Project Name:	Ebeeme	**PIN:**	17088.00
Stream Name:	Stinking Brook	**Town:**	Ebeeme
Bridge Name:	Stinking Brook Bridge	**Bridge No.**	3868
Route No.	11	**USGS Quad:**	
Analysis by:	AWMann	**Date:**	5/20/2009

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999)

Enter data in blue cells only!

	km^2	mi^2	ac	
A	5.12	1.978	1265.9	***Enter data in [mi^2]*** Watershed Area
W	0.14	0.054	34.4	Wetlands area (by NWI)
P_c	496394	5033334		watershed centroid (E, N; UTM 19N; meters)
County	Piscataquis S			*choose county from drop-down menu*
pptA	41.0			mean annual precipitation (inches; by look-up)
SG	0.00			sand & gravel aquifer as decimal fraction of watershed A

A (km^2)	5.12	**Conf Lvl**	0.67
W (%)	2.72		

Worksheet prepared by:
Charles S. Hebson, PE
Chief Hydrologist
Maine Dept. Transportation
Augusta, ME 04333-0016
207-287-1105
Charles.Hebson@maine.gov

Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m^3/s)	Upper	Q_T (ft^3/s)
1.1		1.55		54.6
2	2.56	3.64	5.16	128.4
5	4.35	6.22	8.90	219.8
10	5.72	8.27	11.95	292.0
25	7.61	11.18	16.43	394.9
50	9.11	13.57	20.22	479.3
100	10.71	16.18	24.44	571.2
500	14.66	22.95	35.94	810.4

Reference:

Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

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

HYDRAULIC REPORT
(Existing Bridge)

Stinking Brook Bridge (#3868) is located in T5R9 NWP (Ebeeme Twp.) on Rte 11 over Stinking Brook. The culvert was built in 1965. The existing bridge is a single steel pipe arch 11'-5" Span x 7'-3"" Rise x 70' long. The slope of the culvert is about 3.4%. The culvert is in poor condition. The bottom of the culvert is heavily rusted and severe efflorescence coming through the bolt holes in the top plates.

Stinking Brook empties into Ebeeme Lake approx ½ mile downstream of the bridge. The drainage basin is relatively small at approx 2.0 sq. miles. The existing culvert has been analyzed using HY8. The existing structure appears to be adequately sized although the pipe is 93% full at $Q_{50.}$ (Slightly higher than the 90% standard for new structures) Outlet velocities are moderately high. A small scour hole is present downstream but does not appear problematic.

SUMMARY

	Existing Structure Single Steel Pipe Arch 11'-5" Span x 7'-3" Rise
Area of Waterway Opening	64.0 ft^2
Elevation of Centerline of Roadway	494.8 ft.
Invert Elevation @ Inlet	485.6 ft
Invert Elevation @ Outlet	483.2 ft
Inlet Depth @ $Q_{1.1}$	1.91 ft
Outlet Depth @ $Q_{1.1}$	1.07 ft
Headwater Elevation @ $Q_{1.1}$	487.51 ft
Headwater Elevation @ Q_{50}	492.35 ft
Headwater Elevation @ Q_{100}	493.16 ft
HW/D @ Q_{50}	0.93
Discharge Velocity @ $Q_{1.1}$	6.98 fps
Discharge Velocity @ Q_{50}	13.69 fps
Discharge Velocity @ Q_{100}	14.12 fps

Reported By: Brian J. Nichols
Date: December 31, 2009

HYDRAULIC REPORT
(Proposed Bridge)

Stinking Brook Bridge (#3868) in T5R9 NWP (Ebeeme Twp.) is scoped for bridge culvert rehabilitation in the 2010-2011 BTIP. All alternatives will have 10' wide plain riprap aprons at both ends of the culvert. Plain riprap will also be used for slope protection.

Alternative 1: Concrete invert lining: No hydraulic analysis was conducted on this alternative, but, by inspection, would be hydraulically adequate. Headwater elevations are expected to be somewhat higher than currently exist, but far less then the 12" increase predicted with the sliplining option as the hydraulic opening is significantly larger.

