

**Presentation to the Toronto Transit Commission Board
on November 22, 2023
Agenda Item 17**

**AUDITOR
GENERAL**

TORONTO

Audit of the Toronto Transit Commission's Streetcar Overhead Assets: Strengthening the Maintenance and Repair Program to Minimize Asset Failures and Service Delays

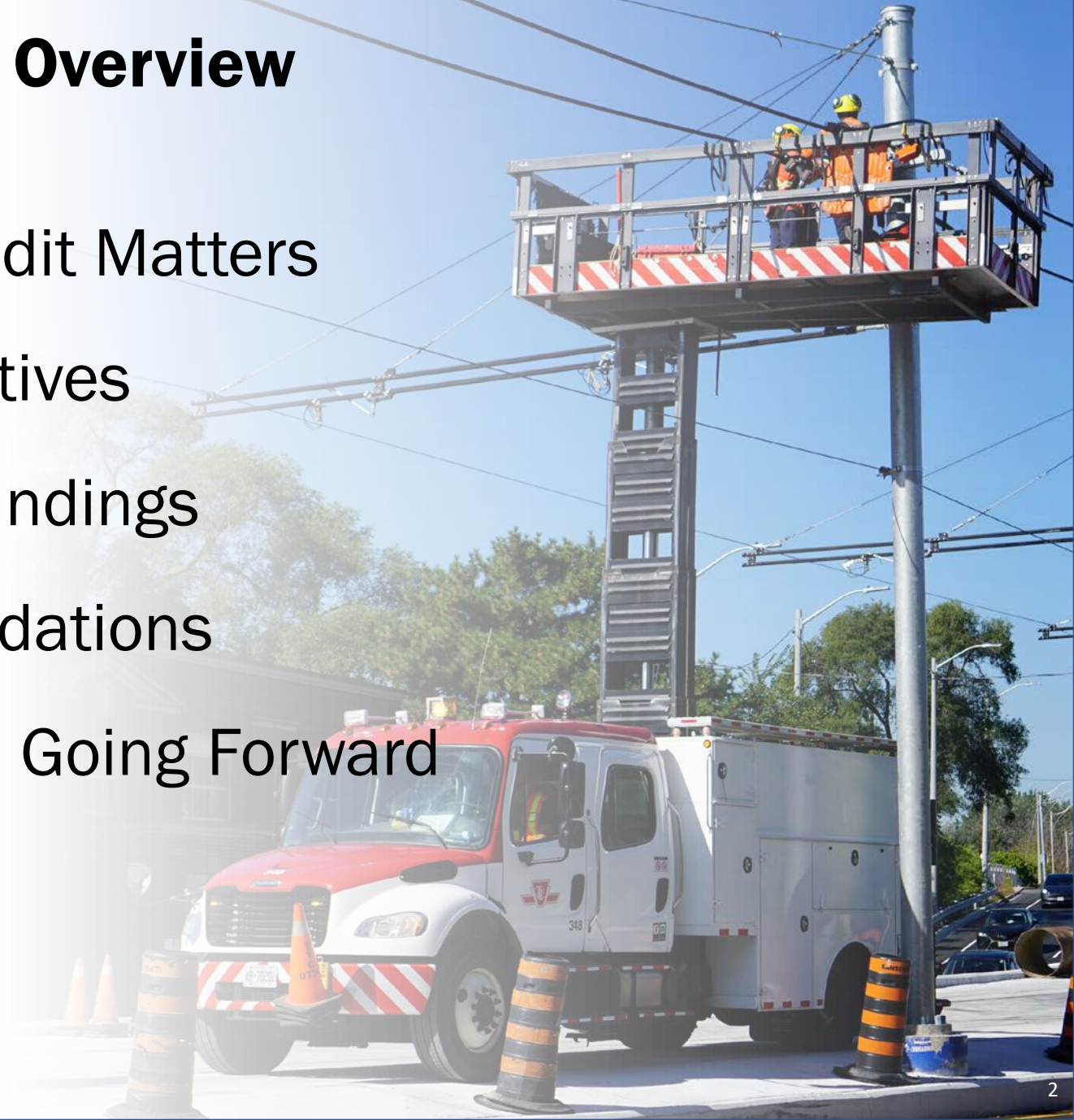
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Presentation Overview

- Why this Audit Matters
- Audit Objectives
- Key Audit Findings
- Recommendations
- Summary – Going Forward





Why This Audit Matters

- Overhead Operations is responsible for the **ongoing maintenance and repair** of the:
 - Overhead Contact System (OCS), which is a 600 VDC electrical system that power the streetcars.
 - Electrical components of electric track switches
- The OCS is **critical** to streetcar operations as asset failures can result in **service disruptions and delays** and **pose public safety risks**.

