TAMC Culvert Asset Management Best Practices

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December 2023

ABSTRACT

The Michigan Transportation Asset Management Council has expended significant effort to launch the Michigan culvert asset management process: including adopting modern condition assessment systems, providing a policy and recommendations for culvert data collection, providing data collection and storage systems for culvert asset data, and funding pilot data collection efforts. However, nationwide, culvert asset management processes are not as developed as those for pavements or bridges. A few successful culvert asset management programs can be used to guide the development of culvert asset management process and best practices.

This report contains the results of a literature review of state and local road-owning agencies that have successfully implemented a culvert asset management program or process. Best practices for creating and maintaining a formal culvert asset management program that can be adapted for use in Michigan have been identified.

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ACKNOWLEDGEMENTS

The Transportation Asset Management Council Bridge Committee and the Center for Technology & Training at Michigan Technological University wish to acknowledge all those who contributed to the development of this report by sharing their experiences through surveys and interviews. Their input has been and will continue to be helpful in the development of guidance on the inventory and condition evaluation of culverts in the State of Michigan.

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
CMP	Corrugated Metal Pipe
CRC	County Road Commission
CRD	County Road Department
CTT	Center for Technology & Training
FHWA	Federal Highway Administration
MDOT	Michigan Department of Transportation
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
PA	Public Act
TAMC	Transportation Asset Management Council
TAMS	Transportation Asset Management System

1.0 EXECUTIVE SUMMARY

The TAMC has expended significant effort to launch a Michigan culvert asset management process, including adopting modern condition assessment systems, providing a policy and recommendations for culvert data collection, providing data collection and storage systems for culvert asset data, and funding pilot data collection efforts. However, nationwide, culvert asset management processes are not as developed as those for pavements or bridges, so there are few successful culvert asset management programs that can be used to guide the development of culvert asset management process and best practices.

The AASHTO *Culvert & Storm Drain System Inspection Guide* (AASHTO 2020) was used as the basis for developing the *TAMC Michigan Non-NBI Culvert Structure Inspection Guide* (TAMC 2021). The AASHTO guide provides recommended best practices for establishing a culvert asset management program, based on guidance from the AASHTO *Transportation Asset Management Guide* (AASHTO 2022), that an agency's asset management approach address five questions:

- What is the current state of physical assets?
- What are the required levels of service and performance delivery?
- Which assets are critical to sustained performance?
- What are the best investment strategies for operations, maintenance, replacement, and improvement?
- What is the best long-term funding strategy?

These questions were used to form an outline for a proposed culvert asset management plan that closely resembles the outlines for the existing TAMC bridge and pavement asset management plan templates (CTT 2023).

The literature review looked at published transportation asset management plans for a selection of state and local agencies that included culverts in their plans. Some agencies included larger culverts (10 feet and larger) as part of their bridge asset management procedure while treating smaller culverts separately. Other agencies kept all culverts (less than 20 feet in span) in their own asset management group. The agencies that were part of the review were California Department of Transportation (DOT), Colorado DOT, Michigan DOT, Minnesota DOT, Ohio DOT, Los Angeles County Department of Public Works (California), Shelby County (Alabama), Loddon Shire (Australia), Central Elgin (Ontario), and Town of The Blue Mountains (Ontario).

The resulting recommendations are to include the following content in a local agency culvert asset management plan:

- Introduction
    - Brief overview of the agency culvert management program

- Culvert assets
    - Table or graphic summarizing overall inventory and condition
- Required level of service/performance targets
    - Example: Goal to have less than 10% of culverts rated poor
- Identification of critical assets
    - Example: culverts rated poor and/or on routes with lengthy detours
- Strategies for operations, maintenance, replacement and improvement
    - Example: using life cycle cost estimates to help define management strategy/project scoping
- Long-term funding strategy
    - Identify existing sources of funding along with potential new sources

2.0 PURPOSE

The Michigan Transportation Asset Management Council (TAMC) began its work on culvert inventory and condition evaluation with a pilot program in 2018. The pilot determined which data were essential for asset management purposes and provided training to local road-owning agencies on data collection and culvert condition assessment (Bershing et. al. 2018).

