



**Office of the Inspector General
Internal Special Audit Unit
Commonwealth of Massachusetts**

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**A Review of Design and Construction
Costs for MassDOT's Veterans
Memorial Bridge**

An analysis of certain change orders and contract overruns for the design and final phase of construction of the Veterans Memorial Bridge over the Taunton River

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Executive Summary

The Massachusetts Department of Transportation (“MassDOT”) is responsible for building and maintaining roads, bridges and tunnels across the Commonwealth. For example, MassDOT oversees 5,171 bridges across the state. In 2017, moreover, MassDOT proposed spending \$2 billion for ongoing bridge repair and replacement between 2018 and 2022. Given MassDOT’s significant financial investment in large-scale transportation projects, the Internal Special Audit Unit (“ISAU”) within the Massachusetts Office of the Inspector General (“Office”) examined MassDOT’s oversight of one such project. Specifically, the ISAU reviewed two aspects of the construction of the Veterans Memorial Bridge in southeastern Massachusetts: the design of the bridge and the final phase of construction.¹ MassDOT completed construction of the bridge in October 2014. The agency formally closed out the final contract with the bridge designer in December 2012 and with the bridge contractor in July 2015.

The ISAU identified opportunities for MassDOT to strengthen its administration of large-scale transportation projects, especially with respect to design errors and cost recoveries:

1. MassDOT paid \$7 million to design the bridge. MassDOT subsequently paid the same bridge designer – Howard Needles Tammen & Bergendoff (“HNTB”) – \$9.2 million in consulting fees that were largely attributable to addressing problems with its own design. This was both wasteful and not in accordance with HNTB’s contracts, which expressly provided that MassDOT would not pay the design firm to correct, complete or clarify its own work.
2. MassDOT paid the contractor for the final phase of construction, Cianbro Middlesex, A Joint Venture (“CMJV”), \$7.4 million as an “equitable adjustment” for costs CMJV incurred largely because of errors and omissions in the bridge design, but MassDOT did not seek to recover any part of this payment from the bridge designer.
3. During the final phase of construction, MassDOT paid \$1.98 million to switch the bridge’s backup power source from natural gas to diesel.
 - a. The change was necessary because the state plumbing board would not issue a permit for the natural gas lines in HNTB’s design. MassDOT reported that HNTB should have sought advanced approval from the plumbing board for the design of the natural gas generators. According to MassDOT, had HNTB done so, the design could have been corrected or revised before construction began. Nevertheless, MassDOT did not seek to recover any portion of the \$1.98 million from the bridge designer.
 - b. MassDOT paid \$475,000 for the three natural gas generators. At the close of this review, however, MassDOT had neither used nor disposed of the generators.

¹ The Office retained an engineering consultant with large-scale bridge expertise to assist with this review.

4. MassDOT used extra work orders to pay CMJV \$5 million to operate and maintain the bridge for two years. While it may have been permissible to use extra work orders for this purpose, when MassDOT did conduct a competitive procurement, the cost to operate the bridge decreased substantially. Therefore, the agency likely would have saved money if it had originally conducted a public procurement instead of using extra work orders.
5. MassDOT paid CMJV \$932,698 to paint the steel beams on the bridge when, according to MassDOT's own specifications, the beams were supposed to be left unpainted.
6. During the final phase of construction, MassDOT engineers identified almost \$16 million² in potential cost recoveries related to design errors and omissions. Nevertheless, at the time of the ISAU's review, MassDOT's cost-recovery committee had been inactive for five years and it had not pursued any of these potential recoveries.

Shortly after the ISAU made inquiries about MassDOT's cost-recovery efforts in 2016, the agency reconvened the committee and began pursuing cost recoveries. MassDOT also appointed a full-time cost recovery administrator in May 2016. At the close of this review, the committee had determined that 54 extra work orders warranted further pursuit and it had successfully recovered \$1.9 million from three design firms on four different projects. However, MassDOT indicated it would not pursue recoveries on closed contracts, such as the HNTB contracts.

7. MassDOT continued to work with the bridge designer on several subsequent projects. MassDOT indicated there are limited design firms with the skills necessary to design large-scale, complex bridges. Department officials also noted that HNTB's Boston office changed its leadership since the completion of the Veterans Memorial Bridge. Following the leadership change, MassDOT has observed improvements in HNTB's internal procedures, communication and work quality.

The Office acknowledges that MassDOT has made efforts to improve its contract administration efforts since the ISAU's review began. For instance, MassDOT has enhanced its training for field staff for contractor oversight, notably with the implementation of the Highway Core Curriculum training program. The Highway Core Curriculum provides a comprehensive overview of various aspects of the Highway Division. Many of the classes are intended to help employees understand the roles and responsibilities of each technical section within the division. However, the curriculum also includes classes related to construction contracts, including contract administration and the procedures for closing out a construction project. Furthermore, as noted earlier, MassDOT has revamped its cost-recovery efforts and initiated recoveries from recent design vendors.

² This amount represents the total potential recoveries based on all extra work orders that MassDOT categorized as design errors or item omissions during the final phase of construction. Due to the volume and complexity of extra work orders, the ISAU focused its review on ten extra work orders, totaling \$8.3 million.

Based on the ISAU's review, MassDOT's oversight of design and construction contracts on large-scale projects would still benefit from improvement. Given that MassDOT proposes to expend \$2 billion for ongoing bridge repair and replacement between 2018 and 2022, improved contract administration could have a large financial impact for the Commonwealth.

The ISAU therefore recommends that the agency:

1. Evaluate existing contract administration policies and its enforcement of such policies. Consider developing and implementing enhanced policies and procedures to better manage the day-to-day operations and overall execution of large capital transportation projects.
2. Hold responsible parties accountable for errors and omissions encountered during large-scale construction projects and pursue cost recoveries when appropriate. To the extent that the contracts discussed in this report are closed, MassDOT should look into whether it can recover any funds from responsible parties.
3. Exercise closer scrutiny over consulting contracts to avoid unnecessary cost overruns.
4. Reinforce coordination among all relevant parties (including, but not limited to, MassDOT, the design firm, the construction contractor, permitting boards, utility companies and local municipalities) for capital transportation projects. Such coordination during the design phase and the preconstruction conference may allow the agency to anticipate and handle project issues, thereby avoiding delays and escalating costs.
5. Ensure the cost-recovery committee remains active and pursues all available cost recoveries on an ongoing basis.
6. Assess its procedures for evaluating designers' performance on projects, including the process for documenting and verifying evaluations.
7. Evaluate whether it should sell the three unused natural gas generators. Alternatively, assess whether a different MassDOT or MBTA division, or other state entity, needs the generators.

