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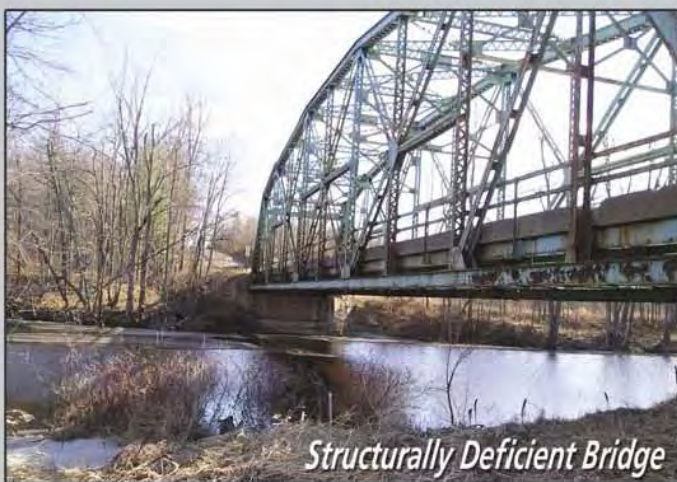


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# Keeping Our Bridges Safe

A report on Maine's bridge inspection and improvement programs - November 26, 2007

Prepared by MaineDOT pursuant to Executive Order Number 04 FY 08/09



*Structurally Deficient Bridge*



*New Bridge on Same Location*



OFFICE OF  
THE GOVERNOR



NO. 04 FY 08 09  
DATE August 2, 2007

**AN ORDER DIRECTING MAINE DOT TO REVIEW MAINE'S  
BRIDGE INSPECTION AND PROGRAMMING**

**WHEREAS**, Maine citizens join the people of Minnesota and the nation in mourning those who lost their lives on August 1, 2007, when a deck truss bridge carrying Interstate 35 over the Mississippi River collapsed; and,

**WHEREAS**, the cause of the bridge collapse is obviously unknown at this time; and,

**WHEREAS**, bridges are an integral part of providing Maine people with a safe and efficient transportation system; and,

**WHEREAS**, the Maine Department of Transportation (MaineDOT) is responsible for nearly 3,000 bridges in Maine, including six deck truss bridges; and,

**WHEREAS**, the Maine Department of Transportation (MaineDOT) currently has a bridge inspection program that meets or exceeds federal standards, such that every public bridge is inspected at least every two years including, as needed, underwater inspection by MaineDOT's Dive Team and use of an underbridge crane to allow inspection of otherwise inaccessible parts of bridges; and,

**WHEREAS**, MaineDOT has an aggressive Bridge Maintenance program, and extensive bridge information systems used to develop Maine's capital and maintenance bridge investment programs; and

**WHEREAS**, the citizens of Maine need to be assured that these programs are adequate to ensure their safety;

**NOW, THEREFORE**, I, John E. Baldacci, Governor of the State of Maine, hereby direct MaineDOT to:

1. Review Maine's bridge inspection program to assure it continues to meet or exceed all applicable federal standards;
2. Utilize the available information on the cause of the Minneapolis bridge collapse to reassess the safety of Maine's bridges and take appropriate action to mitigate any safety concerns;
3. Analyze MaineDOT's capital programming processes and levels for bridges and other critical transportation infrastructure, the failure of which would likely cause loss of life or other significant public safety impacts; and
4. Report back to the Governor on any significant findings as they become available; and within 90 days provide the Governor with a progress report on the review and analysis conducted pursuant to this Order including any findings and recommendations.

**Effective Date**

This Executive Order is effective August 2, 2007 upon signing.

John E. Baldacci, Governor

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## EXECUTIVE SUMMARY

On August 1, 2007, a major bridge carrying Interstate 35 through Minneapolis, Minnesota unexpectedly collapsed, resulting in 13 deaths and 100 injuries. Maine Governor John E. Baldacci immediately took action by issuing an Executive Order directing the Maine Department of Transportation (MaineDOT) to review the safety of Maine's bridges. This report responds to the Executive Order.

Maine bridges are safe. This review process has validated that Maine's inspection, posting and closing procedures are in place to assure public safety by closing bridges when necessary.

Though Maine has programs and processes in place to assure bridge safety, they are more of a "safety net"—not a sustainable solution. We are falling behind in bridge preservation and replacement at an increasing rate. The age and deterioration of our bridge infrastructure is becoming critical, and without a significant infusion of funding, MaineDOT will be forced to post and close an increasing number of bridges, which will significantly impact the economic vitality of the state.

This report contains 25 unanimous recommendations from a team of experts with 284 years of combined professional engineering experience. Their recommendations, if adopted, will assure the future safety of bridges in Maine by strengthening the "safety net" and address the backlog of *poor* (condition) bridges that are in need of repair or replacement.

The team recommends the following major actions:

Strengthen the "safety net" of inspection and posting.

- Improve documentation of bridge inspection policies and procedures
- Implement detailed recommendations for scour and connections
- Respond to new quality assurance recommendations from the Federal Highway Administration (FHWA)
- Adopt a new posting policy
- Submit legislation for photo-enforcement of overweight vehicles on critical bridges

Fund needed repairs and replacements.

- Increase bridge replacements from approximately 14 per year today, to between 30 and 40 per year
- Increase capital bridge funding by \$50 to \$60 million per year (from approximately \$70 million per year today), to between \$120 to \$130 million per year
- Accordingly, \$1.6 to \$1.8 billion (inflation-adjusted) in total bridge funding will be required over the next 10 years

In summary, there are only two ways to protect public safety over the long term: Repair or replace *poor* bridges and preserve *fair* bridges before they become *poor*, OR continue to close bridges when their condition warrants. With over 2,000 bridges in *fair* or *poor* condition, Maine's economy cannot afford to have the highway network become unconnected, nor can we allow unsafe bridges to stay open. Without a balanced, sustainable bridge work plan, load postings and closures will be the only "safety net" left.



# 1. INTRODUCTION

On August 1, 2007, the I-35W Bridge in Minneapolis, Minnesota collapsed, killing 13 people and injuring 100 others. This bridge was 40 years old and has been inspected annually since 1993. The bridge carried an average of about 140,000 vehicles per day.

As an immediate response to the tragedy in Minnesota, Maine Governor John E. Baldacci issued *Executive Order No. 04 FY 08/09*, included in the front of this report, directing the Maine Department of Transportation (MaineDOT) to review Maine's bridge inspection and programming. MaineDOT formed an expert technical team of professional engineers with 284 combined years of experience, including extensive bridge backgrounds, to examine bridge safety and make recommendations found necessary. The team is comprised of professional engineers from MaineDOT, the University of Maine, the Associated General Contractors of Maine, the Federal Highway Administration (FHWA), and a consulting engineer. (The names and biographies of the team participants are included in Appendix A.) The team began work immediately and has met 11 times as a full team to discuss the issues and prepare this report. The recommendations contained in this report have the unanimous support of the team.

The mission of the Maine Department of Transportation (MaineDOT) is "to provide a safe, efficient and reliable transportation system that supports economic opportunity and quality of life." As part of that mission, the responsibility to provide a safe transportation network is of paramount importance. Even with Maine's present transportation improvement program, this responsibility is becoming increasingly challenging due to the aging of our transportation infrastructure and inflationary pressures on construction costs. Bridges and other critical transportation assets are especially vulnerable. This report provides a technical analysis assessing inspection and programming procedures and policies to assure the safety of Maine's bridges and the adequacy of our inspection program. The report will also provide a review to ensure that lessons learned from major bridge failures elsewhere are acted upon. Actions are recommended which, if implemented, will reduce the risk of a safety failure.

MaineDOT's first response was to identify and inspect the six similar deck truss bridges in Maine. Deck truss bridges are identified by the fact that the bridge deck sits on top of a structural steel supporting-truss. This type of structure may be "non-redundant", meaning that a single failure in any of the major components could lead to a collapse. The inspections were completed as of August 10, 2007 and the bridges were found to be safe. Previously, one of these structures had been slated for engineering, one had been programmed for replacement and two had been recently rehabilitated.

Another early response was in reaction to *Technical Advisory 5140.28 – Construction Loads on Bridges* issued by the Federal Highway Administration (FHWA) on August 8, 2007. MaineDOT identified two active construction projects with significant construction loads. The Deer Isle-Sedgwick Bridge and the Waterville I-95 bridges were both reviewed, and it was found that the construction loads have been appropriately accounted for and that the bridges are safe.

