

Washington Metrorail Safety Commission

Safety Audit

of the Washington Metropolitan
Area Transit Authority

**Audit of Elevated Structures
Inspection, Maintenance
and Repair**



Final Report:
January 25, 2021

Prepared under the authority of the Washington Metrorail Safety Commission

Commissioners: Christopher Hart (Chair), Greg Hull (Vice Chair), Debra Farrar-Dyke (Secretary-Treasurer)

Robert Bobb, Michael Rush, John Contestabile

Alternates: Victoria Wassmer, Robert Lauby, Suhair Al Khatib

Report produced by WMSC staff led by CEO David L. Mayer, PhD

Table of Contents

Executive Summary 2

Background and Scope 4

 History 6

 Audit Work 8

 Personnel Interviewed 8

 Documents Reviewed 9

What the WMSC Found 10

 General Assessment 11

 Departmental Silos, Unclear Responsibilities (Findings 1, 3) 12

 No load ratings (Finding 2) 15

 Seismic Risk (Recommendation) 16

 New procedures issued without training (Finding 4) 17

 Inspectors not provided tools, training needed (Findings 6, 7) 18

 Inspections supervisor field time limited (Finding 8) 19

 Missing or outdated SOPs (Findings 5, 9, 12) 20

 Disparate information systems (Finding 10) 21

 Contractor oversight (Finding 11) 22

Findings and Required Corrective Actions 23

Recommendation 29

Next Steps 29



Executive Summary

A significant, ongoing problem facing Metrorail is siloed departments that do not fully coordinate on work instructions, materials or procedures.

Metrorail has taken several positive steps toward improving a structural maintenance and inspection program that faced significant challenges over the past decade, but this Elevated Structures Inspections, Maintenance and Repair Audit finds that work remains for WMATA to fully implement these steps, and that other improvements are needed to address potentially significant shortfalls.

Metrorail does not have basic load ratings for its elevated structures to confirm the number or type of trains or size of equipment that can safely traverse the bridges or stations, which creates a risk that the structures could be inadvertently overloaded. Combined with unduly complex data systems and the long lead time for major structural rehabilitation projects, the lack of load ratings also creates the risk of a significant delay in determining whether a structure is safe for train traffic if an inspector identifies a potential concern or an event unrelated to Metrorail, such as a collision or significant fire under, over or near a structure, occurs that could impact the load rating.

Metrorail recently developed and published its first Structural Inspection Manual, but issued it without any standardized training on the revised policies and procedures for the employees who have to implement the manual.

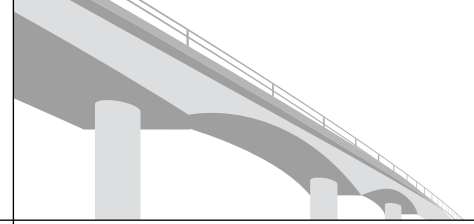
Among the reasons departmental leaders cited for delaying training was the need to immediately make changes to the new manual due to concerns identified by different departments and frontline employees. That demonstrates a separate significant, ongoing problem facing Metrorail: siloed departments that do not fully coordinate on work instructions, materials or procedures.

On the most basic level, those interdepartmental challenges pop up with a lack of clear ongoing responsibility for even documents as important as the new inspection manual.

Elevated structures inspection, maintenance and repair is further complicated by the disparate IT systems used to store inspection, repair and design data that only some individuals, groups or departments have full access to.

Metrorail also does not have important structural steel inspection tools available that are listed in its Structural Inspection Manual. Ultrasonic thickness gauges (D-meters) are required in some circumstances to assess section loss in steel structures and dye penetrant kits are to be used to check potential cracks in those steel structures.





Other issues identified in this audit include the amount of time available to supervisors to spend in the field overseeing the large number of inspectors who are relatively new to WMATA, a lack of documentation of certain engineering practices, and the need to review the credentials of individual contractors who conduct certain inspections.

This report also includes a repeat recommendation to Metrorail to assess the need to incorporate replacement or mitigation plans for rocker bearings on 10 structures into long-term capital projects on those bridges given the risk of failure in a seismic event. The Tri-State Oversight Committee issued a similar recommendation in 2010.

Metrorail does not have basic load ratings for its elevated structures.





Background and Scope

Background and Scope

Metrorail owns and operates 148 elevated structures across the system that carry trains, customers and equipment over water, roadways, railroads, power stations and other obstructions. Many of the structures include multiple bridge spans. Metrorail will soon take ownership of additional elevated structures as part of Silver Line Phase 2. These structures, critical to the safety of the system, are inspected, maintained and repaired by various WMATA departments, often with the assistance of contractors.

The same inspection and maintenance teams are responsible for both elevated structures and other structures in the Metrorail system such as tunnels, non-elevated stations and parking garages.

There are 16 structural inspector positions, which allows for approximately 7 teams working in various parts of the system on a typical day that they are in the field.

The Washington Metrorail Safety Commission advanced this audit of elevated structures inspection, maintenance and repair on its audit schedule due to concerns identified during regular oversight work, including significant concerns (discussed later in this report) identified based on an extensive review of the 2018 and 2019 inspection reports for the Minnesota Avenue Aerial Structure between Stadium-Armory and Minnesota Ave. stations.

Metrorail tracks structural inspection information using AssetWise (InspectTech) digital inspection records software to document structural inspections, Maximo to document work orders, Documentum to track and store design drawings and similar documents, and Optram to log track and certain other issues. Metro uses additional electronic databases for other purposes. Notes are typically taken by hand in the field during inspections, then later entered into the computer systems.

The scope of this audit includes bridges and other elevated structures throughout the Metrorail system, with special emphasis on the Minnesota Avenue Aerial Structure (including the D&G Junction where the Orange, Silver and Blue lines meet), the Yellow Line (L Line) Charles R. Fenwick Bridge over the Potomac River, and the National Airport elevated structure.

Among other areas, the audit focuses on training and certification, which is Element 16 of WMATA's System Safety Program Plan (SSPP).

The Washington Metrorail Safety Commission advanced this audit of elevated structures inspection, maintenance and repair on its audit schedule due to concerns identified during regular oversight work.

Prior reviews of Metrorail's bridge, aerial and otherwise elevated structure maintenance practices over the past decade identified significant safety concerns.

History

Prior reviews of Metrorail's bridge, aerial and otherwise elevated structure maintenance practices over the past decade identified significant safety concerns.

