



OFFICE OF THE
AUDITOR GENERAL
MANITOBA

Department of Infrastructure

Management of Provincial Bridges

July 2016

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July 2016

The Honourable Myrna Driedger
Speaker of the House
Room 244, Legislative Building
450 Broadway
Winnipeg, Manitoba R3C 0V8

Honourable Ms. Driedger:

It is an honour to present my report titled: *Management of Provincial Bridges*, to be laid before the Members of the Legislative Assembly in accordance with the provisions of Sections 14(4) and 28 of *The Auditor General Act*.

Respectfully submitted,

Original document signed by:
Norm Ricard

Norm Ricard, CPA, CA
Auditor General

Table of contents

Auditor General’s comments	1
Main points	3
Summary response from Manitoba Infrastructure	7
Background	9
Audit approach	13
Findings and recommendations	15
1. Many gaps in bridge inspection processes and implementation of inspectors’ recommendations	15
1.1 Inspection policy and manual not kept up-to-date	15
1.1.1 Inspection policy not current, comprehensive, or sufficiently risk-based	15
1.1.2 Inspection manual only recently upgraded to most recent version	17
1.2 Deficiencies in arranging and performing inspections	17
1.2.1 Some structures not inspected as often as required, and several not at all	17
1.2.2 Past performance not considered when selecting external inspectors	19
1.2.3 Inconsistencies in bridge element ratings and inspection documentation	20
1.2.4 Problems with appropriateness, pricing of maintenance recommendations	21
1.2.5 Gaps in processes to ensure inspectors properly trained and qualified	22
1.3 Poor management oversight of inspections	23
1.3.1 No process to ensure inspection reports received promptly	23
1.3.2 Inadequate monitoring of fieldwork and inspection report quality	24
1.3.3 Inadequate follow-up of inspectors’ recommendations	25
2. Weak bridge planning and performance reporting.....	28
2.1 Bridge capital planning lacked structure and sufficient information	28
2.1.1 Capital projects prioritized using undocumented professional judgment	28
2.1.2 Insufficient information for decision-makers approving capital funds	30
2.2 Some risks and better practices identified	32
2.2.1 Some risks identified and mitigation strategies developed	32
2.2.2 Better practices and bridge issues in other jurisdictions monitored	32
2.3 Performance measures and publicly reported information need improvement	33
2.3.1 Bridge performance measures weak.....	33
2.3.2 Public bridge performance information limited	34

Management of Provincial Bridges

3. Quality assurance processes for bridge construction need improvement.....	35
3.1 Submittal management.....	35
3.1.1 Several submittals missing or late, and lacking evidence of review	35
3.2 On-site construction inspection	37
3.2.1 No assurance that all required on-site inspection activities performed.....	37
Summary of recommendations and Manitoba Infrastructure responses.....	39

Auditor General's comments

Maintaining public infrastructure while there are so many demands on the public purse has been challenging for all levels of government. The Department of Infrastructure is responsible for over 3,000 Provincial bridges and large (bridge-sized) culverts, with a replacement value of about \$9.2 billion. Inadequate management of these structures, many of which are more than 50 years old, can adversely affect public safety and undermine economic development.



Bridge inspections are the first line of defense in ensuring bridge safety. That is why it is particularly concerning that we found several bridge structures that were not being inspected as frequently as required or at all, as well as maintenance and rehabilitation work recommended by inspectors often being waived or deferred without any documented rationale. Better management oversight of inspections would reduce the risk of an undetected problem or inaction regarding a significant problem.

Surprisingly, some bridges and large culverts that are a Provincial responsibility are under the purview of other departments, not Infrastructure. We found that these structures are not being inspected, creating a potential safety risk. Given its expertise, mandating the Department to conduct, or oversee, the inspection of these structures would help mitigate this risk.

In developing its capital plans for bridge rehabilitation and replacement, the Department is prioritizing capital projects using undocumented professional judgment. As a result, it could not clearly show that structures most in need of work were being prioritized and, as such, that it was making the best use of its limited funding. More structured and documented processes, information, and tools are needed.

With respect to the Department's quality assurance processes for bridge construction, we found that a number of construction contractors' submittals (such as material samples and stressing calculations) were missing, late, or lacking evidence of Department review. We also found that on-site construction inspectors were not using the Department's inspection checklists. Both increase the risk that planned work will not be done as specified.

The Department has been challenged with staff shortages and difficulties in implementing new information systems, which have contributed to the issues noted. As it strives to overcome these challenges, I am pleased that the Department is taking steps to implement our 20 recommendations.

I would like to thank the dedicated staff at the Department for their cooperation and assistance throughout our audit.

**Original document signed by:
Norm Ricard**

Norm Ricard, CPA, CA
Auditor General

Main points

What we examined

The Department of Infrastructure manages about 3,000 bridges and large (bridge-sized) culverts on the Provincial road and water control networks. We examined the Department's management of these structures, including its processes for:

- inspecting bridges and large culverts, and implementing related maintenance recommendations.
- bridge inventory planning and performance reporting.
- ensuring quality assurance in bridge construction.

Why it matters

A well-maintained bridge inventory is essential for public safety and economic development. Inadequate management of this critical infrastructure can have significant adverse consequences, as recent high-profile bridge collapses in Canada and the United States have shown. About 40% of the Province's bridge inventory is more than 50 years old.

What we found

Many gaps in bridge inspection processes and implementation of inspectors' recommendations

Deficiencies in arranging and performing inspections

Not all bridges considered the Department's responsibility were being inspected as frequently as required by the Department, and several were not being inspected at all. Some received detailed Level 2 inspections (required every 2-6 years, depending on the structure's size, location, and other factors) one year late. About half did not receive less detailed Level 1 inspections every year as required. More importantly, 616 were not being inspected at all. And another 288 were not being inspected by the Department because it considered other government departments or certain conservation districts to be responsible for them.

Inspectors completed bridge inspections using standardized inspection forms, but sometimes provided inadequate documentation to support the ratings they assigned to bridge elements. For example, measurements and descriptions varied in how comprehensively they described noted deterioration.

There were also problems with inspectors' maintenance recommendations. Department officials said inspectors, particularly external inspectors, sometimes recommended unnecessary work. They also said inspectors sometimes priced their maintenance recommendations inaccurately. These problems adversely affected the Department's ability to prioritize maintenance work and calculate deferred maintenance properly.

Noted problems may reflect gaps in the Department's processes for ensuring properly trained and qualified inspectors. Attendance records showed that not all Level 1 inspectors had completed the

Department's Level 1 inspector-training course. There were no training plans or other records kept for the on-the-job training the Department required for Level 2 inspectors. And some external inspectors lacked the Department's stated minimum qualifications.

Poor management oversight of inspections and inspectors' recommendations

Senior inspection staff reviewed external inspectors' reports in detail, placing little reliance on the quality assurance processes it required of all external service providers. However, there was no similarly rigorous system for reviewing the inspection reports prepared by internal staff. They also rarely assessed work quality by observing inspections in the field or re-performing inspections.

Department staff responsible for scheduling bridge maintenance and rehabilitation work often waived inspectors' recommendations because they deemed them unnecessary. They also often lengthened recommended timeframes for doing the work, viewing it as less urgent. Senior management did not review these actions to ensure they were appropriate.

Senior management also did not monitor whether all work deemed necessary was eventually scheduled. Nor did it monitor the total dollar amount of necessary work that had been deferred, or the number of affected structures.

Weak bridge planning and performance reporting

Bridge capital planning lacked structure and sufficient information

The Department prioritized capital projects using undocumented professional judgment. It therefore could not clearly show that it was prioritizing funding for the bridge structures most needing rehabilitation or replacement and making the best use of its limited funding. Department officials said they considered—but did not typically document—many factors (for example, safety, economic, and funding factors, plus a structure's strategic importance and the distance of alternative routes).

Some jurisdictions use a Bridge Condition Index (BCI) or a similar index to assess the condition of individual bridges and the overall condition of their bridge inventory. This helps them set capital planning priorities. The Department collects the information needed to calculate BCIs and used a spreadsheet to calculate BCIs for some bridges several years ago—but stopped to work on a more sophisticated Bridge Management System (BMS). In addition to calculating BCIs, the planned BMS will forecast structure degradation and help the Department calculate the most cost-effective time for preventative maintenance and rehabilitation work.

The Department was not providing Treasury Board with sufficient information to support its capital planning decisions. Treasury Board lacked information on the total capital dollars being requested for Provincial bridges, as well as information on the dollar amount of necessary bridge maintenance and rehabilitation/replacement work the Department had deferred. And because the Department did not calculate BCIs, Treasury Board lacked information on the overall trend in the condition of bridges, including the percentage in poor condition.

Performance measures weak

Performance measures needed improvement. As a result, the usefulness of publicly reported performance information was limited. The Department tracked the number of Level 1 and 2 inspections performed annually, but not the percentage of required inspections completed or the overall condition of its bridge inventory. Nor did it set a specific and measurable target for the condition of its bridges. In March 2014, the Province publicly committed to investing over \$700 million in bridges over 5 years, but it was unclear how or whether the Department would publicly report on this commitment.

Quality assurance processes for bridge construction need improvement

Several submittals missing or late, and lacking evidence of review

The Department requires construction contractors to submit various pieces of information referred to as “submittals” (such as material samples, transportation and erection plans, and stressing calculations) to its engineers for review and approval. The submittals provide assurance that planned bridge rehabilitation and replacement projects will be done as specified.