In 2020, the project was continued as observations gathered from 2018 pilot participants were used to update training materials, improve efficiency, and improve data consistency across agencies (Gilbertson et. al. 2020).

In 2021-2022, the TAMC Bridge Committee developed a "Policy for Collection of Culvert Inventory and Condition Data" (TAMC 2022) that defined training requirements, reimbursement requests, and provided guidance on data collection frequency, culvert condition assessment, and data storage and management tools. The TAMC Bridge Committee also created the *Michigan Non-NBI Culvert Inspection Guide* (TAMC 2021), which included a new condition evaluation system in response to the 2020 AASHTO publication of the *Culvert & Storm Drain System Inspection Guide* (AASHTO 2020). The Center for Technology & Training worked with TAMC in 2021-2022 to provide assistance in developing the inspection guide, update the existing culvert inspection training, update the Roadsoft culvert module, and conducted a follow-up survey of pilot participants (Gilbertson et.al 2022).

As agencies complete their inventory and condition data collection, they will be able to further integrate culverts into their overall asset management goals and project planning. The purpose of this report is to overview the existing Michigan local agency culvert practices and policies for inventory and condition evaluation and to conduct a literature review to determine best practices in culvert asset management from agencies who have completed their inventory and evaluation and are taking the next steps in asset management. Best practices from state and local road-owning agencies with successful culvert asset management programs will help to inform future updates to the existing Michigan asset management plan templates (pavement,

bridge, and/or compliance plans—i.e., transportation asset management plans designed for compliance with Public Act 325 of 2018) to expand culvert asset management.

3.0 BACKGROUND

Inventory

The TAMC Bridge Committee provided guidance on the culvert inventory data that should be collected based on feedback from the 2018 pilot (Bershing et. al 2018):

- Identification number
- Inspection date
- GPS coordinates
- Material type
- Shape
- Skew angle
- Length
- Rise
- Width (single barrel)
- Span (multi-barrel)
- Number of barrels
- Depth of cover
- Roadway surface type
- Condition rating

Evaluation

Culvert condition data was based on a good/fair/poor/severe rating for various characteristics of a culvert and the associated roadway and appurtenant structures. At the highest level, the overall condition of the culvert barrel was deemed most important for the needs of assessing the overall state-wide condition of local agency culverts. The culvert barrel rating is based on an assessment of characteristics associated with different culvert barrel types: corrugated metal pipe, plastic, concrete, masonry, or timber. The overall vicinity may also be rated based on characteristics described for the roadway, channel scour and blockage, and end treatments and appurtenant structures. The *Michigan Non-NBI Culvert Inspection Guide* (TAMC 2021) has a flowchart (Figure 1) that illustrates the breakdown of required and optional ratings.