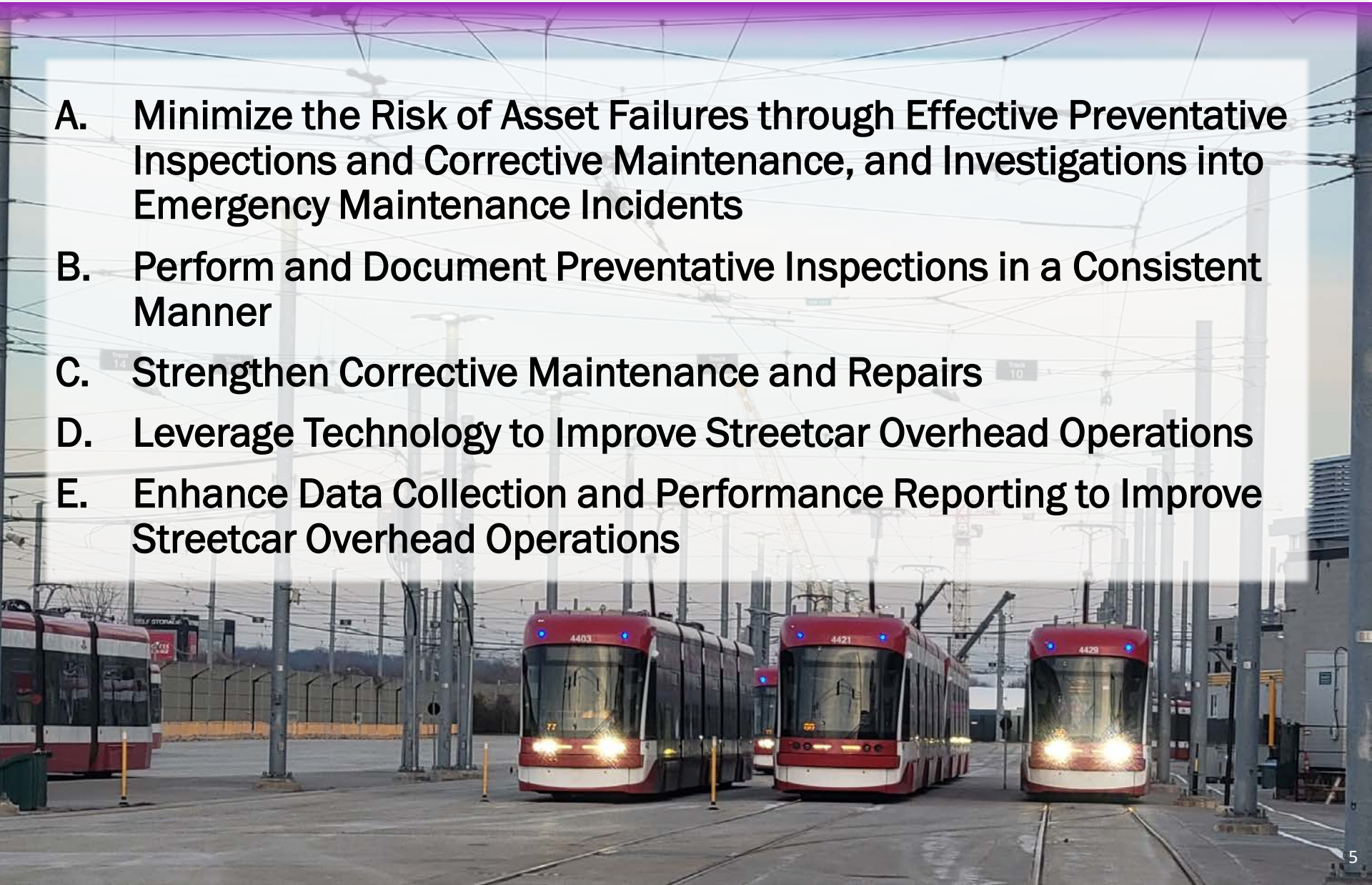


Audit Objectives

1. Are the TTC's streetcar overhead infrastructure assets **maintained and repaired** in accordance with TTC's policies and procedures and relevant industry standards?
2. Are there opportunities for the TTC to **further leverage the use of data and technology** in managing its work orders, informing decision-making, and managing Overhead Operations services?
3. Are there opportunities for the TTC to **strengthen its policies, procedures, standards, and Key Performance Indicators** related to streetcar overhead?

