
Submitted to:



PERFORMANCE AUDIT OF THE OHIO DEPARTMENT OF TRANSPORTATION

RFP Reference Number: AOS 2019-002

Bridge Final Report

February 23, 2021

Submitted by:

The Kercher Group, Inc.

and supported by



TABLE OF CONTENTS

GLOSSARY	2
BRIDGES	4
EXECUTIVE SUMMARY	4
INTRODUCTION	6
APPROACH	6
REPORT ORGANIZATION.....	7
ORGANIZATIONAL APPROACH	9
ODOT BRIDGE INVENTORY, INSPECTION PROCEDURES, AND PERFORMANCE MEASURES.....	13
A. 10-YEAR TRENDLINES - EXPENDITURES VERSUS CONDITIONS.....	14
B. BRIDGE MANAGEMENT SYSTEMS	23
C. BRIDGE MANAGEMENT PRACTICE (RESOURCE, TRAINING AND OVERSIGHT PRACTICES)	34
D. MAJOR BRIDGE PROGRAMMING	37
E. MATCHING FINANCIAL SOURCES TO NEEDS	42
APPENDIX A - ODOT DISTRICT BRIDGE PERFORMANCE MEASURE TEN-YEAR TRENDS	58
District 1	58
District 2	59
District 3	60
District 4	61
District 5	62
District 6	63
District 7	64
District 8	65
District 9	66
District 10	67
District 11	68
District 12	69

GLOSSARY

AASHTOAmerican Association of State Highway Transportation Officials

AOSAuditor of State

BMS..... Bridge Management System

CPACapital Programs Administrator

CAGR..... Compound Annual Growth Rate

CS Element Condition State

CSF Critical Success Factors

DO.....Division of Operations

DOT.....Department of Transportation

DQMP Data Quality Management Plan

ELLIS ODOT designed web-based project management application

FC.....Floor Condition

FHWA.....Federal Highway Administration

FYFiscal Year

GAGeneral Appraisal

GARVEE..... Grant Anticipation Revenue Vehicle

GCR General Condition Rating

GIS.....Geographic Information Mapping

HCAPHighway Capital Improvement

HPMS Highway Performance Monitoring System

LTPP Long-Term Pavement Performance

MBIManual for Bridge Inspection

MFT..... Motor Fuel Tax

NBISNational Bridge Inspection Standards

NBI National Bridge Inventory

NCHRP..... National Cooperative Highway Research Project

NHSNational Highway System

ODOT Ohio Department of Transportation

OPEOffice of Pavement Engineering

OSE.....Office of Structural Engineering

PCR..... Pavement Condition Rating

PCS..... Protective Coating System

PM Program Management

PMS..... Pavement Management System
STIP State Transportation Improvement Program
TAM Transportation Asset Management
TAMP Transportation Asset Management Plan
TP..... Transportation Policy Division
TPM..... Transition Probability Matrices
VMT Vehicle Miles Traveled
WGA..... Weighted General Appraisal

BRIDGES

Executive Summary

The Kercher/PFM consulting team (Kercher) is pleased to provide this performance audit report on the Ohio Department of Transportation's (ODOT) bridge program. This report is a component of a comprehensive performance audit of ODOT being performed in compliance with HB 62 of the 133rd General Assembly of Ohio.

The report covers Kercher's review of the ODOT bridge program to determine the extent to which the agency applies nationally recognized asset management practices in its development and delivery. Kercher also examined the extent to which ODOT's asset management plans and policies are put into effect and influence decisions made by ODOT management and the 12 districts in the following areas:

- Programming of projects
- Selection of treatment options
- Allocation of funds
- Conducting maintenance activities
- Measurement of performance

Major Findings

Kercher's analysis of the ODOT Bridge program found the following:

- ODOT's bridge conditions are better than most of its peer states despite having one of the largest bridge inventories by number of bridges and total deck area of bridges compared to peer states.
- ODOT has good bridge performance measures that track bridge replacement and rehabilitation needs, deck rehabilitation or replacement needs, deck wearing surface needs, and protective steel coating needs. These performance measures will be well suited to an advanced bridge management system. These performance measures are known by each of the Ohio Districts and are incorporated into their annual work planning process.
- ODOT has bridge preventive maintenance and repair guidelines with annual objectives for bridge cleaning, sweeping, and sealing which helps them preserve "good" and "fair" bridges and reduces the need for more costly bridge replacement projects.
- ODOT is spending less on bridges than most of its peer states but has higher bridge conditions. Ohio apparently is benefiting from decades of good management of bridges by ODOT. These good practices need to be preserved.

However,

- To comply with Federal regulations, ODOT needs to develop an advanced computerized bridge management system that will require dedicated resources and commitment.
- Once the management system is in place, ODOT will be able to better determine the benefit/cost of various treatment options to optimize their bridge program and promote good bridge life cycle planning.

Major Recommendations

- ***Implement and support a successful Bridge Management System installation that meets the FHWA minimum documented standards (23 CFR 515.17)***

- *Enhance ODOT's annual work plan by documenting the annual work plan results to include reporting to ODOT leadership performance objective trends, challenges, and recommendations for each district and statewide*
- *Provide a project certification process to indicate central office agreement with district project selections*
- *Monitor performance trends of major bridges using ODOTs bridge performance measures and use bridge asset management techniques to forecast future needs for major bridges and dedicate funding in those years*

Introduction

The Kercher/PFM consulting team (Kercher) is pleased to provide this performance audit report on the Ohio Department of Transportation's (ODOT) bridge program. This document is one of three (3) such reports (the others covering the pavement and maintenance management functions of ODOT) produced by the consulting team under contract to the Ohio Auditor of State (AOS). These reports are components of a comprehensive performance audit of ODOT being performed in compliance with HB 62 of the 133rd General Assembly of Ohio.

The report covers Kercher's review of the ODOT bridge program to determine the extent to which the agency applies nationally recognized asset management practices in its development and delivery. Kercher also examined the extent to which ODOT's asset management plans and policies are put into effect and influence decisions made by ODOT management and the 12 districts in the following areas:

- Programming of projects
- Selection of treatment options
- Allocation of funds
- Conducting maintenance activities
- Measurement of performance

Approach

The Kercher team used the following, common approach in performing the respective performance audit reports:

- Performed a baseline analysis of ODOT
- Identified and interviewed a sample of peer states
- Reviewed topic reference resources for best practice guidance/information
- Benchmarked ODOT against peer state practices and best practice guidance
- Identified potential practice improvement opportunities considered applicable to ODOT
- Provided results of the benchmarking exercise
- Recommended practice changes (if any) and identified potential benefits

Kercher produced this report in three (3) stages and a final report as described below:

1. ODOT Baseline Task
2. Peer State / Best Practice Task
3. Draft Final Report
4. Final Report

ODOT provided comments to each draft. Kercher addressed these comments as appropriate when creating additional report content; as such, each draft included additional refinements of previously submitted information.

Report Organization

This report is organized around the review areas identified in the request for proposal (RFP) for this project. This design was intended to simplify efforts to find specific areas of interest.

Within each topic area, the report generally is organized around the following headings:

1. Topic Introduction
2. Baseline Task
3. Peer State / Best Practice Review
4. Recommendations and Benefits

This following text provides a general introduction to each of the heading areas. Specific information related to each of these headings is found in each review area.

Topic Introduction

In each review area, Kercher describes the significance of the subject to the overall performance of the DOT bridge program. This discussion is intended to provide context for comparing the ODOT approach in each practice area to peers and best practice.

Baseline Task

Kercher carried out the baseline phase of the audit by conducting interviews with the ODOT Transportation Policy Division¹ (TP) and district staff who are involved with the bridge program. Research efforts included the following:

- Reviewed ODOT manuals and guides
- Studied ODOT bridge program performance measures and objectives
- Examined ODOT ten-year bridge condition trends in accordance to ODOT performance metrics and correlated annual expenditures to ODOT's bridge condition
- Reviewed ODOT's Bridge Management System (BMS) in accordance with the Code of Federal Regulations (23 CFR 515.17) related to the minimum documented procedures for a BMS
- Reviewed ODOT's Transportation Asset Management Plan (TAMP) regarding bridge asset management²
- Examined the ODOT bridge management oversight functions to determine if ODOT districts consistently apply bridge management treatments, preservation activities, maintenance actions
- Reviewed ODOT's resources, training, and oversight of the districts to ensure that industry practices to manage bridges for the lowest practical life cycle cost are in place and functioning

¹ "TP" primarily refers to the noted ODOT offices in [Figure 1](#) but can include other units in the Transportation Policy Division.

² Ohio's Federally-Compliant Transportation Asset Management Plan, June 2018.

http://www.dot.state.oh.us/AssetManagement/Documents/ODOT_TAMP.pdf

- Studied ODOT’s programming practices for its cohort of “major bridges,” (excluding the Brent Spence Bridge)
- Reviewed how ODOT matches its financial sources such as state and federal funds or bonds to bridge needs

Peer State / Best Practice Review

The Kercher team identified a subset of states for the bridge review task, based on proximity to Ohio, environmental similarities, and related considerations (size of system, etc.) From this initial candidate list, the following six (6) states were selected:

1. Illinois
2. Indiana
3. Kentucky
4. Michigan
5. Minnesota
6. Wisconsin

Table 1 identifies the number of bridges and deck area of the DOT-owned bridges in each state:

Table 1: Ohio and Peer State Owned NBI Length Bridges (Number and Deck Area in Square Feet)³

	Bridges Owned By State DOTs						
	Illinois	Indiana	Kentucky	Michigan	Minnesota	Ohio	Wisconsin
Total Number of Bridges	7,849	5,735	9,074	4,488	3,674	10,475	5,247
Total Deck Area	85,880,690	52,478,532	62,615,662	49,720,357	49,289,958	109,324,053	53,000,014

Kercher conducted this outreach via a series of phone and virtual interviews conducted over a period of several weeks. Each interview averaged between 1-2 hours, following a prepared interview guide that was provided to each DOT in advance of the call.

The ODOT Director assisted in encouraging these states to participate in this effort by writing a letter to his counterpart at each DOT. This assistance significantly helped in gathering this information.

In addition to the time spent directly participating in the interview, most state participants required some level of preparation time. In many cases, additional phone calls and/or emails were used to provide supplemental information. Not every DOT was able to answer all questions but even an inability to provide an answer was meaningful within the context of this benchmarking effort.

Participating DOTs were offered a copy of the peer states information gathered through this effort. This information is summarized in [Appendix A - ODOT District bridge Performance Measure Ten-Year Trends].

Analysis

In this section, Kercher compared and contrasted ODOT practices with those of the peer states as well as any relevant guidance information from AASHTO, FHWA, NCHRP or resources related to these areas. The consulting team used its professional judgement in identifying applicable best practice in these review areas. This provides the basis for the identified “Recommendations and Benefits”.

³ FHWA National Bridge Inventory website: <https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm>

Recommendations and Benefits and Anticipate benefits

Kercher provided all topic area recommendations in these sections. In cases where ODOT already is employing best practice, the team's recommendation indicates that ODOT should continue accordingly. In cases where Kercher perceived that ODOT could benefit from change, the appropriate recommendation is identified along with the anticipated benefit of this change.

Organizational Approach

Topic Introduction

Organizational theory suggests that organizations centralize for efficiency and control and decentralize for flexibility and responsiveness. The tradeoffs between these approaches must consider the extent to which the functions in question are highly specialized in nature and need some degree of pooling of resources to avoid creating hard-to-maintain islands of expertise within an organization.

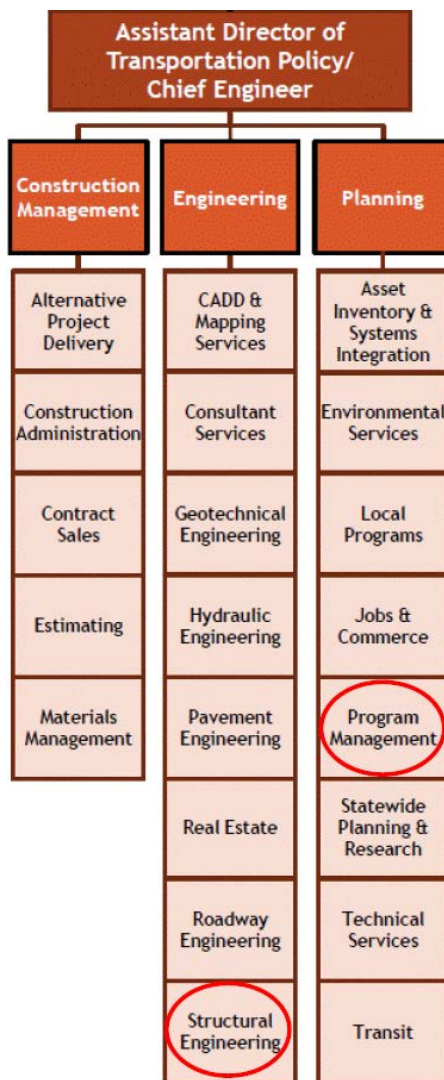
As inferred, all organization approaches have strengths and weaknesses and each state DOT varies somewhat in its organization approach to performing its mission. These variances reflect a variety of factors and influences including state history, approach to government, state size and population distribution, etc.

ODOT's organizational structure for performing bridge asset management includes positions under ODOT's Chief Engineer and in each of the 12 districts as described below.

Central Office

As shown in [Figure 1](#), TP units with aspects of bridge responsibility include the Office of Structural Engineering (located in the Division of Engineering) and the Office of Program Management (located in the Division of Planning).

Figure 1: ODOT Central Office Organization Structure⁴



Office of Structural Engineering (OSE)

The OSE is responsible for bridge inspection, bridge maintenance, bridge management, bridge design resources, and bridge standards. OSE’s mission statement states that this office exists to provide ODOT districts with standards, policy, procedures, training, design resources, data, and research to allow them to continually monitor and improve the quality of ODOT’s bridge inventory.⁵ With regards to bridge asset management, OSE does the following:

- Develops policy and procedure
- Provides quality assurance for the bridge inspection program

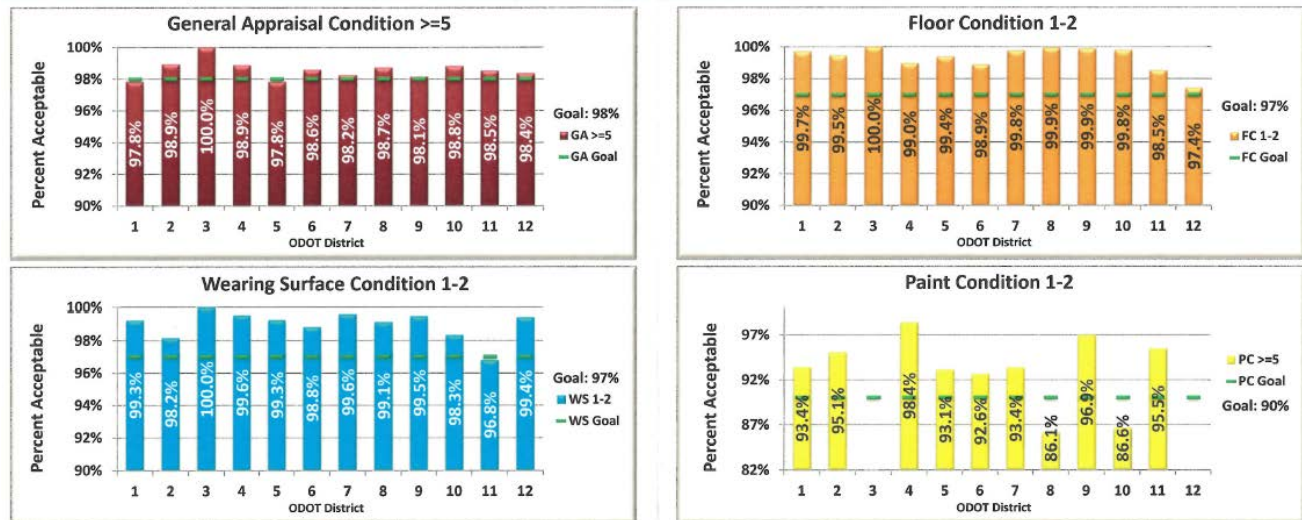
⁴ ODOT Organization Chart. <http://www.dot.state.oh.us/policy/Pages/ODOTTableofOrganization.aspx>

⁵ ODOT Office of Structural Engineering Webpage, <http://www.dot.state.oh.us/Divisions/Engineering/Structures/Pages/default.aspx>

- Provides annual targets for bridge maintenance cleaning, sweeping, and deck sealing activities
- Participates in annual work plan presentation meetings and comments on district work plans
- Reviews district project selections and contacts districts to resolve issues if work type selections are questionable
- Runs monthly queries of the bridge database showing performance with respect to ODOT's bridge performance measures

Figure 2 includes a sample of performance measure charts from a typical Monthly bridge report.⁶

Figure 2: ODOT Monthly Bridge Report Performance Measure Monitoring



Program Management (PM)

PM has the following responsibilities related to bridge asset management:

- Identifying and selecting new projects to fund
- Ensuring each program is fiscally restrained
- Monitoring the scope, schedule and budget of the projects funded
- Providing bridge program funding allocations to the districts as part of the annual work plan development process
- Providing a presentation template for the annual work plan that provides updates on performance goal objectives
- Approving encumbrances and change orders
- Coordinating and overseeing district bridge work plans, monitoring agency performance measures, and preparing ODOT's TAMP

⁶ Monthly Bridge Report Provided by ODOT. File - monthly bridge report.pdf

- Reviewing the multi-year work plan and project selections benchmarking results submitted annually by the ODOT districts. These work plans detail the district's strategies for maintaining and improving the state's bridges over the upcoming planning horizon.⁷
 - Providing a major bridge program manager, who is responsible for budgeting, managing, and coordinating major bridge projects⁸

Districts

ODOT's 12 districts generally organize the bridge asset management function around some variation of the following structure:

- Each district has a Capital Programs Administrator (CPA), who is responsible for overall management of the district capital program that includes the bridge program
- Each district has a Bridge Engineer who reports to the CPA. The Bridge Engineer is responsible for the following activities:
 - Managing bridge inspections, including performing quality control
 - Reviewing bridge maintenance needs and implementing annual program
 - Selecting capital projects as part of the annual work plan
- Most districts have several qualified team leaders, bridge inspectors and team members

Depending upon the size of the district and number or complexity of bridges managed, there may be additional support staff responsible for activities such as scoping, programing, and hydraulics (including culvert inspection and management).

Peer States / Best Practice Findings

Like ODOT, peer states use an organizational structure that shares the responsibility for bridge management between the central office and regions/districts. Typically, the central office is responsible for developing the annual bridge program and work plan, allocation of funds (for those agencies that have dedicated bridge funds), maintaining and enhancing the BMS, and oversight or certification of bridge project selections. The regions/districts usually handle bridge inspection, maintenance, and selection of bridge projects for the annual work plan.

Highlights of relevant peer state practices include the following:

Indiana

IDOT's Bridge Management Division (which is part of the Office of Asset Management) has a four (4) member bridge management team. This group is responsible for the development and implementation of process and applications capable of analyzing bridge data to provide the following recommendations:

- Identifying cost-effective bridge projects for improving the bridge network

⁷ Planning Division, Major Programs web page.

<http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/MajorPrograms/Pages/DistrictPavementBridgeWorkPlans.aspx>

⁸ Office of Program Management Contact List.

<http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/Documents/Contacts.pdf>

- Reporting on bridge network condition
- Recommending alternatives and policies to enhance bridge condition at project as well as network levels.

One (1) staff member of this team is dedicated to running Indiana’s Bridge Management System (BMS).

Minnesota

MnDOT has a comprehensive bridge management section. This group currently is being enhanced through the creation of a new Bridge Asset Management Engineer position. This new position is responsible for “champion[ing] asset management principles for the Bridge Office.” Other responsibilities include bridge inventory management, bridge preservation, creating a bridge management plan and performing bridge modeling.

Michigan

MDOT Office of Structure Preservation and Management (OSPM) includes a four (4) person Bridge Management Systems (BMS) unit. The BMS unit is responsible for the BMS software, bridge scoping, and data management. Members of the BMS unit include a bridge program manager and a “Big Bridge” manager.

The Bureau of Planning, Statewide Planning Division administers the annual Call for Projects and provides bridge funding “templates” to the field operations.

