

## Underwater Inspection Report



## **MEMORIAL BRIDGE**

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### **SUMMARY**

The underwater portions of the substructure units were found to be in Fair condition due to the more advanced deterioration to the back channel pier. The concrete on the Piscataqua River piers is sound with no significant deterioration except minor deterioration of the outermost ½-inch around the low water line. No evidence of scour was observed. The limits of the underwater inspection extended from low water to the mudline.

The task also included the extraction of six concrete cores, concrete characterization, and material service life prediction. The findings of that study are contained in a separate report but generally support the visual and tactile findings of the underwater inspection.

### **INTRODUCTION**

In June 2009, Appledore Marine Engineering, Inc. (AMEI) completed an underwater inspection of the Memorial Bridge. The inspection was performed by a four-man dive team under the direction of a Professional Engineer, and included a visual and tactile inspection of the North and South Main Bridge Piers and the Kittery Approach Pier. The other bridge substructure units including the Portsmouth Abutment and Kittery approach column foundations are entirely exposed at low water and therefore were excluded from the scope of the underwater inspection.

Previously, Appledore completed underwater inspections for this structure in 2003 and 2008.

### **OBJECTIVE**

The objective of this project is to provide a general description and assessment with recommendations of the underwater condition of the North and South Main Bridge Piers and the Kittery Approach Pier.

### **FACILITY DESCRIPTION**

The Memorial Bridge was constructed in the early 1920's and is approximately 85 years old. It spans over the Piscataqua River connecting Portsmouth, NH with Kittery, ME. The North and South Main Bridge Piers consist of a concrete foundation placed on bedrock at elevation -83 feet (MLW) and -73 feet, respectively. Both piers are constructed of reinforced concrete and have a granite block fascia protecting the concrete through the tidal zone. A timber fender system encompasses the piers from approximately 2 feet above mean high water down to 5 feet below mean low water. The Kittery Approach Pier is of similar construction with a steel sheetpile cofferdam exposed at low water.

### **OBSERVATIONS**

The structures are generally covered in light marine growth and representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration.

#### **North and South Main Bridge Piers**

The concrete is generally in overall sound condition with limited areas of minor deterioration. The deterioration is generally more concentrated around low water. In the low water zone hammer soundings identified that the outer ½-inch of concrete is soft (Photo 1&2). Once the deteriorated concrete was removed, the underlying concrete was sound. The structure also has 12-inch by 12-inch block outs in the concrete from timber members that were originally cast into the piers and marine borers subsequently deteriorated the timber. These voids extend approximately 12-inches into the structure and have had no deleterious effect on the concrete pier (Photo 3).

The timber fender systems have moderate marine borer deterioration throughout (Photo 4). The deterioration has progressed since the 2003 inspection and estimated to have affected approximately

10% - 20% of the timber members. It is important to note that marine borer deterioration is difficult to detect and could be more prevalent within the interior of the timber members.

### **Kittery Approach Pier**

The approach pier is encased in a steel sheet piling. The steel sheet piling has major deterioration due to corrosion and areas of complete section loss. The steel sheeting is believed to be part of the original construction (cofferdam) and likely no longer required, but does provide some abrasion protection for the concrete. No concrete deterioration was observed behind the steel sheeting voids.

### **ASSESSMENTS**

Based on our underwater inspection, the underwater condition of these structures is Satisfactory due to isolated areas of minor deterioration. The deterioration noted in this report is considered minor and no load reductions are required as a result of the underwater structures. Detailed examinations of the concrete cores and service life predictions determined that the concrete below low water has a remaining service life greater than 50 years, provided 1-2 inches of section loss can be tolerated.

The detailed concrete examination and material service life prediction determined that concrete exposed to higher oxygen levels in the tidal and atmospheric zones may require rehabilitation to provide an extended service life.

### **RECOMMENDATIONS**

No repairs are recommended to the underwater portions of the concrete piers.

The fender system is progressively deteriorating and recommended it be replaced in the short term (0-10 years). Our estimate of the probable cost of construction is depicted in Table 1 and is based on in-kind replacement.

