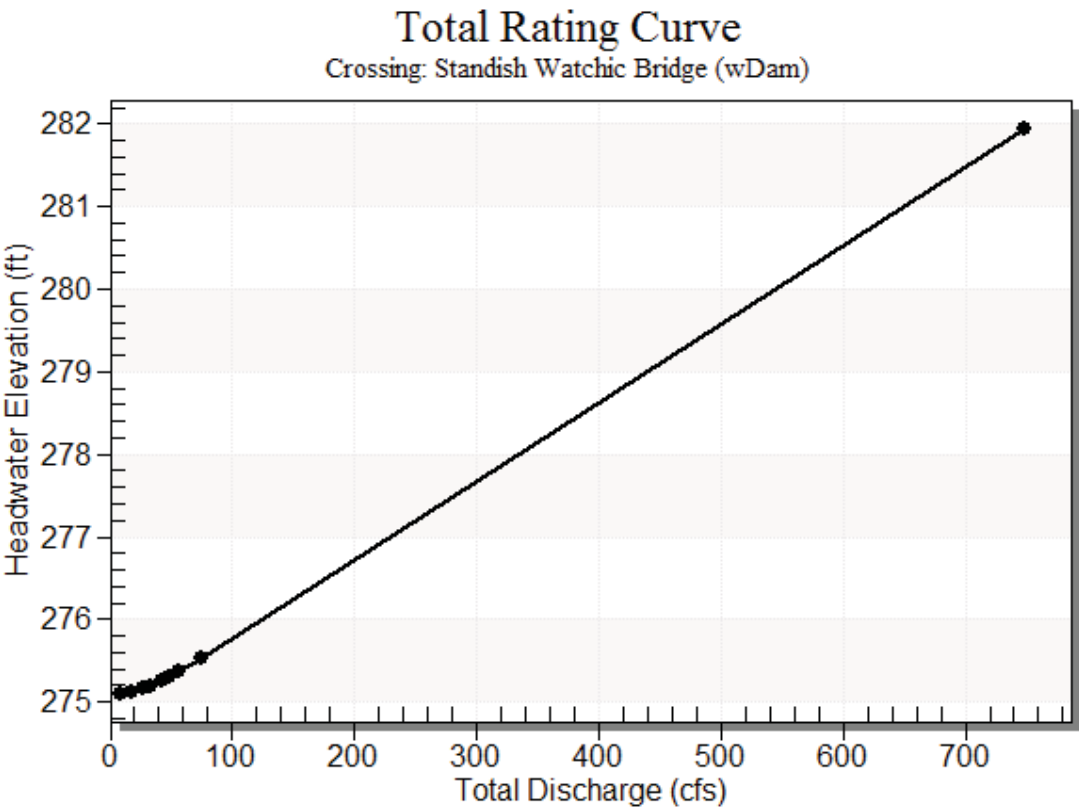
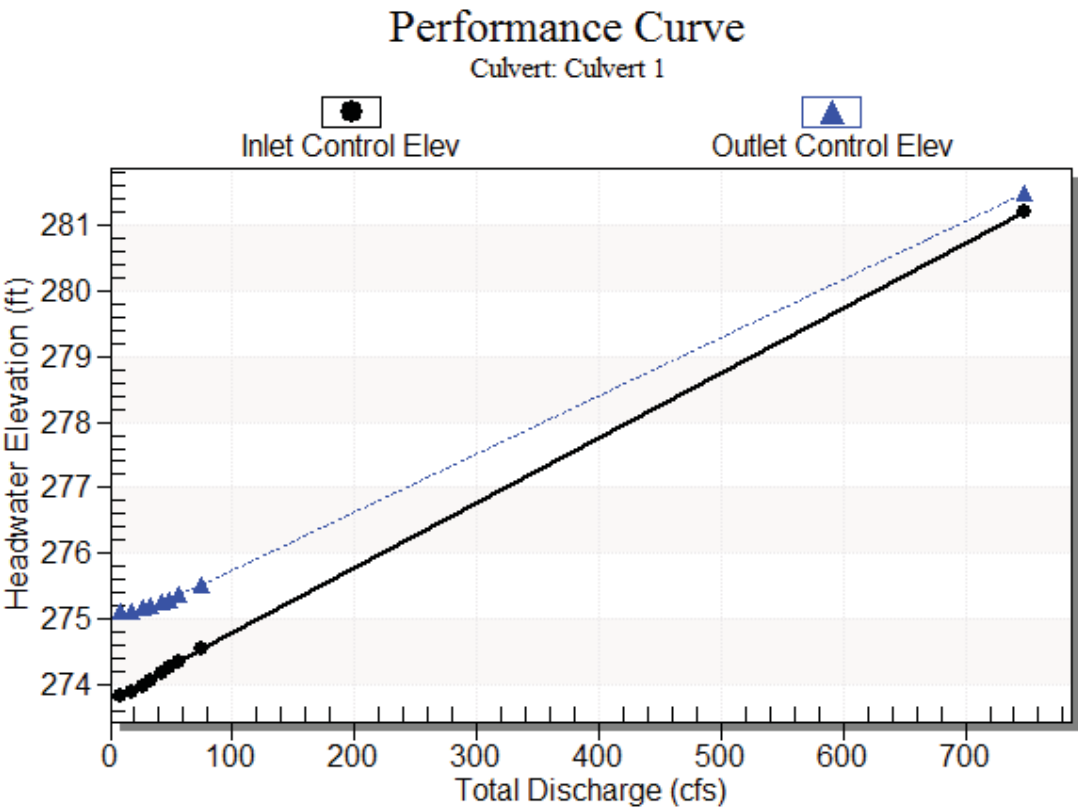


Table 8 - Culvert Summary Table: Culvert 1

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)
Q1.1	9.20	9.20	275.11	0.816	2.107	3-M1t	0.924	0.623	2.200	1.200	0.425
Q2	17.90	17.90	275.13	0.891	2.127	3-M1t	1.222	0.789	2.200	1.200	0.827
Q5	27.10	27.10	275.16	0.952	2.161	3-M1t	1.478	0.932	2.200	1.200	1.252
Q10	33.10	33.10	275.19	1.040	2.191	3-M1t	1.625	1.017	2.200	1.200	1.530
Q25	43.10	43.10	275.25	1.174	2.252	3-M1t	1.847	1.148	2.200	1.200	1.992
Q50	48.80	48.80	275.29	1.245	2.293	3-M1t	1.964	1.217	2.200	1.200	2.255
Q100	57.00	57.00	275.36	1.343	2.359	3-M1t	2.121	1.312	2.200	1.200	2.634
Q500	74.30	74.30	275.52	1.530	2.521	3-M2t	2.424	1.493	2.200	1.200	3.433

Straight Culvert
Inlet Elevation (invert): 273.00 ft, Outlet Elevation (invert): 272.90 ft
Culvert Length: 45.00 ft, Culvert Slope: 0.0022

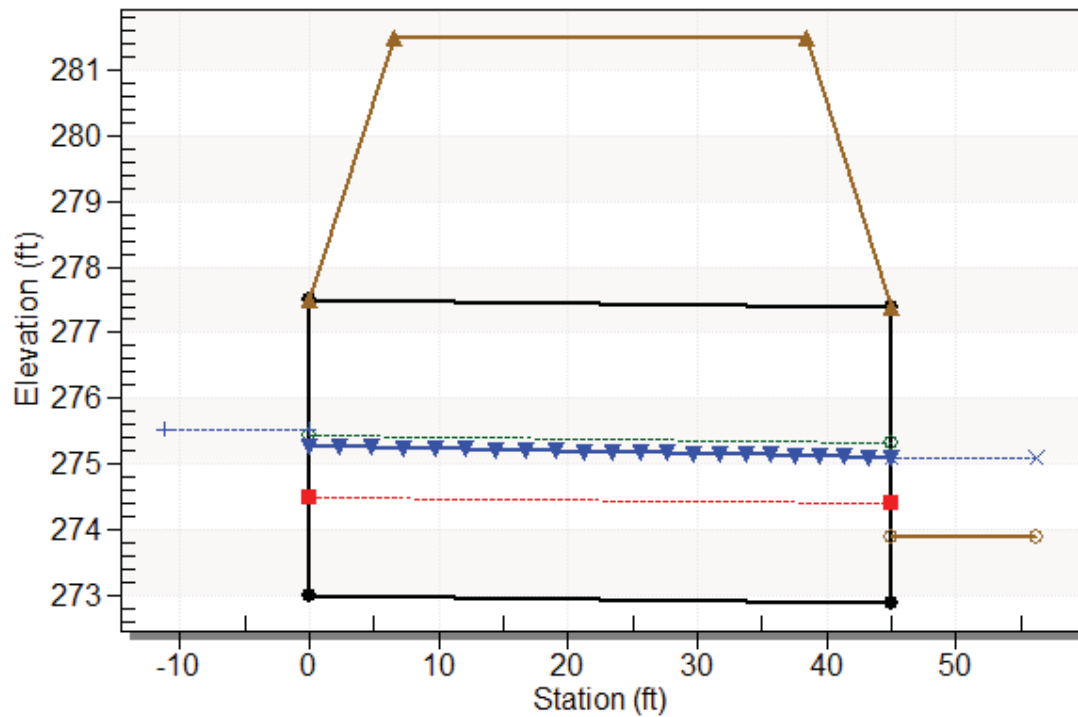
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Standish Watchic Bridge (wDam), Design Discharge - 74.3 cfs

