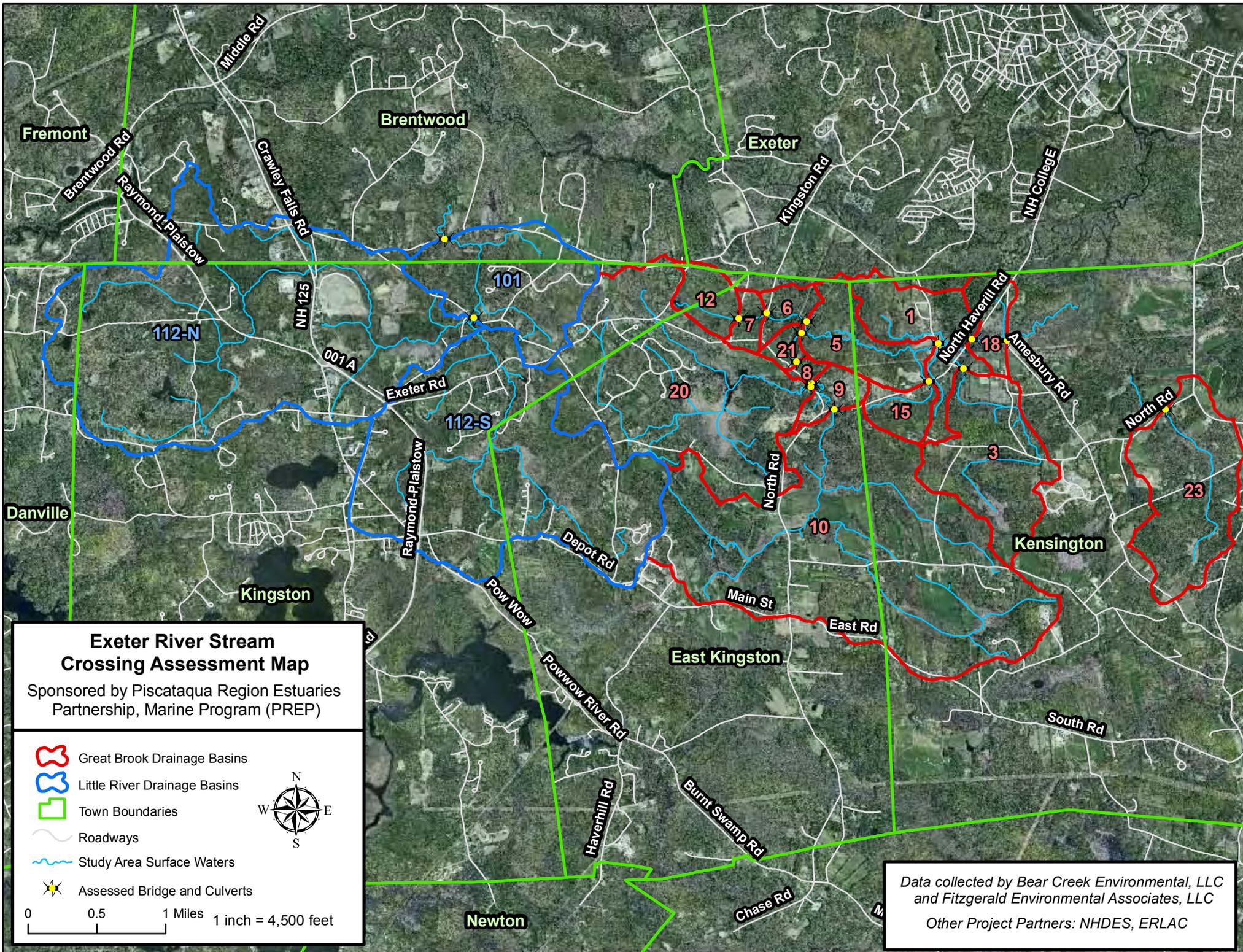


## **APPENDIX A**

### **PREP CHANNEL CROSSINGS ON TRIBUTARIES OF THE MIDDLE AND LOWER EXETER RIVER**



**Exeter River Stream Crossing Assessment Map**

Sponsored by Piscataqua Region Estuaries Partnership, Marine Program (PREP)

-  Great Brook Drainage Basins
-  Little River Drainage Basins
-  Town Boundaries
-  Roadways
-  Study Area Surface Waters
-  Assessed Bridge and Culverts