In light of these concerns, MaineDOT conducted a thorough review of the policies and procedures with regard to construction loading of bridges (see Appendix B), and has developed and will implement the following recommendations:

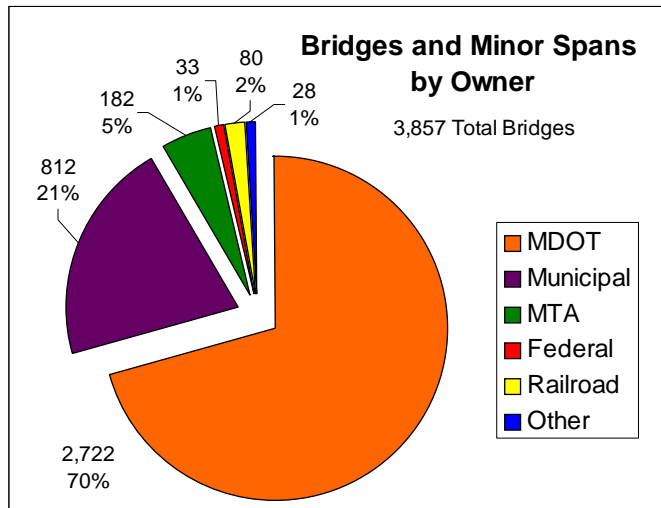
- A standard note will be added to contract plans indicating what construction loads were considered during the design of the project.

- A subsection will be added to the *MaineDOT Standard Specifications* to address construction loadings on bridges. This subsection will address the contractor’s equipment (both construction equipment and equipment within legal loads) that will be used on the structure under construction, and materials placed or stored on the structure during construction.

This report is organized roughly in accordance with the Executive Order. Section 2 explains the scope of this report, Section 3 identifies safety risks, Section 4 details inspection protocols and methods, Section 5 outlines risks associated with truck loads beyond legal limits, Section 6 talks about the challenges of maintaining a technically competent staff, and Section 7 addresses the programming and funding aspects.

## 2. SCOPE OF REVIEW

There are 3,857 known bridges (defined as longer than 20 feet) and minor spans (10 to 20 feet long) in the State of Maine. In this report, “bridges” generally refers to both categories.



*Figure 1*

Figure 1 depicts the entire population of bridges in Maine. MaineDOT is responsible for 70% (2,722) of these bridges. This report will focus on the bridges under MaineDOT jurisdiction. We will share our findings with other identified owners.

### Town Bridges

Currently there are 615 bridges that are less than 20, but greater than 10, feet in length (minor spans) and 197 low-use or redundant bridges on town ways, for which the towns have responsibility. For these bridges and minor spans, MaineDOT’s responsibilities are governed by MRSA Title 23, §563: “... the department shall advise the municipality of its inspection findings, noted deficiencies and recommendations regarding posting or closure. The municipality has sole responsibility and authority to determine whether a structure must be posted or closed, except that the department may close the structure in cases of emergency or when the department reasonably determines closure is necessary to protect the traveling public from imminent hazard. If the department becomes aware of deficiencies in a structure that could impact posting or closure decisions, the department shall promptly notify the municipality. The municipality is responsible



for all costs and expenses related to the posting and closure, including any needed notifications, procedures, signing and barricades.”

Currently, MaineDOT inspects all of these bridges on a two-year cycle. If a bridge is in a condition that in MaineDOT’s professional judgment is not adequate to carry its posted load, MaineDOT sends the town a letter detailing its concerns and recommendations. Suggested enhancements to this procedure are detailed in the “Inspection Program” section.

### **Other Critical Infrastructure**

The team also reviewed other critical transportation infrastructure for inclusion in this report, but found that a significant inventory and inspection program is a first, necessary step to determine the safety risk to the public from such structures.

The team recommends that the following list of structures be inventoried and inspected:

- Highway lighting and traffic signals
- Overhead sign structures
- Pedestrian structures
- Ports and piers
- Retaining walls and earth-retaining structures
- Dams
- Cell phone towers
- Private structures (walkways) over public highways
- Struts (large culvert pipes)

The remainder of this report will focus on bridges only.

## **3. IDENTIFIED SAFETY RISKS**

The team identified, categorized, discussed, prioritized, and developed mitigation strategies to further reduce the probability of a bridge safety event occurring in Maine. Using this approach, the team prioritized the following three categories of risk to bridges in Maine:

1. Scour
2. Structural connections
3. Age and deterioration

### **3.1 Scour**

The most common cause of bridge failure is “scour”. Scour is an engineering term for water-induced erosion of the soil surrounding bridge foundations (piers and abutments). Many bridges nationwide have failed due to scour, and Maine is not immune to this type of failure. A 2003 study in the *Journal of Performance of Constructed Facilities*, which is published by the American Society of Civil Engineers, examined over 500 bridge collapses in the U.S. and found that the average



*Abutment scour with exposed timber piles*

age of the failed structure was 52.5 years, and that the most common causes were flood and scour, which accounted for almost 53 percent of the incidents. Over the past year, Maine has had to close, replace or repair 10 bridges due to scour. Many of Maine’s bridges were designed using spread footings founded directly on gravel. Many were constructed below streambed and armored with heavy rocks, while others were not armored or have had their rocks moved by the water over time.

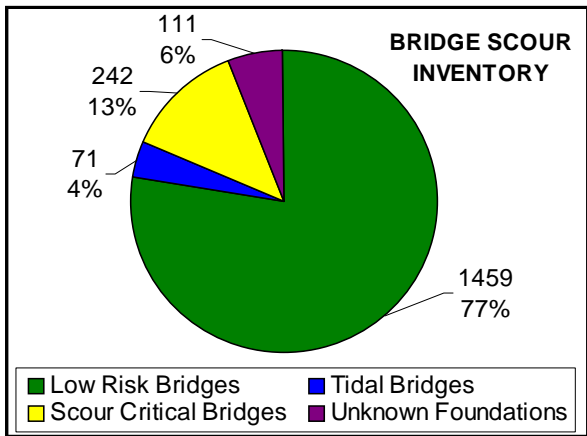


Figure 2

In 1988, pursuant to the FHWA’s National Bridge Scour Program, MaineDOT identified 1883 bridges over water, both on and off the federal system (including town bridges) that needed to be evaluated because the foundations were “scour critical”, scour calculations had not been made, the foundations were unknown, or they were located in waterways influenced by tidal action. Figure 2 presents the outcome of this evaluation and shows that 13% of all bridges over water are scour critical.

The next phase of the scour program as recommended by FHWA is to evaluate the risk of tidal bridges and bridges with unknown foundations, representing another 10% of the total. FHWA is currently developing guidelines for that effort.

Underwater inspections are performed on all bridges that cannot be accessed by wading due to water depth or stream velocity. Photographs and sketches showing streambed profiles and foundation depths are part of the regular documentation for underwater inspections. In addition, bridge managers routinely inspect bridges during and after high water events. The outline and information needed for Plans of Action (POA) for scour critical bridges are in place and the data-gathering process is under way, as time and resources permit. After this is complete, each bridge will need a POA specific to closure during an event or countermeasures needed to limit risk.

Recommendations:

- Complete *Scour Plans of Action* and implement the plans.
- Evaluate tidal and unknown foundations in accordance with FHWA’s pending guidelines.
- Create statewide water-basin maps in order to evaluate critical bridges during high water events.
- Prioritize and implement scour countermeasures on critical routes.
- Document at least one stream cross-section at each bridge for baseline comparison and identification of scour-susceptible bridges.

### 3.2 Structural Connections and Fracture Critical Members

A connection is necessary whenever two or more structural members must be tied together. Connections are common in many steel bridge superstructures. In addition to the necessary welds, bolts (or rivets), pins and additional hardware such as gusset or splice plates, a connection includes the portions of structural members that are bolted, riveted, pin-connected or welded. A connection is defined more broadly in this report to include cover plates, stiffeners, and other attachments. The

recommendations presented here also apply to fracture critical members, which are tension members whose failure can cause the structure to collapse.

Because of locally high stress discontinuities or flaws inherent in connections, they are much more susceptible to fatigue cracking than a plain structural member. Certain details used in the past, such as fully welded vertical web stiffeners, are known to be at particularly high risk for fatigue cracking. Fractures in pin-connected members are a concern due to the possibility of defects that are not easily detected. In addition, heavy connections involving multiple members and connection plates can be especially susceptible to corrosion, since moisture, chemicals and corrosive debris can collect between connector plates and structural members.