In 2010, the Tri-State Oversight Committee (TOC) identified concerns with maintenance and repairs, seismic risks to select bridges, a lack of quick and easy access to critical documents, and conditions in enclosed box girders. At the time, bridge rating scales were not fully understood by inspectors, there was no inspection checklist, and there was no standard structural inspection procedure. Metrorail was beginning to use InspectTech.

A 2015 TOC audit identified concerns with a lack of documented quality control checks, outdated references and procedures, no connection between InspectTech and the Maximo work order database, no complete list of structures, and a lack of complete training for structural maintenance personnel among other things.

Also in 2015, WMATA's Office of Inspector General found that inspection report remarks and photos were being copied over year after year from one report to another, that there was little consistency among inspectors, and that there was still no inspection manual in place.

In 2017, Metrorail's internal Office of Quality Assurance, Internal Compliance and Oversight (QICO) conducted a review that found significant delays in completing inspection reports, that inspections were not completed on time, that the version of InspectTech used by WMATA did not have adequate customization or features for WMATA, that there was still no inspection manual for bridges, that there was no review or quality checking of inspection reports, that findings that did not pose an imminent danger were not being addressed efficiently, that engineers were not consistently reviewing inspection reports, that inspection reports continued to use old photos or remarks that were copied from one year to the next, and that materials and equipment were past expiration or certification dates (equipment certification lapses led to inspections falling behind). The review also identified ongoing concerns about a lack of long-term access agreements for certain property below bridges, such as CSX right of way, where Metrorail inspectors must go to properly inspect structures.

As this audit work was concluding, WMATA announced plans to rehabilitate or conduct major repairs over the next two years on approximately 9 structures with significant deterioration that were overdue for repairs, including the Cheverly



Aerial and Grosvenor Aerial. Funding for the projects had not yet been formally approved at the time of this report due to WMATA's budget cycle.

Several additional aerial structures that have also deteriorated significantly are now projected to undergo rehabilitation or retrofitting work by 2024, according to WMATA's capital delivery group.

Currently, ENGA engineering experts provide a prioritization list for major structural work based on technical considerations. Actual scheduling and decision-making regarding timelines, contracts and construction are determined by the capital delivery, and strategy, planning and program development teams.

WMATA's Capital Delivery and Strategy, Planning and Program Management teams told the WMSC and provided documents that indicated approximately 31 aerial structures have been identified as being in the most significant need of rehabilitation or repair and in a situation where planning for construction can advance. That includes the structures noted above and two others that have recently had that work completed. Approximately 12 of the 31 structures remain in the "initiation" stage, with no firm work plans in place.

WMATA's overall structural priority list places steel tunnel liner leaks and repairs, specifically including the Yellow Line tunnel between L'Enfant Plaza Station and the bridge over the Potomac River, as the top structural priority due to portions of the Yellow Line tunnel liner with more than 50 percent section loss and a large number of active leaks identified across the system by mid-2019.

The Cheverly Aerial Structure is second on the priority list due to concrete and stray current issues.

Other items currently listed as "Priority A" (construction needed within one year) include platform edges and vent shafts, the Rhode Island Avenue Station and aerial structure (designs completed in 2018), Grosvenor Aerial Structure, Yellow Line Bridge and Greenbelt Outer Loop Ramp Bridge bearing and expansion joint replacement, Orange Line bridge over the Capital Beltway weld and anchor rod repairs (drawings prepared in 2012), a series of repairs to bridges on the Green and Blue lines, repairs needed "ASAP" on the Minnesota Avenue Aerial Structure and additional cable tray, grime and water ponding removal there, a number of station canopies, several pedestrian bridges, and the Wheaton Parking Garage Bridge.

Many of these structures have been listed as requiring repairs on a similar urgent timeline for several years.

Approximately 31 aerial structures have been identified as being in the most significant need of rehabilitation or repair and in a situation where planning for construction can advance.



Audit Work

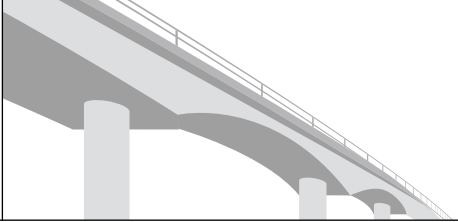
The WMSC received initial documents related to this audit from WMATA in August, conducted extensive interviews in September, and received follow up documents and conducted document reviews into November 2020.

An exit conference was held on September 28, 2020 with Metrorail staff to summarize the status of the audit to that point.

The WMSC later provided a draft of this report to WMATA for technical review and incorporated any technical corrections as appropriate. As a result of the WMSC's careful analysis of WMATA's technical review submission, the WMSC did not remove any audit findings but did make some wording changes for clarity in addition to any necessary technical corrections. For example, a finding regarding dye penetrant and D-meters was reworded to be more precise. Other parts of WMATA's submission did not prompt the WMSC to make changes because the information was either inaccurate, immaterial, or self-contradictory.

Personnel Interviewed





Documents Reviewed

- ▶ Inspection schedules and prioritization
- ▶ Inspections conducted
- ▶ Inspection reports, including the 2018 and 2019 Minnesota Ave. Aerial, 2019 Yellow Line Bridge, 2019 Reagan National Airport Aerial, 2019 Rhode Island Ave. Aerial, 2019 Cheverly Aerial, 2019 Landover Aerial, 2019 New Carrollton Aerial, 2019 Bush Hill Aerial, 2019 OR I-495 Aerial, and 2017 Underwater Bridge Inspections (systemwide)
- ▶ List of structures and classification by type
- ▶ List of structures with rocker bearings
- ▶ List of structures
- ▶ Structural Inspection Manual versions dated 2019 and 2020
- ▶ Draft pocket guide for Structural Inspection Manual
- ▶ Structural Inspection Manual implementation plan
- ▶ Project Implementation Manual (Vol. I and II) version dated August 2020
- ▶ WMATA Manual of Design Criteria version dated November 2016
- ▶ Bridge Inspection Manual (BIRM) version dated November 2015
- ▶ Bridge pier inspection reports, including 2020 Paint Branch Creek
- ▶ Engineering reports, including the 2018 Minnesota Ave. Aerial Anchor Rod and Welded Joint Inspection, 2018 L Line Bridge, 2018 Eisenhower Ave. Aerial
- ▶ Maintenance reports
- ▶ Priority defects reports
- ▶ Major repairs and rehabilitation records
- ▶ Equipment available for inspections
- ▶ Vehicle inspection sheets
- ▶ Training records
- ▶ Training requirements
- ▶ Training lesson plans
- ▶ QICO Structural Evaluation Technician Course Evaluation
- ▶ Position classifications
- ▶ Contracts for third-party inspectors
- ▶ Rules, policies and procedures
- ▶ Standard Operating Procedures
- ▶ FY2019-FY2028 10-Year Capital Needs Forecast
- ▶ Organization charts (MOWE, RIME, TRST)
- ▶ 2015 OIG Report of Investigation 14-0005-I Bridge, Platform and Tunnel Inspection Allegation