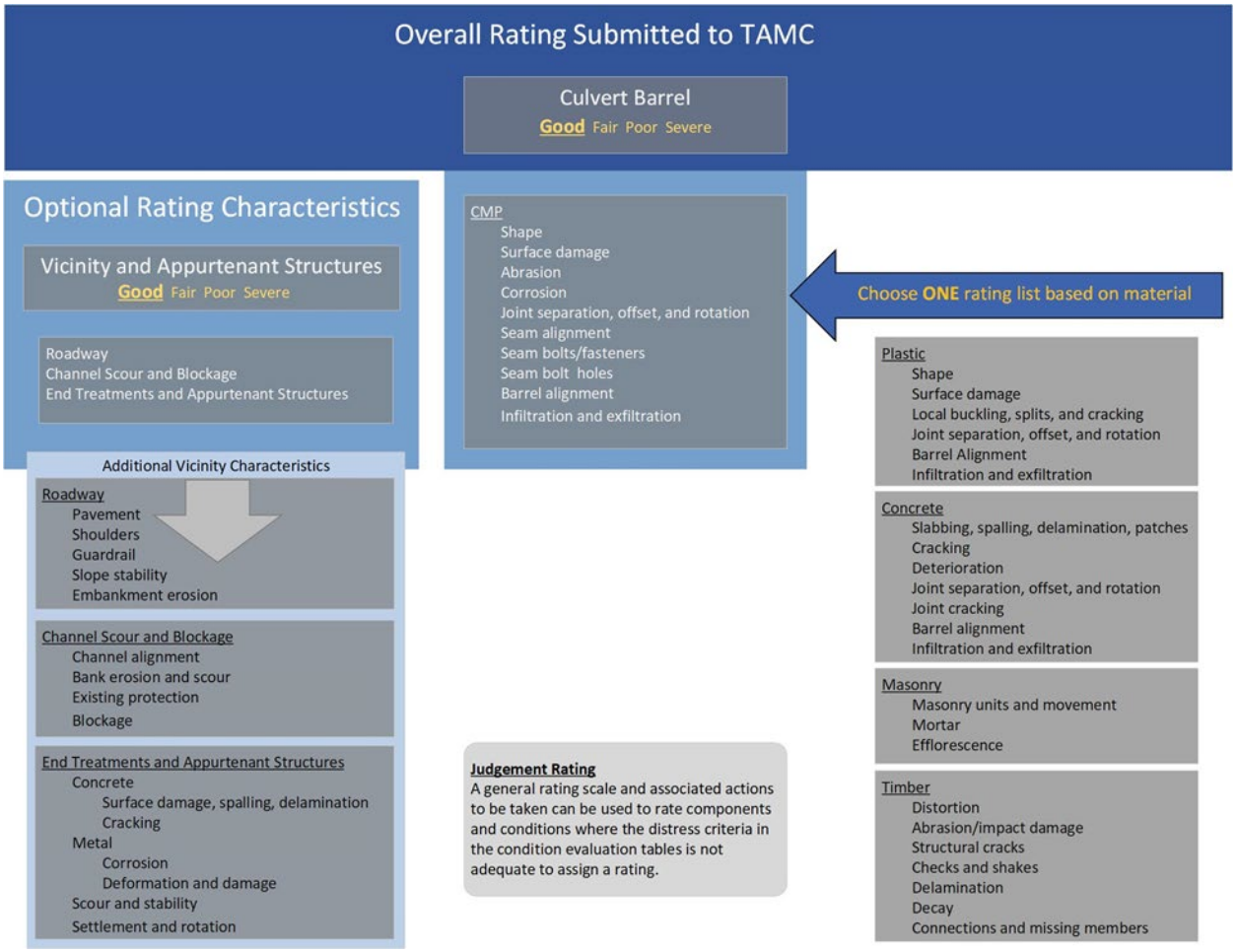

Figure 1: The TAMC's *Michigan Non-NBI Culvert Inspection Guide* has a flow chart detailing required and optional rating elements for culverts

Schedule

Culvert owners are encouraged by the TAMC to adopt a risk-based inspection frequency not to exceed a six-year cycle. The approach taken by an agency should balance its available resources with its asset management resource needs. Table 1 provides risk-based recommendations on inspection intervals considering condition rating, size material, age, and average daily traffic (ADT).

Table 1: Recommended Maximum Inspection Intervals				
Non-NBI Culvert Inspection*	Maximum Inspection Interval (in months)			
	≤12	≤24	≤48	≤72
Condition Rating				
Good				X
Fair			X	
Poor		X**		
Severe	X**			
Size (inches)				
≤24				X
>24 and ≤48				X
>48 and ≤120			X	
>120 (10 feet) and <240 (20 feet)		X		
Material				
No material-specific concerns				X
Material-specific concerns			X	
Age**				
Consider reducing frequency as appropriate				
ADT**				
If limited resources require an agency to exceed the above recommendations for some structures, ADT maybe used to prioritize which culverts pose the least risk to extended frequencies.				
* Culvert structures that meet the National Bridge Inspection Standards (NBIS) definition of a bridge MUST be inspected per the NBIS and the *Michigan Structure Inspection Manual* (MiSIM) ** In the case of poor and severe condition in-depth inspections or structural analysis may be required; use engineering judgment to obtain culvert-specific frequencies				

Policy for Collection of Culvert Inventory and Condition Data

The TAMC adopted a policy on culvert inventory and data collection (TAMC 2022). The policy recommends that those collecting culvert data take part in culvert data collection training, outlines regional and metropolitan planning organizations regional coordinator responsibilities

in facilitation of culvert data collection and reimbursement, and describes the frequency with which data should be collected.