Culvert - Culvert 1, Culvert Discharge - 74.3 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 273.00 ft

Outlet Station: 45.00 ft

Outlet Elevation: 272.90 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 21.00 ft

Barrel Rise: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

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

Manning's n: 0.0330 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

**Table 9 - Downstream Channel Rating Curve (Crossing: Standish Watchic Bridge
(wDam**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
9.20	275.10	1.20
17.90	275.10	1.20
27.10	275.10	1.20
33.10	275.10	1.20
43.10	275.10	1.20
48.80	275.10	1.20
57.00	275.10	1.20
74.30	275.10	1.20

Tailwater Channel Data - Standish Watchic Bridge (wDam)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 275.10 ft

Roadway Data for Crossing: Standish Watchic Bridge (wDam)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 281.50 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 10 - Summary of Culvert Flows at Crossing: Standish Watchic Bridge (w/oDam)

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
274.08	Q1.1	9.20	9.20	0.00	1
274.41	Q2	17.90	17.90	0.00	1
274.69	Q5	27.10	27.10	0.00	1
274.86	Q10	33.10	33.10	0.00	1
275.10	Q25	43.10	43.10	0.00	1
275.23	Q50	48.80	48.80	0.00	1
275.41	Q100	57.00	57.00	0.00	1
275.74	Q500	74.30	74.30	0.00	1
281.50	Overtopping	495.90	495.90	0.00	Overtopping

Rating Curve Plot for Crossing: Standish Watchic Bridge (w/oDam)

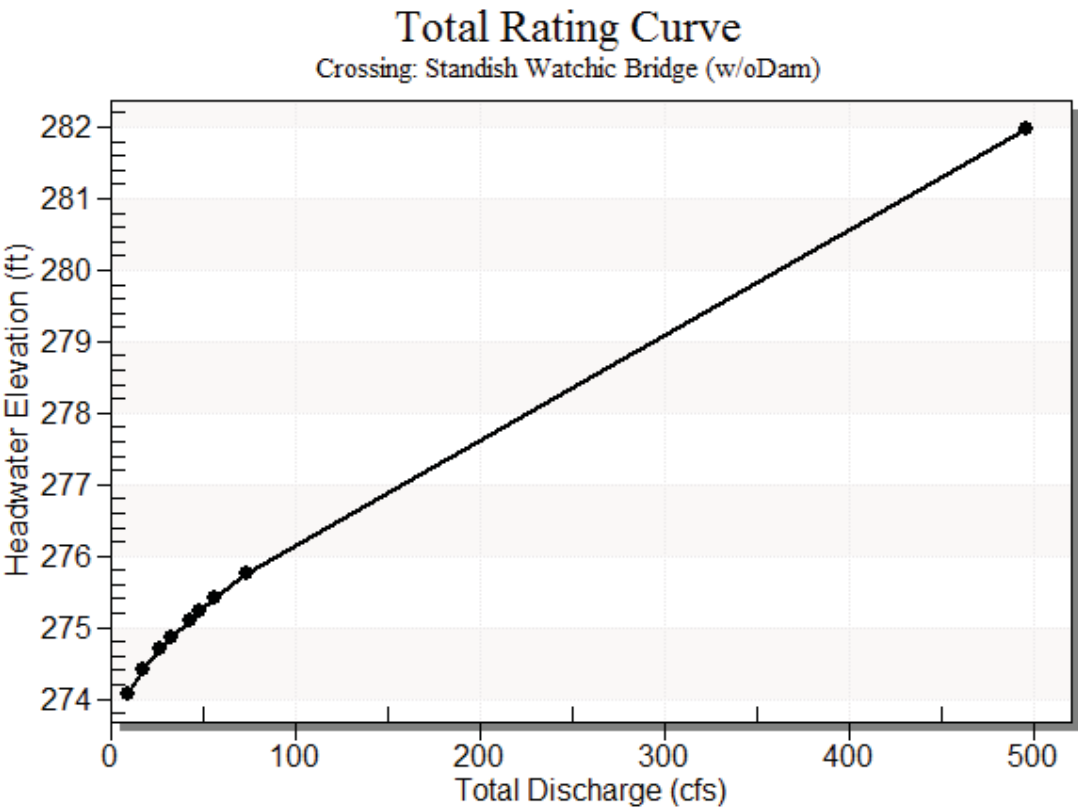
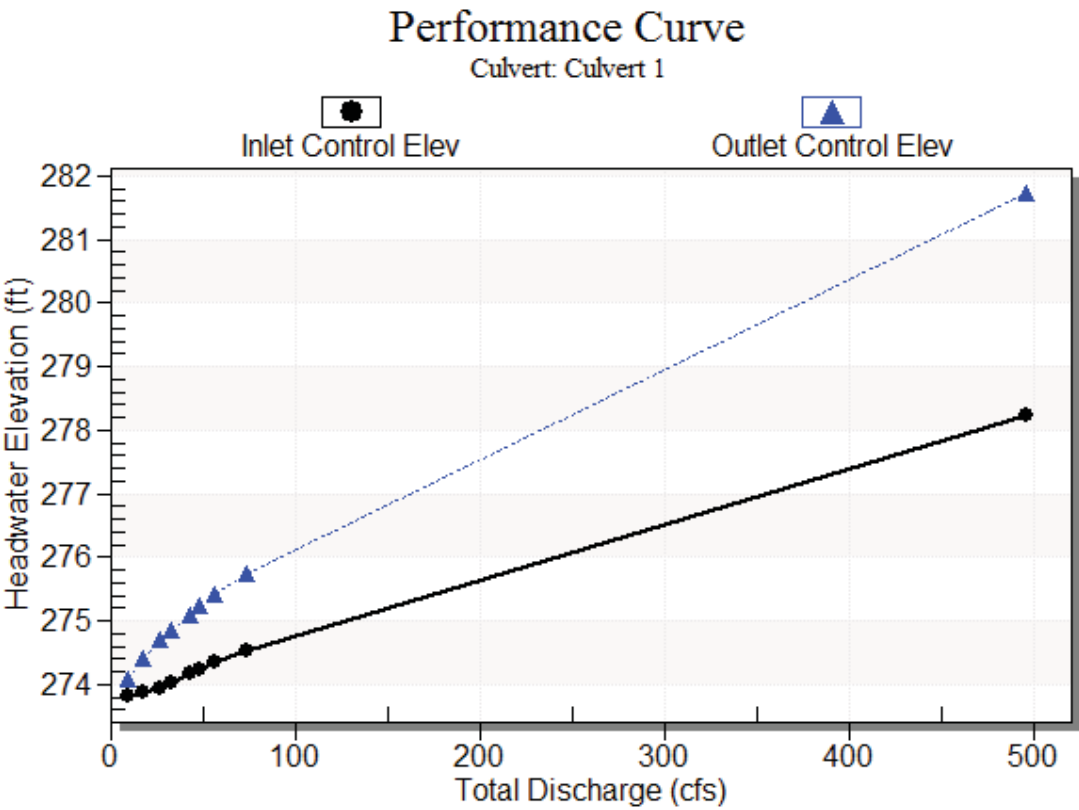


Table 11 - Culvert Summary Table: Culvert 1

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)
Q1.1	9.20	9.20	274.08	0.816	1.081	3-M1t	0.924	0.623	1.093	0.593	1.146
Q2	17.90	17.90	274.41	0.891	1.412	3-M1t	1.222	0.789	1.384	0.884	1.573
Q5	27.10	27.10	274.69	0.952	1.695	3-M1t	1.478	0.932	1.635	1.135	1.884
Q10	33.10	33.10	274.86	1.040	1.857	3-M1t	1.625	1.017	1.780	1.280	2.045
Q25	43.10	43.10	275.10	1.174	2.103	3-M1t	1.847	1.148	1.999	1.499	2.270
Q50	48.80	48.80	275.23	1.245	2.232	3-M1t	1.964	1.217	2.115	1.615	2.379
Q100	57.00	57.00	275.41	1.343	2.407	3-M1t	2.121	1.312	2.273	1.773	2.520
Q500	74.30	74.30	275.74	1.530	2.745	3-M1t	2.424	1.493	2.577	2.077	2.769

Straight Culvert
Inlet Elevation (invert): 273.00 ft, Outlet Elevation (invert): 272.90 ft
Culvert Length: 45.00 ft, Culvert Slope: 0.0022