What the **WMSC** Found

What the **WMSC** Found

General Assessment

Metrorail is aware based on internal and external reviews over the last decade that the structural inspections, maintenance and repair programs were not adequate, and WMATA appears to be making some positive efforts that could significantly improve these programs.

Many of these positive steps though have not been fully implemented. Basic information such as the amount of weight each structure can hold is not readily available or considered, and significant additional training, interdepartmental coordination, documentation, IT workflow and equipment improvements are required.

For example, an extensive WMSC review of the 2018 and 2019 inspection reports for the Minnesota Avenue Aerial Structure (including the D&G Junction) demonstrates that, as recently as the last two years, inspectors have been reusing information in reports that is years old, have conducted inspections using binoculars without physically examining those parts of the structure, have incorrectly rated key parts like a pier as “N” for not applicable, have not been provided with important inspection tools like dye penetrant kits to identify potential cracks in steel members or D-Meters to measure the thickness of remaining sections, and have identified safety hazards without clearly documenting whether work orders have been issued for repairs. The formatting of the inspection reports also made it difficult to identify the status of priority repairs and to identify important recommendations such as drilling more drain holes, sealing joints, and taking more steps to keep birds out of the box girders.

WMATA engineers have determined in their structural priority list that the “Crossbox [g]rout pads needs to be repaired ASAP”. That is one reason the Minnesota Avenue Aerial Structure is in the top category of needs, Priority A, construction needed within one year. Cable trays and conduits also must be removed from the box girder, because that work was inadvertently left out of a prior contract. Engineers have determined similar structural repairs are needed “ASAP” on the Grosvenor Aerial Structure. Plans for these long-needed repairs have just recently begun to move forward.

Even structures lower down the priorities list, in a second category that is identified as needing construction within 2-3 years, are in significant need of repairs as demonstrated by the June 2020 indefinite closure of the Rockville Pedestrian Bridge due to further deterioration.

A new Structural Inspection Manual issued in late 2019 and revised and re-issued in July 2020 includes procedures that would prevent inspection deficiencies to ensure that concerns are clearly identified and communicated earlier, but frontline workers have yet to be trained on the manual despite Metrorail stating that the manual and the rules contained in it are in effect. After the WMSC raised this during its audit work, an

As recently as the last two years, inspectors have been reusing information in reports that is years old.



Frontline workers have yet to be trained on the manual despite Metrorail stating that the manual and the rules contained in it are in effect.

initial introduction was provided to inspectors. A more substantive training course has not yet been developed.

Further adding to the importance of uniform, clear guidelines and procedures, nearly all Metrorail structural inspectors have been inspectors at WMATA for less than three years.

Positive practices identified during this audit work include:

- Metrorail requires structural inspectors complete the basic National Highway Institute (NHI) bridge inspection course within their first year of employment
- Metrorail has developed a Structural Inspection Manual
- Metrorail is finalizing a pocket guide based on the manual (the WMSC reviewed a 112-page draft version)
- Metrorail provided records demonstrating up-to-date underwater inspections conducted in 2017. Metrorail policy requires these inspections at least once every five years
- Inspection records and interviews showed Metrorail inspectors conduct underwater sounding of piers in shallow water

The following details provide the primary basis for the 12 findings and one recommendation in this audit report.

Departmental Silos, Unclear Responsibilities (Findings 1, 3)

Steps toward improvements are complicated and slowed by a lack of complete coordination and ongoing communication among Metrorail departments that is demonstrated in structures inspections and maintenance by the unacceptable silos each involved department tends to operate in, creating safety risks.

A lack of regular, complete communication among various levels of ENGA, TRST and MOWE and other interested departments contributes to conflicting or unclear instructions that are not always specifically followed, to a lack of proper training, and to questionable work that could lead to safety deterioration.

For example, the Structural Inspection Manual that was issued in 2019 was published by MOWE and officially made effective without complete coordination with ENGA and TRST, which led to a manual that was technically in effect but that inspectors were directed not to act on for several months. The manual was published before final coordination and reviews involving ENGA, TRST, MOWE and other departments were

complete. Interviews also established that there was only limited, late input on the manual from at least some members of the Safety Department.

Inconsistencies between written policies that are technically in place and the actual expectations for work that is being done creates a risk that work will not be completed properly.

Even after the updated manual was issued in July 2020, TRST inspectors responsible for implementing the manual have not been provided with any standardized formal training on the new policies and procedures, including WMATA's new direction on element inspections. After the WMSC raised this during its audit work, an initial introduction was provided to inspectors. A more substantive training course has not yet been developed.

Limited interdepartmental communication has also, in the past, appeared to limit the effectiveness of structural priority repair and rehabilitation lists to trigger immediate action as required. More recently, Metrorail appears to have made significant strides to plan, schedule and implement at least some of the most important structural repair and rehabilitation projects identified by structural experts.

The WMSC has observed similar coordination issues in other audits, inspections and investigations and other oversight activities of many different parts of Metrorail.

Metrorail must address this in a broad, systemic way.

The National Transportation Safety Board (NTSB) identified similar concerns in its investigation into a 2007 derailment near the Mt. Vernon Square Station, making two recommendations regarding improvements to interdepartmental coordination. R-07-25 recommended WMATA establish procedures to ensure coordination between all departments responsible for car maintenance and engineering, and R-07-27 recommended that WMATA establish rail lubrication procedures that include close coordination between operating and track engineering departments.

A Federal Transit Administration (FTA) audit report issued in March 2010 following the fatal 2009 Red Line crash near Fort Totten Station concluded that "it does not appear that there is effective interdepartmental coordination regarding the identification and management of maintenance-related safety hazards."