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Background

I. The Internal Special Audit Unit

The Office of the Inspector General for the Commonwealth of Massachusetts (“Office”) is an independent agency charged with preventing and detecting fraud, waste and abuse in the use of public funds and public property. Created in 1981, it was the first state inspector general’s office in the country. In keeping with its broad statutory mandate, the Office investigates allegations of fraud, waste and abuse at all levels of government; reviews programs and practices in state and local agencies to identify systemic vulnerabilities and opportunities for improvement; and provides assistance to both the public and private sectors to help prevent fraud, waste and abuse in government spending.

The Office’s Internal Special Audit Unit (“ISAU”) monitors the quality, efficiency and integrity of the Massachusetts Department of Transportation’s (“MassDOT”) operating and capital programs. As part of its statutory mandate, the ISAU seeks to prevent, detect and correct fraud, waste and abuse in the expenditure of public and private transportation funds. The ISAU is also responsible for examining and evaluating the adequacy and effectiveness of MassDOT’s operations, including its governance, risk-management practices and internal processes.

II. The Massachusetts Department of Transportation

Created as part of Transportation Reform in 2009, MassDOT oversees the Commonwealth’s roadways, public transit systems, and transportation licensing and registration. It consists of four divisions: the Highway Division, the Registry of Motor Vehicles (“RMV”), the Aeronautics Division, and Rail and Transit.

The Highway Division is responsible for the state’s roadways, bridges and tunnels, including those formerly managed by the Massachusetts Highway Department and the Massachusetts Turnpike Authority. The RMV is responsible for the administration of driver’s licenses, motor-vehicle registrations and vehicle inspections across the state. The Rail and Transit Division includes the Massachusetts Bay Transportation Authority (“MBTA”) and regional transit authorities. The Aeronautics Division coordinates aviation policy and oversees the safety, security and infrastructure of thirty-seven public airports across Massachusetts.

III. Veterans Memorial Bridge

The Veterans Memorial Bridge is a drawbridge that connects the cities of Somerset and Fall River and serves as the pathway for Route 6 and Route 138 across the Taunton River. MassDOT constructed the Veterans Memorial Bridge to replace the failing Brightman Street Bridge.

MassDOT began construction of the Veterans Memorial Bridge in 1998 and completed the bridge in October 2014. MassDOT divided the bridge’s construction into four phases, each with its own scope, public bid and contract.

| Phase | Dates | Description |
|-------------|-------------------------------|--|
| Phase 1 | June 1998 – November 1999 | Site preparation and related work |
| Phase 2 | August 1999 – December 2005 | Construction of approach span substructure and pier protection |
| Phase 3 | February 2001 – November 2003 | Substructures and related work |
| Final Phase | April 2007 – October 2014 | Construction of drawbridge and related work |
| | July 2015 | MassDOT closes out the construction contract |
| | October 2015 | MassDOT issues final payment for the construction contract |

Table 1: Description of each phase of construction.³

The total cost to design and build the bridge was \$322,439,064. The ISAU’s review focused on the contracts with two companies involved in the project: the bridge designer, Howard Needles Tammen & Bergendoff, and the general contractor for the final phase of construction, Cianbro Middlesex, A Joint Venture.

IV. Bridge Designer

In May 1992, MassDOT and Howard Needles Tammen & Bergendoff (“HNTB”) entered into a five-year contract with a maximum obligation of \$5.685 million. The scope of services included the following:

- Drawbridge design
- Design of the interchanges, traffic signals and the approach roadway viaduct
- Design plan for demolishing the Brightman Street Bridge
- Environmental permit applications
- Highway design
- Preparation of a complete package of construction documents

The original completion date for the design work was September 1994; however, a series of time extensions and contract modifications extended the contract to 2006, and led to a final design cost of \$7 million.

A. Consulting Services and Additional Design Work.

The original HNTB contract contemplated paying HNTB for design and consulting work that MassDOT needed because of unforeseen circumstances or design changes.⁴ The contract provided:

³ See Appendix A for a detailed timeline of the design and construction of the bridge.

⁴ See Contract No. 92607 between MassDOT and HNTB, dated May 13, 1992 (“Original HNTB Contract”), at Article V, Section B(2).

If after receiving written approval of his work ... the Consultant [*i.e.*, HNTB] shall be ordered in writing by the engineer to make revisions of the plans and/or other data, the Consultant shall be entitled to additional compensation as provided [in another section of the contract].⁵

The contract also required HNTB to provide certain services at no additional charge. First, HNTB had to furnish general consulting services throughout the construction of the bridge. The contract stated:

As part of his General Fee, the Consultant [*i.e.*, HNTB] shall furnish consultation and interpretation of his drawings and specifications as may be required by the Engineer.⁶

In addition, Section 600 of the contract outlined other services that HNTB was supposed to provide MassDOT during bridge construction without an additional charge:

- Attend pre-bid and pre-construction meetings
- Review all highway shop and other drawings
- Review bridge and wall shop drawings
- Furnish advice
- Review bascule shop drawings⁷

Finally, the contract prohibited paying HNTB for design work or consulting services related to errors, omissions or insufficient data on the part of HNTB. *See* Original HNTB Contract at Article I, Section 15 (prohibiting payments for revisions necessitated by HNTB's "errors, omissions, oversight or neglect") and Article V, Section B(1) (stating that MassDOT shall not pay for consulting work relating to "errors, omissions or insufficient data in work previously submitted by the Consultant").⁸

B. Additional Consulting Contracts with HNTB

As set forth above, the original design contract required HNTB to provide certain services throughout bridge construction. Nevertheless, in 2001, MassDOT entered into a consulting contract with HNTB to provide engineering consulting services during the end of

⁵ *See* Original HNTB Contract at Article I, Section 15.

⁶ *See* Original HNTB Contract at Article V, Section B(2).

⁷ *See* Original HNTB Contract at Article VIII, Section 615A. A bascule is the moveable section of road that forms part of a drawbridge.

⁸ *See also* Original HNTB Contract at Article VI, Section B (reiterating that "[n]o payment to the Consultant shall be made for visits to the construction site in connection with errors and/or omissions, or insufficient data in work previously submitted by the Consultant").

phase 3 and part of the final phase, *i.e.*, during the actual construction of the bridge.⁹ In 2009, MassDOT and HNTB entered into a second consulting contract to provide consulting services through the end of construction.