*Corrosion of a structural connection*

Under current processes, identification of at-risk connections and fracture critical members is accomplished through routine and special bridge inspections, which include the examination of connections. Serious and immediate problems such as missing or sheared bolts and failed welds are noted. Any existing cracks in members or connection plates are noted and measured. Loss of paint and corrosion are also identified in the inspection. An inventory of connection types is currently maintained to assist in identifying potentially problematic connections.

A procedure for identifying and assessing at-risk connections and fracture critical members is currently in place and functioning as part of bridge inspections. The fact that no bridges have been lost in Maine due to connection failures is a testament to this statement. However, the importance of connection performance to a bridge's structural integrity, and the inevitable deterioration of a connection with increasing years of service, point to the need for continued improvement in existing procedures. Particular areas in which existing procedures can be improved include the ranking of critical connections on a per-bridge basis and the accurate identification of fracture critical members, coupling engineering analysis and design with the inspection process, and with documentation of existing procedures.

#### Recommendations:

- Review plans and other documentation of existing bridges and perform structural analysis as needed to identify all potentially problematic connections and fracture critical members.
- Create schematics of the above connections and any fracture critical members for ready reference in the bridge inspector's file for each bridge.
- Develop special written procedures for inspecting and monitoring critical members and connections.
- Monitor and evaluate the research into new technologies and techniques for inspection and evaluation of connectors and fracture critical members, and implement them, if appropriate.

### 3.3 Age and Deterioration

Material deterioration is inherent in any exposed structure. The materials that are of primary concern are structural concrete, structural steel, reinforcing steel and steel piles. Other materials of

concern include wood and wood piles. The causes of deterioration in concrete include the effects of freeze-thaw cycles, permeability, abrasion, Alkali-Silica Reactivity (ASR) and cracking. The causes of deterioration in structural and reinforcing steel and steel piles include breakdown of protective coatings, attack from chemicals such as chlorides, and stray electrical currents. The causes of deterioration in wood include abrasion, chemical attack, and biological attack.

Although the age of a structure can be a general indicator of the level of its deterioration, the actual level of deterioration of structures of the same age can vary considerably, depending on factors such as structure type and the environmental conditions to which it is subjected. Many older structures are in *fair* to *good* condition and still fit for service.



*Advanced corrosion and section loss*

#### Recommendations:

- Repair or replace critical deteriorated bridges or components before they become a safety issue requiring a bridge to be closed or posted.
- Continue to replace or repair overhead concrete structures that pose a hazard to the public.
- Focus maintenance attention on work that will reduce exposure to corrosive elements on critical structural members and connections, thereby extending service life.
- Provide cathodic protection (a technique for steel protection using a sacrificial metal, therefore preserving the structure) for sub-structure units that are exposed to corrosive environments.



*Concrete spalling and exposed reinforcing steel*

## 4. INSPECTION PROGRAM

MaineDOT's current inspection practices are strong. A team of trained inspectors visits all bridges on a cycle of at least every two years, and MaineDOT also maintains its own dive team for underwater inspections. But Maine's transportation infrastructure is deteriorating faster than our renewal programs can address. Because of this, the inspection program needs to increase the vigilance on these critical structures so that we can continue to assure public safety.

The team recommends the following actions to strengthen the policies/procedures in use at MaineDOT:

- Review the quality assurance procedures of the inspection and posting processes, information systems, and data gathering.
- Adopt a new posting policy (Appendix C).
- Improve documentation of bridge inspection policies and procedures.

- Respond to upcoming changes in National Bridge Inspection Standards (NBIS) Quality Assurance (QA) procedures.
- Develop guidelines for triggers requiring field review and load rating by a professional engineer.
- Implement a 24-month inspection cycle in place of the current biennial cycle in order to more fully comply with federal standards. (For a description of MaineDOT's Bridge Inspection Program, see Appendix D).
- Implement enhanced procedures for town bridges, as set forth below.

#### Enhanced Procedures for Town Bridges:

- To ensure that towns receive and understand notifications recommending needed repairs, posting or closure, MaineDOT will send such recommendations to the town's chief officer (town manager, head selectman, etc.) via certified mail. As cited in the law above, MaineDOT may close a bridge at any time if public safety is threatened.
- To ensure proper notification and protect public safety, these letters will be copied to the public works director or road commissioner. This will alert these officials and allow them to take timely actions.
- MaineDOT will provide in these notifications directions to MaineDOT's public bridge Web site which will contain the bridge posting and closure processes, pertinent bridge laws, typical weights of various styles of vehicles, and information on how small towns may acquire engineering support.
- Finally, MaineDOT will continue to maintain and update its information on the condition, posting, and closure status of town-maintained bridges.

## 5. OVERLOADS

Despite the state's recent efforts to protect our highways and bridges through increased fines for illegally loaded vehicles, significant numbers of overloads still cross Maine's bridges and decrease their margin of safety. Based on 2006 data from "weigh-in-motion" (WIM) stations, approximately 15% of all trucks are overweight, meaning that perhaps 30% of *loaded* trucks are over the legal weight limit. Truck configurations that would be legal at 100,000 pounds have been documented at over 150,000 pounds. Unfortunately, recent increases in fuel prices have hurt the trucking industry and provided additional incentive for some to overload.

The technology now exists to combine real-time WIM with photo enforcement to increase bridge safety, and MaineDOT actually utilized such a system on the Waldo-Hancock Bridge to minimize overloads. Date-and-time stamped pictures showing each overloaded truck with its gross weight and license plate were automatically generated, and the registered owner was contacted and advised that unchecked overloads could result in the bridge being further posted or even closed. Even without the authority to use these pictures for enforcement purposes, this approach decreased overloads by 80%, from 25 per day to less than 5 on most days.

#### Recommendation:

- The state should work with the trucking industry on enabling legislation to allow enforceable photo/WIM technology on critical bridges where weight compliance is particularly necessary to ensure public safety.

## 6. TECHNICAL COMPETENCE

Bridge evaluation for safety is a highly complex endeavor that requires years to master and maintain with ever-changing specifications and technical advancements. In order for the department to make sound technical decisions regarding important life-safety issues facing our state, a pool of talented, technically experienced engineers is essential. This talent pool can only be developed by having engineers spend significant time designing bridges.

Recommendation:

- MaineDOT should implement a technical career track for bridge designers that would provide an avenue for advancement without their having to leave bridge design work to enter the management career ladder.

## 7. PROGRAMMING AND FUNDING

Given Maine's topography and waterways, bridges are vital. Supporting a viable bridge network remains one of MaineDOT's top priorities for funding. Bridges literally connect dozens of communities throughout the state, and bridges that are posted or closed can mean lost productivity and inconvenience due to time-consuming detours. MaineDOT's *Biennial Capital Work Plan for Fiscal Years 2008-2009* includes \$138.6 million for bridges—almost \$70 million per year.

MaineDOT's current biennial work programming balances safety and socio-economic implications when prioritizing bridges for repair and replacement. This effort includes the use of bridge management optimization software and engineering field reviews to make the best use of available funding. Due to many factors including age, deterioration rates and inflation, funding has become insufficient to maintain bridge serviceability, as evidenced by the increasing number of load postings and outright bridge closures. The State of Maine owns and manages a network of 2,722 bridges. As MaineDOT reported to the Transportation Committee in early 2007, 288 of these bridges are at risk of posting, reposting at a lower weight, or closure over the next ten years, unless repair, rehabilitation, or replacement is undertaken.

As directed, this report focuses on the structural deficiencies of Maine bridges that, if not addressed, could result in the posting or closure of these bridges. However, there are other needs associated with the function of bridges. Narrow travel lanes, low overhead clearance, lack of shoulders, a history of structure-related crashes, and lack of pedestrian/bicycle accommodations are examples of what define functionally deficient bridges. Although these shortcomings do not directly affect the structure, they do impact efficiency and safety. Functional needs across the state are estimated in the hundreds of million of dollars. Since MaineDOT currently focuses on the structural needs of bridges as it rehabilitates and replaces the bridge network, these needs will remain, and may also require investment as safety and economic concerns grow, thus competing for limited financial resources.

If bridge investment is increased without additional resources, the result would be a commensurate reduction in funding from other programs such as highway modernization and reconstruction, highway paving, highway capacity and efficiency projects, and Transportation Enhancement projects, to name a few. Without additional resources, these and other programs will not be able to keep up with growing system demands.