0 0.5 1 Miles 1 inch = 4,500 feet

Data collected by Bear Creek Environmental, LLC and Fitzgerald Environmental Associates, LLC  
 Other Project Partners: NHDES, ERLAC

**Exeter River Stream Crossing Assessments**

Sponsored by Piscataqua Region Estuaries Partnership, Marine Program (PREP)

Data Collection by Bear Creek Environmental, LLC and Fitzgerald Environmental Associates, LLC

Other Project Partners: NHDES, ERLAC

January 25, 2010

Survey Conducted on August 13 and 14, 2009

**Table 1.** Summary of culvert ranking for replacement and retrofit using flooding potential, geomorphic compatibility and aquatic organism passage.

Stream Name	Crossing Location	Local Structure ID	Structure Type	HGC <sup>1</sup> Bankfull Channel Width (ft)	Structure Width	Structure Width as % of Bankfull Width <sup>2</sup>	Estimated Structure Capacity for Flood Events (% Capacity) <sup>3</sup>		Geomorphic Compatibility <sup>4</sup>	Aquatic organism Passage (AOP) <sup>5</sup>	Condition	Priority for Replacement
							25-Year	50-Year				
Brickyard Brook	B & M Railroad Culvert	6	Culvert	7.9	4.0	51%	14%	13%	Partially Compatible	Reduced AOP	Old	High
	Joslin Road	7	Culvert	6.6	4.0	61%	52%	44%	Partially Compatible	Reduced AOP	Old/rusted	Moderate
	Greystone Road	12	Culvert	5.4	2.0	37%	226%	190%	Partially Compatible	Reduced AOP	New	Moderate
Hobbs Brook	Hobbs Road	3	Culvert	11.1	4.0	36%	73%	61%	Mostly Incompatible	No AOP	New	High
Spring Brook	North Haverill Road	15	Culvert	5.2	2.5	48%	78%	66%	Mostly Incompatible	No AOP	Old	High
York Brook	Giles Road	20	Culvert	17.2	4.0	23%	18%	15%	Partially Compatible	Reduced AOP	Old/rusted	High
Tributary to Mill Brook	North Road	23	Culvert	11.8	3.5	30%	15%	12%	Partially Compatible	Reduced AOP	Old/rusted	High
Little River	South Road	101	Bridge	32.8	15.0	46%	69%	56%	Partially Compatible	NA	Old/repair work	Low
	Little River Road	112	Bridge	30.8	17.5	57%	144%	117%	Partially Compatible	NA	New	Low
Great Brook	Amesbury Road	18	Culvert	34.0	12.0	35%	5%	5%	Mostly Compatible	Reduced AOP	Old	High
	North Haverill Road	1	Culvert	33.6	10.0	30%	23%	22%	Mostly Compatible	Reduced AOP	Old	High
	Kimball Road	5	Culvert	29.8	4.0	54%	48%	40%	Mostly Incompatible	Reduced AOP	Old/rusted	Moderate
	B & M Railroad Arch	21	Arch	28.2	11.5	41%	549%	517%	Mostly Incompatible	NA	Old	Moderate
	B & M Railroad Bridge	8	Bridge	22.5	11.5	51%	709%	690%	Partially Compatible	NA	Old	Low
	Bioteau Drive	9	Culvert	22.4	8.1	36%	51%	51%	Partially Compatible	Reduced AOP	Old/rusted	Moderate
	North Road	10	Culvert	22.0	8.0	36%	51%	43%	Mostly Compatible	Reduced AOP	New	Moderate

<sup>1</sup> NH Hydraulic Geometry Curves (HGC) used to calculate the bankfull width; <sup>2</sup> Shaded for bankfull width percentage less than 50%; <sup>3</sup> Shaded based on estimated capacity of structure to pass flood flows for existing hydrologic conditions; <sup>4</sup> Scores and Ratings developed with the VTANR Geomorphic Compatibility Screening Tool; <sup>5</sup> Aquatic Organisms Passage ratings developed with the VTANR methodology; Note: AOP Screen not applicable to bridges.