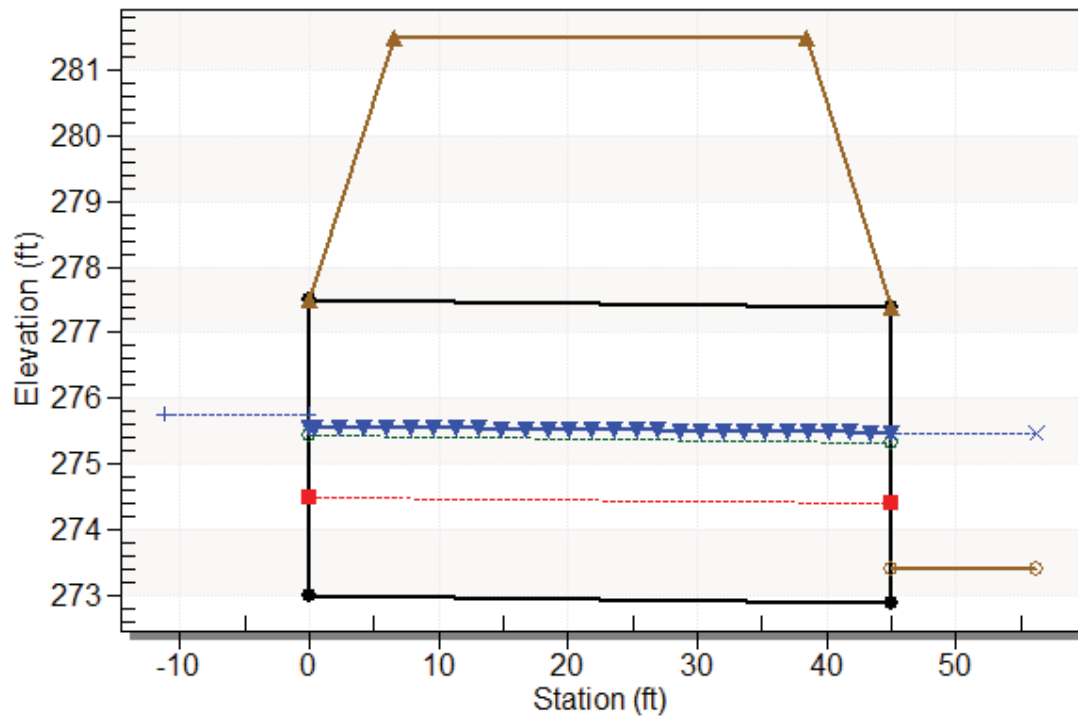
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Standish Watchic Bridge (w/oDam), Design Discharge - 74.3 cfs

Culvert - Culvert 1, Culvert Discharge - 74.3 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 273.00 ft

Outlet Station: 45.00 ft

Outlet Elevation: 272.90 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: User Defined

Barrel Span: 21.00 ft

Barrel Rise: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

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

Manning's n: 0.0330 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: Standish Watchic Bridge)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.20	273.99	0.59	0.83	0.03	0.19
17.90	274.28	0.88	1.07	0.04	0.21
27.10	274.53	1.13	1.25	0.05	0.21
33.10	274.68	1.28	1.34	0.06	0.22
43.10	274.90	1.50	1.47	0.07	0.22
48.80	275.02	1.62	1.54	0.07	0.22
57.00	275.17	1.77	1.63	0.08	0.22
74.30	275.48	2.08	1.78	0.09	0.23

Tailwater Channel Data - Standish Watchic Bridge (w/oDam)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 18.00 ft

Side Slope (H:V): 1.00 (1:1)

Channel Slope: 0.0007

Channel Manning's n: 0.0320

Channel Invert Elevation: 273.40 ft

Roadway Data for Crossing: Standish Watchic Bridge (w/oDam)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 281.50 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft



Computations

Project: Watchic Bridge	Project #: 55189.00
Location: Standish, ME	Sheet: _____
Calculated by: JAW	Date: 11/12/2018
Checked by: _____	Date: _____
Title: Scour	

Scour

Evaluate scour using guidance in HEC 14. Assume cohesionless soils.

$$\left[\frac{h_s}{R_c}, \frac{W_s}{R_c}, \frac{L_s}{R_c}, \frac{V_s}{R_c^3} \right] = C_s C_h \left(\frac{\alpha}{\sigma^{1/3}} \right) \left(\frac{Q}{\sqrt{g}(R_c^{2.5})} \right)^\beta \left(\frac{t}{316} \right)^\theta \quad \text{HEC 14, Eq. 5.1}$$

where,

- h_s = depth of scour, m (ft)
- W_s = width of scour, m (ft)
- L_s = length of scour, m (ft)
- V_s = volume of scour, m³ (ft³)
- R_c = hydraulic radius at the end of the culvert (assuming full flow)
- Q = discharge, m³/s (ft³/s)
- g = acceleration of gravity, 9.81 m/s² (32.2 ft /s²)
- t = time in minutes
- σ = $(D_{84}/D_{16})^{0.5}$, material standard deviation
- α, β, θ are coefficients, see Table 5.1
- C_s = slope correction coefficient, see Table 5.2
- C_h = drop height adjustment coefficient, see Table 5.3



Computations

Project: Watchic Bridge	Project #: 55189.00
Location: Standish, ME	Sheet:
Calculated by: JAW	Date: 11/12/2018
Checked by:	Date:
Title: Scour	

Scour

HEC 14, Table 5.1:

	α	β	θ
hs	2.27	0.39	0.06
Ws	6.94	0.53	0.08
Ls	17.1	0.47	0.1
Vs	127.08	1.24	0.18

$$g = 32.2 \text{ ft/s}^2$$

Q = see below

$$t = 30 \text{ minutes}$$

$$\sigma = 9.18 \text{ see below}$$

$$Cs = 1 \text{ buried invert to match channel}$$

$$Ch = 1 \text{ minimal slope}$$

Particle Size Analysis from Nobis:

SS-2, taken in channel:

$$D_{85} = 41.29 \text{ mm}$$

$$D_{15} = 0.49 \text{ mm}$$

$$\sigma = 9.18 \text{ Material is graded}$$

	Q100	Q500
Q(cfs)	57	74.3
Pwet (ft)	15.81	19.92
Aflow (sf)	26.4	30.67
Rc (ft)	1.67	1.54
hs (ft)	2.34	2.59
Ws (ft)	7.89	9.33
Ls (ft)	17.45	20.05
Vs (cf)	659.5	923.6
Vs (cy)	24.43	34.21
Lm (ft)	6.98	8.02



Computations

Project:	Watchic Bridge	Project #:	55189.00
Location:	Standish, ME	Sheet:	
Calculated by:	JAW	Date:	11/12/2018
Checked by:		Date:	
Title:	Riprap sizing		

Riprap sizing

Size riprap at outlet based on HEC 23 guidance.

$$d_{50} = \frac{K_r y_o}{(S_g - 1)} \left(\frac{V_{AC}^2}{g y_o} \right)^{0.33} \quad (18.1)$$

where:

d_{50} = Riprap median size (50% finer) ft or m
 K_r = Sizing Coefficient equal to 0.38 from the best fit lab data, 0.68 for design curve that envelops the lab data
 V_{AC} = Average velocity at the culvert entrance, ft/s or m/s
 y_o = Average flow depth at the culvert entrance before scour, ft or m
 S_g = Riprap specific gravity
 g = Acceleration of gravity ft/s² or m/s²

K_r = 0.68
 V_{ac} = 2.10 ft/s
 S_g = 2.65
 g = 32.2
 y_o = 2.74 ft

d_{50} = 0.42 ft
5.04 in

Per MaineDOT, use Special Fill placed above Plain Riprap.

Extend beyond culvert minimum of:

2	x	y_o	=	5.48	ft or	10	ft	US
4	x	y_o	=	10.96	ft or	20	ft	DS

Due to minimal velocity and anticipated scour depth, limit riprap apron at inlet and outlet to length required for grading.

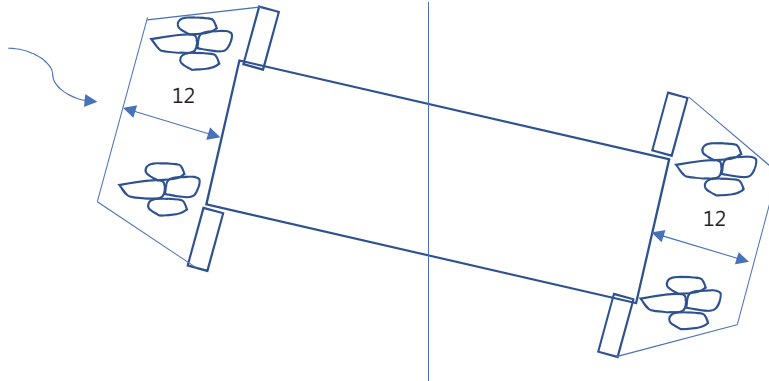


Computations

Project:	Watchic Bridge	Project #:	55189.00
Location:	Standish, ME	Sheet:	
Calculated by:	JAW	Date:	11/12/2018
Checked by:		Date:	
Title:	Riprap sizing		