More recently, in addition to WMSC audit findings, investigations and inspections identifying a lack of coordination among departments such as Vehicle Program Services (CENV) and Track Engineering, Metrorail's own Office of Quality Assurance, Internal Compliance and Oversight (QICO) identified similar significant concerns regarding interdepartmental coordination regarding grout pad construction, maintenance and repair.



Inconsistencies between written policies that are technically in place and the actual expectations for work that is being done creates a risk that work will not be completed properly.

Metrorail must develop and implement procedures that ensure all departments work together to establish uniform procedures and to identify and fully rectify issues in a timely fashion.



That QICO review, completed in late 2020 to follow up on several years of concerns, found that there is limited coordination between the same departments the WMSC identified in this audit: ENGA, MOWE and TRST. In that case, the issue relates to conflicting work instructions and materials for the same task, disputes over whether work instructions should be followed, inadequate quality control checks (TRST is already required by the WMSC to address this under CAP C-0031), and unapproved materials being used that could lead to deterioration of grout pads or require more force during maintenance that could damage elevated structures. Using materials with excessive strength can contribute to crews using jackhammers that are too large to safely use on elevated structures without causing damage, allowing grout pads to block drainage paths or not conform to size requirements can contribute to water damage or electrical arcing, and failing to conduct proper pull tests in areas like the Yellow Line bridge over the Potomac River can contribute to premature deterioration or other problems.

Metrorail must develop and implement procedures that ensure all departments work together to establish uniform procedures and to identify and fully rectify issues in a timely fashion.

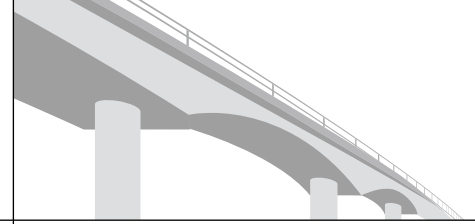
No one has ongoing responsibility for the Structural Inspection Manual. Although ENGA is responsible for setting standards, MOWE led development of the manual, and TRST is responsible for carrying out day-to-day inspections. Based on our audit interviews, key individuals in SAFE were not fully included in the development of the manual and were only given an opportunity to review the final draft of the document prior to its apparently rushed issuance to meet a self-imposed deadline in December 2019.

Various departments outside MOWE nearly immediately identified several changes that would be required, and a revised version was issued in July 2020.

Neither version of the manual designates the party responsible for reviewing the document on any regular schedule or keeping the document updated, and no one interviewed for this audit could say who is responsible for the document now.

SOP 100-23 attempts to address some of the underlying issues by identifying the department(s) responsible for inspection and maintenance of certain structures, but does not delineate responsibility for the manual.

Metrorail must clearly designate the department and current job function with ownership of the manual and any related procedures, and the coordination process that will be used for future updates and reviews. The designation must also include a specific timeline for required reviews of the documents.



No load ratings (Finding 2)

Metrorail could not provide any load ratings for its bridges and aerial structures.

Although Metrorail purchased heavier 7000 Series trains within the last decade that now represent more than half of the railcar fleet, runs more eight-car trains, and is finalizing plans for similar 8000 Series trains, there are no load ratings available for elevated structures to specify the maximum weight each structure can safely hold.

Metrorail said it does not have a load ratings table for all structures, and that it does not have individual load ratings for the National Airport elevated structure, Minnesota Ave. Aerial/D&G Junction or the Yellow Line Bridge over the Potomac River.

Metrorail also could not provide any load rating assessment conducted ahead of the procurement, testing or operation of 7000 Series railcars in the system.

Bridge capacities change from design load capacities as conditions change and the bridges are used. Heavier cars and longer trains being used on a regular basis can slowly make bridges more vulnerable to failure over time.

The lack of any load rating assessment poses a risk that structures could be inadvertently overloaded or that necessary reductions in load ratings could be missed by inspectors.

Without a base load rating, it also becomes difficult to quickly calculate what weight is safe on the bridge if an issue is identified, which could lead to a need to shut down structures for an extended period while that load rating is calculated. Such an issue could include something found in inspections, or an unplanned emergency that WMATA may not even have control over, such as a vehicle fire under a bridge or a collision with a bridge pier.

Metrorail must conduct a load rating assessment for all bridges and elevated structures or otherwise raised platforms or tracks (prioritizing the structures with the most severe deficiencies and concerns), compare those load ratings to the actual maximum loads that could be placed on those structures, and make any operational adjustments required for safety.

Metrorail must then establish a process, including clear procedures and load rating guidelines, to keep the load ratings up to date. Metrorail must also establish a process to evaluate rail vehicle (single car or maintenance machine and entire consist) weight relative to the weight ratings of structures across the system to ensure that no structure is overloaded during scheduled activities or unplanned events.

Metrorail could not provide any load ratings for its bridges and aerial structures.

The lack of any load rating assessment poses a risk that structures could be inadvertently overloaded or that necessary reductions in load ratings could be missed by inspectors.

Rocker bearings use rotation to provide longitudinal flexibility, but include the risk of corrosion and other maintenance issues as well as the risk of failure during seismic events.

If Metrorail does not have the original design ratings as a baseline for its load rating assessment, WMATA should be able to get that information from the original design firms.

Seismic Risk (Recommendation)

The WMSC also identified a concern regarding 10 structures that have steel rocker bearings, which are no longer used in most new American transportation bridge construction projects due to the risk of failure during an earthquake or similar seismic event. Rocker bearings use rotation to provide longitudinal flexibility, but include the risk of corrosion and other maintenance issues as well as the risk of failure during seismic events. In 2010, the TOC identified the need for further seismic resistance evaluation and the prioritization of inspection, maintenance and repair of structures with rocker bearings.

The bearings are currently in place on:



WMATA told the WMSC during this audit that it has no plans to replace these bearings on any of these structures, despite an upcoming major repair project planned on the Cheverly Aerial in 2022 and the potential for later major rehabilitation work on the Route 7 Bridge and Route 7 Ramp A Bridge. ENGA has identified the need for bearing replacement on these three structures and several others.