Both of the consulting contracts were on a time-and-materials basis and MassDOT ultimately paid HNTB \$9.2 million under the two agreements. Of the \$9.2 million in consulting fees, HNTB received \$8.1 million during the final phase. *See* Table 2.

| Contract | Contract Number | Original Contract Dates | Final End Date | Original Contract Award | Actual Paid on Contract |
|------------------------------------|-----------------|-------------------------|----------------|-------------------------|-------------------------|
| Original design contract | 92607 | 5/13/92 - 5/12/97 | 12/31/06 | \$5,685,000 | \$7,008,882 |
| First consulting contract | 31065 | 8/22/01 - 12/31/06 | 12/31/09 | \$1,820,000 | \$4,807,211 |
| Second consulting contract | 58308 | 7/1/09 - 12/31/12 | 12/31/12 | \$4,500,000 | \$4,397,128 |
| Total Cost of Bridge Design | | | | | \$16,213,221 |

Table 2: HNTB’s three contracts for the Veterans Memorial Bridge.¹⁰

The consulting contracts included work that was provided for in the original design contract. The consulting contracts included, but were not limited to:

- Attending meetings with construction contractors and MassDOT personnel
- Reviewing various shop drawings
- Furnishing advice to MassDOT and construction contractors
- Providing on- and off-site assistance and advice during construction
- Providing landscape technical advice
- Conducting routine site visits to the project site during construction
- Providing geotechnical engineering services
- Reviewing construction procedures
- Providing monitoring services
- Providing periodic written reports and on-site assistance and advice to MassDOT

Like the original HNTB contract, both consulting contracts stated that MassDOT would not pay HNTB to make revisions “caused by errors, omissions, oversight or neglect on the part

⁹ Furthermore, MassDOT closed out HNTB’s original design contract in 2006, thereby ending HNTB’s obligations under that agreement.

¹⁰ HNTB completed the original design in 2000; however, MassDOT kept the contract open administratively until 2006.

of the Consultant.”¹¹ Nor would MassDOT pay for work “in relation to errors and omissions or insufficient data in work previously submitted by the Consultant.” *See* First Consulting Contract at Article V, Section C; *see also* Second Consulting Contract at Article V, Section C.

V. Bridge Construction Contractor

The Cianbro Corporation and the Middlesex Corporation created a joint venture – Cianbro Middlesex, A Joint Venture (“CMJV”) – to bid on the final phase of bridge construction, which included building the drawbridge itself. CMJV’s winning bid was \$186 million. The total cost of the final phase was \$218 million, which included \$22 million in extra work orders, \$10 million in general cost overruns and \$7.4 million as an “equitable adjustment.”¹² The notice-to-proceed date for the contract was May 17, 2007. The bridge opened to traffic on October 11, 2011 (while construction was ongoing), and CMJV completed its work on October 1, 2014.

The scope of work for building the actual bridge included construction or installation of the following bridge components:

- Drawbridge
- Concrete piers
- Control house
- Abutment and retaining walls
- Four ramp bridges
- Electrical and mechanical equipment for operation and control of the drawbridge
- Installation of four back-up generators¹³

The contract also required CMJV to build all associated roadways, ramps, bikeways, walkways, sidewalks, driveways and drainage, as well as to provide all signage, traffic signals, pavement markings, lighting and landscaping.

¹¹ *See* Contract No. 31065 between MassDOT and HNTB, dated August 22, 2001 (“First Consulting Contract”), at Article I, Section 15. *See also* Contract No. 58308 between MassDOT and HNTB, dated July 1, 2009 (“Second Consulting Contract”), at Article I, Section 15.

¹² *See* Section VII of the Background section for a further discussion of the equitable adjustment.

¹³ The original scope included four generators; however, CMJV ended up purchasing and installing three generators.

VI. Extra Work Orders

MassDOT used extra work orders – or “change orders” – to authorize additional work that was necessary in order to complete the bridge project. According to Subsection 4.05 of MassDOT’s *1988 Standard Specifications for Highways and Bridges*,¹⁴

[t]he Engineer shall be authorized to issue Extra Work Orders for such additional work outside the scope of the original contract as in his/her judgment is reasonably necessary for the satisfactory completion of the project provided that the work to be done under such an Extra Work Order, either standing alone or in conjunction with any previously authorized Extra Work Order, shall not result in a change of such magnitude as to be incompatible with the provisions of Chapter 29, Section 20A and Chapter 149, Section 44J of the General Laws.

Extra work orders are a necessary and common part of the construction process; they allow the agency to address unforeseen issues that arise during construction, such as unforeseeable excavation problems.

CMJV submitted 188 extra work orders for this project, totaling \$22 million. Due to the volume and complexity of the extra work orders, the ISAU focused its review on ten extra work orders, totaling \$8.3 million.¹⁵

VII. CMJV’s Requests for Equitable Adjustments

Throughout the construction of the final phase, CMJV voiced concerns about HNTB’s design plans and drawings. The contractor submitted over 800 written requests – referred to as Requests for Information (“RFIs”) – asking HNTB to clarify its design. Often, the RFIs resulted in design revisions, extra change orders and construction delays.

While RFIs are a common part of bridge construction, MassDOT officials indicated that CMJV had to submit significantly more RFIs than contractors typically require in order clarify or correct the design. The ISAU’s consulting engineer agreed that the number of RFIs during the final phase was atypically high.

Ultimately, CMJV submitted two requests for equitable adjustment (“REAs”) to MassDOT seeking \$12 million for expenses, financial hardships and time delays it incurred during the final phase. In the first REA, CMJV alleged that it had incurred \$7.7 million because HNTB’s design was defective, unclear and incomplete, and, to a much lesser extent, because it had to fix construction errors by the contractor for phase 3. The second REA, which sought \$7.8 million, was based solely on alleged errors and omissions in HNTB’s design.

¹⁴ The *1988 Standard Specifications for Highways and Bridges* (“Standard Specifications”) is a manual that, among other things, outlines contractors’ responsibilities and obligations in performing highway and bridge work for MassDOT. The Standard Specifications were incorporated into CMJV’s contract by reference. See Contract No. 50501 between MassDOT and CMJV, dated March 28, 2007, at Addendum No. 15.

¹⁵ See summary of extra work orders at Appendix C.

CMJV claimed, for example, that:

The discovery of defective construction at the outset (work performed by others)¹⁶ was followed by the discovery of significant errors, defects and missing details in the “Released for Construction” documents that had been prepared by HNTB as designer of record for MassDOT.... The project has now been required to submit approximately 790 requests for information (“RFIs”) and to date there are nearly 150 Change Orders submitted, pending and/or approved... This volume of missing or incorrect information represents an extraordinary effort required by the general contractor [CMJV] and MassDOT to build the project.¹⁷

CMJV alleged that HNTB’s errors and omissions cost the contractor millions of dollars. CMJV stated, for example:

This process required additional staff on-site and for longer periods of time dedicated to solving problems, it created enormous inefficiency in planning and executing the work, it required the work to take a longer period of time to complete and it required greater amounts of equipment to be on-site for longer periods of time. Off-site resources not planned (or budgeted) were required to mitigate impacts by accelerating change order design work....The cost of this effort has been enormous....¹⁸

MassDOT hired a construction consulting firm, PMA Associates, to help the agency analyze the REAs. Working with PMA, MassDOT discounted some requests and found that CMJV made a strong case with respect to others. Ultimately, in 2011 and 2012 MassDOT negotiated a settlement of \$7.4 million to resolve the REAs. In a memorandum summarizing the negotiations, a MassDOT official indicated the agency “intend[ed] to pursue cost recovery with HNTB on a number of [Extra Work Orders] where it is felt the design was deficient.”¹⁹ However, MassDOT did not seek to recover any part of this payment from the bridge designer because the cost-recovery group was inactive.