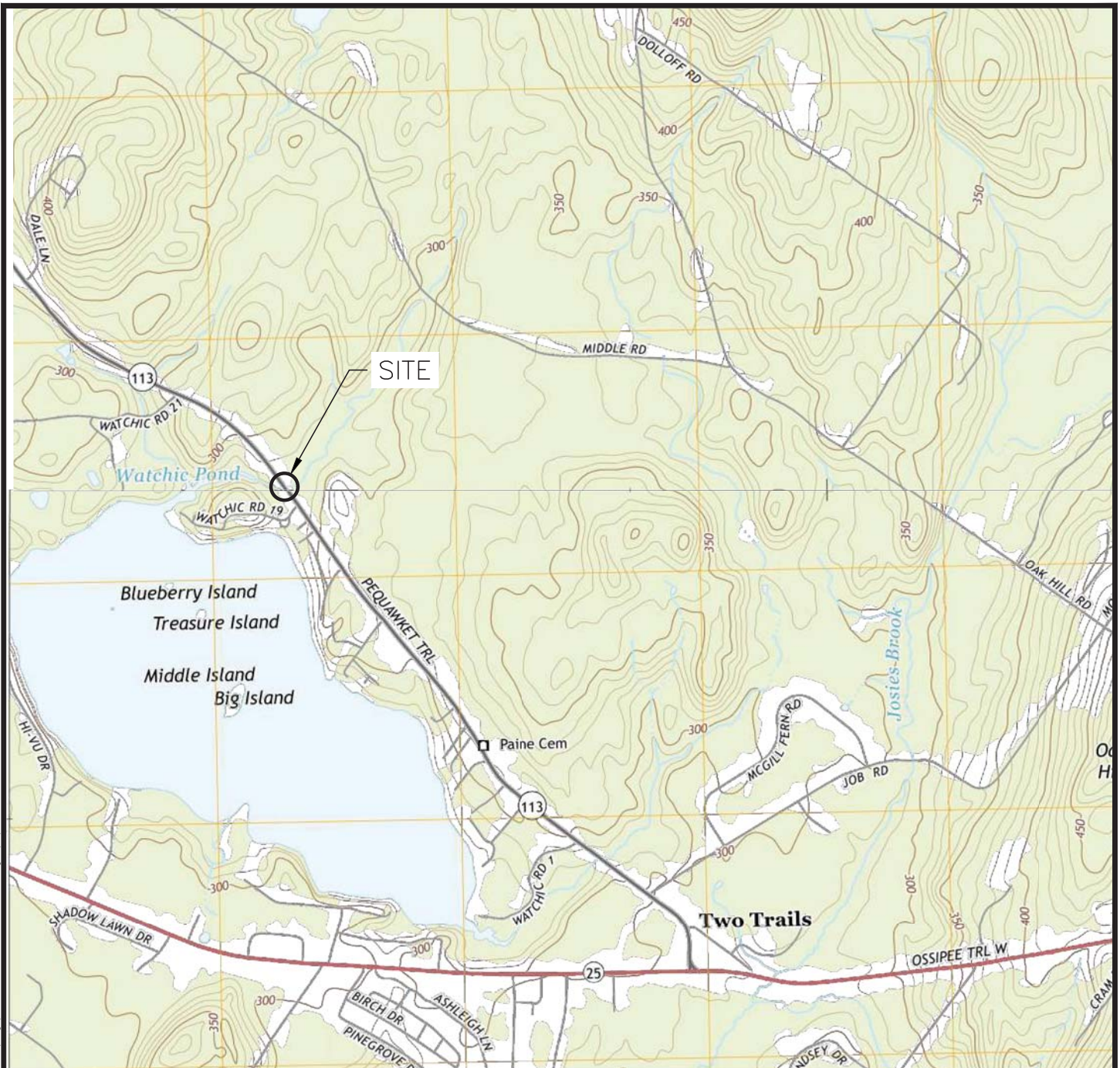
Riprap sizing

Based on scour calculations and considering site conditions and parameters outlined in the MaineDOT BDG, use the following layout for inlet and outlet protection:



Extend riprap to limits of wingwall and connect based on grading. Layout shown is approximate, see plans for final layout

G:\Active\92270.05 - MaineDOT State Route 113 Over Page Brook, Standish\CAD\dwg\92270.05-GT-100-LOCUS.dwg 1/9/2018 2:54 PM



2014 USGS TOPOGRAPHIC MAPS
STANDISH & SEBAGO LAKE QUADRANGLES
STANDISH, MAINE
CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

APPROXIMATE SCALE
1 INCH = 2,000 FEET



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www.nobiseng.com

Client - Focused, Employee - Owned



QUADRANGLE LOCATION

FIGURE 1

SITE LOCUS PLAN
WATCHIC BRIDGE (#2914)
STATE ROUTE 113 OVER PAGE BROOK
STANDISH, MAINE

PROJECT NO. 92270.05

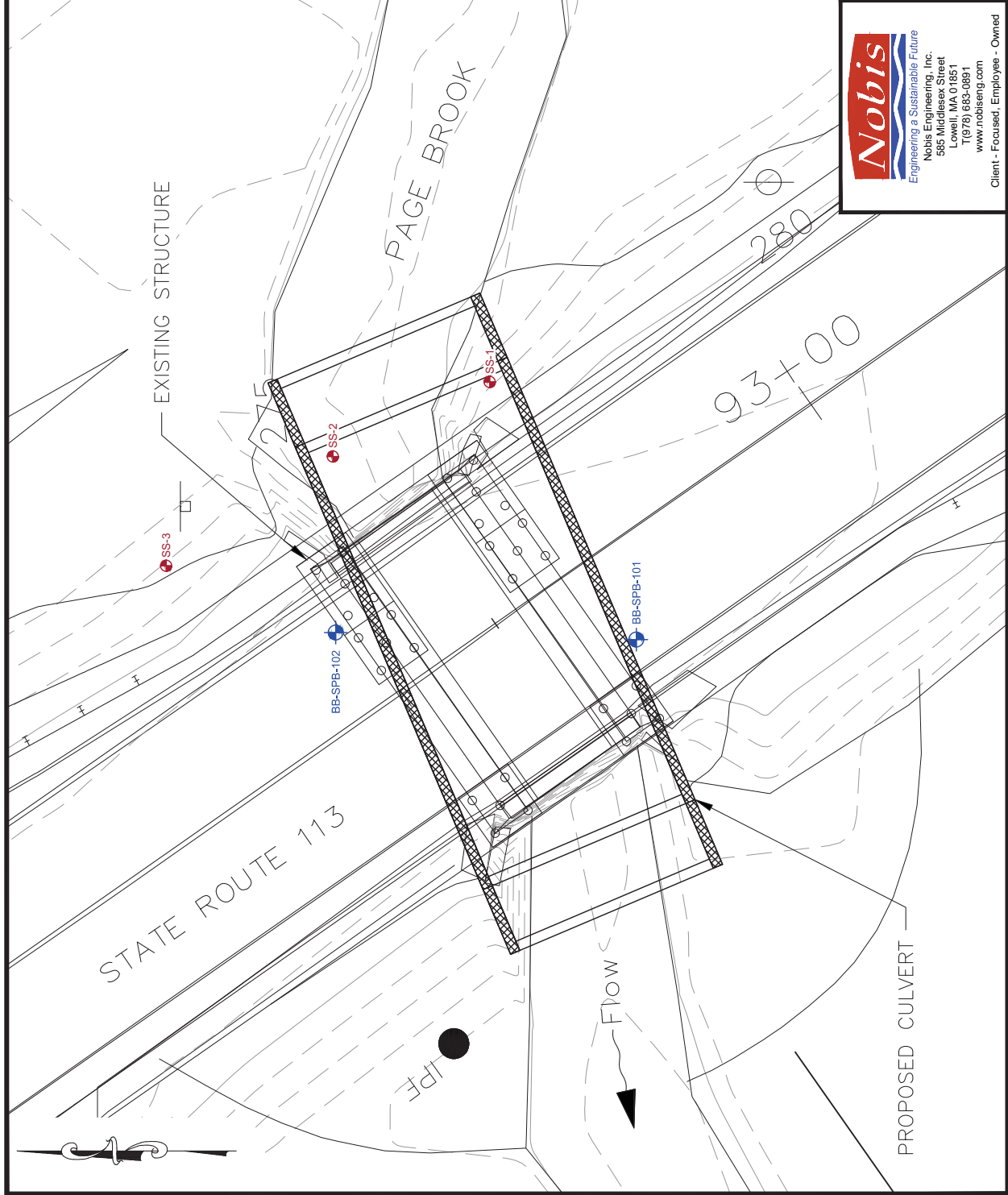
DATE: JANUARY 2018

NOTES:

1. THE BASE PLAN WAS DEVELOPED FROM DGN FILES PROVIDED BY MAINE DEPARTMENT OF TRANSPORTATION ON DECEMBER 27, 2017.
2. SOIL BORINGS WERE DRILLED BY NEW ENGLAND BORING CONTRACTORS OF HERMON, MAINE, AND OBSERVED BY NOBIS BETWEEN NOVEMBER 1 AND 3, 2017.
3. LOCATIONS AND SITE FEATURES DEPICTED ARE APPROXIMATE AND GIVEN FOR ILLUSTRATIVE PURPOSES. ELEVATIONS ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
5. REFER TO FIGURE 5 FOR SUBSURFACE PROFILE.