**TABLE 1**

<b>Item No.</b>	<b>Recommended Repairs</b>	<b>Estimated Construction Cost (ECC)</b>
1	Replace fender system in-kind	\$ 660,000
	<b>Subtotal</b>	<b>\$ 660,000</b>
	Est. Engineering fees (15%) Insp., Design, Permits, and Const Admin.	\$ 100,000
	<b>TOTAL * say</b>	<b>\$ 760,000</b>

Costs are in 2009 dollars and include: Contingency, Mobilization, and Contractor Overhead and Profit.

## PHOTOGRAPHS

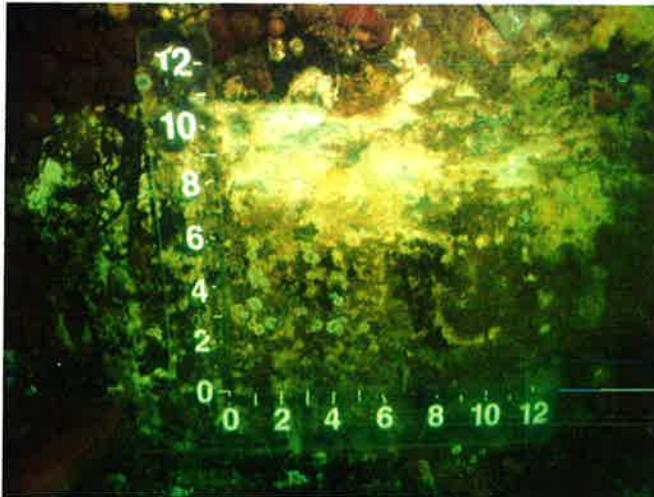


Photo 1:  
Typical concrete deterioration  
around low water. Limited to ½-inch  
in depth.

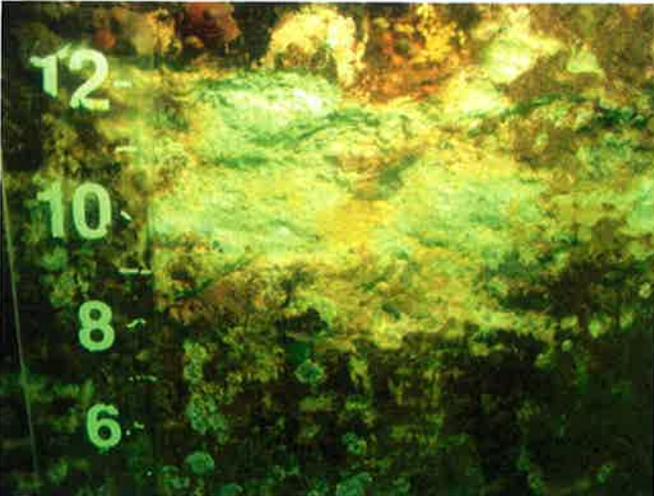


Photo 2:  
Close view of deterioration after  
hammer removal of deteriorated  
concrete.

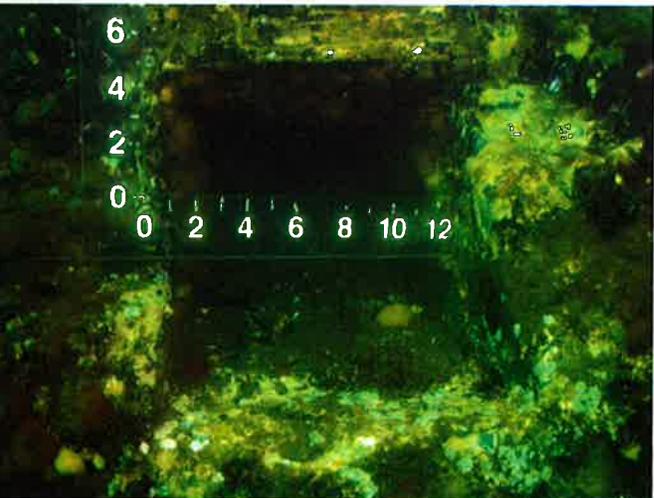


Photo 3:  
Typical blockout in the concrete piers  
where timber elements were once  
connected. Concrete is sound at  
these locations.