4.0 CULVERT ASSET MANAGEMENT IN MICHIGAN

Local agencies have continued to show an interest in culvert inventory and condition evaluation since the 2018 pilot program. Surveys conducted following the pilot showed that local agencies had a vested interest in continuing to collect culvert data and planned on incorporating this into their routine inspection program. Road-owning agencies have found ways to use their culvert data for planning purposes (Gilbertson et. al. 2020 and Gilbertson et. al 2022).

The TAMC compliance plan template is a tool used by local agencies to create a document for submittal to the TAMC in an effort to meet the requirements of PA325 of 2018. This document combines an agency's asset management plans for pavements, bridges, culverts, and signals. The section on culvert assets must at a minimum contain information on an agency's inventory of assets, goals, and planned projects. This is accomplished with a general description of an agency's overall culvert inventory including findings from condition evaluations. Goals for an agency's culvert inventory may range from maintaining culverts at their current overall condition state to improving that overall state. Planned projects may specifically identify planned culvert repair or replacement projects and/or the agencies general policy toward replacement of culverts, such as repair or replace culverts concurrent with pavement projects and as part of preventive maintenance projects.

5.0 BEST PRACTICES FROM STATE AND LOCAL AGENCIES WITH ESTABLISHED CULVERT ASSET MANAGEMENT PROGRAMS

In August of 2020, AASHTO published the first edition of the *Culvert & Storm Drain System Inspection Guide (AASHTO 2020)*. This replaced the outdated 1986 *FHWA Culvert Guide* and serves as the basis for the inventory and inspection guide (TAMC 2021) developed by the TAMC to serve Michigan Agencies. Section 5 of the guide introduces asset management, provides examples of best practices, and has references for more information.

The AASHTO *Transportation Asset Management (TAM) Guide* (AASHTO 2022) is recommended in the AASHTO Culvert & Storm Drain System Inspection Guide (AASHTO 2020) for developing a culvert asset management plan. AASHTO (2020) recommends that an agency's management approach address five questions:

- What is the current state of physical assets?
- What are the required levels of service and performance delivery?
- Which assets are critical to sustained performance?
- What are the best investment strategies for operations, maintenance, replacement, and improvement?
- What is the best long-term funding strategy?

The literature review that follows, draws on the experience of several state departments of transportation (DOTs) and local agencies (including international examples) that have existing asset management programs that are at the level of having produced and published asset management plans. California, Colorado, Michigan, Minnesota, and Ohio are among the state transportation asset management plans that were reviewed. Los Angeles County Department of Public Works (California) and Shelby County (Alabama) were highlighted as case studies for their asset data collection and management solutions in Federal Highway Administration research reports (FHWA 2007 & FHWA 2014) though no asset management plans for these agencies could be found online. Published asset management plans were found from several international local agencies; Loddon Shire (Australia), Central Elgin (Ontario), and Town of The Blue Mountains (Ontario); these plans demonstrated that many of the asset management practices found in the state asset management plans were relevant to local agencies needs. The following sections will take a look at how these agency's asset management practices and plans address the questions posed in the AASHTO Culvert & Storm Drain System Inspection Guide (AASHTO 2020).

REQUIRED LEVELS OF SERVICE AND PERFORMANCE TARGETS

Levels of service and performance targets are used to define expectations and goals for a culvert asset management plan. These are measurable goals that help guide resource allocation and help an agency monitor its progress in achieving its goals.

Caltrans established a 10-year goal to have drainage structures (including culverts) rate at 70% good, 20% fair, and 10% poor (Caltrans 2022). Colorado DOT similarly has a performance target of 95% of its culverts in good or fair condition (Colorado DOT 2022). Minnesota DOT includes culverts 10 feet and larger with its bridges, which have a performance goal of 60% or more rated as good for the non-NHS (National Highway System) network and 10% or less rated as poor; its goal for highway culverts (less than 10 feet) is 10% or less rated in poor condition (Minnesota DOT 2019). Ohio DOT has a goal for 95% of its conduits (culverts and storm drains) to rate as good or fair (Ohio DOT 2022).