As provided in the WMSC Program Standard, the WMSC is issuing this concern as a recommendation rather than a finding because the existence of the rocker bearings in the Metrorail system today does not violate any policy or procedure, but the Federal Highway Administration and the American Association of State Highway

and Transportation Officials have concluded that rocker bearings have a higher risk of failure in an event such as a nearby explosion or the 2011 earthquake that shook the Washington region. Steel rocker bearings also have a history of relatively poor performance and additional long-term maintenance requirements compared to other bearing types.

Metrorail should develop and implement a plan as part of its capital program to incorporate the replacement of rocker bearings with elastomeric or spherical bearings into other capital projects on these bridges. Metrorail could also implement an appropriate interim mitigation. Examples of such mitigation could include installing a redundant cable support system to reduce the risk of catastrophic failure.

Metrorail is required to evaluate this recommendation, determine whether a Corrective Action Plan is required, and convey the full details of the evaluation to the WMSC. If a CAP is required, it will follow the regular CAP process.

New procedures issued without training (Finding 4)

Metrorail's first Structural Inspection Manual, issued in December 2019, was made effective before all final coordination and reviews were complete and without communicating the contents of the manual to the employees responsible for implementing it.

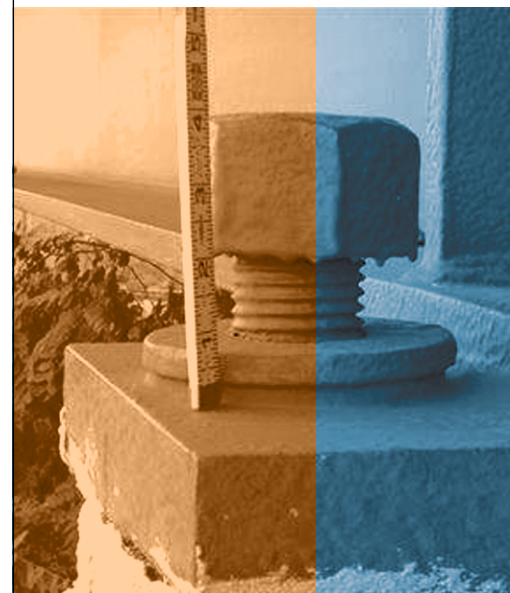
A second version of the manual was issued in July 2020, again without any formal training for employees despite significant changes that they were supposed to be following such as the use of element inspections for elevated structures.

Element inspections provide specific, quantifiable numbers regarding the conditions of each part of a bridge that, if properly tracked and analyzed, can provide for improved bridge management decision-making and forecasting.

Supervisors have attempted to provide some limited on-the-job training on the manual by highlighting parts of the 327-page document or by rejecting inspection reports and highlighting certain changes that are needed, but supervisors also received no formal training on the new manual so may not be able to accurately identify all areas of concern.

The limited, non-standardized training is of particular concern given the scope of the manual, the lack of any documentation of prior practices, and no material indicating what the manual changes from prior practices.

A second version of the manual was issued in July 2020, again without any formal training for employees.





After the WMSC raised this training issue during this audit work, an initial introduction was provided to inspectors in late October 2020. A more substantive training course has not yet been developed.

Before this manual was issued, Metrorail relied only on national bridge inspection standards issued by the Federal Highway Administration. ENGA had begun developing a manual in 2017 meant to address aspects of inspections processes specifically for WMATA inspectors, but that never advanced out of development. Interviews demonstrated that the early drafts of that ENGA document were not used in any way as part of development of the 2019 or 2020 manuals.

Metrorail must continue to develop training materials and must provide necessary initial and recurring training to cover all relevant aspects of the Structural Inspection Manual and related procedures, including proper reporting of element inspections and proper completion of all reports, work orders and other documentation. This training development must be coordinated with and approved by the departments involved in finalizing the manual including TRST, ENGA, MOWE and SAFE, and must be provided to all relevant employees.

Inspectors not provided tools, training needed (Findings 6, 7)

Metrorail does not have important structural steel inspection tools available that are listed in its Structural Inspection Manual, and inspectors are not provided with the training required to use those tools.

Ultrasonic thickness gauges (D-meters) used to measure steel member section loss from a single side surface and dye penetrant kits used to identify and confirm potential cracks in steel members are listed in Metrorail's manual as tools to be used as necessary when inspectors identify distress or deterioration. However, Metrorail told the WMSC that it does not have any dye penetrant kits or D-meters available, and that its inspectors are not trained to use these important tools. Metrorail stated that contractors may use these tools in some cases, but Metrorail provided only one inspection report that showed the use of dye penetrant by a contractor.

Metrorail must provide its inspectors with both access to and training on tools such as dye penetrant kits and D-meters that are listed in the Structural Inspection Manual as tools to be used for certain inspections.

Cracks and section loss issues are particularly important to identify and monitor in fracture-critical members, the steel parts of a bridge whose failure could lead to something as serious as a bridge collapse. However, Metrorail does not require that all structural inspectors who work on bridges complete the National Highway Institute

Metrorail structures inspectors are not provided with the tools required to conduct certain key safety-related activities and are not provided with the training required to use those tools.

(NHI) fracture-critical member training course and does not have a fixed schedule requirement for NHI bridge inspection refresher training courses.

Although Metrorail has taken the positive step of requiring inspectors to take the initial NHI bridge inspection course, requiring the refresher course a set number of years after the inspector's last initial or refresher class would ensure that all inspectors remain consistent and up to date. Other agencies typically require this refresher course at intervals of every 3, 4 or 5 years.

Metrorail also must set consistent requirements for refresher or additional safety training for inspection and maintenance personnel on key equipment such as scissor lifts or bucket trucks. Metrorail provides initial safety training on these vehicles but does not require refresher training for the equipment.

Beyond more obvious safety concerns, this lack of refresher training also contributes to vehicle inspections checklists being left incomplete (e.g. checking whether a fire extinguisher is charged), different versions of the same form being used, and a general lack of opportunity for frontline workers to expand their knowledge and abilities.

Inspections supervisor field time limited (Finding 8)

To ensure quality control and adequate support, particularly with changing rules and procedures, supervisors must have the opportunity to frequently observe and interact with inspectors in the field.

**Time in the field
for supervisors is
necessary to ensure
that inspectors learn,
grow and gain from
their daily experience.**



ENGA stated it samples TRST structural inspection reports, however there is no documented requirement or procedure to carry out this quality control and assurance practice.

Metrorail inspection, repair and design data are spread across disparate systems.