LEGEND

- BB-SPB-101 APPROXIMATE BORING LOCATION
- SS-1 APPROXIMATE SEDIMENT SAMPLE LOCATION



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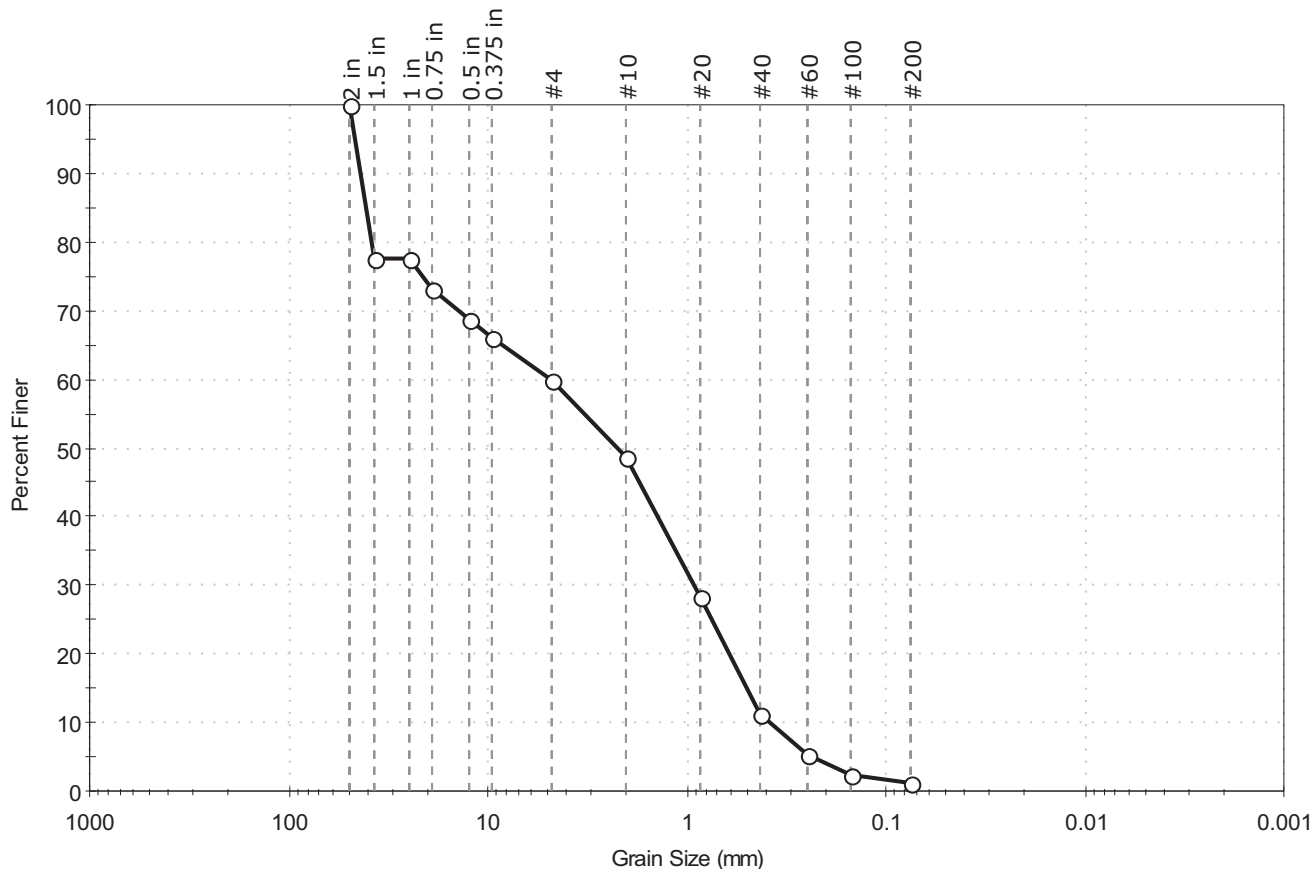
FIGURE 2

BORING LOCATION PLAN
WATCHIC BRIDGE (#2914)
STATE ROUTE 113 OVER PAGE BROOK
STANDISH, MAINE

DRAWN BY:	PCC	CHECKED BY:	BTW
PROJECT NO.	92270.05	DATE:	JANUARY 2018

Client: Nobis Engineering, Inc.	Project No: GTX-307131
Project: Rt 113 over Page Brook	
Location: Standish, ME	
Boring ID: 92270.05	Sample Type: bag
Sample ID: SS-2	Test Date: 10/12/17
Depth: 0-1.5 ft	Test Id: 427689
Test Comment: ---	
Visual Description: Moist, brown sand with gravel	
Sample Comment: Contains asphalt	

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	40.1	58.8	1.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 in	50.00	100		
1.5 in	37.50	77		
1 in	25.00	77		
0.75 in	19.00	73		
0.5 in	12.50	69		
0.375 in	9.50	66		
#4	4.75	60		
#10	2.00	49		
#20	0.85	28		
#40	0.42	11		
#60	0.25	5		
#100	0.15	2		
#200	0.075	1.1		

Coefficients

$D_{85} = 41.2868$ mm $D_{30} = 0.9090$ mm
 $D_{60} = 4.8476$ mm $D_{15} = 0.4933$ mm
 $D_{50} = 2.2304$ mm $D_{10} = 0.3792$ mm
 $C_u = 12.784$ $C_c = 0.450$

Classification

ASTM Poorly graded sand with gravel (SP)

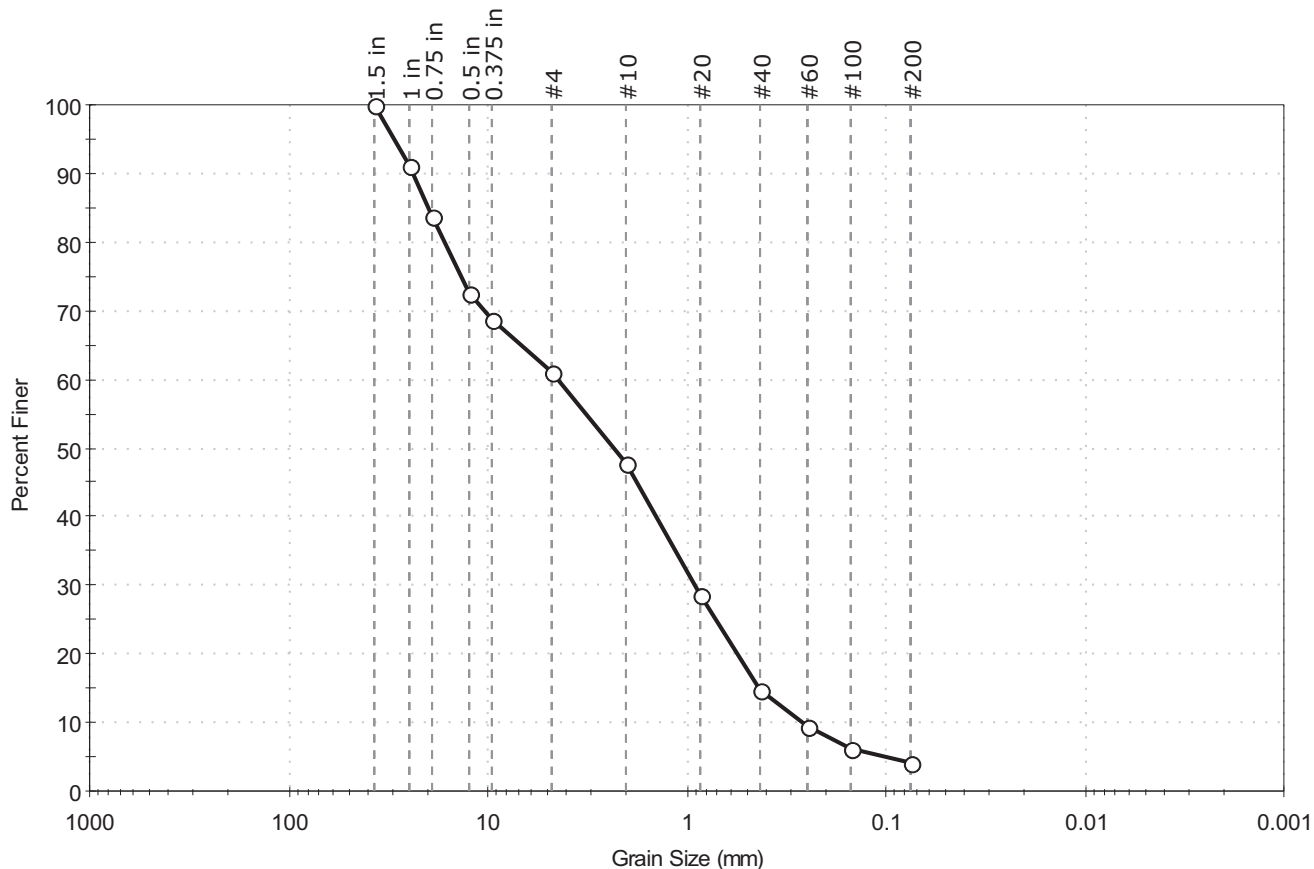
AASHTO Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR
 Sand/Gravel Hardness : HARD

Client: Nobis Engineering, Inc.	Project No: GTX-307131
Project: Rt 113 over Page Brook	
Location: Standish, ME	
Boring ID: 92270.05	Sample Type: bag
Sample ID: SS-3	Test Date: 10/12/17
Depth: 1-2 ft	Test Id: 427690
Test Comment: ---	Tested By: jbr
Visual Description: Moist, brown sand with gravel	Checked By: jsc
Sample Comment: ---	

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	38.9	57.0	4.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	91		
0.75 in	19.00	84		
0.5 in	12.50	73		
0.375 in	9.50	69		
#4	4.75	61		
#10	2.00	48		
#20	0.85	29		
#40	0.42	15		
#60	0.25	9		
#100	0.15	6		
#200	0.075	4.1		

Coefficients

D ₈₅ = 19.8039 mm	D ₃₀ = 0.9032 mm
D ₆₀ = 4.4025 mm	D ₁₅ = 0.4297 mm
D ₅₀ = 2.3033 mm	D ₁₀ = 0.2650 mm
C _u = 16.613	C _c = 0.699

Classification

ASTM Poorly graded sand with gravel (SP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (1))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR
Sand/Gravel Hardness : HARD



Client:	Nobis Engineering, Inc.		
Project:	Rt 113 over Page Brook		
Location:	Standish, ME	Project No:	GTX-307131
Boring ID:	BB-SPB-101	Sample Type:	jar
Sample ID:	S-4	Test Date:	11/22/17
Depth :	10-12	Test Id:	433289
Test Comment:	---		
Visual Description:	Moist, very dark brown silt with organics		
Sample Comment:	---		

Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
BB-SPB-101	S- 4	10-12	Moist, very dark brown silt with organics	254.2