MassDOT closed out the contract with CMJV in July 2015, with final payment in October 2015.

VIII. MassDOT’s Cost-Recovery Procedures

An extra work order for a bridge contract must include a justification – or reason – for the additional work. When an extra work order is approved because of a design error or design omission, MassDOT is supposed to determine whether to recover the extra costs from the bridge designer. In 2016, the ISAU found that the committee responsible for evaluating such cost

¹⁶ The ISAU did not review contracts related to this earlier work.

¹⁷ “Second Request for Equitable Adjustments,” dated “Draft Final 10.11.11,” from CMJV to MassDOT, at pp. 2-3.

¹⁸ CMJV’s Second Request for Equitable Adjustment at p. 3.

¹⁹ MassDOT document titled “Record of Negotiations with Cianbro/Middlesex,” undated, at p. 1.

recoveries had been inactive since at least 2011. Shortly after the ISAU made inquiries in 2016 about MassDOT's cost-recovery efforts, the agency reconvened the committee and began pursuing cost recoveries. MassDOT also appointed a full-time cost recovery administrator in May 2016.

Specifically, MassDOT maintains a cost-recovery group within the Highway Division to pursue potential financial recoveries related to design errors or omissions. In general, the objective of the cost-recovery process is to determine whether to pursue costs or damages that occur on highway projects due to a designer's errors or deficient performance.

Therefore, when the District Highway Director approves an extra work order due to an error or omission in the design, a copy of the extra work order is supposed to be sent to the cost-recovery group. According to the 2006 MassDOT Cost Recovery Standard Operating Procedures, the group is supposed to meet monthly to review potential cost recoveries. Based on the group's review, as well as the response from the bridge designer, the cost-recovery group determines whether to recommend seeking a recovery. MassDOT's Chief Engineer makes the final determination; she may concur with the group's recommendation or may choose some other course of action. If MassDOT's Chief Engineer decides that a cost-recovery is appropriate, MassDOT's legal division then pursues the appropriate course of action.

During the final phase of construction of the Veterans Memorial Bridge, MassDOT's engineers flagged 118 extra work orders totaling \$15.9 million that appeared to be the result of design errors and item omissions. MassDOT did not pursue recoveries for these extra work orders. As stated above, the cost-recovery group had not conducted recovery activities since 2011. Following the ISAU's inquiries, MassDOT reconvened the cost-recovery committee and began pursuing financial recoveries on open contracts. At the close of this review, the committee had held 17 meetings and had identified 114 separate potential recoveries. Of those, the committee determined that 54 warranted action and the agency successfully recovered \$1,967,737.24 from three design firms on four different projects. MassDOT indicated it would not pursue recoveries on closed contracts, such as the HNTB contracts, however.

Findings

I. MassDOT Paid the Bridge Designer Millions of Dollars to Correct, Clarify and Complete Its Design.

A. Overview

MassDOT entered into two contracts with HNTB – for a total of \$9.2 million – to provide design and consulting services during the end of phase 3 and all of the final phase of the project. The need for the contracts is unclear, since the original contract (a) required HNTB to provide consulting services free of charge throughout construction; and (b) provided for HNTB to be paid for all additional work it performed. Furthermore, much of HNTB’s work under these contracts related to correcting, clarifying and completing its own design. All three HNTB contracts prohibited the firm from being paid for such work.

Finally, HNTB’s invoices for the contracts lacked details showing work completed or deliverables created, making it impossible to evaluate the specific work that HNTB performed. This, coupled with the fact that MassDOT paid more for these consulting contracts than it did for HNTB to design the bridge, raise concerns about the cost of the consulting contracts.

B. Discussion

As discussed above, HNTB’s original contract required the firm to provide engineering consulting during actual construction.²⁰ MassDOT closed the original design contract in 2006, before construction had begun, and entered into two additional design and consulting contracts with HNTB at a cost of \$9.2 million, which exceeded the entire cost of the original design contract (\$7 million). Of the \$9.2 million, MassDOT paid HNTB \$8.1 million during the final phase of the construction.

| Contract | Contract Number | Original Contract Dates | Final End Date | Original Contract Award | Actual Paid on Contract |
|------------------------------------|-----------------|-------------------------|----------------|-------------------------|-------------------------|
| Original design contract | 92607 | 5/13/92 - 5/12/97 | 12/31/06 | \$5,685,000 | \$7,008,882 |
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| Total Cost of Bridge Design | | | | | \$16,213,221 |

Table 3: HNTB’s three contracts for the Veterans Memorial Bridge.

²⁰ See pages 7 to 8.

The ISAU received conflicting explanations about why MassDOT entered into the consulting contracts when the original agreement required HNTB to provide consulting services throughout construction. During the ISAU's review, MassDOT officials stated that HNTB's original design was flawed, unclear and incomplete. As a result, MassDOT needed HNTB to be on site every day during bridge construction to correct and clarify its design. On the other hand, late in the ISAU's review, MassDOT officials also reported that HNTB had to be on site every day because of the size and complexity of the Veterans Memorial Bridge.

Based on the ISAU's review, the evidence indicates that much of the work HNTB performed under the two consulting contracts was necessary because HNTB's original design was flawed, unclear and incomplete. For example, CMJV reported that the original designs contained significant errors, defects and missing details. MassDOT corroborated this assertion and reported that the design plans were so flawed that CMJV frequently required clarification and, ultimately, revision of the design plans before it could proceed with various aspects of construction. On this project alone, CMJV submitted over 800 Requests for Information ("RFI") to HNTB for clarification of the design plans. While it is not unexpected to submit multiple RFIs on a complex, multi-million dollar bridge project, MassDOT officials stated (and the ISAU's consultant agreed) that the project required an atypically high number of RFIs.