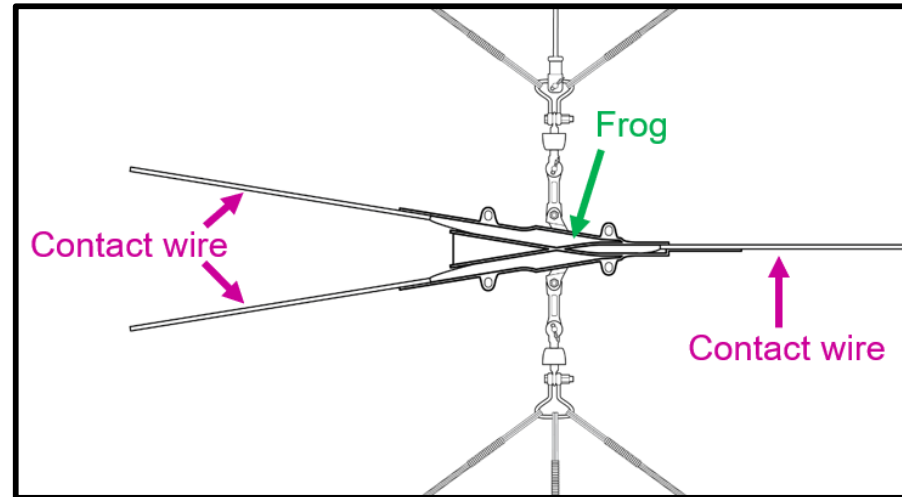
Key Audit Findings and Recommendations

- A. Minimize the Risk of Asset Failures through Effective Preventative Inspections and Corrective Maintenance, and Investigations into Emergency Maintenance Incidents
- B. Perform and Document Preventative Inspections in a Consistent Manner
- C. Strengthen Corrective Maintenance and Repairs
- D. Leverage Technology to Improve Streetcar Overhead Operations
- E. Enhance Data Collection and Performance Reporting to Improve Streetcar Overhead Operations



A. Minimize the Risk of Asset Failures through Effective Preventative Inspections and Corrective Maintenance

- An Example of Untimely/Missed Preventative Inspections
 - On January 14, 2022, there was a service delay at King Street West and Shaw Street
 - Asset failure: worn contact wire and worn “frog”



- Preventative inspection target = **1/year**
- Cause: There was **no inspection performed in 2021**. This **missed inspection** contributed to the service delay, as it could have identified the worn assets had it been conducted

A. Minimize the Risk of Asset Failures through Effective Preventative Inspections and Corrective Maintenance



• An Example of Incomplete Preventative Inspections

- On December 30, 2022, at Dundas Street West and Lansdowne Avenue, fire resulted after the streetcar's pantograph was entangled in a downed wire

- Asset failure: **cotter pin** that supports the span wire failed to remain intact