Currently, supervisors are told to spend at least two out of five days per week in the field, less than half of their work week. The remaining time is spent reviewing inspection reports and handling other administrative duties. Supervisors are also responsible for tracking compliance with training requirements for areas such as traffic control setup.

Although the review of reports is important, ensuring that the inspections are done properly and safely with adequate quality control is also important. Time in the field for supervisors is necessary to ensure that inspectors learn, grow and gain from their daily experience.

Limited direct supervision can open opportunities for practical drift away from the written procedures. The WMSC has observed this drift from procedures in safety event investigations and other audits, such as the Audit of Roadway Worker Protection and Training.

Supervisors told the WMSC in this audit that they need to be able to spend more time in the field, inspectors told the WMSC in this audit that more time in the field for supervisors would be useful, and the FTA identified similar concerns in other parts of WMATA dating back to the 2015 Safety Management Inspection. Metrorail must conduct an assessment of the workload, job responsibilities, training and territory, work assignments and travel time for structures inspections supervisors, to determine whether any changes to work assignment strategies or additional positions are required to implement and sustain this increase in field time. Metrorail must act on the conclusions of this assessment.

Missing or outdated SOPs (Findings 5, 9, 12)

Metrorail took some steps meant to improve its Standard Operating Procedures (SOPs) pertaining to structural inspection and maintenance in conjunction with the creation of the Structural Inspection Manual, but the revised and partly consolidated SOP does not match the latest version of the manual.

Interviews and a review of SOP 208-07 (dated March 2020) and the current version of the manual (dated July 2020) demonstrated conflicts including: the memos used to identify and communicate urgent defects have different names in the two documents; the SOP references an outdated version of the manual; and the SOP requires that a position title that does not appear to exist review the SOP every two years.

These documents serve as the basis for safety-related inspection steps, so any conflict or confusion creates a safety risk.

Separately, the Department of Engineering and Architecture (ENGA) does not document its findings when inspectors call for an engineer to examine a potential problem in person or a problem is reviewed using an inspection report. That creates a risk that the information from that engineer could be lost and a safety issue could be missed or remain unresolved.

There are also no documented SOPs or other procedures requiring ENGA to spot check TRST structural inspections. ENGA stated it samples TRST structural inspection reports, however there is no documented requirement or procedure to carry out this quality control and assurance practice.

To address these missing or outdated SOPs, Metrorail must review and update SOP 208-07 or the Structural Inspection Manual to eliminate conflicts or outdated information and provide clear standards and requirements. Metrorail must then communicate these updates to all relevant employees and provide any necessary training related to the revisions.

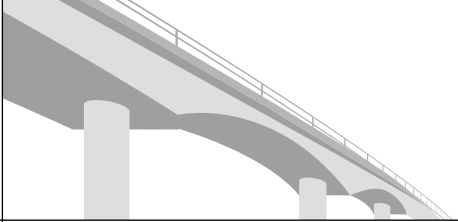
Metrorail must also establish a documentation pathway for an engineer's observations to be added directly into inspection and maintenance records systems such as AssetWise (InspectTech), Maximo or Optram, and must create and implement a written procedure requiring ENGA personnel to sample structural inspection reports.

Disparate information systems (Finding 10)

Metrorail inspection, repair and design data are spread across disparate systems in a way that makes certain work challenging, creating the risk that safety issues could be misidentified or slip through the cracks.

Not all departments have access to all structures inspection and repair systems, some data are entered separately into different systems, the naming conventions used for drawings or prints crucial to the new element inspection process are unduly complicated, and entering important data can be time consuming, delaying the communication of important information.

For example, information entered into an inspection report in AssetWise (InspectTech) does not automatically get conveyed to Maximo, so a separate work order is required that then must be manually noted back into AssetWise (InspectTech). The current initial efforts at reporting element inspections are being attached to inspection reports as a PDF rather than entered into a more useful database. Completing those inspections properly can require digging through physical or digital files with complicated naming conventions to get basic data only to find that the necessary numbers are too blurry to read in documents that are old, documents that have been copied multiple times or documents that may have been scanned in low resolution.



Metrorail must assess technology needs and identify any changes that would improve workflows to ensure that all identified issues are communicated to each relevant department and addressed in a timely manner.

Other departments have access to Optram that conveys location information in a more straightforward fashion, but Optram includes only track issues not elevated structures concerns.

Metrorail must assess technology needs and identify any changes that would improve workflows to ensure that all identified issues are communicated to each relevant department and addressed in a timely manner.

Contractor oversight (Finding 11)

Metrorail does not review the credentials, training and qualifications of individual contractor employees before allowing them to conduct a structural inspection.

During audit interviews, Metrorail employees responsible for administering the contract agreed that a reliance on initial commitments from contractors to meet training requirements is likely not sufficient, and proof of qualifications and training should be provided to Metrorail for each inspector working on any part of the rail system.

If contractors do continue to be used for select elevated structures inspections, Metrorail's current practice of rotating the structures that the contractors are responsible for each year is a good process that allows for Metrorail inspectors to inspect that structure the following time to act as a check on the contractor and the contractor's inspections of various structures to act as a check on Metrorail inspectors.





Findings and Required Corrective Actions

Findings and Required Corrective Actions

1

Metrorail departments involved in structures inspections and maintenance operate in unacceptable silos, which creates safety risks.

A lack of regular communication among ENGA, TRST and MOWE contributes to conflicting instructions that are not specifically followed and to a lack of proper training and questionable work that could lead to safety deterioration. The siloed nature of each department contributes to challenges in understanding the instructions and procedures that may fall short. Limited inter-departmental communication has also appeared to limit the effectiveness of structural priority repair and rehabilitation lists to trigger immediate action as required. The WMSC has observed this lack of cooperation and siloing among many Metrorail departments during its regular inspections, audits and other oversight work. This lack of cooperation and regular collective review of necessary ongoing training, parts and policy updates was also identified in the investigation into the fatal 2009 Red Line crash near Fort Totten.

Minimum Corrective Action: Metrorail must develop and implement procedures that ensure all departments work together to establish uniform procedures and to identify and fully rectify issues.

2

WMATA does not have load ratings for its bridges and aerial structures.

As Metrorail's structures age and heavier cars are used, Metrorail could not provide any documents demonstrating the load ratings of its elevated structures. Metrorail said it does not have a load ratings table for all structures, and that it does not have load ratings for the National Airport elevated structure, Minnesota Ave. Aerial/D&G Junction or the Yellow Line Potomac River bridge. This poses a risk that structures could be overloaded or that necessary reductions in load ratings could be missed by inspectors.