**LEGEND**

Parameter	Category	Percentage	Parameter	Category	Explanation
Bankfull Width	Significantly Undersized	≤50%	Geomorphic Compatibility	Fully Incompatible	Structure fully incompatible with channel and high risk of failure
	Undersized	51-99%		Mostly Incompatible	Structure mostly incompatible with channel and moderate risk of failure
	Adequate	≥100%		Partially Compatible	Structure compatible with either current form or process, but not both
Estimate Flood Capacity	Significantly Reduced	0-25%	Aquatic Organism Passage	Mostly Compatible	Structure mostly compatible and there is low risk of failure
	Reduced to Sig. Reduced	26-50%		Fully Compatible	Structure fully compatible with natural channel form and process
	Reduced	51-99%		No AOP	No passage for all aquatic organisms including adult salmonids
	Adequate	≥100%		No AOP	No passage for all aquatic organisms except adult salmonids
				Reduced AOP	Reduced aquatic organism passage for all aquatic organisms
		Full AOP	Full aquatic organism passage for all aquatic organisms		
			NA	Not applicable, structure is a bridge or arch	

**Priority for Replacement or retrofit\***

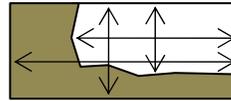
Parameter	High	Moderate	Low
Aquatic Organism Passage	No AOP	Reduced AOP	
Geomorphic Compatibility	Fully Incompatible	Mostly Incompatible	Partially Compatible
Estimated Flood Capacity	Flood capacity ≤25%	Flood capacity ≤50%	Flood capacity <100%

\* The structures have been assigned a priority for replacement or retrofit based on meeting one or more of the above criteria.

The condition of the structure should also be considered when developing replacement/retrofit options.

**Brickyard Brook  
East Kingston, NH**

Location: B&M Railroad  
Local Structure ID: 6  
Culvert Length: 95.0 feet  
Culvert Height: 2.5 feet (upstream dimension 2.0 feet – blocked with sediment)  
Culvert Width: 6.0 feet (upstream dimension 4.0 feet – blocked with sediment)  
Condition: Old



Inlet



Outlet – at grade

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Undersized (51%)

Slope – Culvert slope lower than channel slope

Approach Angle – Mild bend

Erosion and Armoring – Sharp bend below structure with high bank erosion downstream

Sediment Continuity – Elevation of sediment deposits upstream is greater than ½ bankfull elevation

Additional problems noted: Inlet of culvert obstructed by wood and sediment; culvert is likely 6 foot wide by 2.5 foot wide, but so much sediment has aggraded within the structure that it is significantly blocked at the upstream end; water in crossing is deeper and slower than stream.

**Aquatic Organism Passage – Reduced**

- Structure opening partially obstructed
- Sediment likely not throughout structure, if present substrate is silt

**Estimated Flood Capacity – Significantly Reduced**

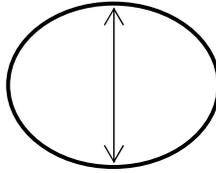
Flood capacity for flood events

- 25 year – 14%
- 50 year – 13%

**Priority for Replacement - High**

**Brickyard Brook  
East Kingston, NH**

Location: Joslin Road  
Local Structure ID: 7  
Culvert Length: 52.0 feet  
Culvert Height: 3.0 feet  
Culvert Width: 4.0 feet  
Condition: Old/rusted



Inlet



Outlet – cascade

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Undersized (61%)

Slope – Culvert slope higher than channel slope

Approach Angle – Naturally straight

Erosion and Armoring – Downstream bank armoring failing; high bank erosion (widening) below structure

Sediment Continuity – Elevation of sediment deposits upstream is greater than ½ bankfull elevation; mid-channel bars upstream and downstream of structure

Notes: Evidence of beaver activity (cleared trees, but no beaver dams observed); water in crossing is shallower and faster than stream

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Reduced to Significantly Reduced**

Flood capacity for flood events

- 25 year – 52%
- 50 year – 44%

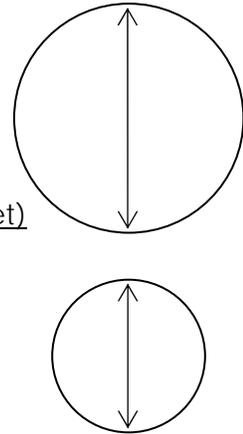
**Priority for Replacement - Moderate**

**Brickyard Brook  
 East Kingston, NH**

Location: Greystone Road  
 Local Structure ID: 12  
Culvert  
 Culvert Length: 112.5 feet  
 Culvert Height: 2.0 feet  
 Culvert Width: 2.0 feet  
 Condition: New