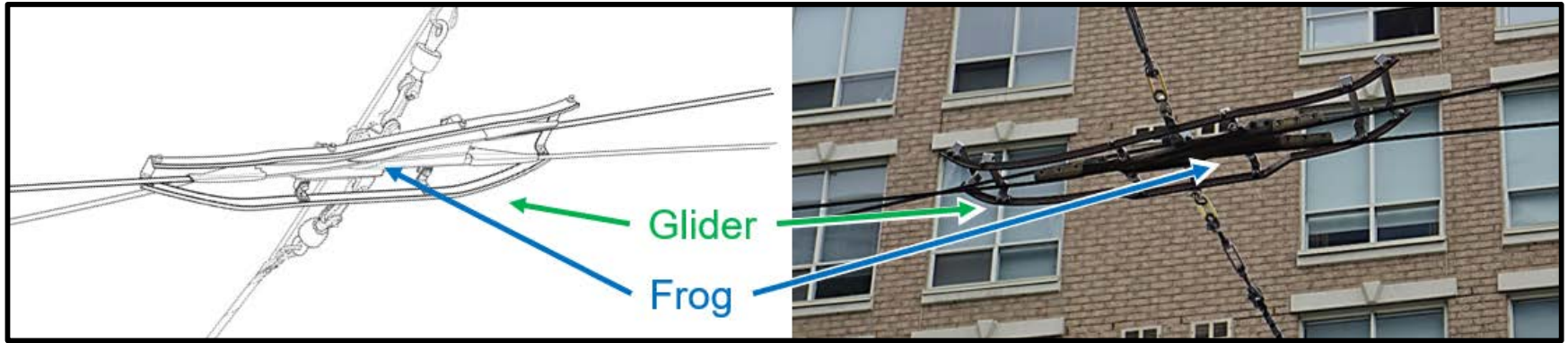
- Cause: Preventative inspections' **job plans did not specifically include inspecting the cotter pins**, therefore they were not inspected.



A. Minimize the Risk of Asset Failures through Effective Preventative Inspections and Corrective Maintenance

- **An Example of Untimely/Missed Corrective Maintenance**

- On August 18, 2022, there was a service delay at Queen Street East and Church Street due to a **defect in the combined frog and glider combination unit asset**



- **Issues were identified** for this asset in the preventative inspection **10 weeks earlier on June 10, 2022**; resulting Corrective Maintenance work order created on June 14, 2022 but was not completed prior to August 18, 2022.
- **Cause: Corrective Maintenance work order was not prioritized and completed in a timely manner**

B. Perform and Document Preventative Inspections in a Consistent Manner



- Annual preventative inspection **targets not met for 48%** of assets sampled
 - Example: An intersection had an *annual target of two inspections*, but *only one inspection was done in 2022*
- Inspections **not completed at specified time intervals**
 - Example: An asset with an inspection target of *every three months* had inspections *performed 26 days apart in 2022*.

B. Perform and Document Preventative Inspections in a Consistent Manner

- **Variability** in the performance and documentation of preventative inspections
 - Example below – inspection extracts for the same asset that had two inspections performed on March 2, 2022 and March 18, 2022

Inspection on March 2, 2022

| Work Method Details: | | |
|---|-----------|-------------|
| Activities | Done(Y/N) | Observation |
| 10 HOLD TAILBOARD CONFERENCE (OSAP) | N | |
| 20 AT SECTION INSULATOR (Step #30 to 120) | N | |
| 30 CHECK SUSPENSION | N | ✓ |
| 40 CHECK COND. OF T/W ENTERING SECTION INSULATOR | N | 5.5mm |
| 45 CHECK COND. OF CONTACT ELEMENTS, SCREW TORQ-40Nm, MAGNETS | N | |
| 48 CHECK FOR CORRECT DIRECTION OF TRAVEL (N or S Polarity) | N | ✓ |
| 49 CHECK FOR CORRECT AIR GAP (15mm x 3) | N | ✓ |
| 50 CHECK COND. OF UNDERRUN (SKIDS, ANCHORING TIP SCREW TORQ-20Nm, INSUL RUNNER BAR) | N | 6mm |
| 60 CHECK COND. OF INSUL, MOUNT LUGS AND HANGER WIRES | N | |
| 70 CHECK COND. OF DIODE, SHUNT AND MOUNT HARDWARE | N | |

Inspection on March 18, 2022

| Work Method Details: | | |
|---|-----------|-------------|
| Activities | Done(Y/N) | Observation |
| 10 HOLD TAILBOARD CONFERENCE (OSAP) | N | |
| 20 AT SECTION INSULATOR (Step #30 to 120) | N | |
| 30 CHECK SUSPENSION | N | |
| 40 CHECK COND. OF T/W ENTERING SECTION INSULATOR | N | 12mm |
| 45 CHECK COND. OF CONTACT ELEMENTS, SCREW TORQ-40Nm, MAGNETS | N | |
| 48 CHECK FOR CORRECT DIRECTION OF TRAVEL (N or S Polarity) | N | |
| 49 CHECK FOR CORRECT AIR GAP (15mm x 3) | N | |
| 50 CHECK COND. OF UNDERRUN (SKIDS, ANCHORING TIP SCREW TORQ-20Nm, INSUL RUNNER BAR) | N | |
| 60 CHECK COND. OF INSUL, MOUNT LUGS AND HANGER WIRES | N | |
| 70 CHECK COND. OF DIODE, SHUNT AND MOUNT HARDWARE | N | |