## Bridge Needs

Maine’s Bridges are aging. Many were constructed in the first half of the last century, and many are reaching the end of their service lives. Through proactive bridge maintenance activities and capital investments, MaineDOT’s strategic objective is to achieve an average replacement age of 80 years. However, based on current funding and rate of replacement, bridges will need to last an average of 180 years. Though age is not the only predictor, this poses a challenge which, if not addressed strategically over the next several decades, would require future generations to fund a large number of bridges at once, or be faced with numerous postings and long detour routes.

For this report, two approaches were undertaken to quantify Maine’s structural bridge needs. The first focuses on bridge age distribution and estimates an appropriate replacement rate. The second method groups Maine’s bridge population into *good*, *fair*, and *poor* categories by the Federal Functional Class of the roadway carried.

### Bridge Age Distribution Approach

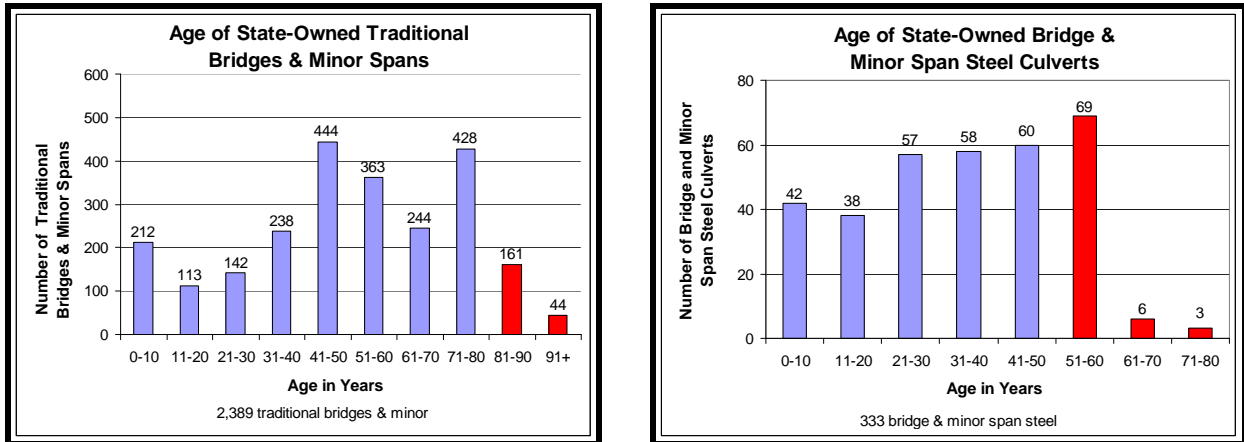


Figure 3

To generate an estimate of capital need that considers the age distribution of Maine’s bridges reflected in the chart above, consider the following approach:

MaineDOT’s steel culvert replacement rate has been adequate. The primary concern is the inadequate rate of traditional bridge replacement and the need to increase our preservation and maintenance investment. Today, there are 205 traditional bridges over 80 years old. At the current rate of replacement (14 bridges per year), the number of bridges over 80 years old will double in 8 years, triple in 20 years, and quadruple in 30 years.

<b>Capital Need</b>		
# of Bridges older than 50 years	1,240	
Assume all will need to be replaced within 30 years <sup>1</sup>	41	
Average Replacement Cost	\$2.5	Replacements/yr
Need =	\$103	million/structure
	<u>\$206</u>	million/year or
		<b>million/biennium</b>
<b>08/09 Investment Level other than replacement</b>		
08/09 Steel Culvert Investment <sup>2</sup>	\$5	million
08/09 Preservation Investment <sup>3</sup>	\$25	million
08/09 Bridge Maintenance		million
'Other'	\$13	
08/09 Bridge Rehabilitation	\$7	million
	<u>\$50</u>	<b>million/biennium</b>
<b>Total Bridge Need</b>	<b>\$256</b>	<b>million/biennium</b>

**The cost to avoid posting or closing necessary bridges in Maine is estimated at \$260 million/biennium or \$130 million/year.**

<sup>1</sup> Not all of these structures will need to be replaced in 30 years. However, not all structures 'younger' than 50 will last 30 more years. This analysis assumes that for every bridge in the +50 age group that does not get replaced over the 30 year period one in the less than 50 age group will.

<sup>2</sup> Over the last 8 years, MaineDOT's rate of steel culvert replacement has kept pace with this asset's deterioration.

<sup>3</sup> Increasing preservation investments will cost-effectively extend bridge service life and reduce overall bridge life cycle costs.

*Figure 4*

**Good, Fair, and Poor Approach**

While age distribution is a good general indicator, a more technical analysis considering bridge size distribution and specific condition follows below, to arrive at a recommended annual funding level.

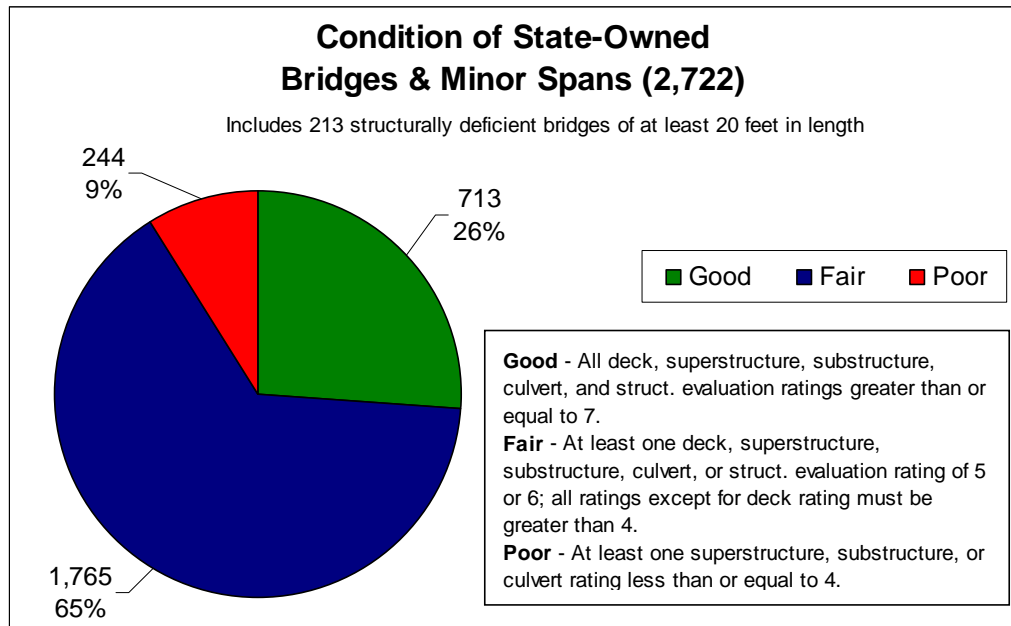
The latest *National Bridge Inspection Standards* (NBIS) were used to create Figure 5. The ratings are on a 0-to-9 scale with 9 reflecting *excellent* condition and zero *failed* condition. The NBIS condition rating descriptions for decks, superstructure, and substructures are shown below.



### Condition Ratings

The following general condition ratings shall be used as a guide in evaluation:

<u>Code</u>	<u>Description</u>
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION – no problems noted.
7	GOOD CONDITION – some minor problems.
6	SATISFACTORY CONDITION – structural elements show some minor deterioration.
5	FAIR CONDITION – all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
4	POOR CONDITION – advanced section loss, deterioration, spalling or scour.
3	SERIOUS CONDITION – loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	CRITICAL CONDITION – advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
1	“IMMINENT” FAILURE CONDITION – major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic but corrective action may put back in light service.
0	FAILED CONDITION – out of service – beyond corrective action.



*Figure 5*

At present, 244 bridges, or 9% of our network is in *poor* condition; 1,765 bridges or 65% are in *fair* condition; and only 713 bridges or 26%, are in *good* condition. The number and square footage of Maine’s bridges, by highway functional class and general condition, are shown in Figure 6.