Minimum Corrective Action: Metrorail must conduct a load rating assessment for all bridges and elevated structures or otherwise raised platforms or tracks (prioritizing the structures with the most severe deficiencies), compare those load ratings to the actual maximum loads that could be placed on those structures, and make any operational changes required for safety. Following that assessment, Metrorail must establish a process, including clear procedures and load rating guidelines, to keep the load ratings up to date. Metrorail must also establish a process to evaluate rail vehicle (both single car or single maintenance machine and entire consist) weight relative to the weight ratings of structures across the system to ensure that no structure is overloaded during scheduled activities or unplanned events.





3

Metrorail has not clearly assigned responsibility for the Structural Inspection Manual and has not set a timeline for review of the manual. As a governing document, the manual was developed by MOWE with input from other departments. None of the departments believed they were responsible for the document moving forward. SOP 100-23 attempts to address some of the underlying issues by identifying the department(s) responsible for inspection and maintenance of certain structures, but does not clearly delineate responsibility for the manual.

Minimum Corrective Action: Metrorail must clearly designate the department and current job function with ownership of the manual and any related procedures, and the coordination process that will be used for future updates and reviews. The designation must also include a specific timeline for required reviews of the documents.

4

A new Structural Inspection Manual was made effective without any associated training for the employees responsible for implementing it. Metrorail distributed a newly developed Structural Inspection Manual effective December 2019 without any training for the employees responsible for implementing the manual in practice and before all final coordination and reviews were complete. A first revision to the manual was issued effective July 23, 2020, again without any formal training for implementation of any of the changes such as element inspections. While supervisors have attempted to provide on-the-job training, it has been limited and not conducted in any standardized fashion.

Minimum Corrective Action: Metrorail must continue to develop training materials and must provide necessary initial and recurring training to cover all relevant aspects of the manual and related procedures, including proper reporting of element inspections and proper completion of all reports, work orders and other documentation. This training development must be coordinated with and approved by the departments involved in finalizing the manual including TRST, ENGA, MOWE and SAFE, and must be provided to all relevant employees.

5

Standard Operating Procedure 208-07 (dated March 2020) contains outdated and conflicting references. Review of the documents and interviews demonstrated conflicts between SOP 208-07 and the Structural Inspection Manual dated July 2020. Among other issues, the memos used to identify and communicate urgent defects have different names in the two documents, the SOP references an outdated version of the manual, and the SOP requires a position that does not exist review the SOP every two years.

6

Minimum Corrective Action: Metrorail must review and update SOP 208-07 or the Structural Inspection Manual to eliminate conflicts or outdated information and provide clear standards and requirements. Metrorail must then communicate these updates to all relevant employees and provide any necessary training related to the revisions.

Metrorail does not have important structural steel inspection tools available that are listed in its Structural Inspection Manual.

TRST structural inspectors are not provided with training on, not provided with, and no longer use ultrasonic thickness gauges (D-meters) or dye penetrant kits, even though the Structural Inspection Manual includes these tools. Dye penetrant kits help identify and confirm potential cracks in steel structural members and D-meters are used to measure section loss on steel members from a single side surface. The manual states that dye penetrant testing or a D-meter are to be used as necessary if inspectors identify distress or deterioration, however Metrorail told the WMSC that it does not have any dye penetrant kits or D-meters available and that its inspectors are not trained to use these important tools. Metrorail stated that contractors may use these tools in some cases, but Metrorail provided only one inspection report that showed the use of dye penetrant by a contractor.

Minimum Corrective Action: Metrorail must provide its inspectors with both access to and training on tools such as dye penetrant kits and D-meters that are listed in the Structural Inspection Manual as tools to be used for certain inspections.

7

Metrorail does not have consistent requirements for refresher or additional training for structures inspection and maintenance teams.

Not all structural inspectors who work on bridges are required to have fracture-critical member training, there is no fixed schedule for NHI refresher training courses. There is no refresher safety training required for certain equipment such as scissor lifts or bucket trucks. This contributes to vehicle inspections checklists being left incomplete (e.g. checking whether fire extinguisher is charged), different versions of the same form being used, and a general lack of opportunity for frontline workers to expand their knowledge and abilities.

Minimum Corrective Action: Metrorail must formalize a timeline for sufficient NHI refresher training courses and fracture-critical member training (including element inspection training). Metrorail must establish sufficient requirements for employee refresher training on the safe use of equipment such as scissor lifts or bucket trucks and proper use of inspection checklists for those vehicles or equipment.



8

Structures inspections supervisors are not able to spend adequate time in the field, creating concerns about work quality and workload. Supervisors need to be able to effectively oversee inspectors in the field and provide support so that inspectors can learn, grow and gain from their daily experience. Work assignments must account for leave and provide adequate opportunity to both review inspection reports and provide guidance and oversight in the field. Metrorail must validate its staffing levels based on the total effective time supervisors spend in the field in order to continually ensure and improve the quality of inspections and inspection reports given the ongoing expansion of the Metrorail system and the increased inspection frequencies required as aspects of the system age. Similar concerns were identified in the Federal Transit Administration's 2015 Safety Management Inspection, supervisors told the WMSC in this audit that they need to be able to spend more time in the field, inspectors told the WMSC in this audit that more time in the field for supervisors would be useful, and the WMSC has identified similar concerns in other Metrorail departments during other audit and oversight work.

Minimum Corrective Action: Metrorail must conduct an assessment of the workload, job responsibilities, training and territory, work assignments and travel time for structures inspections supervisors, to determine whether any changes to work assignment strategies or additional positions are required to implement and sustain this increase in field time. Metrorail must act on the conclusions of this assessment.

9

The Department of Engineering and Architecture (ENGA) does not document its findings when inspectors call for an engineer to examine a potential problem in person or through review of an inspection report. This creates a risk that information or records could be lost, and a safety issue could remain unresolved.

Minimum Corrective Action: Metrorail must establish a documentation pathway for an engineer's observations to be added directly into inspection and maintenance records systems such as AssetWise (InspectTech), Maximo or Optram.