March 2 – wire measurement was taken from under the wire fitting (5.5 mm)

March 18 – wire measurement was taken for the whole wire (12 mm)

March 2 – measurement recorded for this inspection task (6 mm)

March 18 – **no** measurement was recorded for the same inspection task

C. Strengthen Corrective Maintenance and Repairs

- **58%** of sampled inspections with issues identified **did not have corrective maintenance work performed**
 - Example: Asset OVH-LB-59 had a preventative inspection generated on November 24, 2022 (WO 4792756), where crews identified a problem:

| |
|---|
| Work Done |
| Problem Found |
| Wire worn end of tip entering & exiting 5mm |
| Action Taken |

- Per Maximo system records for asset OVH-LB-59, there was no corrective maintenance work order generated. The next work order generated on May 31, 2023 (WO 5015257) was another preventative inspection work order.

| <input type="checkbox"/> | Record | Class | Status | Reported Date | Target Start Date | Description |
|--------------------------|---------|-----------|--------|----------------|-------------------|--|
| <input type="checkbox"/> | 5015257 | WORKORDER | WAPPR | 5/31/23 12:55 | 5/31/23 00:00 | Sectioner (Line Insulator) |
| <input type="checkbox"/> | 4792756 | WORKORDER | CLOSE | 11/24/22 15:54 | 11/24/22 00:00 | Diode Controlled Section Breaks -A Version 2 New Style |

C. Strengthen Corrective Maintenance and Repairs

- Average time to complete corrective maintenance after the inspection was **5 weeks**

| Time between Inspection Completion Date and CM Generation | Preventative Inspections That Generated CMs | |
|---|---|-----|
| | Number | % |
| <1 week | 26 | 56 |
| 1 to <2 weeks | 7 | 16 |
| 2 to <3 weeks | 5 | 10 |
| 3 to <4 weeks | 2 | 4 |
| 4 to <5 weeks | 2 | 4 |
| 5 to <6 weeks | 1 | 2 |
| 6 to <7 weeks | 1 | 2 |
| 7 to <8 weeks | 2 | 4 |
| 8 to <9 weeks | 1 | 2 |
| Total | 47 | 100 |