Wisconsin

Wisconsin DOT has dedicated positions for the review and certification of bridge project selections in accordance to the Department’s preservation rules.

Analysis

Table 2 shows a comparison of ODOT’s organizational structure compared to the peer states.

Table 2: Organizational Structure Comparison

	Ohio	Illinois	Indiana	Kentucky	Michigan	Wisconsin
Decentralized	Yes	Yes	Yes	Yes	Yes	Yes
Central Office Bridge Management Section	Yes	Yes	Yes	Yes	Yes	Yes

Recommendations and Benefits

No recommendation

ODOT Bridge Inventory, Inspection Procedures, and Performance Measures

Appendix A of this report was being prepared at this time this report was submitted. This appendix contains the results of the consulting team’s benchmarking analysis of ODOT’s bridge inspection program compared to peer and best practice. It includes a detailed analysis of the benefits and risks associated with the associated recommendations in this topic.

A. 10-year Trendlines - Expenditures versus Conditions

ODOT Baseline

Performance Measures and Objectives

ODOT's primary bridge "Critical Success Factor" is its General Appraisal (GA) score. The GA is defined as the lower of the FHWA NBI GCR of the superstructure and substructure major components for bridge type structures. If the structure is a culvert-type structure, then the GA is the culvert GCR.

ODOT's overall bridge performance objectives are as follows:

- Achieve and maintain an average GA of 6.8, weighted by deck area statewide
- Achieve and maintain 98 percent of bridge deck area of non-major bridges rated in fair or better condition in each district

For a bridge superstructure or substructure to be considered fair or better condition, the NBI GCR must be rated 5 or above. A superstructure or substructure in poor or worse condition typically represents a bridge needing major rehabilitation or replacement.

ODOT also has the following three (3) internal performance measures for bridges:

1. Floor Condition

The floor is the primary load carrying member of the deck.⁹ It often is observed from the bottom surface (also called soffit). This measure uses the historical ODOT 1-4 rating system.

The performance target is to achieve and maintain 97% of bridge floor condition rated 1 (good) or 2 (fair) weighted by deck area. This includes bridges where the GA is in good or fair condition and the deck floor condition is in good or fair condition divided by the total deck area.

2. Wearing surface

This is the top surface of a bridge deck. The wearing surface incorporates any part of the deck above the first layer of reinforcing steel¹⁰, any type of overlay placed over the structural concrete deck such as rigid overlays (latex-modified concrete, silica-fume modified concrete) or flexible overlays (epoxy overlay, hot mix asphalt overlay, etc.).

This measure uses the historical ODOT 1-4 rating system. The performance target is to achieve and maintain 97% of bridge deck wearing surface rated 1 (good) or 2 (fair) weighted by deck area. This includes bridges where the GA is in good or fair condition, the deck floor condition is in good or fair condition, and the deck wearing surface is in good or fair condition divided by the total deck area.

3. Protective Coating System (PCS)

The PCS is the primary means by which the superstructure (beams) are protected from the elements.¹¹ This can be paint or weathering steel patina protecting steel components and concrete sealers protecting concrete components.

This measure uses the historical ODOT 1-4 rating system. The performance target is to achieve and maintain 90% of bridge PCS rated 1 (good) or 2 (fair) weighted by deck area. This

⁹ Ohio Department of Transportation, Manual of Bridge Inspection, November 2006, Page 98.

¹⁰ Ohio Department of Transportation, Manual of Bridge Inspection, November 2006, Page 21.

¹¹ Ohio Department of Transportation, Manual of Bridge Inspection, November 2006, Page 107.

includes bridges where the GA is in good or fair condition, and the Protective Coating System is in good or fair condition divided by the total deck area.

ODOT Ten Year Budget

ODOT provided their bridge program budget for the past ten years, 2010 – 2019 as shown in Table 3. ODOT also has a Major Bridge Program budget which is discussed in a later section.

Table 3: Bridge Program and Major Bridge Program Budgets

Year	Bridge Program Budget
2010	\$204,890,000
2011	\$213,086,000
2012	\$223,740,000
2013	\$234,927,000
2014	\$219,907,000
2015	\$215,873,000
2016	\$263,291,000
2017	\$275,494,000
2018	\$275,494,000
2019	\$228,500,000

Analysis

ODOT’s Bridge Program provided NBI bridge major component GCR (summary ratings) for the superstructure, substructure, and culvert for the past ten years, along with the ODOT 1-4 Ratings for the deck wearing surface, deck floor condition, and PCS.

The following descriptions apply to the figures indicated below:

- Figure 3 through Figure 7 show the ten-year trend comparing ODOT performance measures and annual non-major bridge program budget for all the ODOT bridge performance measures listed in the TAMP¹².
- Figure 3 and Figure 4 show that over this time ODOT has achieved and is maintaining their General Appraisal (GA) statewide goals of an average GA weighted by deck area of 6.8, and 98 percent of bridge deck area rated fair or better.
- Figure 5 shows ODOT is maintaining their internal performance measure goal for wearing surface goal of 97 percent of bridge deck area rated fair or better.
- Figure 6 shows in 2017 ODOT met the deck floor condition goal of 97 percent deck area rated fair or better.

¹² Ohio Department of Transportation, Transportation Asset Management Plan (TAMP), June 2019, Page 8

- Figure 7 shows in 2019 ODOT fell below their goal of 90 percent weighted by deck area for their performance measure for PCS.

Figure 3: Ten-Year Trend - ODOT Bridge Average Weighted General Appraisal with Bridge Budgets

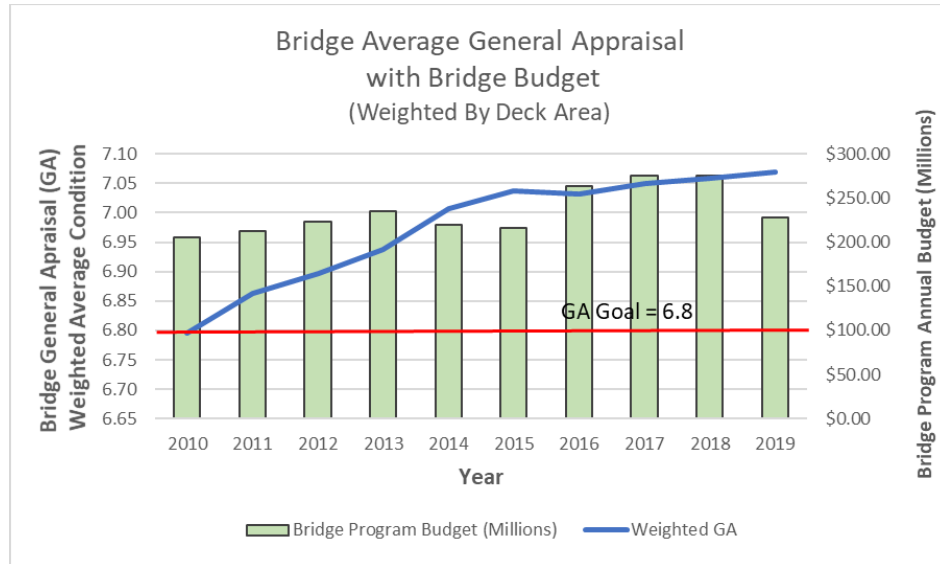


Figure 4: Ten-Year Trend - ODOT Bridge General Appraisal Weighted Percent Acceptable Condition with Bridge Budget

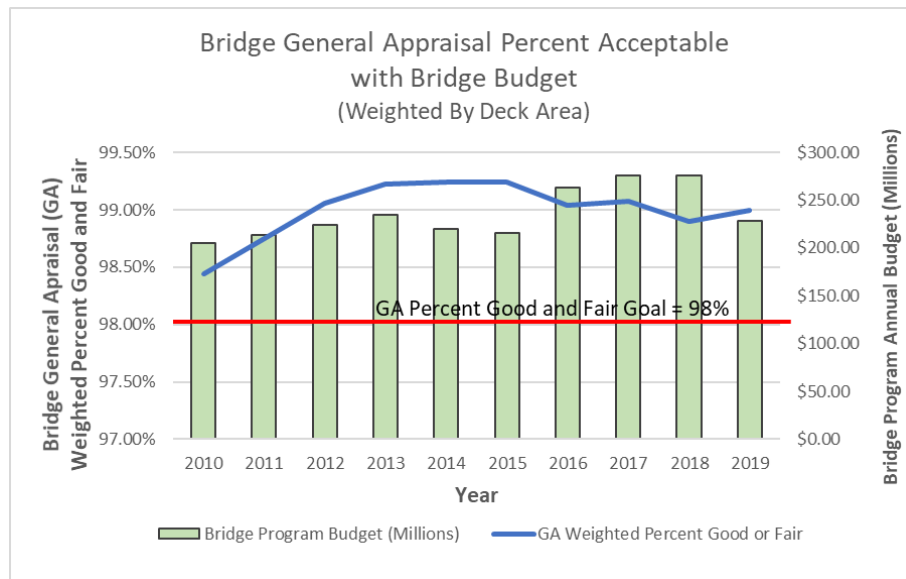


Figure 5: Ten-Year Trend - ODOT Bridge Deck Wearing Surface Weighted Acceptable Condition with Bridge Budget

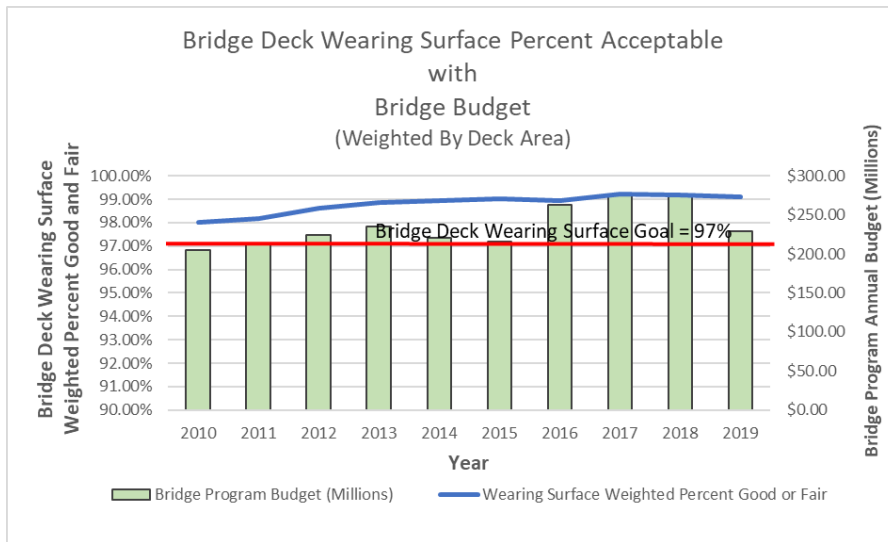


Figure 6: Ten-Year Trend - ODOT Bridge Deck Floor Weighted Acceptable Condition with Bridge Budget

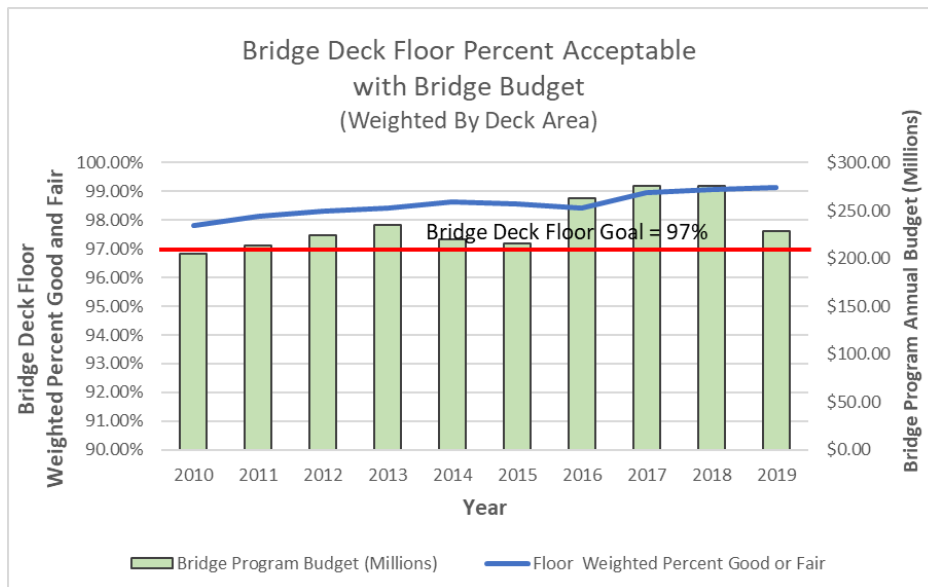
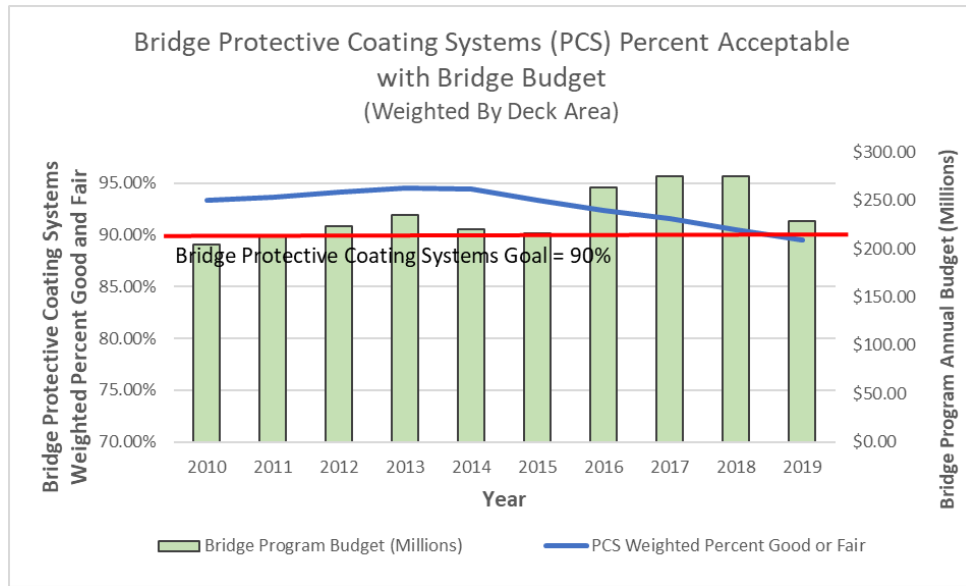


Figure 7: Ten-Year Trend - ODOT Bridge Protective Coating Systems (PCS) Weighted Acceptable Condition with Bridge Budget

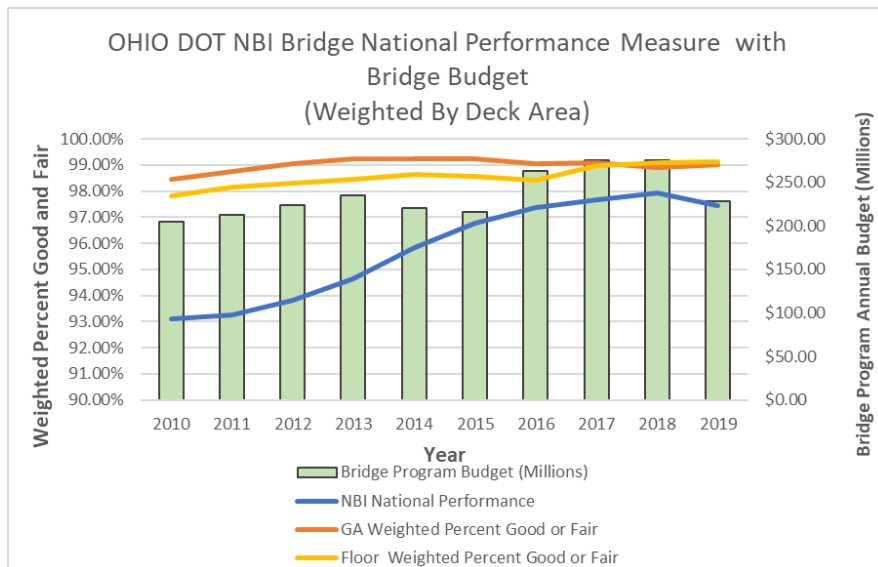


Comparison of ODOT Performance Measures to the FHWA National Performance Measure

Figure 8 shows the FHWA National Performance Measure ten-year trend for ODOT’s bridges compared to ODOT’s annual bridge program budget and their GA and Floor condition performance measures. The FHWA National performance measure is weighted by deck area and it takes the minimum GCR of the bridge deck, superstructure, substructure, or culvert.

The ODOT GA is weighted by deck area of the minimum GCR of the superstructure, substructure, or culvert, and the ODOT Floor Condition is measured separately using the ODOT 1-4 rating system which has a direct correlation to the NBI GCR rating system. Another difference between the measures is the FHWA National Performance Measure shown in the chart includes all ODOT owned bridges including their “major” bridges. When comparing ODOT performance to the peer states, all ODOT-owned bridges are included since the peer states do not define a major bridge program in the same way as ODOT.

Figure 8: OHIO DOT NBI National Performance Measure with Bridge Budget



Variance by District

ODOT monitors bridge performance measure trends for each of the 12 districts shown in [Figure 9](#): . Bridge performance measure charts are shown for each district in Appendix A.

Observations from the district bridge performance measures ten-year trend:

- Districts 1, 2, 4, 5, 6, 7 are currently meeting all of the performance measures.
- Districts 3, 8, 9, 10, and 12 are not currently meeting the Protective Coating Systems (PCS) performance measure of 90% good or fair.
- District 11 currently is not meeting the performance measure for deck wearing surface of 97% good or fair, and they are trending down (worse).
- District 12 does not, and for the past 10 years has not, met ODOT's General Appraisal goal of having an average condition better than 6.8 percent; however, District 12 does meet the General Appraisal condition goal of 98% good or fair. This shows that many District 12 bridges have superstructure and/or substructure ratings of GCR 5 which is the low end of fair. These are structures that are at risk of becoming poor in the near future.

Figure 9: ODOT Districts¹³

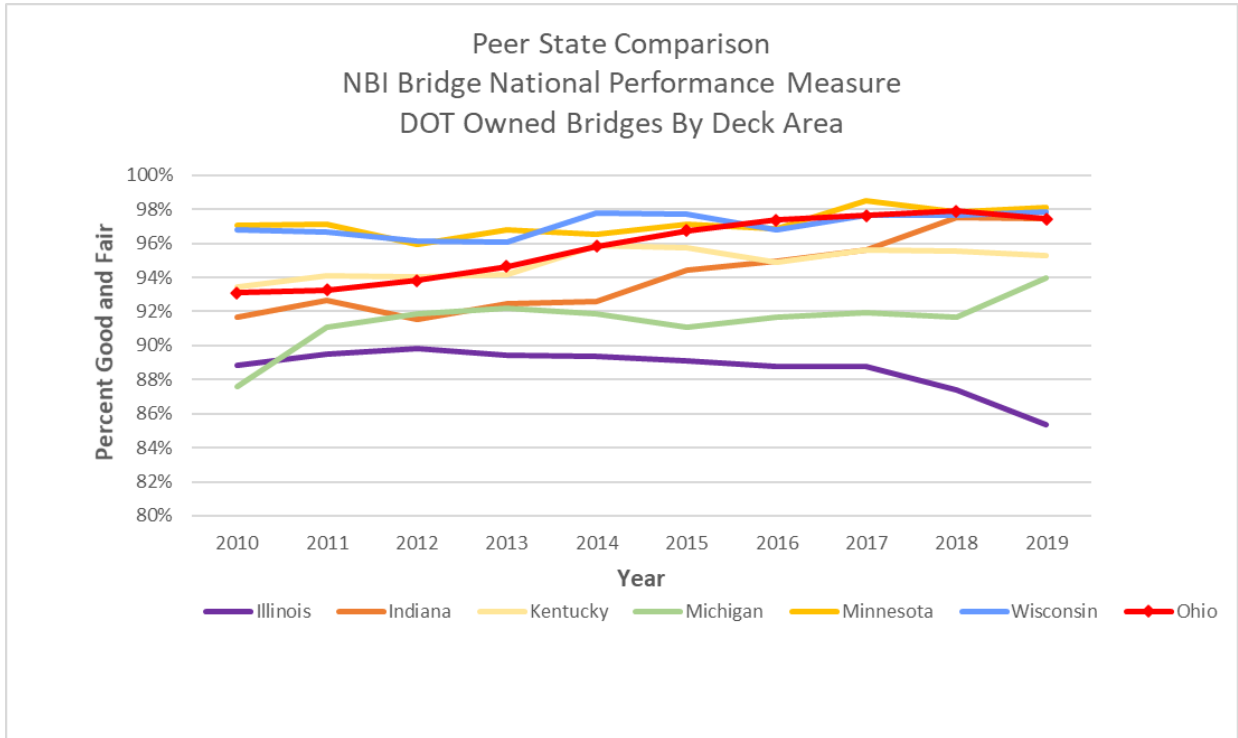


Peer States / Best Practice Findings

The Ohio bridge condition ten-year trend was compared to the peer states as shown in Figure 10: . This chart is based on the NBI General Condition Ratings (GCRs) and the national performance measures. As this chart indicates, Ohio is near the top of these ratings and mostly has been trending upwards.