10

Metrorail inspection, repair and design data are spread across disparate systems in a way that makes certain work challenging, creating the risk that safety issues could be misidentified or slip through the cracks. Not all departments have access to all structures inspection and repair systems, some data are entered separately into different systems, the naming conventions used for drawings or prints crucial to the new element inspection process are complex, and entering important data can be time consuming, delaying the communication of important information. Other documents are available

only through time-consuming searches, that may only be successful in turning up documents that have been copied too many times or scanned in low resolution, resulting in critical information being too blurry to read.

Minimum Corrective Action: Metrorail must assess technology or other needs and identify any changes that would improve workflows to ensure that all documents are legible, up to date and accessible, and that all identified issues are communicated to each relevant department and addressed in a timely manner.

11

Metrorail does not review contractor credentials, qualifications or training before a contractor conducts an elevated structures inspection. Metrorail relies on initial commitments from contractors to meet training requirements but does not require submission of individual training records or resumes.

Minimum Corrective Action: Metrorail must require and review proof of credentials, qualifications and training for contractors used to inspect or repair elevated structures.

12

Metrorail does not have a written procedure for spot checks of TRST structural inspections. ENGA representatives stated that they sample 10 to 15 percent of TRST structural inspection reports, however there is no documented requirement to continue this good practice of quality control and assurance.

Minimum Corrective Action: Metrorail must create and implement a written procedure requiring ENGA personnel to sample structural inspection reports.





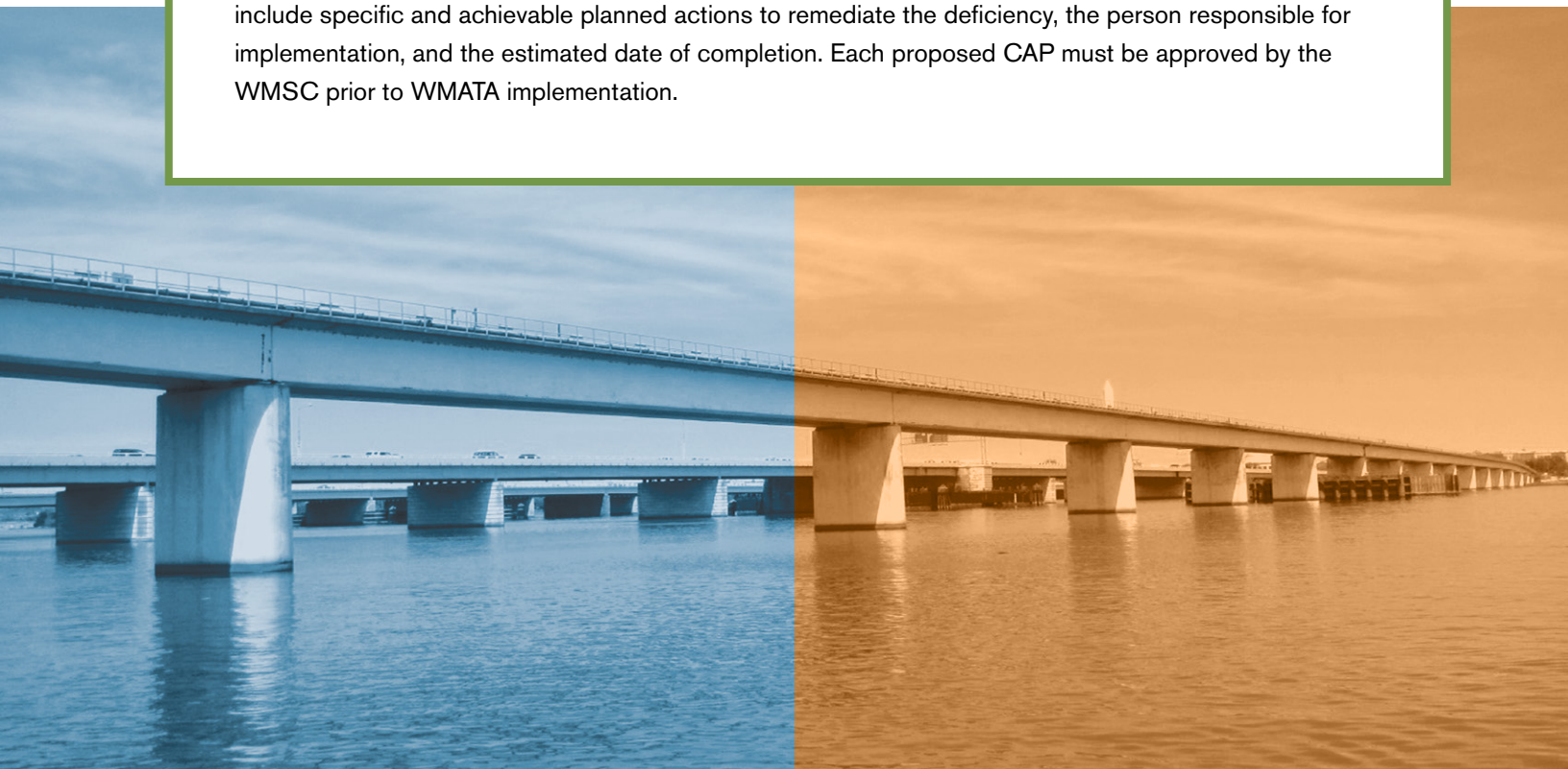
Recommendation:

Ten Metrorail structures have steel rocker bearings, which creates a risk in the event of an earthquake or other seismic event. In 2010, the Tri-State Oversight Committee (TOC) identified the need for further seismic resistance evaluation and the need to prioritize inspection, maintenance and repair of structures with rocker bearings, however WMATA still has no plan to replace these bearings.

Possible Corrective Action: Metrorail should develop and implement a plan as part of its capital program to incorporate the replacement of these steel rocker bearings with elastomeric or spherical bearings into other capital projects on these bridges. Metrorail could also implement an appropriate interim mitigation such as installing a redundant cable support system to reduce the risk of catastrophic failure.

Next Steps

WMATA is required to propose CAPs for each finding and to submit a CAP or conclusions letter regarding the recommendation no later than 45 days after the issuance of this report. Each proposed CAP must include specific and achievable planned actions to remediate the deficiency, the person responsible for implementation, and the estimated date of completion. Each proposed CAP must be approved by the WMSC prior to WMATA implementation.





750 First St. NE • Ste. 900 • Washington, D.C. 20002 • 202-384-1520

www.wmsc.gov