Despite their importance, in a sample of 5 bridge rehabilitation and replacement projects, the Department received only 81% of the 118 submittals required. Further, engineers’ submittal logs were missing 50% of the required submittals. They were also inconsistent in tracking due dates, waived submittals and their rationale, identified concerns and their resolution, and approval dates.

No assurance that all required on-site inspection activities performed

The Department’s *Contract Administration and Construction Inspection Manual* had several inspection checklists for the various stages of bridge construction, but the Department’s on-site construction inspectors were not using these checklists to guide and document their on-site inspection work. Without this information, the Department cannot show it is ensuring the use of proper construction methods and materials.

Summary response from Manitoba Infrastructure

Manitoba Infrastructure (the Department) would like to thank the Office of the Auditor General (OAG) for its review of the processes related to the management of Provincial bridges. The Department strives to ensure safe and reliable infrastructure that supports economic growth and development throughout the Province.

As a Department, we recognize the importance of proper stewardship of infrastructure and agree in principle with all of the OAG's recommendations. To the extent possible at this early stage, work has already commenced on implementing many of the recommendations, including improved performance reporting that will lead to better public understanding, transparency and access to information.

To ensure strong management and stewardship of bridge assets, Manitoba Infrastructure is focused on being a knowledgeable owner in all activities that we undertake and oversee. As a knowledgeable owner, through partnership and collaboration with research entities and national organizations, we are able to assess and implement new and innovative technologies and materials that can address gaps or improve efficiencies to assist in managing this challenging and technically complex asset class.

As noted in your report, over the past five to seven years, there have been challenges that have limited our ability to fully achieve this goal:

Implementation of critical information technology systems specific to bridges: Advances in information technology (IT) over the past five years has resulted in substantial efficiencies in how information is collected, analyzed and shared. As a result, the demand for new IT systems throughout the Department and the Manitoba government far exceeds resources committed to IT development and implementation. This has forced prioritization of all IT needs across the Manitoba government, which has resulted in the delay in implementation of an improved Bridge Inventory System and a Bridge Management System.

A significant backlog of required preservation and replacement work due to aging infrastructure assets: Manitoba, in conjunction with most jurisdictions across North America, struggles with an aging transportation network that requires a significant infusion of funding to maintain the status quo service standard. The result is a backlog of preservation and replacement work required throughout the Province.

Effects of recent major flood events: The Department had to undertake emergency repairs and replacements resulting from damage caused by the 2009, 2011 and 2014 flood events. Over \$150M will be spent between 2009 and 2019 at approximately 175 damaged bridge sites throughout southern Manitoba as a direct result of these events. The internal resources required for emergency response, inspection, assessment, engineering design and construction oversight necessitated reassignment from normal operations for a substantial portion of the past seven years.

Management of Provincial Bridges

Delivery of a dramatically increased capital program over a relatively short timeframe:

Addressing deteriorating infrastructure condition has recently become a focus of many jurisdictions, including Manitoba. Significantly increased funds have been allocated over the past several years to address the condition gap of the Provincial bridge inventory. Between 2006 and today, funding allocated specifically to bridges and large, bridge-sized culverts has increased approximately ten-fold with only minimal increases in resources to manage program delivery. While we are proud of our commitment to continuous improvement and in advancing innovative program delivery models, this significant increase in the program, as well as the flood response and recovery efforts described above, has placed an enormous strain on resources at all levels throughout the organization.

We appreciate the identification of a gap in responsibility for bridges and large, bridge-sized culverts that are owned by the Province, but fall outside the current mandate of Manitoba Infrastructure. Clarifying the responsibility for these assets will result in improved public safety.

Again, on behalf of the Department, thank you for the report and recommendations.

Specific comments related to the recommendations have been provided [and have been presented following each recommendation].

Background

Bridge responsibilities and related legislation

The Department of Infrastructure (the Department) is responsible for managing and maintaining the Province's bridge inventory. This encompasses bridges (including overpasses) and large (bridge-sized) culverts on the Provincial road and water control networks. **Figure 1** shows an example of a large timber box culvert.

Figure 1: The Department includes large culverts in its bridge inventory



Source: Department of Infrastructure records

Municipalities are responsible for most other bridges and large culverts in Manitoba. Three key pieces of legislation set out the responsibilities for the Province and municipalities: *The Highways and Transportation Act* and related regulations, *The Municipal Act*, and *The Water Resources Administration Act*.

Goals and objectives for the bridge management program

The Department's overall goal for its bridge management program is to ensure that public and commercial vehicles can move safely, efficiently, and conveniently across the bridges and large culverts on the Provincial road network and the Provincial water control network. Related objectives are to plan, design, construct, inspect, and preserve these assets to maintain them to acceptable standards.

Key bridge-inventory statistics

At the time of our audit, the Department's records showed that it had:

- 1,782 bridges (66% timber, 24% concrete, 10% steel).
- 1,317 large culverts (66% steel, 31% concrete, 3% timber).

Management of Provincial Bridges

As **Figure 2** shows, 40% of these structures were over 50 years old, and another 24% were 40-50 years old. Department officials said that, given the structures' expected lifespans, many of them need (or will soon need) either major rehabilitation or replacement. Officials also said the replacement value of the bridge inventory at the time of our audit was about \$9.2 billion.

Figure 2: 40% of bridge inventory over 50 years old

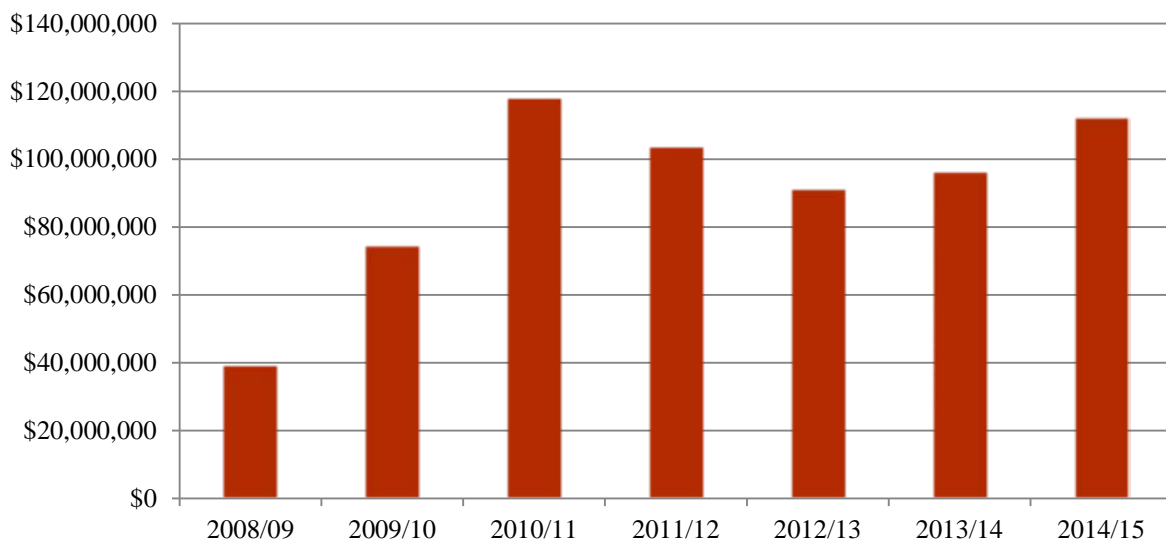
Age (in years)	Bridges		Large culverts		Total structures	
	#	%	#	%	#	%
> 50*	679	38	546	41	1225	40
40-50	527	30	202	15	729	24
30-40	331	19	251	19	582	19
20-30	134	7	155	12	289	9
10-20	68	4	102	8	170	5
<10	43	2	61	5	104	3
Total	1782	100	1317	100	3099	100

* Includes 202 bridges and 266 large culverts of unknown age considered likely to be more than 50 years old.
Source: Department of Infrastructure records

Annual bridge expenditures

Figure 3 shows that annual capital expenditures for the Department's bridge inventory grew from \$39.9 million to \$112.7 million between 2008/09 and 2014/15. This significant growth reflected an increased focus on rehabilitating (or replacing) older structures, plus the costs incurred (about \$160 million) for the bridges on the new Centreport Canada Way expressway that opened in November 2013.

Figure 3: Significant growth in bridge capital expenditures since 2008/2009



Source: Department of Infrastructure records

Management of Provincial Bridges

The Department charges the more routine and basic maintenance work on its bridges and large culverts to its annual operating budget. Unlike capital expenditures, these costs have risen much more modestly, from \$4.4 million in 2008/09 to \$5.4 million in 2014/15.

Department divisions and branches with bridge responsibilities

The Department has allocated bridge responsibilities on the Provincial road and water control networks to 2 divisions and several branches within those divisions. **Figure 4** shows the allocation of bridge responsibilities discussed in this report.

Figure 4: Bridge responsibilities allocated to several different branches

Bridge responsibility	Water Management and Structures Division					Engineering and Operations Division
	Preservation and Planning Services Branch		Water Control Operations Branch	Structures Design and Construction Branch		Regional Operations Branch
	Road network structures	Water control network structures	Water control network structures	Road network structures	Water control network structures	Road network structures
Level 1 inspections			✓			✓
Level 2 inspections	✓	✓				
Review of inspection reports	✓	✓				
Maintenance planning	✓		✓			
Performing maintenance			✓			✓
Capital planning	✓		✓	✓	✓	
Bridge construction oversight			✓	✓	✓	

Source: Department of Infrastructure records

Importance of properly managing the Province’s bridge inventory

A well-maintained bridge inventory is a critical part of the Province’s infrastructure. It helps ensure citizen safety and supports economic development. Without proper management (regular inspection, maintenance, and rehabilitation or replacement), the bridge inventory can be adversely affected by age, traffic volumes, vehicle types and weights, environmental factors, and events such as floods and fires.