Notes: Temperature of Drying : 110° Celsius



Client:	Nobis Engineering, Inc.		
Project:	Rt 113 over Page Brook		
Location:	Standish, ME	Project No:	GTX-307131
Boring ID:	BB-SPB-101	Sample Type:	jar
Sample ID:	S-4	Test Date:	11/21/17
Depth :	10-12	Test Id:	433290
Test Comment:	---		
Visual Description:	Moist, very dark brown silt with organics		
Sample Comment:	---		

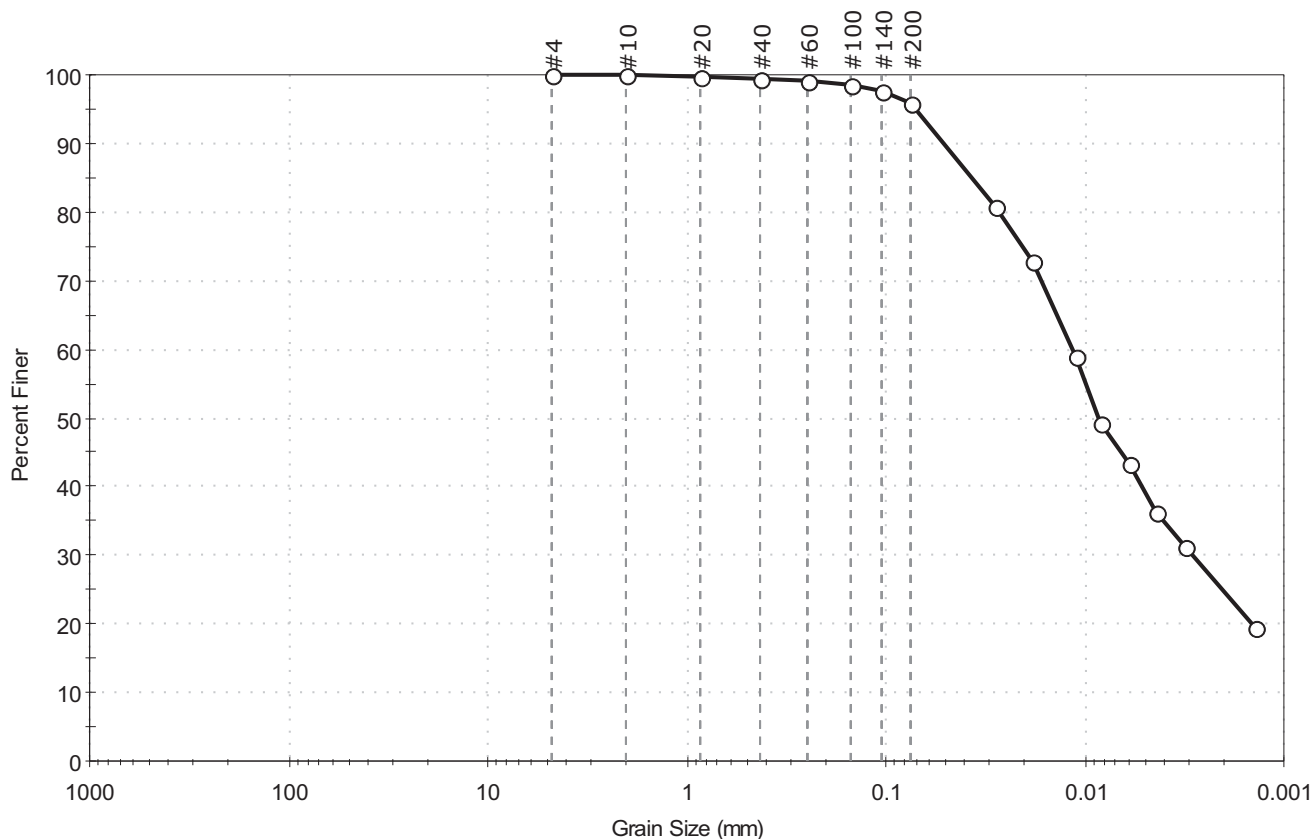
Moisture, Ash, and Organic Matter - ASTM D2974

Boring ID	Sample ID	Depth	Description	Moisture Content, %	Ash Content, %	Organic Matter, %
BB-SPB-101	S-4	10-12	Moist, very dark brown silt with organics	254	64.3	35.7

Notes: Moisture content determined by Method A and reported as a percentage of oven-dried mass;
dried to a constant mass at temperature of 105° C
Ash content and organic matter determined by Method C; dried to constant mass at temperature 440° C

Client: Nobis Engineering, Inc.	Project No: GTX-307131
Project: Rt 113 over Page Brook	
Location: Standish, ME	
Boring ID: BB-SPB-101	Sample Type: jar
Sample ID: S-7B	Tested By: jbr
Depth: 20-22	Test Date: 11/30/17
	Checked By: emm
	Test Id: 433287
Test Comment: ---	
Visual Description: Moist, gray clay	
Sample Comment: ---	

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	4.2	95.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	99		
#60	0.25	99		
#100	0.15	98		
#140	0.11	98		
#200	0.075	96		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0282	81		
---	0.0184	73		
---	0.0112	59		
---	0.0084	49		
---	0.0060	43		
---	0.0044	36		
---	0.0031	31		
---	0.0014	19		

Coefficients

$D_{85} = 0.0370$ mm $D_{30} = 0.0029$ mm
 $D_{60} = 0.0116$ mm $D_{15} = \text{N/A}$
 $D_{50} = 0.0086$ mm $D_{10} = \text{N/A}$
 $C_u = \text{N/A}$ $C_c = \text{N/A}$

Classification

ASTM N/A

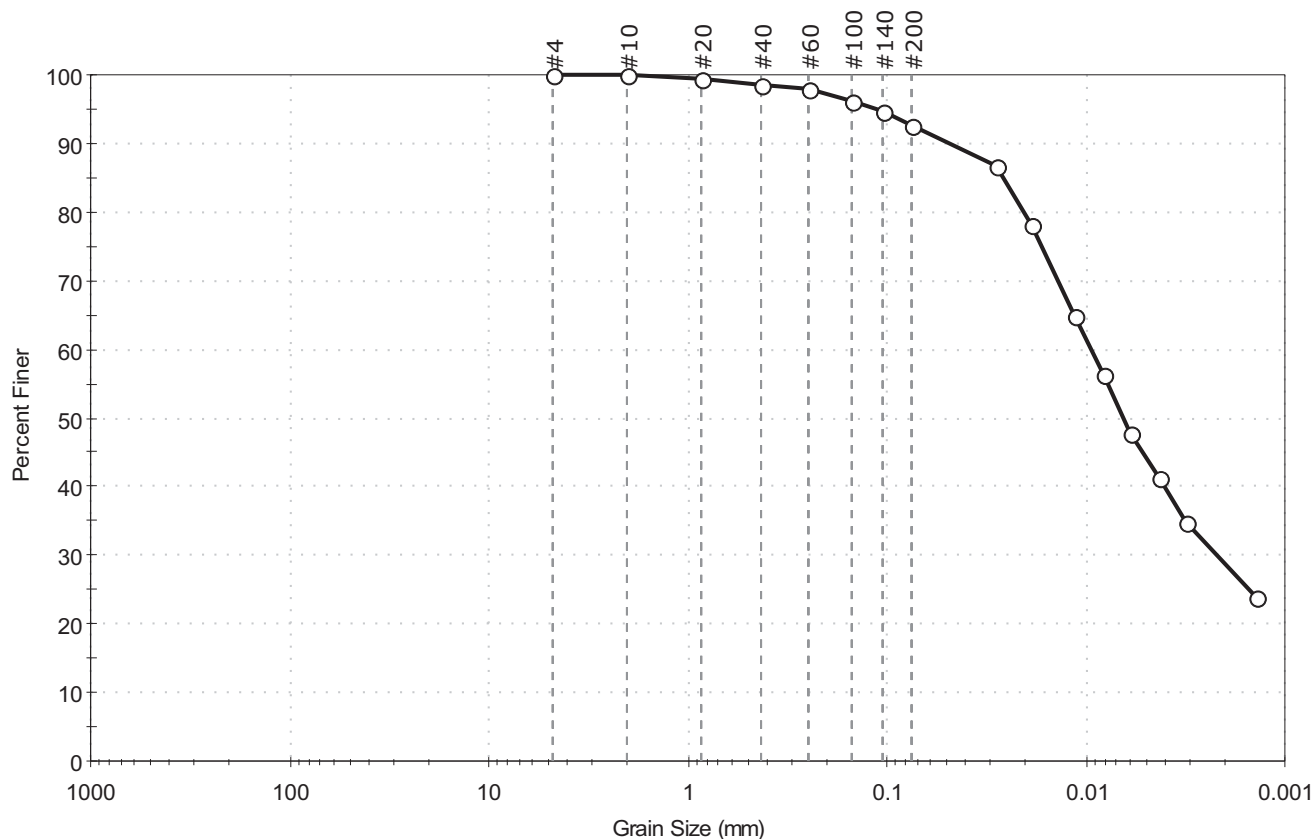
AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---
 Sand/Gravel Hardness : ---
 Dispersion Device : Apparatus A - Mech Mixer
 Dispersion Period : 1 minute
 Specific Gravity : 2.65
 Separation of Sample: #200 Sieve

Client: Nobis Engineering, Inc.	Project No: GTX-307131
Project: Rt 113 over Page Brook	
Location: Standish, ME	
Boring ID: BB-SPB-102	Sample Type: jar
Sample ID: S-9	Test Date: 11/30/17
Depth: 30-32	Test Id: 433288
Test Comment: ---	Tested By: jbr
Visual Description: Moist, gray clay	Checked By: emm
Sample Comment: ---	