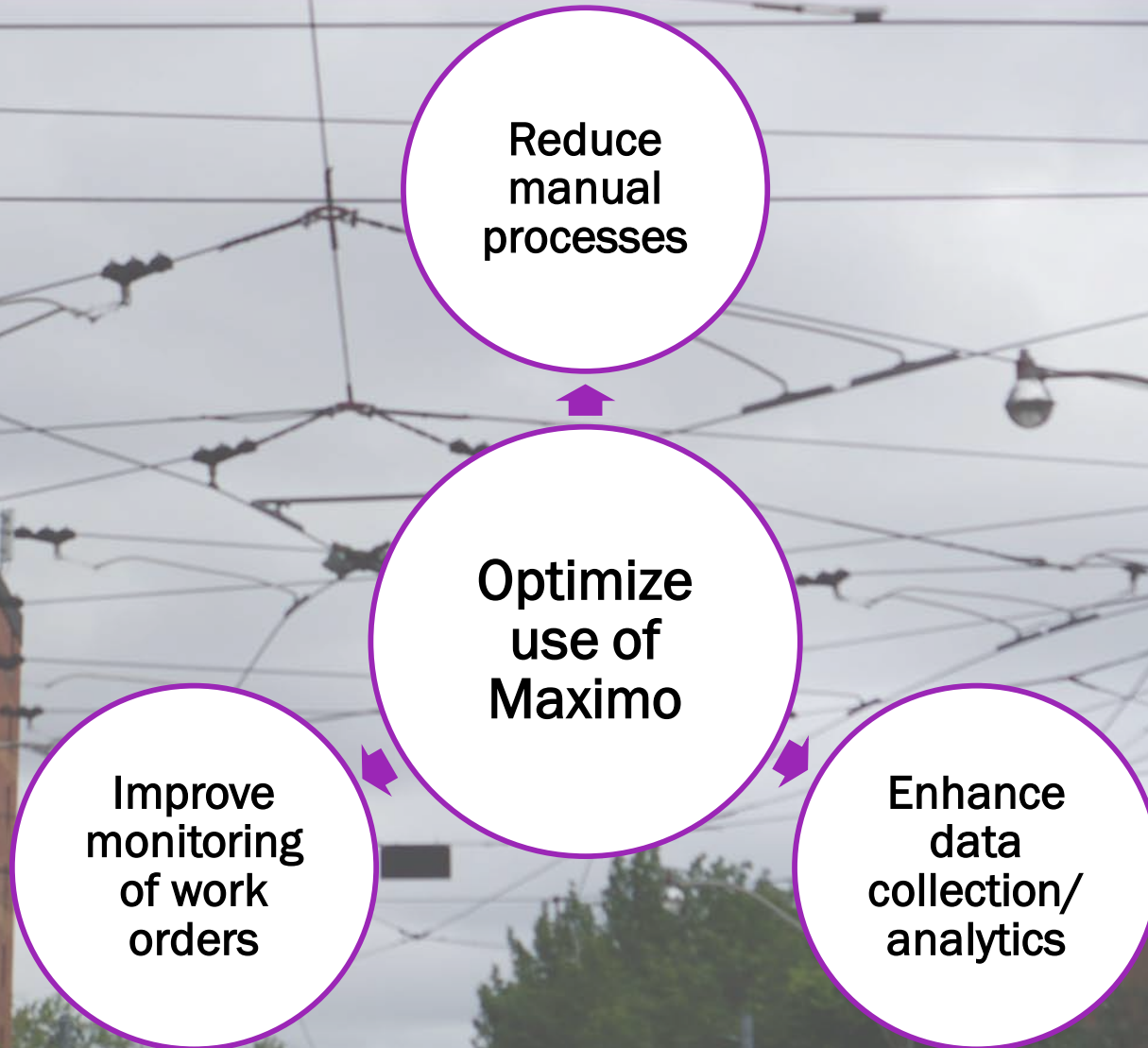
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| Time between CM Generation and CM Completion | CM Work Orders | |
|--|----------------|-----|
| | Number | % |
| <2 week | 206 | 54 |
| 2 to <4 weeks | 52 | 14 |
| 4 to <6 weeks | 59 | 15 |
| 6 to <8 weeks | 26 | 7 |
| 8 to <10 weeks | 8 | 2 |
| 10 to <12 weeks | 5 | 1 |
| 12 to <14 weeks | 6 | 2 |
| 14 to <16 weeks | 10 | 3 |
| 16 to <40 weeks | 8 | 2 |
| Total | 380 | 100 |