State-Owned Bridges (2,722)				
	Good	Fair	Poor	Total
<b>Arterials</b>	286 Bridges Deck Area = 3,088,476 sq ft	590 Bridges Deck Area = 3,964,723 sq ft	42 Bridges Deck Area = 228,180 sq ft	<b>918 Bridges</b> <b>7,281,379 sq ft</b>
<b>Collectors</b>	279 Bridges Deck Area = 883,610 sq ft	845 Bridges Deck Area = 1,862,133 sq ft	129 Bridges Deck Area = 397,706 sq ft	<b>1,253 Bridges</b> <b>3,143,449 sq ft</b>
<b>Local</b>	148 Bridges Deck Area = 414,253 sq ft	327 Bridges Deck Area = 715,611 sq ft	70 Bridges Deck Area = 89,648 sq ft	<b>545 Bridges</b> <b>1,219,512 sq ft</b>
<b>Off-System Bridges</b>	0 Bridges	3 Bridges 8,089 sq ft	3 Bridges 4,993 sq ft	<b>6 Bridges</b> <b>13,082 sq ft</b>
<b>Total</b>	<b>713 Bridges</b> <b>4,386,339 sq ft</b>	<b>1,765 Bridges</b> <b>6,550,556 sq ft</b>	<b>244 Bridges</b> <b>720,527 sq ft</b>	<b>2,722 Bridges</b> <b>11,657,422 sq ft</b>

Figure 6

For analysis purposes, it is assumed that preventive maintenance can keep *good* bridges in the *good* category over the next 10 years and capital preservation and rehabilitation projects will be undertaken for most *fair* bridges over the next 30 years. Almost 500 of the 1,765 *fair* bridges are one rating point away from the *poor* category. Assuming that, over the next 10 years 250 of these bridges will move to the *poor* category, bringing the total number of *poor* bridges to 494. If 200 bridges can remain in the *poor* category at the end of the analysis period, then 294 *poor* bridges would need to be replaced in 10 years, or about 30 per year.

The cost of preservation/rehab of one third of remaining *fair* bridges over 10 years is \$60 million/ year.

The cost of replacement of 294 *poor* bridges over 10 years is \$60 million/year.

The total cost equals \$60 + \$60 or **\$120 million/year**. (See Appendix E for full computations and assumptions.)

**In conclusion, each approach used to quantify Maine’s bridge needs results in an additional investment needed of between \$50 and \$60 million per year (in 2007 dollars) over and above the current capital program (which itself is the largest in recent history).** The biennial bridge investment level would be between \$240 and \$260 million. Looking forward, construction inflation is expected to be at least 7% annually, bringing the total estimated cost over 10 years to a staggering \$1.6 to \$1.8 billion in inflation-adjusted dollars. Even at this level of investment, it is anticipated that bridge closures would need to occur on some low-priority, redundant bridges (except for emergencies). Further load postings would still be necessary for those bridges that were

only designed for lighter trucks, but the rate of postings due primarily to deterioration (condition) would decrease.

Furthermore, MaineDOT has programmed about 85% of funding for bridge replacements, with only about 15% going for preservation treatments, in order to realize the full service life of middle-aged bridges. If this trend continues, the number of bridges in *poor* condition (Figure 5) will soon become unmanageable, and the “safety net” (posting and closure) will be the only way to ensure public safety. This will adversely impact Maine businesses and citizens in every corner of the state, as entire corridors become restricted. The age distribution chart (Figure 3) provides a way to visualize what is ahead. With the decreasing buying power of our federal and state revenues, caused by unprecedented construction inflation, the funding challenge is extraordinary.

In summary, there are only two ways to protect public safety over the long term: Repair/replace *poor* bridges and preserve *fair* bridges before they become *poor*, OR continue to close bridges when their condition results in an unacceptable factor of safety. With over 2,000 bridges in *fair* or *poor* condition, Maine’s economy cannot afford to have the highway network become unconnected, nor can we allow unsafe bridges to stay open. Without a balanced, sustainable bridge work plan, load postings and closures will be the only “safety net” left.

Recommendations:

- Increase capital bridge funding by \$50 to \$60 million per year (from approximately \$70 million per year today), to between \$120 to \$130 million per year
- Continue reviewing MaineDOT’s current bridge-related programming to ensure that bridge safety remains adequately considered.
- Enhance bridge preservation actions to increase average bridge service life.

## 8. SUMMARY OF RECOMMENDATIONS

### Inspection-Related Recommendations:

- 1) Complete *Scour Plans of Action* and implement the plans.
- 2) Evaluate tidal and unknown foundations in accordance with FHWA’s pending guidelines.
- 3) Create statewide water-basin maps in order to evaluate critical bridges during high water events.
- 4) Prioritize and implement scour countermeasures on critical routes.
- 5) Document at least one stream cross-section at each bridge for baseline comparison and identification of scour susceptible bridges.
- 6) Review plans and other documentation of existing bridges and perform structural analysis as needed to identify all potentially problematic connections and fracture critical members.
- 7) Create schematics of the above connections and any fracture critical members for ready reference in the bridge inspector’s file for each bridge.
- 8) Develop special written procedures for inspecting and monitoring critical members and connections.

- 9) Monitor and evaluate the research into new technologies and techniques for inspection and evaluation of connectors and fracture critical members and implement them, if appropriate.
- 10) Review the quality assurance procedures of the inspection and posting processes, information systems, and data gathering.
- 11) Adopt a new posting policy.
- 12) Improve documentation of bridge inspection policies and procedures.
- 13) Respond to upcoming changes in National Bridge Inspection Standards (NBIS) Quality Assurance (QA) procedures.
- 14) Develop guidelines for triggers requiring field review and load rating by a professional engineer.
- 15) Implement a 24-month inspection cycle in place of the current biennial cycle in order to more fully comply with federal standards. (For a description of MaineDOT's Bridge Inspection Program, see Appendix D).
- 16) Implement enhanced communication procedures for town bridges.

**Maintenance and Operations-Related Recommendations:**

- 17) Continue to replace or repair overhead concrete structures that pose a hazard to the public.
- 18) Focus maintenance attention on work that will reduce exposure to corrosive elements on critical structural members and connections, thereby extending service life.
- 19) Work with the trucking industry on enabling legislation to allow enforceable photo/WIM technology on critical bridges where weight compliance is particularly necessary to ensure public safety.

**Capital-Related Recommendations:**

- 20) Repair or replace critical deteriorated bridges or components before they become a safety issue requiring a bridge to be closed or posted.
- 21) Provide cathodic protection (a technique for steel protection using a sacrificial metal, therefore preserving the structure) for substructure units that are exposed to corrosive environments.
- 22) Implement a technical career track for bridge designers, to provide an avenue for advancement without their having to leave their bridge design work to enter the management career ladder.
- 23) Increase capital bridge funding by \$50 to \$60 million per year (from approximately \$70 million per year today), to between \$120 to \$130 million per year
- 24) Continue reviewing MaineDOT's current bridge-related programming to ensure that bridge safety remains adequately considered.
- 25) Enhance bridge preservation actions to increase average bridge service life.

## **APPENDICES**

## APPENDIX A

### TEAM BIOGRAPHIES (Alphabetical)

#### **David Bernhardt, P.E.**

Title: Director, Maintenance and Operations

Affiliation: MaineDOT, AASHTO Subcommittee on Maintenance (SCOM), AASHTO  
Subcommittee on Systems Operation and Management

Date of PE: 1989 (18 years)

Education:

Major: B.S. in Civil Engineering, University of Maine

Present Work: David Bernhardt is the Director of Maintenance and Operations. The Bureau has approximately 1400 permanent employees who are responsible for the delivery of a \$130 million/per year maintenance and betterment program. Dave is a 1984 graduate of the University of Maine at Orono, with Associates and Bachelors of Science degrees in Civil Engineering, and is a Registered Professional Engineer. Dave has been with the Maine Department of Transportation for the past 23 years, and is an active participant on national and state committees involved in transportation issues.

#### **John Buxton, P.E.**

Title: Bridge Maintenance Engineer

Affiliation: MaineDOT, Bureau of Maintenance and Operations, Bridge Maintenance Division

Date of PE: 1986 (21 years)

Education:

Major: B.S. in Civil Engineering/Structural, University of Maine at Orono, 1980

Present Work: The Bridge Maintenance Engineer is responsible for maintaining public bridges and state rail lines. The position ensures the safety of the public through development and execution of a maintenance work program, a bridge inspection program, posting bridges to maximum safe truck weights, operation of movable bridges, and advising municipalities regarding actions required on municipal bridges.

General: 20 years experience in Bridge Design and 6 years experience in Bridge Maintenance.

#### **Edward B. Caswell, P.E.**

Title: Structural Engineer

Affiliation: Caswell Engineering

Date of PE: 1975 (32 years)

Education:

Major: B.S. in Civil Engineering/Structural, University of Maine Orono, 1970

Present Work: President, Caswell Engineering: a structural engineering consulting firm in Topsham, Maine.