Alternative 2: Slipline with a single aluminum structural plate pipe arch, 8'-5" span x 6'-3" rise. The size was selected as it was the largest size that would fit inside the existing while providing adequate annular space to account for pipe distortion. Hydraulic analysis showed that headwater elevations would be increased by approx. 0.98' at Q_{50}. The reduction in hydraulic capacity would also cause overtopping around Q_{100}. Additionally, as a result of the reduction in pipe size, the pipe would be full at a level approx equal to Q_{10}. Due to significant adverse hydraulic performance, this alternative has been rejected.

Alternative 3: Replace existing with a single aluminum structural plate pipe arch, 14'-0"span x 8'-7" rises. A steel culvert was not considered due to a life of only 45 years for the existing bridge. The size was selected to improve hydraulic performance as compared to existing condition. Headwater elevations are lowered by about 12"-14" until overtopping occurs slightly below $Q_{100.}$ Outlet velocities are also lower than existing.

Alternative 4: Replace existing with a single precast concrete box culvert, 14'-0" span x 7'-0" rise. Similarly to Alternative 3, the size was selected to improve hydraulic performance as compared to existing condition. Headwater elevation is reduced by 1.9' @ Q_{50} and $Q_{100.}$ Although HY8 analysis indicates that outlet velocities are increased considerably, lower velocities are anticipated as the software is not capable of reliably predicting the effects of a natural stream bottom in the box. However, the outlet velocity @ $Q_{1.1}$ is expected to be greater than the maximum sustained velocity for juvenile Atlantic salmon of 2.6 fps. A pool and weir system is needed inside the culvert to allow fish to pass. The combination of a buried invert and fish weirs should reduce outlet velocities so that scour can be minimized with the typical 10' plain riprap apron.

As a result of the hydraulic analysis, Alternative 2 was eliminated from consideration. Final selection of structure type will be made based on other factors such as life cycle, construction methods and maintenance of traffic.

Reported By: Brian J. Nichols
Date: January 27, 2010

HY-8 Analysis Results

Culvert Summary Table - Culvert 1

Culvert Crossing: Existing

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)
54.60	54.60	487.51	1.91	0.0*	1-S2n	1.07	1.28	1.07	1.39	6.98	3.85
106.26	106.26	488.27	2.67	0.0*	1-S2n	1.54	1.81	1.54	1.95	8.22	4.61
157.92	157.92	488.92	3.32	0.0*	1-S2n	1.84	2.25	1.84	2.36	9.33	5.13
209.58	209.58	489.57	3.97	0.0*	1-S2n	2.14	2.62	2.14	2.69	10.00	5.52
261.24	261.24	490.11	4.51	0.0*	1-S2n	2.42	2.97	2.43	2.99	11.04	5.85
312.90	312.90	490.61	5.01	0.0*	1-S2n	2.71	3.28	2.72	3.24	11.92	6.13
364.56	364.56	491.12	5.52	0.0*	1-S2n	2.98	3.59	3.00	3.48	12.58	6.37
416.22	416.22	491.65	6.05	0.0*	1-S2n	3.24	3.86	3.25	3.69	13.15	6.60
467.88	467.88	492.22	6.62	0.0*	1-S2n	3.49	4.13	3.50	3.89	13.61	6.79
479.30	479.30	492.35	6.75	0.0*	1-S2n	3.55	4.19	3.55	3.94	13.69	6.84
571.20	543.84	493.16	7.55	0.0*	5-S2n	3.87	4.50	3.89	4.26	14.12	7.15