Loddon Shire's performance goals are being developed (Loddon Shire 2022). Central Elgin's goal is to have less than 25% of its bridges/large culverts load or size restricted (Central Elgin 2021). Town of the Blue Mountains developed its asset management plan using current levels of service (proposed levels of service to be implemented in 2024) in the following areas: percentage of bridges/large culverts load or size restricted, average bridge/culvert condition index value (overall bridge rating), percent of structures with a bridge condition index less than 40, number of full structure replacements planned in 10 year period, number of structures with no spending forecasted for 10 years (Blue Mountains 2021).

IDENTIFICATION OF CRITICAL ASSETS

A variety of factors can be used to identify critical culvert assets. Many agencies give priority to culverts rated in poor condition and/or on routes that would have lengthy detours should a culvert fail.

Minnesota DOT culverts are prioritized based on evaluation results with the poorest culverts identified as needing top priority for maintenance while culverts with lesser degrees of distress are fixed as time and resources allow (FHWA, 2007). Ohio DOT looks at culvert condition. When a culvert is flagged as being in poor condition, Ohio DOT does annual tracking until the maintenance or replacement takes place (Najafi et. al 2008). Los Angeles County Department of Public Works has maintenance districts complete an initial prioritization of culverts, putting

higher priority on culverts under roads that have no alternative path if the culvert were to fail (FHWA 2014).

STRATEGIES FOR OPERATIONS, MAINTENANCE, REPLACEMENT, AND IMPROVEMENT

After culvert inventory and condition evaluation is complete, there are several ways agencies determine what course of action should be taken and when. Most agencies use some level of life-cycle planning where deterioration curves, treatment options, and/or cost estimates are used to help define their asset management strategy. Many of the agencies included 10-year plans for scoping and budgeting culvert repair and replacement. Some agencies used unit costs based on past projects for common repair and replacement options, and others determined estimates for specific structures when programming their 10-year repair and maintenance plans.

The California DOT has implemented life cycle planning for its assets, including culverts. Culverts are modeled with deterioration rates, treatments, and unit costs. Keeping track of the life cycle of culverts allows for Caltrans to be aware of typical rehabilitation or replacement costs, and develop a rough schedule for the culvert's entire life cycle (Caltrans 2022).

A life-cycle planning section in the Colorado Transportation Asset Management Plan focuses on optimization of investments and prolonging the life of the assets. CDOT's life-cycle planning consists of cost-benefit analyses in order to determine what culverts/maintenance to prioritize. Life-cycle analysis is completed through Asset Investment Management System (AIMS) software, which uses data, deterioration curves, and treatments to predict the condition of Colorado's asset classes. AIMS brings CDOT assets together into one budgeting software. The software gets loaded each year with relevant inventory and condition data, and outputs a 20-year forecast; it also creates a list of possible repair, rehabilitation, and replacement treatments (Colorado DOT 2022).

Los Angeles County Department of Public Works integrated its culvert maintenance expenditures into its financial management system to help track spending on culvert management. Its goal is to establish costs for specific maintenance actions and correlate that to life-cycle costs to assist itself in future life-cycle decision making plans (FHWA 2014).

Minnesota DOT uses AASHTOWare Bridge Management software to predict deterioration of structures and remaining service life as well as to make recommendations for repair and rehabilitation (FHWA 2007).

Shelby County, Alabama, follows both the worst-first replacement and corridor-improvements-driven replacement prioritization. It also includes replacement or rehabilitation of existing structures in all of its road-widening and corridor-enhancing projects (FHWA 2007).

Ohio DOT culvert data is integrated with its state GIS system database, allowing the agency to view culvert needs in relation to scheduled paving projects so it is better able to leverage resources. Ohio DOT uses its system to create preliminary cost estimates for culvert repair and to determine the benefit of preventive action (FHWA 2014).

LONG-TERM FUNDING STRATEGY

Long-term funding strategies generally evaluated a 10-year period and considered budgeted annual funding over that period, anticipated maintenance/replacement projects required to meet performance goals, and any resulting funding gap. Existing sources of funds were generally identified along with other potential sources of funding. Some agencies noted funding gaps but did not directly address any concerns. Other agencies used funding gaps to discuss alternative strategies to accept an inability to meet performance goals, suggest alternative maintenance/replacement options, or suggest changes in how their culvert asset management programs are funded.