Management of Provincial Bridges

Recent high profile bridge collapses in Canada and the United States have made bridge safety a priority. They have highlighted the importance of properly managing bridge infrastructure and the potential impacts when a bridge fails. **Figures 5 and 6** show the results of 2 of these failures.

Figure 5: 2007 Minneapolis I-35 Bridge collapse resulted in 13 deaths, 145 injuries



Source: Getty Images

Figure 6: 2006 Quebec De la Concorde Overpass collapse resulted in 5 deaths, 6 injuries



Source: Montreal Gazette

Audit approach

We examined the adequacy of the Department's management of Provincial bridges. This included examining processes related to:

- inspecting bridges and large (bridge-sized) culverts, and implementing related maintenance recommendations.
- bridge inventory planning and performance reporting.
- ensuring quality assurance in bridge construction.

We conducted our audit between January 2014 and July 2015, and primarily examined processes in place between January 2012 and July 2015. We performed our audit in accordance with the value-for-money auditing standards established by the Chartered Professional Accountants of Canada and, accordingly, included such tests and other procedures as we considered necessary in the circumstances.

The audit included review and analysis of related legislation, as well as the Department's policies and practices, information systems, records, reports, minutes, correspondence, and files. We selected a sample of 51 structures and reviewed inspection documentation related to the 2 most recent inspection reports available at the time (reports from the 2013 and prior inspection seasons). We also interviewed Department staff, staff from other government departments and agencies, and selected external service providers. Our examination of quality assurance processes in bridge construction focused on processes for submittals and on-site construction inspection.

Findings and recommendations

1. Many gaps in bridge inspection processes and implementation of inspectors' recommendations

1.1 Inspection policy and manual not kept up-to-date

1.1.1 Inspection policy not current, comprehensive, or sufficiently risk-based

At the time of our audit, the Department had a single written inspection policy, last updated in 1996. The policy described different types of bridge inspections and the inspection frequencies for different types of structures. It also set out bridge inspector qualifications. However, the policy had gaps and was often inconsistent with the Department's current intended practice for inspection frequencies. The Department did not have a formal process for periodically updating the policy to ensure it remained current, comprehensive, and risk-based.

Inspection types and frequencies

The policy required Level 1 inspectors to conduct Level 1 inspections (described as “general inspections”) annually (every spring, as soon as possible after water levels receded to normal). It required Level 2 inspectors to conduct Level 2 inspections (described as “detailed visual inspections that might require the use of specialized tools, techniques and equipment”) every 2-6 years, depending on the structure's type, size, and location. **Figure 7** summarizes the various Level 2 inspection frequency requirements in the written policy.

Figure 7: Written policy required Level 2 inspections every 2-6 years

Structure type	Minimum required inspection frequency
Bridges longer than 6 metres on Provincial trunk highways	every 2 years
All other road bridges longer than 6 metres	every 4 years
Road bridges 6 metres or shorter	every 6 years
Culverts on Provincial trunk highways	every 4 years
All other culverts	every 6 years
All new structures	after 2 years

Source: Department of Infrastructure records

The policy did not specify the size of the culverts requiring inspection, implying that it applied to all culverts. However, Department officials said they only intended it to apply to larger (bridge-sized) culverts with a diameter over 1.8 metres.

The policy set inspection frequencies only for bridges on roads, not for bridges on the Province's water control network. However, Department officials said they expected all bridges on the water control network to have Level 1 inspections annually and Level 2 inspections every 4 years. The policy also stated that bridges 6 metres or shorter on Provincial roads were to be inspected every

6 years, but officials said they expected these bridges to be inspected every 4 years because there were not that many and it made scheduling inspections more efficient.

The policy did not cover all types of inspections. It had no guidance for the Department's Level 3 inspections (underwater investigations and other similarly specialized inspections) or its emergency inspections (inspections following accidents, floods and other adverse events that focused only on the specific structural elements affected).

The policy noted that a structure's age, known deficiencies, and increased traffic volumes (in other words, riskier situations) might indicate a need for more frequent inspection, but provided no further guidance. In practice, officials said they expected Level 2 inspections every 2 years, even if not otherwise required, for all:

- steel truss bridges (because they were old and susceptible to critical fractures that might cause them to fail).
- overpasses (because they were located in high traffic areas and where significant amounts of road salt were used).
- bridges on the Red, Assiniboine, Souris, Pembina, Burntwood, and Winnipeg rivers (because they were socially and economically important and susceptible to problems caused by heavy water flows).

However, the Department needs a more refined risk-based approach. **Section 1.3.3** explains that the Department did not implement inspectors' maintenance recommendations for some structures because related traffic volumes were very low. Some of these structures may not require inspections as frequently as similar structures with higher traffic volumes. Level 1 and 2 inspections are sometimes required in the same year, but the Department does not schedule them in a coordinated fashion. Department staff told us that, in at least one instance, both a Level 1 and a Level 2 inspector had inspected the same bridge on the same day. A more refined policy would consider these factors (lower traffic volumes and coordination between Level 1 and Level 2 inspections) and allow the Department to allocate its inspection resources more efficiently.

We compared the Department's intended inspection frequencies to those in Alberta, Ontario, Quebec, New Brunswick, and Newfoundland and Labrador. All required annual "general", "routine", or "maintenance" inspections, which was consistent with the expected frequency of the Department's Level 1 inspections. Frequencies for more detailed inspections (like the Department's Level 2 inspections) varied, from every 2 years for all types and sizes of bridges to every 2, 3, 4 or 6 years—depending on the bridge type, size and other factors. This variation may have reflected differences in the types of bridges each province inspected.

Inspector qualifications

The policy required Level 1 inspectors to have high school diplomas (or equivalent education and experience), and to have received bridge inspection training from a Level 2 inspector. Level 2 inspectors had to have civil engineering degrees and at least 2 years of related experience (or equivalent education and experience). They also had to have certified bridge-inspector training, or to have received on-the-job bridge inspector training from a qualified Level 2 inspector. The policy had no requirements for bridge inspection assistants.

We compared the Department's Level 2 bridge inspector qualifications to those in other selected jurisdictions. All had similar basic education requirements, but some also required formal bridge-inspector training courses. The courses typically had set curriculums, both classroom and field training, and a formal final assessment. The Department may want to explore the costs and benefits of requiring similar training. Ontario provides its bridge inspectors with formal training based on its bridge inspection manual and, as **section 1.1.2** explains, Manitoba conducts its inspections using Ontario's manual, with some Manitoba-specific revisions. Department officials told us that some inspectors attended Ontario's training several years ago.

Recommendation 1: We recommend that the Department review and update its bridge inspection policy so that it is comprehensive, risk-based, and reflects intended Department practice.

Response of officials: The Department agrees and is already working towards implementation of this recommendation.

1.1.2 Inspection manual only recently upgraded to most recent version

The Department requires its staff (and any service providers working on its behalf) to use the *Ontario Structure Inspection Manual*, which is also used by several other provinces.

The Manual describes in detail:

- structural components and elements to be inspected.
- inspection procedures to be performed.
- inspection equipment to be used in different circumstances.
- types of element degradation to be identified in different types of materials.
- condition states (excellent, good, fair, or poor) for various bridge elements.
- documentation to be kept (such as measurements, photographs, and samples).
- guidance for conducting additional types of investigations (such as underwater investigations, steel fatigue investigations, structural evaluations, and ultrasonic testing).

The Department has developed an 11-page supplement to the Manual. The supplement lists additional count, length, width, and height calculations required in Manitoba for certain bridge sub-elements. It also provides additional guidance for measuring defects in timber bridges.

The Department did not start using the 2008 version of the Manual uniformly until the spring of 2015, using the 2003 version in the interim. Department officials said that this was because of delays in upgrading the Department's bridge inventory system to accommodate the new inspection forms supporting the requirements of the revised manual.

1.2 Deficiencies in arranging and performing inspections

1.2.1 Some structures not inspected as often as required, and several not at all

The Department was not inspecting all of the bridge structures that were the Province's responsibility in accordance with required inspection frequencies. Department documents stated that Civil Legal Services had identified a significant (potential) liability to the Province if the

Management of Provincial Bridges

Department failed to conduct inspections in accordance with its inspection policy.

For the 2013 inspection season, the spreadsheet the Department used to schedule Level 2 inspections listed 2,260 structures, but the bridge inventory system listed 3,099. This meant the Department might not have been inspecting all the structures it should. Department staff started to reconcile the two in the summer of 2013 and completed this work in July 2015. They found 31 structures in the inventory system missing from the inspection spreadsheet, plus structures in the bridge inventory system that:

- had never been the Department's responsibility, although responsibility may have once been mistakenly assumed (for example, structures that were the responsibility of the federal government or municipalities).
- had been transferred to other parties (such as municipalities or conservation districts), without properly updating the bridge inventory records.
- were smaller-sized culverts that did not require Level 2 inspections.

Of further concern, Department officials told us that there were 585 large culverts on the water control network missing from both the spreadsheet and the inventory system. They planned to add these culverts to their inventory system in the near future and to their inspection schedule over the next 4 years, starting in 2016.

In addition, the Department was not inspecting some bridges and large culverts that were the Province's responsibility. Department officials felt that they lacked the mandate to inspect structures governed by legislation administered by other government departments. However, the other departments were also not inspecting these structures, creating a potential safety risk. For example, the police investigation of a fatal accident on one of these bridges noted that the lack of railings on the bridge might have been a contributing factor. When later asked to inspect the bridge, Department officials recommended closing it because of its poor condition. There are 16 structures in these other government departments.