In addition, CMJV sought \$12 million in "equitable compensation" from MassDOT, primarily because of issues with HNTB's design. According to CMJV, these issues included errors, defects and missing details in the construction documents that HNTB prepared. MassDOT acknowledged the monetary impact to CMJV that resulted from the design errors and omissions, and the agency paid CMJV \$7.4 million as an equitable adjustment. In a memo discussing the project, moreover, a MassDOT official indicated that the agency would seek to recover from HNTB the cost of extra work orders that were the result of design errors. All of these factors, including CMJV's requests for equitable adjustments and the high volume of RFIs during the final phase, are strong indications that the original bridge design contained errors and was incomplete.

Finally, during the review, MassDOT officials noted that the design fees paid to HNTB during the final phase equaled less than 5% of the construction costs for that phase.²¹ Agency officials further stated that it was not unusual for design fees to equal five percent of the construction costs for a project. Regardless of this standard, MassDOT should not have paid HNTB to complete, correct or clarify its own design.

C. Conclusion

The agency paid HNTB \$9.2 million in consulting fees that were largely related to addressing problems with the design itself. This was both wasteful and not in accordance with MassDOT's three contracts with HNTB, which prohibited paying the design firm to correct, complete or clarify its own work.

²¹ \$8.1 million ÷ \$186 million = 0.44 or 4.4%.

D. Recommendations

MassDOT should:

1. Improve its contract administration procedures to ensure proper contract oversight.
2. Reconsider the use of time-and-materials contracts for design consultant contracts unless the agency can perform close oversight and validate all consultant hours expended for the contract.
3. Hold design consultants accountable for correcting design errors and clarifying incomplete or unclear plans. Emphasize the construction engineering services clause in design contracts to reduce future financial liability and place the risk of producing complete and accurate contract plans on the design consultant.
4. Require design firms to review their design plans prior to the bid solicitation phase to ensure that all documents associated with the contract are up to date and adhere to current laws, regulations and MassDOT specifications.
5. Evaluate whether it can recover from HNTB any portion of the \$7.4 million that MassDOT paid to CMJV as an equitable adjustment.
6. Consider additional penalties against design firms that previously submitted flawed construction plans, especially those plans that significantly increased costs, caused project delays and required substantial updates.

II. MassDOT Had to Replace Emergency Backup Generators During Bridge Construction, Leading to an Estimated Cost Overrun of \$1.98 Million.

A. Overview

The ISAU found that during the final phase, MassDOT paid CMJV \$523,670 to install natural gas generators and then spent at least \$2.29 million to remove the generators and replace them with diesel models. The change was necessary because the Massachusetts Board of State Examiners of Plumbers and Gas Fitters (“Plumbing Board”) would not issue a permit for the natural gas lines in HNTB’s design. MassDOT reported that HNTB should have sought advanced approval from the Plumbing Board for the design of the natural gas generators. According to MassDOT, had HNTB done so, the design could have been corrected or revised before the construction began.

The ISAU estimates that the switch from natural gas to diesel generators led to a cost overrun of at least \$1.98 million. MassDOT did not recover these additional costs from HNTB or any other contractor. Furthermore, MassDOT kept the three natural gas generators but has not used them.

B. Discussion

HNTB designed the Veterans Memorial Bridge to include three natural gas generators as a backup power source in emergencies. The original design included one gas line to supply all three generators. MassDOT reported that the designer (here, HNTB) is responsible for ensuring that the design meets building code requirements, including plumbing and gas fitting codes. Both MassDOT officials and the ISAU’s consultant reported that, as a result, designers frequently seek stamped approval from the relevant code inspectors on the feasibility of a proposed design. HNTB’s original drawings for the bridge did not contain any stamps from the Plumbing Board; a stamp would indicate that HNTB consulted with the board on its design.

Pursuant to the design plans, CMJV purchased and installed three natural gas generators at a cost of \$523,670.²² Each generator was approximately 149” x 71” x 86” and weighed roughly between 8,800 to 10,500 pounds. *See* Appendix B.

| Costs for Natural Gas Generators | | | |
|---|-------------------|--------------------------------------|-------------------------|
| Contract Line Item | Bid Amount | Extra Work Order Description | Amount |
| 345.3 | \$44,950 | Four Inch Underground Gas Service | \$48,670 |
| 880.8 | \$475,000 | Natural Gas Emergency Generators (3) | \$475,000 ²³ |
| | | TOTAL | \$523,670 |

Table 4: Cost for natural gas generators.

CMJV subsequently applied to the Plumbing Board for the gas-line permit. The Plumbing Board rejected the permit. The State Plumbing Inspector determined that, for safety reasons, CMJV needed to install four dedicated gas lines, instead of the one larger gas line called for in HNTB’s design.

After the Plumbing Board rejected the permit, HNTB modified the bridge designs to accommodate the four gas lines that the Plumbing Board required. MassDOT estimated that these changes would cost an additional \$2 million, which it determined was cost-prohibitive. The agency therefore opted to replace the natural gas generators with diesel generators.

As a result, CMJV uninstalled the natural gas generators, transported them to various MassDOT locations, and purchased and installed diesel generators. This process took nearly three years and cost MassDOT almost \$2 million.²⁴

²² CMJV’s original cost to install the natural gas generators and the gas lines was \$816,050. CMJV spent only \$523,570 of this amount, however, because it could not get the permit for the gas lines.

²³ This includes both the cost of the generators and the labor to install them.

²⁴ The switch to diesel generators also resulted in indirect costs to MassDOT. The agency, for instance, had to devote its own staff and resources to addressing the problem. Similarly, a small portion of the equitable settlement with CMJV was attributable to delays and costs that CMJV incurred because the firm had to switch out the generators. Because of unavailability of records, the ISAU did not quantify MassDOT’s indirect costs.

| COSTS RELATED TO CHANGE TO DIESEL GENERATORS | | | |
|---|------------------------------|--|---------------------------|
| Extra Work Order No. | Extra Work Order Date | Extra Work Order Description | Amount |
| 80 | 10/12/10 | Rental costs for portable backup generator to operate drawbridge while MassDOT and HNTB handled generator change decisions. | \$34,719 |
| 80.1 | 7/19/11 | Additional rental costs for portable backup generator to operate drawbridge while MassDOT and HNTB handled generator change decisions. | \$43,399 |
| 118 | 7/22/11 | Time and materials costs to replace natural gas backup generators with diesel generators. | \$1,300,000 ²⁵ |
| 130 | 12/21/11 | Modifying the HVAC system in the control house due to the change of the secondary power system from natural gas to diesel. | \$283,103 |
| 80.2 | 3/8/12 | Additional rental costs for portable backup generator to operate drawbridge while MassDOT and HNTB handled generator change decisions. | \$26,039 |
| 118.1 | 8/10/12 | Additional funds to complete generator conversion. | \$433,945 |
| IAH ²⁶ #5 | 3/11/10 | HNTB's development of plans for elevated gas lines | \$175,000 |
| | | HNTB's development of plans for diesel generators | Records not available |
| | | TOTAL | \$2,296,205 |

Table 5: Costs related to the change to diesel generators.