General: Mr. Caswell has worked 37 years as a structural engineer, 34 years in the bridge engineering field. As a private consulting engineer, he has worked with MaineDOT assisting them with the delivery of the department's bridge program. He has also worked with Maine communities helping them to solve bridge engineering problems. Mr. Caswell's experience includes the design of steel and concrete structures varying from minor culverts to major multi-span continuous bridges.

### **Dr. William (Bill) Davids, P.E.**

Title: John C. Bridge Associate Professor of Civil and Environmental Engineering

Affiliation: Dept. of Civil and Environmental Engineering, University of Maine

Date of PE: 1995 (11 years)

Education:

Major: Ph.D. in Civil Engineering, University of Washington, 1998

Major: M.S. in Civil Engineering, University of Maine, 1991

Major: B.S. in Civil Engineering, University of Maine, 1989

Present Work: Professor at University of Maine since September 1998. Professor Davids teaches senior electives in steel and concrete design, as well as graduate courses in bridge engineering, advanced structural analysis, and numerical methods. He maintains an active research program that covers topics including the mechanics of wood and engineered wood structures, bridge design and monitoring, mechanics of concrete and asphalt pavements, and inflatable fabric structures.

General: Professor Davids' prior work experience includes nearly four years as a structural engineer at Sverdrup Corp. in Seattle, WA, 1991-1994. He was responsible for the design and retrofit of various bridges, including pre-stressed girder structures, cable-stayed bridges, steel superstructures, and moveable bridges. He designed structures for the State of Washington, various cities, and county agencies. He also designed and detailed columns and substructure components for high seismic loads. Professor Davids' road rated numerous bridges for Washington State DOT, and has participated in condition assessments for several bridges.

### **Maria Drozd, P.E.**

Title: Bridge Engineer

Affiliation: FHWA Maine Division Office

Date of PE: July 1991 (16 years)

Education:

Major: Civil Engineering/Structural, University of New Hampshire

Present Work: Ms. Drozd administers the Federal-Aid bridge program in Maine. Her responsibilities include bridge design, construction, and maintenance, hydraulics, geotechnical, Highway Bridge Program, and National Bridge Inventory System Program.

General: Structural Engineer, FHWA, FLH Bridge Design Office, 1992-2003

Highway Engineer, FHWA, FLH Roadway Design Office 1991-1992

Civil Engineer, New Hampshire DOT, Bridge Design Office 1986-1989

### **Rick J. Dubois, P.E.**

Title: Director, Systems Management Division

Affiliation: MaineDOT Bureau of Planning

Date of PE: 1989 (18 years)

Education:

Major: B.S. in Civil Engineering, University of Maine

Present Work: Mr. Dubois directs and oversees MaineDOT's Management Systems including:

- Bridge Management
- Pavement Management
- Transportation Analysis (Congestion Management)
- Transportation Reporting, Inventory and Mapping

### **Rhonda Fletcher, P.E.**

Title: Region Manager, MaineDOT Region 2

Affiliation: MaineDOT

Date of PE: 1988 (19 years)

Education:

Major: B.S. in Civil Engineering, University of Maine

Present Work: Ms. Fletcher administers a \$24 million Region 2 budget; and provides management oversight for 250 employees, 15 highway facilities, 3 bridge facilities and a Region Office. Region 2 maintains 1800 miles of State and State-Aid Highways with a fleet of 160 vehicles, including pick-ups, dump trucks, backhoes, and loaders. She works with MaineDOT's Bureaus of Project Development and Planning to prioritize corridors and determine appropriate treatment to meet the overall needs of the region's transportation system.

General: Rhonda began her career with MaineDOT in 1985 as an Inspector than Resident Engineers in the Construction Division and has also held the position of Assistant Highway Design Engineer and Highway Construction Engineer.

### **Bradford Foley, P.E.**

Title: Director, Safety Office

Affiliation: MaineDOT

Date of PE: 1991 (16 years)

Education:

Major: B.S. in Civil Engineering, University of Vermont

Present Work: Bradford Foley has worked for MaineDOT for 20 years. In July of 2004, he was appointed to be Director of the Safety Office, and is tasked with directing and coordinating all safety activities, initiatives, and programs within the department to achieve meaningful safety improvements to Maine's Transportation Systems. He has been instrumental in developing the State's Strategic Highway Safety Plan (SHSP) entitled "One is Too Many". The SHSP has identified opportunities and strategies to save lives and reduce injuries in Maine. Brad also serves as the Chair of the Maine Transportation Safety Coalition (MTSC), an organization made up of public and private partners whose mission is to promote safe transportation in Maine. This year the Coalition is focusing on "Younger Driver



General: His position prior to that appointment was Assistant Program Manager for the Urban and Arterial Highway Program, focusing on the development, design, and construction of highway projects. Previously, within MaineDOT, Brad worked as a designer and project manager on numerous projects, as well as a consultant coordinator overseeing the design efforts of outside consultants.

### **Ben Foster, P.E.**

Title: Assistant Bridge Maintenance Engineer

Affiliation: MaineDOT

Date of PE: January 2002 (4 years)

Education:

Major: M.S. Civil Engineering, University of Maine, 1998

Major: B.S. Civil Engineering, University of Maine, 1996

Present Work: Mr. Foster is responsible for MaineDOT's Bridge Inspection Program, and he approves all inspections.

General: Prior to his appointment to this position, Mr. Foster worked for nine years designing bridges at MaineDOT.

### **James Foster, P.E.**

Title: Bridge Management Engineer

Affiliation: MaineDOT

Date of PE: 1986 (21 years)

Education:

Major: B.S. in Agricultural Engineering Technology, University of Maine Orono, 1978

Major: Civil Engineering, continuing education through 1983, University of Maine Orono

Present Work: The Bridge Management Engineer determines funding needs and strategies for the repair, rehabilitation and replacement of Maine's bridge network. This section is responsible for the bridge portion of the MaineDOT's *Biennial Capital Work Plan*, and supports the Bridge Maintenance Inspection Program and the maintenance work plan. The Bridge Management Engineer is responsible for activities relating to the development and operation of a computer-based network-level management system, which provides direction for MaineDOT to optimize investments in capital and maintenance expenditures on bridges. Responsibilities include quality assurance and oversight of incoming field data, data analysis, report generation, and investigations leading to analysis model revision.

General: Mr. Foster has 28 years of experience at Maine DOT, including more than 13 years experience in the Bridge Design Division, two years of bridge inspection, and 12 years experience in the Bridge Management Division.

### **Chip Getchell, P.E.**

Title: Assistant to the Chief Engineer

Affiliation: MaineDOT

Date of PE: 1995 (12 years)

Education: University of Maine

Advanced mathematics and structural engineering courses

Present Work: Chip splits his time between the Chief Engineer's Office and the Executive Office, where he provides department-wide engineering policy oversight and certain legislative functions. He is Chair of MaineDOT's Engineering Council.

General: Prior to joining the Executive Office, Chip spent 10 years in the Bridge Section, where he gained design and construction experience, and went on to manage the Local Bridge Program. He also assisted with the delivery of two major design-build projects – the Sagadahoc Bridge and the Penobscot Narrows Bridge and Observatory.

### **Peter Krakoff, P.E.**

Title: Vice President/Chief Engineer

Affiliation: CPM Constructors, Freeport, Maine

Date of PE: 1984 (23 years)

Education:

Major: B.S. in Civil Engineering, University of Maine 1980

Major: B.A. in Liberal Arts, Colby College 1972

Present Work: CPM is a general contractor performing bridge, highway and other heavy civil work throughout northern New England. Mr. Krakoff manages the company's estimating department as well as overseeing the in-house engineering and design functions for the company. In 2005-2006, he was also the on-site project manager for the rehabilitation of the Augusta Memorial Bridge.

### **Eric C. Shepherd, P.E.**

Title: Assistant Program Manager

Affiliation: MaineDOT, Bridge Program

Date of PE: July 1988 (19 years)

Education:

Major: B.S. in Civil Engineering, University of Maine, 1983

Present Work: Assist the Program Manager in overseeing all aspects of project development within the Bridge Program, including: Lead role in major contract disputes; point person in Program for revision of Standard Specifications; active participant in 6-Year Plan field reviews to determine project scoping, schedules and budgets; member of the Department's Bridge Posting Committee; Bridge Program representative on the Contractor Pre-qualification Committee.