Colorado DOT identified its long-term funding plan but also created a plan for strategic use of additional revenue, identifying that its first priority is to eliminate any funding gaps related to achieving its culvert performance targets. If additional funds are available beyond that initial

need, it would reduce the backlog of culverts rated as poor, starting with the most critical (Colorado DOT 2022).

Minnesota DOT identified its current conditions, target goals, planned investments, and additional investment needed to reach targets for both its large and highway culverts (Minnesota DOT 2019).

Ohio DOT evaluated its bridge and large culvert needs and funding over a 10-year period and did not find a performance gap in achieving the performance goals (Ohio DOT 2022).

Lodden Shire, Australia, identified its funding needs over a 10-year period, its current allocated funding, and the resulting shortfall. It identified what services could be provided with existing funds and what could not be done without an increase in funds. It proposed two funding options: funding of bridge/culvert replacements, which was in excess of its current allocated funding, or funding of an optimized solution including maintenance and repair of individual bridge and large culvert elements that may be achieved within its allocated funding. Funding sources were identified from its local agency source funds, external grant opportunities, and donated assets (Lodden Shire 2022).

Central Elgin, Ontario, developed an estimate for its current required annual funding to meet the goals of its asset management plan. It then created a chart projecting 10 years into the future and showed the required annual funding, its current funding (less than needed), an alternative funding line with a reduced level of service, a proposed plan for an incremental tax increase, and a blended plan for a lesser increase in taxes and taking on debt to achieve its bridge/culvert asset management goals (Central Elgin 2021).

The Town of the Blue Mountains, Ontario, found its operating budget was insufficient for minor repairs and maintenance of its structures. Beginning in 2021, an operating budget was included for bridge/large culvert maintenance. Beginning in 2015, the town created a Bridge and Culvert Asset Replacement Reserve fund that received increasing contributions each year; however, this was found to fall short of what was needed for its 10-year plan. To remedy this shortfall,

the town proposed a significant increase in funding beginning with 1% of its tax levy and increasing by an additional 1% of the levy for 4 years until 4% of its annual tax levy is deposited into its bridge/culvert replacement fund (Blue Mountains 2021).

6.0 TRANSPORTATION ASSET MANAGEMENT PLANS – CULVERT EXAMPLES

The literature review looked at transportation asset management plans, which have been required for each state since April 30, 2018. Information was found from a review of select plans to determine how agencies create or use asset management practices specifically for their culvert assets. California, Colorado, Michigan, Minnesota, and Ohio include culverts in their transportation asset management plans. Some agencies addressed culverts separately while others included large culverts (10 ft or greater) with bridges and smaller culverts separately. Colorado was unique in that its TAMP included an appendix with a standalone culvert asset management plan. Local agency examples were found for several international locations: two in Ontario, Canada, and one in Australia. These particular examples echoed and illustrated that the management practices shown in the state documents are also applicable to smaller local agencies. A summary of the findings for each of these agencies is presented below.

Caltrans

The California Transportation Assets Management Plan considers drainage/culverts as one of its four primary assets. Culverts (structures less than 20 feet) are excluded from its bridge asset management plan. Culvert deterioration rates, treatments, and unit costs are modeled. Unit costs are assessed per culvert with activity/treatment selections of maintenance, invert paving/plating, culvert restoration/liner, jack and bore new pipe, culvert inspection, culvert cleaning. Caltran's strategy is to identify culverts in need of immediate attention in order to restore the expected level of service and identify appropriate treatment options (Caltrans 2022).

Colorado DOT

Colorado DOT includes a culvert asset management plan as an appendix in its 2022 Transportation Asset Management Plan. Culverts are defined as structures less than 20 feet and are managed independently of bridges or pavements. The culvert asset management plan summarizes culvert assets; describes performance management; and includes inventory and condition data, life cycle planning, risk management, financial plan, investment strategies, performance gap analysis, and future improvements to the culvert program (Colorado DOT 2022).