The Department was responsible for the bridges and large culverts on the Provincial road and water control networks in 14 of 18 conservation districts. The Province had transferred this responsibility to the other 4 conservation districts, but the Department had been working since 2011 to either take back this responsibility (to treat all districts consistently) or establish an oversight mechanism for these structures. The Department's records showed that the 4 districts had 139 bridges and 133 large culverts.

During the audit, we learned that the Department had recently paid about \$6 million to replace a timber railway bridge that had burned down. Department officials said that the railway owned the bridge, but that a 1964 agreement between the Department and the railway made the Department responsible for replacing the bridge, if necessary for any reason. Officials said that they had been unaware of the magnitude of this potential liability and that there could be other bridges, in unknown conditions, with similar agreements.

The East Side Road Authority (ESRA) manages construction of the Province's East Side Road. At the time of our audit, future inspection plans for recently constructed and yet-to-be constructed bridges on this road were unclear as discussions between the Department and ESRA were ongoing. Department officials said they hoped to add these bridges to the Department's bridge

inventory and inspection regimen.

In a sample of 51 structures, inspectors had performed 92% of the Level 2 inspections following the Department's expected inspection frequency. Department officials said the one-year delays in doing the remaining 8% were intentional and reflected workload balancing.

Department officials had recently reviewed the annual Level 1 inspections performed for structures on the road network and had found that staff conducted these inspections only about half of the time. A sample of 25 files for structures on the water control network had a similar level of non-compliance. Department officials said this reflected the need to prioritize activities assigned to limited regional and water-control-network staff.

Recommendation 2: We recommend that the Department identify all the bridges and large culverts that the Province is responsible for and ensure they all receive Level 1 and Level 2 inspections in accordance with risk-based inspection frequency standards.

Response of officials: The Department agrees with this recommendation subject to the availability of resources to meet the specified frequency standards.

1.2.2 Past performance not considered when selecting external inspectors

The Department began outsourcing Level 2 bridge inspections in 2005/06 because insufficient internal resources had created a significant backlog. It initially outsourced most of its Level 2 inspections, paying \$15.6 million for outsourced inspections between 2005/06 and 2014/15. Recently, the percentage of outsourced inspections has been decreasing. Department officials said they planned to eventually outsource only 20-30% of their Level 2 inspections. They felt this would be cost efficient and still maintain some external capacity if it was needed because of unexpected events (such as floods).

The Department selected service providers for the 2013 and 2014 inspection seasons using a competitive process that allowed external engineering firms to bid on bundled packages of bridges. Each year, it issued a Request for Proposal (RFP) asking interested parties to submit the following: a proposed methodology and work plan; a proposed team, including support staff; the qualifications of proposed inspection team members; and a price.

The RFP also set out the qualifications the Department expected the external inspection team to have:

- lead inspectors were to be certified engineering technologists with at least 5 years of bridge engineering experience, and at least 2 years of bridge inspection experience.
- inspection assistants were to have at least a high school education and 5 years of experience in engineering support.

In addition, each firm was to assign the quality control duties outlined in the RFP to a supervising Inspection Engineer.

Before reviewing the price information, a departmental evaluation committee screened each proposal to see if it met the Department's minimum requirements. After screening-in a proposal, staff scored its required elements, opened the price information, and calculated a "price per

point”. Staff then selected the lowest “price per point” bidder. This selection process did not consider the past performance of service providers, even though some had previously submitted poor quality inspection reports or provided inspection staff with fewer qualifications than they claimed in their winning bids.

Recommendation 3: We recommend that the Department amend its process for selecting external service providers to include an assessment of any recent experience with their bridge inspection work.

Response of officials: The Department agrees with this recommendation.

1.2.3 Inconsistencies in bridge element ratings and inspection documentation

Using the standard *Ontario Structure Inspection Manual* bridge inspection form as a template, the Department developed different inspection forms for bridges and culverts, and for steel, concrete, and timber structures. In a sample of 101 Level 2 inspections, all used the proper form. However, as explained below, inspectors did not document their findings consistently. Nor did they always adequately support the condition ratings (excellent, good, fair or poor) that they gave to bridge elements.

The Department required standard photographs for bridges and culverts, plus supporting photographs (if possible) for all elements rated in poor condition. **Figure 8** shows an inspection photo supporting a “poor” rating for a corroded bridge girder. Following inspection, the bridge was immediately restricted to one lane.

Figure 8: Inspection photo of a bridge girder given a “poor” condition rating



Source: Department of Infrastructure records

In a sample of 101 inspection forms, all had the required standard photographs and all the elements rated as poor had the required supporting photographs. The Department did not require photographs of elements rated as fair. This may make it harder for management to assess if any elements rated as fair should have been rated as poor. In some cases, detailed measurements or estimates of the degraded area partly compensated for the lack of photographs—but these were not always included in the inspection reports, as described below.

Inspector documentation supporting element ratings other than “poor” was inconsistent. Some inspectors provided more detailed and specific descriptions, or more extensive measurements, of an element’s degraded condition than others did. For example, in relatively similar situations, some inspectors described girders as a group, while others described each individual girder. In addition, some simply described the degradation as “typical” of the rating assigned, while others fully described the extent and location of the degradation on the element. Inspectors did not (and were not required to) record all of the measurements taken during the inspections on the inspection forms.

Element-condition ratings were usually reasonably consistent with the accompanying descriptions and photographs. But in a sample of 51 Level 2 inspection forms, inspectors rated 68 of the 1,044 elements (7%) in better condition than the prior inspection rated them—even though there was no evidence any maintenance had been performed on the elements between inspections. In one case an inspector rated a drainage system described as “partly missing” as being in “excellent” condition.

There were also documentation issues for Level 1 inspections. Department officials said that their review of Level 1 inspection forms (described in **section 1.2.1**) noted several instances where required photographs were missing and descriptions of bridge conditions were incomplete. The Department did not formally track or quantify the extent of these deficiencies.

Recommendation 4: We recommend that the Department improve the consistency and quality of bridge element ratings and inspection documentation, and that it assess whether more guidance, training, photographs, and supervisory review are needed to achieve this.

Response of officials: The Department agrees with this recommendation.

1.2.4 Problems with appropriateness, pricing of maintenance recommendations

Using the assessed condition of each element on a structure, inspectors recommend any maintenance they deem necessary, plus a timeframe for completing the work. They also calculate an estimated cost for the work, using prices from a spreadsheet the Department provides. However, there were problems with the appropriateness and pricing of maintenance recommendations. This affected the Department’s ability to accurately calculate deferred maintenance and properly prioritize recommended work.

Department staff said that they felt that inspectors, particularly external inspectors, sometimes recommended significant unnecessary work. In addition, inspectors sometimes rated over 50% of

a bridge element as poor, but made no maintenance recommendations and documented no explanations for this.

The pricing of maintenance recommendations was also problematic. Some staff said the spreadsheet prices and therefore the total price estimates for recommendations were sometimes too high or low. Department officials said senior staff members reviewed historical costs and used their collective experience to set the spreadsheet prices, but that historical cost records were poor. In addition, inspectors' expertise in estimating material quantities, labour hours, and equipment requirements varied. They also said the prices were last updated 2 years before our audit. The Department may want to consider if pricing should be done centrally, rather than by each inspector.

Inspectors had to choose a timeframe for recommended maintenance. When we started our audit, available timeframe choices were as follows: urgently, within 1 year, within 1-5 years, or in 5 plus years. We noted that recommending and costing work that would not need to occur before the next scheduled inspection seemed inefficient, and that the 1-5 year timeframe seemed too wide to be very useful in prioritizing the recommended work. During our audit, the Department revised the choices to urgent, within 1 year, within 1-2 years, or in 2 plus years. Department officials told us that "2 plus years" effectively meant "before the next inspection date". The revised timeframes were generally consistent with those set out in the most recent version of the *Ontario Structure Inspection Manual*.

Recommendation 5: We recommend that the Department improve the appropriateness and pricing of all bridge inspectors' maintenance recommendations, and that it assess whether additional guidance, training, supervisory review, and centralization are needed to achieve this.

Response of officials: The Department agrees with this recommendation and will be reviewing the internal processes used for developing and monitoring the maintenance program.

1.2.5 Gaps in processes to ensure inspectors properly trained and qualified

The Department set the qualifications for inspection staff in its inspection policy and in the RFPs it issued for external service providers, but it did not always ensure that all staff met its stated qualifications. This may have contributed to some of the inspection problems previously noted.

The Department developed a Level 1 inspector training-course and kept attendance sheets for this course. Department officials told us that the Department had provided the course to 105 staff since 2009. However, in a sample of 11 internal inspectors performing Level 1 inspections, attendance records showed that 4 (36%) had not taken the required training.

In a sample of 5 Department staff performing Level 2 inspections, all had the required post-secondary education and experience. However, there was no evidence that they had received the required on-the-job inspection training from a qualified Level 2 inspector. The Department had no documented training plan or any other records for its on-the-job training for Level 2 inspectors. As **section 1.1.1** notes, the Department does not require its Level 2 bridge inspectors to complete a formal bridge-inspector training course, as Ontario does.

Documents provided by external service providers during the Department's selection process listed the staff the providers proposed to assign to the inspections, together with their qualifications. But the Department had no processes to verify the claimed qualifications of proposed staff. Nor did it have any processes to ensure that the originally proposed team members performed the inspections, although external service providers were supposed to have any changes verbally approved. In a sample of 29 inspection reports completed by external service providers, there were 10 instances where the service providers supplied team members less qualified than those originally proposed in their winning bids. In 3 cases, these individuals still met the Department's minimum qualifications, although they would have earned the provider fewer points during the selection process. However, they did not meet the Department's stated minimum qualifications in the other 7 cases.