Additional experience:

- Construction Support Manager in the Highway Program of MaineDOT for Divisions 1, 2, 3 and 6 (Aroostook, Washington, Hancock, Penobscot, Piscataquis, Cumberland and York counties).
- Construction Engineer in the Bridge Program of MaineDOT for Divisions 4, 6 and 7 (Kennebec, Somerset, Cumberland, York, Franklin and Oxford counties).
- Assistant Construction Engineer in the Construction Division of MaineDOT for the Division 6 Region (Cumberland and York counties).

- Resident Engineer in the Construction Division of MaineDOT, including Resident Engineer on the \$37.8 million Bascule Substructure and Bascule Superstructure contracts of the Casco Bay Bridge Project.
- Senior Engineer for Great Northern Paper Company.

**David Sherlock, P.E.**

Title: Bridge Program Manager

Affiliation: MaineDOT

Date of PE: 1983 (24 years)

Education:

Major: B.S. in Civil Engineering, University of Maine 1977

Present Work: Mr. Sherlock was recently appointed as Manager of the Bridge Program, Bureau of Project Development. He is responsible for all capital bridge improvements in the state from the funding stage to construction completion. He works with the Bureau of Planning and the Bridge Maintenance Division in prioritizing and developing the capital work plan.

General: Mr. Sherlock started work at MaineDOT in 1980 as an inspector in bridge construction and then resident engineer. He started in Maintenance and Operations in 1993 as an Assistant Division Engineer. The position was restructured in 2000 to encompass more region based highway construction programming, design, and construction oversight.

**Kenneth L. Sweeney, P.E.**

Title: Director, Bureau of Project Development, Deputy Chief Engineer

Affiliation: MaineDOT

Date of PE: 1979 (28 years)

Education:

Major: M.S. in Public Administration, University of Maine

Major: B.S. in Civil Engineering, Lowell Technological Institute, Lowell, MA

Present Work: Mr. Sweeney was promoted in April 2003 to his present position. He is responsible for the internal operations of the Bureau of Project Development. The Bureau has 400 people who are responsible for the delivery of a \$300 million/year capital improvement program.

General: Mr. Sweeney has held several positions of increasing responsibility throughout the Department of Transportation since 1978.

## APPENDIX B

### TECHNICAL ADVISORY 5140.28 – CONSTRUCTION LOADS ON BRIDGES

August 8, 2007



U.S. Department  
of Transportation  
Federal Highway  
Administration

## Memorandum

Subject: Technical Advisory 5140.28 - Construction Loads on Bridges Date: August 8, 2007

From: Frederick G. Wright (Bud)  
Executive Director (HOA-3)

To: Division Administrators  
Directors of Field Services  
Federal Land Highway Division  
Engineers

#### PURPOSE

In the ongoing investigation of the collapse of the I-35W Bridge in Minneapolis, the National Transportation Safety Board has identified construction equipment and materials loading on the bridge as part of their review. While no conclusions have been reached, in an abundance of caution, we strongly advise the State Transportation Agencies and other bridge owners who are engaged in or contemplating any construction operation on their bridges to ensure that any construction loading and stockpiled raw materials placed on a structure do not overload its members.

For more discussion on this issue, please refer to the AASHTO Standard Specifications for Highway Bridges, 17<sup>th</sup> Edition, Division II, Section 8.15 or the AASHTO Load Resistance and Factor Design Bridge Design Specifications, 4<sup>th</sup> Edition, Section 3.

Please refer any questions to Benjamin Tang at 202-366-4592 or [benjamin.tang@dot.gov](mailto:benjamin.tang@dot.gov).

MOVING THE  
AMERICAN  
ECONOMY



## APPENDIX C

November 5, 2007

### Maine Department of Transportation

#### Draft Bridge Posting Policy

The purpose of this policy is to establish uniform practices that reflect national standards for the load posting of Maine's bridges that cannot safely carry American Association of State Highway and Transportation Officials (AASHTO) standard design loads or Maine's legal loads. For state-maintained bridges, the department has sole responsibility and authority to determine if a bridge must be posted or closed.

Bridges are inspected in accordance with the National Bridge Inspection Standards and are load rated in accordance with the latest AASHTO Manual for Condition Evaluation of Bridges.

The responsibility for recommending to the Chief Engineer for the load posting or closing of state-maintained bridges, except for emergency and operational situations, shall be the responsibility of the Bridge Posting Committee. The Bridge Posting Committee is comprised of the following members:

Bridge Maintenance Engineer (Chair)	Assistant Bridge Maintenance Engineer
Bridge Program Manager (Vice Chair)	Assistant Bridge Program Manager
Bridge Management Engineer (Secretary)	Engineer of Traffic

#### Posting Determination for State-Maintained Bridges

If the maximum legal loads under state law or AASHTO standard design loads exceed the safe load carrying capacity of a bridge, restrictive load posting must be considered. When a bridge is considered for load posting, load posting evaluations will be based on AASHTO design loads and/or Maine's legal truck configurations.

Bridges of span lengths equal to or less than 70 feet with HS Operating Ratings less than 43 tons, and bridges of span lengths greater than 70 feet with HS Operating Ratings less than 33 tons, will be screened and rated using the legal truck configurations for posting/closing consideration. If analysis shows that a bridge's Operating Rating is exceeded, or if the bridge is non-redundant, fracture critical or fatigue-prone indicating that the bridge should be posted closer to the Inventory Rating then the bridge will be referred to the Bridge Posting Committee for evaluation.

Additionally, if a bridge exhibits a loss of carrying capacity, such that in the opinion of a responsible bridge engineer, it may not be able to safely carry legal loads or the pre-existing posted loads, the bridge will be referred to the Bridge Posting Committee for evaluation.

The Bridge Posting Committee shall evaluate bridges for posting or closing using engineering data and judgment. The level of analysis, testing, field verification or inspection should be increased, if

needed, in order to minimize adverse social or economic impacts. Recommendations for appropriate action will be made to the Chief Engineer. Factors and data to be taken into consideration include:

- Operating and Inventory Ratings
- Presence of fracture critical members
- Presence of fatigue prone details
- Volume of heavy truck traffic
- Type and nature of truck traffic
- Condition of the main structural components
- Structure type and materials
- Social and economic impacts

In general, a bridge with less than 500 trucks daily may be posted at or near its Operating Rating, unless other factors suggest a rating nearer its Inventory rating. Any bridge requiring a posting less than three tons will be closed.

### **Signing**

Signing will comply with the Manual on Uniform Traffic Control Devices. In general, posting will be with pictorial signs depicting the legal truck configurations with the maximum gross vehicle weight for each configuration. If the gross vehicle weight limit is 15 tons or less, then signing will simply consist of “Weight Limit X Tons”.

### **Posting Procedure for State-Maintained Bridges**

1. Posting candidates will be forwarded to the Secretary of the Bridge Posting Committee. The Secretary will schedule a Committee meeting.
2. The Bridge Posting Committee submits posting and closing recommendations, justifications and logic for such recommendations and posting traffic impacts to the Chief Engineer for approval.
3. The Chief Engineer approves the posting, forwards to the Engineer of Traffic for implementation and advises executive staff of the pending action.
4. The Engineer of Traffic prepares an alternate route plan, prepares appropriate signing, advises the municipal authorities and county commissioners of the pending action and prepares the item for the Commissioner’s Record.
5. The Engineer of Traffic implements the authorized posting.

### **Municipally Maintained Bridges**

For municipally maintained bridges, the Department shall advise the municipality regarding posting and closure. The municipality has sole responsibility and authority to determine if a municipally maintained bridge must be posted or closed, except that the Department may close a bridge if it determines closure is necessary to protect the traveling public from imminent danger.

### **Emergency Situations**

Where an emergency situation warrants immediate action to preserve public safety, a Region Bridge Manager, or any Professional Engineer of the Department is authorized to take immediate action to restrict traffic from either a state maintained or municipally maintained bridge. By statute, a municipality may close a state maintained bridge in cases of emergency.

## **Operational Situations**

Where an operational situation due to a maintenance or construction activity on a state maintained bridge warrants restriction of traffic, the Bridge Maintenance Engineer or Bridge Program Manager are authorized to take the necessary traffic restriction actions. Any such actions will be included in the public process for the respective activity.