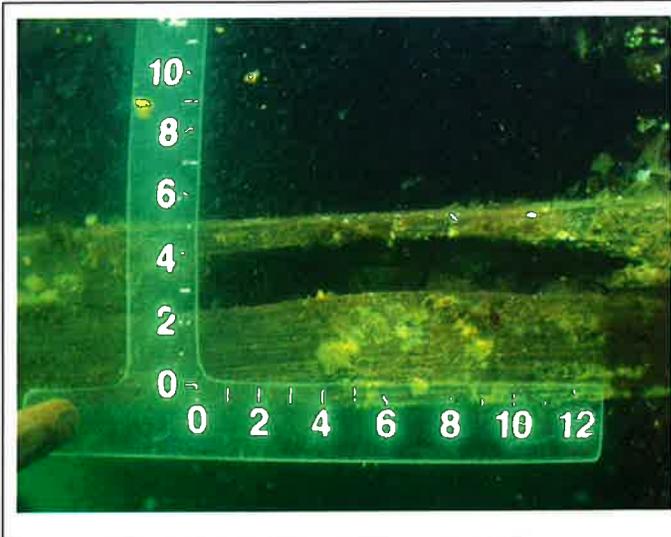
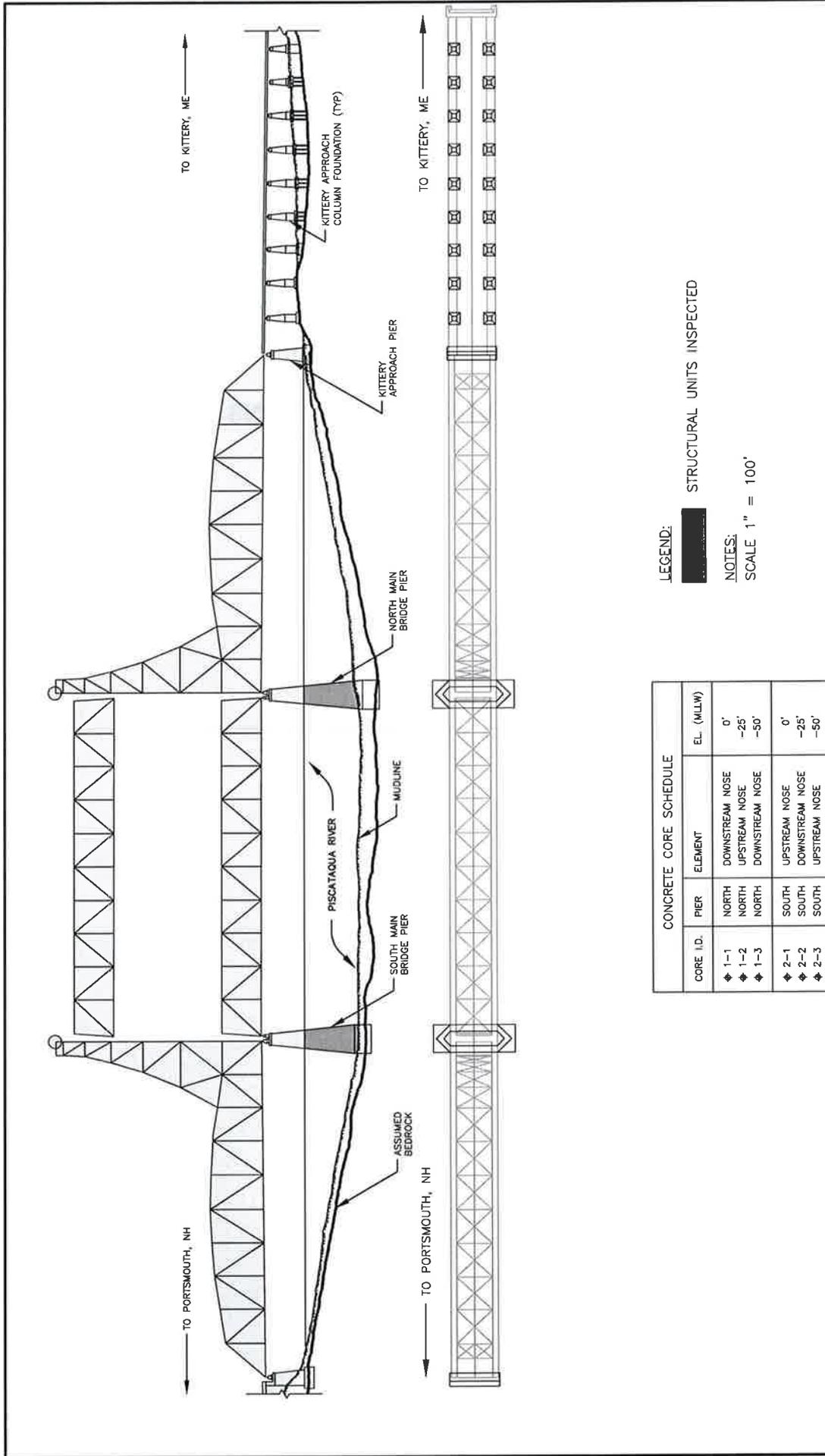