HY-8 Analysis Results

Culvert Summary Table - Culvert 1

Culvert Crossing: Slipline

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)
54.60	54.60	488.11	2.24	0.0*	1-S2n	1.17	1.32	1.17	1.39	6.47	3.85
106.26	106.26	489.02	3.15	0.0*	1-S2n	1.59	1.87	1.61	1.95	7.87	4.61
157.92	157.92	489.99	4.12	0.0*	1-S2n	1.95	2.26	1.95	2.36	8.86	5.13
209.58	209.58	490.86	4.99	0.0*	1-S2n	2.21	3.03	2.22	2.69	9.71	5.52
261.24	261.24	491.72	5.85	0.0*	1-S2n	2.48	3.47	2.48	2.99	10.33	5.85
312.90	312.90	492.61	6.74	1.00	5-S2n	3.46	3.83	3.46	3.24	12.08	6.13
364.56	341.50	493.14	7.27	1.24	5-S2n	3.67	4.01	3.68	3.48	12.31	6.37
416.22	348.92	493.28	7.41	1.45	5-S2n	3.73	4.06	3.73	3.69	12.38	6.60
467.88	354.76	493.40	7.53	0.0*	5-S2n	3.77	4.10	3.77	3.89	12.43	6.79
479.30	355.95	493.42	7.55	0.0*	5-S2n	3.78	4.10	3.78	3.94	12.44	6.84
571.20	364.45	493.59	7.72	0.0*	5-S2n	3.85	4.16	3.85	4.26	12.50	7.15

HY-8 Analysis Results

Culvert Summary Table - Culvert 1

Culvert Crossing: Aluminum Pipe Arch

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)
54.60	54.60	486.89	1.89	0.0*	1-S2n	0.94	1.11	1.00	1.39	6.10	3.85
106.26	106.26	487.64	2.64	0.0*	1-S2n	1.32	1.61	1.34	1.95	7.82	4.61
157.92	157.92	488.23	3.23	0.0*	1-S2n	1.62	1.96	1.65	2.36	8.61	5.13
209.58	209.58	488.74	3.74	0.0*	1-S2n	1.83	2.29	1.88	2.69	9.38	5.52
261.24	261.24	489.25	4.25	0.0*	1-S2n	2.05	2.55	2.07	2.99	10.25	5.85
312.90	312.90	489.74	4.74	0.0*	1-S2n	2.26	2.80	2.26	3.24	10.82	6.13
364.56	364.56	490.21	5.21	0.0*	1-S2n	2.41	3.09	2.42	3.48	11.32	6.37
416.22	416.22	490.68	5.68	1.69	1-S1t	2.56	3.59	4.69	3.69	7.72	6.60
467.88	467.88	491.17	6.17	0.0*	1-S2n	2.71	3.90	2.72	3.89	12.25	6.79
479.30	479.30	491.28	6.28	0.0*	1-S2n	2.74	3.95	2.74	3.94	12.42	6.84
571.20	571.20	492.22	7.22	0.0*	1-S2n	3.01	4.34	3.01	4.26	12.97	7.15

HY-8 Analysis Results

Culvert Summary Table - Culvert 1

Culvert Crossing: Precast Box Culvert (buried 12")

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)
54.60	54.60	486.30	1.30	0.0*	1-S2n	0.37	0.78	0.38	1.39	10.25	3.85
106.26	106.26	487.01	2.01	0.0*	1-S2n	0.66	1.22	0.66	1.95	11.56	4.61
157.92	157.92	487.62	2.62	0.0*	1-S2n	0.83	1.58	0.87	2.36	12.90	5.13
209.58	209.58	488.16	3.16	0.0*	1-S2n	1.00	1.91	1.08	2.69	13.88	5.52
261.24	261.24	488.66	3.66	0.0*	1-S2n	1.17	2.22	1.27	2.99	14.74	5.85
312.90	312.90	489.12	4.12	0.0*	1-S2n	1.31	2.50	1.45	3.24	15.45	6.13
364.56	364.56	489.57	4.57	0.0*	1-S2n	1.44	2.77	1.62	3.48	16.07	6.37
416.22	416.22	489.99	4.99	0.0*	1-S2n	1.57	3.02	1.79	3.69	16.60	6.60
467.88	467.88	490.41	5.41	0.0*	1-S2n	1.70	3.27	1.96	3.89	17.08	6.79
479.30	479.30	490.50	5.50	0.0*	1-S2n	1.73	3.32	1.99	3.94	17.19	6.84
571.20	571.20	491.24	6.24	0.0*	5-S2n	1.94	3.73	2.28	4.26	17.90	7.15