¹³ Ohio Department of Transportation, Manual of Bridge Inspection, ORC 5501.47 Published 1973 Revised 2014 (v.8). Page 9

Figure 10: Peer State NBI Bridge National Performance Measure comparison



Analysis

Each state has different methods for providing funding for their bridge program and each has different accounting procedures. Some agencies have specified bridge program funding in categories of work such as preservation, rehabilitation, and replacement while others include a portion, or all their bridge program funds in the overall highway program. Funding for the bridge program often fluctuates depending on major bridge needs and special programs to reduce poor bridges. Some peer states have had special, limited duration program funding to reduce the volume of poor bridges. The following are two examples:

- In 2009 Minnesota DOT started the Chapter 152 program¹⁴, where it replaced, retrofitted, or rehabilitated 140 bridges, at a cost of approximately \$1 Billion on top of their normal bridge program. The program was in effect from 2009 - 2018. Including the Chapter 152 program, Minnesota DOT’s bridge program peaked at approximately \$240 million per year from 2014-2017, but currently their bridge program is \$119 million annually¹⁵.

¹⁴ Minnesota Department of Transportation - 2019 Final Report on the Trunk Highway Bridge Improvement Program: Chapter 152, January 2019. <https://www.dot.state.mn.us/govrel/reports/2019/2019%20Chapter%20152%20Bridge%20Improvement%20Program%20report-final.pdf>

¹⁵ Minnesota Department of Transportation - Transportation Asset Management Plan, June 2019. <http://www.dot.state.mn.us/assetmanagement/pdf/tamp/tamp.pdf>

- “Bridging Kentucky¹⁶” is an initiative by the Kentucky Transportation Cabinet (KYTC) to improve safety and soundness of Kentucky highway bridges, with a focus on protecting current structures. The objective of the \$700 Million program was to rehabilitate, repair, or replace more than 1,000 critical structures in six (6) years (2019 – 2024).

Of the peer states, only Michigan and Illinois DOTs were able to provide comparable bridge program funding over the past ten years (8 years for Illinois) for benchmarking purposes with ODOT. Table 4 shows a comparison using a common measure of annual spending divided by deck area. This includes all DOT-owned bridges including major bridges. However, the identified deck area only includes NBI qualifying structures. Of note, ODOT and the Michigan DOT include structures 10 to 20 feet in their bridge program. On a per-square-foot of deck area basis, ODOT’s annual spending was less than the identified available peer states that were able to provide comparable data.

Table 4: DOT Owned Bridges Average Annual Spending Per Deck Area

DOT Owned Bridges Average Funding Past Ten Years			
	Illinois	Michigan	Ohio
Total Deck Area (Sq. Ft.)	85,880,690	49,720,357	109,324,053
Average Bridge Program Budget (Millions)	\$ 439.00	\$ 201.51	\$ 335.59
Annual Spending by Deck Area (Per Sq. Ft.)	\$ 5.11	\$ 4.05	\$ 3.07

Peer state TAMP’s were reviewed to make a general comparison of agency expected bridge future funding (next ten years) using a common measure. Results are shown in Table 5. Of note, NHS is only a portion of the state’s bridge program and the TAMP may be showing NHS funding for all NHS bridges including locally owned structures.

Table 5: Annual NHS Bridge Program Spending Per Deck Area

NHS Deck Area and Budget Reported in TAMP						
	Illinois	Indiana	Kentucky	Michigan	Minnesota	Ohio
NHS Deck Area	64,687,958	29,985,465	28,528,005	36,980,431	31,444,986	87,682,012
NHS only 10-Year Avg. Budget (Millions)	\$ 524.51	\$ 219.38	\$ 176.30	\$ 117.40	\$ 69.50	\$ 202.90
Annual Spending by Deck Area (\$ Per Sq. Ft.)	\$ 8.11	\$ 7.32	\$ 6.18	\$ 3.17	\$ 2.21	\$ 2.31

Comments:

- As indicated, Ohio has comparable or better bridge conditions than peer states as measured by the uniform national bridge performance measures. These relatively good conditions exist despite ODOT having substantially more truck traffic than the peer states.
- Ohio also ranks towards the lowest of its peers in terms of annual spending by NHS deck area.
- Comparing future expected bridge funding in some peer states to the bridge conditions in some ODOT districts (e.g., District 12) suggests that ODOT soon may need more bridge funds to maintain the current state of good repair.

¹⁶ Bridging Kentucky Program Website: <https://bridgingkentucky.com/>

Commendable/leading practice:

- ODOT's bridge performance indicators program of using General Appraisal (GA), floor condition, wearing surface, and protective Steel Coating performance measures should function well with an advanced Bridge Management System (BMS). These measures provide a logical basis for supporting the decision tree logic used in BMS systems. ODOT should continue with these performance measures.
- ODOT's actual bridge conditions and trends are a notable achievement as they have comparable or better condition than the peer states while having an annual bridge program budget lower per square feet of bridge deck than most peer states.

Recommendations and Benefits

1. ***ODOT should focus more effort on Bridge Protective Coating Systems (PCS) as several districts do not meet this measure and statewide this measure has dropped below the target.***

Benefit:

Protective coatings are a cost-effective means of reducing the rate of deterioration and delaying the need to more expensive remedial treatments.

B. Bridge Management Systems

Topic Introduction

The FHWA broadly describes asset management as a strategic and systematic process of operating, maintaining, and improving physical assets with a focus on engineering and economic analysis based upon quality information.¹⁷ The objective of asset management is to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.¹⁸

The FHWA Bridge Preservation Guide¹⁹ categorizes bridge work activities into the following three (3) categories:

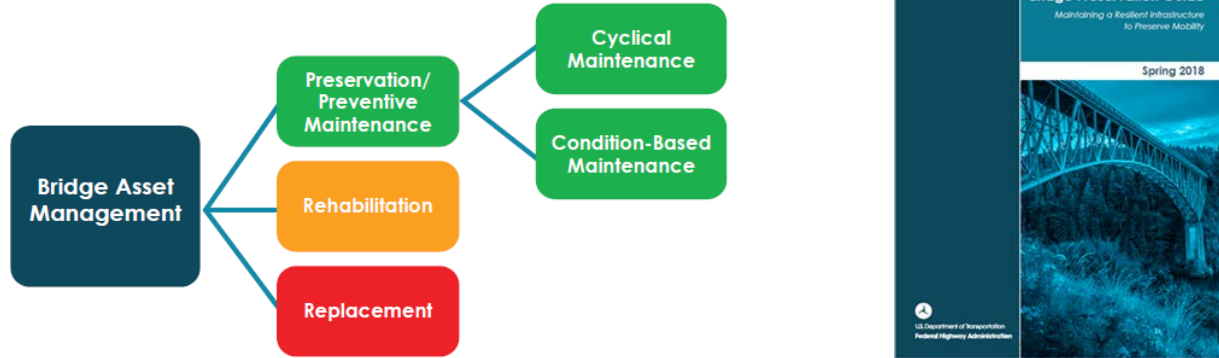
1. Replacement (also called reconstruction)
2. Rehabilitation
3. Preservation (also called preventive maintenance). Preservation can be further categorized into cyclic maintenance and condition-based maintenance.

¹⁷ FHWA Asset Management Webpage; <https://www.fhwa.dot.gov/infrastructure/asstmgmt/>

¹⁸ 23 CFR 515.5 – Asset Management Definition (23 U.S.C. 101(a)(2), MAP-21 § 1103).

¹⁹ FHWA, Bridge Preservation Guide Maintaining a Resilient Infrastructure to Preserve Mobility, Spring 2018.

Figure 11: Bridge Action Categories and the Cover of the FHWA Bridge Preservation Guide



The FHWA preservation guide uses the following definitions for the corresponding actions:

- “Replacement” (reconstruction) refers to the total replacement of an existing bridge with a new facility constructed in the same general traffic corridor. Replacement projects are often done to bridges in “poor” condition where rehabilitation actions are no longer cost effective.
- “Rehabilitation” is major work required to restore the structural integrity of a bridge, as well as work necessary to correct major safety defects. Examples of bridge rehabilitation include partial or complete deck replacement, superstructure replacement, and substructure/culvert strengthening or partial/full replacement. Rehabilitation projects are often done to bridges when one or more of the major components are in poor condition.
- “Preservation” (preventive maintenance) is a category of activities or strategies that extend the service life of highway bridges by applying cost effective treatments to bridge elements while they are in “good” or “fair” condition. Preservation activities prevent, reduce or delay future deterioration and defer large expenses in bridge rehabilitation or replacement.

Bridge Management Systems

A BMS is the combination of tools, processes, and procedures used to develop an optimal agency bridge program. A BMS also refers to software/applications used by agencies to support this function. In either usage, an effective BMS enables an agency to make informed, data-driven, short-term, and long-term investment decisions across a range of work types. The Code of Federal Regulations (23 CFR 515.17)²⁰ describes the minimum documented procedures for bridge and pavement management systems as the following:

- Collecting, processing, storing, and updating inventory and condition data for all NHS pavement and bridge assets
- Forecasting deterioration for all NHS pavement and bridge assets

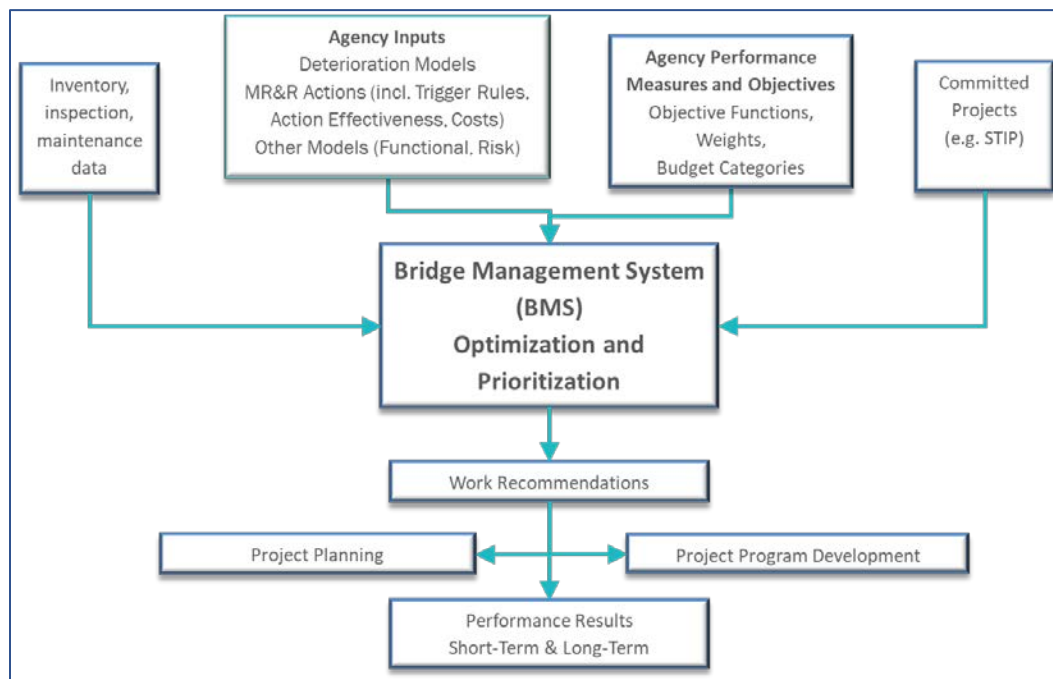
²⁰ Code of Federal Regulation 23 CFR 515.17

<https://www.govinfo.gov/content/pkg/CFR-2017-title23-vol1/pdf/CFR-2017-title23-vol1-sec515-17.pdf>

- Determining the benefit-cost over the life cycle of assets to evaluate alternative actions (including no action decisions), for managing the condition of NHS pavement and bridge assets
- Identifying short-and long-term budget needs for managing the condition of all NHS pavement and bridge assets
- Determining the strategies for identifying potential NHS pavement and bridge projects that maximize overall program benefits within the financial constraints
- Recommending programs and implementation schedules to manage the condition of NHS pavement and bridge assets within policy and budget constraints

BMS software requires calibration with many user inputs as shown in [Figure 12](#): . The resulting outputs are used for program development, project planning, and short/long-term performance monitoring.

Figure 12: Bridge Management System Flow Chart²¹



Note: “MR&R” denotes maintenance, repair and rehabilitation

ODOT Baseline

BMS

Kercher reviewed ODOT’s BMS in accordance with the Federal Regulation (23 CFR 515.17) regarding the six (6) minimum documented procedures of a pavement and bridge management system. Comments are as follows:

²¹ FHWA Bridge Management System Workshop

1. Collecting inventory and condition data

ODOT has a wealth of historical bridge inventory and condition data that is available for bridge management. This data is used to support their existing bridge management program and is centered around performance measures with specific objectives.

2. Forecasting Deterioration

ODOT conducted deterioration modeling research with the University of Cincinnati to develop models for Operational Performance Indices (OPIs), forecasting the following ODOT performance measures: GA, Wearing Surface, Floor Condition, and PCS.²² ODOT bridge engineers use this research as a reference when setting degradation rates of these key components, when doing basic forecasting for the annual work plan, and when developing the TAMP. These deterioration models should be useful when ODOT sets agency inputs into its BMS software (when implemented).

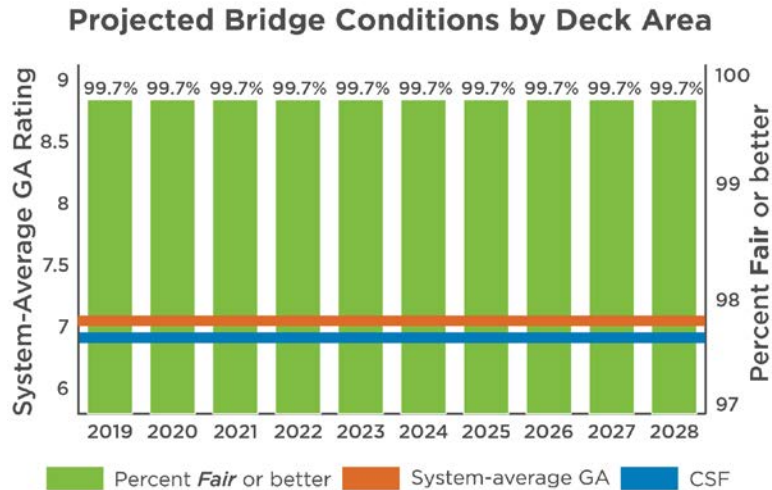
ODOT requires review of bridges just above deficient (poor) and allocates funding that considers this degradation. ODOT perceives that these forecasting methods provide reasonably accurate forecasts for short-term project and programming decisions. However, more refined models would be needed for longer range forecasts.

Regarding the TAMP bridge condition projections, as shown in [Figure 13](#), ODOT predicts it will continue to exceed the Bridge GA goal of 6.8% average condition ratings and maintain 99.7% of their bridges in fair or better condition (each measure is weighted by deck area) for each year of the 10-year analysis through 2028. ODOT noted that these projections are based on current network level trends²³ and are not bridge level projections.

²² Development of Degradation Rates for Various Bridge Types in the State of Ohio, FHWA/OH-2011/9, March 2011

²³ Based on interview notes from TAMP interview meeting 3/19.

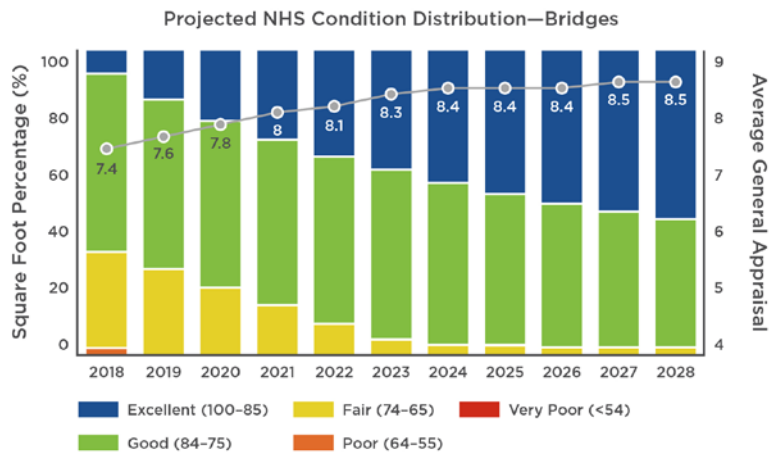
Figure 13: Projected Bridge Conditions by Deck Area from the ODOT TAMP²⁴



For the NHS, with the initiation of the TAMP process in roughly 2016, ODOT estimates that, “if just 5 percent of the NHS Bridges were to receive an appropriate preservation treatment annually, up to \$50 million could be reallocated across the system to maximize service life.”²⁵ As a result the trends were analyzed and estimated to result in the condition projections shown in [Figure 14](#).

ODOT has a “life-cycle modeling” spreadsheet it uses to do network-level forecasting. However, this approach, even in combination with the other efforts and tools described above, does not meet 23 CFR 515.17 requirements for having asset deterioration forecasting capability.

Figure 14: Projected NHS Condition Distribution for Bridges from the ODOT TAMP²⁶



²⁴ Ohio Department of Transportation, Transportation Asset Management Plan (TAMP), June 2019, Section 7.0 Performance Gap Analysis, Page 68.

²⁵ Ohio Department of Transportation, Transportation Asset Management Plan (TAMP), June 2019, Section 4.0 Life Cycle Planning, Page 31.

²⁶ Ohio Department of Transportation, Transportation Asset Management Plan (TAMP), June 2019, Section 7.0 Performance Gap Analysis, Page 68.

3. Benefit-Cost Analysis

ODOT is not currently performing analytical benefit-cost analysis.

4. Identifying Short and Long-term Budget Needs

The ODOT bridge management process begins each year in December/January with the call for an annual work plan. The TP does an analysis of need with respect to ODOT performance measures and assigns bridge program budgets to each of the 12 districts using a forecasting spreadsheet.

ODOT's bridge program budget has remained relatively stable for many years. During project interviews, TP and district bridge staff feel the overall program budget has been adequate to meet their needs. However, budget restrictions from recent years are identified as beginning to strain the program.

No high level BMS currently is in place to determine short-term or long-term budget needs.

5. Determining the strategies

ODOT strategy is based upon performance statewide and in each district regarding the five (5) bridge program performance measures (also called focus areas):

- 1) Average GA
- 2) Percent Good and Fair
- 3) Surface Condition
- 4) Deck Floor Condition
- 5) PCS

The strategy has remained the same for many years. District bridge engineers review and select rehabilitation and replacement projects from the bridges in poor or worse condition. They also review bridges that "could become deficient" to forecast need within the upcoming six-year program.

ODOT does not currently have an advanced BMS that can be used to determine the program or project strategy.