Overflow Culvert (5.3' higher at inlet)

Culvert Length: 81.0 feet  
 Culvert Height: 3.0 feet  
 Culvert Width: 3.0 feet



Inlet



Outlet – at grade



inlet of overflow culvert

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Significantly undersized (37%)

Slope – Culvert slope higher than channel slope

Approach Angle – Mild bend

Erosion and Armoring – No hardbank armoring; no bank erosion upstream and low bank erosion downstream of structure

Sediment Continuity – Steep riffle above structure

Notes: Crossing has two stacked culverts. Base flow culvert below is small; 2 foot diameter and overflow culvert is significantly larger 3 foot diameter.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Adequate**

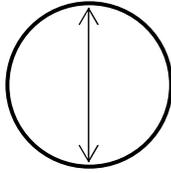
Flood capacity for flood events

- 25 year – 226%
- 50 year – 190%

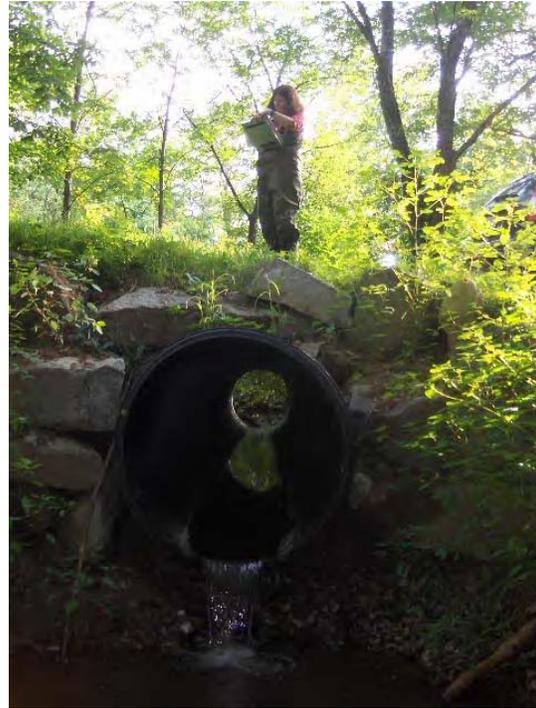
**Priority for Replacement - Moderate**

**Hobbs Brook  
Kensington, NH**

Location: Hobbs Road  
Local Structure ID: 3  
Culvert Length: 35.0 feet  
Culvert Height: 4.0 feet  
Culvert Width: 4.0 feet  
Condition: New



Inlet



Outlet – freefall

**Geomorphic Compatibility – Mostly Incompatible**

Percent Bankfull Width – Significantly undersized (36%)

Slope – Culvert slope about the same as channel slope

Approach Angle – Sharp bend

Erosion and Armoring – No hard bank armoring; bank erosion high downstream of structure

Sediment Continuity – Mid-channel bar and side bar above structure, but sediment deposits less than ½ bankfull elevation

Notes: Upstream of culvert the channel has good floodplain access and wetland vegetation. However, this culvert is new and has been installed without regard to fish passage and hydrology. It is undersized and severely perched.

**Aquatic Organism Passage – No AOP**

- Outlet freefall and outlet drop greater than 1 foot
- Outlet freefall and water depth at outlet less than 0.3 feet

**Estimated Flood Capacity – Reduced**

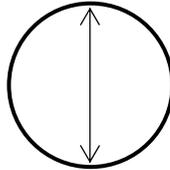
Flood capacity for flood events

- 25 year – 73%
- 50 year – 61%

**Priority for Replacement - High**

**Spring Brook  
Kensington, NH**

Location: North Haverill Road  
Local Structure ID: 15  
Culvert Length: 65.0 feet  
Culvert Height: 2.5 feet  
Culvert Width: 2.5 feet  
Condition: Old



Inlet



Outlet – freefall



Channel upstream of culvert

**Geomorphic Compatibility – Mostly Incompatible**

Percent Bankfull Width – Significantly undersized (48%)

Slope – Culvert slope about the same as channel slope

Approach Angle – Sharp bend

Erosion and Armoring – Coarse gravel sized material on the slope between the culvert and road on the downstream end is washing into the channel; bank erosion high above structure