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	7.5	92.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	99		
#40	0.42	99		
#60	0.25	98		
#100	0.15	96		
#140	0.11	95		
#200	0.075	92		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0285	87		
---	0.0188	78		
---	0.0114	65		
---	0.0082	56		
---	0.0059	48		
---	0.0043	41		
---	0.0031	35		
---	0.0014	24		

Coefficients

$D_{85} = 0.0263$ mm $D_{30} = 0.0022$ mm
 $D_{60} = 0.0094$ mm $D_{15} = \text{N/A}$
 $D_{50} = 0.0065$ mm $D_{10} = \text{N/A}$
 $C_u = \text{N/A}$ $C_c = \text{N/A}$

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---
 Sand/Gravel Hardness : ---
 Dispersion Device : Apparatus A - Mech Mixer
 Dispersion Period : 1 minute
 Specific Gravity : 2.65
 Separation of Sample: #200 Sieve



Client:	Nobis Engineering, Inc.		
Project:	Rt 113 over Page Brook		
Location:	Standish, ME	Project No:	GTX-307131
Boring ID:	---	Sample Type:	---
Sample ID:	---	Test Date:	11/27/17
Depth :	---	Test Id:	433292
		Tested By:	rlc
		Checked By:	jsc

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
BB-SPB-101	RC-3	46.7-51.7	161	20953	1	Yes	---
BB-SPB-102	RC-2	47.6-52.6	163	23275	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.
All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure
(See attached photographs)



Client:	Nobis Engineering, Inc.	Test Date:	11/27/2017
Project Name:	Rt. 113 over Page Brook	Tested By:	rlc
Project Location:	Standish, ME	Checked By:	jsc
GTX #:	307131		
Boring ID:	BB-SPB-101		
Sample ID:	RC-3		
Depth:	46.7-51.7 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		DEVIATION FROM STRAIGHTNESS (Procedure S1)		Straightness Tolerance Met?	
Specimen Length, in:		Maximum gap between side of core and reference surface plate: Is the maximum gap ≤ 0.02 in.?		YES	
Specimen Diameter, in:				YES	
Specimen Mass, g:				YES	
Bulk Density, lb/ft ³				YES	
Length to Diameter Ratio:				YES	
END FLATNESS AND PARALLELISM (Procedure FP1)					
END 1					
Diameter 1, in	-0.875	-0.750	0.125	0.375	0.625
Diameter 2, in (rotated 90°)	-0.00020	-0.00030	0.00000	0.00000	0.00000
	-0.00010	-0.00010	0.00000	0.00000	0.00000
END 2					
Diameter 1, in	-0.875	-0.750	0.125	0.375	0.625
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00000	0.00000	0.00000
	0.00010	0.00010	0.00000	0.00000	0.00000
Difference between max and min readings, in:		0° = 0.00030		90° = 0.00020	
Maximum difference must be ≤ 0.0020 in.		0° = 0.0001		90° = 0.0003	
Difference = ± 0.00015		Flatness Tolerance Met?		YES	
DIAMETER 1		DIAMETER 2		Parallelism Tolerance Met?	
End 1:		End 1:		Spherically Seated	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00011	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00636	
End 2:		End 2:		0.00006	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00344	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00292	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00401	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	
Slope of Best Fit Line:		Slope of Best Fit Line:		0.00229	
Angle of Best Fit Line:		Angle of Best Fit Line:		0.00229	
Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
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Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
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Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
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Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
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Maximum Angular Difference:		Maximum Angular Difference:		0.00229	
Parallelism Tolerance Met?		Parallelism Tolerance Met?		YES	
Spherically Seated		Spherically Seated		YES	
Diameter 1		Diameter 2		0.00007	
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Angle of Best Fit Line:		Angle of Best Fit Line:		0.00003	
End 2:		End 2:		0.00172	



Client:	Nobis Engineering, Inc.
Project Name:	Rt. 113 over Page Brook
Project Location:	Standish, ME
GTX #:	307131
Test Date:	11/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SPB-101
Sample ID:	RC-3
Depth, ft:	46.7-51.7



After cutting and grinding



After break



Client:	Nobis Engineering, Inc.	Test Date:	11/27/2017
Project Name:	Rt. 113 over Page Brook	Tested By:	rlc
Project Location:	Standish, ME	Checked By:	jsc
GTX #:	307131		
Boring ID:	BB-SPB-102		
Sample ID:	RC-2		
Depth:	47.6-52.6 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		DEVIATION FROM STRAIGHTNESS (Procedure S1)	
Specimen Length, in:	2	Average	
Specimen Diameter, in:	4.20	4.20	YES
Specimen Mass, g:	1.98	1.98	
Bulk Density, lb/ft³	554.65		
Length to Diameter Ratio:	2.1		
END FLATNESS AND PARALLELISM (Procedure FP1)		Straightness Tolerance Met? YES	
END 1			
Diameter 1, in	-0.875	-0.750	0.375
Diameter 2, in (rotated 90°)	-0.00030	-0.00020	0.00010
	0.00020	0.00010	0.00000
Difference between max and min readings, in:		90° = 0.00040	
Maximum difference must be < 0.020 in.		90° = 0.0004	
Flatness Tolerance Met?		Flatness Tolerance Met? YES	
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00286	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00286	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
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		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
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Spherically Seated			
DIAMETER 1			
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
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End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
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Spherically Seated			
DIAMETER 1			
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Maximum Angular Difference:		0.00172	
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DIAMETER 2			
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Maximum Angular Difference:		0.00172	
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DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
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DIAMETER 2			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
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Maximum Angular Difference:		0.00172	
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DIAMETER 2			
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Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 2			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
Maximum Angular Difference:		0.00172	
Parallelism Tolerance Met?		YES	
Spherically Seated			
DIAMETER 1			
End 1:		Slope of Best Fit Line	
		Angle of Best Fit Line:	
End 2:			

Client:	Nobis Engineering, Inc.
Project Name:	Rt. 113 over Page Brook
Project Location:	Standish, ME
GTX #:	307131
Test Date:	11/27/2017
Tested By:	rlc
Checked By:	jsc
Boring ID:	BB-SPB-102
Sample ID:	RC-2
Depth, ft:	47.6-52.6



After cutting and grinding



After break



Computations

Project: Watchic Bridge	Project #: 55189.00
Location: Standish, ME	Sheet:
Calculated by: JAW	Date: 11/12/2018
Checked by:	Date:
Title: H&H Info	

Hydraulic Evaluation

Page Brook is a tributary to Watchic Lake, which is dam controlled. The dam is generally closed after ice out (typically March or April) and is opened after Columbus Day (mid-October). The dam is controlled as needed to maintain the full pond elevation within a few inches during the summer. The dam was reconstructed in 2010 and a new gate was installed in 2015. Dam records, provided from 2008 up to 2018, indicate water levels vary a few inches during the summer and drop between 11 to 18 inches once the dam is opened in the fall. Surveyed WSE at the culvert in July 2016 indicates WSE close to assumed full pond at approximately El. 275. A review of the dam records for 2016 indicates stable WSE through the summer, with minor variations to +0.5" and -1.5". Fall site photos indicate low flow through the culvert with some velocity, indicating minimal to no impoundment due to Watchic Lake. Summer site photos indicate impounded water levels at the bridge due to dam closure with very little velocity. Considering historic information and using survey data, the hydraulic analysis will include a downstream TW condition to simulate typical summer conditions and another analysis with a defined channel at the outlet to simulate typical fall through early spring conditions to complete the hydraulic analysis. A channel profile analysis was conducted using available survey data to determine a typical channel slope for free outfall analysis. Survey data provides typical channel shape at the outlet.

Design Criteria:

Per MaineDOT BDG, 2.3.10.2-A:

HW/D ≤	0.9	(Q50)
FB =	1	ft at EOP (Q100)

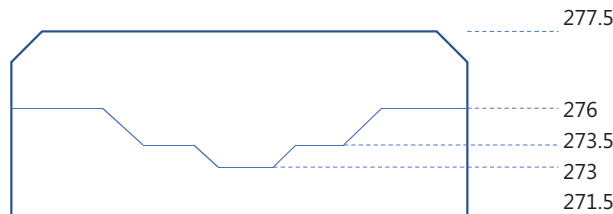
Per MaineDOT BDG, 2.3.11.1:

Design Scour =	Q100	57	cfs
Check Scour =	Q500	74.3	cfs

Geometry:

July 2016 surveyed WSE = 275

	DS	US	Say
Surveyed top of curb	282.1	281.9	
curb ht	-4.5	-4.5	
underside	277.6	277.4	
Chamfer ht	-1.5	-1.5	
bottom of chamfer	276.1	275.9	
12/18 d from underside to WSE	-3.5	-3.5	
WSE on 11/12/18	274.1	273.9	274.0
Summer/High WSE	275.2	275.0	275.1 High TW due to dam impoundment



