



**THE STATE OF NEW HAMPSHIRE**  
**DEPARTMENT OF TRANSPORTATION**



**CHARLES P. O'LEARY, JR.**  
**COMMISSIONER**

Bureau of Bridge Design  
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February 4, 2008

**JEFF BRILLHART, P.E.**  
**ASSISTANT COMMISSIONER**

Deborah S. Loiselle  
River Restoration Coordinator  
NH Department of Environmental Services  
Water Division - Dam Bureau  
29 Hazen Drive, PO Box 95  
Concord, NH 03302-0095

Re: Removal of Merrimack Village Dam and affect on the Chamberlain Bridge  
US Route 3 over the Souhegan River, Br. No. 116/120

Dear Ms. Loiselle:

This letter is in response to the many past discussions and correspondence regarding the above referenced subject. It is my understanding that NHDES has requested an opinion from the NHDOT Bridge Design Bureau regarding the potential impacts that removal of the Merrimack Village Dam could have on the Chamberlain Bridge. Background information on this bridge will be followed by our perspective on removal of the dam and its affect on the bridge.

Our opinion is based on the information contained in the *Ice Impacts Resulting from Removal of the Merrimack Village Dam*, a report prepared by Carrie M. Vuyovich, PE, of the US Army Cold Regions Research Laboratory in Hanover, NH. This report is dated November 2007 and was prepared for Gomez and Sullivan Engineers with support from the US Army Corps of Engineers Wetlands Regulatory Assistance Program. We also obtained information from our inspection records of this bridge as well as engineering references, as appropriate.

Please note that our response does not include any review or opinion regarding the assumptions, calculations, or conclusions of the hydraulic, hydrologic, and ice modeling data of the Souhegan River area. Our response is directed solely to the issue of the effect the dam removal may have on the bridge structure.

Background:

The Chamberlain Bridge is owned by the Town of Merrimack. It is a stone masonry arch structure founded on ledge when constructed in 1921. It was extended to the downstream side in 1934 to provide a wider roadway area above the arch. It has a total bridge length of 113' and is comprised of two spans; a 60' span for the main channel of the Souhegan River and a 21.5' span that provides an opening for a raceway from the dam that originally directed water to an adjacent mill. Although they no longer serve the mill, the raceway and arch opening receive minimal leakage from the gates and overflow during flood events. The Merrimack Village Dam is located approximately 130' upstream of the Chamberlain Bridge. The Souhegan River meets the Merrimack River approximately 2,000' downstream from the Chamberlain Bridge.

This bridge is inspected every two years by NHDOT Bridge Inspectors, in accordance with National Bridge Inspection Standards. It was last inspected in January 2006 and is scheduled for inspection in early 2008. The inspection data is reviewed and load capacity ratings performed, if needed, before copies of the inspection report are sent to the Town Officials. Its condition is currently rated as "6-Satisfactory" and has been rated as such for at least 10 years, although some deficiencies exist in its structural condition. It currently has an E-2 load posting which allows it to carry most legal loads. This bridge is considered historic and is listed on the New Hampshire State Register of Historic Places.

#### Impacts to Chamberlain Bridge due to Dam Removal:

The report prepared by Carrie M. Vuyovich, PE, *Ice Impacts Resulting from Removal of the Merrimack Village Dam*, concludes that an ice jam event is more likely to occur and extend up the Souhegan River to the bridge once the dam is removed. The worst case for ice jams was determined to be at or between the 2-year and 10-year flood flows, with a resulting water depth of about 12'. Since this equates to the water/ice still being below the top of the arch waterway opening, water and ice are not expected to overtop the roadway. The anticipated water flow velocities under the bridge during the 2-year and 10-year flow events were estimated to be 10 fps or less.

An arch-type structure is inherently stable, providing that it is founded on sufficiently solid material to prevent uneven settlement of the arch stones. If any settlement were to occur, distortion in the alignment of the arch stones could result and cause it to become unstable, perhaps even to the point of failure. However, since the Chamberlain Bridge is founded on exposed bedrock, and since there is no indication of any uneven settlement or distortion of the masonry arch, the Department has no concerns with the overall stability of this structure due to scour and/or water flow at the bridge, whether or not the dam is removed.