Sediment Continuity – Nothing noted

Notes: Undersized and fish passage issue; water in crossing is shallower and faster than stream

**Aquatic Organism Passage – No AOP**

- Outlet freefall and outlet drop greater than 1 foot
- Outlet freefall and water depth at outlet less than 0.3 feet

**Estimated Flood Capacity – Reduced**

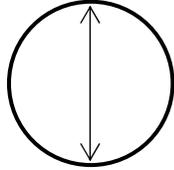
Flood capacity for flood events

- 25 year – 78%
- 50 year – 66%

**Priority for Replacement - High**

**York Brook  
East Kingston, NH**

Location: Giles Road  
Local Structure ID: 20  
Culvert Length: 60.0 feet  
Culvert Height: 4.0 feet  
Culvert Width: 4.0 feet  
Condition: Old/rusted



Inlet



Outlet - cascade

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Significantly undersized (23%)

Slope – Culvert slope higher than the channel slope

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion was noted; however, hard bank armoring is failing above and below the structure.

Sediment Continuity – Nothing noted

Notes: Culvert is perched and the bottom is rusted out at the upstream end. This culvert is in poor condition and should be replaced. A wetland is located upstream of the culvert, so no bankfull measurement could be made.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Significantly Reduced**

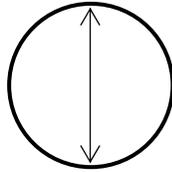
Flood capacity for flood events

- 25 year – 18%
- 50 year – 15%

**Priority for Replacement - High**

**Tributary to Mill Brook  
Kensington, NH**

Location: North Road  
Local Structure ID: 23  
Culvert Length: 28.0 feet  
Culvert Height: 3.5 feet  
Culvert Width: 3.5 feet  
Condition: Old/rusted



Inlet with beaver baffle



Outlet at grade

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Significantly Undersized (30%)

Slope – Culvert slope about the same as channel slope

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion was noted; however, hard bank armoring is failing below the structure.

Sediment Continuity – Nothing noted

Notes: Structure has a beaver baffling device through it that extends out into the upstream wetland. No beaver activity was noted at the time of the survey; but the site has the potential to be dammed that could lead to flooding.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Significantly Reduced**

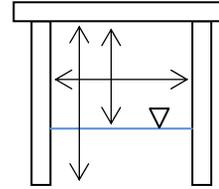
Flood capacity for flood events

- 25 year – 15%
- 50 year – 12%

**Priority for Replacement - High**

**Little River  
Brentwood, NH**

Location: South Road  
Local Structure ID: 101  
Bridge Length: 22.0 feet  
Bridge Clearance: 6.5 feet to water surface, 9.5 feet to thalweg  
Bridge Span: 15.0 feet  
Condition: Old/repair work on underside of bridge



Erosion of the bridge underside looking downstream at the inlet



Pool downstream of the outlet

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Significantly undersized (46%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion was noted; however, hard bank armoring is failing below the structure.

Sediment Continuity – Nothing noted

Notes: Structure is a severe constriction. Degradation to the road surface and underside of the structure was observed. Structure was being restored at the time of the survey. Poor erosion control was noted, including a failing silt fence.

**Aquatic Organism Passage – Not applicable**

**Estimated Flood Capacity – Reduced**

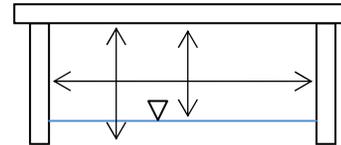
Flood capacity for flood events

- 25 year – 69%
- 50 year – 56%

**Priority for Replacement - Low**

**Little River  
Kingston, NH**

Location: Farm Road  
Local Structure ID: 112  
Bridge Length: 22.0 feet  
Bridge Clearance: 6.6 feet to water surface, 8.0 feet to thalweg  
Bridge Span: 17.5 feet  
Condition: New



Bridge Inlet



Outlet

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Undersized (57%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion was noted; however, hard bank armoring above structure is failing.

Sediment Continuity – Nothing noted

Notes: Structure located about 100 feet downstream of a crib dam. The structure is a channel constriction, but does not appear to be causing localized geomorphic instability. Japanese knotweed is present downstream of the bridge.