Recommendation 6: We recommend that the Department verify that all internal and external bridge inspection staff have the training and experience the Department currently requires them to have, and that it assess if currently required training adequately meets its needs.

Response of officials: The Department agrees with this recommendation.

1.3 Poor management oversight of inspections

1.3.1 No process to ensure inspection reports received promptly

If the Department does not receive inspection reports promptly, then it cannot review them promptly. This creates a risk that it may not promptly identify and resolve significant issues.

All inspectors are expected to notify Department officials immediately if they observe "urgent and significant structural or safety concerns", and to submit the related inspection reports on an expedited basis. However, this does not completely mitigate the risk because inspectors may not consistently identify and flag all significant issues as expected.

The Department requires both internal and external inspectors to submit their Level 2 inspection reports within 4 weeks of the inspection, but has no process to ensure compliance. It monitors whether it receives expected internal and external inspection reports, but not the date of receipt or system uploading. Inspection reports show only the inspection date.

For the 2013 inspection season, summary reports submitted by external service providers (described in **section 1.3.3**) showed that the Department received 56% of the providers' reports (192 of 344) more than one week late. Of the late reports, 32% (62 of 192) were more than 5 weeks late. Department officials said this improved in 2014, but regressed in 2015.

Recommendation 7: We recommend that the Department track scheduled bridge inspection dates so that it will know when related inspection reports are due, and follow-up promptly on all overdue reports.

Response of officials: The Department agrees and is already working towards implementation of this recommendation.

1.3.2 Inadequate monitoring of fieldwork and inspection report quality

The Department's processes for monitoring the quality of field inspections and related inspection reports were not risk-based and had significant gaps. Monitoring processes for Level 1 and internally conducted Level 2 inspections had several deficiencies. Processes for out-sourced Level 2 inspections were inefficient, as they placed little reliance on the quality assurance processes the Department required external service providers to provide.

Monitoring internal inspectors' fieldwork and reports

A Level 2 inspector reviewed all Level 1 inspection reports completed by Department staff. However, he did not adequately document this review, visit any bridge sites to observe how diligently the Level 1 inspectors performed their inspections, or periodically re-perform any Level 1 inspections. This review also excluded the majority of structures on the water control network, as most were not receiving regular Level 1 inspections (as **section 1.2.1** describes).

Senior management told us that regular management review of internally-prepared Level 2 inspection reports was limited to those flagged as urgent because of significant structural or safety concerns (as **section 1.3.1** describes), plus the first 10 completed by each of 6 internal inspection teams. Management did not document these reviews, but said they provided feedback to staff at team meetings and that, at one recent meeting, this feedback focused on the need to improve descriptions and measurements of element conditions. In addition, management said they interacted with internal inspectors on a daily basis and were available for consultation when internal inspectors were in the office writing up their inspection reports. Management rarely re-performed inspections or observed staff performing inspections. Nor did they monitor the time inspectors took to inspect individual structures to see if inspectors were diligent. Overall, this was a more informal and less rigorous process than that used to monitor the work done by external inspectors (described further below). Senior management said they planned to establish a better monitoring system soon.

Monitoring external inspectors' fieldwork and reports

The Department's agreements with the external service providers conducting Level 2 inspections require the providers to have their own Inspection Engineers "continuously review and audit the inspection work of the teams". This is to include "reviewing all documentation produced by the teams". Before the 2014 inspection season, the agreements also required the external Inspection Engineers to be "stationed in the field at all times when bridge inspections are underway; splitting his/her time between the individual teams". Starting with the 2014 inspection year, the Department revised this to simply "being available at all times when bridge inspections are being undertaken" and "visiting all sites with critical deficiencies". But only visiting sites with identified critical deficiencies (to validate that the deficiencies are indeed significant) provides no assurance that staff have properly flagged all significant deficiencies.

The Department placed little reliance on the quality control processes it required the service providers to have in place. For example, it did not require external inspection engineers to sign letters saying they had met all obligations. Nor did it require them to supply any documents (such as inspection-report review forms) showing their managerial oversight. Instead, the Department

had a senior Level 2 inspector review all external service providers' inspection reports to see if the reports:

- were complete.
- had any significant unexplained changes in the structure's condition from the time of the last inspection that warranted further investigation.
- had any inconsistencies between descriptions of identified degradation and related photographs.

The Department followed up and resolved any gaps or inconsistencies identified through this review by requesting updated or corrected inspection reports from the external inspectors, and occasionally re-examining bridge elements. Documentation for the 2014 inspection season showed the Department had reviewed 236 externally prepared inspection reports and performed 8 field visits. The Department did not track the number and types of issues resolved.

Recommendation 8: We recommend that the Department develop risk-based and documented management processes to monitor the quality of all inspectors' fieldwork and inspection reports, and that it assess the feasibility of obtaining documentation that would allow it to place some reliance on the quality assurance processes it requires all external service providers to have in place.

Response of officials: The Department agrees and will review the internal processes used to monitor inspections performed by external service providers.

1.3.3 Inadequate follow-up of inspectors' recommendations

Senior management did not monitor that inspection report recommendations were properly actioned. The Department often did not carry out recommended repairs and rehabilitation work within the inspectors' recommended timeframes, and sometimes did not carry out recommended work at all. In addition, staff did not document why they waived recommendations or implemented them in a different timeframe than recommended. This is described in detail below.

Forwarding maintenance recommendations to those responsible for scheduling the work

Senior management expected all internal inspectors to send any recommendations to the appropriate person responsible for scheduling the recommended work. Internal inspectors had to send their recommendations from each inspection to 1 of 8 possible people:

- the person who scheduled maintenance for structures on the road network.
- the senior manager who participated in capital planning decisions involving rehabilitation or replacement of structures on the road network.
- 1 of the 6 people (depending on the region) who both:
 - scheduled maintenance for structures on the water control network.
 - provided input to the senior manager who participated in capital planning decisions involving rehabilitation or replacement of structures on the water control network.

Internal inspectors said they gave their recommendations to the right people by email, phone, or in-person. Beginning in 2014, they tracked which inspection reports had forwarded

recommendations. But the inspectors did not follow up on these recommendations or give the people with scheduling responsibilities a list of all forwarded recommendations.

The Department handled recommendations from external inspectors separately. The senior Level 2 inspector who reviewed the quality of external inspection reports (as described in **section 1.3.2**) forwarded the external inspectors' recommendations to the same 8 people listed above for internal inspectors. The person who scheduled basic maintenance for roads also reviewed all the external inspection reports and flagged related recommendations.

Department officials told us that planned upgrades to its bridge inventory system would allow more documented and systematic tracking of inspectors' recommendations.

Disposition of inspectors' forwarded recommendations

The people responsible for scheduling recommended work did not systematically track the recommendations referred to them. Nor did they keep documentation showing how (or if) recommendations referred to them were implemented. They also did not document any rationale for disregarding recommendations or altering recommended timeframes. After reviewing related inspection reports (including any accompanying photographs), occasionally conducting undocumented site visits, and considering the Department's staff resources and budget, they sometimes decided that recommended work:

- was not needed.
- could be deferred, considering the cost and benefits.
- needed to be done sooner than recommended.

In the 101 inspection reports reviewed, inspectors made 76 basic maintenance recommendations that they said needed to be done urgently or in less than a year. These spanned the 2008-2013 inspections seasons. As of September 2014, the Department could not show that the recommended work had been completed for 68 of 76 (89%) of these recommendations. In 3 of 8 instances where the recommended work had been completed, it was done within the recommended 1-year timeframe; in all other instances it took 2-3 years. Where the Department had not completed the recommended work:

- 53% of the time the scheduler said he had disagreed with the original recommendation and decided the recommended work was unnecessary.
- 37% of the time the scheduler said he planned to schedule the work in the future. As of September 2014, these recommendations were on average 30 months old, and the age of individual recommendations ranged from 12 to 59 months.
- 10% of the time no explanation was offered.

One staff member suggested that external inspectors often had a lower risk tolerance than the Department, and were more likely to make unnecessary recommendations. In the inspection reports reviewed, the scheduler disagreed with the basic maintenance recommendations of internal inspectors 21% of the time, and those of external inspectors 52% of the time.

Senior management did not see most basic maintenance recommendations (except those flagged and brought forward because of their significance) and did not review those situations where the

schedulers and inspectors disagreed. Nor did senior management perform any review to ensure that work deemed necessary was eventually scheduled.

Because recommendations to rehabilitate or replace structures were forwarded directly to senior management, senior managers decided whether (and when) to include these recommendations in the Department's capital planning. However, they did not track the recommendations received or document any reason for waiving or altering them.

In a sample of 51 structures, 10 had recommendations for major rehabilitation or replacement work. Five of the 10 were listed on the Department's capital planning lists, with 3 of the 5 scheduled within the recommended timeframes. There was no documented explanation for the other 5 not on the lists. Department staff explained the 5 not listed as follows:

- 4 were water control structures given low priority (2 on dirt roads; 1 a cattle crossing; 1 for a single farmer's access).
- 1 was a water control structure later found to be a municipal responsibility.

Apart from the 10 structures described above, 6 structures in our sample were on the Department's capital planning lists—even though the related inspection reports had no recommendations for major rehabilitation or replacement. Department officials stated that inspectors' reports were just one of many considerations in prioritizing capital projects. **Section 2.1.1** describes the Department's capital planning processes.