6. Recommending Programs and Implementation Schedules

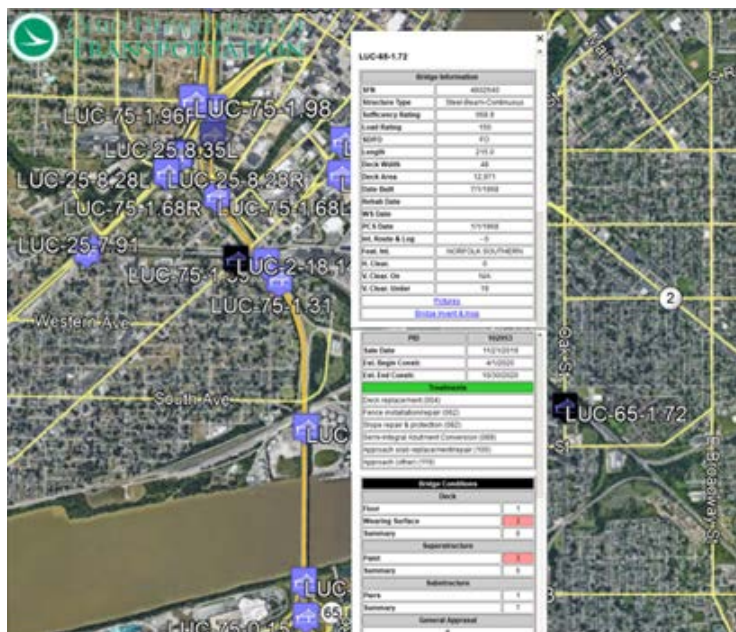
It is each district's responsibility to select projects that meet the focus areas and high-level goals of the bridge program. Each district prepares a presentation and presents it to the TP. The work plan is created by the district bridge engineer in collaboration with the district CPA, who is responsible for management of the overall district annual work plan. The CPA coordinates bridge projects with other programs such as the pavement program.

No high level BMS is used to determine programs and implementation schedules.

Other Management Systems

ODOT uses Geographic Information Mapping (GIS) to help manage their bridge program. As shown in [Figure 15](#), ODOT's bridges are shown on interactive maps along with asset information such as inventory, condition, project development, and construction information. Bridge condition is color coded, flagging deficiencies which can be used to evaluate need. These files are updated/refreshed daily to ensure the information is representative of actual/live data.

Figure 15: ODOT Bridge GIS Maps



Districts categorize project needs using the ODOT bridge performance measures. The more detailed needs then are determined using additional condition information from ODOT 1-4 condition ratings and the AASHTO elements. Currently this is a manual process that will be automated through the planned BMS implementation. District bridge engineers make project decisions using all information on the bridge inspection reports and audit the reports by visiting the bridges to confirm deficiencies.

ODOT districts vary from urban, to rural, to a combination of both. Topography and climate differ through-out the state. This results in different bridge conditions and needs.

During the interviews, district bridge engineers demonstrated a good understanding of their specific needs and manage their respective programs accordingly. Some noteworthy practices communicated by the districts include the following:

- Bundling preservation projects along corridors because this generates more interest from contractors
- Using GIS mapping and ad-hoc queries to help manage their bridges and make project selections
- Using element level information to determine repair details
- Auditing bridge inspections to confirm deficiencies and determine possible repair actions
- Having monthly meetings with operations staff
- Identifying future needs of “near deficient” bridges

ODOT’s bridge preventive maintenance program includes targets in the annual work plan for cleaning, sweeping, and deck sealing. Districts are required to report on these measures in the annual work plan as to how well they are meeting the set targets for each. Figure 16: shows an example table provided in an annual work plan showing bridge cleaning targets and accomplishment.

Figure 16: Example Bridge Cleaning Targets and Accomplished in Annual Work Plan²⁷

District 1 Operations			
County	Planned	Completed	% Completed
ALL	19	0	0.00%
DEF	8	8	100.00%
HAN	17	17	100.00%
HAR	3	3	100.00%
PAU	5	0	0.00%
PUT	9	1	11.11%
VAN	7	0	0.00%
WYA	14	10	71.43%

Figure 17: shows the planned future bridge investments from ODOT’s TAMP.²⁸ These estimates are based on the projects awarded/committed for 2019.²⁹ For 2020-2028 the figures are derived based on a 2% increase per year from the 2019 figures.

Kercher notes that FHWA guidance states "...the State DOT must integrate its TAMP into the State DOT's planning processes that lead to the STIP..."³⁰. This indicates that the management system should be used as input to the STIP, rather than using the STIP to project planned funding.

Figure 17: ODOT’s 10-Year NHS Investment Strategy (in millions) from the ODOT TAMP

Bridges			
	2019	2020-2028 Annual Avg.	10-Year Total
Maintenance	\$5.0	\$5.6	\$54.6
Preservation	\$7.4	\$8.1	\$82.5
Rehabilitation	\$71.3	\$79.4	\$783.1
Reconstruction	\$86.8	\$96.1	\$948.6
New Construction	\$14.9	\$16.1	\$160.0
Totals	\$185	\$205	\$2,029

²⁷ ODOT District 1 Multi-Year Work Plan Presentation, April 18, 2018

²⁸ Ohio Department of Transportation, Transportation Asset Management Plan (TAMP), June 2019, p64, Section 6.0 ODOT’s Performance-Based Investment Plan.

²⁹ Based on spreadsheet “TAMP Financials Final_20190627.xlsx” received from ODOT.

³⁰ See TAMP Guidance Questions & Answers (Q&As) <https://www.fhwa.dot.gov/asset/guidance/faqs.cfm>

Peer States / Best Practice Findings

BMS Implementation Support Efforts

Many state DOTs currently are working to set up and run a BMS that complies with Federal Regulation (23 CFR 515.17). Two (2) notable initiatives to support these efforts are underway and described below.

FHWA Bridge Management System Workshop

The FHWA is sponsoring a Bridge Management System workshop, for which the objective is described as follows:

“The primary objective of the workshop is to advance the use of BMS software programs and analysis tools to support investment strategy analysis and selection, performance measurement and target setting, and project and program planning, with the goal of maximizing benefits and minimizing cost over the long-term.”³¹

In recognition of the fact that many states are in the early stages of implementing their BMS, the FHWA includes the following statement in the participants workbook:

“State Departments of Transportation (DOTs) are using Bridge Management System (BMS) software programs and analysis tools for different purposes. Many are just beginning to use BMS for analyzing investment strategies and recommending work actions and projects in accordance with an optimal investment strategy. Also, many are just beginning to use BMS to support decision making that considers long-term benefits of proposed work including life-cycle cost, condition, functional, and risk reduction-based benefits.

The Moving Ahead for Progress in the 21st Century legislation (MAP-21), as incorporated in 23 USC 119, requires that each State DOT develop an asset management plan for the National Highway System. Furthermore, MAP-21 legislation as incorporated in 23 USC 150 requires the use of BMS when developing and implementing asset management plans. These requirements are continued in Fixing America’s Surface Transportation Act.

Given the state of current practice, some State DOTs require knowledge enhancement, implementation assistance, or opportunities to discuss questions and challenges associated with implementing and using their BMS. This workshop will serve as a resource to help address these needs.”

National Working Group for Bridge Management Systems

The American Association of Highway Transportation Officials (AASHTO), through its Transportation System Preservation Technical Services Program (TSP-2), created the “National Working Group for Bridge Management Systems”.³² The organization charter for this group³³ identifies the following three (3) tiers of BMS advancement: 1) Basic, 2) Intermediate and 3) Advanced. The “Desired End Product from BMS” for each of these categories are defined below:

³¹ Federal Highway Administration, Bridge Management System Workshop Outline of Modules.

³² Bridge Preservation BMS Working Group; <https://tsp2bridge.pavementpreservation.org/national-working-groups/#Bridge%20Preservation%20BMS%20Working%20Group>

³³ Bridge Preservation BMS Working Group Charter; <https://tsp2bridge.pavementpreservation.org/files/2018/10/BMS-Working-Group-Attachment-A-Final.pdf>

1. Basic

- a) Inventory and condition data that is accurate and meets the needs of an agency's BMS
- b) Goals and performance measures are in place
- c) Bridge conditions and monitored along with performance trends
- d) Reports are available that show network bridge condition with respect to agency goals and performance measures

2. Intermediate

- a) Deterioration models are used for forecasting bridge, major components, or elements conditions
- b) Network level preservation actions, quantities, and costs are tracked
- c) Strategic plan for BMS is linked to short-and long-term budgets for the agency's major categories of work such as preservation, rehabilitation, and replacement
- d) Forecasts of future network bridge condition and performance measure are available
- e) Gap analysis of target condition versus desired goals is tracked
- f) Data to support and validate agency rules for network level bridge preservation policies exists and is used
- g) Reports effectively communicate Benchmarking Results and expected outcomes based on network level analysis.

3. Advanced

- a) Based on element level inspection data, the BMS identifies the most appropriate actions for individual bridges with an estimated cost for the work and indicate when the work should be done utilizing benefit-cost analysis that can also include life-cycle cost and user cost analysis
- b) Projects and programs are prioritized and optimized to achieve optimal network budget efficiencies, progress towards agency goals, reduction of risk, and coordination with other infrastructure work
- c) Scenario comparisons are available and used
- d) Reports effectively communicate Benchmarking Results and expected outcomes based on bridge and/or element level analysis.

Peer States' BMS Status

The consulting team interviewed the peer states to determine the comparative level of BMS advancement per the Federal Regulation's (23 CFR 515.17) six (6) minimum documented procedures of a BMS. A summary of the findings follows:

- All the peer states have advanced Bridge Inspection Systems (BIS) in which they house bridge inventory and condition data.
- Illinois, Kentucky, and Michigan are using the AASHTOWare BrM BMS software. However, none of these agencies have the BrM software fully configured and running to meet the minimum requirements of a BMS (23 CFR 515.17).
- Michigan, Minnesota, Wisconsin rely on in-house developed BMS tools. A described benefit of using these in-house developed tools is they are "fully transparent" (because the DOT developed the code and algorithms). The referenced tools can determine short- and long-term budget

needs, determine strategies, and recommend programs and implementation schedules, at least at the network level. All these tools would be classified as intermediate level BMS tools, as none of the in-house tools can perform benefit-cost analysis or optimization.

- All the peer states have done research or in-house development of deterioration models for forecasting. Kentucky is just initiating this process.
- Indiana is using the Deighton dTIMS BMS software, which is fully configured and operational, to provide benefit-cost analysis and optimization (using GCR ratings only). In accordance with the TSP2 BMS National working group guidelines, Indiana perceives the agency is at an intermediate-to-advanced BMS level. (InDOT does not perceive that the agency is at an advanced BMS tier because of only using GCRs to evaluate bridge conditions.)

Analysis

Table 6 shows a comparison of ODOT’s BMS development status compared to the peer states.

Table 6: Bridge Management System Development Status

	Ohio	Illinois	Indiana	Kentucky	Michigan	Wisconsin
Inventory and Condition Data	Yes	Yes	Yes	Yes	Yes	Yes
Forecast Deterioration	Yes	Yes	Yes	Yes	Yes	Yes
Benefit-Cost Analysis	No	No	Yes	No	No	No
Identifying Short and Long-term Budget Needs	No	No	Yes	No	Yes	No
Determining Strategies	No	No	Yes	No	Yes	No
Recommending Programs and Implementation Schedules	No	No	Yes	No	No	No
Tier of BMS Advancement	Basic-Intermediate	Basic-Intermediate	Intermediate-Advanced	Intermediate	Intermediate	Intermediate

Most peer state DOTs are using a combination of in-house developed BMS tools and commercial BMS. None of the peer states have AASHTOWare BrM fully implemented and operational, and all expressed concern with having staff and time to dedicate to this effort.

Indiana DOT chose to use a different commercial BMS, Deighton dTIMS. InDOT considers the implementation successful and the agency is satisfied with the performance of the software. InDOT currently is performing benefit-cost analysis and optimization using GCRs. However, the level of detail in decisions that can be made with GCRs is limited, especially as with regard to preservation actions.

As indicated, based on TSP2 BMS National working group standards, Ohio DOT is at a beginning to intermediate BMS level.

Recommendations and Benefits

2. *Ensure that adequate resources are provided to successfully implement and support a successful Bridge Management System installation that meets the FHWA minimum documented standards (23 CFR 515.17).*

- Feedback gathered through the peer state interviews, and the consulting team's direct experience in working with other DOTs, suggest that implementing an advanced BMS system takes considerable resources on both an initial and ongoing basis

Benefit:

- Providing adequate resourcing to leverage these new BMS tools is key in ensuring that these systems are used to optimize asset investment decisions, resulting in lower lifecycle costs for the value assets

3. *Continue to set up, calibrate, and implement ODOT's chosen BMS to fully meet the minimum documented requirements of 23 CFR 515.17*

4. *Leverage available BMS training and support resources:*

- *Participate in the FHWA-developed BMS workshop for assisting agencies in advancing the use of BMS software programs*
- *Participate in the TSP2 National Working Group for Bridge Management Systems*

Benefit:

- Supports optimizing investments in the BMS system to assisting in making prudent asset investment decisions that can result in lower asset lifecycle costs

C. Bridge Management Practice (Resource, Training and Oversight Practices)

ODOT Baseline

ODOT resources for managing its bridge assets include the following:

- Bridge database that is queried monthly to monitor bridge program performance measures
- Online Bridge Inspection Website³⁴
- ODOT *Manual for Bridge Inspection*³⁵
- ODOT On-line Bridge Maintenance Manual - Preventive Maintenance/Repair Guidelines for Bridges and Culverts³⁶

³⁴ ODOT Online Bridge Inspection Website

<http://www.dot.state.oh.us/Divisions/Engineering/Structures/bridge%20operations%20and%20maintenance/Pages/default.aspx>

³⁵ Ohio Department of Transportation, Manual of Bridge Inspection, ORC 5501.47 Published 1973. Revised 2014 (v.8).

³⁶ ODOT On-line Bridge Maintenance Manual - Preventive Maintenance/Repair Guidelines for Bridges and Culverts.

- ODOT Structure Management System (SMS) YouTube channel³⁷
- Planning and Operations Guidance Documents for cleaning³⁸, sweeping³⁹ and sealing.⁴⁰
- The annual work plan template and past work plan presentations

ODOT does not have specific training for bridge asset management other than on-the-job training. New district bridge engineers learn their position from the previous person in the position (when that person is available), help from the OSE, annual work plan meetings and presentations, monthly conference calls, and the annual bridge engineers meeting.

Districts indicate that there is an abundance of institutional knowledge at this time as many of the district bridge engineers have been in their positions for many years, however, one district has set up an internal knowledge transfer process because of the number of staff in impacted positions that will be eligible for retirement in the next five (5) years.

ODOT's OSE provides oversight throughout the annual work plan process and project selection by reviewing projects and asking questions about project selection. Issues are discussed until both sides are satisfied. District bridge engineers report perceiving that a good working relationship exists with the OSE and consider program development to be a collaborative effort.

Peer States / Best Practice Findings

The peer state DOTs have similar bridge management practices to ODOT. There is a shared responsibility between the central office and regions/districts. Typically, the central office is responsible for developing the annual bridge program and work plan, allocation of funds (for those agencies that have dedicated bridge funds), maintaining and enhancing the BMS, and oversight or certification of bridge project selections. The regions/districts are responsible for bridge inspection, maintenance, and selection of bridge projects to be placed in the annual work plan. All the peer states have guidelines, manuals, office memorandums that guide their bridge management activities and annual work plan.

Highlights of peer state practices includes the following:

Illinois

IDOT has and uses a *Bridge Preservation Guide*⁴¹ with objectives, performance measures, and recommended activities schedule.

<http://www.dot.state.oh.us/Divisions/Engineering/Structures/bridge%20operations%20and%20maintenance/PreventiveMaintenanceManual/Pages/default.aspx>

³⁷ ODOT Structure Management System (SMS) YouTube Channel.

<https://www.youtube.com/channel/UCn2r5ZtyvrOxWW4j92mYFQg>

³⁸ Planning Operations Guidance Document – Cleaning Bridges

³⁹ Planning Operations Guidance Document – Sweeping Bridge Decks

⁴⁰ Planning Operations Guidance Document – Sealing of Concrete Bridge Decks

⁴¹ Bridge Preservation Guide; <http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Specialty-Lists/Highways/Bridges/Bridge%20Preservation%20Guide.pdf>

Indiana

INDOT has a *Bridge Design Manual*⁴² in which Chapter 412 is focused on Bridge Preservation. INDOT also has a *Bridge Preservation Treatments and Best Practices*⁴³ document that identifies preservation objectives, performance measures and recommends activity schedules.

Michigan

MDOT has and uses a “Call for Projects” (CFP) process that starts with instructions in the MDOT *Call Manual*⁴⁴ for preparing its annual business plan/budget. This process follows instructions provided in the CFP, with the Planning Division providing funding templates for each of the department programs.

MDOT’s Bridge Unit has a Replacement/Rehabilitation/Preservation template, and “Big Bridge” template. Central office program managers, region system managers and bridge engineers select projects in accordance to the *Call Manual*.

Each region must show their progress towards statewide performance measures and objectives. Regions provide a report showing their response to the CFP, including a strategy discussion, anticipated results, and identifying concerns/challenges.

Each region submits a CFP binder with a high-level executive summary for each program. This is compiled into a report which is submitted to the CFP approval committee, and finally department executive leadership. Oversight is provided through the CFP review meetings.

For the bridge program, each region’s CFP binder is reviewed by the central office and select region bridge engineers who are part of the review team. Region bridge engineers take turns serving this function. Michigan DOT feels this is a best practice that provides training and brings conformity to their program.

Minnesota

MnDOT has a comprehensive bridge management program. Each year, in late Fall, the Office of Finance (Finance) starts the State Transportation Improvement Program (STIP). Finance develops the formula for funding and has a kick-off meeting to review how the coming year program differs from the previous year.

Using the Bridge Replacement and Improvement Management (BRIM) program, Finance develops a plan of bridge projects (assuming an unconstrained budget) that meet department selection criteria. Internal experts review the selections, then have a STIP Check-in meeting.

At the STIP meeting, a functional group reviews the projects to see how much money each district is putting into various program areas, forecast performance, then recommends changes or approve projects. The projects then go the Transportation Program Investment Committee (TPIC) for approval of the program (STIP and CHIP), and finally STIP approval.

The Bridge Preservation and Improvement Guidelines (BPIG) document describes the process for developing repair, rehabilitation, and replacement projects. For preservation and rehabilitation projects, the BPIG describes minimum criteria the bridge candidate projects must meet.

⁴² INDOT Bridge Design Manual, Chapter 412, Bridge Preservation;
https://www.in.gov/indot/design_manual/files/Ch_412_2013.pdf

⁴³ Bridge Preservation Treatments and Best Practices:
<https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=3106&context=jtrp>

⁴⁴ This is not a publicly available document

Minnesota DOT is starting to develop “Bridge Management Plans” for individual bridges. This is done for major structures and other structures deemed to have special need such as bridges in major corridors. The Bridge Management Plan is a long-term plan of proactive preservation actions that represent the least cost path for management of the bridge.

Wisconsin

The WisDOT’s Bureau of Structures (BOS) issues a list of bridge needs developed using its asset management system, *WiSAMS*. WisDOT regions pick projects and determine how money is spent. BOS reviews project selections and certifies the work type, time frame, and scope.

A WisDOT *Structure Certification Tool* is used to create bridge projects and recommend what year the work should be done. If a region-selected project meets work type and year, it is certified for funding; if not, it gets flagged and the WisDOT Central Office group reviews the project to determine if it makes sense. Candidate projects that qualify are then reviewed to see if other bridge needs exist such as secondary work.

The described WisDOT certification process is intended to provide program consistency and control. The goal is to ensure that bridges are not replaced too early or in response to a need that could be addressed more cost-effectively another way (such as just installing a new bridge deck).

Comments:

Commendable/leading peer state practice includes the following:

- Illinois DOT Bridge Preservation Guide with objectives and performance measures and recommended activities schedule
- Indiana DOT Bridge Preservation and Best Practices
- Michigan DOT’s Call for Projects (CFP) process with Region peer review of annual program, and report to the CFP approval committee
- Minnesota DOT’s comprehensive program
- Wisconsin DOT’s project certification process

Recommendations and Benefits

5. Document the annual work plan results to include reporting to ODOT leadership performance objective trends, challenges, and recommendations for statewide and each district

Benefit:

- Provides a continuous improvement feedback loop for evaluating the effectiveness of asset management planning and execution efforts

6. Provide a project certification process to indicate central office agreement with district project selections

Benefit:

- Promotes program consistency and control and help ensure the most appropriate and cost-effective treatment selection to minimize lifecycle costs

D. Major Bridge Programming

ODOT Baseline

The ODOT Major Bridge Program was established in 2002 with the purpose of funding high cost bridge rehabilitations and replacements for the largest structures in the state. The creation of this program

allowed the expense of maintaining major bridges to be addressed while not overburdening district general bridge allocation funds, which could be entirely consumed by just one major bridge rehabilitation project.