The ISAU estimates that the switch from natural gas to diesel generators cost MassDOT at least \$1.98 million, calculated as follows. MassDOT spent \$523,670 to install the natural gas generators and \$2.29 million to switch to diesel generators, meaning it cost MassDOT \$2.81 million to install backup generators for the bridge. The original estimate to purchase and install the natural gas generators was \$816,050.²⁷ MassDOT's best estimate of how much it would have cost to install diesel generators from the outset of the project was \$831,504. Using the higher of the two amounts, the switch from natural gas generators to diesel models cost MassDOT at least \$1.98 million in direct costs. *See* Table 6 below.

²⁵ This includes \$831,504 for the diesel generators.

²⁶ "IAH" refers to Increase in Assignment Hours. This is an official MassDOT form used to document a verbal authorization for a contractor to proceed with a particular service.

²⁷ *See* footnote 22 above.

| COSTS RELATED TO GENERATOR CONVERSION | | |
|---|-----------------------------------|-------------------------------|
| Description | Cost to Install Generators | Estimated Cost Overrun |
| Installation of natural gas generators | \$523,670 | |
| Switch from natural gas to diesel generators | + \$2,296,205 | |
| Total cost to install backup generators | \$2,819,875 | \$2,819,875 |
| MassDOT's best estimate of how much it would have cost if it had installed diesel generators from the start of the project. | | - \$831,504 |
| ESTIMATED COST OVERRUN | | \$1,988,371 |

Table 6: Costs related to generator conversion.

C. Conclusion

Switching the generators cost the public almost \$2 million and delayed the completion of the bridge. HNTB should have sought stamped approval from the Plumbing Board while preparing its initial drawings in order to verify the feasibility of its design. Based on the information the ISAU reviewed, HNTB sought approval only after CMJV purchased and installed the generators.

Finally, when this problem first arose, MassDOT should have evaluated whether to recover the \$1.98 million overage (or a portion of the overage) from HNTB.

D. Recommendations

MassDOT should:

1. Reinforce coordination among all relevant parties (including, but not limited to, MassDOT, the design firm, the construction contractor, permitting boards, utility companies and local municipalities) for large-scale transportation projects. Such coordination during the design phase and preconstruction conference may allow the agency to anticipate and handle project issues, and delays, thereby avoiding cost overruns.
2. Resolve all major construction issues, including potential permitting issues, before purchasing equipment and initiating construction on project milestones.
3. Evaluate whether it should sell the three unused generators. Alternatively, assess whether a different MassDOT or MBTA division, or other state entity, could use the idle generators.

III. MassDOT Used Extra Work Orders to Pay CMJV \$5 Million for Drawbridge Operations and Maintenance Services.

A. Overview

MassDOT used extra work orders to pay CMJV \$5,099,526 to operate the bridge from October 2012 to October 2014. While it may have been permissible to use extra work orders for this purpose, other qualified contractors did not have the opportunity to bid on these services. Further, when MassDOT did conduct a competitive procurement, the cost to operate the bridge decreased substantially. Therefore, the agency likely would have saved money if it had conducted a public procurement instead of using extra work orders.

B. Discussion

CMJV's contract required it to operate the bridge when it first opened. Thereafter, MassDOT was supposed to take over the bridge operations, with the assistance of a full-time technical expert from CMJV. The contract stated:

The Contractor [*i.e.*, CMJV] shall provide a full-time bridge operations crew to operate the [drawbridge] and associated equipment for a period of not less than 275 calendar days following successful completion and acceptance by the Engineer of Stage 2....

Upon commencement of Stage 4, the Contractor's responsibilities under the Contract shall remain unchanged, provided, however, that [MassDOT] will assume responsibility for the operation and maintenance of the [drawbridge] and associated equipment. The Contractor shall provide a full time, on-site, technical support person to assist [MassDOT] with any and all problems that may arise in the 12 month period following completion and acceptance by the Engineer of Stage 3.²⁸

In or about 2011, MassDOT concluded that it did not have personnel with the expertise to operate and maintain the bridge. Consequently, MassDOT used two extra work orders to pay CMJV \$5,099,526 to operate and maintain the bridge for two years.

1. The Use of Extra Work Orders to Operate the Bridge

Arguably, MassDOT was permitted to use extra work orders to hire CMJV to maintain and operate the bridge. Under the contract with CMJV, the agency could use extra work orders for work that was "reasonably necessary for the satisfactory completion of the project" as long as the work did "not result in a change of such magnitude as to be incompatible with the provisions of Chapter 29, Section 20A and Chapter 149, Section 44J of the General Laws."²⁹ The contract

²⁸ See Contract No. 50501 between MassDOT and CMJV, dated April 12, 2007 ("CMJV Contract"), at Item 995.022.

²⁹ See Standard Specifications for Highways and Bridges, dated 1988, at Subsection 4.05.

also gave MassDOT the authority “to increase, decrease or eliminate the quantity of any particular item of work...”³⁰

Since the contract already required CMJV to operate the bridge for approximately nine months, it is arguable that MassDOT could extend operations under its authority to “increase ... the quantity of any particular item of work...” It is less clear that CMJV’s operation of the bridge for two years was “reasonably necessary” to complete the project, *i.e.*, construction of the drawbridge.

2. The Cost of Not Conducting a Public Procurement.

After CMJV stopped operating the bridge, MassDOT conducted three public procurements to operate and maintain the Veterans Memorial Bridge. The competitive procurements all resulted in lower operation and maintenance costs. First, in 2014, MassDOT conducted a public procurement to operate and maintain seven bridges – the Veterans Memorial Bridge and six others – for one year. The winning bid was \$1,897,340 and the final cost was \$2,515,086 –similar to what CMJV charged to operate only the Veterans Memorial Bridge (although this new contract covered seven bridges). MassDOT subsequently conducted a public procurement for the Veterans Memorial Bridge and seven other area bridges. The contract award value for that contract – *i.e.*, for the operation and maintenance of eight bridges – was \$3,506,522 for a two-year period. Once that contract expired, MassDOT conducted another public procurement for seven bridges, including the Veterans Memorial Bridge. The contract award value for that contract was \$3,478,630, again for a two-year period.

| Bridge Operator | Dates | Contract Length | Bridges Included in the Contract | Cost |
|----------------------------------|-------------------|-----------------|----------------------------------|-------------|
| CMJV (Extra Work Order 165) | 10/2/12 - 10/1/13 | 1 year | 1 | \$2,475,789 |
| CMJV (Extra Work Order 165.1) | 10/2/13 - 10/1/14 | 1.25 years | 1 | \$2,623,737 |
| SPS New England | 7/10/14 - 7/10/15 | 1 year | 8 | \$2,515,086 |
| N.E.L. Corp. | 6/2/15 - 6/1/17 | 2 years | 8 | \$3,999,209 |
| N.E.L. Corp. | 3/22/17 – 3/22/19 | 2 years | 7 | \$3,478,630 |

Table 7: The cost of not conducting a public procurement.