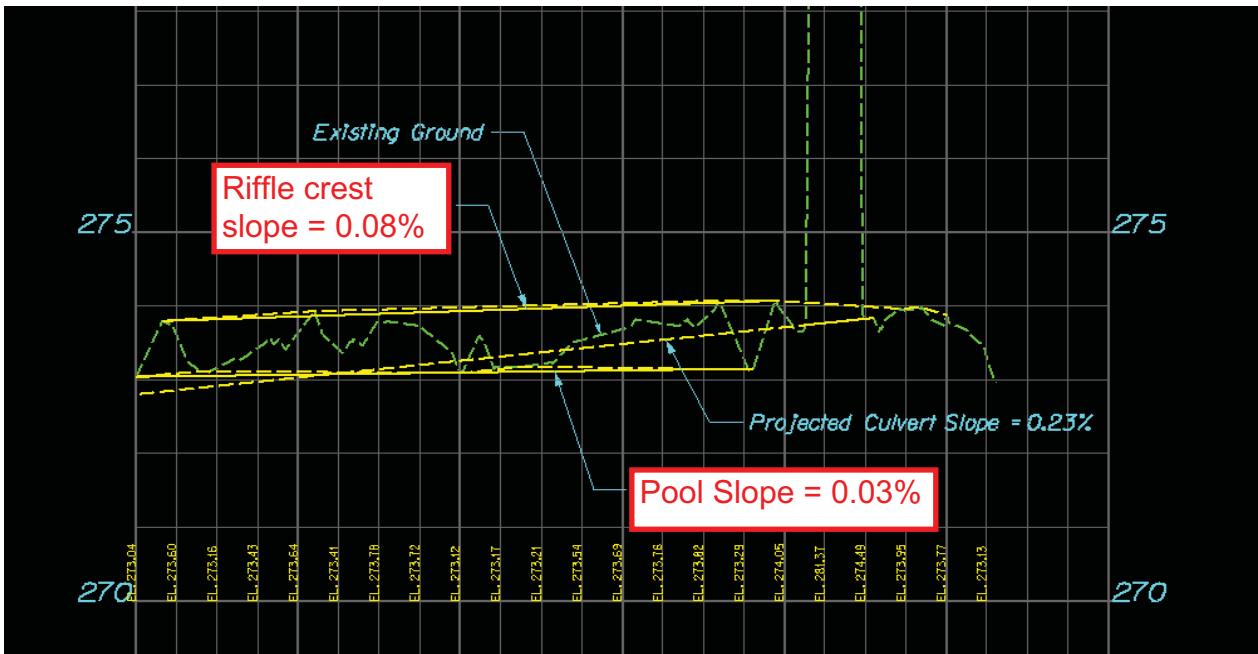


Computations

Project:	Watchic Bridge	Project #:	55189.00
Location:	Standish, ME	Sheet:	
Calculated by:	JAW	Date:	11/12/2018
Checked by:		Date:	
Title:	H&H Info		

Hydraulic Evaluation

Channel Profile Evaluation:



A profile along the existing channel was used to determine channel slope downstream of the culvert. VHB compared the "riffle" and "crest" slopes to the projected culvert slope. An average slope of 0.07% was used for the free outfall channel slope to accurately reflect the existing channel, which will not be reconstructed.



Computations

Project: Watchic Bridge	Project #: 55189.00
Location: Standish, ME	Sheet:
Calculated by: JAW	Date: 11/12/2018
Checked by:	Date:
Title: H&H Info	

Hydraulic Evaluation

Proposed Results:

No TW

Event	Q (cfs)	Q (cfs)	HW El.	Inlet d	Outlet d	Type	Normal d	Critical d	Outlet d	TW d	Outlet V	TW V	FB (ft)
Q1.1	9.2	9.2	274.08	0.82	1.08	3-M1t	0.92	0.62	1.09	0.59	1.15	0.83	3.42
Q2	17.9	17.9	274.41	0.89	1.41	3-M1t	1.22	0.79	1.38	0.88	1.57	1.07	3.09
Q5	27.1	27.1	274.69	0.95	1.69	3-M1t	1.48	0.93	1.63	1.13	1.88	1.25	2.81
Q10	33.1	33.1	274.86	1.04	1.86	3-M1t	1.63	1.02	1.78	1.28	2.05	1.34	2.64
Q25	43.1	43.1	275.1	1.17	2.1	3-M1t	1.85	1.15	2	1.5	2.27	1.47	2.4
Q50	48.8	48.8	275.23	1.25	2.23	3-M1t	1.96	1.22	2.12	1.62	2.38	1.54	2.27
Q100	57	57	275.41	1.34	2.41	3-M1t	2.12	1.31	2.27	1.77	2.52	1.63	2.09
Q500	74.3	74.3	275.74	1.53	2.74	3-M1t	2.42	1.49	2.58	2.08	2.77	1.78	1.76

TW-high

Event	Q (cfs)	Q (cfs)	HW El.	Inlet d	Outlet d	Type	Normal d	Critical d	Outlet d	TW d	Outlet V	TW V	FB (ft)
Q1.1	9.2	9.2	275.11	0.82	2.11	3-M1t	0.92	0.62	2.2	1.2	0.43	0	2.39
Q2	17.9	17.9	275.13	0.89	2.13	3-M1t	1.22	0.79	2.2	1.2	0.83	0	2.37
Q5	27.1	27.1	275.16	0.95	2.16	3-M1t	1.48	0.93	2.2	1.2	1.25	0	2.34
Q10	33.1	33.1	275.19	1.04	2.19	3-M1t	1.63	1.02	2.2	1.2	1.53	0	2.31
Q25	43.1	43.1	275.25	1.17	2.25	3-M1t	1.85	1.15	2.2	1.2	1.99	0	2.25
Q50	48.8	48.8	275.29	1.25	2.29	3-M1t	1.96	1.22	2.2	1.2	2.26	0	2.21
Q100	57	57	275.36	1.34	2.36	3-M1t	2.12	1.31	2.2	1.2	2.63	0	2.14
Q500	74.3	74.3	275.52	1.53	2.52	3-M2t	2.42	1.49	2.2	1.2	3.43	0	1.98

Design Values:

Event	Q (cfs)	HW El.	Outlet V	FB (ft)
Q1.1	9.2	275.11	0.43	2.39
Q2	17.9	275.13	0.83	2.37
Q5	27.1	275.16	1.25	2.34
Q10	33.1	275.19	1.53	2.31
Q25	43.1	275.25	1.99	2.25
Q50	48.8	275.29	2.26	2.21
Q100	57	275.41	2.52	2.09
Q500	74.3	275.74	2.77	1.76

HW/D check:

D = 4 ft
HW = 2.29 ft
HW/D = 0.5725 ft
OK

Bottom of structure = 277.5



Computations

Project: Watchic Bridge	Project #: 55189.00
Location: Standish, ME	Sheet:
Calculated by: JAW	Date: 11/12/2018
Checked by:	Date:
Title: H&H Info	

Hydraulic Evaluation

No TW

Event	Q (cfs)	Q (cfs)	HW El.	Inlet d	Outlet d	Type	Normal d	Critical d	Outlet d	TW d	Outlet V	TW V	FB (ft)
Q1.1	9.2	9.2	274.1	0.39	0.6	3-M1t	0.49	0.26	0.59	0.59	1.29	0.83	3.4
Q2	17.9	17.9	274.42	0.62	0.92	3-M1t	0.73	0.4	0.88	0.88	1.69	1.07	3.08
Q5	27.1	27.1	274.69	0.81	1.19	3-M1t	0.94	0.53	1.13	1.13	1.99	1.25	2.81
Q10	33.1	33.1	274.85	0.93	1.35	3-M1t	1.06	0.61	1.28	1.28	2.16	1.34	2.65
Q25	43.1	43.1	275.1	1.11	1.6	3-M1t	1.24	0.74	1.5	1.5	2.4	1.47	2.4
Q50	48.8	48.8	275.23	1.2	1.73	3-M1t	1.33	0.81	1.62	1.62	2.52	1.54	2.27
Q100	57	57	275.4	1.33	1.9	3-M1t	1.46	0.89	1.77	1.77	2.68	1.63	2.1
Q500	74.3	74.3	275.75	1.59	2.25	3-M1t	1.72	1.07	2.08	2.08	2.98	1.78	1.75

Existing Model:

TW-high

Event	Q (cfs)	Q (cfs)	HW El.	Inlet d	Outlet d	Type	Normal d	Critical d	Outlet d	TW d	Outlet V	TW V	FB (ft)
Q1.1	9.2	9.2	275.11	0.39	1.61	3-M1t	0.49	0.26	1.7	1.7	0.45	0	2.39
Q2	17.9	17.9	275.13	0.62	1.63	3-M1t	0.73	0.4	1.7	1.7	0.88	0	2.37
Q5	27.1	27.1	275.16	0.81	1.66	3-M1t	0.94	0.53	1.7	1.7	1.33	0	2.34
Q10	33.1	33.1	275.19	0.93	1.69	3-M1t	1.06	0.61	1.7	1.7	1.62	0	2.31
Q25	43.1	43.1	275.25	1.11	1.75	3-M1t	1.24	0.74	1.7	1.7	2.11	0	2.25
Q50	48.8	48.8	275.29	1.2	1.79	3-M1t	1.33	0.81	1.7	1.7	2.39	0	2.21
Q100	57	57	275.35	1.33	1.85	3-M1t	1.46	0.89	1.7	1.7	2.79	0	2.15
Q500	74.3	74.3	275.52	1.59	2.02	3-M2t	1.72	1.07	1.7	1.7	3.64	0	1.98

Event	Q (cfs)	HW El.	Outlet V	FB (ft)
Q1.1	9.2	275.11	0.45	2.39
Q2	17.9	275.13	0.88	2.37
Q5	27.1	275.16	1.33	2.34
Q10	33.1	275.19	1.62	2.31
Q25	43.1	275.25	2.11	2.25
Q50	48.8	275.29	2.39	2.21
Q100	57	275.4	2.68	2.1
Q500	74.3	275.75	2.98	1.75