Our sample of inspection reports had only one recommendation (from an internal inspector in 2012) that a bridge be weight-restricted. The bridge was weight-restricted in June 2015 and was inspected annually in the intervening years.

Tracking work recommended and necessary, but deferred

Department officials told us that operating and capital budgets were insufficient to do all recommended work in the recommended time and that deferred maintenance was a significant problem. However, they also said that it posed no significant public safety risk because structures were weight-restricted or closed if there were safety concerns. We could not validate either assertion. The Department kept no centralized record or total of the maintenance, rehabilitation, and replacement work recommended and considered necessary, but deferred. Nor did it document a rationale for waived and deferred recommendations.

The Department required each external service provider to submit a report summarizing all the recommendations made for all inspections performed during an individual inspection season. It also required all service providers to use Department-specified database software to do this. However, it did not summarize the recommendations from its own internal inspections, which would have let it combine all the reports in a single database, making it easier to track and follow up recommendations. Department officials said this was because they lacked sufficient staff resources. They also said that planned improvements to the Department's bridge inventory system (described more in **section 2.1.1**) would help them to better track recommendations and deferred maintenance.

As of May 28, 2014, the Department's records showed that 49 bridge structures were weight restricted (31 on the road network, 18 on the water control network). Another 20 were lane or

speed restricted (14 on the road network, 6 on the water control network). And 48 were closed (9 on the road network, 39 on the water control network).

Recommendation 9: We recommend that the Department strengthen management oversight of bridge inspectors' recommendations by developing systems and processes that let senior engineering staff:

- a. track recommendations through to final disposition.
- b. monitor and approve staff decisions to waive inspectors' recommendations, or to alter inspectors' recommended timeframes for implementing recommendations, after considering documented reasons for such decisions.
- c. monitor whether scheduled work is completed on time.
- d. monitor the total amount of deferred basic maintenance, as well as deferred rehabilitation or replacement work, considered necessary.

Response of officials: The Department agrees with these recommendations. The implementation timeframe is subject to having a fully functional Bridge Inventory System (BIS) and Bridge Management System (BMS) and the filling of vacant senior engineering positions. Manitoba Infrastructure will continue to urge central government's IT organization to place BIS and BMS as a high priority on their list of projects.

2. Weak bridge planning and performance reporting

2.1 Bridge capital planning lacked structure and sufficient information

2.1.1 Capital projects prioritized using undocumented professional judgment

Using its current capital planning processes and tools, the Department cannot clearly show that it is prioritizing funding for structures with the most urgent need for rehabilitation or replacement. These processes and tools are described more fully below.

Developing capital plans

Each year the Department develops 2 capital plans for bridges and large culverts on the Provincial road network (the first plan is for the next 5 years, and the second is for the 5 years following the first plan). It also develops a third 5-year capital plan for structures on the water control network. At the time of our audit, the first plan (for 2015/16 - 2019/20) had 102 projects totaling \$579 million. The second plan (for 2020/21 - 2024/25) had 131 projects, but showed no related costs. The third plan (for 2014/15 - 2018/19) had 70 projects totaling \$36 million.

We selected 6 capital projects from the first plan and 5 from the second. All related inspection reports supported the planned projects, but most recommended that the work occur sooner than planned. The reports did not explain why the projects in the first plan were more urgent than those in the second.

A Department committee set the capital priorities for the road network. The committee included the Assistant Deputy Minister (ADM) responsible for Water Management and Structures, the

Management of Provincial Bridges

Director of Structures, the Senior Inspection and Maintenance Engineer, and 2 other people with bridge design and construction responsibilities. The ADM and the Director of Water Operations set priorities for the water control network.

Department officials told us that Department staff provided input to these priority-setting processes as well. Regional highway staff held informal conversations with members of the Department committee setting priorities for the road network. And regional water control staff listed specific capital priorities for the ADM and Director of Water Operations to consider.

The starting points for the various capital plans were previous plans, the staff input received, and senior management's recall of the inspectors' recommendations brought to their attention (as described in **section 1.3.3**). Department officials said they then used their professional experience and judgment and considered various factors to decide capital priorities. This included assessing the information on underlying inspection reports, industry and departmental capacity, the availability of federal funding for specific projects, and project complexity. They also assessed whether the structures:

- needed to be (or had already been) closed or weight-restricted because of safety concerns.
- had higher or lower traffic volumes, and whether this was expected to change in the future.
- typically carried higher or lower-weight vehicles.
- had greater or lesser economic importance to the area (for example, structures located on key commercial or tourist routes would have greater economic importance).
- had no additional access, and were a shorter or a more significant detour distance from alternative crossings.
- could have their needed work coordinated with other work required in the same area (such as roadwork), which could lead to cost savings.

The senior managers setting capital priorities for the road and water control networks did not document their assessment of these factors, although those setting priorities for the water control network had once used scoring forms to prioritize work for closed structures. Scoring factors on the forms had included economic and social importance to the area, average daily traffic, and the number and length of available detour routes.

Departmental officials said that, despite the number of bridges they might identify as being in poor condition, they had to work within an annual capital budget target of about \$85-95 million for structures on the road network and \$5-7 million for structures on the water control network. This excluded any additional funding received for special projects, such as the new Centreport Canada Way structures.

Tools to help develop capital plans

Some provinces use a Bridge Condition Index (BCI), or a similar index, to help them assess the overall condition of their bridges (including the percentage in poor condition) and set capital planning priorities. The BCI is calculated using bridge element ratings (excellent, good, fair, or poor, as determined through the inspection process) and the replacement cost of each element. It can be calculated for individual bridges and large culverts, and for entire bridge networks. It is not typically the sole factor in setting capital priorities, but it provides a way to compare the structural condition of bridges.

Management of Provincial Bridges

The BCI has limitations. It weighs the importance of various bridge elements by their cost, which may not coincide with their structural importance. In addition, it is not meant to be an indicator of safety, although safety issues are generally more likely to develop on structures with lower BCIs (in poor condition) than those with higher BCIs (in good condition).

The Department's inspection forms already collect all the information the Department needs to calculate BCIs. Department staff said the Department used data from inspection forms and a spreadsheet to calculate BCIs for several bridges about 8-10 years ago, but found it too resource-intensive to continue. Instead, they planned to have a new Bridge Management System (BMS) use inspection information stored in its bridge inventory system to calculate BCIs soon and had been working on this for over 10 years at the time of our audit.

The planned BMS will also forecast structure degradation and help the Department calculate the most cost-effective time for both preventative maintenance and rehabilitation work on each structure. However, the Department needs more accurate and complete information in its bridge inventory system for the BMS to operate effectively. As **section 1.2.1** noted, the bridge inventory excludes some assets the Department is responsible for and includes some that it is not responsible for. In addition, the Department has not been tracking maintenance and rehabilitation work (needed for the BMS), although a module in the bridge inventory system is designed to do this. Department officials said that the bridge information system also requires an upgrade in order to be able to provide the information to the BMS.

Recommendation 10: We recommend that the Department use documented risk considerations and Bridge Condition Index information to support its capital planning decisions for bridges and large culverts.

Response of officials: The Department agrees with this recommendation subject to having a fully functioning BIS and BMS.

Recommendation 11: We recommend that the Department ensure that its bridge inventory system has all the information needed to maximize use of the Department's planned bridge management system.

Response of officials: The Department agrees in principle with this recommendation and is moving towards providing Treasury Board with information on asset classes. The timeframe for implementation is subject to having a fully functioning BIS and BMS.

2.1.2 Insufficient information for decision-makers approving capital funds

The Department does not give Treasury Board sufficient information to support its capital planning decisions for bridges and large culverts. The related processes and the information the Department provides to support them are described below.

Treasury Board approves the Department's 5-year capital plan for bridge structures located on the road network as part of the Department's 5-year highway capital program. This includes funding for roads, plus the bridges and large culverts on them. For 2015/16-2019/20, the total approved highway capital program totaled \$2.7 billion, with bridge structures accounting for \$579 million,

about 21% of this amount.

Treasury Board separately approves the Department's 5-year capital plan for bridge structures on the water control network, as part of the Department's 5-year water-infrastructure capital plan. This includes funding for drain rehabilitation, dams, and flood protection, as well as bridge structures. For 2014/15-2018/19, the total water-infrastructure plan totaled \$272 million, with bridge-related structures accounting for \$36 million, about 13% of this amount.

For both capital plans, Treasury Board receives a list of all associated projects (56 pages for the highway capital plan; 29 pages for the water-infrastructure capital plan). However, there is no separate disclosure of the amounts related to bridges and large culverts. Treasury Board also separately approves the East Side Road Authority's funding, including funding for bridge structures on the East Side Road.

Because 3 different budgets are involved, Treasury Board lacks an integrated picture of the priorities and funding for the Province's bridge inventory. It also lacks sufficient information to assess the potential consequences of its decisions properly because it lacks information on:

- the total amount of maintenance and rehabilitation work that the Department considers necessary, but has deferred.
- measured trends in the condition of the Province's bridge inventory.
- the percentage of bridge-related capital spending intended for brand new projects versus rehabilitation/replacement projects.

Recommendation 12: We recommend that the Department provide integrated summary information on all Provincial bridges and large culverts in its road and water-infrastructure capital budget requests to Treasury Board, and that this include:

- a. the total capital spending proposed for bridges and large culverts, plus the percentage proposed for new structures versus rehabilitation or replacement of existing structures.
- b. the dollar amount of maintenance, rehabilitation, and replacement work that it considers necessary, but has deferred, and the number of affected structures.
- c. measured trends in the condition of the bridge inventory, including changes in the Bridge Condition Index and the percentage of structures in poor condition.