Major bridges include bridges that meet one or more of the following criteria:

- More than 1,000 feet in length
- Single bridge with a deck area \geq 81,000 square feet
- Twin bridges with a deck area \geq 135,000 square feet
- Spans the Ohio River
- Moveable bridge
- Continuous/cantilever truss bridge
- Suspension bridge

Based on a 2019 data snapshot provided by ODOT,⁴⁵ out of the 14,248 bridges that ODOT is responsible for maintaining, 181 are defined as a major bridge and are therefore eligible for major bridge program funding.⁴⁶ Thirty five (35) major bridges cross the Ohio River and have various lead states (Ohio-2, Kentucky-14, West Virginia-19). ODOT has financial responsibilities associated to all public Ohio River Crossings.

ODOT management determines the major bridge budget based upon current or near future need. ODOT’s major bridge program budget is shown in Table 7. Because these structures are large and expensive, the major bridge program budget can vary greatly from year to year.

Table 7: ODOT Major Bridge Program Budget

Year	Major Bridge Program Budget
2010	\$58,247,000
2011	\$68,103,000
2012	\$93,493,000
2013	\$27,859,000
2014	\$83,978,000
2015	\$56,986,000
2016	\$86,085,000
2017	\$90,390,000
2018	\$335,891,000

⁴⁵ Auditors_bridge_data_historical.xlsx

⁴⁶ ODOT Major Bridge Program website.

<http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/MajorPrograms/Pages/MajorBridge.aspx>

Year	Major Bridge Program Budget
2019	\$99,655,000

As with ODOT’s other bridges, forecasting of condition is not currently being done for major bridges. ODOT anticipates that AASHTOWare Bridge Management BMS software will be used for this purpose in the future.

Processes and procedures for the major bridge program are provided in the *Major Bridge Program Standard Procedure*.⁴⁷ This document provides scope, background and purpose, definitions, and procedure for ODOT’s major bridge program.

ODOT has a major bridge program engineer in the Planning Division that is responsible for budgeting, managing, and coordinating major bridge projects.⁴⁸ This Major Bridge Program Manager typically works with district planning engineers, district bridge engineers, and personnel from the OSE depending on the nature of the project or if there are specific/unique issues. Districts often are involved with inspection of major bridges and providing preservation benchmarking results.

The ODOT Major Bridge Program Manager has a systems tool that flags new deficiencies to major bridges that enter the bridge database. The tool sends an email anytime a new deficiency has been observed. This allows ODOT to quickly identify the structure, reach out to the district to gather further information, and to understand the magnitude and importance of the deficiency.

At times, there are major bridge projects which exceed the program’s typical yearly allocation. These projects require the involvement of additional ODOT management personnel to ensure the additional investment being considered is based upon sound judgement and meets the intent of ODOT leadership.

TP and district bridge engineers expressed an appreciation for the program, noting that the districts would not be able to fund these high cost bridges on their own.

Major Bridge Condition Trends

ODOT does not have any documented goals or performance measures for their major bridges. ODOT notes that with a relatively small data set, a couple of deficient structures may pull any performance measure value below the defined target. Additionally, for very large structures it may take several years to complete the project and in the interim, the structure will continue to be recorded as being in a deficient state, even though the issue(s) are actively being addressed.

ODOT’s undocumented goal is to address all identified deficiencies within the planning horizon. ODOT indicates that all current deficiencies at major bridges are at various stages of being addressed through project development or construction. ODOT also strives to ensure all major bridges’ issues/concerns are programmed under one project rather than doing various/numerous smaller projects.

⁴⁷ Major Bridge Program Standard Procedure.

<http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/MajorPrograms/Major%20Bridge/Major%20Bridge%20Standard%20Procedure.pdf>

⁴⁸ Office of Program Management Contact List.

<http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/Documents/Contacts.pdf>

Figure 18: through Figure 22: show ten-year trends for ODOT's major bridges:

Figure 18: Major Bridge Average Weighted General Appraisal Ten-Year Trend

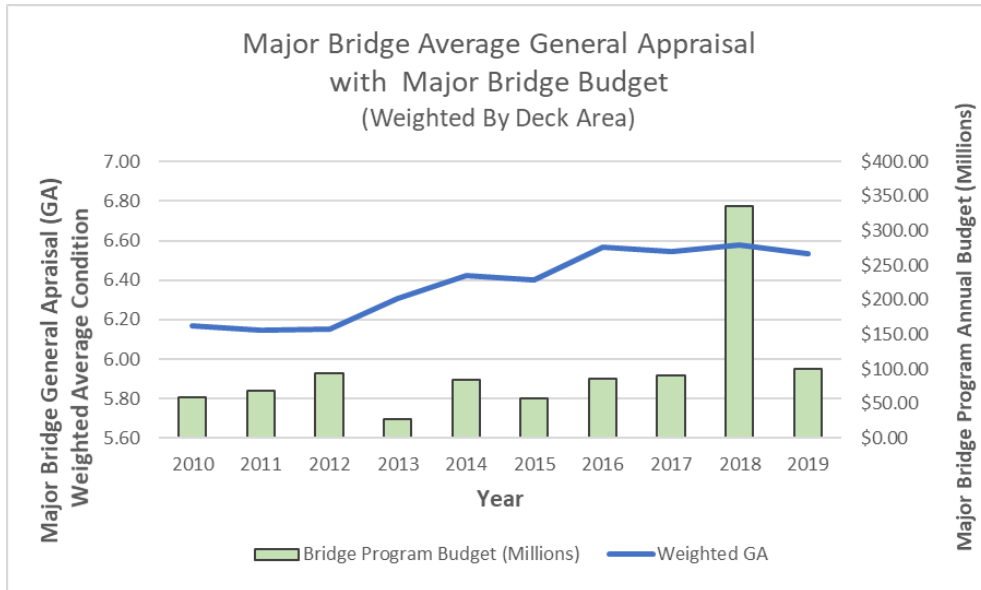


Figure 19: Major Bridge Acceptable General Appraisal Conditions Ten-Year Trend

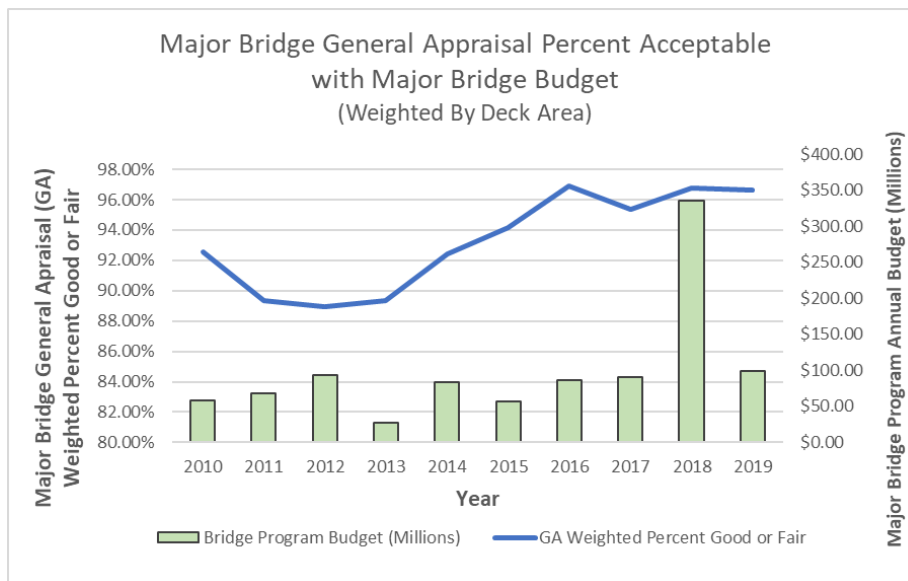


Figure 20: Major Bridge Acceptable Wearing Surface Conditions Ten-Year Trend

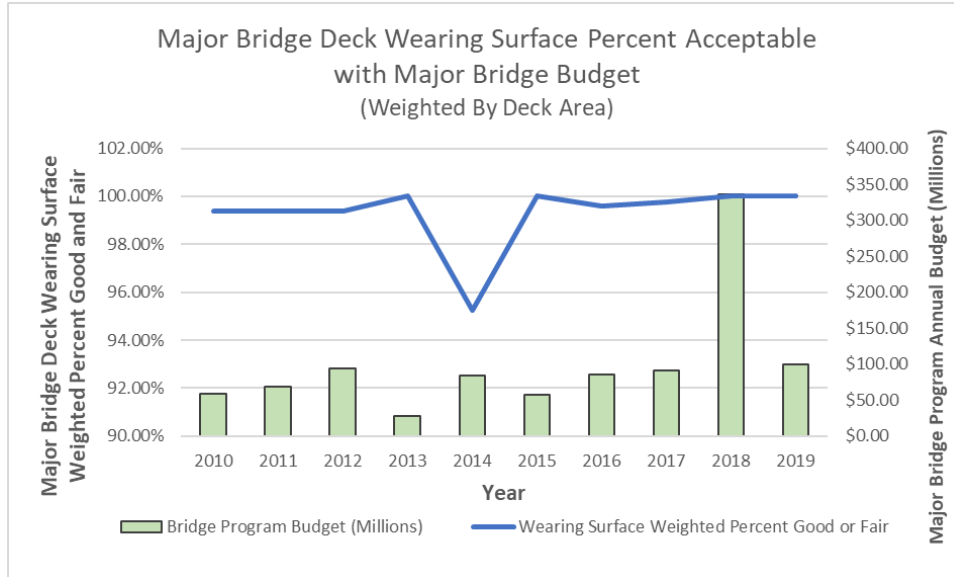


Figure 21: Major Bridge Acceptable Floor Conditions Ten-Year Trend

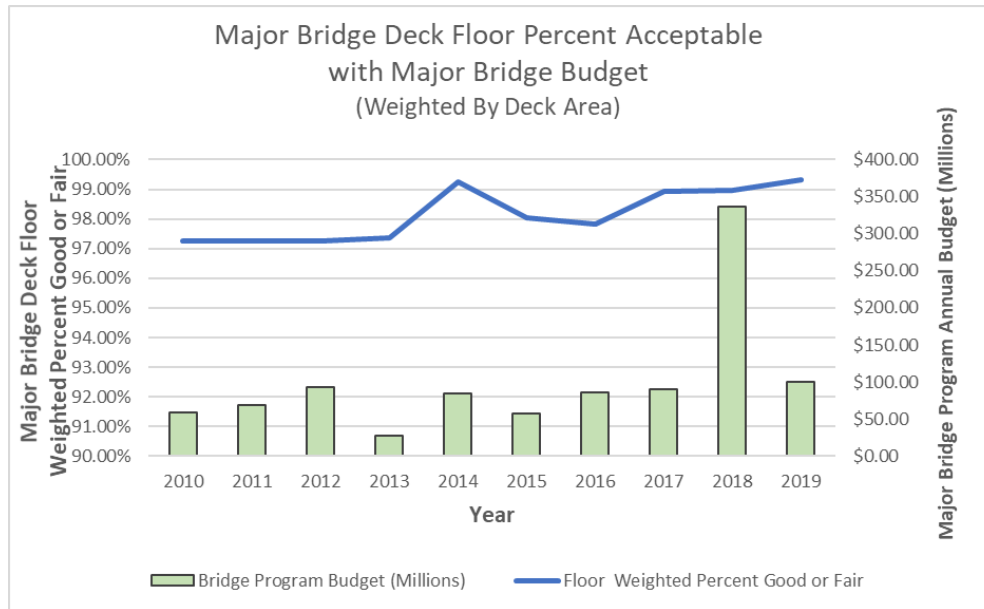
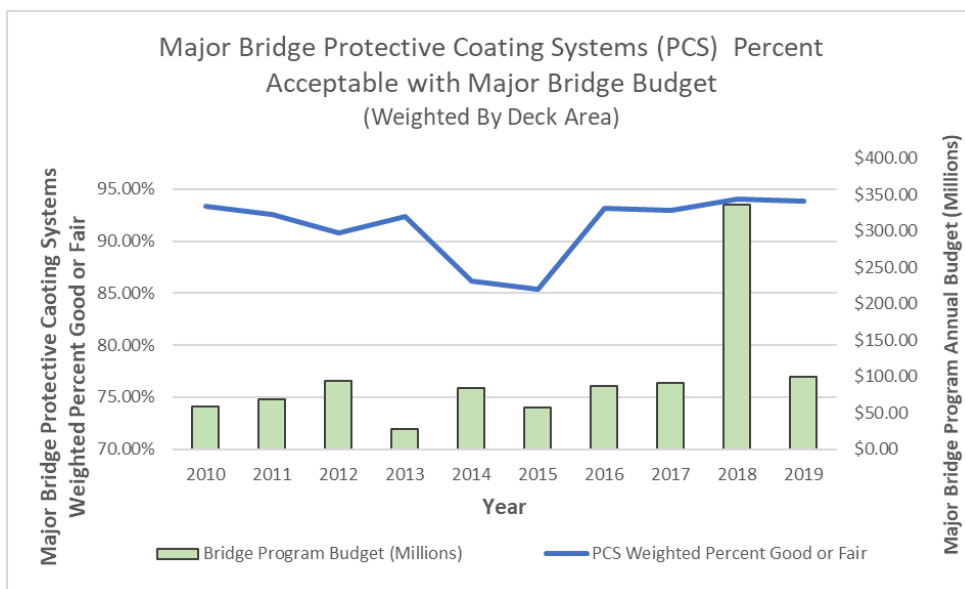


Figure 22: Major Bridge Weighted Protective Coating Systems Ten-Year Trend



Peer States / Best Practice Findings

Major bridges are those structures that, because of their size, expense, or complexity, an agency may choose to manage separately from the more typical highway bridges. All the peer states have some form of a major bridge program similar to Ohio DOT. The consulting team perceives that organizing major bridges in such a program to be state DOT best practice.

Recommendations and Benefits

7. Monitor performance trends of major bridges using current bridge performance measures

Benefit:

- Would be consistent with ODOT’s use of key performance indexes in other asset management areas

8. Use bridge asset management techniques to forecast future needs for major bridges and dedicate funding in those years

Benefit:

- Leverages the BMS tool being implemented to provide ODOT a holistic view of bridge funding needs

E. Matching Financial Sources to Needs

ODOT Baseline

Funding Approach Overview

ODOT is responsible for allocating funds among highway projects in a way that maximizes its resources. Over a 10-year period between FY2019 and FY2028, ODOT expects to invest nearly \$3.3 billion to preserve,

improve and replace state-maintained bridges (\$299 million in FY2019 and \$331 million annually FY2020-FY2028).⁴⁹

As outlined in the ODOT TAMP, beginning in 2015, the Department’s approach to project selection and the associated funding decisions shifted. ODOT adopted a long-term view of the costs required to keep its bridges (and pavements) in service. The focus of this approach is on the increased use of preservation treatments – a move ODOT indicates will reduce the rate of asset deterioration and make more cost-effective use of available funding. The TAMP states:

“By investing regularly in certain low-cost preservation treatments, the value of these assets is preserved and the cost of maintaining system conditions is reduced, because costly repairs and replacements are needed less frequently. Preserving the condition of the highway system so fewer assets must be replaced is an important objective for the investments included in the TAMP.”⁵⁰

Figure 23 illustrates this approach to bridge investments in practice:

Figure 23: Bridge Preservation Strategies



Source: ODOT TAMP

In 2017, ODOT established a Funding Council to assist in allocating available funding to ODOT’s operating and capital programs, including its bridge programs. According to Funding Council Charter, membership is comprised of the following:

- Funding Council “Executive Champions”
 - Chief of Staff/Assistant Director

⁴⁹ ODOT, “Federally-Compliant Transportation Asset Management Plan,” (June 2019)

⁵⁰ Ibid.

- Assistant Director, Operations
- Assistant Director, Chief Engineer
- Funding Council Co-Chairs
 - Two (2) District Deputy Directors
- Funding Council Voting Members (in addition to Co-Chairs)
 - Seven (7) District Deputy Directors
- Funding Council Non-Voting Members
 - Deputy Director, Division of Planning
 - Deputy Director, Division of Finance
 - Executive Financial Advisor
 - Administrator, Office of Budget and Forecasting (administrative support)

The mission of the Council is to guide the overall use of ODOT’s financial resources by recommending funding allocations for operating and capital programs to the ODOT Governance Board (comprised of the Director, Chief of Staff and Assistant Directors).⁵¹

The Funding Council’s goal is to develop a balanced budget using the agency’s Funding Proforma to recommend a fiscally responsible budget approach to make funding allocations. The Funding Council ensures that the optimum level of funding is provided to each program to achieve ODOT’s mission, vision, values, goals, and Critical Success Factors. The Council bases its benchmarking results on a data-driven decision process that focuses on creating steady-state conditions for the Department’s assets.⁵²

ODOT uses the following process to select bridge projects:

1. Funding needs for bridges are developed based on agency-developed spreadsheet tools that forecast changes in bridge conditions over time.
2. Aggregate funding levels allocated to bridges are based on estimates of the amount of work needed to maintain bridge CSFs on a statewide basis.
3. Districts are assigned CSF goals and their bridge programs are developed to address existing deficiencies. The bridge programs are based, in part, on a list provided to the districts each year by the OSE that identifies bridges that should be cleaned, swept and sealed as part of the Department’s Bridge Preservation Program.
4. Other bridge improvements are based on an analysis of the general appraisals conducted by the OSE.⁵³

The process of matching ODOT’s financial and funding sources to projects begins with the development of its pro forma budget, which includes revenue projections of its various state and federal funding sources (described in detail below). These anticipated funding levels and uses are vetted through ODOT’s Funding Council and approved by ODOT’s Governance Board. In instances where a delta exists (in other

⁵¹ ODOT Funding Council Charter

⁵² Ibid.

⁵³ ODOT, “Federally-Compliant Transportation Asset Management Plan,” (June 2019)

words, when projected funding is less than the investment required for those projects), the use of bonds is considered in order to balance the budget.

To determine whether bonds should, in fact, be issued, ODOT's cash forecasting model analyzes its bond appropriations and determines when associated cash is likely to be used. As a supplement to this model, ODOT's internally developed cash forecasting pipeline analyzes historical data to estimate when funds for various projects are likely to be spent in the future. Based on the results of these analyses, and in consideration of other factors (such as debt service payments and constitutional limits on state bond issuances), ODOT determines when it should issue bonds and for what amount (typically in 18-month cycles).

According to ODOT's current bond policy, "leadership recommends capital program funding levels based on forecasts of revenue and capital program needs as well as from various sources within the Department. Program funding levels include projects that will be funded entirely from a single revenue source or from a combination of state and federal highway revenue and proceeds from the issuance of bonds. The use of a decision model is recommended to determine if it is less costly to currently undertake projects funded by bonds or to defer projects until a later date when the project may cost more due to inflation. By adjusting to present values, the model compares the interest cost on bonds needed to finance the project with the projected inflation cost that results from delaying the project."⁵⁴

The decision model recommended in ODOT's current bond policy is a different tool. It compares whether individual projects should be financed with bonds – and at what point – using a present value calculation that compares the cost of undertaking a project in the near term to the cost of borrowing. Because interest rates are at historically low levels, this decision model has not been in use recently.

Bridge Funding/Financing Sources

ODOT uses a variety of funding and financing sources to make investments under its Major Bridges and System Preservation programs, including state revenue, federal revenue, bonds and local funds. Each of these sources is described below:

- **State revenue** is generated by several sources, with the largest percentage coming from the state Motor Fuel Tax (MFT). The MFT revenue is shared between ODOT, local governments and other state agencies, with each type of entity using it for road and bridge maintenance and construction as prescribed in the Ohio constitution.