**Aquatic Organism Passage – Not applicable**

**Estimated Flood Capacity – Adequate**

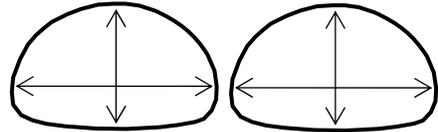
Flood capacity for flood events

- 25 year – 144%
- 50 year – 117%

**Priority for Replacement - Low**

**Great Brook  
Kensington, NH**

Location: Amesbury Road  
Local Structure ID: 18  
Culvert Length: 55.0 feet  
Culvert Height: 4.0 feet  
Culvert Width: 6.0 feet  
Number of Culverts: 2, Side-by-side (Same dimensions)  
Condition: Old/good condition overall



Wetland Upstream



Outlet Wetland

**Geomorphic Compatibility – Mostly Compatible**

Percent Bankfull Width – Significantly undersized (35%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion was noted, wetland setting up and downstream

Sediment Continuity – Nothing noted

Additional problems noted: The capacity to handle large flood events at this structure site is very low. The road has reportedly been flooded over with water during large storm events.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Significantly Reduced**

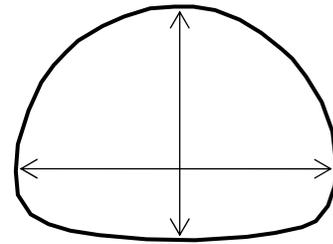
Flood capacity for flood events

- 25 year – 5%
- 50 year – 5%

**Priority for Replacement - High**

**Great Brook  
Kensington, NH**

Location: North Haverill Road  
Local Structure ID: 1  
Culvert Length: 40.0 feet  
Culvert Height: 7.0 feet  
Culvert Width: 10.0 feet  
Condition: Old



Inlet



Downstream Wetland

**Geomorphic Compatibility – Mostly Compatible**

Percent Bankfull Width – Significantly undersized (30%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion or bank armoring was noted

Sediment Continuity – Nothing noted

Additional problems noted: The capacity to handle large flood events at this structure site is low.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Significantly Reduced**

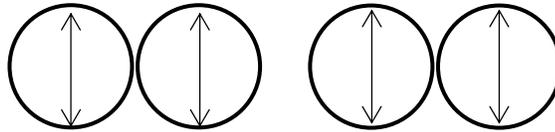
Flood capacity for flood events

- 25 year – 23%
- 50 year – 22%

**Priority for Replacement - High**

**Great Brook  
Kensington, NH**

Location: Kimball Road  
Local Structure ID: 5  
Culvert Length: 34.0 feet  
Culvert Height: 4.0 feet  
Culvert Width: 4.0 feet  
Number of Culverts: 4, Side-by-side (Same dimensions)  
Condition: Old/rusted



Inlet



Downstream Wetland

**Geomorphic Compatibility – Mostly Compatible**

Percent Bankfull Width – Undersized (54%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion or bank armoring was noted

Sediment Continuity – Nothing noted

Additional problems noted: The two culverts to the north are partially rusting out on the bottom; this could be problematic in the future.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Reduced to Significantly Reduced**

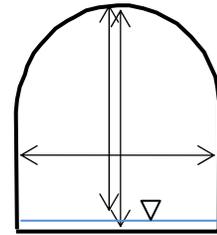
Flood capacity for flood events

- 25 year – 48%
- 50 year – 40%

**Priority for Replacement - Moderate**

**Great Brook  
East Kingston, NH**

Location: Boston and Maine Railroad Arch Crossing  
Local Structure ID: 21  
Arch Length: 70.0 feet  
Arch Clearance: 12.3 feet to water surface, 12.5 feet to thalweg  
Arch Span: 11.5 feet  
Condition: Old



Inlet



Outlet

**Geomorphic Compatibility – Mostly Incompatible**

Percent Bankfull Width – Significantly undersized (41%)

Approach Angle – Sharp bend

Erosion and Armoring – High degree of bank erosion was observed up and downstream and hard bank armoring was failing up and downstream

Sediment Continuity – Point bar observed upstream that was greater than ½ of bankfull height.

Additional problems noted: Channel is braided downstream and appears to enter into a wetland approximately 1,000 feet downstream. The structure is robust, but the constriction has led to some aggradation upstream in the form of bars, and some bank erosion and a large pool downstream. The bottom of the structure is lined with large slabs of stone.