The configuration of the masonry arch presents a vertical stone face, perpendicular to the direction of water flow, with the arch opening allowing water to flow under the roadway. This means that any water or ice flowing downstream outside the arch opening would impact the vertical headwalls and ring stones of this arch. AASHTO Specifications list four modes of ice action, as noted below and including our perspective:

1. Dynamic pressure due to moving sheets or floes of ice being carried by stream flow, wind, or currents. Ice moving in the river could impact individual stones with a force much greater than the pressure of water flow against the headwall. This could be equated to the force of a hammer blow against a single stone as compared to a constant pressure being distributed along the entire face of the headwall. Such an impact by ice chunks may not actually damage any of the granite stones, but if any of the arch stones were to become dislodged, the overall stability of the arch could be called into question. This would be our greatest concern for the bridge. Having said that, we feel that the likelihood is fairly low that an arch stone will be dislodged as a result of ice impact. Obviously we cannot guarantee that such an event will not ever occur, but considering that the bridge remains stable and in good alignment after being in service for about 80 years, we do not have significant concerns with such damage occurring.

2. Static pressure due to thermal movements of ice sheets. This force would be present if an ice sheet were to form under the arch and remain in place between the sides of the arch itself. As a static (stationary) force, this would act on the arch as the ice expands and contracts. Since the water at the Chamberlain Bridge is always in motion and flowing, this type of force would not apply and thus is of no concern.

3. Pressure resulting from hanging dams or jams of ice. This is the 0.20 ksf force referenced in the above referenced report by Carrie M. Vuyovich. The resulting 24,000 lbs. total lateral force is assumed to be acting on the full submerged face of the arch headwall, as estimated in the report. This total force is not sufficient to cause any overturning of the structure, and thus the arch will remain stable in that plane. Therefore, this ice force is of little concern for this bridge structure and site.

4. Static uplift or vertical load resulting from adhering ice in waters of fluctuating level. This would act as an upward force or a downward force due to ice adhering to the face or headwall of the stone arch. It would be present only if the water level were to fluctuate, e.g., to raise and "push" the ice upward or to lower and allow gravity to "drag" the ice downward, from the face of the arch and headwall. Since the water level at this site does not fluctuate in that manner, and since the water is always moving so that an ice sheet would not adhere to the arch or headwall, this ice force is of little concern for this bridge structure and site.

Summary:

Based on the information included or referenced in this response, it is the Department's perspective that the actual impacts to the Chamberlain Bridge (and the risk of their occurrence) associated with removal of the Merrimack Village Dam, seem to be acceptable.

I trust this addresses your inquiry. If you have further questions or if you need additional information, please feel free to contact me. A copy of the latest bridge inspection report and a reduced set of bridge plans (which also show the dam) are attached for your use and reference.

Sincerely,



Mark W. Richardson, PE  
Administrator, Bridge Design

MWR

cc: W. Cass, D. Powelson, N. Mayville  
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**RECEIVED**

FEB -- 4 2008

**DEPARTMENT OF  
ENVIRONMENTAL SERVICES**



**Bridge Inspection Report**

Merrimack 116/120

Federal or State Definition Bridge: Fed. Definition Bridge  
 Roadway Functional Class: Rural Minor Arterial  
 New Hampshire Highway System and Class: Primary-Compact Maint.  
 Eligibility for the National Register of Historic Places: Eligible (Historic)  
 Traffic Direction: Two-way traffic

**National Bridge Inventory (NBI) Appraisal Ratings:**

Deck Geometry: Minimum Tolerable  
 Underclearances: Not Applicable (NBI)  
 Approach Alignment: Equal Minimum Criteria  
 Structural Evaluation: Intolerable, Correctable  
 Channel/Channel Protection: Minor Damage  
 Waterway Adequacy: Above Desirable Criteria  
 Bridge Scour Critical Status: Stable for extreme flood  
 Riprap Condition: Good Condition  
 Debris Present: No Debris Present  
 Date of Underwater Inspection: Not Applicable

**AASHTO CoRe Element Condition State Data:**

No.	Description	Env.	Material Notes and Condition Notes
39	Concrete Slab - Unprotected, with Asphalt Pavement	Moderate	ASPHALT- CRACKED, SETTLED. CONCRETE SIDEWALK SPALLED AT EAST.
105	Reinforced Concrete Box Girder (Closed Web)	Moderate	SPALLED WITH REBAR EXPOSED.
144	Reinforced Concrete Arch	Moderate	
145	Other Material Arch	Moderate	MASONRY ARCH. LIGHT LEAKING, VOIDS AT BASE. LOOSE AND MISSING MORTAR AT JOINTS.
155	Reinforced Concrete Floor Beam	Moderate	CRACKED AND SPALLED.
333	Other Material Bridge Railing	Moderate	
359	Soffit of Conc Deck or Slab Condition Warning Flag	Moderate	LIGHT LEAKING.