H.B. 62 increased the motor fuel tax rate effective July 1, 2019 – a change expected to generate an additional \$865 million per fiscal year during the FY2020-FY2021 biennium, with \$476 million allocated to the Highway Operating Fund and \$389 million allocated to local governments.⁵⁵ According to ODOT Division of Finance leadership, as of March 2020, actual MFT collections are below estimate by approximately \$22 million. This is primarily due to decreased levels of fuel consumption statewide (-2.4 percent) attributable to increased vehicle fuel efficiency.⁵⁶

Other sources of state revenue include the fuel use tax, interest income from investments and other miscellaneous sources. As shown in [Figure 24](#), total state funding dedicated for bridge

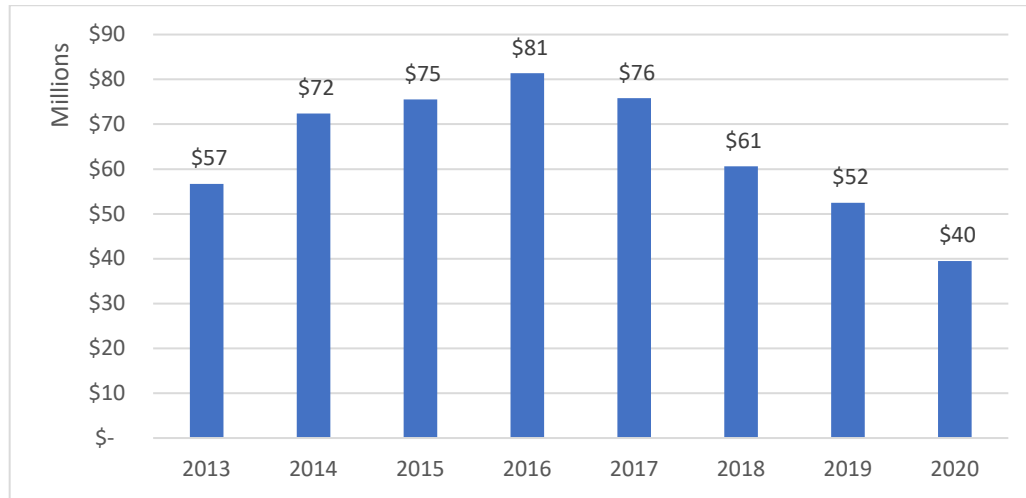
⁵⁴ ODOT, "State Highway Capital Improvement Bond and Grant Anticipation Revenue Vehicles Bond Policy (effective April 17, 2015).

⁵⁵ Ohio Legislative Services Commission, "Greenbook: LBO Analysis of Enacted Transportation Budget," (September 2019).

⁵⁶ Interview with ODOT Division of Finance leadership team (March 17, 2020).

projects increased between FY2013 and FY2016 but has decreased each year since, totaling approximately \$40 million in FY2020. Over the eight (8) year period, use of state funding for bridge projects declined at a -5 percent compound annual growth rate (CAGR).

Figure 24: State Revenue Dedicated to Bridge Projects, FY2013-FY2020

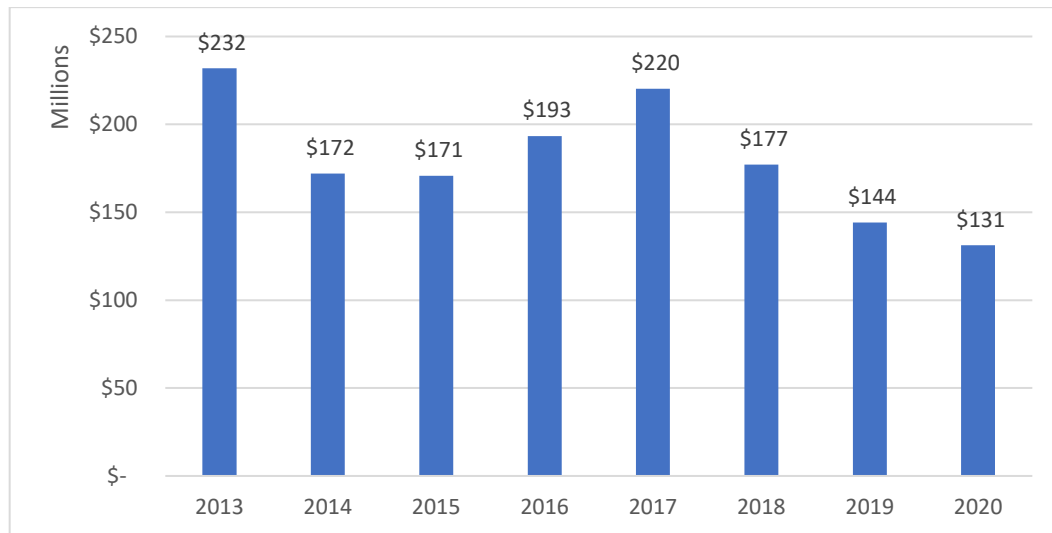


Source: ODOT pavement and bridge project funding data

- Federal funding** is provided through the Highway Trust Fund, which is financed primarily by the federal fuel tax. Congress is responsible for authorizing federal funding, which is apportioned to projects in accordance with certain requirements. Although federal funding fluctuates annually, the average level of funding over the last five (5) years has been relatively constant. Current projections for Federal funding show flat levels over the next several years.

As shown in [Figure 25](#), federal funding for bridge projects – totaling \$131 million in FY2020 - has fluctuated in recent years but has trended downward since peaking in FY2013 at \$232 million. Over the subsequent eight (8) year period, funding from this source dedicated to bridge projects decreased by a CAGR of -7.8 percent.

Figure 25: Federal Revenue Dedicated to Bridge Projects, FY2013-FY2020



Source: ODOT pavement and bridge project funding data

- **Highway bonds** used by ODOT to finance bridge projects consist of two (2) types: 1) State Highway Capital Improvement (HCAP) bonds and 2) Grant Anticipation Revenue Vehicle (GARVEE) bonds, both of which are issued by the Treasurer of State’s Office. HCAP bonds are used to pay the costs of construction, reconstruction or improvements of highways throughout the State and are repaid using state resources (primarily state MFT revenue). GARVEE bonds are issued to finance highway construction projects that are eligible for federal funding and are repaid with federal dollars (transportation funds allocated to the State, subject to biennial appropriation).⁵⁷ The most recent ODOT bond issuances include the following:⁵⁸
 - In June 2020, the Treasurer's Office issued \$68 million in HCAP bonds (General Obligation Highway Capital Improvement Bonds, Series W) on behalf of ODOT. These bonds funded 27 capital road and bridge projects spanning 19 Ohio counties. Such projects include resurfacing and rehabilitation of portions of I-77 in Stark County; rebuilding, resurfacing and widening of structures in the I-70/I-71 “split” in Franklin County; and a major bridge and multi-lane reconstruction and widening of I-75 in Wood and Lucas Counties.
 - In December 2019, the Treasurer's Office issued \$180 million in GARVEE bonds (Major New State Infrastructure Bonds, Series 2019-1) on behalf of ODOT. These bonds funded 18 capital road and bridge projects statewide, including the reconstruction and widening of I-75 in Hancock County, replacement of decks on the twin I-480 bridges over the Cuyahoga River Valley, and reconstruction and widening of portions of I-70 in Franklin County.
 - In addition, the current Transportation Budget authorizes the issuance of \$57 million in state highway bonds to be deposited into the Highway Capital Improvement Fund to supplement Highway Operating Fund revenues for road and bridge construction.⁵⁹

During the FY2020-FY2021 Biennium, ODOT’s bond funding appropriation is just over \$264 million; its associated debt service appropriation is just over \$684 million.

Table 8: Bond Funding Sources and Debt Service, FY2020-FY2021 Biennium (in millions)

	Total Biennial Appropriation	Debt Service Appropriation
Federal GARVEE Bonds	\$133.8	\$366.6
State Highway Bonds	\$130.0	\$317.5
Total Bond Funding	\$263.8	\$684.1

Source: ODOT Transportation Budget, FY2020-FY2021

According to ODOT Division of Finance leadership, the vast majority of bond dollars are allocated to long-term bridge (and pavement) projects that tend to be larger and more capital-intensive.

⁵⁷ The State has also covenanted to use for the payment of debt service, if necessary, other State transportation moneys that have been appropriated to ODOT.

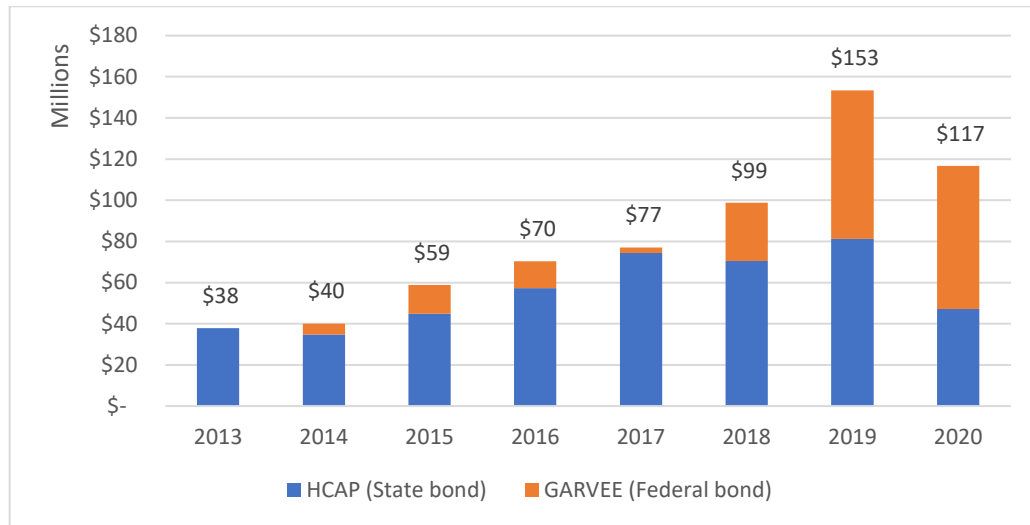
⁵⁸ Ohio Transportation Bond Programs, “Recent Transactions”

⁵⁹ Ohio Legislative Services Commission, “Greenbook: LBO Analysis of Enacted Transportation Budget,” (September 2019).

However, ODOT has had to use bond funding in recent years to meet basic preservation needs. As a result of the MFT increase in 2019, ODOT currently, is pushing to transition to a model in which bonding is used primarily for major bridge and major new projects.⁶⁰ Additionally, the FY2020-FY2021 ODOT Transportation Budget indicates that, as a result of the increase in the MFT, bond revenue will not be relied on at the level it has been in prior years.

As shown in [Figure 26](#), bond financing for bridge projects increased significantly between FY2013 and FY2019 before decreasing to \$117 million in FY2020. During the period of time under discussion, use of this funding source for bridge projects grew by a CAGR of 17.4 percent.

Figure 26: Bond Financing Dedicated to Bridge Projects, FY2013-FY2020

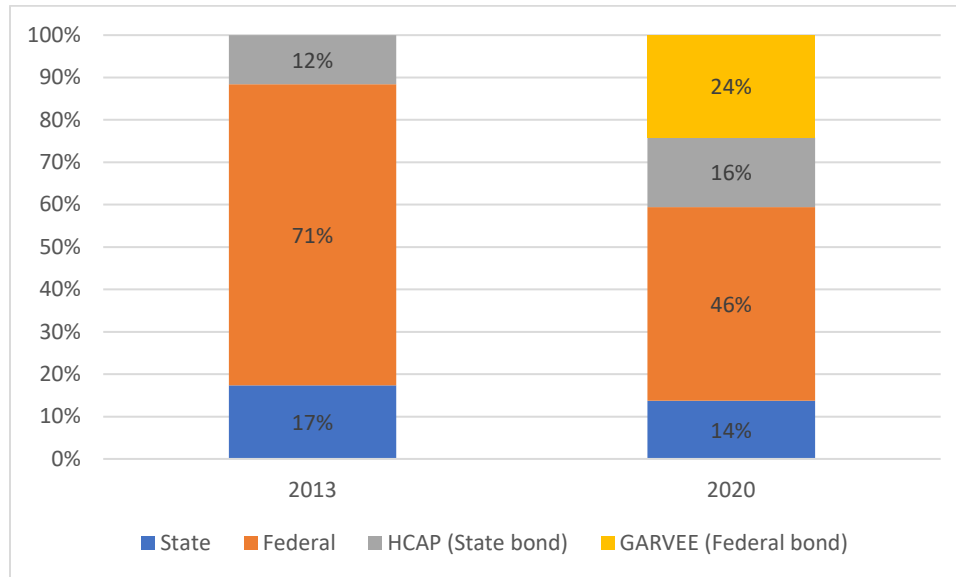


Source: ODOT pavement and bridge project funding data

It is notable that the overall composition of ODOT’s bridge project funding sources has changed over time. For example, in FY2013 federal funds attributed 71 percent of the total, state funds were 17 percent, and bonds provided 12 percent. By FY2020, federal funds accounted for just 46 percent of the total, and there was a slightly reduced reliance on state funds to 14 percent. The overall effect is that the use of bonds to fund bridge projects (referenced above) has increased significantly as a share of the total, with HCAP and GARVEE bonds now comprising 40 percent of the total.

⁶⁰ Interview with ODOT Division of Finance leadership team (March 17, 2020).

Figure 27: Composition of ODOT Bridge Funds, FY2013 and FY2020



Source: ODOT pavement and bridge project funding data

- Local Matching Funds** - some bridge projects require local governments to match. For example, ODOT’s local bridge programs generally require an 80 percent federal, 20 percent local match. [Table 9](#) summarizes local government matching funds provided for bridge projects between FY2013 and FY2020.

Table 9: ODOT Bridge Project Local Government Match Totals, FY2013-FY2020 (in millions)

2013	2014	2015	2016	2017	2018	2019	2020
\$6.1	\$9.8	\$8.8	\$28.0	\$22.8	\$14.3	\$19.4	\$16.1

Source: ODOT pavement and bridge project funding data

Use of Funds

The following is a summary of how these various sources have been applied to different types of bridge projects. As indicated, federal funds play a significant role in available funding. As described previously, total federal funding has declined over time - and as a result, fewer overall funds are available for projects.

- Replacement/Reconstruction** projects are largely funded by federal funds, which account for 60 percent of total funds allocated in FY2020. State funds comprise an additional 19 percent, while bonds account for the remaining 21 percent.
- Rehabilitation** projects are also primarily funded using federal dollars, which account for 61 percent of the total. Similar to replacement/reconstruction projects, bond funds and state funds each account for approximately 20 percent of the remainder.
- Preservation/Preventative Maintenance** projects have a very high reliance on federal funds (83 percent of the total), with an additional 15 percent comprised of state sources. Only two percent is attributable to HCAP bonds, with no GARVEE bond funds allocated for the purpose.
- New Construction** projects are also highly reliant upon federal funds (82 percent); state funds account for the remainder of the total.

Peer States / Best Practice Findings

Table 10 identifies each benchmark state's reliance on various revenue sources to fund projects on state-administered highways in 2018 (the most recent year for which FHWA data is available). At 23 percent of total revenues, Ohio's reliance on highway user revenues is the lowest among peer states, which average 39 percent (when excluding Ohio). While its reliance on bond issuances for capital outlay (27 percent) is the highest among its peers, when combined with bond issuances for debt service, ODOT's reliance on bonds is comparable to Pennsylvania (33 percent) and Wisconsin (30 percent) and lower than West Virginia (43 percent).

Table 10: Sources of Revenues Used by States for State-Administered Highways as a Share of Total Receipts, 2018

	OH	KY	MD	NY	PA	WI	WV
Balance, Beginning of Year, millions (a)	\$1,660	\$680	\$1,443	\$1,561	\$4,472	\$1,076	\$114
Highway User Revenues:							
Motor Fuel Taxes	13%	22%	7%	6%	20%	17%	17%
Motor Vehicle and Motor Carrier Taxes	4%	22%	8%	6%	6%	12%	16%
Road and Crossing Tolls (b)	06%	0%	35%	24%	10%	0%	4%
Total	23%	45%	50%	36%	37%	29%	38%
Gen. Fund Approps. (c)	10%	1%	10%	12%	9%	4%	1%
Other State Imposts (d)	0%	0%	5%	2%	0%	3%	0%
Miscellaneous	5%	12%	1%	18%	4%	2%	2%
Issue of Bonds:							
For Capital Outlay	27%	8%	10%	18%	9%	6%	43%
For Debt Service (e)	3%	0%	9%	0%	24%	24%	0%
Payments from Other Governments:							
FHWA	30%	34%	15%	14%	17%	25%	16%
Other Agencies	0%	0%	0%	0%	0%	2%	0%
From Local Governments	2%	0%	0%	0%	0%	4%	0%
Total Receipts	100%	100%	100%	100%	100%	100%	100%

Amounts shown reflect activities of State highway departments, State park boards, other State agencies and quasi-State toll facilities, including direct work on local roads under State control, and State highway debt service transactions.

Source: FHWA Highway Statistics 2018, Table SF-3 (January 2020)

(a) For Reserves for Current Highway Work (in millions)

(b) ODOT does not collect revenue from tolls. However, this comparison is being used to illustrate a comparison among peer states as a proxy, based on the best available data from the FHWA

(c) Amounts shown represent gross general fund appropriations for highways reduced by the amount of highway-user revenues placed in the State General Fund

(d) Includes sales and use taxes, severance taxes and other State taxes

(e) Including refunding

Table 11 displays each benchmark state's distribution of resources for state-administered highways in 2018 (the most recent year for which FHWA data is available). Relative to most of its peers (with the exception of West Virginia), at 54 percent, Ohio directs a higher percentage of its overall disbursements to capital outlay for roads and bridges, followed closely by Kentucky at 53 percent.

Table 11: Share of Disbursements for State-Administered Highways by Category, 2018

	Cap. Outlay for Roads & Bridges	Maint. & Hwy Svcs.	Admin., Research & Planning	Hwy Law Enforcement & Safety	Interest	Bond Retirement	Total
OH	54%	14%	7%	12%	3%	10%	100%
KY	53%	20%	1%	5%	7%	14%	100%
MD	37%	13%	3%	9%	6%	32%	100%
NY	34%	26%	5%	6%	9%	20%	100%
PA	38%	17%	5%	8%	6%	27%	100%
WI	39%	11%	7%	3%	2%	39%	100%
WV	81%	10%	3%	2%	0%	3%	100%

Source: FHWA Highway Statistics 2018, Table SF-4 (April 2020)

Table 12 displays each benchmark state’s change in indebtedness related to its state highway obligations in 2018 (the most recent year for which FHWA data is available). With a 5.2 percent increase in indebtedness, Ohio’s experience is similar to Kentucky (also 5.2 percent), New York (6.2 percent) and Wisconsin (4.3 percent).

Table 12: Obligations for State Highways: Change in Indebtedness, 2018 (in thousands)

	Obligations Outstanding, Beginning of Year	Total Obligations Issued (Original & Refunding)	Obligations Retired (By Current Revenues or Sinking Funds)	Obligations Outstanding, End of Year	% Change in Indebtedness
OH	\$2,072,115	\$516,290	\$408,125	\$2,180,280	5.2%
KY	\$1,604,662	\$430,610	\$347,887	\$1,687,385	5.2%
MD	\$2,951,206	\$140,000	\$145,089	\$2,946,117	-0.2%
NY	\$5,457,158	\$1,193,122	\$852,406	\$5,797,874	6.2%
PA	\$5,821,428	\$3,464,711	\$1,687,048	\$7,599,091	30.5%
WI	\$2,618,326	\$245,310	\$132,476	\$2,731,160	4.3%
WV	\$658,059	\$886	\$65,091	\$593,854	-9.8%

Source: FHWA Highway Statistics 2018, Table SB-2 (April 2020)

Funding Sources and Approaches

While all states levy some form of a gasoline tax, 22 have a variable-rate gas tax that adjusts, to some degree, with inflation or prices without regular legislative action. Among the benchmark states are the following practices:⁶¹

- **Ohio** and **Wisconsin** have non-variable levels of motor fuel taxes.
- **Kentucky, Pennsylvania, New York** and **West Virginia** have a gas tax which varies with fuel price.
- **Maryland’s** fuel tax varies based on both fuel price and the Consumer Price Index.

⁶¹ National Conference of State Legislatures, “Variable Rate Gas Taxes,” (April 11, 2019).

While it is common for the motor fuel tax to be the largest source of state revenue for highway programs, in Illinois, the single-largest source is motor vehicle registrations, which support both road and bridge projects.

Some states have adopted creative approaches to preserving highway revenue. For example, **Pennsylvania's** Motor License Fund (MLF) has had both a decreasing balance and an increase in usage by other state agencies. Fiscal code changes capped the amount of MLF funding diverted to other agencies to preserve a predictable revenue stream to invest into highway and bridge projects.