Michigan DOT

The Michigan DOT Transportation Asset Management Plan was updated in July 2022. While the primary focus is on pavements and bridges, the collection of culvert data is mentioned as an asset that must be appropriately designed and maintained to reduce the likelihood of roadway damage or closures during extreme participation events. The collected culvert data is used to inform project scoping (Michigan DOT 2022).

Minnesota DOT

Minnesota DOT includes large culverts (10 feet or larger) alongside bridges. Pavements and bridges (including large culverts) are considered required assets. Highway culverts are included along with stormwater tunnels, overhead signs, light towers, noise walls, traffic signals, and other infrastructure assets as “other assets”.

Total asset counts and valuations are determined by the Minnesota DOT for both bridges and large culverts as well as highway culverts. Valuations are reported as replacement value and current value (adjusted for condition state). Life-cycle analysis of highway culverts is based on two scenarios: minimum maintenance and MnDOT’s current practice of performing three corrective actions –joint repair, pave invert, and replace ends—as needed on highway culverts (Minnesota DOT 2019).

OHIO DOT

Ohio DOT has identified three “most critical” (or “Tier 1") assets in its TAMP. These assets are pavements, bridges, and conduits (culverts and storm sewers). Culverts and storm sewers are not uniquely identified but detailed conduit inventory and condition data is provided in the TAMP.

Life-cycle cost models are used for evaluating conduits. The TAMP includes a section on life-cycle planning, which serves to justify the value of investing in maintenance. Examples show life-cycle cost savings using preservation techniques over a replacement only strategy, overall condition relative to funding, and a summary on return on investment.

The Ohio TAMP contains a detailed summary of typical routine maintenance, preservation, rehabilitation, and reconstruction work associated with conduits along with the average low, medium, and high costs associated with the work (Ohio DOT 2022).

International Local Agency Plans

Several examples of transportation asset management plans that included culverts were found online. These examples show how agencies organize their plans.

Loddon Shire (Australia) includes “major” culverts within its bridge asset management plan. Major culverts are referenced often in the Loddon Shire asset management plan but are not specifically defined (Loddon Shire 2022).

Central Elgin (Ontario) has a bridge asset management plan that includes culverts. Specifically, those over 3 meters in span (approximately 10 feet). Culverts are organized by construction design (concrete box and corrugated steel culverts) For each culvert type, the overall replacement cost, average age, and average condition is reported, and each culvert is located on a map. The asset management strategy is driven by a life-cycle approach and considers costs, risks, and performance for establishing maintenance priorities. Maintenance activities are categorized as follows: planned major and minor rehabilitations (relining barrel, inlet repairs), general maintenance (obstruction removal), and planned maintenance (response to inspection

report). Planned projects are scoped out in a prioritized list along with estimated project costs (Central Elgin 2021).

The Town of The Blue Mountains (Ontario) also groups its large culverts (over 3 meters, or 10 feet) within its bridge asset management plan and specifically identified individual structures of high priority, which were included in its 10-year capital plan (Blue Mountains 2021).

These local agency plans were organized with similar outlines consisting of the following components:

- General description of overall culvert assets (age, size)
- Overall percentages in good/fair/poor/severe condition
- Location map
- Asset management approach/expectations
- Maintenance plan
- 10-year capital plan (replacement/rehab)
- Financial projections and obligations

7.0 SUMMARY

The current state of practice in culvert asset management suggests that Michigan local agencies are at the forefront in actively pursuing asset management practices for culverts. Michigan local agencies have been collecting inventory and condition evaluation data for their culverts and storing the data in Roadsoft or similar GIS programs. The next step is to use this data in conjunction with asset management plans in order to help direct agencies in the management of their culvert assets.

The AASHTO *Transportation Asset Management (TAM) Guide* (AASHTO 2022) is the recommended resource in the AASHTO *Culvert and Storm Drain System Inspection Guide* (AASHTO 2020) for developing a culvert asset management plan. The *TAM Guide* recommends that an agency's management approach address five questions:

- What is the current state of physical assets?
- What are the required levels of service and performance delivery?
- Which assets are critical to sustained performance?

- What are the best investment strategies for operations, maintenance, replacement, and improvement?
- What is the best long-term funding strategy?

