The following presentation is supplemental to *NCHRP Research Report 1076: A Guide to Incorporating Maintenance Costs into a Transportation Asset Management Plan*. (NCHRP Project 23-08 of the same title). The full report can be found by searching on *NCHRP Research Report 1076* on the National Academies Press website (nap.nationalacademies.org).

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Guide for Incorporating Maintenance Costs into a TAMP
Topics

- Background
  - Challenges to Incorporating Maintenance Costs into a TAMP
  - Benefits of The Guide
  - Intended User Groups
- Defining Maintenance
- Framework for Incorporating Maintenance into a TAMP
  - Data Needed
  - Life-cycle Planning
  - Risk Management
  - Financial Planning
  - Investment Strategies
- Implementation and Continual Improvement
Background

- 23 CFR 515 Requires State DOTs to develop TAMPs that indicate planned investments in five different work types
- As of 2019, only 11 State DOTs included detailed information on maintenance costs in their TAMPs

TAMP WORK TYPES (23 CFR 515.5)
- Initial Construction
- Maintenance
- Preservation
- Rehabilitation
- Reconstruction
NCHRP 23-08

Literature Search
- Current TAMPs
- NCHRP Research
- AASHTO Guides
- FHWA Publications

Peer Exchanges
- State and County DOTs
- Four virtual sessions held in 2020

Case Studies
- Alabama DOT
- Florida DOT
- Maryland SHA
- New York State DOT
- Nevada DOT
- Texas DOT
- Maricopa County DOT
Challenges to Incorporating Maintenance Costs into a TAMP

OBSTACLES

- Lack of a common definition for maintenance
- Lack of quality data
- Limited understanding of the maintenance and asset life-cycle relationship
- Immature risk management practices
- Separation of maintenance and capital budgets
- Maintenance and asset management have different budget or planning periods
- Unlike other work types, maintenance is applicable at all life-cycle stages
Benefits of the Guide

- Better incorporate maintenance costs into TAMPs.
- Establish clear connections between maintenance investments and asset condition.
- Understand how maintenance activities support asset management strategies.
Intended Users

**Asset Managers’ Concerns**
- Long-term planning
- 10-year investment strategies
- Asset condition ratings
- All funding
- Enterprise and programmatic risks

**Maintenance Managers’ Concerns**
- Short-term operations
- Annual budgets
- Maintenance quality assessments
- Maintenance budget
- Implementation of risk mitigation efforts
Framework Overview

1. Collect Needed Maintenance Cost Data
2. Incorporate Maintenance Costs into Risk Management
3. Incorporate Maintenance Costs into Investment Strategies
4. Define Maintenance Activities
5. Incorporate Maintenance Costs into LCP
6. Implement, Monitor, Evaluate, and Improve

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Defining and Categorizing Maintenance Activities

- Define Maintenance Activities
- Collect Needed Maintenance Cost Data
- Incorporate Maintenance Costs into Risk Management
- Incorporate Maintenance Costs into LCP
- Incorporate Maintenance Costs into Investment Strategies
- Implement, Monitor, Evaluate, and Improve

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Reliability Centered Maintenance

- **Condition-Based**
  - Routine condition monitoring
  - Failure predictable using condition forecasting models

- **Interval-Based**
  - Subject to wear-out
  - Consumable replacement
  - Failure pattern is known

- **Reactive**
  - Small items
  - Non-critical
  - Inconsequential
  - Likely to fail
  - Redundant

- **Risk-Based**
  - Impact of failure is much greater than the cost of the asset
  - Failure is significant to safety or operations
## Categorizing Maintenance Activities

<table>
<thead>
<tr>
<th>Category</th>
<th>Activity Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations and routine maintenance</td>
<td>Road patrol, mowing, snow and ice control.</td>
</tr>
<tr>
<td>Preventive maintenance</td>
<td>Crack seal, chip seal, sweeping, drain cleaning, bridge washing.</td>
</tr>
<tr>
<td>Repair</td>
<td>Mill and inlay, deck repair, replacement of parts.</td>
</tr>
<tr>
<td>Unit or major component replacement</td>
<td>Sign panel replacement, striping, traffic signal component replacement.</td>
</tr>
<tr>
<td>Organizational strengthening</td>
<td>Training, safety briefings, management system use, planning supervision.</td>
</tr>
</tbody>
</table>
Collecting Needed Data

- Collect Needed Maintenance Cost Data
- Define Maintenance Activities
- Incorporate Maintenance Costs into LCP
- Incorporate Maintenance Costs into Risk Management
- Incorporate Maintenance Costs into Investment Strategies
- Implement, Monitor, Evaluate, and Improve
Maintenance Data Collection Attributes

**Required**
- **Asset ID**: a shared, unique identifier for the asset
- **Location**: spatial, linear referencing
- **Asset Categories**: a specific grouping of the asset
- **Key Condition/Performance Attributes**: as appropriate