**Aquatic Organism Passage – Not applicable**

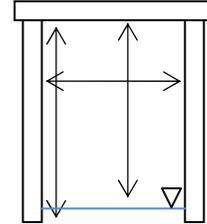
**Estimated Flood Capacity – Adequate**

Flood capacity for flood events

- 25 year – 549%
- 50 year – 517%

**Priority for Replacement - Moderate**

**Great Brook  
East Kingston, NH**



Location: Boston and Maine Railroad  
Bridge Crossing and Private Driveway

Local Structure ID: 8

Bridge Length: 130.0 feet

Bridge Clearance: 13.6 feet to water surface, 14.0 feet to thalweg (B&M)

Bridge Span: 11.5 feet (B&M)

Bridge Clearance: 11.8 feet to water surface, 12.3 feet to thalweg (Driveway)

Bridge Span: 11.5 feet (Driveway)

Condition: Old



Inlet



Outlet

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Undersized (51%)

Approach Angle – Naturally Straight

Erosion and Armoring – High degree of bank erosion was observed downstream and hard bank armoring was failing up and downstream

Sediment Continuity – Mid-channel bar observed downstream along with large debris

jam Additional problems noted: Bridge assessment is for two individual crossings that have the same stone sidewall structure for 130' the downstream crossing is the B & M Railroad Bridge and the upstream crossing is a small bridge that is part of a private driveway. The channel bed within the structure is large rock slabs, similar to the arch downstream.

**Aquatic Organism Passage – Not applicable**

**Estimated Flood Capacity – Adequate**

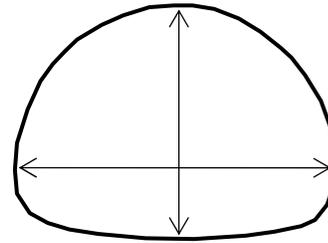
Flood capacity for flood events

- 25 year – 709%
- 50 year – 690%

**Priority for Replacement - Low**

**Great Brook  
East Kingston, NH**

Location: Bioteau Drive  
Local Structure ID: 9  
Culvert Length: 25.0 feet  
Culvert Height: 7.8 feet  
Culvert Width: 8.1 feet  
Condition: Old/rusted



Inlet



Outlet

**Geomorphic Compatibility – Partially Compatible**

Percent Bankfull Width – Significantly undersized (36%)

Approach Angle – Mild bend, Channel will follow road for 10 feet if avulsion occurs.

Erosion and Armoring – Low bank erosion was noted; stone headwall in good shape.

Sediment Continuity – Nothing noted

Additional problems noted: Culvert is a squashed culvert that is a bankfull and floodprone channel constriction. Upstream of Bioteau Drive crossing the west bank had some gravel that seems to have been placed there. The culvert bottom is rusted at the inlet.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Reduced**

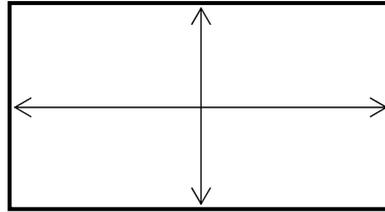
Flood capacity for flood events

- 25 year – 51%
- 50 year – 51%

**Priority for Replacement - Moderate**

**Great Brook  
East Kingston, NH**

Location: North Road  
Local Structure ID: 10  
Culvert Length: 43.0 feet  
Culvert Height: 4.3 feet  
Culvert Width: 8.0 feet  
Condition: New



Upstream from Inlet



Outlet

**Geomorphic Compatibility – Mostly Compatible**

Percent Bankfull Width – Significantly undersized (36%)

Approach Angle – Naturally straight

Erosion and Armoring – No bank erosion or armoring was noted

Sediment Continuity – Nothing noted

Additional problems noted: Structure is a bankfull and floodprone constriction. There were invasive herbaceous species noted at this crossing; both purple loosestrife and Japanese knotweed. Aerial imagery shows ponding in the upstream channel approximately 250 feet above.

**Aquatic Organism Passage – Reduced**

- Sediment not throughout structure

**Estimated Flood Capacity – Reduced to Significantly Reduced**

Flood capacity for flood events

- 25 year – 51%
- 50 year – 43%

**Priority for Replacement - Moderate**