In response to declining fuel tax revenues associated with increasing vehicle fuel economy and electric car usage, the I-95 Corridor Coalition (a multi-state partnership of transportation agencies and other related organization) conducted a pilot study of a mileage-based tax system in **Pennsylvania** and **Delaware**, where a driver would pay a fee based on miles driven (commonly referred to as vehicle miles traveled or VMT) in lieu of a per-gallon fuel tax. Both **California** and **Oregon** have also conducted pilot programs that tax certain drivers' VMT instead of gasoline purchased. It should be noted that there are administrative challenges in measuring VMW.

Rhode Island has put into place truck-only tolls to help fund a state bridge repair program; **Connecticut** is currently considering a similar proposal.

In 2015, **Indiana** conducted a study to assess its transportation funding needs and potential funding sources.⁶² The study indicated that Indiana's transportation funding would decrease over the next 20 years as a result of inflation and increased fuel efficiency. As a result of the study, in April 2017, the Indiana General Assembly passed House Enrolled Act 1002, also known as "Next Level Indiana." The sources of funding for Next Level Indiana include the following:⁶³

- Fuel tax increase on gasoline
- Increase of special fuel tax
- Increase of motor carrier surcharge tax
- Transportation improvement fee for all motor vehicle registrations
- Supplemental registration fee for electric vehicles
- Redirecting a larger portion of the sales tax collected on fuel from the state general fund to dedicated highway funds

1. Financing and Debt

In 2017, the Transportation Research Board published a synthesis of evolving debt finance practices for surface transportation. One area of analysis was how a state decides between whether to issue debt backed by federal funding or state funding for transportation purposes. Among the benchmark states, responses included the following:⁶⁴

⁶² "Study of Indiana Transportation Infrastructure Funding Mechanisms" (October 2015).

⁶³ INDOT, TAMP

⁶⁴ Transportation Research Board of the National Academies of Sciences, Engineering and Medicine, "Evolving Debt Finance Practices for Surface Transportation," (2017).

Ohio

The bonding decision process is largely driven by project type and funding eligibility. Since funding used on federal (GARVEE) bonds is more restrictive, it limits the use of these funds. ODOT also is restricted by coverage ratios used on debt covenants of past bond issuances; for instance, ODOT has an informal internal policy to limit GARVEE debt service to 20% of federal revenues.

Kentucky

GARVEEs are used for federal projects that have been identified in their biennial highway plan and approved by FHWA and the General Assembly. Road Fund bonds are issued for state funded projects that have been identified in the biennial highway plan and approved by the General Assembly.

Maryland

In the State of Maryland, the use of GARVEEs requires special legislative authorization.

New York

The State of New York does not leverage federal highway/transit apportionments.

Pennsylvania

The choice of bond usage is made through discussions with the Governor's Office of Budget. Primary considerations include how much debt service payments will be, for how long, and is it more beneficial than using current revenues for projects. Pennsylvania does not use GARVEE debt.

West Virginia

State of West Virginia bonding usage is determined on a case-by-case basis, based on available funds and need.

Wisconsin

The State of Wisconsin currently does not have the authority to issue debt backed by federal funding for transportation purposes.

Michigan

The decision to bond is made by MDOT's Director in cooperation with the Finance Bureau; additional oversight is provided by the Transportation Commission and legislature.

2. *Alternative Financing and Other Innovative Approaches*

The FHWA encourages the consideration of public-private partnerships in the development of transportation improvements, noting that "early involvement of the private sector can bring creativity, efficiency and capital to address complex transportation problems facing state (and local) governments"⁶⁵. As of September 2019 (and with the exception of New York), most peer states have either broad or limited enabling statutes:⁶⁶

- Broad enabling statute: **Ohio, Kentucky, Maryland, Pennsylvania, West Virginia**

⁶⁵ FHWA, Public Private Partnerships

⁶⁶ [Bureau of Transportation Statistics, "Public Private Partnership Legislation by State," \(September 2019\)](#)

- Limited enabling statute: **Wisconsin**

Like Ohio, **New York** has used a bundled finance approach to realize efficiencies – but for state-owned bridges – as part of its New York Works Accelerated Bridge Program. The 112 deficient bridges addressed under the program used both the traditional design-bid-build, and newly authorized design-build project delivery methods. In Phase 1A of the program, NYSDOT initially procured six (6) bundles totaling 64 bridges on a design-bid-build basis. In Phase 1B, it used its new design-build contractual authority to let an additional three bundles totaling 32 bridges, for which NYSDOT estimated a 27 percent cost savings over traditional design-bid-build project delivery.⁶⁷

Considered to be a “value capture” strategy by the FHWA’s Center for Innovative Finance Support, many states have established commissions or study groups to identify transportation funding gaps and suggest strategies for overcoming them, including nearly all peer states.⁶⁸

- **Ohio:** 21st Century Transportation Priorities Task Force (2009)
- **Kentucky:** Enhancing Kentucky’s Transportation Funding Capacity: A Review of Six Innovative Funding Options (2005)
- **Maryland:** Blue Ribbon Commission on Transportation Funding (2011)
- **Pennsylvania:** Transportation Funding Advisory Commission (2011)
- **West Virginia:** Blue Ribbon Commission on Highways (2012)
- **Wisconsin:** The WI Commission on Transportation Finance and Policy (2013)

Recommendations and Anticipated Benefits

9. Reserve bonding for projects with a long useful life

Benefit:

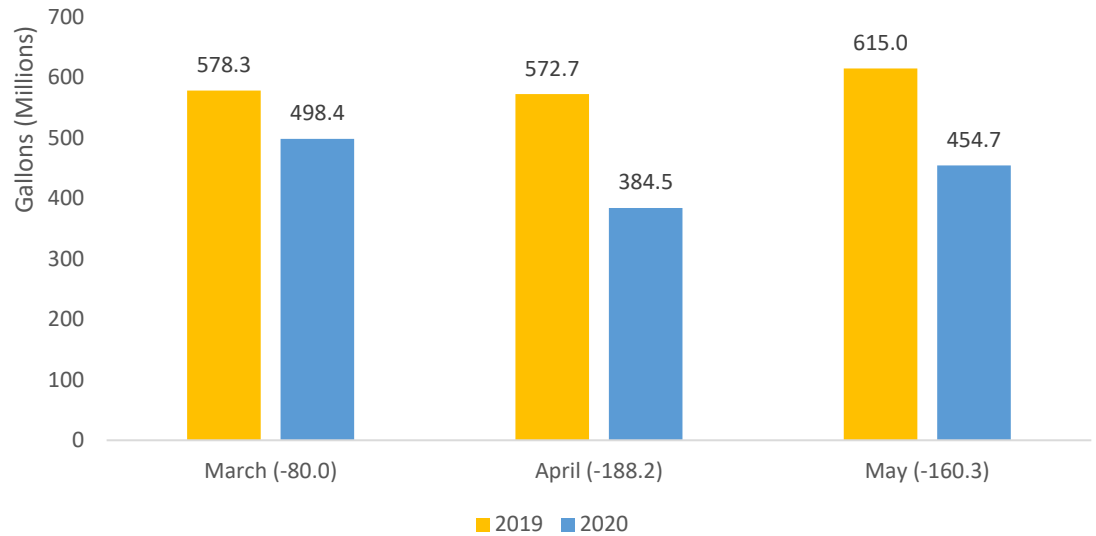
- Financial best practice is to tie bond length to useful life, issuing bonds only when they can be paid off before the value of the project is depleted.

According to ODOT representatives, bonds have been used in recent years to address basic preservation needs. While ODOT indicated it is their intention to move away from this practice in conjunction with the 2019 fuel tax increase, the current economic downturn has resulted in fewer drivers and, therefore, less fuel subject to taxation. For example, in the aggregate, net taxable gallons for the months of March, April and May 2020 were 428.5 million (24.3 percent) lower than during the same months in 2019. The year-over-year variances for these months is displayed in [Figure 28](#).

⁶⁷ FHWA, “NYSDOT New York Works Accelerated Bridge Program.”

⁶⁸ FHWA Center for Innovative Finance Support, “State Transportation Revenue Commission.”

Figure 28: Net Taxable Gallons of Motor Fuel, March-May 2019 and 2020



Source: Ohio Department of Taxation Motor Fuel Reports, FY2019 and FY2020

While it is commendable that ODOT has strived to move away from bonding for basic preservation in recent years, if the fuel tax increase is, in fact, what enabled the Department to do so, a decline in fuel tax revenues may jeopardize this goal. It is recommended that ODOT maintain its commitment to reserve bonding for projects with a long useful life in alignment with best practices.

10. Require debt affordability studies to gauge when ODOT can afford to take on new debt prior to pursuing new bond issuances

Benefit:

- Ensures that any new debt incurred can be supported and serviced
- Supports strong bond ratings, which reduce the cost of borrowing

Debt affordability studies are data-driven analyses that equip states with the ability to manage debt in a way that aligns with their resources as well as their spending priorities by evaluating the impact of potential issuances on self-imposed debt caps. According to a study by the Pew Charitable Trusts (Pew), although all states employ some measures to track their debt, 23 states – including Ohio – do not conduct debt affordability studies.⁶⁹

According to Pew’s analysis of state debt affordability studies, best-practice states:

- Evaluate their debt affordability using metrics, benchmarks and multi-year projections under several scenarios.
- Define a purpose for the affordability study and include all relevant debt. The purpose should reflect the state’s debt issuance structure.
- Require that debt affordability studies be conducted and make clear their purpose, use and who will prepare them. Spell out a timetable so the report is released as the

⁶⁹ The Pew Charitable Trusts, “Strategies for Managing State Debt,” (June 2017).

governor is putting together capital and operating budget proposals to submit to the legislature.

An example of a best practice state, North Carolina uses an interesting approach: Its study separately assesses (a) debt supported by general funds and (b) borrowing backed by transportation revenue, and then combines the results of the two evaluations. This allows its legislature to focus in on liabilities of particular purpose (e.g., transportation debt) while also taking a broader view of its long-term obligations.⁷⁰

11. Clarify in ODOT's bond policy⁷¹ that its GARVEE bond program's capacity is based on future estimated funds

Benefit:

- Taking the future trend of federal funds into consideration reflects the availability of pledged revenues in the future, conservatively factoring in the risk that anticipated fund growth may not materialize.

The availability of future, pledged revenues affects debt repayments. Accordingly, sound financial management strategy suggests the need to consider future federal funds availability when considering whether debt can be supported. Forecasting future federal funds is challenging and might be considered an aggressive approach. However, if the anticipated funds growth does not materialize, or decreases, then that risk will be factored in anyway.

The following provision of ODOT's current bond policy appears to suggest that its GARVEE program's limitation is based on historical federal funds:

- "This stipulation was further changed with the Series 2012-1 bonds such that additional debt service charges could not exceed twenty percent (20%) of the highest annual amount of Obligation Authority distributed during any of the three most recently completed FFY immediately previous to the date of such issuance and delivery."

A separate provision within the same policy seems to conflict, implying instead that capacity is based on future estimated funds:

- "Due to the relative difficulty in forecasting future Federal-aid receipts from year to year, the forecasts prepared by the Division of Finance will base the calculation on ODOT's estimated total annual Federal-aid Highway Obligation Authority."

12. Petition the Ohio legislature to remove the requirement for biennial legislative approval of pledged revenue for GARVEE debt service payments.

Benefit:

- Potentially increase credit ratings, thereby reducing the cost of borrowing

⁷⁰ North Carolina Department of State Treasurer, "Debt Affordability Study," (February 1, 2020).

⁷¹ Ohio Department of Transportation, "State Highway Capital Improvement Bond and Grant Anticipation Revenue Vehicles Bond Policy (effective April 17,2015).

According to the State constitution, the Ohio legislature must approve biennial appropriations of state's FHWA funds – the source of pledged revenue – for GARVEE debt service payments. While this has not historically been an issue in practice, as there has been no delay in appropriation, the requirement itself has been cited as a credit challenge by ratings agencies. In 2018, for example, Moody's Investors Service indicated that the removal of this requirement could lead to an upgrade, and that the failure to provide timely appropriation to allow for payment of debt service could lead to a downgrade.⁷² In alignment with this analysis, Fitch Ratings has stated that "In instances where state appropriation policies may affect the distribution of federally received funds, standalone GARVEE ratings are capped below the state rating to reflect appropriation risk."⁷³

Such ratings changes have been observed in other states. In May 2020, for example, Fitch Ratings downgraded the New Jersey Transportation Trust Fund Authority (NJTTFA)'s outstanding federal highway reimbursement revenue notes from A- to BBB+ in part due to this issue, stating, "As with other similarly structured GARVEE transactions, the financial resources of the NJTTFA are limited to the discretion of the NJDOT to appropriate revenue to the trustee for debt service, which increases bondholder vulnerability should the HTF experience future gaps or delays in funding...Though it is highly unlikely federal-aid transportation funds would be appropriated for other uses, the legal ability to do so is still factored in to GARVEE ratings."⁷⁴

13. *Prioritize the use of bridge program funds for maintenance, repair and rehabilitation needs versus inspection*

Benefit:

- Focus bridge investment funding on activities that retaining or improve asset value rather than assess asset condition

According to ODOT representatives, bridge inspection activities are funded from bridge program dollars. While allowable, this approach decreases the amount of funds that could be spent on bridge maintenance, repair and rehabilitation needs. It is recommended that other funding sources be used for these activities.

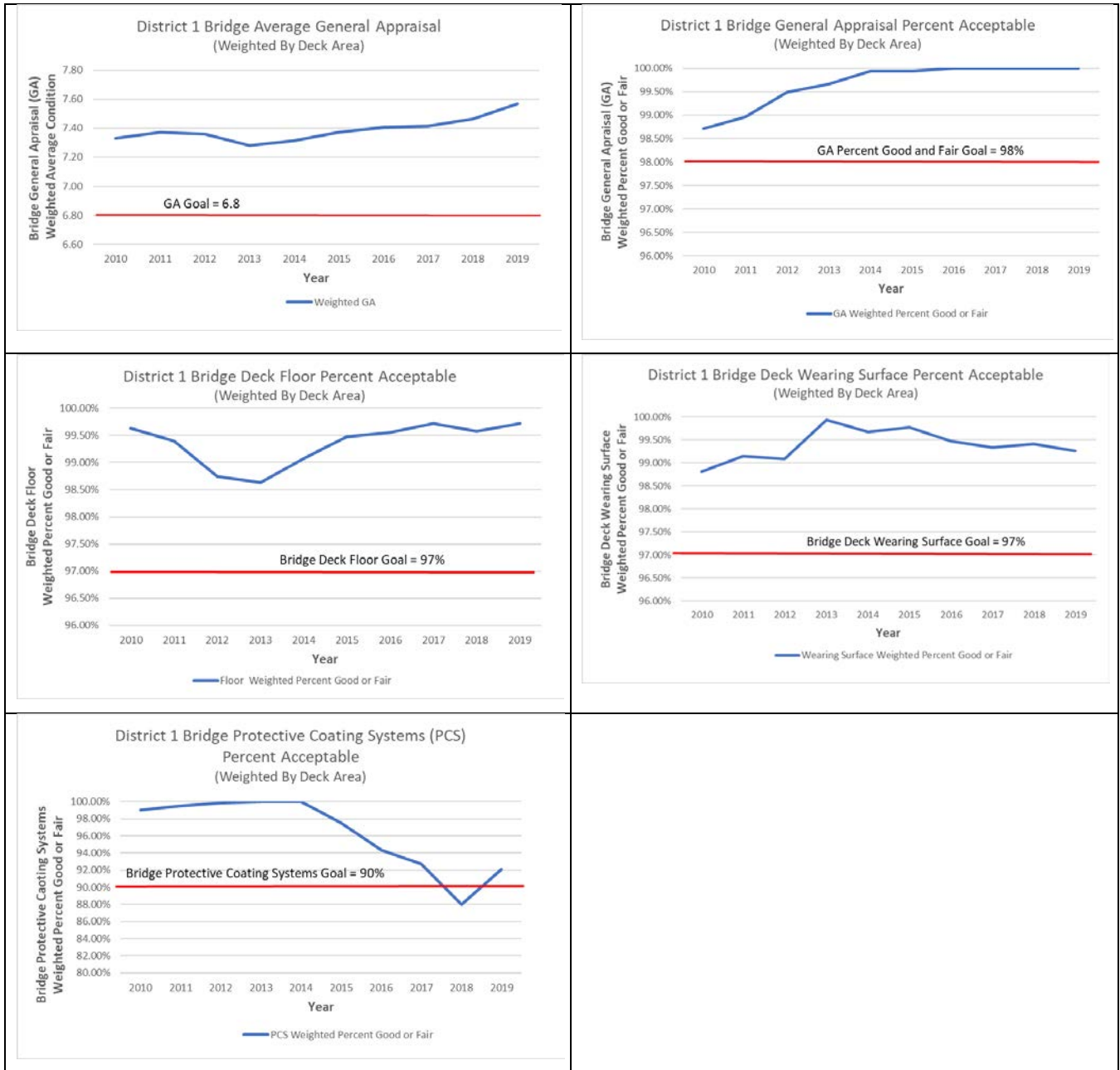
⁷² Moody's Investors Service, "Ohio DOT Fed. Grant Anticipation Program: Update to Credit Analysis," (March 12, 2018).

⁷³ Fitch Ratings, "Fitch Affirms U.S. Municipal Standalone GARVEE Ratings," (May 28, 2020).

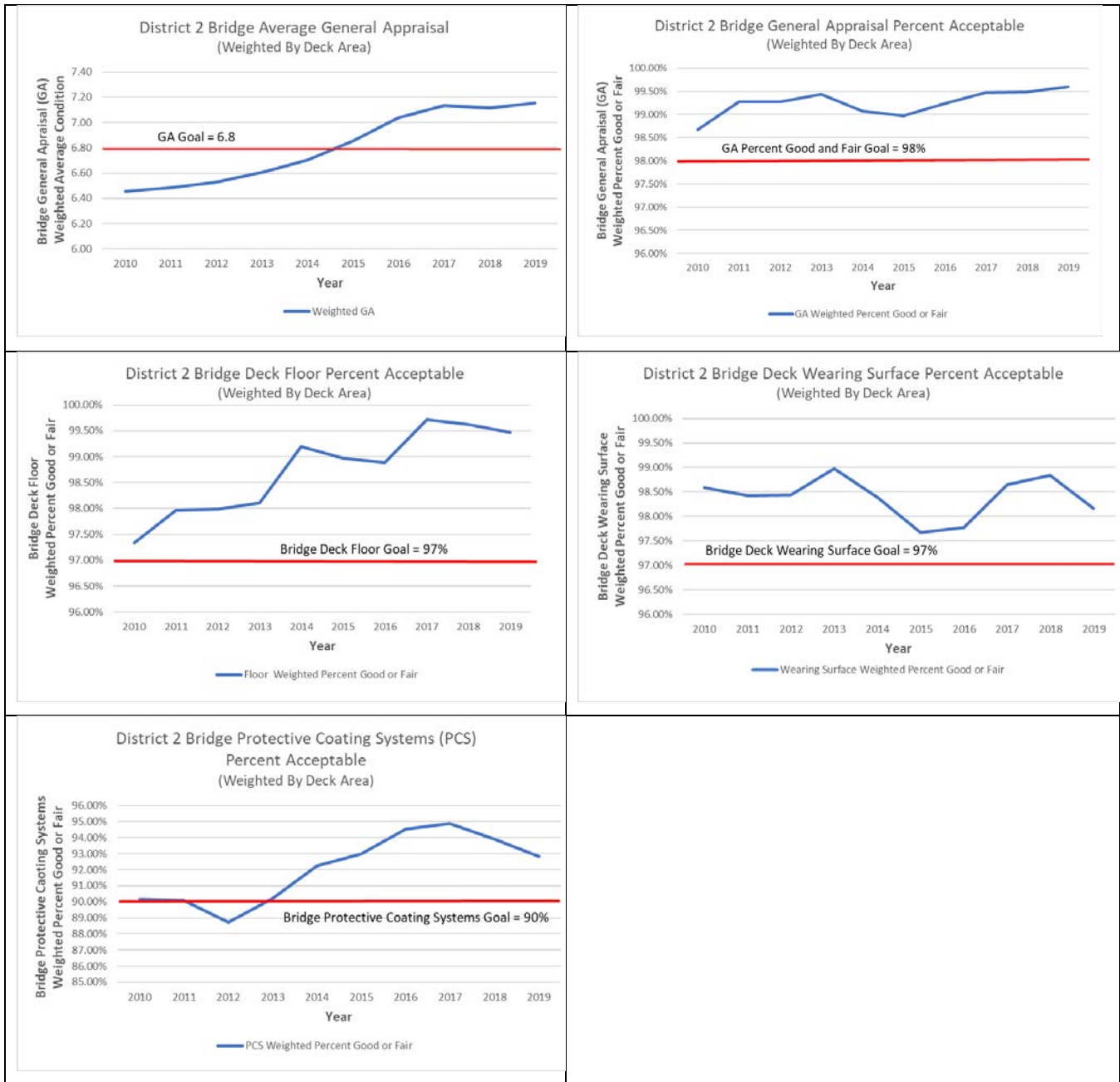
⁷⁴ Fitch Ratings, "Fitch Downgrades NJTTFA's Outstanding GARVEE Bonds to 'BBB+'; Outlook Negative," (May 22, 2020).