Response of officials

- a. The Department agrees with this recommendation and is moving towards providing Treasury Board with information on asset classes. Information provided in the past commits to providing this for future multi-year program requests. The timeframe for implementation is subject to having fully functioning Bridge Inventory and Bridge Management Systems.
 - b. The Department agrees in principle. Information is currently provided to Treasury Board on some aspects of deferred maintenance during the estimates process and we will consider how best to present this information to Treasury Board to ensure a better understanding.
 - c. The Department agrees with this recommendation and this will be implemented when the BIS and BMS are fully functional.
-

2.2 Some risks and better practices identified

2.2.1 Some risks identified and mitigation strategies developed

The Department had identified the following risks to managing its bridge structures:

- many structures were old and reaching the end of their service life, particularly timber bridges.
- inadequate funding, creating significant deferred maintenance.
- information gaps (poorly functioning bridge inventory system, no bridge management system or bridge performance measures).
- insufficient staff (exacerbated by difficulties in attracting professional engineering staff, staff turnover, and various staff vacancies).
- more frequent and severe adverse events (such as flooding), leading to more damaged bridges and increased scour risk on bridges (scour is the erosion of streambed material under a bridge foundation, generally when a river has high water flows).
- increasing pressure on operating budgets from non-discretionary amortization and interest flowing through from increased capital budgets, leaving less funding for basic maintenance and preservation activities.

The Department had developed risk mitigation strategies for identified risks. It was prioritizing capital spending, conducting after-flood inspections, increasing its inspection frequency for bridges subject to increased risk (for example, those susceptible to scour), and out-sourcing some bridge inspections to supplement its internal staff resources. It was also working on improving its bridge inventory system and obtaining a Bridge Management System.

Our audit recommends mitigating several other risks. These include various gaps in bridge inspection processes and in the implementation of bridge inspectors' recommendations.

2.2.2 Better practices and bridge issues in other jurisdictions monitored

The Department monitors better practices and bridge issues in other jurisdictions through its membership in the Transportation Association of Canada (TAC). TAC is a not-for-profit association, with both industry and government members. It provides a forum for exchanging ideas and information on technical guidelines and best practices related to Canadian transportation and roadway sectors, and has a bridges sub-group. For example, Department officials said that when one province experienced problems with a particular type of girder, it alerted the other provinces. Officials also said that shared information about bridge design and bridge scour problems influenced their own inspection procedures.

The Department also monitors developments in smart sensor technology and drones. It has placed smart sensors on 6 bridges to monitor bridge movements associated with load and temperature fluctuations. This supplements its detailed visual inspections. It has also discussed using drones to supplement inspections being done under difficult conditions, but officials said this would first require modifying the drones because drone cameras are bottom-mounted, restricting their usefulness.

In addition, the Department monitors bridge failures in other jurisdictions (particularly those in Canada and the United States), focusing on the causes of the failures. Department officials said

this lets them consider the need for any remedial action to prevent similar failures on the Province’s bridges.

2.3 Performance measures and publicly reported information need improvement

2.3.1 Bridge performance measures weak

Figure 9 shows that the Department’s internal strategic plan for 2014/15 had 3 performance measures for its bridge management program:

Figure 9: 2014/15 internal performance measures for the bridge management program			
Reported performance measure	Stated importance of measure	Reported data	Reported information on trend over time
Number of structures renewed and capital program projects completed	Public safety	30 rehabilitated or replaced; 135 major maintenance	Condition state deteriorating
Number of detailed Level 2 bridge inspections completed annually	Public safety	715 inspections	Variable; number of inspections based on policy but depends on inventory network risk
Percentage of annual Level 2 inspections done by internal staff	Cost effectiveness	Approximately 80% (550 inspections) outsourced in 2012/13	Increasing internal inspections; decreasing external inspections

Source: Department of Infrastructure records

This performance information needs improvement. Simply counting the number of Level 2 inspections does not show whether all required inspections were completed. Similarly, simply counting the number of structures renewed does not show how many still require renewal. More importantly, the Department does not measure the overall condition of its bridge inventory, even though one of its goals is to improve the overall condition state of its bridges. As **section 2.1.1** discusses, this is because, unlike some other jurisdictions, the Department does not currently calculate a condition rating for each bridge and then an overall rating for its bridge inventory. Without this information, the Department’s assertion in **Figure 9** that the bridge condition state is deteriorating is not well supported.

Without calculating an overall condition rating, the Department cannot set a target condition state or propose one for elected officials to consider. For example, a jurisdiction might want 90% of the bridges on key roads and waterways to be in good or fair condition. The Department’s annual report states that the objective of its preservation and planning services for its bridge inventory is to maintain these assets “to acceptable standards”. However, the Department has not defined what those acceptable standards are.

Management of Provincial Bridges

Publicly reported performance measures in other jurisdictions that would be useful for internal management purposes include:

- annual bridge replacement and rehabilitation spending (sometimes calculated as a percentage of the total replacement cost of the bridge inventory or per square foot of related deck area).
- number of annually required inspections completed.
- number and percentage of bridges in “fair or good” versus “poor” condition (typically measured using the BCI or a similar index).
- number and percentage of bridges weight-restricted or closed.
- number and percentage of “scour critical” bridges, plus annual spending for scour repair.
- number and percentage of bridges reaching a particular age or the end of their service life, or the average age of bridges.

Recommendation 13: We recommend that the Department annually measure and monitor the percentage of required Level 1 and Level 2 inspections actually completed and the overall condition of its bridge inventory.

Response of officials: The Department agrees with this recommendation.

Recommendation 14: We recommend that the Department set a specific and measurable target for the condition of its bridge inventory.

Response of officials: The Department agrees with this recommendation and will set a target when it has some experience using the new inventory technology. Funding levels will also be a consideration in setting and meeting targets.

2.3.2 Public bridge performance information limited

The Department discloses very limited performance information to the public on its management of bridge structures. None of the key performance measures in a table at the back of its annual report are related to its bridge inventory.

The Department’s annual report for 2013/14 disclosed the number of bridges and large culverts the Department managed, but provided no information on their condition. In addition, the numbers were inconsistent with the Department’s records. The report also noted the number of Level 1 and Level 2 inspections performed, but not the results of those inspections or whether the numbers represented all inspections required by the Department’s policy.

The annual report listed the cost of some of the Department’s larger bridge projects scattered under various “highlights” and “major projects” headings for different divisions. It also disclosed the number of structures receiving “major maintenance”, and the number “constructed or rehabilitated”. However, it did not combine this information or link it to a graph showing “enhancement expenditures” of about \$90 million for bridge structures.

The Province’s publicly available *5-Year Plan to Build a Stronger Manitoba*, released in March 2014, outlines infrastructure priorities and states that the Province will invest over \$700 million in

bridges (including overpasses) over 5 years. However, at the time of our audit the Department had not decided how or whether it would further publicly report on this important commitment.

As **section 2.3.1** notes, some jurisdictions publicly disclose information about the condition of their bridge inventories so that legislators and the public can see if the condition is stable, improving, or deteriorating over time. Some also report this information against a stated target. And some jurisdictions post individual bridge inspection reports on their public websites.

Recommendation 15: We recommend that the Department ensure that the bridge-related information in its annual public report is accurate and that it include:

- a. a measure of the overall condition of Provincial bridges, and whether the condition is improving, declining, or stable.
- b. the percentage of required Level 1 and Level 2 bridge inspections completed.
- c. progress in meeting the Province's commitment to invest over \$700 million in bridges over 5 years.

Response of officials: The Department agrees with this recommendation and notes that implementation of 15(a) requires a fully functioning BMS. The Department is already working towards implementation of 15(b) and (c).

3. Quality assurance processes for bridge construction need improvement

3.1 Submittal management

The word “submittals” refers to the various information construction contractors must submit to design professionals (typically engineers) to provide assurance that construction will be done as planned and meet contract specifications. Examples of submittals for bridges include: girder transportation and erection plans, pile driving procedures, mix design for concrete elements, fabrication certification for materials such as steel (listing grade and strength), welders’ certifications and welding procedures, stressing calculations, concrete and rubber samples, and laboratory test results.

The submittals process is important. Submittal literature often cites the 1981 collapse of the Kansas City Hyatt Regency Walkway. Investigators concluded that engineers had not properly dealt with submitted shop drawings showing an alternate steel rod design. The design increased the loads on the bolts, leading to the Walkway’s collapse; 114 people died and more than 200 were injured.

3.1.1 Several submittals missing or late, and lacking evidence of review

The Department has developed 49 different sets of construction specifications for possible stages of a bridge construction project, and each set lists the submittals required. However, Department staff were not adequately tracking required submittals, which were sometimes late or missing. Also, the Department could not show that it had reviewed and responded to all submittals received.

Management of Provincial Bridges

In a sample of 5 major bridge rehabilitation and replacement projects, 118 submittals were required. But the Department received only 96 (81%). Department staff had waived 10 of the 22 not received, without documenting the waiver or the reason for it. Staff said that they waived submittal requirements if they considered them outdated and therefore unnecessary. They also sometimes received and approved submittals only verbally.

Of the 96 submittals received, only 73 (76%) had documentation to show if the Department received them by the required date. Of these, 23 of 73 (32%) were late. Further, 8 of the late submittals (35%) were received after the relevant construction phase had started. In one case, a girder transportation plan arrived after the contractor had erected the girders.