In short, when MassDOT conducted public procurements, the cost to operate and maintain the bridge decreased considerably. Specifically, CMJV’s cost to operate only the Veterans Memorial Bridge for a two-year period was \$5,099,526, over \$580,000 more than the average cost of the two publicly bid contracts that followed. Moreover, those subsequent contracts included either seven or eight bridges. Based on the documents and information provided, MassDOT likely paid a substantial premium for bridge operations by not conducting a public procurement.

³⁰ See CMJV Contract at Subsection 4.06.

C. Conclusion

While MassDOT arguably was permitted to use extra work orders for the bridge operations, the decision was a costly one. Moreover, the use of extra work orders lacked transparency and excluded other qualified companies from the opportunity to provide the services to the Commonwealth. Finally, MassDOT reported that it did not conduct a public procurement because of concerns that union employees would object if MassDOT outsourced the bridge operations. However, apprehensions about potential union disputes are not a valid reason for circumventing public bidding requirements.³¹

D. Recommendation

MassDOT should evaluate its use of extra work orders to procure services outside of the scope of the contract, and always consider competitive bidding processes to procure supplies and services.

IV. MassDOT Paid CMJV \$932,698 to Paint Girders That Did Not Require Painting.

MassDOT approved \$932,698 in extra work orders to paint girders that, according to MassDOT's bridge specifications, should not have been painted.³²

HNTB's design plans called for CMJV to use "weathering steel" for the drawbridge girders on the Veterans Memorial Bridge. Weathering steel is designed to resist corrosion and therefore does not require paint to protect against deterioration. Consequently, MassDOT's *Standard Specifications for Highways and Bridges* – which CMJV was required to follow – prohibit painting over weathering steel.³³

During construction, CMJV requested formal clarification from HNTB regarding whether to paint the girders. In response, HNTB instructed CMJV to paint them, apparently based on direction from MassDOT.³⁴ CMJV therefore submitted – and MassDOT approved – two extra work orders to paint the girders, for a cost of \$932,698.

³¹ In any event, the Department did outsource the operation and maintenance of the bridge – but through the use of extra work orders.

³² Girders are large support beams used on bridges.

³³ Furthermore, during the bid process for the final phase of construction of the bridge, MassDOT issued *Addendum 12* to answer contractors' questions related to coating requirements for the girders. The contract addendum stated that "All superstructure steel shall be painted in accordance with [MassDOT's *Standard Specifications for Highways and Bridges*], Subsection 960.63." Subsection 960.63 expressly states that "Structural steel meeting [American Association of State Highway Transportation Officials'] M 270/M 270M Grade 345W (50W), Grade 485HPS (70HPS) and other weathering steels shall not be painted except when and where specifically called for on the plans." In this instance, the design plans did not specifically call for additional painting.

³⁴ During the ISAU's review, the agency reported that HNTB would not have made any decisions on formal inquiries without direction or approval from MassDOT.

MassDOT should:

1. Improve its contract administration procedures to ensure that it does not pay for unnecessary work.
2. Evaluate the design firm's responses to the contractor to determine whether the additional work directed is in accordance with federal and/or state specifications.

V. MassDOT's Cost-Recovery Committee Did Not Pursue Any Cost Recoveries in Connection With Errors or Omissions in the Bridge Design.

As discussed above, MassDOT has a committee that evaluates potential cost recoveries from bridge designers. *See* page 12. During the final phase of the construction of the Veterans Memorial Bridge, District 5 engineers identified \$15,910,738³⁵ in potential financial recoveries based on errors or omissions in the bridge design. This is in addition to the \$7.4 million that MassDOT paid CMJV as an equitable adjustment. *See* pages 10 to 12. MassDOT did not seek to recover any of these funds from HNTB. Moreover, MassDOT reported that the agency's cost-recovery committee had not been in operation since 2011.

After the ISAU inquired about the committee's status in 2016, MassDOT reconvened the committee and began pursuing cost recoveries for current contracts. At the close of this review, MassDOT had determined that 54 extra work orders warranted action and the agency successfully recovered \$1,967,737.24 from design firms on four different projects. MassDOT indicated it would not pursue recoveries on closed contracts, such as the HNTB contracts, however.

MassDOT should:

1. Continue its cost recovery efforts on open contracts.
2. Evaluate whether it can recover any costs related to the Veterans Memorial Bridge from HNTB, including the \$15 million in extra work orders and the \$7.4 million in equitable compensation paid to CMJV.

³⁵ This is the total cost of 118 extra work orders that MassDOT categorized as design errors or omissions for the entire bridge project.