Many of Michigan's local agencies can answer the question "What is the current state of physical assets?" if asked about their culverts or they are in the process of being able to answer that question. The remaining questions form the basis of an agency's culvert asset management plan.

The existing "Culvert Assets" section of the TAMC compliance plan template contains basic fields that allow an agency to articulate their plan for culvert asset management by including an inventory of assets, goals, and planned projects. Based on recommendations from the AASHTO *Culvert and Storm Drain System Inspection Guide* (AASHTO 2020) and a review of culvert asset management plans of a sample of state DOT's and local agencies, agencies may wish to include additional content to their culvert asset management plans.

Added content may not apply to all culverts owned by a local agency. Some agencies have chosen to divide their culverts by size, including culverts 10 feet and larger with their asset management plans for bridges and include smaller culverts independently. The decision for separating larger culverts from smaller ones should be made by a local agency based on their funding sources and strategy. Larger culverts may look like a bridge and may have repair and replacement costs similar to those of bridges. Therefore, it may make sense for a local agency to consider larger culverts alongside bridges when establishing project prioritization, funding, and 10-year plans. There is already precedence within MDOT and some local agencies to conduct inspections and record findings for culverts greater than 10 feet alongside the agency's bridges.

The TAMC bridge asset management plan template that has been used by Michigan local agencies for over four years contains the following sections:

- Bridge Assets
    - Inventory
        - Types

        - Locations & Sizes
        - Condition
    - Goals
    - Prioritization, Programmed/Funded Projects, and Planned Projects
        - Prioritization
        - Programmed/Funded Projects
        - Planned Projects
    - Gap Analysis
- Financial Resources
    - Anticipated Revenues
    - Anticipated Expenses
- Risk Management

The sections contained within the TAMC bridge asset management plan template align with the recommendations for culvert asset management within the AASHTO *Culvert & Storm Drain System Inspection Guide* (AASHTO 2020) and could be updated to include larger culverts if an agency so desired.

Based on the findings of this report, the existing "Culvert Assets" section of the TAMC compliance plan could be updated to provide more value to local agencies desiring to develop plans for managing their culvert assets. A proposed outline based on the AASHTO *Culvert & Storm Drain System Inspection Guide* (AASHTO 2020) with samples pulled from agency plans reviewed in this report is as follows:

Introduction

This section should contain a brief overview of the agency and policies and procedures established by the agency for their culvert management program.

Culvert assets

The plan should summarize the agency's general statistics regarding their culvert inventory and condition. This summary may include total number of culverts, number of culverts of various size or materials, number of culverts in each of the good/fair/poor/severe condition states. This summary may be presented in table format or displayed as a dashboard graphic.

Required level of service/performance targets

A culvert asset management plan should include levels of service and performance targets, which define expectations and goals. These goals should be measurable to help

guide resource allocation and help an agency monitor their progress in achieving their goals. A typical example is to define a goal for the overall condition of culverts, such as less than 10% of culverts rated poor or more than 95% of culverts rated good or fair.

Identification of critical assets

A variety of factors can be used to identify critical culvert assets. Many agencies give priority to culverts rated in poor condition and/or on routes that would have lengthy detours should a culvert fail. Most agencies provide a definition that would help establish a priority for maintenance funding and do not identify individual structures.

Strategies for operations, maintenance, replacement and improvement

There are several ways agencies determine what course of action should be taken and when. Most agencies use some level of life cycle planning where deterioration curves, treatment options, and/or cost estimates are used to help define their asset management strategy. Many of the agencies discussed in this report included 10-year plans for scoping and budgeting culvert repair and replacement. Some agencies used unit cost tables based on past projects for common repair and replacement options while other agencies determined estimates for specific structures when programming their 10-year repair and maintenance plans.

Long-term funding strategy

Existing sources of funds should be identified along with other potential sources of funding. Funding gaps may be used to discuss alternative strategies in order to accept an inability to meet performance goals, suggest alternative maintenance/replacement options, or suggest alternatives for how culvert asset management programs are funded. This section may also describe strategic use of unexpected revenue, such as making a first priority to eliminate funding gaps related to achieving culvert performance targets and then to reduce the backlog of culverts rated as poor, starting with the most critical.

8.0 SOURCES

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