Appendix A - ODOT District bridge Performance Measure Ten-Year Trends

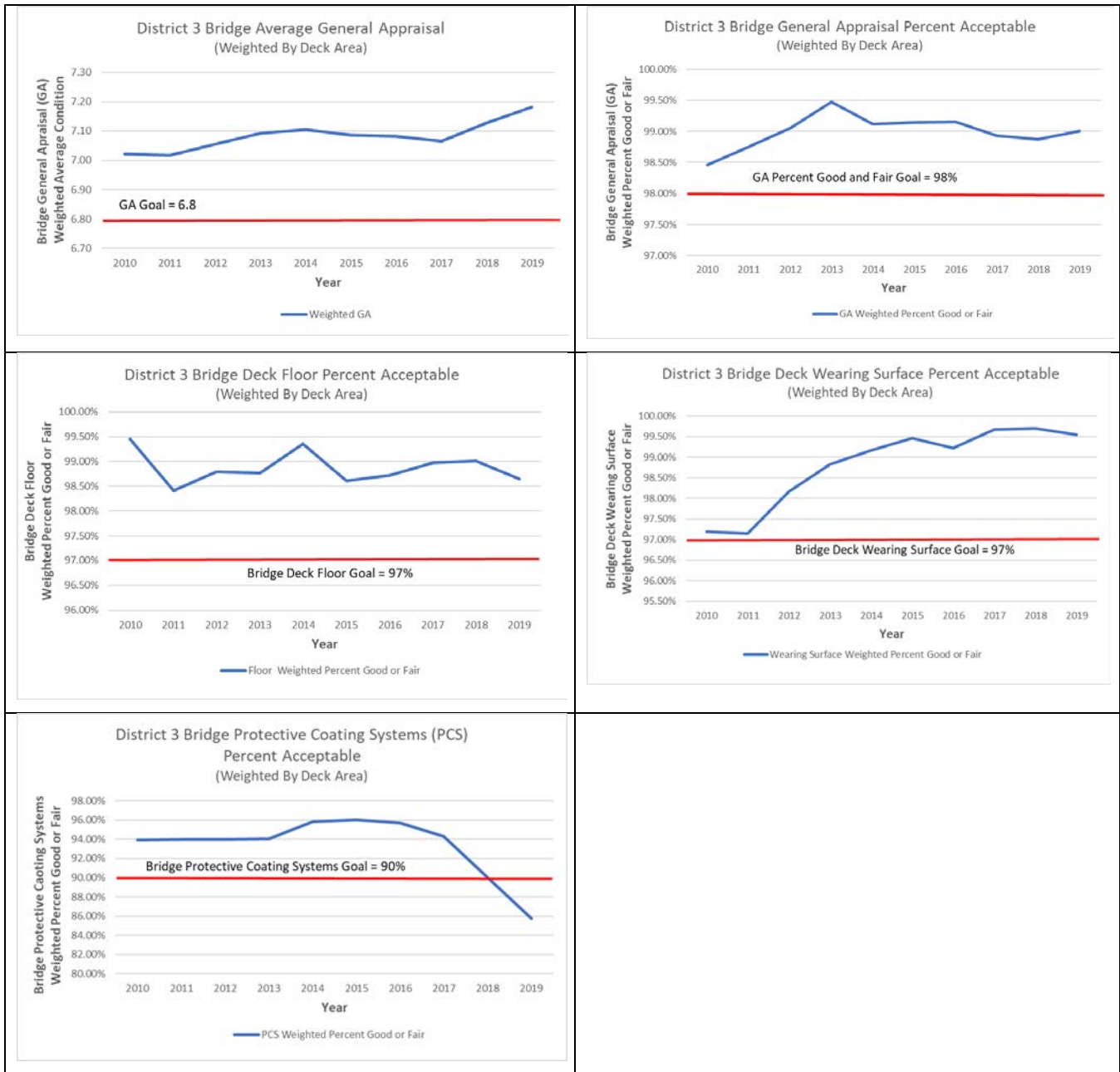
District 1



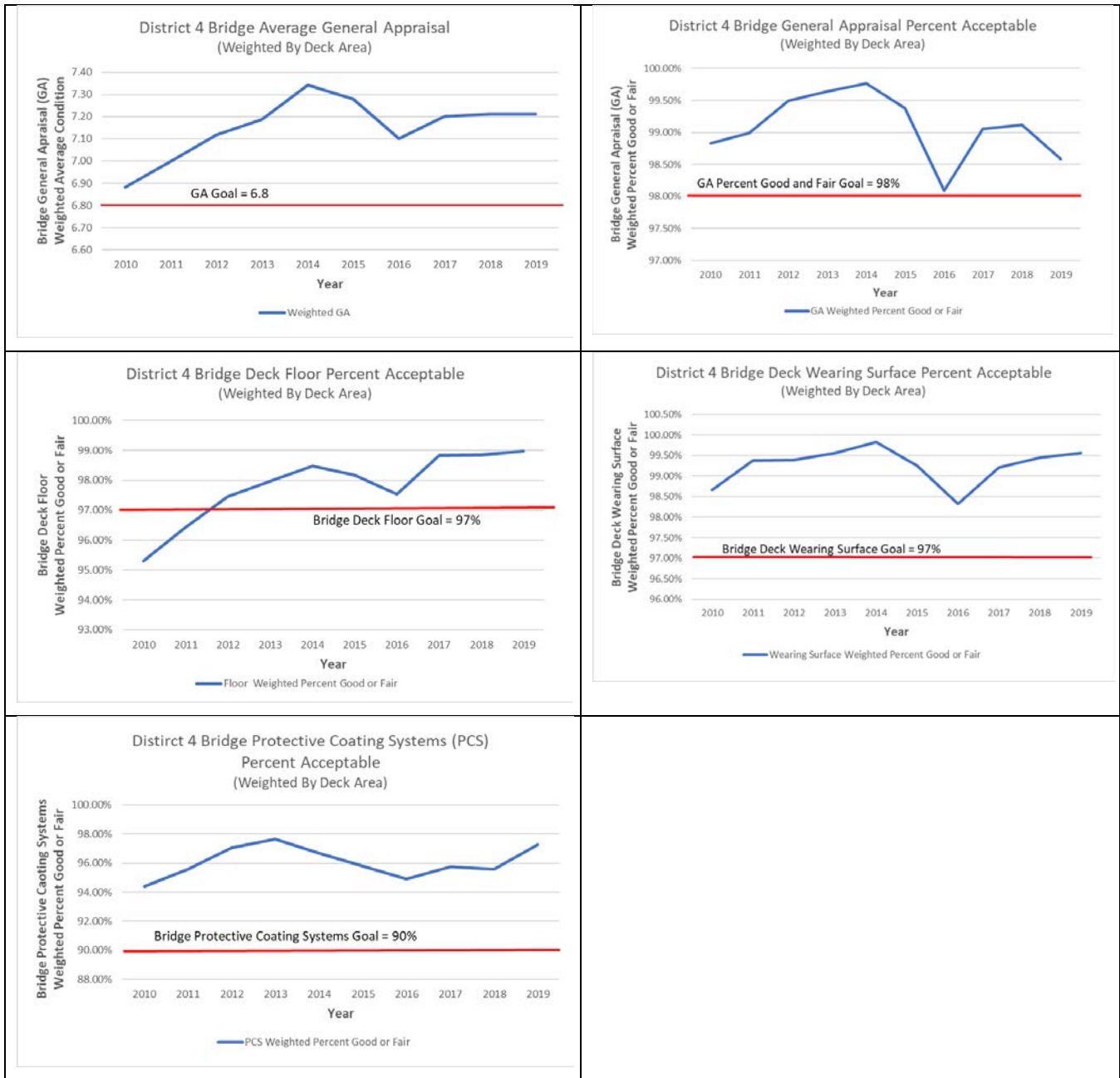
District 2



District 3



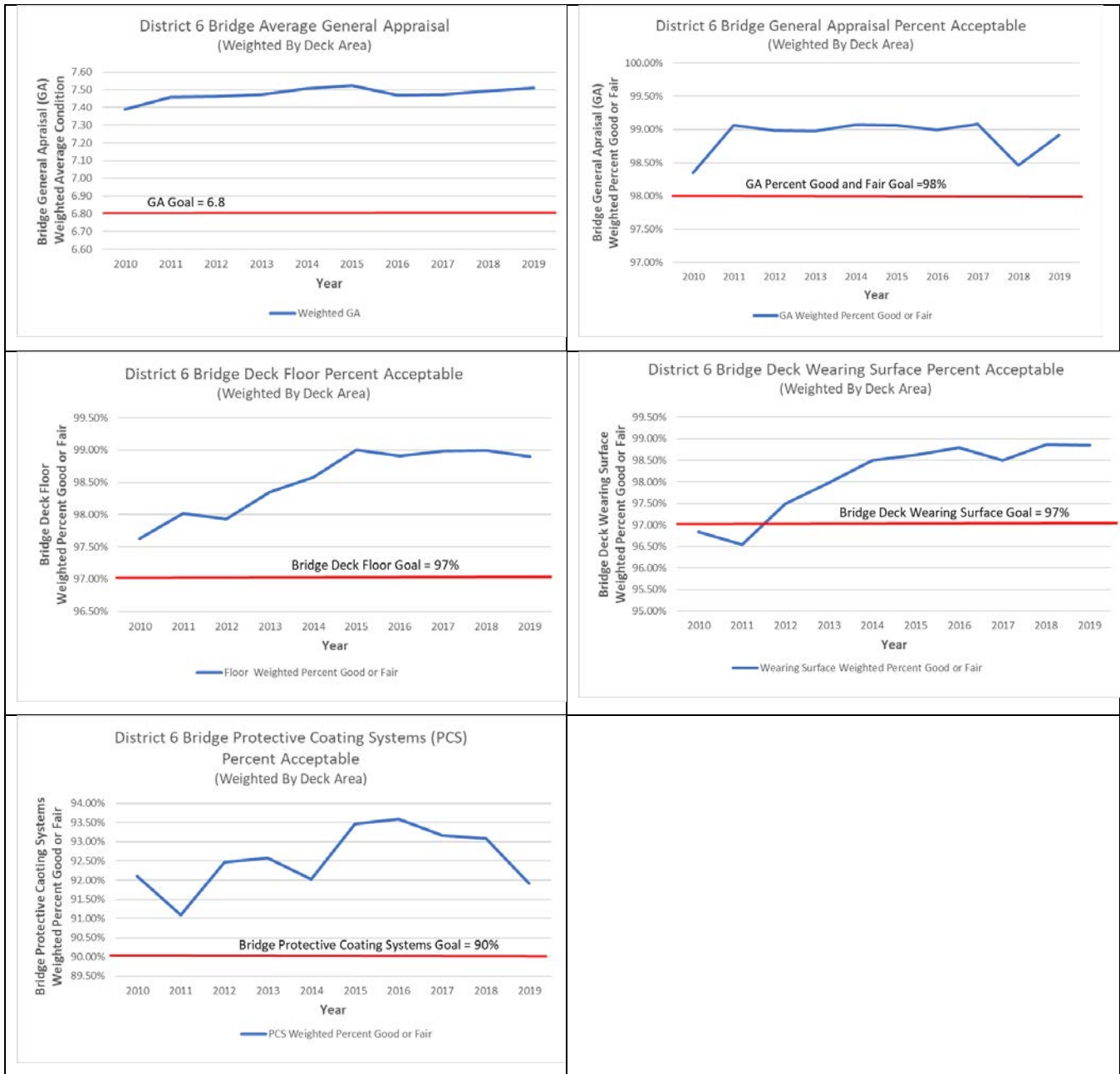
District 4



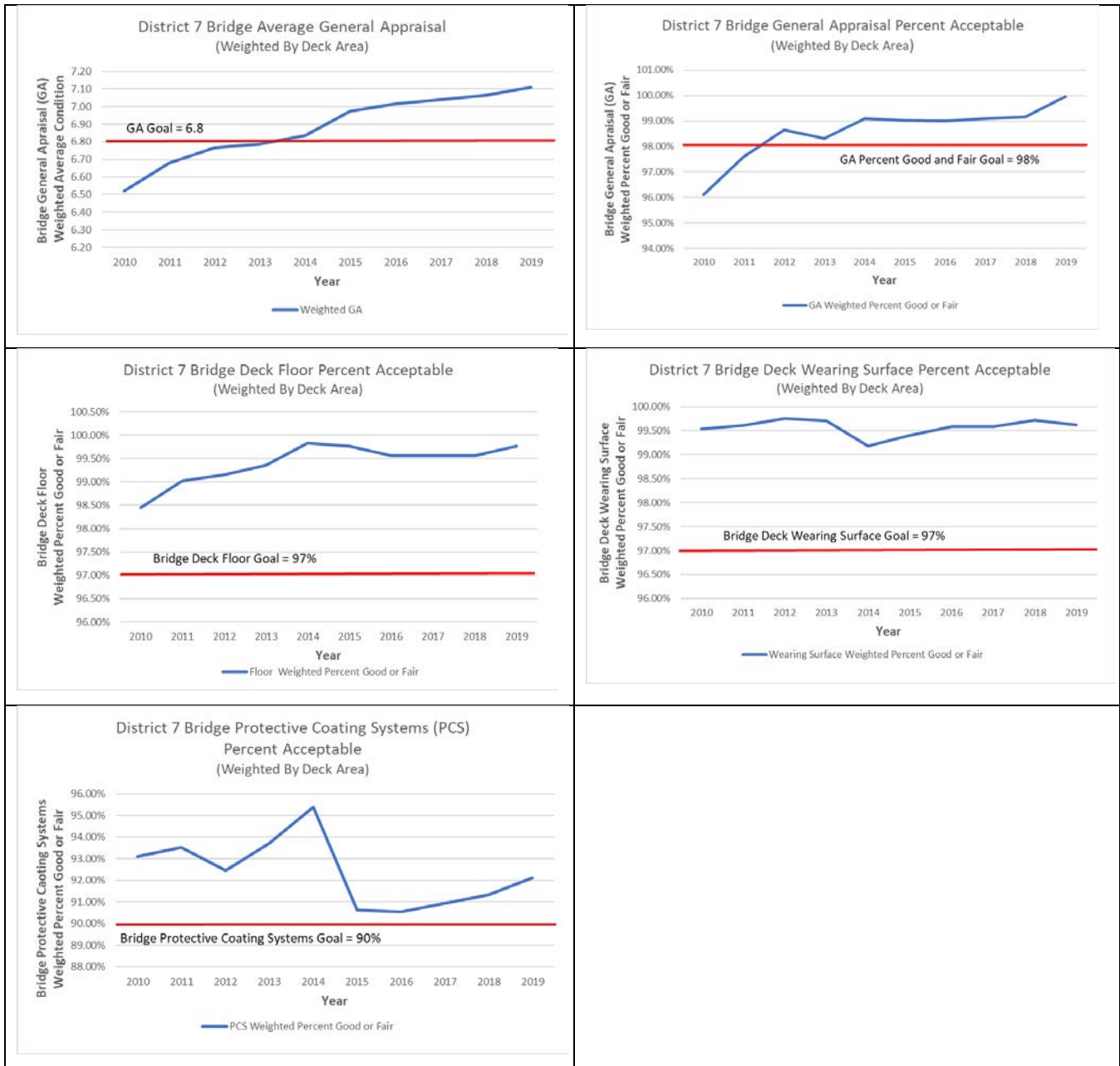
District 5



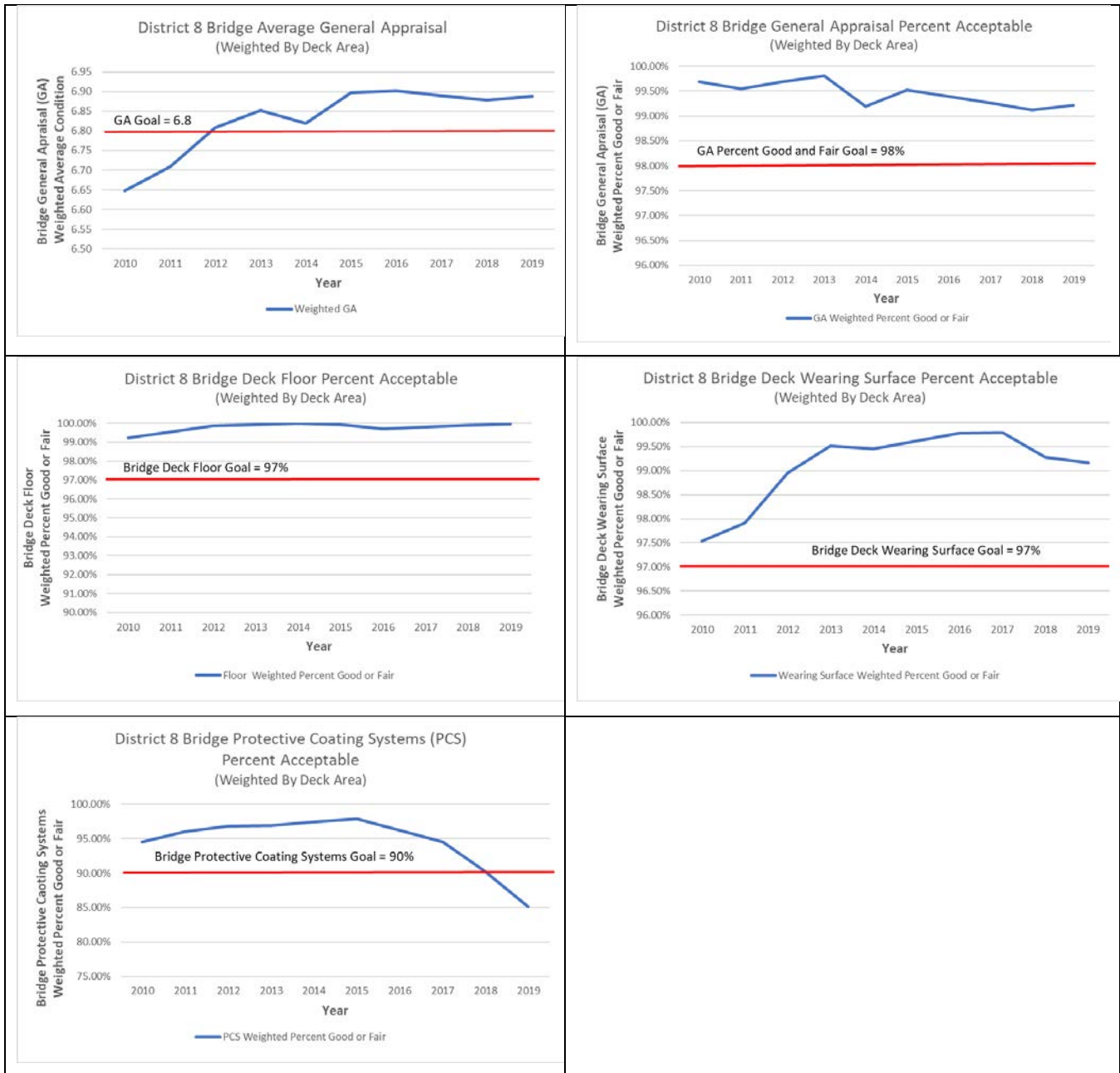
District 6



District 7



District 8



District 9



District 10



District 11



District 12