# Bridge Inspection Report

Merrimack 116/120

No.	Description	Env.	Quantity	Units	State 1	State 2	State 3	State 4	State 5
39	Concrete Slab - Unprotected, with Asph	Moderate	301	(SF)	0 %	0 %	100 %	0 %	0 %
105	Reinforced Concrete Box Girder (Closed	Moderate	59	(LF)	0 %	100 %	0 %	0 %	
144	Reinforced Concrete Arch	Moderate	10	(LF)	0 %	100 %	0 %	0 %	
145	Other Material Arch	Moderate	33	(LF)	0 %	100 %	0 %	0 %	
155	Reinforced Concrete Floor Beam	Moderate	20	(LF)	85 %	10 %	5 %	0 %	
333	Other Material Bridge Railing	Moderate	226	(LF)	100 %	0 %	0 %		
359	Soffit of Conc Deck or Slab Condition W	Moderate	1	(EA)	0 %	100 %	0 %	0 %	0 %

**Bridge Notes:**

Bridge added to the State Register of Historic Places October 2003

Approach and Roadway Notes: ASPHALT- CRACKED.

**Inspection History:**

<p>Inspection Date: 01/12/2006</p> <p>Notes:</p> <p>JEL inspection comments - DECK- ASPHALT- CRACKED, SETTLED. CONCRETE SIDEWALK SPALLED AT EAST. VOIDS AT BASE OF MASONRY ARCH.</p>	<p>Inspector: JEL</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>
<p>Inspection Date: 09/17/2004</p> <p>Notes:</p> <p>Sufficiency Rating Calculation Accepted by DMB at 12/30/2005 08:54:46 JEL inspection comments- APPROACH SIDEWALK AT NE SPALLED. VOIDS AT BASE OF MASONRY ARCH.</p>	<p>Inspector: JEL</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>
<p>Inspection Date: 09/12/2002</p> <p>Notes:</p> <p>Sufficiency Rating Calculation Accepted by DEP at 10/28/2003 10:10:09</p> <p>FNM inspection comments - PICTURE: B155-16. APPROACH SIDEWALK AT NE SPALLED.</p>	<p>Inspector: FNM</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>
<p>Inspection Date: 07/28/2000</p> <p>Notes:</p> <p>Sufficiency Rating Calculation Accepted by DEP at 12-06-2000 13:26:22 FNM inspection comments - PICTURES: B103- 07. SOUTH APPROACH 08. WEST ELEVATION</p>	<p>Inspector: FNM</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>
<p>Inspection Date: 12/07/1998</p> <p>Notes:</p> <p>Sufficiency Rating Calculation Accepted by DEP at 02-10-1999 15:45:09 JEL inspection comments- MASONRY ARCH- LEAKING, MORTAR MISSING, CONCRETE ARCH AND SLAB EXTENSION DOWNSTREAM. CONCRETE TEE BEAMS ON DECK EXTENSION, SPALLED WITH REBAR EXPOSED ABUTME</p>	<p>Inspector: JEL</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>
<p>Inspection Date: 08/01/1996</p> <p>Notes:</p> <p>Sufficiency Rating Calculation Accepted by dep at 8-20-1998 08:22:55</p>	<p>Inspector: Not Available</p>	<p>Deck: 6 Satisfactory</p> <p>Super: 6 Satisfactory</p> <p>Substr: 6 Satisfactory</p> <p>Culvert: N N/A (NBI)</p>

# Bridge Inspection Report

Merrimack 116/120

### Inspection History:

Inspection Date: 12/01/1994  
Notes:

Inspector: Not Available

Deck: 6 Satisfactory  
Super: 7 Good  
Substr: 6 Satisfactory  
Culvert: N N/A (NBI)

Inspection Date: 01/01/1993  
Notes:

Inspector: Not Available

Deck: 6 Satisfactory  
Super: 7 Good  
Substr: 6 Satisfactory  
Culvert: N N/A (NBI)

### Copy Distribution:

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