Photo 4:  
Marine borer deterioration to the  
fender system.

## FIGURES



**CONCRETE CORE SCHEDULE**

CORE ID.	PIER	ELEMENT	EL. (MILL)
◆ 1-1	NORTH	DOWNSTREAM NOSE	0'
◆ 1-2	NORTH	UPSTREAM NOSE	-25'
◆ 1-3	NORTH	DOWNSTREAM NOSE	-50'
◆ 2-1	SOUTH	UPSTREAM NOSE	0'
◆ 2-2	SOUTH	DOWNSTREAM NOSE	-25'
◆ 2-3	SOUTH	UPSTREAM NOSE	-50'

**LEGEND:** [REDACTED] STRUCTURAL UNITS INSPECTED

**NOTES:**  
SCALE 1" = 100'

**DRAWING REFERENCE:**  
STATE OF NEW HAMPSHIRE HIGHWAY DEPARTMENT BRIDGE DIVISION, GENERAL PLAN & ELEVATION, FILE NO. 1-18-3-1, 7/30/43, BRIDGE NO. 2471084

	DATE	<b>HR</b> ONE COMPANY 895 ATLANTIC AVE   2ND FLOOR   BOSTON   MA   02111 PORTSMOUTH, NH <b>MEMORIAL BRIDGE</b> PLAN
	GRAPHIC SCALE	AS NOTED
	AUGUST 2009	FIG. NO. 1

## **CONDITION RATING DESCRIPTIONS**

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<b>Rating</b>	<b>Description</b>
Good	<p>No visible damage, or only minor damage is noted.</p> <p>Structural elements may show very minor deterioration, but no overstressing is observed.</p> <p>No repairs are required.</p>
Satisfactory	<p>Limited minor to moderate defects or deterioration are observed, but no overstressing is observed.</p> <p>No repairs are required.</p>
Fair	<p>All primary structural elements are sound, but minor to moderate defects or deterioration is observed.</p> <p>Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure.</p> <p>Repairs are recommended, but the priority of the recommended repairs is low.</p>
Poor	<p>Advanced deterioration or overstressing is observed on widespread portions of the structure, but does not significantly reduce the load-bearing capacity of the structure.</p> <p>Repairs may need to be carried out with moderate urgency.</p>
Serious	<p>Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components.</p> <p>Local failures are possible and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.</p>
Critical	<p>Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components.</p> <p>More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary.</p> <p>Repairs may need to be carried out on a very high priority basis with strong urgency.</p>

From: *Underwater Investigations, Standard Practice Manual*, ASCE, 2001.