Conclusion

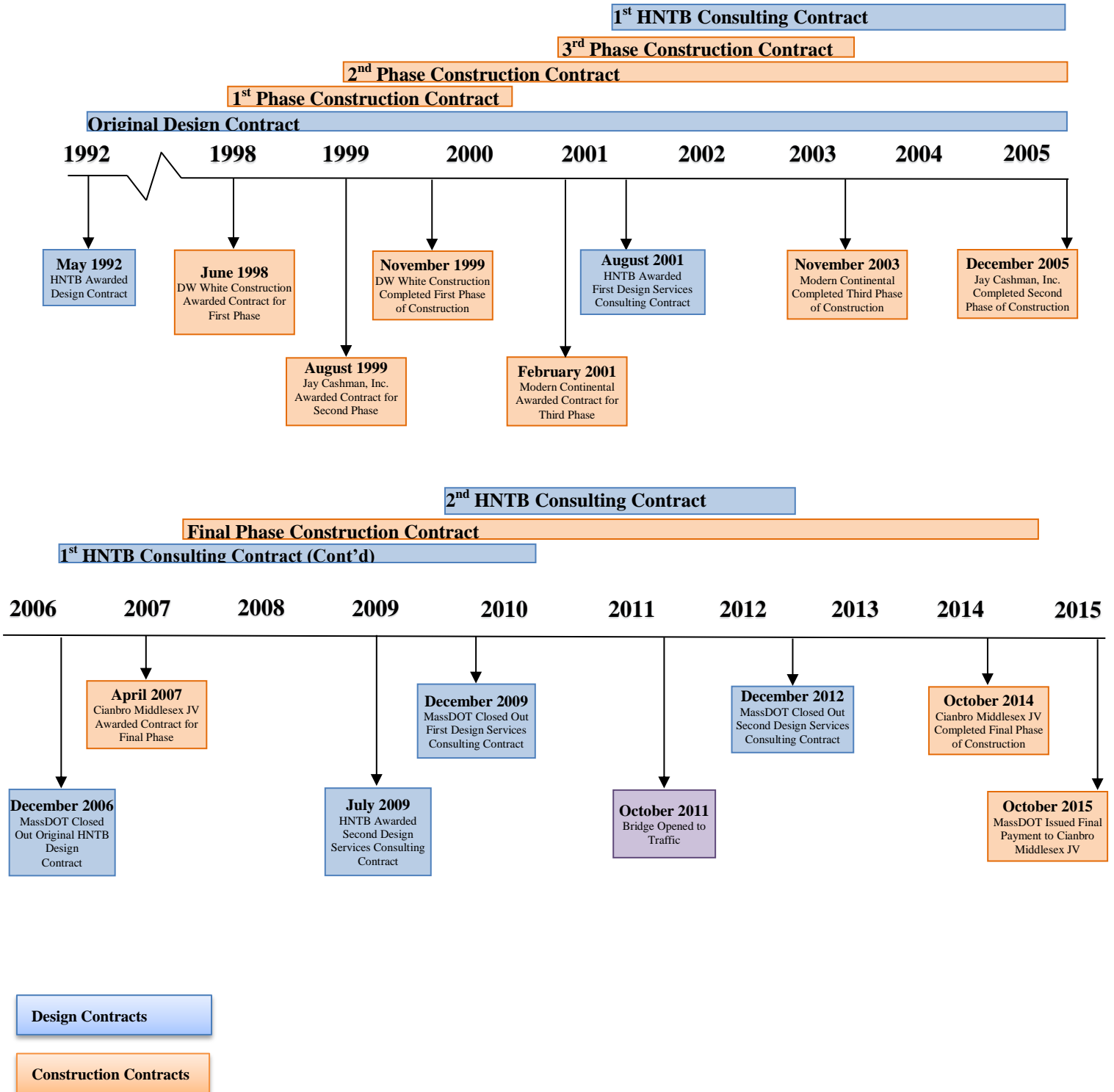
MassDOT has opportunities to strengthen its administration and oversight of design and construction contractors. Extra work orders and cost overruns on large-scale bridge design and construction projects are not unusual. Many of the extra work orders on this project were likely necessary and unavoidable due to the complexity and magnitude of the Veterans Memorial Bridge. Despite this, MassDOT could have avoided extra costs by executing proper contract administration procedures. Specifically, the agency should:

1. Evaluate existing contract administration policies and its enforcement of such policies. Consider developing and implementing enhanced policies and procedures to better manage the day-to-day operations and overall execution of large capital transportation projects.
2. Hold responsible parties accountable for errors and omissions encountered during large-scale construction projects and pursue cost recoveries when appropriate. To the extent that the contracts discussed in this report are closed, MassDOT should look into whether it can recover any funds from responsible parties.
3. Exercise closer scrutiny over consulting contracts to avoid unnecessary cost overruns.
4. Reinforce coordination among all relevant parties (including, but not limited to, MassDOT, the design firm, the construction contractor, permitting boards, utility companies and local municipalities) for capital transportation projects. Such coordination during the design phase and the preconstruction conference may allow the agency to anticipate and handle project issues, thereby avoiding delays and escalating costs.
5. Ensure the cost-recovery committee remains active and pursues all available cost recoveries on an ongoing basis.
6. Assess its procedures for evaluating designers' performance on projects, including the process for documenting and verifying evaluations.
7. Evaluate whether it should sell the three unused natural gas generators. Alternatively, assess whether a different MassDOT or MBTA division, or other state entity, needs the generators.

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Appendix

A. Veterans Memorial Bridge Timeline



B. Photo of Unused Natural Gas Generator on State Property



ISAU photo of one of the natural gas generators that MassDOT paid for, but never used. MassDOT houses this generator behind the District Six Headquarters building on Kneeland Street in Boston, underneath Interstate 93. This photo was taken on November 2, 2017.

C. Summary of Extra Work Orders Included in the ISAU’s Review

| Extra Work Order | Date | Cost Estimate | Scope ³⁶ | Reason |
|------------------|----------|--------------------|--|----------------------|
| 14 | 6/18/08 | \$574,550 | To provide payment for painting of all weathered steel, including the bascule pier girders, which were not specifically called out to be painted in the contract documents. ³⁷ | Item Omission |
| 42 | 7/28/10 | \$358,148 | To pay the contractor for the field painting of the weathering steel on the drawbridge. | Item Omission |
| 80 | 10/12/10 | \$38,864 | To pay the contractor for supplying and wiring of a portable generator to supply power to the control house for the ability to raise and lower the drawbridge for navigational use of the channel during an electrical power outage as required by the Coast Guard. | Design Error |
| 80.1 | 7/19/11 | \$43,399 | To pay the contractor for additional rental costs for a portable generator to supply power to the control house. This is an overrun of the original extra work order 80. | Design Error |
| 80.2 | 3/8/12 | \$26,039 | To pay the contractor for additional rental costs for a portable generator to supply power to the control house. This is an overrun of the original extra work order 80 and 80.1. | Design Error |
| 118 | 7/22/11 | \$1,300,000 | To pay the contractor for the change of the backup generators from natural gas to diesel during the period that their final scope and design is being completed by the designer and reviewed by MassDOT. | Design Error |
| 118.1 | 8/10/12 | \$433,946 | This extra work order is an overrun of extra work order 118. It is to pay the contractor for the change of the backup generators from natural gas to diesel due to requirements of the Plumbing Board for additional separate gas lines to fuel each natural gas generator separately and the future MassDOT maintenance concerns of those same gas lines. | Design Error |
| 130 | 12/21/11 | \$283,103 | To pay the contractor for revamping of the HVAC system due to the change of the secondary power system from natural gas fired to diesel. | Design Error |
| 165 | 9/25/12 | \$2,547,968 | To pay the contractor to assume the duties of the operation and maintenance of the Veterans Memorial Bridge during Stage IV (one year) based on the criteria given. | Other Agency Request |
| 165.1 | 8/15/13 | \$2,702,117 | To pay the contractor for operation and maintenance of the Veterans Memorial Bridge for the period 10/2/13 to 10/1/14 (one year) as the agency does not have personnel in place to perform the responsibility specified in the special provisions under Item 995.002. | Other Agency Request |
| Total | | \$8,308,134 | | |

³⁶ MassDOT’s scope description that is reflected in each extra work order.