The Department expected engineering staff to review and approve all the submittals received. If they considered a submittal inadequate, they were supposed to seek revisions before approval. Staff engineers kept submittal logs for all 5 projects reviewed, but the logs were not standardized. Most logs did not record submittal due dates; some did not record the date submittals were received. In addition, the logs did not always list all required submittals. In total, 59 of 118 (50%) of required submittals were missing from the logs.

The logs also did not consistently indicate that engineers had reviewed the submittals to identify and correct any non-compliance with contract specifications or other quality deficiencies. The Department only had evidence to show that staff had reviewed 55% of the submittals received. Further, 40% of these lacked documentation clearly showing the results of the review or any indication of how identified issues were resolved. Without adequate submittals logs, the Department has no assurance that planned bridge rehabilitation and replacement projects will be done as specified.

We did not assess whether Department staff should have approved the submittals they reviewed. Management said that supervisors reviewed the performance of staff in charge of submittal logs through discussion and limited review of submittal documents.

Recommendation 16: We recommend that the Department periodically review and update the submittals required in its bridge construction specifications to ensure they are current and reflect better practices.

Recommendation 17: We recommend that the Department require staff to track all required bridge submittals using standardized logs that show due dates, waived submittals and their rationale, receipt dates for all originally submitted and re-submitted information, review comments, identified concerns and their resolution, and approval dates.

Recommendation 18: We recommend that the Department require supervisors to regularly review bridge submittal logs and a sample of related submittals to ensure staff are tracking and handling submittals appropriately.

Response of officials: The Department agrees and is already in the process of implementing these three recommendations.

3.2 On-site construction inspection

The Department's *Contract Administration and Construction Inspection Manual* requires a construction inspector to be on-site as much as possible during all phases of construction. The inspector's role is to ensure that the bridge is built according to plans and specifications. To do this, the inspector needs to be thoroughly familiar with the contract, plans, and specifications for all construction phases. The inspector also needs to communicate with the engineer who reviews and approves submittals so that construction does not proceed until the submittal process is complete. And the inspector needs to keep a record of everything occurring at the job-site. This documentation enables quality assurance and the tracking of material quantities and construction progress to support contractor payments.

3.2.1 No assurance that all required on-site inspection activities performed

For our sample of 5 major bridge construction/rehabilitation projects, the Department's available documentation did not show that inspectors had performed all inspection activities required to ensure contractors followed contract plans and specifications. In addition, inspectors did not always document communications received from engineers responsible for submittals.

Although the Department's *Contract Administration and Construction Inspection Manual* had various inspection checklists for the different stages of bridge construction, inspectors were not using them. And neither the inspectors' weekly reports nor their daily logbooks had similarly detailed information. Without completed checklists, the Department cannot show it is ensuring the use of proper construction methods and materials.

Management said supervisors reviewed the performance of construction inspectors through discussion and limited review of weekly reports, daily logs, and other available quality control documentation. However, supervisors did not specifically look for completed checklists, as the Department did not require inspectors to use them.

Recommendation 19: We recommend that the Department ensure that its bridge construction inspectors receive documented notice of all submittals that are outstanding or unapproved at their due dates so that they can decide if construction needs to be delayed until this is rectified.

Recommendation 20: We recommend that the Department require its bridge construction inspectors to use the bridge-construction inspection checklists it has developed.

Response of officials: The Department agrees and is already in the process of implementing these two recommendations.

Summary of recommendations and Manitoba Infrastructure responses

Bridge inspection processes and implementation of inspectors' recommendations

1. We recommend that the Department review and update its bridge inspection policy so that it is comprehensive, risk-based, and reflects intended Department practice.

Response of officials: The Department agrees and is already working towards implementation of this recommendation.

2. We recommend that the Department identify all the bridges and large culverts that the Province is responsible for and ensure they all receive Level 1 and Level 2 inspections in accordance with risk-based inspection frequency standards.

Response of officials: The Department agrees with this recommendation subject to the availability of resources to meet the specified frequency standards.

3. We recommend that the Department amend its process for selecting external service providers to include an assessment of any recent experience with their bridge inspection work.

Response of officials: The Department agrees with this recommendation.

4. We recommend that the Department improve the consistency and quality of bridge element ratings and inspection documentation, and that it assess whether more guidance, training, photographs, and supervisory review are needed to achieve this.

Response of officials: The Department agrees with this recommendation.

5. We recommend that the Department improve the appropriateness and pricing of all bridge inspectors' maintenance recommendations, and that it assess whether additional guidance, training, supervisory review, and centralization are needed to achieve this.

Response of officials: The Department agrees with this recommendation and will be reviewing the internal processes used for developing and monitoring the maintenance program.

6. We recommend that the Department verify that all internal and external bridge inspection staff have the training and experience the Department currently requires them to have, and that it assess if currently required training adequately meets its needs.

Response of officials: The Department agrees with this recommendation.

7. We recommend that the Department track scheduled bridge inspection dates so that it will know when related inspection reports are due, and follow-up promptly on all overdue reports.

Response of officials: The Department agrees and is already working towards implementation of this recommendation.

8. We recommend that the Department develop risk-based and documented management processes to monitor the quality of all inspectors' fieldwork and inspection reports, and that it assess the feasibility of obtaining documentation that would allow it to place some reliance on the quality assurance processes it requires all external service providers to have in place.

Response of officials: The Department agrees and will review the internal processes used to monitor inspections performed by external service providers.

9. We recommend that the Department strengthen management oversight of bridge inspectors' recommendations by developing systems and processes that let senior engineering staff:
- track recommendations through to final disposition.
 - monitor and approve staff decisions to waive inspectors' recommendations, or to alter inspectors' recommended timeframes for implementing recommendations, after considering documented reasons for such decisions.
 - monitor whether scheduled work is completed on time.
 - monitor the total amount of deferred basic maintenance, as well as deferred rehabilitation or replacement work, considered necessary.

Response of officials: The Department agrees with these recommendations. The implementation timeframe is subject to having a fully functional Bridge Inventory System (BIS) and Bridge Management System (BMS) and the filling of vacant senior engineering positions. Manitoba Infrastructure will continue to urge central government's IT organization to place BIS and BMS as a high priority on their list of projects.

Bridge planning and performance reporting

10. We recommend that the Department use documented risk considerations and Bridge Condition Index information to support its capital planning decisions for bridges and large culverts.

Response of officials: The Department agrees with this recommendation subject to having a fully functioning BIS and BMS.

11. We recommend that the Department ensure that its bridge inventory system has all the information needed to maximize use of the Department's planned bridge management system.

Response of officials: The Department agrees in principle with this recommendation and is moving towards providing Treasury Board with information on asset classes. The timeframe for implementation is subject to having a fully functioning BIS and BMS.

12. We recommend that the Department provide integrated summary information on all Provincial bridges and large culverts in its road and water-infrastructure capital budget requests to Treasury Board, and that this include:
- the total capital spending proposed for bridges and large culverts, plus the percentage proposed for new structures versus rehabilitation or replacement of existing structures.
 - the dollar amount of maintenance, rehabilitation, and replacement work that it considers necessary, but has deferred, and the number of affected structures.
 - measured trends in the condition of the bridge inventory, including changes in the Bridge Condition Index and the percentage of structures in poor condition.

Response of officials:

- The Department agrees with this recommendation and is moving towards providing Treasury Board with information on asset classes. Information provided in the past commits to providing this for future multi-year program requests. The timeframe for implementation is subject to having fully functioning Bridge Inventory and Bridge Management Systems.
 - The Department agrees in principle. Information is currently provided to Treasury Board on some aspects of deferred maintenance during the estimates process and we will consider how best to present this information to Treasury Board to ensure a better understanding.
 - The Department agrees with this recommendation and this will be implemented when the BIS and BMS are fully functional.
13. We recommend that the Department annually measure and monitor the percentage of required Level 1 and Level 2 inspections actually completed and the overall condition of its bridge inventory.

Response of officials: The Department agrees with this recommendation.

14. We recommend that the Department set a specific and measurable target for the condition of its bridge inventory.

Response of officials: The Department agrees with this recommendation and will set a target when it has some experience using the new inventory technology. Funding levels will also be a consideration in setting and meeting targets.

15. We recommend that the Department ensure that the bridge-related information in its annual public report is accurate and that it include:
- a measure of the overall condition of Provincial bridges, and whether the condition is improving, declining, or stable.
 - the percentage of required Level 1 and Level 2 bridge inspections completed.
 - progress in meeting the Province's commitment to invest over \$700M in bridges over five years.

Response of officials: The Department agrees with this recommendation and notes that implementation of 15(a) requires a fully functioning BMS. The Department is already working towards implementation of 15(b) and (c).

Quality assurance processes for bridge construction

16. We recommend that the Department periodically review and update the submittals required in its bridge construction specifications to ensure they are current and reflect better practices.
17. We recommend that the Department require staff to track all required bridge submittals using standardized logs that show due dates, waived submittals and their rationale, receipt dates for all originally submitted and re-submitted information, review comments, identified concerns and their resolution, and approval dates.
18. We recommend that the Department require supervisors to regularly review bridge submittal logs and a sample of related submittals to ensure staff are tracking and handling submittals appropriately.
19. We recommend that the Department ensure that its bridge construction inspectors receive documented notice of all submittals that are outstanding or unapproved at their due dates so that they can decide if construction needs to be delayed until this is rectified.
20. We recommend that the Department require its bridge construction inspectors to use the bridge-construction inspection checklists it has developed.

Response of officials to recommendations 16 - 20: The Department agrees and is already in the process of implementing these five recommendations.

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