**Recommended**
- **Supporting Condition/Performance Attributes**: such as drainage or bleeding issues on a pavement
- **Component Inventory**: such as controller models for traffic signal or guardrail blockout material types
- **Field Priority**: field identified priorities for investment

**Optional**
- **Detailed Inventory or Assessment Notes**: captures unique circumstances, context, and one-off conditions
- **Detailed Component Information**: installation dates of individual components
- **Attachments**: providing detailed supporting documents
# Defining Performance for Different Maintenance Strategies

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<tr>
<th>Approaches</th>
<th>Condition Data</th>
<th>Age / Last Treatment</th>
<th>Risk Data</th>
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<td>✓</td>
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<td>Interval</td>
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<tr>
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</table>
Maintenance Quality Assurance Program

ALABAMA DOT EXAMPLE

MQA program enables ALDOT to compare asset condition over time and across organizational units in a consistent manner.
Maintenance Quality Assurance Program

**ALABAMA DOT EXAMPLE**

MQA program enables ALDOT to compare asset condition over time and across organizational units in a consistent manner.

<table>
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<th>2019</th>
<th>2020</th>
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<td>Asphalt—Potholes</td>
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<td>Shoving</td>
<td>C</td>
<td>F</td>
<td>D-</td>
<td>F</td>
<td>D-</td>
</tr>
</tbody>
</table>
Tracking Maintenance by Contract Costs

TEXAS DOT EXAMPLE

- Work Order Created in MMS
- WO with associated Chartfields are interfaced to PeopleSoft
- Requisition submitted in PeopleSoft with WO number
- Services are received in PeopleSoft
- Data is interfaced to MMS as an Other Costs Day Card associated with the WO

Data source: Texas DOT
Relating Pavement Condition to Maintenance Costs

MINNESOTA DOT EXAMPLE

**10-Year Patching Predicted Costs—by Revenue Scenario Pavement Condition**

Annual Pothole Patching Costs

- PLO, $32,684,865
- PL-1, $16,744,978
- PL-2, $48,928,594

Data source: Minnesota DOT
Supporting Life-Cycle Planning (LCP)
Approaches for Considering Maintenance Costs in LCP

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Case Examples – Maintenance Costs in LCP

- New York State DOT – Use of structural repairs to defer the need for bridge replacements.
- Nevada DOT – Prioritizing preservation over replacement treatments maximizes cost-effectiveness (i.e., level of condition improvement) of ITS assets.
Addressing Risk

- Define Maintenance Activities
- Collect Needed Maintenance Cost Data
- Incorporate Maintenance Costs into Risk Management
- Incorporate Maintenance Costs into LCP
- Incorporate Maintenance Costs into Investment Strategies

Implement, Monitor, Evaluate, and Improve

NCHRP 23-08 Guide for Incorporating Maintenance Costs into a TAMP
Incorporating Maintenance Costs into Risk Management

**TRENDS**
- Funding fluctuation
- Aging infrastructure
- Staffing
- New infrastructure
- Environmental changes

**EVENTS**
- Extreme weather (emergency events and 23 CFR 667)
- Economic disruption
- Regulations or requirements
Financial Planning

- Collect Needed Maintenance Cost Data
- Incorporate Maintenance Costs into Risk Management
- Incorporate Maintenance Costs into Investment Strategies
- Define Maintenance Activities
- Incorporate Maintenance Costs into LCP

Implement, Monitor, Evaluate, and Improve
Financial Plan Development Process

The 7-step process helps agencies to list maintenance sources and uses to forecast maintenance costs for TAMP financial plan.

1. Determine TAM scope
2. Identify funding sources
3. Establish fund uses
4. List fund sources and uses
5. Validate list
6. Document constraints
7. Document fixed cost
Financial Planning

- Define Maintenance Activities
- Collect Needed Maintenance Cost Data
- Incorporate Maintenance Costs into Risk Management
- Incorporate Maintenance Costs into LCP
- Incorporate Maintenance Costs into Investment Strategies
- Implement, Monitor, Evaluate, and Improve
This guidance adjusted the 10-step process established in NCHRP 898 and FHWA guidance for maintenance activities that are not delivered through construction project.
Implementation and Continual Improvement

Define Maintenance Activities

Collect Needed Maintenance Cost Data

Incorporate Maintenance Costs into Risk Management

Incorporate Maintenance Costs into Financial Plans

Implement, Monitor, Evaluate, and Improve

Incorporate Maintenance Costs into Investment Strategies

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Keys to Success

* Coordination with capital program
  - ALDOT’s maintenance contracting
  - NYSDOT’s innovative maintenance contracting

* Coordinate timing of maintenance delivery
  - TDOT’s coordination among maintenance, safety, and operations

* Training, equipping, and supplying
  - NYSDOT’s investment in organizational development
NCHRP 23-08 Products

- A Guide for Incorporating Maintenance Costs into a TAMP
- Executive Summary
- Tech Memo
- Presentation
- Workshop (To be held at the 2023 TRB Annual Meeting)