2 weeks – average time between inspection completion and CM generation

3 weeks – average time between CM generation and CM completion

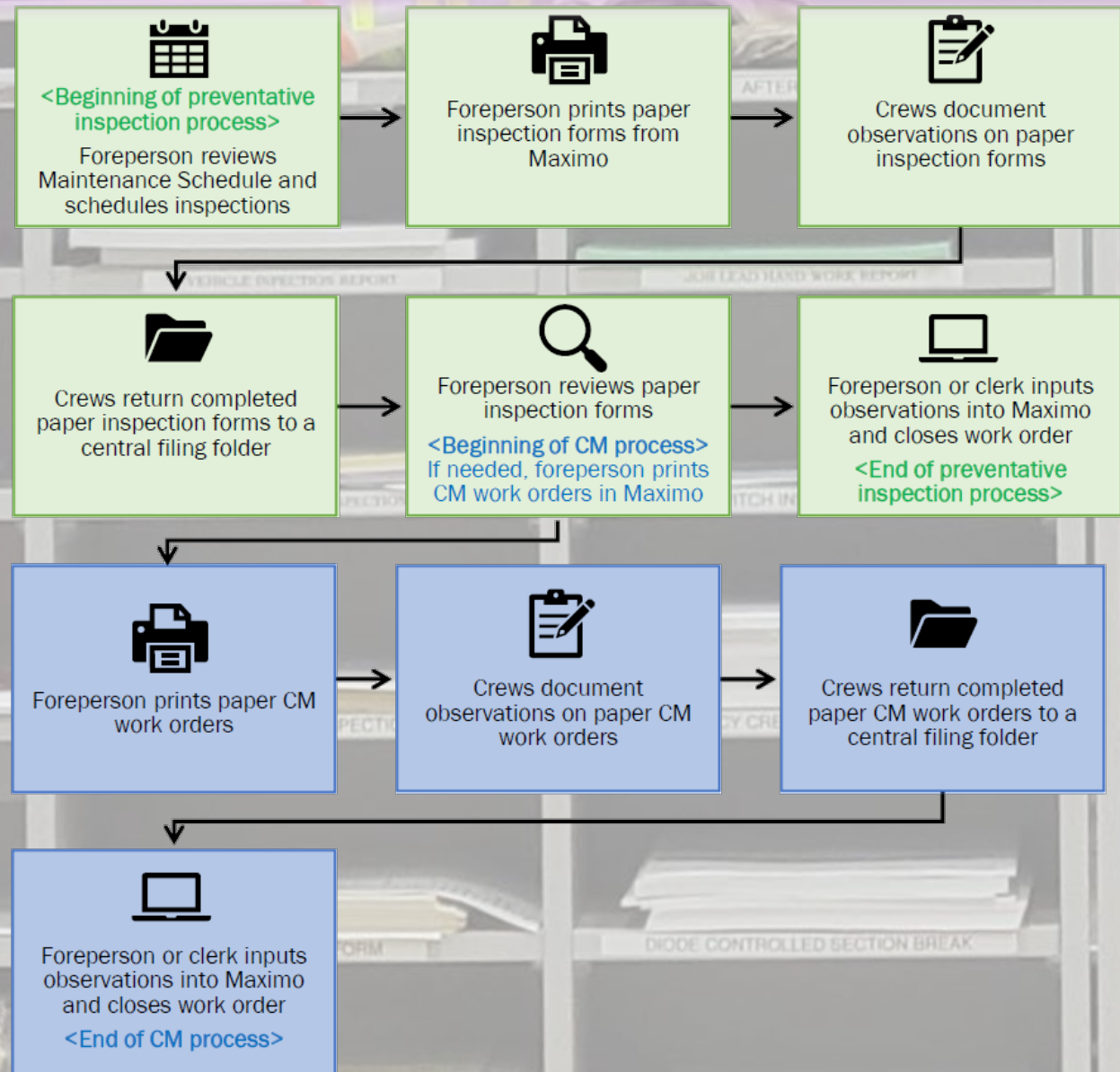
D. Leverage Technology



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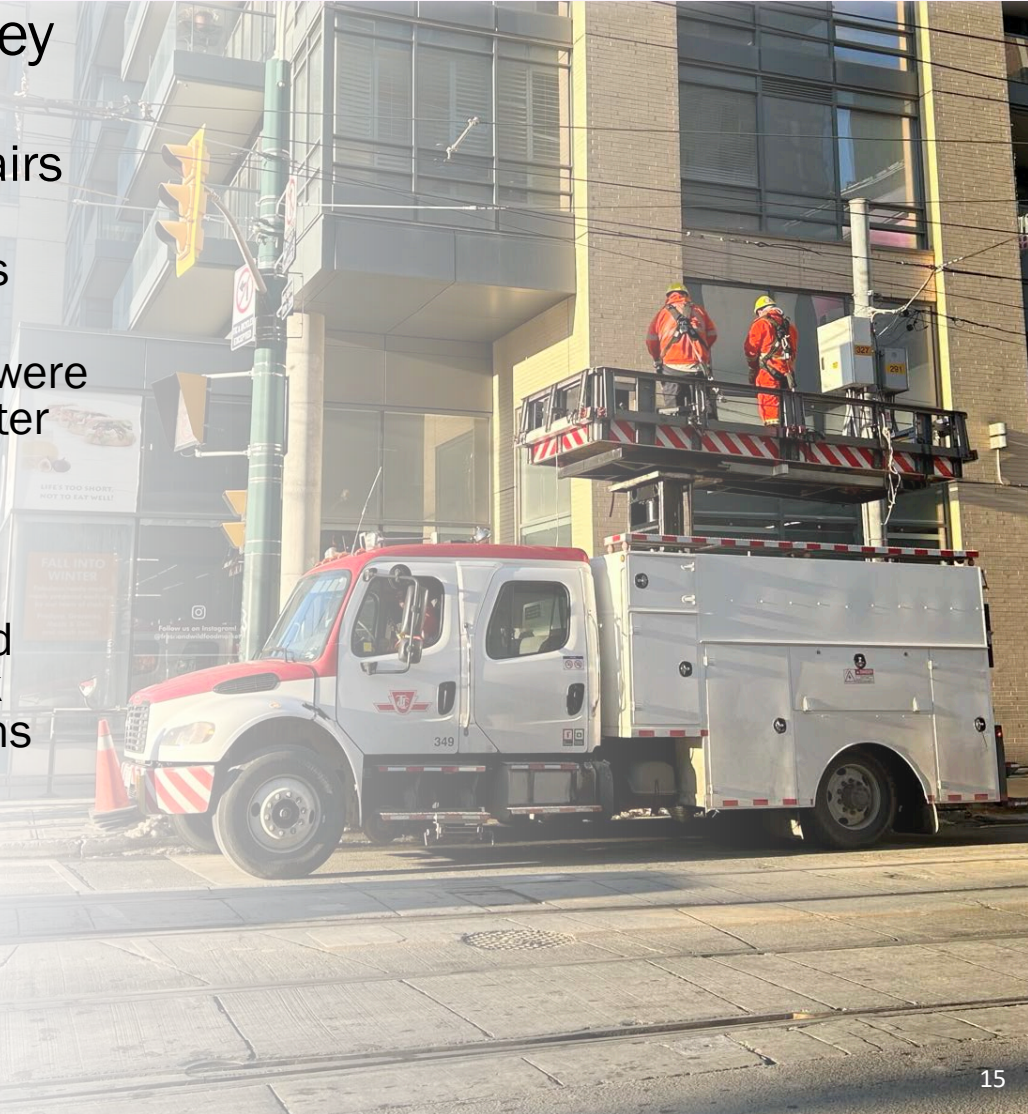
Overhead Operations' Preventative Inspection and Corrective Maintenance (CM) Work Order Process

- manual
- paper-driven



E. Enhance Data Collection and Performance Reporting

- Establish **Outcome-Focused Key Performance Indicators**
 - **Timeliness** of maintenance/ repairs
 - Annual preventative inspection **targets not met** for 48% of assets sampled
 - 46% of CM work orders in 2022 were completed **two weeks or more** after the work order was generated
 - **Quality** of maintenance/ repairs
 - Example: For one asset, we noted five corrective maintenance work orders within a span of 12 months
- Ensure KPIs and targets are **clearly defined, with accurate and complete supporting data**



20 Recommendations

Our recommendations will increase the **efficiency and effectiveness** of the TTC's Overhead Operations' maintenance and repair program by:

- **Strengthening asset and workflow management**
- **Leveraging technology and data**
- **Enhancing policies and procedures**



Summary – Going Forward

Short to Medium Term:

- Update and formalize the **manual, policies and procedures, and provide training and oversight**, giving clear guidance and expectations to staff to ensure consistency of work performed and documented
- Strengthen **controls to improve planning, scheduling, and tracking** of the preventative inspections and corrective maintenance and repairs
 - e.g. accurate and complete asset inventory and Maintenance Schedule, preventative inspection targets and compliance, timely completion of corrective maintenance and repairs
- Collect data and perform **root cause analyses/ investigations** of all asset failures and service delays
- Improve **KPIs** to be outcome-based, **supported by complete and accurate data** to better inform decision making

Summary – Going Forward

Maximo IT System - Short to Medium Term:

- Develop a **comprehensive Maximo implementation plan** for both an enterprise asset management system and workflow process management system, with target dates and timelines
- Review and update Streetcar Overhead Operations' **asset inventory and job plans/activity tasks in Maximo** to ensure they are complete, accurate, and up-to-date

Longer Term:

- Ensure **staff are fully trained and users' needs met** before go-live implementation of updated Maximo system
- Develop and implement a **process using Maximo to track the real-time status of work orders** to support ongoing work order management and supervision, including the use of data analytics



Thank You

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