## **APPENDIX D**

### **MaineDOT's Bridge Inspection Program**

- MaineDOT is responsible for inspecting nearly 3,000 bridges every two years; these include all of the state-owned and municipal-owned bridges on public roads.
- There are 185 bridges (5%) that are inspected every 12 months due to findings from previous inspections.
- Underwater inspections for scour and structural integrity are conducted every 60 months unless a finding determines that a more frequent inspection is required.
- Inspections are conducted to the national standards in the National Bridge Inspection Standards (NBIS) [as required by the federal government in Title 29 CFR]. The NBIS program was developed from engineering judgment and from past experiences with bridge failures. NBIS sets national policy on bridge-inspection frequency, inspector qualifications, report formats, and inspection and rating procedures. Results of inspections are provided annually to the Federal Highway Administration.
- All inspection reports are reviewed and approved by a professional engineer. Capital improvement planning, repair work, and bridge load-postings are driven by information derived from these inspections.
- The Bridge Inspection Program has five full-time and two part-time bridge inspectors, a full-time manager of the underwater dive team, 20 part-time underwater inspectors, and an under-bridge crane to gain access to difficult-to-reach components. The inspection program is managed by a professional engineer.
- When a critical finding is identified, the department has a procedure for providing notification to the public, and for addressing the problem.



## APPENDIX E

### GOOD, FAIR, POOR ANALYSIS DETAILS

CTI -- Good, Fair, Poor Cost Estimate 11/20/2007

XX

Replacement Cost			\$600/sf			
Preservation/Rehab Cost			\$300/sf			
	<b>Now</b>			<b>In 10 years with no investment</b>		
	#	SF	SF/Bridge	#	SF	SF/Bridge
<b>Good</b>	713	4,386,339	6152	713	4,386,339	6,152
<b>Fair</b>	1765	6,550,556	3711	1515	5,622,165	3,711
<b>Poor</b>	244	720,527	2953	494	1,648,277	3,337
			<b>10 year est</b>	<b>per year</b>	<b>Assumptions</b>	
Replacement Cost		294	3,337	\$ 60	294 out of the 494 population of Poor will be replaced over 10 years leaving 200 bridges in the Poor category.	
Preservation & Rehab		505	3,711	\$ 60		
				<u>\$ 120</u>	one third of Fair bridges will require a Preservation/Rehab treatment over 10 years	



# APPENDIX F

## Structurally Deficient Bridges in the United States

State	All Bridges		
	All Bridges	Structurally Deficient Bridges	Percent Structurally Deficient
OKLAHOMA	23,460	6,299	26.8%
RHODE ISLAND	753	191	25.4%
PENNSYLVANIA	22,327	5,582	25.0%
IOWA	24,825	5,152	20.8%
SOUTH DAKOTA	5,945	1,186	19.9%
MISSOURI	24,024	4,595	19.1%
MISSISSIPPI	16,952	3,170	18.7%
NORTH DAKOTA	4,482	776	17.3%
VERMONT	2,710	436	16.1%
MICHIGAN	10,887	1,746	16.0%
NEBRASKA	15,452	2,413	15.6%
WEST VIRGINIA	6,956	1,075	15.5%
MAINE	2,380	343	14.4%
HAWAII	1,110	156	14.1%
LOUISIANA	13,347	1,869	14.0%
SOUTH CAROLINA	9,238	1,275	13.8%
NEW HAMPSHIRE	2,359	317	13.4%
ALABAMA	15,879	2,102	13.2%
NORTH CAROLINA	17,666	2,256	12.8%
CALIFORNIA	23,625	2,994	12.7%
WYOMING	3,027	381	12.6%
ALASKA	1,210	151	12.5%
NEW YORK	17,335	2,110	12.2%
KANSAS	25,440	3,038	11.9%
NEW JERSEY	6,420	760	11.8%
MASSACHUSETTS	4,947	586	11.8%
PUERTO RICO	2,133	246	11.5%
INDIANA	18,364	2,066	11.3%
NEW MEXICO	3,848	401	10.4%
OHIO	27,946	2,884	10.3%
MONTANA	5,002	500	10.0%
KENTUCKY	13,637	1,362	10.0%
WISCONSIN	13,770	1,335	9.7%
ILLINOIS	25,943	2,447	9.4%
VIRGINIA	13,357	1,197	9.0%

State	NHS Bridges		
	NHS Bridges	Structurally Deficient Bridges	Percent Structurally Deficient
RHODE ISLAND	272	55	20.2%
PENNSYLVANIA	3,897	591	15.2%
CALIFORNIA	7,467	1,030	13.8%
VERMONT	478	57	11.9%
ALASKA	415	46	11.1%
MICHIGAN	2,541	261	10.3%
OKLAHOMA	2,733	280	10.2%
WEST VIRGINIA	1,137	108	9.5%
MASSACHUSETTS	2,020	187	9.3%
PUERTO RICO	580	50	8.6%
WYOMING	1,330	109	8.2%
ILLINOIS	3,627	297	8.2%
SOUTH CAROLINA	1,375	107	7.8%
HAWAII	414	32	7.7%
NEW JERSEY	2,503	175	7.0%
DIST. OF COL.	115	8	7.0%
NEW HAMPSHIRE	684	46	6.7%
IOWA	1,848	122	6.6%
OREGON	1,520	99	6.5%
MAINE	448	28	6.3%
NEW YORK	3,580	227	6.3%
UTAH	1,104	69	6.3%
KENTUCKY	1,798	112	6.2%
NORTH CAROLINA	2,638	160	6.1%
COLORADO	2,212	136	6.1%
NEW MEXICO	1,782	105	5.9%
IDAHO	740	40	5.4%
MISSOURI	2,768	125	4.5%
INDIANA	2,447	108	4.4%
OHIO	4,148	178	4.3%
CONNECTICUT	1,571	66	4.2%
ALABAMA	2,776	108	3.9%
WISCONSIN	2,720	102	3.8%
WASHINGTON	2,325	89	3.8%
SOUTH DAKOTA	811	29	3.6%

DIST. OF COL.	245	22	9.0%
OREGON	7,234	645	8.9%
MINNESOTA	13,008	1,135	8.7%
UTAH	2,827	239	8.5%
ARKANSAS	12,502	1,068	8.5%
CONNECTICUT	4,166	351	8.4%
IDAHO	4,062	334	8.2%
MARYLAND	5,059	410	8.1%
GEORGIA	14,523	1,113	7.7%
COLORADO	8,311	575	6.9%
TENNESSEE	19,803	1,324	6.7%
WASHINGTON	7,548	381	5.0%
TEXAS	49,518	2,219	4.5%
DELAWARE	849	35	4.1%
NEVADA	1,630	50	3.1%
FLORIDA	11,553	305	2.6%
ARIZONA	7,248	161	2.2%
TOTALS	597,340	73,784	12.4%

LOUISIANA	2,676	90	3.4%
VIRGINIA	3,307	112	3.4%
MARYLAND	1,470	47	3.2%
NEBRASKA	1,270	39	3.1%
MINNESOTA	1,659	47	2.8%
TENNESSEE	3,075	74	2.4%
ARKANSAS	1,929	43	2.2%
MONTANA	1,264	27	2.1%
NORTH DAKOTA	528	9	1.7%
KANSAS	2,397	41	1.7%
MISSISSIPPI	2,166	32	1.5%
GEORGIA	2,529	33	1.3%
TEXAS	15,302	184	1.2%
ARIZONA	2,631	26	1.0%
NEVADA	788	7	0.9%
FLORIDA	4,109	22	0.5%
DELAWARE	248	0	0.0%
TOTALS	116,172	6,175	5.3%

Prepared for the Honorable James L. Oberstar - Committee on Transportation and Infrastructure - August 8, 2007

U.S. Department of Transportation, Research and Innovation Technology Administration, FHWA, National Bridge Inventory, Deficient Bridges by State and Highway System, August 2, 2007.

## APPENDIX G

### TYPICAL PRESERVATION AND REHABILITATION ACTIONS

Increasing these investments will improve the likelihood of structures reaching or exceeding their design lives.

Preservation Actions	Rehabilitation Actions
Cut brush	Replace or repair deck
Clean and wash all bridges	Repair curbs/sidewalk
Seal all expansion joints	Repair main support members
Seal cracks in bituminous wearing surface	Repair joints and drains
Apply protective coatings to concrete surfaces	Repair abutments - scour
Paint steel elements	Repair retaining walls
Maintain proper drainage	Repair piers
Maintain channels	Repair bridge rail